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Processing of the JEFF-3.1 Cross Section Library into a Continuous Energy Monte Carlo Radiation Transport and Criticality Data Library

OECD NEA Data Bank

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For the Data Bank

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1. Introduction: Report contents

The source of the evaluated nuclear data is JEFF-3.1 [JEFF-3.1] being one the most recent released evaluated nuclear data libraries. The library comprises 381 materials and some thermal scattering evaluations.

The processing code system to be used is NJOY99 [NJOY-99] and in particular the ACER module.

It is a multi-temperature ACE-format neutron library for a wide range of up to ten temperatures depending on the application needs: 300, 400, 500, 600, 700, 800, 900, 1000,1200 and 1800 degrees Kelvin.

The processed data also contains production and gas production data whenever such data are contained in JEFF-3.1. Kinematic KERMA factors and total damage energy production data are processed.

The nuclides to be processed are all those of the General Purpose Library and Thermal Scattering Library, including important light nuclei, the structural materials, the fission products, control rod materials and burnable poisons, all major and minor actinides.

Some patches to the processing code NJOY are needed, and they are provided together with the library and the documentation. The inputs used for the processing are also included.

The library at 300K has been verified: visually (no discontinuities, correct processing in all range) and with comparisons with other libraries available for the same purposes (ENDF/B-VI.8, JEF2.2, JENDL3.3, …)

A set of experiments using MCNP4c [MCNP4c] are used in order to validate the processed library.

2. Processing evaluated nuclear data to ACE format.

NJOY is a modular computer code used for converting evaluated nuclear data in the ENDF format into different types of libraries useful for applications calculations.

The JEFF-3.1 evaluated nuclear data file has been processed using the NJOY-99.90 modular code system with some additional updates. The patch up90 was not able to process the whole JEFF-3.1 library.

The processing sequence for generating the ACE-formatted library suitable for use by the MCNP4c code is shown below.

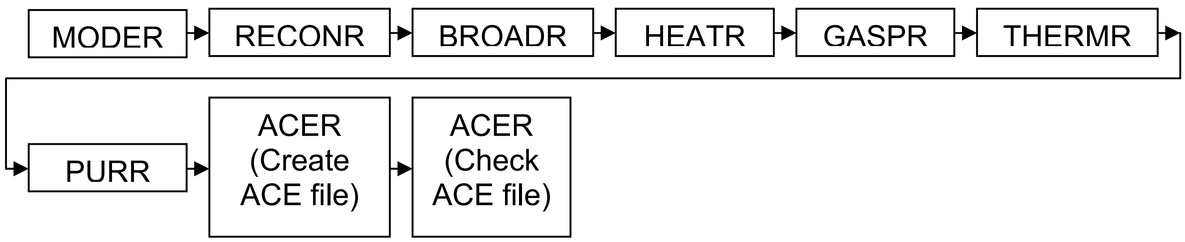

Figure 2.1. NJOY processing sequence for an ACE-format neutron library

The list of NJOY modules can be described by:

- **MODER**: Converts between ENDF/B standard coded mode and the NJOY blocked binary mode
- **RECONR**: Reconstructs pointwise cross sections from ENDF resonance parameters and interpolation schemes
- **BROADR**: Doppler-broadens and thins pointwise cross sections
- **HEATR**: Generates pointwise heat production cross section (KERMA factors) and radiation damage production cross sections
- **GASPR**: Adds gas production to PENDF
- **THERMR**: Generates neutron scattering cross sections and point-to-point scattering kernels in the thermal range for free or bound atoms
- **PURR**: Prepares unresolved region probability tables for the MCNP continuous energy Monte Carlo code
- **ACER**: Prepares libraries in ACE format for the Los Alamos continuous energy Monte Carlo code MCNP

For each material the processing sequence can be divided into two calculations:

- First calculation, to produce point-wise data in ENDF format

- Second calculation, the module ACER generates the ACE formatted file that can be directly used in MCNP calculations. Here, error checking and consistency checks are also performed.

2.1. NJOY inputs to process Cross Section in ACE format

The NJOY processing system is a modular computer code used for processing JEFF-3.1 into ACE format. Each module performs a well-defined processing task. These modules are linked by input and output files (tapes).

We have prepared a reference input file for each material and at a specific temperature. An example of NJOY input is given in Figure 2.2. The complete set of inputs is available through NEA Data Bank.

Figure 2.2. NJOY input used to generate an ACE library for Ac225 (code 8925) at 300K.

```
moder / Extract/convert neutron evaluated data
1 -21
'89-Ac-225 from JEFF3.1'/
20 8925
0/
reconr / Reconstruct XS for neutrons
-21 -22
'JEFF3.1 PENDF for 89-Ac-225'/
8925 2/
0.001 0. 0.003/ err tempr errmax
'JEFF3.1: 89-Ac-225 from JEFF3.1'/
'Processed by NJOY-99.90 at NEA Oct2005'/
0/
broadr / Doppler broaden XS
-21 -22 -23
8925 1 0 0 0./
0.001 2.0e6 0.003/ errthn thnmax errmax
300.
0/
heatr / Add heating kerma and damage energy
-21 -23 -24/
8925 7 0 0 0 2/
302 303 304 318 402 443 444/
gaspr / Add gas production
-21 -24 -25
thermr / Add thermal scattering data
  0 -25 -41
0 8925 12 1 1 0 1 221 1/
300.
0.001 4.0
purr / Process Unresolved Resonance Range if any
-21 -41 -26
8925 1 1 20 100/ matd ntemp nsigz nbin nladr
300.
1.E+10
0/
acer / Prepare ACE files
-21 -26 0 27 28
1 0 1 .31/
'89-Ac-225 from JEFF3.1(JEFF3.1) NJOY 99.90 NEA Oct2005'/
8925 300.
1 1/
/
acer / Check ACE files
0 27 0 29 30
7 1 1 -1/
/
stop
```

2.1.1. NJOY step by step

The ACE files have been processed following the specifications given in Refs. [ANRCP-1999-28, ADS-Lib/V1.0, ALEPH-DLG, ENDF2ACE, LA-UR-02-1235, LA-UR-03-0954, NJOY-99, YUCCA]. We present a summary of the most important processing options used by NJOY in a typical input file (Ac-225 at 300K).

<u>MODER</u>
Convert ENDF "tapes" back and forth between formatted (that is, ASCII, EBCDIC, etc.) and blocked binary modes.

```
moder / Extract/convert neutron evaluated data
1 -21
'89-Ac-225 from JEFF3.1'/
20 8925
0/
```

- Input unit: 20 (tape20, JEFF-3.1 cross section library)
- Material: 8925 (Ac-225)

MODER reads the JEFF-3.1 file (tape20) which contains the material (for Ac-225 the material number is 8925), extract it and put the ENDF file in binary mode in tape21.

<u>RECONR</u>
Reconstruct pointwise (energy-dependent) cross sections from ENDF resonance parameters and interpolation schemes.

```
reconr / Reconstruct XS for neutrons
-21 -22
'JEFF3.1 PENDF for 89-Ac-225'/
8925 2/
0.001 0. 0.003/ err tempr errmax
'JEFF3.1: 89-Ac-225 from JEFF3.1'/
'Processed by NJOY-99.90 at NEA Oct2005'/
0/
```

- Reconstruction tolerance: 0.1%
- Resonance-integral-check tolerance: 0.3%
- Reconstruction temperature: 0.0 K

RECONR read tape21, extract material 8925 and reconstruct cross section at 0K with a reconstruction tolerance of 0.1%. The resulting pointwise cross section is written in tape22.

BROADR

Doppler-broadens and thins pointwise cross sections.

```
broadr / Doppler broaden XS
-21 -22 -23
8925 1 0 0 0./
0.001 2.0e6 0.003/ errthn thnmax errmax
300.
0/
```

- Thinning tolerance: 0.1%
- Integral criterion tolerance: 0.3%
- Maximum energy: Doppler broadening was forced up to the upper energy limit of the resolve resonance range, but never above 2 MeV
- Temperature: 300 K

BROADR reads tape21-tape22 and Doppler-broadens at 300K for material 8925.The tolerance used is 0.1%. The results are written in tape23.

HEATR

Generates pointwise heat production cross sections (KERMA factors) and radiation-damage-production cross sections.

```
heatr / Add heating kerma and damage energy
-21 -23 -24/
8925 7 0 0 0 2/
302 303 304 318 402 443 444/
```

- MT=302: Elastic
- MT=303: Non-elastic
- MT=304: Inelastic
- MT=318: Fission
- MT=402: Capture
- MT=443: Total kinematic kerma
- MT=444: Total damage energy production

HEATR computes energy-balance heating and damage energy for material 8925 at 300K. Input files are tape21-tape23. The output file is tape24.

GASPR

Adds gas production (mt203-207) to PENDF.

```
gaspr / Add gas production
-21 -24 -25
```

GASPR add gas production reactions to PENDF tape24. Output file is tape25

THERMR

Produces cross sections and energy-to-energy matrices for free or bound scatterers in the thermal energy range.

```
thermr / Add thermal scattering data
  0 -25 -41
0 8925 12 1 1 0 1 221 1/ MATDE MATDP NBIN NTEMP IINC ICOH NATOM MTREF IPRINT
300.
0.001 4.0
```

- Number of angles bins: 12
- Tolerance: 0.1%
- Max. energy: 4 eV
- Scattering option: 221 (free gas)
- Temperature: 300 K

THERMR generates neutron scattering cross sections and point-to-point scattering kernels in the thermal range. The input file is only tape25, the output file is tape41. The generation of neutron scattering cross sections concerns for material 8925 with 12 equi-probable angles at 300K. Free gas option is chosen and no elastic cross sections in the thermal range. A tolerance of 0.1% and the maximum energy for thermal treatment is 4 eV.

PURR

Prepares unresolved-region probability tables for the MCNP continuous-energy Monte Carlo code.

```
purr / Process Unresolved Resonance Range if any
-21 -41 -26
8925 1 1 20 100/ matd ntemp nsigz nbin nladr
300.
1.E+10
0/
```

- Number of probability bins: 20
- Number of resonance ladders: 100
- Temperature: 300 K
- Bondarenko σ_0 value: 1.0E+10

PURR calculates probability tables for treating unresolved-resonance self-shielding for Monte Carlo codes. Inputs tape21-tape41, output in tape 26. Calculation performed for material 8925 at 300K with one σ_0 value (1.0E+10, infinite dilute cross section). A total number of 20 probability bins and 100 resonance ladders were selected.

ACER (cross section libraries)
Prepares libraries in ACE format for the Los Alamos continuous-energy Monte Carlo code MCNP.

```
acer / Prepare ACE files
-21 -26 0 27 28
1 0 1 .31/
'89-Ac-225 from JEFF3.1(JEFF3.1) NJOY 99.90 NEA Oct2005'/
8925 300.
1 1/
/
acer / Check ACE files
0 27 0 29 30
7 1 1 -1/
/
```

- Type of ACE file: 1 (ascii)
- ZAID suffix: .31
- No thinning
- Temperature: 300 K

ACER prepares a data library for MCNP (in ASCII). Input files: tape21-26, output files: tape27 (ACE file) and tape28 (XSDIR file). The material processed is 8925 at 300K. The id suffix for this material is .31.

Second ACER module checks previous ACE file and prepares new tape29(ACE file) and tape30(XSDIR file).

2.1.2. JEFF-3.1 ACE library.

The library contains pointwise cross section data files for use in the Monte Carlo code MCNP.

For each material two files were given:

- Cross section data file in the ACE type 1 (ASCII) format: *file.ace*
- Information required by *xsdir* file of MCNP code system: *file.dir*

  These files were rewritten by the UpdXSDIR code [UpdXSDIR] to give the correct ACE filename and to update the route to 0.

Both files were prepared by the ACER module of NJOY-99. Also, probability tables (ptable) have been generated for those materials with unresolved resonance data.

Table 2.1. Information on the JEFF-3.1 ACE library at 300K.

No.	Nuclide	ZAID	PT Tables	ACE filename	XSDIR filename
1	1-H - 1	1001.31c	-	H1.ACE	H1.DIR
2	1-H - 2	1002.31c	-	H2.ACE	H2.DIR
3	1-H - 3	1003.31c	-	H3.ACE	H3.DIR
4	2-He- 3	2003.31c	-	He3.ACE	He3.DIR
5	2-He- 4	2004.31c	-	He4.ACE	He4.DIR
6	3-Li- 6	3006.31c	-	Li6.ACE	Li6.DIR
7	3-Li- 7	3007.31c	-	Li7.ACE	Li7.DIR
8	4-Be- 9	4009.31c	-	Be9.ACE	Be9.DIR
9	5-B - 10	5010.31c	-	B10.ACE	B10.DIR
10	5-B - 11	5011.31c	-	B11.ACE	B11.DIR
11	6-C - 0	6000.31c	-	C0.ACE	C0.DIR
12	7-N - 14	7014.31c	-	N14.ACE	N14.DIR
13	7-N - 15	7015.31c	-	N15.ACE	N15.DIR
14	8-O - 16	8016.31c	-	O16.ACE	O16.DIR
15	8-O - 17	8017.31c	-	O17.ACE	O17.DIR
16	9-F - 19	9019.31c	-	F19.ACE	F19.DIR
17	11-Na- 22	11022.31c	ptable	Na22.ACE	Na22.DIR
18	11-Na- 23	11023.31c	-	Na23.ACE	Na23.DIR
19	12-Mg- 24	12024.31c	-	Mg24.ACE	Mg24.DIR
20	12-Mg- 25	12025.31c	-	Mg25.ACE	Mg25.DIR
21	12-Mg- 26	12026.31c	-	Mg26.ACE	Mg26.DIR
22	13-Al- 27	13027.31c	-	Al27.ACE	Al27.DIR
23	14-Si- 28	14028.31c	-	Si28.ACE	Si28.DIR
24	14-Si- 29	14029.31c	-	Si29.ACE	Si29.DIR
25	14-Si- 30	14030.31c	-	Si30.ACE	Si30.DIR
26	15-P - 31	15031.31c	-	P31.ACE	P31.DIR
27	16-S - 32	16032.31c	-	S32.ACE	S32.DIR
28	16-S - 33	16033.31c	-	S33.ACE	S33.DIR
29	16-S - 34	16034.31c	-	S34.ACE	S34.DIR

30	16-S - 36	16036.31c	-	S36.ACE	S36.DIR
31	17-Cl- 35	17035.31c	-	Cl35.ACE	Cl35.DIR
32	17-Cl- 37	17037.31c	-	Cl37.ACE	Cl37.DIR
33	18-Ar- 36	18036.31c	ptable	Ar36.ACE	Ar36.DIR
34	18-Ar- 38	18038.31c	ptable	Ar38.ACE	Ar38.DIR
35	18-Ar- 40	18040.31c	-	Ar40.ACE	Ar40.DIR
36	19-K - 39	19039.31c	-	K39.ACE	K39.DIR
37	19-K - 40	19040.31c	-	K40.ACE	K40.DIR
38	19-K - 41	19041.31c	-	K41.ACE	K41.DIR
39	20-Ca- 40	20040.31c	-	Ca40.ACE	Ca40.DIR
40	20-Ca- 42	20042.31c	-	Ca42.ACE	Ca42.DIR
41	20-Ca- 43	20043.31c	-	Ca43.ACE	Ca43.DIR
42	20-Ca- 44	20044.31c	-	Ca44.ACE	Ca44.DIR
43	20-Ca- 46	20046.31c	-	Ca46.ACE	Ca46.DIR
44	20-Ca- 48	20048.31c	-	Ca48.ACE	Ca48.DIR
45	21-Sc- 45	21045.31c	-	Sc45.ACE	Sc45.DIR
46	22-Ti- 46	22046.31c	-	Ti46.ACE	Ti46.DIR
47	22-Ti- 47	22047.31c	-	Ti47.ACE	Ti47.DIR
48	22-Ti- 48	22048.31c	-	Ti48.ACE	Ti48.DIR
49	22-Ti- 49	22049.31c	-	Ti49.ACE	Ti49.DIR
50	22-Ti- 50	22050.31c	-	Ti50.ACE	Ti50.DIR
51	23-V - 0	23000.31c	-	V0.ACE	V0.DIR
52	24-Cr- 50	24050.31c	-	Cr50.ACE	Cr50.DIR
53	24-Cr- 52	24052.31c	-	Cr52.ACE	Cr52.DIR
54	24-Cr- 53	24053.31c	-	Cr53.ACE	Cr53.DIR
55	24-Cr- 54	24054.31c	-	Cr54.ACE	Cr54.DIR
56	25-Mn- 55	25055.31c	-	Mn55.ACE	Mn55.DIR
57	26-Fe- 54	26054.31c	-	Fe54.ACE	Fe54.DIR
58	26-Fe- 56	26056.31c	-	Fe56.ACE	Fe56.DIR
59	26-Fe- 57	26057.31c	-	Fe57.ACE	Fe57.DIR
60	26-Fe- 58	26058.31c	ptable	Fe58.ACE	Fe58.DIR
61	27-Co- 58	27108.31c	-	Co58M.ACE	Co58M.DIR
62	27-Co- 58	27058.31c	-	Co58.ACE	Co58.DIR
63	27-Co- 59	27059.31c	-	Co59.ACE	Co59.DIR
64	28-Ni- 58	28058.31c	-	Ni58.ACE	Ni58.DIR
65	28-Ni- 59	28059.31c	-	Ni59.ACE	Ni59.DIR
66	28-Ni- 60	28060.31c	-	Ni60.ACE	Ni60.DIR
67	28-Ni- 61	28061.31c	-	Ni61.ACE	Ni61.DIR
68	28-Ni- 62	28062.31c	-	Ni62.ACE	Ni62.DIR
69	28-Ni- 64	28064.31c	-	Ni64.ACE	Ni64.DIR
70	29-Cu- 63	29063.31c	-	Cu63.ACE	Cu63.DIR
71	29-Cu- 65	29065.31c	-	Cu65.ACE	Cu65.DIR
72	30-Zn- 0	30000.31c	-	Zn0.ACE	Zn0.DIR
73	31-Ga- 0	31000.31c	-	Ga0.ACE	Ga0.DIR
74	32-Ge- 70	32070.31c	-	Ge70.ACE	Ge70.DIR
75	32-Ge- 72	32072.31c	-	Ge72.ACE	Ge72.DIR
76	32-Ge- 73	32073.31c	-	Ge73.ACE	Ge73.DIR
77	32-Ge- 74	32074.31c	-	Ge74.ACE	Ge74.DIR
78	32-Ge- 76	32076.31c	-	Ge76.ACE	Ge76.DIR
79	33-As- 75	33075.31c	-	As75.ACE	As75.DIR
80	34-Se- 74	34074.31c	-	Se74.ACE	Se74.DIR
81	34-Se- 76	34076.31c	-	Se76.ACE	Se76.DIR

82	34-Se- 77	34077.31c	-	Se77.ACE	Se77.DIR
83	34-Se- 78	34078.31c	-	Se78.ACE	Se78.DIR
84	34-Se- 79	34079.31c	ptable	Se79.ACE	Se79.DIR
85	34-Se- 80	34080.31c	-	Se80.ACE	Se80.DIR
86	34-Se- 82	34082.31c	-	Se82.ACE	Se82.DIR
87	35-Br- 79	35079.31c	-	Br79.ACE	Br79.DIR
88	35-Br- 81	35081.31c	-	Br81.ACE	Br81.DIR
89	36-Kr- 78	36078.31c	-	Kr78.ACE	Kr78.DIR
90	36-Kr- 80	36080.31c	-	Kr80.ACE	Kr80.DIR
91	36-Kr- 82	36082.31c	-	Kr82.ACE	Kr82.DIR
92	36-Kr- 83	36083.31c	-	Kr83.ACE	Kr83.DIR
93	36-Kr- 84	36084.31c	-	Kr84.ACE	Kr84.DIR
94	36-Kr- 85	36085.31c	-	Kr85.ACE	Kr85.DIR
95	36-Kr- 86	36086.31c	-	Kr86.ACE	Kr86.DIR
96	37-Rb- 85	37085.31c	-	Rb85.ACE	Rb85.DIR
97	37-Rb- 86	37086.31c	-	Rb86.ACE	Rb86.DIR
98	37-Rb- 87	37087.31c	-	Rb87.ACE	Rb87.DIR
99	38-Sr- 84	38084.31c	-	Sr84.ACE	Sr84.DIR
100	38-Sr- 86	38086.31c	-	Sr86.ACE	Sr86.DIR
101	38-Sr- 87	38087.31c	-	Sr87.ACE	Sr87.DIR
102	38-Sr- 88	38088.31c	-	Sr88.ACE	Sr88.DIR
103	38-Sr- 89	38089.31c	-	Sr89.ACE	Sr89.DIR
104	38-Sr- 90	38090.31c	-	Sr90.ACE	Sr90.DIR
105	39-Y - 89	39089.31c	-	Y89.ACE	Y89.DIR
106	39-Y - 90	39090.31c	-	Y90.ACE	Y90.DIR
107	39-Y - 91	39091.31c	-	Y91.ACE	Y91.DIR
108	40-Zr- 90	40090.31c	-	Zr90.ACE	Zr90.DIR
109	40-Zr- 91	40091.31c	ptable	Zr91.ACE	Zr91.DIR
110	40-Zr- 92	40092.31c	ptable	Zr92.ACE	Zr92.DIR
111	40-Zr- 93	40093.31c	ptable	Zr93.ACE	Zr93.DIR
112	40-Zr- 94	40094.31c	ptable	Zr94.ACE	Zr94.DIR
113	40-Zr- 95	40095.31c	ptable	Zr95.ACE	Zr95.DIR
114	40-Zr- 96	40096.31c	-	Zr96.ACE	Zr96.DIR
115	41-Nb- 93	41093.31c	-	Nb93.ACE	Nb93.DIR
116	41-Nb- 94	41094.31c	ptable	Nb94.ACE	Nb94.DIR
117	41-Nb- 95	41095.31c	ptable	Nb95.ACE	Nb95.DIR
118	42-Mo- 92	42092.31c	ptable	Mo92.ACE	Mo92.DIR
119	42-Mo- 94	42094.31c	ptable	Mo94.ACE	Mo94.DIR
120	42-Mo- 95	42095.31c	ptable	Mo95.ACE	Mo95.DIR
121	42-Mo- 96	42096.31c	ptable	Mo96.ACE	Mo96.DIR
122	42-Mo- 97	42097.31c	ptable	Mo97.ACE	Mo97.DIR
123	42-Mo- 98	42098.31c	ptable	Mo98.ACE	Mo98.DIR
124	42-Mo- 99	42099.31c	ptable	Mo99.ACE	Mo99.DIR
125	42-Mo-100	42100.31c	ptable	Mo100.ACE	Mo100.DIR
126	43-Tc- 99	43099.31c	ptable	Tc99.ACE	Tc99.DIR
127	44-Ru- 96	44096.31c	-	Ru96.ACE	Ru96.DIR
128	44-Ru- 98	44098.31c	-	Ru98.ACE	Ru98.DIR
129	44-Ru- 99	44099.31c	-	Ru99.ACE	Ru99.DIR
130	44-Ru-100	44100.31c	-	Ru100.ACE	Ru100.DIR
131	44-Ru-101	44101.31c	ptable	Ru101.ACE	Ru101.DIR
132	44-Ru-102	44102.31c	-	Ru102.ACE	Ru102.DIR
133	44-Ru-103	44103.31c	ptable	Ru103.ACE	Ru103.DIR

134	44-Ru-104	44104.31c	-	Ru104.ACE	Ru104.DIR
135	44-Ru-105	44105.31c	-	Ru105.ACE	Ru105.DIR
136	44-Ru-106	44106.31c	-	Ru106.ACE	Ru106.DIR
137	45-Rh-103	45103.31c	-	Rh103.ACE	Rh103.DIR
138	45-Rh-105	45105.31c	-	Rh105.ACE	Rh105.DIR
139	46-Pd-102	46102.31c	-	Pd102.ACE	Pd102.DIR
140	46-Pd-104	46104.31c	ptable	Pd104.ACE	Pd104.DIR
141	46-Pd-105	46105.31c	ptable	Pd105.ACE	Pd105.DIR
142	46-Pd-106	46106.31c	ptable	Pd106.ACE	Pd106.DIR
143	46-Pd-107	46107.31c	ptable	Pd107.ACE	Pd107.DIR
144	46-Pd-108	46108.31c	ptable	Pd108.ACE	Pd108.DIR
145	46-Pd-110	46110.31c	ptable	Pd110.ACE	Pd110.DIR
146	47-Ag-107	47107.31c	-	Ag107.ACE	Ag107.DIR
147	47-Ag-109	47109.31c	ptable	Ag109.ACE	Ag109.DIR
148	47-Ag-110	47160.31c	ptable	Ag110M.ACE	Ag110M.DIR
149	47-Ag-111	47111.31c	-	Ag111.ACE	Ag111.DIR
150	48-Cd-106	48106.31c	ptable	Cd106.ACE	Cd106.DIR
151	48-Cd-108	48108.31c	ptable	Cd108.ACE	Cd108.DIR
152	48-Cd-110	48110.31c	ptable	Cd110.ACE	Cd110.DIR
153	48-Cd-111	48111.31c	-	Cd111.ACE	Cd111.DIR
154	48-Cd-112	48112.31c	ptable	Cd112.ACE	Cd112.DIR
155	48-Cd-113	48113.31c	-	Cd113.ACE	Cd113.DIR
156	48-Cd-114	48114.31c	ptable	Cd114.ACE	Cd114.DIR
157	48-Cd-115	48165.31c	-	Cd115M.ACE	Cd115M.DIR
158	48-Cd-116	48116.31c	ptable	Cd116.ACE	Cd116.DIR
159	49-In-113	49113.31c	ptable	In113.ACE	In113.DIR
160	49-In-115	49115.31c	ptable	In115.ACE	In115.DIR
161	50-Sn-112	50112.31c	ptable	Sn112.ACE	Sn112.DIR
162	50-Sn-114	50114.31c	ptable	Sn114.ACE	Sn114.DIR
163	50-Sn-115	50115.31c	ptable	Sn115.ACE	Sn115.DIR
164	50-Sn-116	50116.31c	ptable	Sn116.ACE	Sn116.DIR
165	50-Sn-117	50117.31c	ptable	Sn117.ACE	Sn117.DIR
166	50-Sn-118	50118.31c	ptable	Sn118.ACE	Sn118.DIR
167	50-Sn-119	50119.31c	ptable	Sn119.ACE	Sn119.DIR
168	50-Sn-120	50120.31c	ptable	Sn120.ACE	Sn120.DIR
169	50-Sn-122	50122.31c	ptable	Sn122.ACE	Sn122.DIR
170	50-Sn-123	50123.31c	-	Sn123.ACE	Sn123.DIR
171	50-Sn-124	50124.31c	ptable	Sn124.ACE	Sn124.DIR
172	50-Sn-125	50125.31c	-	Sn125.ACE	Sn125.DIR
173	50-Sn-126	50126.31c	-	Sn126.ACE	Sn126.DIR
174	51-Sb-121	51121.31c	ptable	Sb121.ACE	Sb121.DIR
175	51-Sb-123	51123.31c	ptable	Sb123.ACE	Sb123.DIR
176	51-Sb-124	51124.31c	-	Sb124.ACE	Sb124.DIR
177	51-Sb-125	51125.31c	-	Sb125.ACE	Sb125.DIR
178	51-Sb-126	51126.31c	-	Sb126.ACE	Sb126.DIR
179	52-Te-120	52120.31c	-	Te120.ACE	Te120.DIR
180	52-Te-122	52122.31c	-	Te122.ACE	Te122.DIR
181	52-Te-123	52123.31c	-	Te123.ACE	Te123.DIR
182	52-Te-124	52124.31c	-	Te124.ACE	Te124.DIR
183	52-Te-125	52125.31c	-	Te125.ACE	Te125.DIR
184	52-Te-126	52126.31c	-	Te126.ACE	Te126.DIR
185	52-Te-127	52177.31c	-	Te127M.ACE	Te127M.DIR

186	52-Te-128	52128.31c	-	Te128.ACE	Te128.DIR
187	52-Te-129	52179.31c	-	Te129M.ACE	Te129M.DIR
188	52-Te-130	52130.31c	-	Te130.ACE	Te130.DIR
189	52-Te-132	52132.31c	-	Te132.ACE	Te132.DIR
190	53-I -127	53127.31c	-	I127.ACE	I127.DIR
191	53-I -129	53129.31c	-	I129.ACE	I129.DIR
192	53-I -130	53130.31c	-	I130.ACE	I130.DIR
193	53-I -131	53131.31c	-	I131.ACE	I131.DIR
194	53-I -135	53135.31c	-	I135.ACE	I135.DIR
195	54-Xe-124	54124.31c	-	Xe124.ACE	Xe124.DIR
196	54-Xe-126	54126.31c	-	Xe126.ACE	Xe126.DIR
197	54-Xe-128	54128.31c	-	Xe128.ACE	Xe128.DIR
198	54-Xe-129	54129.31c	-	Xe129.ACE	Xe129.DIR
199	54-Xe-130	54130.31c	-	Xe130.ACE	Xe130.DIR
200	54-Xe-131	54131.31c	-	Xe131.ACE	Xe131.DIR
201	54-Xe-132	54132.31c	-	Xe132.ACE	Xe132.DIR
202	54-Xe-133	54133.31c	-	Xe133.ACE	Xe133.DIR
203	54-Xe-134	54134.31c	-	Xe134.ACE	Xe134.DIR
204	54-Xe-135	54135.31c	-	Xe135.ACE	Xe135.DIR
205	54-Xe-136	54136.31c	-	Xe136.ACE	Xe136.DIR
206	55-Cs-133	55133.31c	ptable	Cs133.ACE	Cs133.DIR
207	55-Cs-134	55134.31c	-	Cs134.ACE	Cs134.DIR
208	55-Cs-135	55135.31c	ptable	Cs135.ACE	Cs135.DIR
209	55-Cs-136	55136.31c	-	Cs136.ACE	Cs136.DIR
210	55-Cs-137	55137.31c	ptable	Cs137.ACE	Cs137.DIR
211	56-Ba-130	56130.31c	ptable	Ba130.ACE	Ba130.DIR
212	56-Ba-132	56132.31c	ptable	Ba132.ACE	Ba132.DIR
213	56-Ba-134	56134.31c	ptable	Ba134.ACE	Ba134.DIR
214	56-Ba-135	56135.31c	ptable	Ba135.ACE	Ba135.DIR
215	56-Ba-136	56136.31c	ptable	Ba136.ACE	Ba136.DIR
216	56-Ba-137	56137.31c	ptable	Ba137.ACE	Ba137.DIR
217	56-Ba-138	56138.31c	-	Ba138.ACE	Ba138.DIR
218	56-Ba-140	56140.31c	ptable	Ba140.ACE	Ba140.DIR
219	57-La-138	57138.31c	ptable	La138.ACE	La138.DIR
220	57-La-139	57139.31c	ptable	La139.ACE	La139.DIR
221	57-La-140	57140.31c	-	La140.ACE	La140.DIR
222	58-Ce-140	58140.31c	-	Ce140.ACE	Ce140.DIR
223	58-Ce-141	58141.31c	ptable	Ce141.ACE	Ce141.DIR
224	58-Ce-142	58142.31c	ptable	Ce142.ACE	Ce142.DIR
225	58-Ce-143	58143.31c	-	Ce143.ACE	Ce143.DIR
226	58-Ce-144	58144.31c	ptable	Ce144.ACE	Ce144.DIR
227	59-Pr-141	59141.31c	ptable	Pr141.ACE	Pr141.DIR
228	59-Pr-142	59142.31c	-	Pr142.ACE	Pr142.DIR
229	59-Pr-143	59143.31c	-	Pr143.ACE	Pr143.DIR
230	60-Nd-142	60142.31c	-	Nd142.ACE	Nd142.DIR
231	60-Nd-143	60143.31c	ptable	Nd143.ACE	Nd143.DIR
232	60-Nd-144	60144.31c	ptable	Nd144.ACE	Nd144.DIR
233	60-Nd-145	60145.31c	ptable	Nd145.ACE	Nd145.DIR
234	60-Nd-146	60146.31c	ptable	Nd146.ACE	Nd146.DIR
235	60-Nd-147	60147.31c	-	Nd147.ACE	Nd147.DIR
236	60-Nd-148	60148.31c	ptable	Nd148.ACE	Nd148.DIR
237	60-Nd-150	60150.31c	-	Nd150.ACE	Nd150.DIR

238	61-Pm-147	61147.31c	ptable	Pm147.ACE	Pm147.DIR
239	61-Pm-148	61198.31c	-	Pm148M.ACE	Pm148M.DIR
240	61-Pm-148	61148.31c	-	Pm148.ACE	Pm148.DIR
241	61-Pm-149	61149.31c	-	Pm149.ACE	Pm149.DIR
242	61-Pm-151	61151.31c	-	Pm151.ACE	Pm151.DIR
243	62-Sm-144	62144.31c	-	Sm144.ACE	Sm144.DIR
244	62-Sm-147	62147.31c	ptable	Sm147.ACE	Sm147.DIR
245	62-Sm-148	62148.31c	-	Sm148.ACE	Sm148.DIR
246	62-Sm-149	62149.31c	ptable	Sm149.ACE	Sm149.DIR
247	62-Sm-150	62150.31c	-	Sm150.ACE	Sm150.DIR
248	62-Sm-151	62151.31c	ptable	Sm151.ACE	Sm151.DIR
249	62-Sm-152	62152.31c	ptable	Sm152.ACE	Sm152.DIR
250	62-Sm-153	62153.31c	-	Sm153.ACE	Sm153.DIR
251	62-Sm-154	62154.31c	-	Sm154.ACE	Sm154.DIR
252	63-Eu-151	63151.31c	ptable	Eu151.ACE	Eu151.DIR
253	63-Eu-152	63152.31c	ptable	Eu152.ACE	Eu152.DIR
254	63-Eu-153	63153.31c	ptable	Eu153.ACE	Eu153.DIR
255	63-Eu-154	63154.31c	ptable	Eu154.ACE	Eu154.DIR
256	63-Eu-155	63155.31c	ptable	Eu155.ACE	Eu155.DIR
257	63-Eu-156	63156.31c	-	Eu156.ACE	Eu156.DIR
258	63-Eu-157	63157.31c	-	Eu157.ACE	Eu157.DIR
259	64-Gd-152	64152.31c	ptable	Gd152.ACE	Gd152.DIR
260	64-Gd-154	64154.31c	-	Gd154.ACE	Gd154.DIR
261	64-Gd-155	64155.31c	ptable	Gd155.ACE	Gd155.DIR
262	64-Gd-156	64156.31c	ptable	Gd156.ACE	Gd156.DIR
263	64-Gd-157	64157.31c	-	Gd157.ACE	Gd157.DIR
264	64-Gd-158	64158.31c	-	Gd158.ACE	Gd158.DIR
265	64-Gd-160	64160.31c	-	Gd160.ACE	Gd160.DIR
266	65-Tb-159	65159.31c	ptable	Tb159.ACE	Tb159.DIR
267	65-Tb-160	65160.31c	-	Tb160.ACE	Tb160.DIR
268	66-Dy-160	66160.31c	-	Dy160.ACE	Dy160.DIR
269	66-Dy-161	66161.31c	ptable	Dy161.ACE	Dy161.DIR
270	66-Dy-162	66162.31c	ptable	Dy162.ACE	Dy162.DIR
271	66-Dy-163	66163.31c	-	Dy163.ACE	Dy163.DIR
272	66-Dy-164	66164.31c	ptable	Dy164.ACE	Dy164.DIR
273	67-Ho-165	67165.31c	-	Ho165.ACE	Ho165.DIR
274	68-Er-162	68162.31c	-	Er162.ACE	Er162.DIR
275	68-Er-164	68164.31c	-	Er164.ACE	Er164.DIR
276	68-Er-166	68166.31c	-	Er166.ACE	Er166.DIR
277	68-Er-167	68167.31c	ptable	Er167.ACE	Er167.DIR
278	68-Er-168	68168.31c	-	Er168.ACE	Er168.DIR
279	68-Er-170	68170.31c	-	Er170.ACE	Er170.DIR
280	71-Lu-175	71175.31c	ptable	Lu175.ACE	Lu175.DIR
281	71-Lu-176	71176.31c	ptable	Lu176.ACE	Lu176.DIR
282	72-Hf-174	72174.31c	ptable	Hf174.ACE	Hf174.DIR
283	72-Hf-176	72176.31c	ptable	Hf176.ACE	Hf176.DIR
284	72-Hf-177	72177.31c	ptable	Hf177.ACE	Hf177.DIR
285	72-Hf-178	72178.31c	ptable	Hf178.ACE	Hf178.DIR
286	72-Hf-179	72179.31c	ptable	Hf179.ACE	Hf179.DIR
287	72-Hf-180	72180.31c	ptable	Hf180.ACE	Hf180.DIR
288	73-Ta-181	73181.31c	ptable	Ta181.ACE	Ta181.DIR
289	73-Ta-182	73182.31c	ptable	Ta182.ACE	Ta182.DIR

290	74-W -182	74182.31c	-	W182.ACE	W182.DIR
291	74-W -183	74183.31c	-	W183.ACE	W183.DIR
292	74-W -184	74184.31c	-	W184.ACE	W184.DIR
293	74-W -186	74186.31c	-	W186.ACE	W186.DIR
294	75-Re-185	75185.31c	ptable	Re185.ACE	Re185.DIR
295	75-Re-187	75187.31c	ptable	Re187.ACE	Re187.DIR
296	76-Os- 0	76000.31c	-	Os0.ACE	Os0.DIR
297	77-Ir-191	77191.31c	ptable	Ir191.ACE	Ir191.DIR
298	77-Ir-193	77193.31c	ptable	Ir193.ACE	Ir193.DIR
299	78-Pt- 0	78000.31c	-	Pt0.ACE	Pt0.DIR
300	79-Au-197	79197.31c	-	Au197.ACE	Au197.DIR
301	80-Hg-196	80196.31c	-	Hg196.ACE	Hg196.DIR
302	80-Hg-198	80198.31c	-	Hg198.ACE	Hg198.DIR
303	80-Hg-199	80199.31c	-	Hg199.ACE	Hg199.DIR
304	80-Hg-200	80200.31c	-	Hg200.ACE	Hg200.DIR
305	80-Hg-201	80201.31c	-	Hg201.ACE	Hg201.DIR
306	80-Hg-202	80202.31c	-	Hg202.ACE	Hg202.DIR
307	80-Hg-204	80204.31c	-	Hg204.ACE	Hg204.DIR
308	81-Tl- 0	81000.31c	-	Tl0.ACE	Tl0.DIR
309	82-Pb-204	82204.31c	-	Pb204.ACE	Pb204.DIR
310	82-Pb-206	82206.31c	-	Pb206.ACE	Pb206.DIR
311	82-Pb-207	82207.31c	-	Pb207.ACE	Pb207.DIR
312	82-Pb-208	82208.31c	-	Pb208.ACE	Pb208.DIR
313	83-Bi-209	83209.31c	-	Bi209.ACE	Bi209.DIR
314	88-Ra-223	88223.31c	-	Ra223.ACE	Ra223.DIR
315	88-Ra-224	88224.31c	-	Ra224.ACE	Ra224.DIR
316	88-Ra-225	88225.31c	-	Ra225.ACE	Ra225.DIR
317	88-Ra-226	88226.31c	-	Ra226.ACE	Ra226.DIR
318	89-Ac-225	89225.31c	-	Ac225.ACE	Ac225.DIR
319	89-Ac-226	89226.31c	-	Ac226.ACE	Ac226.DIR
320	89-Ac-227	89227.31c	-	Ac227.ACE	Ac227.DIR
321	90-Th-227	90227.31c	-	Th227.ACE	Th227.DIR
322	90-Th-228	90228.31c	-	Th228.ACE	Th228.DIR
323	90-Th-229	90229.31c	-	Th229.ACE	Th229.DIR
324	90-Th-230	90230.31c	-	Th230.ACE	Th230.DIR
325	90-Th-232	90232.31c	ptable	Th232.ACE	Th232.DIR
326	90-Th-233	90233.31c	-	Th233.ACE	Th233.DIR
327	90-Th-234	90234.31c	-	Th234.ACE	Th234.DIR
328	91-Pa-231	91231.31c	ptable	Pa231.ACE	Pa231.DIR
329	91-Pa-232	91232.31c	-	Pa232.ACE	Pa232.DIR
330	91-Pa-233	91233.31c	ptable	Pa233.ACE	Pa233.DIR
331	92-U -232	92232.31c	ptable	U232.ACE	U232.DIR
332	92-U -233	92233.31c	ptable	U233.ACE	U233.DIR
333	92-U -234	92234.31c	ptable	U234.ACE	U234.DIR
334	92-U -235	92235.31c	ptable	U235.ACE	U235.DIR
335	92-U -236	92236.31c	-	U236.ACE	U236.DIR
336	92-U -237	92237.31c	ptable	U237.ACE	U237.DIR
337	92-U -238	92238.31c	ptable	U238.ACE	U238.DIR
338	93-Np-235	93235.31c	-	Np235.ACE	Np235.DIR
339	93-Np-236	93236.31c	-	Np236.ACE	Np236.DIR
340	93-Np-237	93237.31c	ptable	Np237.ACE	Np237.DIR
341	93-Np-238	93238.31c	ptable	Np238.ACE	Np238.DIR

342	93-Np-239	93239.31c	-	Np239.ACE	Np239.DIR
343	94-Pu-236	94236.31c	ptable	Pu236.ACE	Pu236.DIR
344	94-Pu-237	94237.31c	-	Pu237.ACE	Pu237.DIR
345	94-Pu-238	94238.31c	ptable	Pu238.ACE	Pu238.DIR
346	94-Pu-239	94239.31c	ptable	Pu239.ACE	Pu239.DIR
347	94-Pu-240	94240.31c	ptable	Pu240.ACE	Pu240.DIR
348	94-Pu-241	94241.31c	ptable	Pu241.ACE	Pu241.DIR
349	94-Pu-242	94242.31c	ptable	Pu242.ACE	Pu242.DIR
350	94-Pu-243	94243.31c	ptable	Pu243.ACE	Pu243.DIR
351	94-Pu-244	94244.31c	ptable	Pu244.ACE	Pu244.DIR
352	94-Pu-246	94246.31c	-	Pu246.ACE	Pu246.DIR
353	95-Am-241	95241.31c	ptable	Am241.ACE	Am241.DIR
354	95-Am-242	95242.31c	ptable	Am242G.ACE	Am242G.DIR
355	95-Am-242	95292.31c	ptable	Am242M.ACE	Am242M.DIR
356	95-Am-243	95243.31c	ptable	Am243.ACE	Am243.DIR
357	95-Am-244	95294.31c	-	Am244M.ACE	Am244M.DIR
358	95-Am-244	95244.31c	-	Am244.ACE	Am244.DIR
359	96-Cm-240	96240.31c	ptable	Cm240.ACE	Cm240.DIR
360	96-Cm-241	96241.31c	-	Cm241.ACE	Cm241.DIR
361	96-Cm-242	96242.31c	ptable	Cm242.ACE	Cm242.DIR
362	96-Cm-243	96243.31c	ptable	Cm243.ACE	Cm243.DIR
363	96-Cm-244	96244.31c	ptable	Cm244.ACE	Cm244.DIR
364	96-Cm-245	96245.31c	ptable	Cm245.ACE	Cm245.DIR
365	96-Cm-246	96246.31c	ptable	Cm246.ACE	Cm246.DIR
366	96-Cm-247	96247.31c	ptable	Cm247.ACE	Cm247.DIR
367	96-Cm-248	96248.31c	ptable	Cm248.ACE	Cm248.DIR
368	96-Cm-249	96249.31c	ptable	Cm249.ACE	Cm249.DIR
369	96-Cm-250	96250.31c	ptable	Cm250.ACE	Cm250.DIR
370	97-Bk-247	97247.31c	-	Bk247.ACE	Bk247.DIR
371	97-Bk-249	97249.31c	ptable	Bk249.ACE	Bk249.DIR
372	97-Bk-250	97250.31c	ptable	Bk250.ACE	Bk250.DIR
373	98-Cf-249	98249.31c	ptable	Cf249.ACE	Cf249.DIR
374	98-Cf-250	98250.31c	ptable	Cf250.ACE	Cf250.DIR
375	98-Cf-251	98251.31c	ptable	Cf251.ACE	Cf251.DIR
376	98-Cf-252	98252.31c	ptable	Cf252.ACE	Cf252.DIR
377	98-Cf-254	98254.31c	-	Cf254.ACE	Cf254.DIR
378	99-Es-253	99253.31c	ptable	Es253.ACE	Es253.DIR
379	99-Es-254	99254.31c	-	Es254.ACE	Es254.DIR
380	99-Es-255	99255.31c	-	Es255.ACE	Es255.DIR
381	100-Fm-255	100255.31c	-	Fm255.ACE	Fm255.DIR

These libraries were processed at different temperatures: 300, 400, 500, 600, 700, 800, 900, 1000, 1200 and 1800 degrees Kelvin.

Table 2.2. Multi-temperature ACE library

#	Temperature (K)	ZAID suffix
1	300	.31c
2	400	.32c
3	500	.33c
4	600	.34c
5	700	.35c
6	800	.36c
7	900	.37c
8	1000	.38c
9	1200	.39c
10	1800	.40c

JEFF-3.1 contains some isotopes in ground and isomeric states. These isotopes are processed using the same procedure to obtain *.ace* and *.dir* files. However, the ZAID suffix of isomeric states has been changed (+50 to the ground state).

Table 2.3. Isotopes in isomeric state (library at 300K).

No.	Nuclide	ZAID	PT Tables	ACE filename	XSDIR filename
1	27-Co – 58M	27108.31c	-	Co58M.ACE	Co58M.DIR
2	47-Ag-110M	47160.31c	ptable	Ag110M.ACE	Ag110M.DIR
3	48-Cd-115M	48165.31c	-	Cd115M.ACE	Cd115M.DIR
4	52-Te-127M	52177.31c	-	Te127M.ACE	Te127M.DIR
5	52-Te-129M	52179.31c	-	Te129M.ACE	Te129M.DIR
6	61-Pm-148M	61198.31c	-	Pm148M.ACE	Pm148M.DIR
7	95-Am-242M	95292.31c	ptable	Am242M.ACE	Am242M.DIR
8	95-Am-244M	95294.31c	-	Am244M.ACE	Am244M.DIR

2.2. NJOY inputs to process ACE Thermal Scattering Libraries

Several *Scattering Thermal Libraries* (STL) have been processed using special NJOY inputs. [NDC(NDS)-0470]

Figure 2.3. NJOY input to generate ACE Thermal Scattering library for H bound in CH2.

```
moder / Extract thermal Scattering Law
1 -61
' H-CH2    from JEFF3.1'/
60 37
0/
moder / Extract/convert neutron evaluated data
1 -21
'1-H-1 from JEFF3.1'/
20 125
0/
reconr / Reconstruct XS for neutrons
-21 -22
'JEFF3.1 PENDF for 1-H-1'/
125 2/
0.001 0. 0.003/ err tempr errmax
'JEFF3.1: 1-H-1 from JEFF3.1'/
'Processed by NJOY99.90+NEA Oct2005'/
0/
broadr / Doppler broaden XS
-21 -22 -23
125 1 0 0 0./
0.001 2.0e6 0.003/ errthn thnmax errmax
293.6
0/
thermr / Add thermal scattering data (free gas)
  0 -23 -62
0 125 12 1 1 11 1 221 1/ MATDE MATDP NBIN NTEMP IINC ICOH NATOM MTREF IPRINT
293.6
0.001 5.0
thermr / Add thermal scattering data (bound)
 -61 -62 -27
37 125 16 1 4 11 2 223 1/MATDE MATDP NBIN NTEMP IINC ICOH NATOM MTREF IPRINT
293.6
0.001 5.0
acer / Prepare ACE files
-21 -27 0 28 29
2 0 1 .31/ IOPT IPRINT NTYPE SUFF
'H-CH2   293.6 K from (JEFF3.1) NJOY99.90+NEA Oct2005'/
125 293.6 'poly01' / MATD TEMPD TNAME
 1001    0     0 / IZA01 IZA02 IZA03
 223 64 224  1  1 4.0 0/ MTI NBINT MTE IELAS NMIX EMAX IWT
acer / Check ACE files
0 28 0 71 81
7 1 1 -1/
/
stop
```

ACER (thermal scattering libraries)

```
acer / Prepare ACE files
-21 -27 0 28 29
2 0 1 .31/ IOPT IPRINT NTYPE SUFF
'H-CH2   293.6 K from (JEFF3.1) NJOY99.90+NEA Oct2005'/
125 293.6 'poly01' / MATD TEMPD TNAME
 1001    0    0 / IZA01 IZA02 IZA03
 223 64 224  1  1 4.0 0/ MTI NBINT MTE IELAS NMIX EMAX IWT
acer / Check ACE files
0 28 0 71 81
7 1 1 -1/
/
```

For hydrogen bound in polyethylene:

Type of ACER run option	IOPT:	2 (THERMAL DATA)
Print control	IPRINT:	0 (MINIMUN)
ACE output type	NTYPE:	1
ID suffix for ZAID	SUFF:	.31

Material to be processed	MATD:	125
Temperature desired	NTEMPD:	293.6K
Thermal ZAID name	TNAME:	‘poly01’

MT for thermal incoherent data*	MTI:	223
Number of bins for incoherent scattering+	NBINT:	64
MT for thermal elastic data*	MTE:	224
COHERENT/INCOHERENT ELASTIC	IELAS	0/1
Number of atom types in mixed moderator	NMIX:	2
Max. energy+	EMAX:	4.0 eV
Weight option	IWT:	0/1 VARIABLE/CONSTANT

* MTI and MTE values from Table 3 included in section XVII-22 (ACER module) in NJOY manual.
\+ Private communication, M.Mattes, IKE.

Table 2.4. Temperatures for Thermal Scattering Libraries.

```
*  Beryllium     - Thermal Neutron Scattering Law Data in MF=7   *  26 1451   17
*                  T=293.6 400 500 600 700 800 1000 1200 K       *  26 1451   19

 Graphite  IKE        EVAL-JAN05 Keinert, Mattes                    31 1451    5
* Temperatures (K) = 293.6, 400, 500, 600, 700, 800, 1000,       *  31 1451   17
*                   1200, 1600, 2000, 3000                       *  31 1451   18

 D(D2O)    IKE        EVAL-FEB04 Keinert,Mattes                     11 1451    5
*Temperatures: 293.6 323.6 373.6 423.6 473.6 523.6 573.6 643.9 K *  11 1451   17

 H(ZrH)    IKE        EVAL-JAN05 Keinert                             7 1451    5
 *  TEMPERATURES = 293.6 400 500 600 700 800 1000 1200 DEG K.    *   7 1451   16


 H(H2O)    IKE        EVAL-JAN04 Keinert,Mattes                      1 1451    5
* Temperatures (K)= 293.6  323.6  373.6  423.6  473 .6 523.6     *   1 1451   17
*                   573.6  623.6  647.2  800   1000              *   1 1451   18

*  Polyethylene  - Thermal Neutron Scattering Law Data in MF=7   *  37 1451   22
*  H (CH2)              are given for the temperatures           *  37 1451   23
*                                    T= 293.6 and 350 K          *  37 1451   24
```

To identify these libraries a code is defined for each isotope, see Table 2.5.

To take into account different temperatures in the STLs, the identification code will change according: “lwtrXX.31.t”, where XX=01,02,03, …

Table 2.5. Information on the JEFF-3.1 Thermal Scattering ACE library at 293.6K.

No.	Nuclide	ZAID	ACE filename	XSDIR filename
1	poly01.31t	Hydrogen bound in polyethylene	H1_H-H2O.ace	H1_H-H2O.dir
2	lwtr01.31t	Hydrogen bound in water	H1_H-CH2.ace	H1_H-CH2.dir
3	hzrh01.31t	Hydrogen bound in ZrH	H1_H-ZrH.ace	H1_H-ZrH.dir
4	grph01.31t	Graphite	C_Graphi.ace	C_Graphi.dir
5	hwtr01.31t	D bound in D2O	H2_D-D2O.ace	H2_D-D2O.dir
6	bena01.31t	Be	Be_4-Be-293.6.ace	Be_4-Be-293.6.dir
7	beo01.31t	Be in BeO	Be_BeO.ace	Be_BeO.dir

ACER (thermal scattering libraries)

- For hydrogen bound in polyethylene

```
acer / Prepare ACE files
-21 -27 0 28 29
2 0 1 .31/
'H-CH2   293.6 K from (JEFF3.1) NJOY99.90+NEA Oct2005'/
125 293.6 'poly01' /
 1001    0    0 /
 223 64 224  1  1 4.0 0/
```

- For hydrogen bound in water

```
acer / Prepare ACE files
-21 -27 0 28 29
2 0 1 .31/
'H-H2O   293.6 K from (JEFF3.1) NJOY99.90+NEA Oct2005'/
125 293.6 'lwtr01' /
 1001    0    0 /
 222 64   0  0  1 4.0 0/
```

- For hydrogen bound in ZrH

```
acer / Prepare ACE files
-21 -27 0 28 29
2 0 1 .31/
'H-ZrH   293.6 K from (JEFF3.1) NJOY99.90+NEA Oct2005'/
125 293.6 'hzrh01' /
 1001    0    0 /
 225 64 226  1  1 4.0 0/
```

- Graphite

```
acer / Prepare ACE files
-21 -27 0 28 29
2 0 1 .31/
'Graphi  293.6 K from (JEFF3.1) NJOY99.90+NEA Oct2005'/
600 293.6 'grph01' /
 6000    0    0 /
 229 64 230  0  1 4.0 0/
```

- For D bound in D2O

```
acer / Prepare ACE files
-21 -27 0 28 29
2 0 1 .31/
'D-D2O   293.6 K from (JEFF3.1) NJOY99.90+NEA Oct2005'/
128 293.6 'hwtr01' /
 1002    0    0 /
 228 64   0  0  1 4.0 0/
```

- For Be

```
acer / Prepare ACE files
-21 -27 0 28 29
2 0 1 .31/
'4-Be    293.6 K from (JEFF3.1) NJOY99.90+NEA Oct2005'/
425 293.6 'bena01' /
 4009    0    0 /
 231 64 232  0  1 4.0 0/
```

- For Be in BeO

```
acer / Prepare ACE files
-21 -27 0 28 29
2 0 1 .31/
'4-Be    293.6 K from (JEFF3.1) NJOY99.90+NEA Oct2005'/
425 293.6 'beo01 ' /
 4009 8016    0 /
 233 64 234  0  2 4.0 0/
```

2.3. QA procedure

2.3.1. Checking NJOY ouput messages for each material.

The total number of messages was compiled. All messages were understood, most of them are related to incomplete evaluations.

Figure . Example of NJOY messages for Fe56.

```
                                                                   FE56
-------
 heatr
  ---message from sixbar---no distribution for mt  5 particle **
  ---message from h6ddx---vertical segment(s) in distribution

 purr
  ---message from purr---mat 2631 has no unresolved parameters

 acer checking
  ---message from consis---consistency problems found

----------------------------------------------------
```

(1) RECONR Output messages

- Message – nonpositive elastic cross section.

  Some evaluations use old single-level Breit-Wigner resonance parameters. This representation occasionally goes negative. NJOY fixes this by setting the cross section to a small positive value.

  ---message from emerge---nonpositive elastic cross sections found.

Ar40	Cd111	Cd113	Cm244	Gd157	Ni61
Te128	W182				

- The initial value of a threshold reaction cross section is different from zero. NJOY has corrected this by using a jump in the cross section at the threshold energy.

  ---message from lunion---xsec nonzero at threshold for mt= **XX**

F19	O16	Cl35	Cl37	Na23	Am243
Eu155	Nd150	Pb204			

- This message can be ignored

---message from rdf2bw---calculation of angular distribution not installed

Al27	Cr50	Cr52	Cr53	Cr54	Cu63
Cu65	Fe54	Fe58	I127	I129	Ni58
Ni60	Si28	Tc99	Pb206	Pb207	Pb208

(2) HEATR Output messages

- File 12 (multiplicities for photon production) is missing from the ENDF file.

```
---message from gheat---no file 12 for this material.
   N15
```

-

```
---message from h6ddx---vertical segment(s) in distribution
   Fe56
```

- No angular distribution is given for the secondary mt in the evaluation. HEATR assumes isotropic distribution

```
---message from hinit---mf4 and 6 missing, isotropy assumed for mt =XX
   B10             N14
```

- The energy-angle distribution for the specified particle is missing in file 6. NJOY requires energy distributions for all secondary particles from a reaction to compute the energy deposition. In this case, NJOY has to make an assumption and generate an approximate to the data needed.

```
---message from hinit---mf6, mtXX does not give recoil za=YY

   B11             Be9               Li7               N14
   Tl0            Mn55              Mo92              Mo94
   Mo95           Mo96              Mo97              Mo98
   Si29           Si30              U235              W182
   W183           W184              W186              Zr90
   Zr91           Zr92              Zr94              Zr96
   Mo100         Np237             Sb121             Sb123
```

- In the ENDF format, mt18 (total fission) is the sum of mt19, mt20, mt21 and mt38

```
---message from hinit---mt18 is redundant
   Am242g        Cm241             Cm244             Cm246
   Pu237         Pu244             Th232              U234
```

- The partial contribution to the total fission, mt19, has no spectrum. NJOY will use the mt18 spectrum

```
---message from hinit---mt19 has no spectrum
   U235           U236              U237              U238
```

- No partial components of the fission energy released are given in the evaluation

```
---message from hinit---mt458 is missing for this mat
   Ac227        Am242g             Am244            Am244m
   Bk247         Bk249             Bk250             Cf249
   Cf250         Cf251             Cf252             Cf254
   Cm240         Cm245             Cm246             Cm247
   Cm249         Cm250             Es254             ES255
   Fm255         Np235             Np236             Np238
   Np239         Pa231             Pa232             Pu243
```

```
Pu246          Ra223              Ra226              Th227
Th228          Th229              Th233              Th234
U232            U237
```

- NJOY does not include energy from delayed emission in the prompt heating. The fission Q-value is changed from the total value given in file 3 to a prompt value using the delayed neutron energy from mf1, mt458.

```
---message from nheat---changed q from   E1 to   E2
U233            U234               U235               U236
U238           Am241              Am243              Cm241
Cm242          Cm243              Cm244              Cm248
Np237          Pa233              Pu236              Pu237
Pu238          Pu239              Pu240              Pu241
Pu242          Pu244              Th230              Th232
Th232         Am242m
```

- The ENDF6 format allows an evaluator to describe a subsection of file 6 using LAW=0 (no distribution given). This is fine for particle yields for gas production, . . . but it is not adequate for computing heating and damage.

```
---message from sixbar---no distribution for mt  5 particle **

Bi209           Ca40               Ca42               Ca43
Ca44            Ca46               Ca48               Fe54
Fe56            Fe57               Fe58               Ge70
Ge72            Ge73               Ge74               Ge76
Pb204          Pb206              Pb207              Pb208
Sc45            Tc99
```

(3) PURR Output messages

- When a material has no resonance parameters associated with it, this message will be issued.

---message from purr---mat 8925 has no resonance parameters

```
Ac225 Ac226 Ac227 Ag111 Am244 Am244m      B10   B11   Be9   C0
Ca46  Cd115M      Ce143 Cf254 Cl35  Cl37  Cm241 Es254 ES255 Eu156
Eu157 F19   Fm255 H1    H2    H3    He3   He4   Hg204 I130  I131
I135  K40   Kr85  La140 Li6   Li7   N14   N15   Np235 Np236 Np239
O16   O17   Pm148 Pm149 Pm151 Pr142 Pr143 Pt0   Pu237 Pu246 Ra223
Ra224 Ra225 Rb86  Rh105 Ru105 Ru106 Ru96  Ru98  S36   Sb124 Sb125
Sb126 Sm144 Sm148 Sm153 Sn123 Sn125 Sn126 Sr89  Sr90  Tb160 Te120
Te127M      Te129M      Te132 Th227 Th233 Th234 Ti46  Ti47  Ti48
Ti49  Ti50  Xe133 Xe135 Xe136 Y90   Y91
```

- The entire resolved energy range seems to overlap the unresolved energy range for this material. NJOY deals with this but no probability tables will be generated by PURR as there will not be any unresolved resonance parameters left (they are removed from the file). Another possibility is that the material has no unresolved resonances and that PURR was run.

---message from purr---mat 4725 has no unresolved parameters

```
Ag107 Al27  Ar40  As75  Au197 Ba138 Bi209 Bk247 Br79  Br81  Ca40
Ca42  Ca43  Ca44  Ca48  Cd111 Cd113 Ce140 Co58  Co58M Co59  Cr50
Cr52  Cr53  Cr54  Cs134 Cs136 Cu63  Cu65  Dy160 Dy163 Er162 Er164
Er166 Er168 Er170 Fe54  Fe56  Fe57  Ga0   Gd154 Gd157 Gd158 Gd160
Ge70  Ge72  Ge73  Ge74  Ge76  Hg196 Hg198 Hg199 Hg200 Hg201 Hg202
Ho165 K39   K41   Kr78  Kr80  Kr82  Kr83  Kr84  Kr86  Mg24  Mg25
Mg26  Mn55  Na23  Nb93  Nd142 Nd147 Nd150 Ni58  Ni59  Ni60  Ni61
Ni62  Ni64  Os0   P31   Pa232 Pb204 Pb206 Pb207 Pb208 Pd102
Pm148M      Ra226 Rb85  Rb87  Ru100 Ru102 Ru104 Ru99  S32   S33
S34   Sc45  Se74  Se76  Se77  Se78  Se80  Se82  Si28  Si29  Si30
Sm150 Sm154 Sr84  Sr86  Sr87  Sr88  Te122 Te123 Te124 Te125 Te126
Te128 Te130 Th228 Th229 Th230 Tl0   U236  V0    W182  W183  W184
W186  Xe124 Xe126 Xe128 Xe129 Xe130 Xe131 Xe132 Xe134 Y89   Zn0
Zr90  Zr96
```

(4) ACER Output messages

- The second acer run provides a consistency check of the ACE file produced by the first ACER run. Whenever something abnormal is found, this message will be printed.

---message from consis---consistency problems found

```
Al27              Be9             Bi209              C0
Ca40             Ca42              Ca43            Ca44
Ca46             Ca48              Cu63            Cu65
Fe54             Fe56              Fe57            Fe58
Ge70             Ge72              Ge73            Ge74
Ge76             I127              I129           Mo100
Mo95             Mo97               N14            Na23
Nb93             Ni61              Ni62            Ni64
O16               P31             Pb204           Pb206
Pb207           Pb208             Pu239           Rh103
Sb121           Sb123              Sc45            Si29
Si30             Tc99              U233            U235
W182             W183              W184            W186
Zr96
```

- This message indicates that a negative PDF value was found; NJOY sets the value to zero and renormalizes the distribution

---message from ptleg2---negative probs found

```
B10               B11              Co58            U232
U233             U235             Ac225           Ac227
Ag109           Am244             Au197           Bk250
Cf254           Cm240             Cm242           Cm243
Cm245           Cm247             Cm248           Er166
Er167           Er168             Er170           Es254
ES255           Fm255             Hf177           Hf179
Hg196           Hg198             Ho165           La139
Pa231           Pd106             Pd107           Pd108
Pd110           Pu238             Pu244           Pu246
Ra223           Ra224             Ra225           Ra226
```

```
Ru101            Sm151            Th229            Th230
Am244m
```

- The ptleg subroutine of the ACER module translates ENDF Legendre angular distributions into tabulated form with equal probability m intervals. In this routine the cosine interval m= -1 to 1 is divided into 1000 intervals and integrated. When the integral of the angular distribution over such an interval is negative, we receive this message. This is caused by the fact that the Legendre polynomial series can lead to negative values.

---message from ptleg---negative area between mu= **XX** and **YY**

```
O16
```

- This error normally surfaces when there is an inconsistency between the threshold energy of a reaction in the ENDF file and the value calculated by NJOY. This is already checked and corrected in reconr so this error should never occur. However, NJOY uses ENDF files to transfer information between modules in which any number is rounded to 6 significant digits. In the case of the above mentioned nuclides, the difference between the calculated value and the one in the ENDF file occurs in the 7th significant digit (which is lost due to rounding).

---message from unionx---threshold error

```
Be9        P31
```

2.3.2. Checking ACE libraries

During the processing of ENDF60 [ENDF60] and ENDF66 [LA-UR-03-0954] standard ACE libraries, several test were performed using external codes. Some of them have already been added to the internal NJOY testing in RECONR and ACER modules.

The second ACE pass performs ACE consistency, checks and corrects problems that might be detected. In fact, the main questions performed by ACER are [ALEPH-DLG, LA-UR-98-5718]:

1. Do threshold values correspond to *Q*-values?
   - Checked by RECONR
2. Is the energy grid monotonically increasing?
   - Checked by RECONR (the unionized grid is assumed monotonic). If two points with the same energy are found (i.e.: a jump in the cross section), a consistency problem is signalled but this can be ignored.
3. Check the angular distributions for the correct reference frame (either CM or LAB)
4. Check the angular distributions for unreasonable cosines
5. Is the emission energy less than the incident energy?
6. Do summation cross sections match sums?
   - Checked by RECONR
7. Ensure that probability density functions are non-negative
   - Checked by ACER
8. Are only appropriate interpolation values used?
9. Do threshold reactions start with a zero cross section?
   - Checked by RECONR

Table 2.6. NJOY output showing several consistency checks

```
ace consistency checks
 -----------------------
 check reaction thresholds against q values
 check that main energy grid is monotonic
 check angular distributions for correct reference frame
 check angular distributions for unreasonable cosine values
 check energy distributions
 check photon production sum
 check photon distributions
 checking particle production sections
  deuteron production
  checking energy distributions
```

In the last section we found consistency problems for many materials, see Table 2.7.

Table 2.7. Output messages in 2nd ACER

Al27	check energy distributions consis: ep.gt.epmax 9.292258E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-11 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Be9	
Bi209	check energy distributions consis: ep.gt.epmax 9.904161E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.ge.180---there could be a legitimate positive-q channel or admixed fission.
C0	check energy distributions consis: ep.gt.epmax 8.509482E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-11 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Ca40	check energy distributions consis: ep.gt.epmax 9.513683E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Ca42	check energy distributions consis: ep.gt.epmax 9.536006E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Ca43	check energy distributions consis: ep.gt.epmax 9.546438E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Ca44	check energy distributions consis: ep.gt.epmax 9.556378E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Ca46	check energy distributions consis: ep.gt.epmax 9.575049E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Ca48	check energy distributions consis: ep.gt.epmax 9.592217E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Cu63	check energy distributions consis: ep.gt.epmax 9.686976E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-11 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Cu65	check energy distributions consis: ep.gt.epmax 9.696388E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-11 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Fe54	check energy distributions consis: ep.gt.epmax 9.636236E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Fe56	check energy distributions consis: ep.gt.epmax 9.648868E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Fe57	check energy distributions consis: ep.gt.epmax 9.654878E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution

Fe58	check energy distributions consis: ep.gt.epmax 9.660670E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Ge70	check energy distributions consis: ep.gt.epmax 9.717621E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Ge72	check energy distributions consis: ep.gt.epmax 9.725303E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Ge73	check energy distributions consis: ep.gt.epmax 9.728998E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Ge74	check energy distributions consis: ep.gt.epmax 9.732582E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Ge76	check energy distributions consis: ep.gt.epmax 9.739489E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
I127	
I129	check energy distributions consis: ep.gt.epmax 9.845319E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Mo100	check that main energy grid is monotonic consis: energy 4.20000100E-01 less than 4.20000100E-01 (see point no. 26576) checking particle production sections proton production: checking energy distributions consis: bad law44 kalbach r for (n,xp) at 1.700000E+01 -> 1.101400E+01 deuteron production: checking energy distributions consis: bad law44 kalbach r for (n,xd) at 1.900000E+01 -> 9.677970E+00
Mo95	check photon production sum consis: mismatch at 1.000001E-03 gpd= 1.039925E-01 sum= 1.040143E-01 checking particle production sections alpha production: checking energy distributions consis: bad law61 cumm. prob for (n,a*c) at 1.000000E-11 -> 4.154300E+00 consis: decreasing law61 cumm. prob for (n,a*c) at 1.000000E-11 -> 4.154300E+00 consis: bad law61 cumm. prob for (n,a*c) at 1.000000E-03 -> 4.154300E+00 consis: decreasing law61 cumm. prob for (n,a*c) at 1.000000E-03 -> 4.154300E+00
Mo97	check that main energy grid is monotonic consis: energy 4.20000100E-01 less than 4.20000100E-01 (see point no. 13003) checking particle production sections proton production: checking energy distributions consis: bad law44 kalbach r for (n,xp) at 1.800000E+01 -> 1.573730E+01
N14	check energy distributions consis: ep.gt.epmax 8.701311E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-11 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution

Na23	check angular distributions for correct reference frame consis: should be lab: (n,n*c)
Nb93	check energy distributions consis: ep.gt.epmax 9.786342E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-11 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Ni61	check energy distributions consis: ep.gt.epmax 9.676960E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-11 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Ni62	check energy distributions consis: ep.gt.epmax 9.682034E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-11 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Ni64	check energy distributions consis: ep.gt.epmax 9.691751E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-11 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
O16	check energy distributions consis: ep.gt.epmax 8.848774E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-11 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
P31	check reaction thresholds against q values consis: threshold 3.40230200E+00 less than the expected 3.40230208E+00 for (n,n*4)
Pb204	check energy distributions consis: ep.gt.epmax 9.901826E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.ge.180---there could be a legitimate positive-q channel or admixed fission.
Pb206	
Pb207	check energy distributions consis: ep.gt.epmax 9.903240E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.ge.180---there could be a legitimate positive-q channel or admixed fission.
Pb208	check energy distributions consis: ep.gt.epmax 9.903702E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.ge.180---there could be a legitimate positive-q channel or admixed fission.
Pu239	check angular distributions for correct reference frame consis: should be lab: (n,n*c) check delayed neutron fraction consis: delayed fractions do not sum to one
Rh103	
Sb121	checking particle production sections proton production: checking energy distributions consis: bad law44 kalbach r for (n,xp) at 1.600000E+01 -> 1.512400E+01 deuteron production: checking energy distributions consis: bad law44 kalbach r for (n,xd) at 1.300000E+01 -> 7.130260E+00 triton production: checking energy distributions consis: bad law44 kalbach r for (n,xt) at 1.800000E+01 -> 9.996470E+00
Sb123	checking particle production sections proton production: checking energy distributions consis: bad law44 kalbach r for (n,xp) at 1.800000E+01 -> 1.512600E+01 deuteron production: checking energy distributions consis: bad law44 kalbach r for (n,xd) at 1.500000E+01 -> 1.008340E+01 triton production: checking energy distributions

Sc45	check energy distributions consis: ep.gt.epmax 9.565927E-12 with q.lt.0 for (n,x) at e 1.000000E-11 -> 1.000000E-06 consis: awr.lt.180---this is probably an error. consis: shifting eprimes greater than epmax and renorming the distribution
Si29	check that main energy grid is monotonic consis: energy 7.30265100E+00 less than 7.30265100E+00 (see point no. 1407)
Si30	check that main energy grid is monotonic consis: energy 7.23453100E+00 less than 7.23453100E+00 (see point no. 2075)
Tc99	
U233	check that main energy grid is monotonic consis: energy 1.09000100E+00 less than 1.09000100E+00 (see point no. 9344) check delayed neutron fractions consis: delayed fractions do not sum to one
U235	check delayed neutron fractions consis: delayed fractions do not sum to one
W182	check that main energy grid is monotonic consis: energy 4.00000100E-01 less than 4.00000100E-01 (see point no. 33722) checking particle production sections proton production: checking energy distributions consis: bad law44 kalbach r for (n,xp) at 1.500000E+01 -> 1.317710E+01 deuteron production: checking energy distributions consis: bad law44 kalbach r for (n,xd) at 1.800000E+01 -> 1.063170E+01 alpha production: checking energy distributions consis: bad law44 kalbach r for (n,xa) at 1.900000E+01 -> 2.616490E+01
W183	check that main energy grid is monotonic consis: energy 1.00000100E-01 less than 1.00000100E-01 (see point no. 21588) checking particle production sections proton production: checking energy distributions consis: bad law44 kalbach r for (n,xp) at 1.500000E+01 -> 1.317740E+01 deuteron production: checking energy distributions consis: bad law44 kalbach r for (n,xd) at 1.500000E+01 -> 9.643280E+00 alpha production: checking energy distributions consis: bad law44 kalbach r for (n,xa) at 1.600000E+01 -> 2.372250E+01
W184	check that main energy grid is monotonic consis: energy 4.00000100E-01 less than 4.00000100E-01 (see point no. 28845) checking particle production sections proton production: checking energy distributions consis: bad law44 kalbach r for (n,xp) at 1.600000E+01 -> 1.268060E+01 deuteron production: checking energy distributions consis: bad law44 kalbach r for (n,xd) at 1.800000E+01 -> 1.063300E+01 alpha production: checking energy distributions consis: bad law44 kalbach r for (n,xa) at 1.800000E+01 -> 2.372540E+01

W186	checking particle production sections proton production: checking energy distributions consis: bad law44 kalbach r for (n,xp) at 1.700000E+01 -> 1.268130E+01 deuteron production: checking energy distributions consis: bad law44 kalbach r for (n,xd) at 1.400000E+01 -> 7.666530E+00 alpha production: checking energy distributions consis: bad law44 kalbach r for (n,xa) at 1.900000E+01 -> 2.324170E+01
Zr96	checking particle production sections deuteron production: checking energy distributions consis: bad law44 kalbach r for (n,xd) at 1.800000E+01 -> 6.609760E+00

However, ACER does not include the capability to check the proper processing of the unresolved resonance probability tables.

The Probability table (PT) method was implemented in MCNP to account statistically for the average resonance parameters specified in the unresolved resonance range. With this method, the average parameters are used to generate ladders of representative resonances.

Cross sections from these ladders are used to form cross-section probability distribution functions, from which a table of cross sections (total, elastic, fission, and radiative capture) as a function of probability is prepared. MCNP samples the total and reaction cross sections at the energy of the neutron, rather than simply using single average values at this energy.

These PTs are calculated in PURR module. Sigma zero values are not required and could be omitted entirely if the only objective is to generate an ACE library.

Verification of the URES library can be performed with a variety of consistency test on the PT data: [LA-UR-98-5718]

- Ensure that any competition reaction specified actually exists
- Check the infinitely-dilute total cross section at the energy of the PT against the sum of the infinitely-dilute elastic, fission, capture and competition cross sections.
- Make sure that the cumulative probabilities as given in the PT are in ascending order, and that the distribution is correctly normalized to 1.
- Check negative values of the total, elastic, fission and capture cross sections in each row of the PT. In addition, check for zero cross sections for the total, elastic and capture.

- Check for zero or negative values of the heating numbers in each row of the PT
- Compare the total cross section from the PT with the sum of the elastic, fission, capture and competition process.
- For each cross section, compare the infinitely dilute value at that neutron energy with the apparent average value from the PT.

The ENDF/B-VI evaluators decided to drop plans to include data for any isotope with a large number of negative cross sections in the PT data. The problems were traced to negative background cross sections in ENDF libraries. (Report LA-UR-03-594). So the negative cross section problems in the PT are related with the evaluation and it is not a problems with the PURR module of NJOY (the method of calculating the probability table as implemented in NJOY should not lead to negative values by itself [ALEPH-DLG])

In short, there are a number of possible problems or abnormalities with the PTs that can be directly noticed for some isotopes:

- Probability bins with a probability of 0, these bins will not be sampled so they can be accepted
- Zero cross section values (either for the entire bin or for specific reactions)
- Negative cross section values

Zero cross sections can occur either in the lower bins because the cross section becomes very small or when the particular row has a fractional probability of zero (in this case, the row will never be sampled). In these cases, zero cross section can be allowed.

Negative cross sections however cannot be allowed (and the library file has to be recalculated without probability tables), unless they appear in a row with zero fractional probability (in which case they will not be used).

The procedure in this work is to simply omit the PT from ACE file whenever negative values are found.

```
11-Na-22    18-Ar-36    44-Ru-101   46-Pd-104   46-Pd-106
46-Pd-107   46-Pd-108   46-Pd-110   47-Ag-109   57-La-139
59-Pr-141   60-Nd-144   60-Nd-145   60-Nd-146   60-Nd-148
61-Pm-147   93-Np-238   88-Cf-252   99-Es-253
```

Negative cross section values for capture PT can be found(see Table 2.8).

Table 2.8. Probability table for Ag-109 at E=9.840E+02 eV.

```
e= 9.8400E+02   spot= 4.9845E+00   dbar= 2.4262E+00   sigx= 1.3423E-07
             total     elastic     fission     capture
     1  1.3139E+01  8.6874E+00  0.0000E+00  4.4517E+00
     2  1.4419E+01  9.4455E+00  0.0000E+00  4.9735E+00
     3  1.4322E+01  9.3227E+00  0.0000E+00  4.9995E+00
...
...
    97  1.3283E+01  8.9758E+00  0.0000E+00  4.3068E+00
    98  1.5700E+01  1.0444E+01  0.0000E+00  5.2565E+00
    99  1.3695E+01  9.1265E+00  0.0000E+00  4.5688E+00
   100  1.4433E+01  9.4805E+00  0.0000E+00  4.9528E+00
  bkgd -2.4793E-01  2.6408E-02  0.0000E+00 -2.7434E-01
  infd  1.3695E+01  9.0847E+00  0.0000E+00  4.6105E+00
  aver  1.3578E+01  9.0208E+00  0.0000E+00  4.5573E+00
  pcsd        5.15        4.99        0.00        6.26
  nres        3315

 bondarenko cross sections by direct sampling
         temp      sig0    p0 total     elastic     fission     capture    p1 total
    3.000E+02 1.000E+10  1.3578E+01  9.0208E+00  0.0000E+00  4.5573E+00  1.3578E+01

 probability table
 tmax 3.00E+02 2.48E+00 3.31E+00 4.06E+00  4.32E+00   4.55E+00   4.71E+00   4.81E+00   4.95E+00  5.15E+00 5.38E+00
               5.66E+00 6.04E+00 6.62E+00  7.60E+00   9.19E+00   1.28E+01   2.72E+01   1.06E+02  2.05E+02 5.77E+02
 prob 3.00E+02 3.61E-03 1.82E-02 6.15E-02  4.91E-02   6.31E-02   6.31E-02   5.80E-02   5.53E-02  6.41E-02 6.18E-02
               5.69E-02 5.75E-02 6.18E-02  6.22E-02   5.55E-02   5.84E-02   6.41E-02   6.25E-02  1.55E-02 6.97E-03
 tot  3.00E+02 2.15E+00 2.99E+00 3.76E+00  4.19E+00   4.44E+00   4.63E+00   4.76E+00   4.88E+00  5.04E+00 5.26E+00
               5.51E+00 5.84E+00 6.31E+00  7.06E+00   8.30E+00   1.07E+01   1.82E+01   5.44E+01  1.43E+02 2.78E+02
 els  3.00E+02 1.65E+00 2.70E+00 3.69E+00  4.22E+00   4.51E+00   4.74E+00   4.90E+00   4.96E+00  5.06E+00 5.19E+00
               5.33E+00 5.48E+00 5.67E+00  5.92E+00   6.27E+00   6.92E+00   9.13E+00   2.47E+01  8.01E+01 1.82E+02
 fis  3.00E+02 0.00E+00 0.00E+00 0.00E+00  0.00E+00   0.00E+00   0.00E+00   0.00E+00   0.00E+00  0.00E+00 0.00E+00
               0.00E+00 0.00E+00 0.00E+00  0.00E+00   0.00E+00   0.00E+00   0.00E+00   0.00E+00  0.00E+00 0.00E+00
 cap  3.00E+02 5.00E-01 2.96E-01 7.19E-02 -2.805E-02 -7.634E-02 -1.096E-01 -1.375E-01 -8.33E-02 -2.07E-02 7.13E-02
               1.86E-01 3.52E-01 6.40E-01  1.145E+00  2.039E+00  3.791E+00  9.097E+00  2.97E+01  6.32E+01 9.58E+01

 bondarenko cross sections from probability table
         temp      sig0    p0 total     elastic     fission     capture    p1 total
    3.000E+02 1.000E+10  1.3578E+01  9.0208E+00  0.0000E+00  4.5573E+00  1.3578E+01
```

2.3.3. Q&A with ACELST code

Our objective in this section is to show the results applied to JEFF-3.1 library using the QA procedure developed by D. López Aldama and A. Trkov in ADS-Lib/V1.0. Here, "*the human eye will be used as a wonderfully complex tool, able to spot inconsistency and error with amazing precision*"[LA-UR-02-1235]:

- Look for unexpected discontinuities in cross sections
- Examine secondary distributions
- Examine threshold regions
- Examine resonance regions

For all the ACE-formatted files, we have converted back to ENDF-6 format using the code ACELST[ACELST]. These ENDF6 files were compared with the original evaluation using different procedures:

- Using NJOY code
- Using PREPRO-2004 code system (LINEAR + RECENT + SIGMA1) [PREPRO2004]

We can conclude that the processed data were judged to be acceptable:

- Differences between NJOY and PREPRO2004 should be investigated
- Differences with other libraries should be considered for later validations.

2.3.4. Example of Q&A with ACELST code: Fe56

- **Comparison ACE result with original ENDF**

NJOY99 code is used to compare original ENDF library with the processed library in ACE format converted-back into ENDF format using ACLST code.

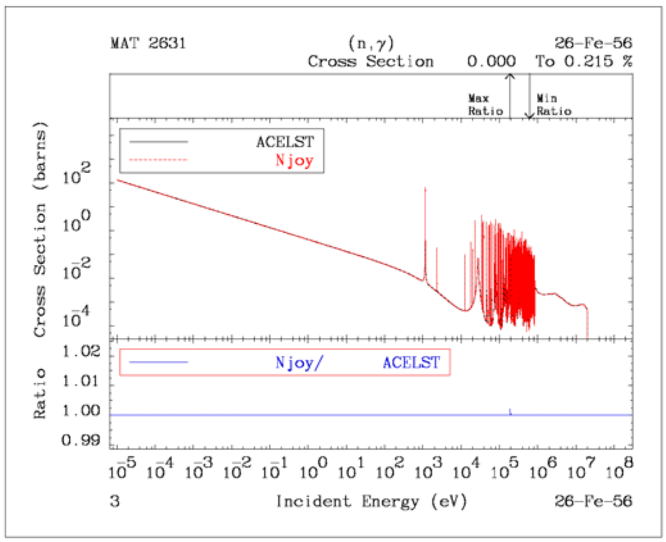

Figure 2.4. Comparison of the capture cross section processed by NJOY in PENDF format: original ENDF versus ACE library processed by ACELST

In conclusion: no deviations in the cross section data were found.

- **Comparison JEFF-3.1 with ENDF/B-VI.R8 processed by NJOY code**

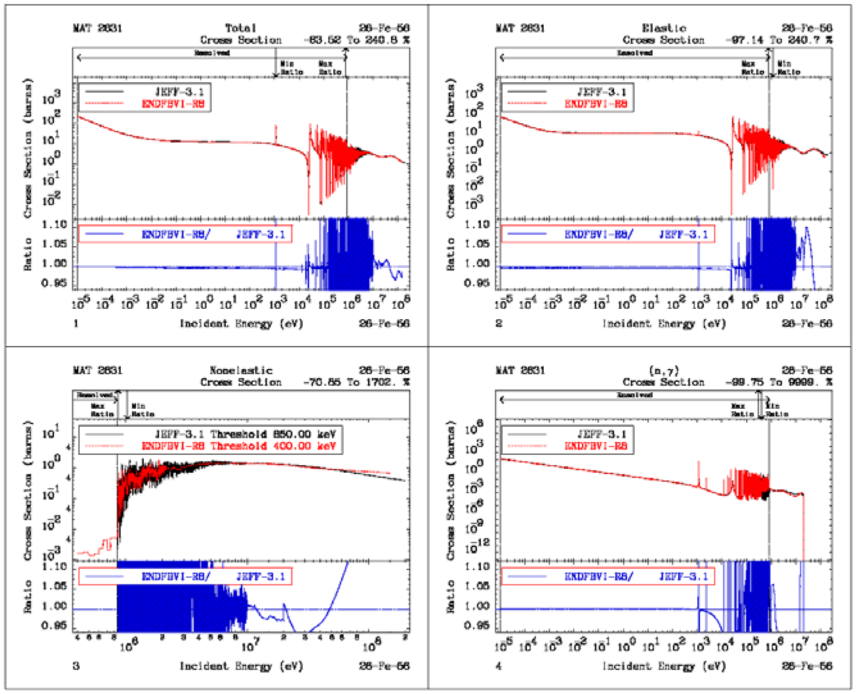

Figure 2.5. Comparison of the Fe-56 cross sections processed by NJOY in PENDF format: ENDF/B-VI.R8 versus JEFF-3.1.

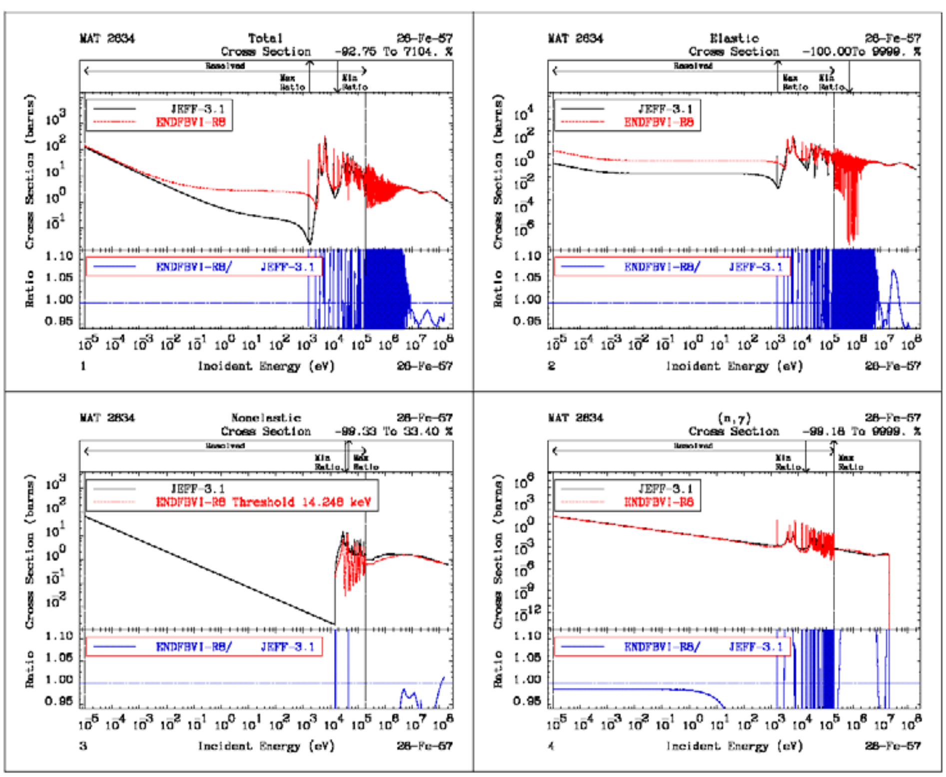

Figure 2.5. Comparison of the Fe-57 cross sections processed by NJOY in PENDF format: ENDF/B-VI.R8 versus JEFF-3.1.

- **Comparison: PREPRO-2004 versus NJOY99**

The ACEQA code developed by D.L. Aldama compares PREPRO-2004 (LINEAR+RECENT+SIGMA1) and NJOY cross sections in PENDF format.

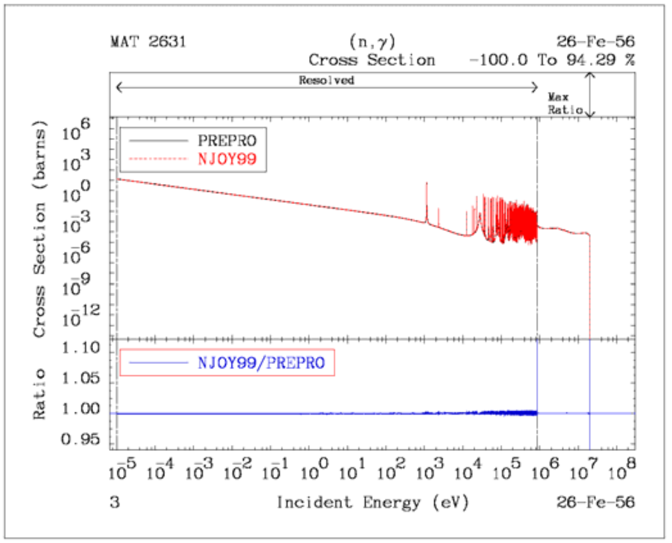

Figure 2.6. Comparison of the capture cross section processed by NJOY and PREPRO2004 codes.

- **PREPRO-2004 Warnings and messages were also compiled**

In order to compare PREPRO-2004 and NJOY99, the ACEQA code runs LINEAR+RECENT+SIGMA1 codes consecutively.

Warnings and messages from these codes are useful to complete an additional check.

Table 2.9. Example of RECENT.LST messages/warnings for ^{56}Fe and ^{57}Fe.

Nuclide	Codes	Warnings
26-Fe- 56	LINEAR	None
	RECENT	WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING L Dependent Scattering Radius in the Evaluation is Zero. Have Defined it to be Equal to the Scattering Radius .544400000 (see, ENDF/B-VI Formats and Procedures Manual, page 2.11) WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING L Dependent Scattering Radius in the Evaluation is Zero. Have Defined it to be Equal to the Scattering Radius .544400000 (see, ENDF/B-VI Formats and Procedures Manual, page 2.11)
	SIGMA1	None
26-Fe- 57	LINEAR	None
	RECENT	WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING L Dependent Scattering Radius in the Evaluation is Zero. Have Defined it to be Equal to the Scattering Radius .650000000 (see, ENDF/B-VI Formats and Procedures Manual, page 2.11) WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING L Dependent Scattering Radius in the Evaluation is Zero. Have Defined it to be Equal to the Scattering Radius .650000000 (see, ENDF/B-VI Formats and Procedures Manual, page 2.11) -- WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING L= 1 J = 1.000 Corresponds to 2 Resonance Sequences. -- -- WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING FOR L = 1 Expect Sum of Statistical Weights (GJ) to Equal (2*L + 1) = 3.000 Found = 2.250 Corrective Action Will be Taken to Correctly Calculate the Potential Scattering Cross Section - This Procedure is Based on the Decision of the National Nuclear Data Center, Brookhaven National Laboratory, Private Communication, Charles Dunford, (April 1991)
	SIGMA1	None

For many materials warnings/messages are obtained when running LINEAR-RECENT-SIGMA1 codes. Only materials with SIGMA1 warnings are shown in Table 2.10.

Table 2.10. List of warnings for JEFF-3.1 library processed with LINEAR-RECENT-SIGMA1 codes. Only materials with SIGMA1 warnings are shown.

Nuclide	Codes	Warnings
22-Ti- 46	LINEAR	-- Material MAT MF MT ENDF/B Kelvin Q-Value Points Points Format eV In Out -- 22-Ti-46 2225 3 2 VI 0.0 0.0 4604 4604 WARNING - Above Cross Section Negative at 11 Energies
	RECENT	
	SIGMA1	-- Projectile MAT MT ENDF/B Kelvin Q-Value Points Points Material Format In eV In Out -- n 22-Ti-46 2225 2 VI 0.0 0.0 4604 8335 WARNING - Above Cross Section Negative at 23 Energies
22-Ti- 49	LINEAR	-- Material MAT MF MT ENDF/B Kelvin Q-Value Points Points Format eV In Out -- 22-Ti-49 2234 3 2 VI 0.0 0.0 5140 5140 WARNING - Above Cross Section Negative at 7 Energies
	RECENT	
	SIGMA1	-- Projectile MAT MT ENDF/B Kelvin Q-Value Points Points Material Format In eV In Out -- n 22-Ti-49 2234 2 VI 0.0 0.0 5140 8282 WARNING - Above Cross Section Negative at 8 Energies
22-Ti- 50	LINEAR	-- Material MAT MF MT ENDF/B Kelvin Q-Value Points Points Format eV In Out -- 22-Ti-50 2237 3 2 VI 0.0 0.0 4577 4577 WARNING - Above Cross Section Negative at 7 Energies
	RECENT	
	SIGMA1	-- Projectile MAT MT ENDF/B Kelvin Q-Value Points Points Material Format In eV In Out -- n 22-Ti-50 2237 2 VI 0.0 0.0 4577 8301 WARNING - Above Cross Section Negative at 10 Energies
27-Co- 58	LINEAR	-- Material MAT MF MT ENDF/B Kelvin Q-Value Points Points Format eV In Out -- 27-Co-58 2722 3 1 VI 0.0 0.0 422 422 WARNING - Above Cross Section Negative at 52 Energies 27-Co-58 2722 3 2 VI 0.0 0.0 326 326 WARNING - Above Cross Section Negative at 249 Energies
	RECENT	-- WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING for L= 0 The Following J Sequences are Missing. J = 2.50 -- WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING FOR L = 0 Expect Sum of Statistical Weights (GJ) to Equal (2*L + 1) = 1.000 Found = 0.400 Corrective Action Will be Taken to Correctly Calculate the Potential Scattering Cross Section - This Procedure is Based on the Decision of the National Nuclear Data Center, Brookhaven National Laboratory, Private Communication, Charles Dunford, (April 1991) Capture 655 404 1041 WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING Above Cross Section is Negative at 109 Energies.

	SIGMA1	-- Projectile MAT MT ENDF/B Kelvin Q-Value Points Points Material Format In eV In Out -- n 27-Co-58 2722 102 VI 0.0 10450000.0 1041 831 WARNING - Above Cross Section Negative at 217 Energies
52-Te-128	LINEAR	-- Material MAT MF MT ENDF/B Kelvin Q-Value Points Points Format eV In Out -- 52-Te-128 5249 3 1 VI 0.0 0.0 612 620 WARNING - Above Cross Section Negative at 185 Energies 52-Te-128 5249 3 2 VI 0.0 0.0 541 558 WARNING - Above Cross Section Negative at 186 Energies
52-Te-128	RECENT	-- WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING for L= 1 The Following J Sequences are Missing. J = 1.50 -- WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING FOR L = 1 Expect Sum of Statistical Weights (GJ) to Equal (2*L + 1) = 3.000 Found = 1.000 Corrective Action Will be Taken to Correctly Calculate the Potential Scattering Cross Section - This Procedure is Based on the Decision of the National Nuclear Data Center, Brookhaven National Laboratory, Private Communication, Charles Dunford, (April 1991) … … Total 16011 620 16608 WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING Above Cross Section is Negative at 485 Energies. Elastic 16011 558 16546 WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING Above Cross Section is Negative at 714 Energies.
52-Te-128	SIGMA1	-- Projectile MAT MT ENDF/B Kelvin Q-Value Points Points Material Format In eV In Out -- n 52-Te-128 5249 1 VI 0.0 0.0 16608 4075 WARNING - Above Cross Section Negative at 673 Energies n 52-Te-128 5249 2 VI 0.0 0.0 16546 3849 WARNING - Above Cross Section Negative at 745 Energies
64-Gd-157	LINEAR	-- Material MAT MF MT ENDF/B Kelvin Q-Value Points Points Format eV In Out -- 64-Gd-157 6440 3 1 VI 0.0 0.0 645 685 WARNING - Above Cross Section Negative at 251 Energies 64-Gd-157 6440 3 2 VI 0.0 0.0 637 669 WARNING - Above Cross Section Negative at 250 Energies
64-Gd-157	RECENT	Elastic 13220 669 13870 WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING...WARNING Above Cross Section is Negative at 229 Energies.
64-Gd-157	SIGMA1	-- Projectile MAT MT ENDF/B Kelvin Q-Value Points Points Material Format In eV In Out -- n 64-Gd-157 6440 2 VI 0.0 0.0 13870 5321 WARNING - Above Cross Section Negative at 312 Energies

2.4. Differences: PREPRO-2004 versus NJOY99

The parameters used to run PREPRO-2004 in LINEAR, RECENT and SIGMA1:

```
***************** Program LINEAR (VERSION 2004-1) ***************
For All Data Greater than 1.0000E-10 barns in Absolute Value
Data Linearized to Within an Accuracy of .100000000 per-cent
***************** Program RECENT (VERSION 2005-1) ***************
for All Data Greater than 1.0000E-10 barns in Absolute Value
Data Linearized to within an Accuracy of .100000000 per-cent
***************** Program SIGMA1 (VERSION 2005-1) ***************
Data Doppler Broadened to 300.000000 Kelvin
for All Data Greater than 1.0000E-10 barns in Absolute Value
Data Linearized to Within an Accuracy of .100000000 per-cent
```

In this section NJOY99 means cross sections converted-back from ACE format using the ACELST code. Consequently, their accuracy options are the options used in processing ACE files.

2.4.1. Case Tl0.nat

Inconsitency found at low neutron thermal energy: it is due to the type of interpolation low used at low energy.

In the cross section library, JEFF-3.1 uses a lin-lin interpolation at low energy.

Table 2.11. MT=102 for Tl0 material taken from JEFF-3.1

```
 8.100000+4 2.026300+2          0          0          0          08100 3102 1077
 6.655800+6 6.655800+6          0          0          1        678100 3102 1078
         67          2                                            8100 3102 1079
 1.000000-5 1.200000+2 2.530000-2 3.430000+0 7.000000-1 8.000000-18100 3102 1080
 1.250000+0 6.500000-1 1.950000+0 5.500000-1 3.450000+0 3.700000-18100 3102 1081
 8.450000+0 2.500000-1 1.310000+1 1.950000-1 1.620000+1 1.830000-18100 3102 1082
 2.050000+1 1.500000-1 2.690000+1 1.490000-1 2.938000+1 1.620000-18100 3102 1083
 3.090000+1 1.700000-1 3.253000+1 1.820000-1 3.434000+1 1.930000-18100 3102 1084
 3.628000+1 2.100000-1 3.762000+1 2.220000-1 3.806000+1 2.250000-18100 3102 1085
…
…
 1.000000+5 3.500800-2 2.000000+5 3.101000-2 3.000000+5 2.800600-28100 3102 1095
 4.000000+5 2.500800-2 5.000000+5 2.251000-2 6.000000+5 2.050600-28100 3102 1096
 8.000000+5 1.730200-2 1.000000+6 1.504900-2 1.500000+6 1.053500-28100 3102 1097
 2.000000+6 8.500700-3 2.500000+6 7.006600-3 3.000000+6 5.003700-38100 3102 1098
 4.000000+6 3.808600-3 5.000000+6 2.506500-3 6.000000+6 2.000500-38100 3102 1099
 8.000000+6 1.205300-3 1.000000+7 7.801200-4 1.200000+7 8.276500-48100 3102 1100
 1.400000+7 9.003600-4 1.600000+7 7.510600-4 1.800000+7 7.036500-48100 3102 1101
 2.000000+7 6.210500-4                                            8100 3102 1102
```

However, SIGMA1 code changes the interpolation law according to the sentences in Table 2.12.

Table 2.12. SIGMA1 code used to interpolation at low energy.

```
C-------------------------------------------------------------------
C
C      USE LOG-LOG INTERPOLATION AT LOW ENERGY
C
C-------------------------------------------------------------------
      ITERP=2
C-----02/03/00 - ADD LOG-LOG ONLY IF CROSS SECTIONS > 0
      IF(XCIN(IFILL).GT.0.0.AND.XCKM1.GT.0.0.AND.
     1   ALPHA*ENEXT.LE.4.0D+01) ITERP=5
      XCCOLD(K)=TERPIT(ENEXT,EIN(IFILL),EKM1,XCIN(IFILL),XCKM1,ITERP)
      ARG=ALPHA*ECOLD(K)
      YCOLD(K)=DSQRT(ARG)
      GO TO 320
```

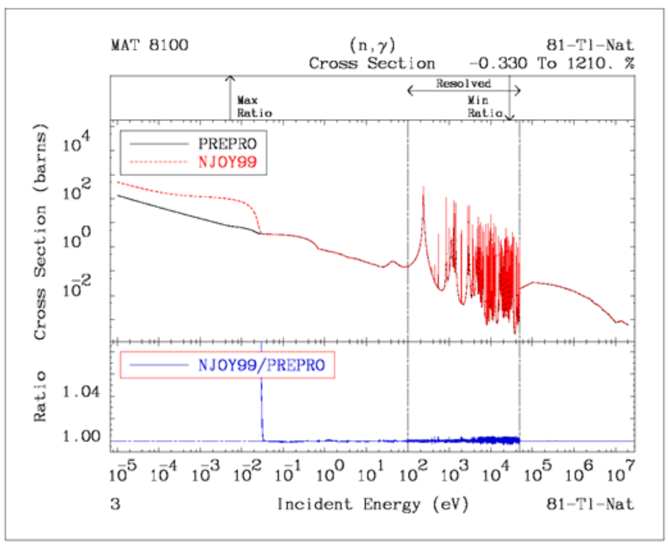

Figure 2.7. Differences in Tl-nat capture cross section

2.4.2. Total cross sections

Differences in the total cross sections are due to:

- NJOY code calculates the total cross section summing the partial cross sections

- PREPRO-2004 processes directly the section MT=1, MF=3.

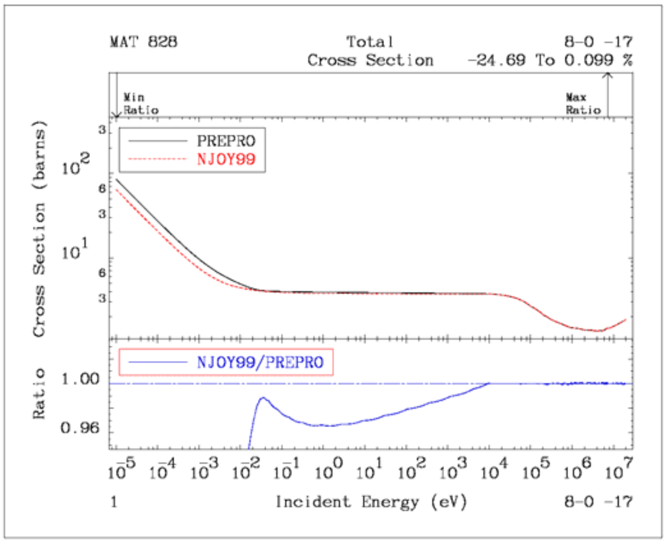

Figure 2.8. Total cross section for O-17 processed by PREPRO-2004 and NJOY99.

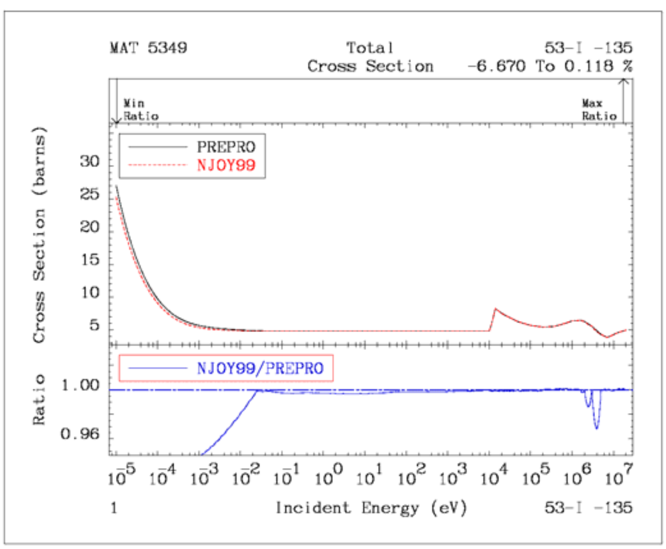

Figure 2.9. Total cross section for I-135 processed by PREPRO-2004 and NJOY99.

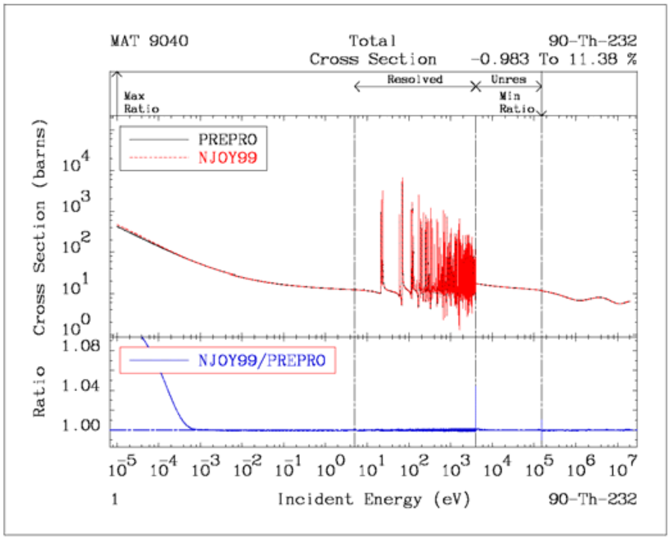

Figure 2.10. Total cross section for Th-232 processed by PREPRO-2004 and NJOY99.

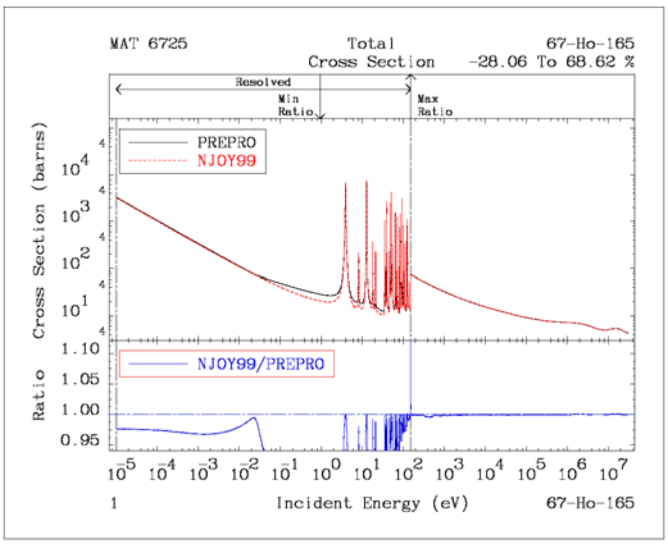

Figure 2.11. Total cross section for Ho-165 processed by PREPRO-2004 and NJOY99.

2.4.3. Resonances

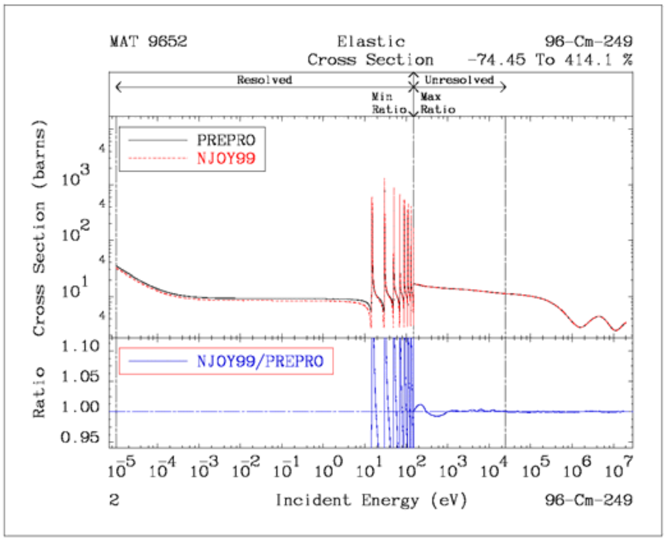

Figure 2.12. Elastic cross section for Cm-249 processed by PREPRO-2004 and NJOY99.

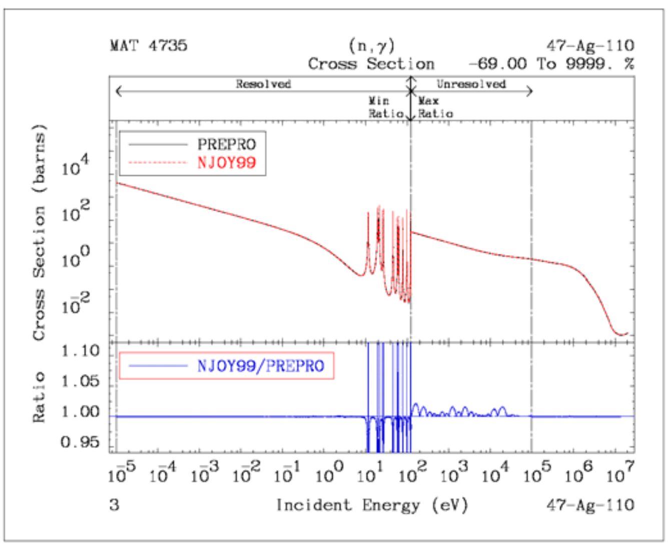

Figure 2.13. Capture cross section for Ag-110M processed by PREPRO-2004 and NJOY99.

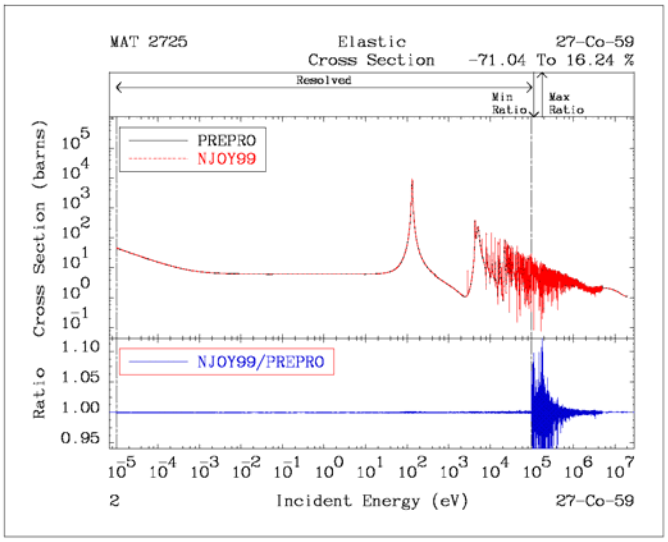

Figure 2.14. Elastic cross section for Co-59 processed by PREPRO-2004 and NJOY99.

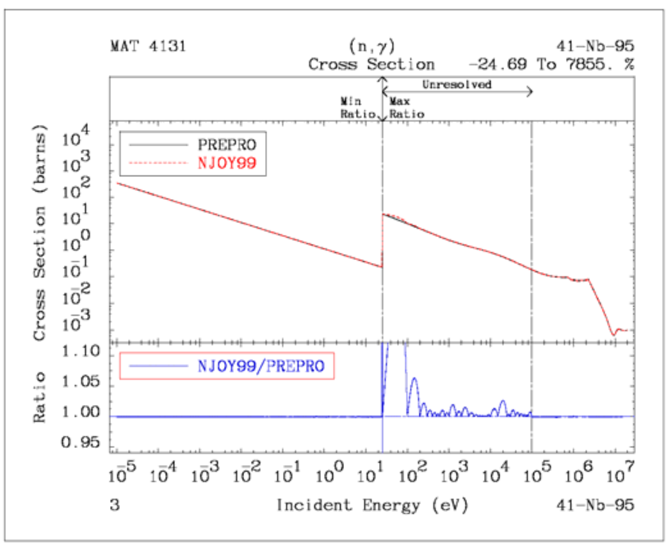

Figure 2.15. Capture cross section for Nb-95 processed by PREPRO-2004 and NJOY99.

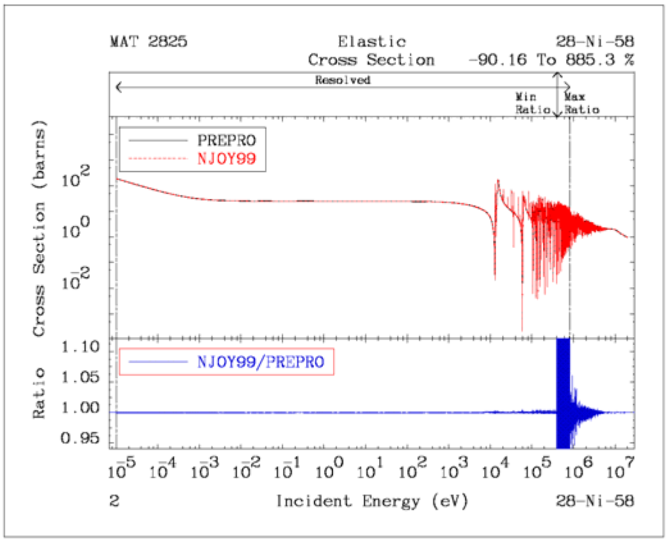

Figure 2.16. Elastic cross section for Ni-58 processed by PREPRO-2004 and NJOY99.

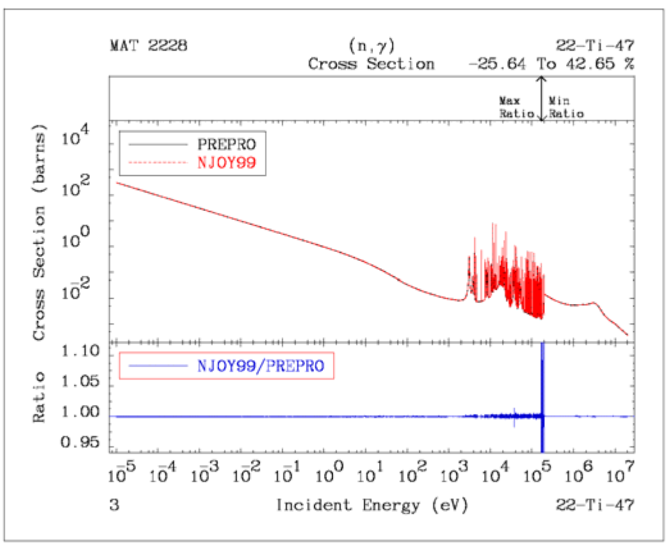

Figure 2.17. Capture cross section for Ti-47 processed by PREPRO-2004 and NJOY99.

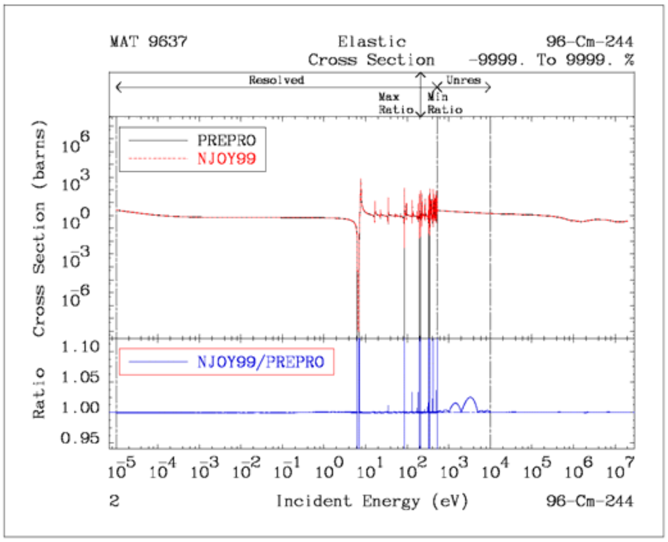

Figure 2.18. Elastic cross section for Cm-244 processed by PREPRO-2004 and NJOY99.

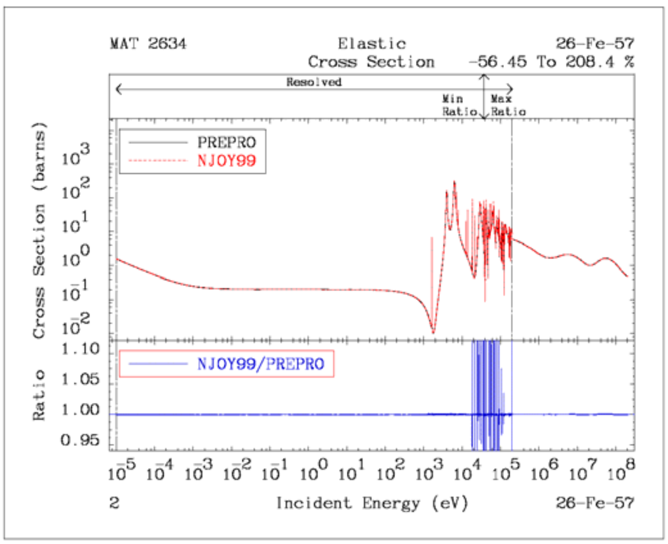

Figure 2.19. Elastic cross section for Fe-57 processed by PREPRO-2004 and NJOY99.

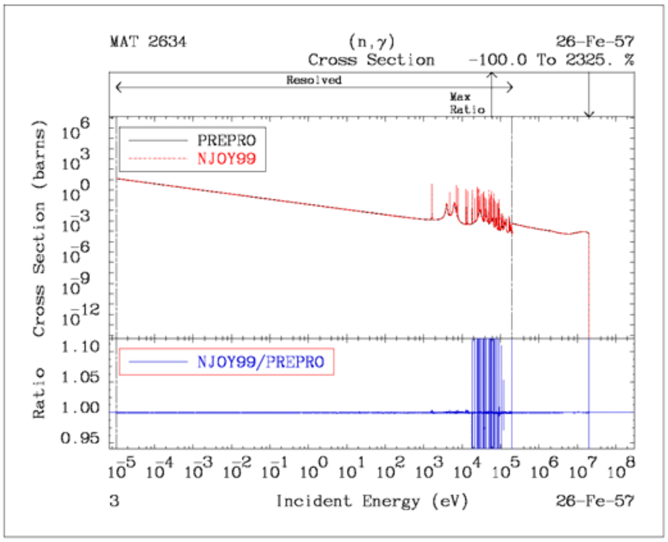

Figure 2.20. Capture cross section for Fe-57 processed by PREPRO-2004 and NJOY99.

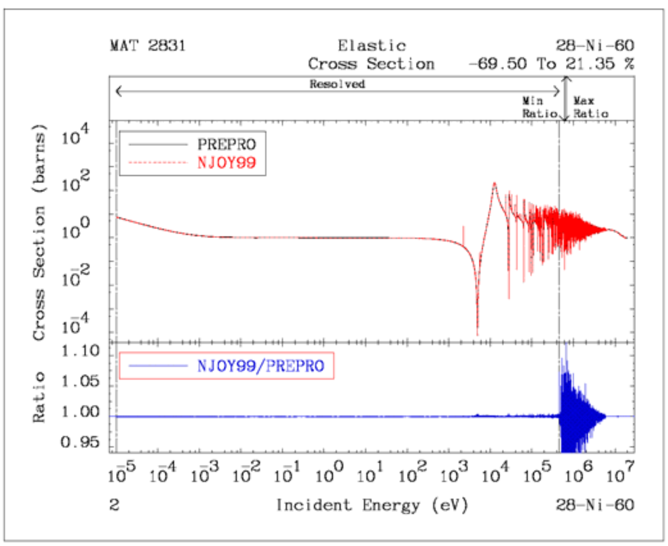

Figure 2.21. Elastic cross section for Ni-60 processed by PREPRO-2004 and NJOY99.

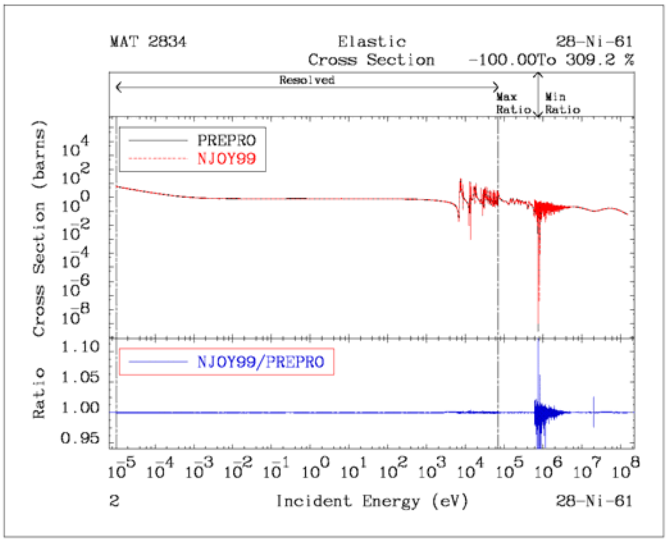

Figure 2.22. Elastic cross section for Ni-61 processed by PREPRO-2004 and NJOY99.

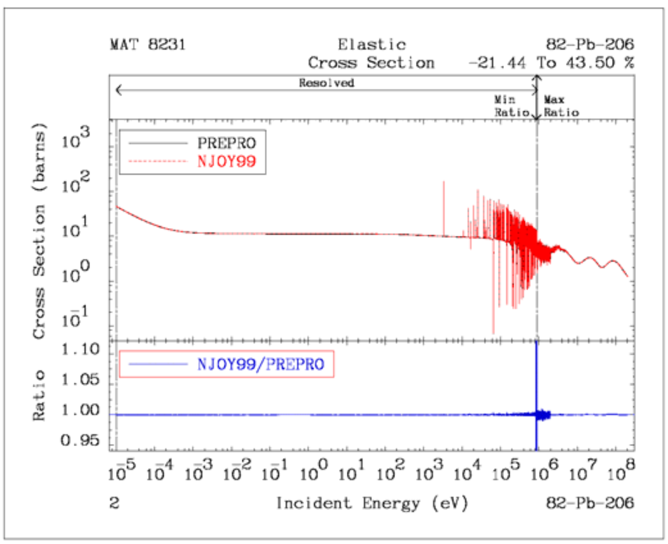

Figure 2.23. Elastic cross section for Pb-206 processed by PREPRO-2004 and NJOY99.

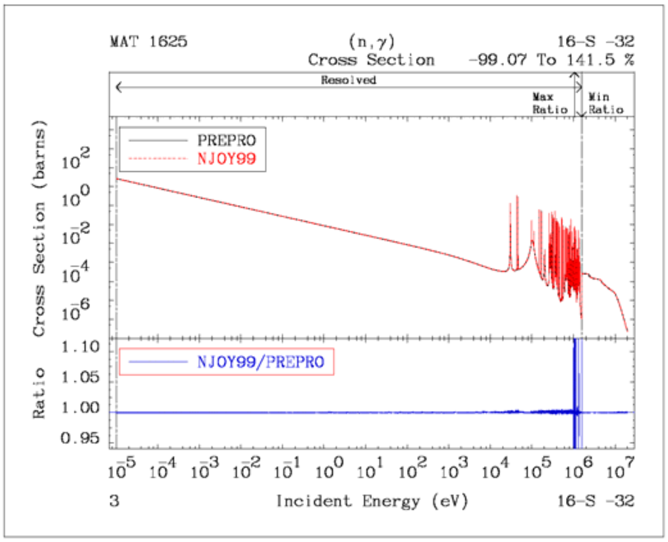

Figure 2.24. Capture cross section for S-32 processed by PREPRO-2004 and NJOY99.

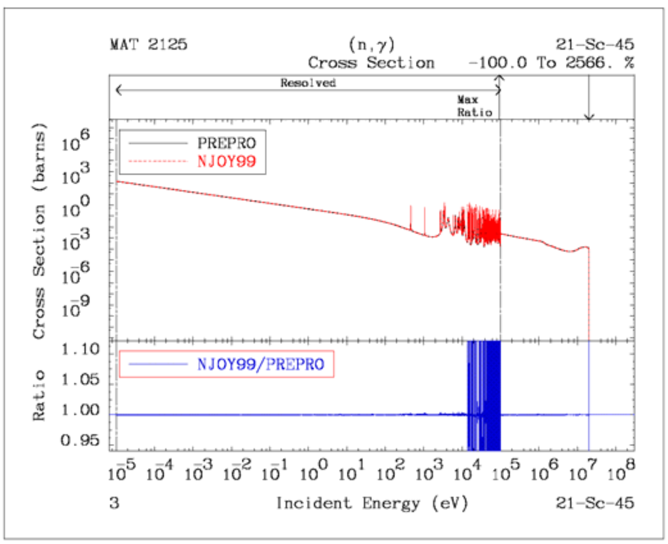

Figure 2.25. Capture cross section for Sc-45 processed by PREPRO-2004 and NJOY99.

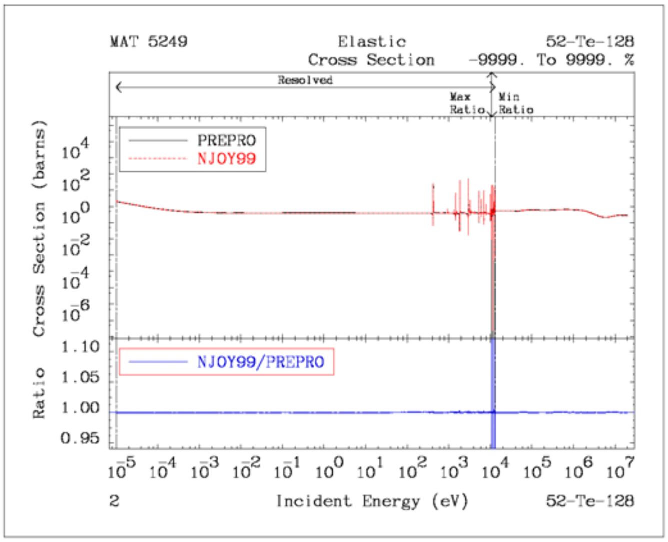

Figure 2.26. Elastic cross section for Te-128 processed by PREPRO-2004 and NJOY99.

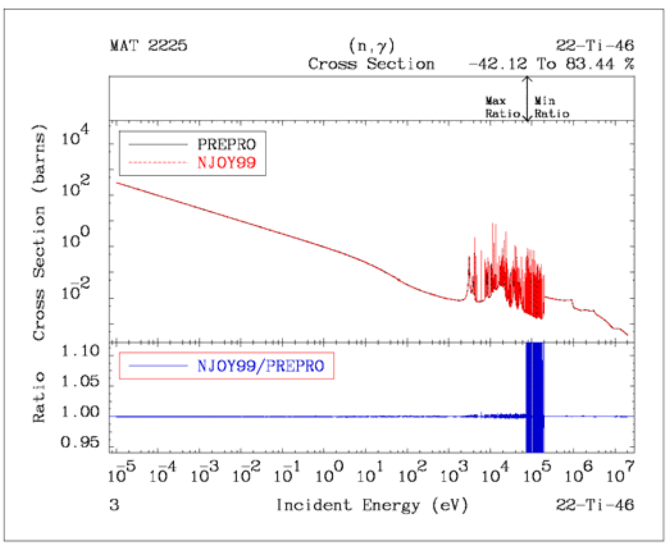

Figure 2.27. Capture cross section for Ti-46 processed by PREPRO-2004 and NJOY99.

2.4.4. Case: Co58

The resonance goes to 0.0 in the resonance capture cross section.

The reason of this problem is due to negative cross sections in MT102 and the combination of a single-level Breit Wigner resonance file.

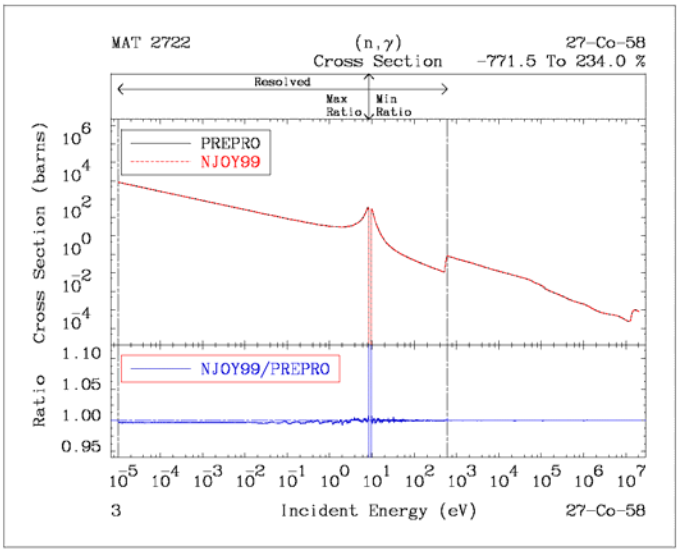

Figure 2.28. Capture cross section for Co-58 processed by PREPRO-2004 and NJOY99.

3. NJOY99.90 + updates to process ACE library.

Several Research Centers have developed specific NJOY99.90 updates to be used in nuclear data processing. Intensive work has been performed in order to compile the most recent NJOY90.90 updates to process the JEFF-3.1 library. [NJOY99_up90, NJOY99_up112]

3.1. NJOY99.90

First, the NJOY99.90 was used to process the JEFF-3.1library. Problems with some isotopes were found in NJOY modules (the NJOY patches able to deal with these problems are identified):

- ACER: Al-27, Cl-35, I-129, Rh-103 (`upn_Cabellos`)
- PURR: Es-253 (`upn_Pescarini`)
- HEATR: Eu-151 (`upn_Pescarini`)
- HETAR: Mo-95 (`upn_Pescarini and upn_Cabellos`)
- GASPR: I-127, Ni-58, Pb-206, Tc-99, Zn0 (`upn_Pescarini or upn_Trkov/Aldama`)

3.2. NJOY99.90+NEA updates

We have considered the most recent NJOY corrections developed by:

- **D. Leichtle, I. Schmuck (FZK)**
  allow for processing of EFF3.0/NMOD=3 9Be with (n,2n) subsections in MT875-890
- **D. L. Aldama, NDS/IAEA Consultant, July 2005**
  Included in ADS-lib/V1.0
- **O. Cabellos, NEA Data Bank Consultant, Sep-2005**
- **A. Hogenbirk (NRG), 21sep2001**
  NRG updates for ACER-processing of delayed neutron data
- **M. Mattes/IKE**
  Thermal scattering cross sections
- **M. Pescarini**
  Updates for JEFF-3.1
- **Kazuaki Kosako**, Shimizu Corporation
- **J.C. Sublet, Feb. 2005**
- **A.Trkov, IAEA**
  IAEA updates, FENDL updates, WLUP updates

We have processed these updates, and we have obtained a unique update to be used in this work. To reach this objective, extensive work has been undertaken:

- checking consistency between different updates
- correcting small bugs

A comparison with the most recent NJOY update, upn112 will be shown in section 3.2.

Figure 3.1. Build NJOY using some NJOY patches

```
REM - Build Updated NJOY for JEFF31 (November 2005)

del *.f

copy
upn90_noup63_noup56+uplf95+upn_Leichtle_Mod+upn_Sublet+upn_Aldama+upn_Mattes+upn_Trkov
+upn_Ads+upn_Cad+upn_Shimizu+upn_Pescarini+upn_Cabellos+upn_Hogenbirk upn

upd.exe

REM -----
REM upn90_noup63_noup56 : (included in upn_Hogenbirk)
REM                  - Include upn90 except for:
REM                  - up63 to treat delayed neutrons (updated in upn_Hogenbirk)
REM                  - up64, up72 and up75 do not include updates for up63
REM                  - up56: converting law7 into law1
REM                  - up64 does not include update for up56
REM
REM uplf95       : for lahey95
REM upn_Trkov    : IAEA upn for fendl2.1
REM       - Include: upiaea1, upijs57,upijs59, upijs61, upijs62, upijs63, upijs64
REM         upiaea2 upiaea3, upfendl1,upfndl2, upfndl3, upfndl4, upfndl5, upfndl6
REM upn_Mattes   : Thermal Scattering Libraries
REM   - Include:  up3_thermr, up1_leapr, up2_leapr, up3_leapr, up4_leapr,
REM               up5_leapr, up_acer
REM                  Modifications in common/xsst/
REM                - Do not include: up_thermr (updated in upn_Aldama)
REM upn_Aldama   : up_therm1 update included in upn_Mattes (included in upn_ADS)
REM upn_Hogenbirk: Delayed neutrons in ACE format for JEFF31.
REM               - Include: nrg_a50, nrg_a52, nrg_a57, nrg_re15 (dla1 in upn_ADS)
REM upn_Sublet   : upki (included in upn_Hogenbirk)
REM upn_ADS      :
REM                  - Include: ads01, ads02, ads03
REM                  - Do not include:
REM                1) upiaea1, upijs57, upijs59, upijs61, upijs62, upijs63, upijs64
REM                   upiaea2 upiaea3, upfendl1, upfndl2, upfndl3, upfndl4,
REM                   upfndl5, upfndl6: included in upn_Trkov
REM                2) wlup2: included in upn_Aldama
REM                3) up3_thermr, up1_leapr, up2_leapr, up3_leapr, up4_leapr,
REM                   up5_leapr, up_acer : included in upn_Mattes
REM                4) upshim: included in upn_Shimizu
REM                5) upcad: included in upn_CAD
REM upn_CAD      : upcad (included in ADS)
REM upn_Shimizu  : upshim (included in ADS)
REM upn_Cabellos : JEFF31 update
REM                -llf
REM upn_Leichtle_Mod : Be-9 and others (Li7)
REM                - Include: upac1, upac2 (with some modifications because it
REM                  corresponds with up57)
REM                - Do not include:
REM                  - upre1 (equivalent to up54)
REM                  - upac3 (equivalent to up57)
REM upn_Pescarini: JEFF31 corrections.
REM              - Does not include updates equivalents to upfndl2, upki,
REM                up_thermr,nrg_re15
REM -----
```

3.3. *NJOY99.112+JEFF3.1-updates*

To process the JEFF-3.1 library with the recently updated release by McFarlane (upn112) we have to include two additional updates:

- The Pescarini's patch

```
*/ --------- correction in heatr/gambar (case Eu-151)
*d heatr.4845

*/ -------- correction in thermr/coh (Be_TH,C_GPH cases)
*i thermr.782

*/ -------- correction in purr/rdf3un (case Es-253)
*i purr.978
```

- The Cabellos' patch

```
*/ Error when processing Al-27, Cl-35,I-129,Rh-103
*/ in acer

*/ Error when processing Thermal Scattering for H-1(in H2O) at
*/ 293.6K (llf=0)
*/ in broadr
```

Table 3.1 . Procedure to obtain NJOY source to process JEFF-3.1 library

```
del *.f

REM ----
copy up112+uplf95+upn_pescarini+upn_cabellos upn
upd.exe
```

In addition, we have compared this upn112 patch with NJOY updates considered in section 3.1. Most of the previous updates are included in upn112, except for:

- The delayed neutron processing by Hogenbirk (FZK). Patch upn112 includes a simplified correction in up96.

```
*/ acer -- 21sep2001 A. Hogenbirk (NRG)
*/ ----------------------------------------------
*/         allow processing of delayed nu data
*/         for use in MCNP (version 4C onwards)
*/ ----------------------------------------------
```

- The Be9(n,2n) processing by D. Leichtle & I. Schmuck (FZK)

```
*/ corrections by D. Leichtle, I. Schmuck (FZK)
*/ allow for processing of EFF3.0/NMOD=3 9Be with (n,2n)
*/ subsections in MT875-890 in ACER.
```

- The upn_Shimizu.

```
*/ Kazuaki Kosako, Shimizu Corporation
*/ MF5 and MF6 INT=21-25 laws modifications
*/ in groupr

*/ Kazuaki Kosako, Shimizu Corporation
*/ kinematic meted
*/ in heatr
```

This upn112 includes the rest of the corrections previously considered in section 3.1. Some additional small corrections are also incorporated in upn112.

4. Conversion of the library: *makxsf*

The program *makxsf* from the MCNP-4C package is used for ASCII to BCD conversion of the library. It can also be used to organize data tables for building cross-section libraries.

Three inputs are required for *makxsf*:

- Nuclear data tables/cross-section libraries
- A data directory file (*xsdir*)
- The file specs (*specs*)

Figure 3.2. Input/Output for makxsf

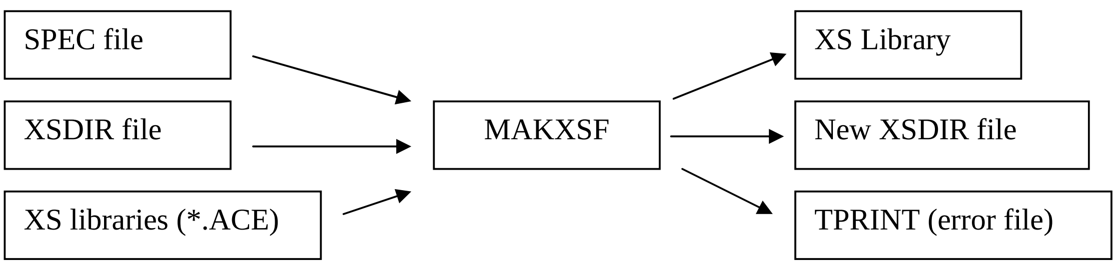

Figure 3.3 . Procedure to make xsdir file: “run_xsdir.bat”

```
REM -------
REM --- Isotopes to build library in: specs_type1
REM --- Update: xsdir_type1 with .dir files
REM -------------------

copy  specs_type1     specs
copy  xsdir_type1     xsdir
makxsf.exe

move tprint tprint_ascii

copy specs_type2      specs
makxsf.exe
move tprint tprint_bin
```

Figure 3.4. File “*specs_type1*”. It describes how the new library will be generated (jeff31_ascii).

```
       xsdir xsdir_ascii
jeff31_ascii          1

  1001.31c
  1002.31c
…
…
 99255.31c
100255.31c
```

Figure 3.5. File “*xsdir_type1* ”. This file contains the header of the classical xsdir file (*datapath*, *atomic weight ratios* and *directory* sections).

The data directory file consists of three sections:

1. Optional line that specifies the path where the cross-section data are located
2. Atomic weight ratios
3. Descriptions of the data tables that form the library. This directory section is completed by adding the *.dir* file for each material processed.

```
datapath=.
atomic weight ratios
   0001  1.000000      0001  1.000000
   1000  0.99931697    1001  0.99916732   1002  1.99679966   1003  2.99013994
   2000  3.96821760    2003  2.99012015   2004  3.96821894
   3000  6.88131188    3006  5.96344945   3007  6.95573316
   4000  8.93476310    4007  6.95665041   4009  8.93476310
…
…
  99000  251.818000    99240  238.006611   99241  238.997765   99242  239.990202
                       99243  240.981544   99244  241.974280   99245  242.966035
                       99246  243.959078   99247  244.951167   99248  245.944369
                       99249  246.936717   99250  247.930357   99251  248.923084
                       99252  249.917457   99253  250.910696   99254  251.905276
                       99255  252.898917   99256  253.893623   99257  254.887399
 100000  252.899000   100255  252.899000
02/03/2000
directory
  1001.31c    0.999170       H1.ACE 0 1   1   10161     0     0 2.585E-08
  1002.31c    1.996800       H2.ACE 0 1   1   10882     0     0 2.585E-08
  1003.31c    2.990140       H3.ACE 0 1   1    7320     0     0 2.585E-08
  2003.31c    2.989032      He3.ACE 0 1   1    9680     0     0 2.585E-08
  2004.31c    3.968200      He4.ACE 0 1   1   26134     0     0 2.585E-08
…
…
 99253.31c  250.910000    Es253.ACE 0 1   1   64848     0     0 2.585E-08 ptable
 99254.31c  251.905000    Es254.ACE 0 1   1   38692     0     0 2.585E-08
 99255.31c  252.899000    Es255.ACE 0 1   1   19107     0     0 2.585E-08
100255.31c  252.899000    Fm255.ACE 0 1   1   17459     0     0 2.585E-08
```

Figure 3.6. File “*specs_type2*”. To convert the ASCII library (jeff31_ascii) into Binary (jeff31_bin).

```
xsdir_ascii  xsdir_bin
jeff31_ascii jeff31_bin 2
```

5. Validation

5.1. Criticality Validation

An extensive criticality validation suite can be used by the *International Handbook of Evaluated Criticality Safety Benchmark Experiments* from the OECD-NEA project ICSBEP [ICSBEP].

It contains cases for a variety of fuels, including:

- 233U
- highly enriched uranium (HEU)
- intermediate-enriched uranium (IEU)
- low-enriched uranium (LEU)
- plutonium

For each type of fuel, there are cases with a variety of:

- moderators
- reflectors
- spectra
- geometries

Two suites of calculations were performed:

1. A Validation Suite proposed by LANL (Russel D. Mosteller)

2. An additional validation, also included in ICSBEP for:
    - Np237
    - heavy-Water solutions
    - very thermal Pu solution
    - unmoderated ZEUS benchmark

Other references have been used to compare these calculations [ALEPH-DLG , JEFDOC-1107].

5.1.1. LANL Validation Suite

A MCNP criticality validation suite has been recently proposed by R.D. Mosteller (LANL) to assess the reactivity impact of improvements to MCNP as well as changes to associated nuclear data libraries [LA-UR-05-8430]. This suite is a collection of 31 benchmarks taken from the *International Handbook of Evaluated Criticality Benchmark Experiments (see Table 1)*. It contains:

- Fuels:
  - 233U
  - 239Pu
  - 235U:
    - highly enriched uranium (HEU)
    - intermediate-enriched uranium (IEU)
    - low-enriched uranium (LEU)

- For each fuel type, there are cases with a variety of:
  - Spectra: Fast, intermediate and thermal
  - Compositions: Metals, oxides and solutions
  - Configurations: Bare and reflected spheres and cylinders, 2-D and 3-D lattices, infinite homogeneous and heterogeneous regions.

Table 4.1. MCNP Criticality Validation Suite proposed by R.D. Mosteller, LANL.

Spectrum	**Fast**			**Intemediate**	**Thermal**	
Geometry	**Bare**	**Heavy reflector**	**Light reflector**	**Any**	**Lattice of fuel Pins in water**	**Solution**
233U	Jezebel-233	Flattop-23	U233-MF-05 (2)*	Falstaff (1)+	SB-2½	ORNL-11
HEU	Godiva Tinkertoy-2 (c11)	Flattop-25	Godiver	UH3 (6) Zeus (2)	SB-5	ORNL-10
IEU	IEU-MF-03	BIG TEN	IEU-MF-04	Zebra-8H#	IEU-CT-02 (3)	STACY-36
LEU					BaW XI (2)	LEU-ST-02
Pu	Jezebel Jezebel-240 Pu Buttons (3)	Flattop-Pu THOR	Pu-MF-11	HISS/HPG	PNL-33	PNL-2

* Numbers in parenthesis identify a specific case within a sequence of benchmarks
\+ Extrapolated to critical
\# k_∞ measurements

The MCNP5 calculations were run with 5,000,000 active neutron histories for all but two cases in the suite (550 generations with 10,000 neutrons per generation, excluding the first 50 generations from the statistics). Only 3,000,000 active histories were used for those cases, SB-5 and Zebra-8H, because they require substantially more computer time per history than the other cases (350 generations). Nonetheless, the standard deviation for keff from those cases is comparable to those for other cases in the suite. This number of histories is sufficient to render the statistical uncertainty from the MCNP5 calculations essentially negligible relative to the benchmark uncertainty for most of the cases in the suite. The cases in the criticality validation suite can be summarized in Table 4.2.

Table 4.2 Description of MCNP Criticality Validation Suite

Name	Spectrum	*Handbook* ID	Description
Jezebel-233	Fast	U233-MET-FAST-001	Bare sphere of ^{233}U
Flattop-23	Fast	U233-MET-FAST-006	Sphere of ^{233}U reflected by normal U
U233-MF-05	Fast	U233-MET-FAST-005, case 2	Sphere of ^{233}U reflected by beryllium
Falstaff-1	Intermediate	U233-SOL-INTER-001, case 1	Sphere of uranyl fluoride solution enriched in ^{233}U
SB-2½	Thermal	U233-COMP-THERM-001, case 3	Lattice of ^{233}U fuel pins in water
ORNL-11	Thermal	U233-SOL-THERM-008	Large sphere of uranyl nitrate solution enriched in ^{233}U
Godiva	Fast	HEU-MET-FAST-001	Bare HEU sphere
Tinkertoy-2	Fast	HEU-MET-FAST-026, case C-11	3 x 3 x 3 array of HEU cylinders in paraffin box
Flattop-25	Fast	HEU-MET-FAST-028	HEU sphere reflected by normal U
Godiver	Fast	HEU-MET-FAST-004	HEU sphere reflected by water
Zeus-2	Intermediate	HEU-MET-INTER-006, case 2	HEU platters moderated by graphite and reflected by copper
UH_3	Intermediate	HEU-COMP-INTER-003, case 6	UH_3 cylinders reflected by depleted uranium
SB-5	Thermal	U233-COMP-THERM-001, case 6	Lattice of HEU fuel pins in water, with blanket of ThO_2 pins
ORNL-10	Thermal	HEU-SOL-THERM-032	Large sphere of HEU nitrate solution
IEU-MF-03	Fast	IEU-MET-FAST-003	Bare sphere of IEU (36 wt.%)
BIG TEN	Fast	IEU-MET-FAST-007	Cylinder of IEU (10 wt.%) reflected by normal uranium
IEU-MF-04	Fast	IEU-MET-FAST-004	Sphere of IEU (36 wt.%) reflected by graphite
Zebra-8H	Intermediate	MIX-MET-FAST-008, case 7	IEU (37.5 wt.%) reflected by normal U and steel
IEU-CT-02	Thermal	IEU-COMP-THERM-002, case 3	Lattice of IEU (17 wt.%) fuel rods in water
STACY-36	Thermal	LEU-SOL-THERM-007, case 36	Cylinder of IEU (9.97 wt.%) uranyl nitrate solution
B&W XI-2	Thermal	LEU-COMP-THERM-008, case 2	Large lattice of LEU (2.46 wt.%) fuel pins in borated water
LEU-ST-02	Thermal	LEU-SOL-THERM-002, case 2	Sphere of LEU (4.9 wt.%) uranyl fluoride solution
Jezebel	Fast	PU-MET-FAST-001	Bare sphere of plutonium
Jezebel-240	Fast	PU-MET-FAST-002	Bare sphere of plutonium (20.1 at.% ^{240}Pu)
Pu Buttons	Fast	PU-MET-FAST-003, case 103	3 x 3 x 3 array of small cylinders of plutonium
Flattop-Pu	Fast	PU-MET-FAST-006	Plutonium sphere reflected by normal U
THOR	Fast	PU-MET-FAST-008	Plutonium sphere reflected by thorium
PU-MF-11	Fast	PU-MET-FAST-011	Plutonium sphere reflected by water
HISS/HPG	Intermediate	PU-COMP-INTER-001	Infinite, homogeneous mixture of plutonium, hydrogen, and graphite
PNL-33	Thermal	MIX-COMP-THERM-002, case 4	Lattice of mixed-oxide fuel pins in borated water
PNL-2	Thermal	PU-SOL-THERM-021, case 3	Sphere of plutonium nitrate solution

This suite can provide a general indication of the overall performance of a nuclear data library, and is not an absolute indicator of the accuracy or reliability of a given nuclear data library.

Table 4.3. Isotopes in these benchmarks models.

Name	Name	Isotopes				
	Jezebel-233	92235	92234	92233	92238	
	Flattop-23	92233	92234	92235	92238	
	U233-MF-05	92233	92234	92238	4009	8016
	Falstaff-1	92234	92233	92232	92238	92235
		9019	8016	26057	26056	26054
		24052	24050	26058	28058	24054
		24053	28062	28061	28060	28064
		4009				
U233	SB-2½	8016	40090	40091	40092	40094
		40096	92233	92234	92238	50112
		50114	50115	50116	50117	50118
		50119	50120	50122	50124	1001
		26054	26056	26057	26058	5010
		24050	24052	24053	24054	25055
		28058	28060	28061	28062	28064
	ORNL-11	92233	92234	92235	92238	7014
		8016	1001	90232	13027	14028
		14029	14030	26054	26056	26057
		26058	29063	29065	25055	
HEU	Godiva	92235	92238	92234		
	Tinkertoy-2					
	Flattop-25	92234	92235	92238		
	Godiver	92234	92235	92236	92238	1001
		8016				
	Zeus-2	92234	92235	92236	92238	12024
		12025	12026	13027	14028	14029
		14030	22046	22047	22048	22049
		22050	24050	24052	24053	24054
		25055	26054	26056	26057	26058
		29063	29065	6000		
	UH3					
	SB-5	8016	40090	40091	40092	40094
		40096	92234	92235	92238	90232
		64152	64154	64155	64156	64157
		64158	64160	50112	50114	50115
		50116	50117	50118	50119	50120
		50122	50124	1001	26054	26056
		26057	26058	5010	24050	24052
		24053	24054	25055	28058	28060
		28061	28062	28064	6000	
	ORNL-10	92233	92234	92235	92236	92238
		1001	7014	8016	13027	14028
		14029	14030	25055	26054	26056
		26057	26058	29063	29065	
LEU	B&W XI-2	5010	8016	92234	92235	92238
		12024	12025	12026	13027	14028
		14029	14030	22046	22047	22048
		22049	22050	24050	24052	24053
		24054	25055	26054	26056	26057
		26058	29063	29065	1001	5011
	LEU-ST-02	92234	92235	92238	9019	1001
		8016	13027	14028	14029	14030
		29063	29065	25055		

IEU	IEU-MF-03	92234	92235	92238	26054	26056
		26057	26058	6000	29063	29065
		28058	28060	28061	28062	28064
		74182	74183	74184	74186	
	BIG TEN	92234	92235	92236	92238	14028
		14029	14030	24050	24052	24053
		24054	25055	26054	26056	26057
		26058	28058	28060	28061	28062
		28064	41093			
	IEU-MF-04	92234	92235	92238	26054	26056
		26057	26058	6000	74182	74183
		74184	74186			
	Zebra-8H	92235	92238	6000	26054	26056
		26057	26058	14028	14029	14030
		1001	13027	8016	24050	24052
		24053	24054	28058	28060	28061
		28062	28064	42092	42094	42095
		42096	42097	42098	42100	25055
		29063	29065	22046	22047	22048
		22049	22050	23000		
	IEU-CT-02	92234	92235	92238	8016	26054
		26056	26057	26058	24050	24052
		24053	24054	28058	28060	28061
		28062	28064	25055	14028	14029
		14030	22046	22047	22048	22049
		22050	6000	1001	64152	64154
		64155	64156	64157	64158	64160
		13027				
	STACY-36	1001	7014	8016	92234	92235
		92236	92238	6000	14028	14029
		14030	25055	15031	16032	16033
		16034	16036	28058	28060	28061
		28062	28064	24050	24052	24053
		24054	26054	26056	26057	26058
PU	Jezebel	94239	94240	94241	31000	
	Jezebel-240	94239	94240	94241	94242	31000
	Pu Buttons	94239	94240	94241	94242	13027
		26054	26056	26057	26058	
	Flattop-Pu	94239	94240	94241	31000	92234
		92235	92238			
	THOR	94239	94240	94241	31000	90232
	PU-MF-11	94239	94240	94241	94242	1001
		8016				
	HISS/HPG	1001	5010	5011	6000	8016
		20040	20042	20043	20044	20046
		20048	94239	94240	94241	94242
	PNL-33					
	PNL-2	94238	94239	94240	94241	94242
		7014	1001	8016	26054	26056
		26057	26058	24050	24052	24053
		24054	28058	28060	28061	28062
		28064	25055			

Table 4.4. Results for the Criticality Validation Suite

		Description	Benchmark	ENDF/B-VII R. D. Mosteller	NRG JEFF3.0	NRG JEFF3.1	NEA JEFF3.1
PU	Fast	Jezebel	1.00000 (200)	0.99980 (30)	1.00052 (40)	1.00010 (19)	1.00038 (26)
		Jezebel-240	1.00000 (200)	1.00030 (30)	-	**1.00428 (67)**	1.00337 (27)
		Pu Buttons	1.00000 (300)	099840 (30)	-	-	0.99698 (30)
		Flattop-Pu	1.00000 (300)	1.00040 (30)	**0.99492 (44)**	**1.00267 (43)**	**1.00277 (31)**
		THOR	1.00000 (60)	**1.00790 (30)***	**1.00937 (45)**	**1.00305 (35)**	**1.00271 (27)**
		Pu-MF-11	1.00000 (100)	0.99920 (40)	-	-	**0.99722 (34)**
	Interm	HISS/HPG	1.00000 (1100)	1.01060 (20)	1.00608 (57)	1.00716 (44)	1.00654 (42)
	Thermal	PNL-33	1.00240 (210)	1.00630 (30)			
		PNL-2	1.00000 (650)	1.00290 (50)	-	-	1.00504 (43)
U233	Fast	Jezebel-233	1.00000 (100)	0.99970 (30)	**1.01359 (38)**	**1.00445 (107)**	**1.00379 (24)**
		Flattop-23	1.00000 (140)	0.99940 (30)	**1.00391 (53)**	**1.00608 (44)**	**1.00612 (30)**
		U233-MF-05_case2	1.00000 (300)	0.99790 (30)	**1.00710 (49)**	1.00033 (48)	1.00010 (30)
	Interm	Falstaff_case1	1.00000 (830)	0.99050 (50)	-	-	0.98416 (48)
	Therm	SB_2.5	1.00000 (240)	0.99880 (40)	0.99848 (112)	0.99761 (112)	0.99700 (44)
		ORNL-11	1.00060 (290)	1.00410 (20)	-	-	0.99723 (17)
HEU	Fast	Godiva	1.00000 (100)	0.99940 (30)	**0.99596 (40)**	**0.99644 (19)**	**0.99696 (27)**
		Tinkertoy-2	1.00000 (380)	1.00040 (30)			
		Flattop-25	1.00000 (300)	1.00290 (30)	**0.99379 (43)**	1.00275(51)	1.00220 (28)
		Godiver	0.99850 (110)	0.99780 (40)	**-**	-	**0.99444 (32)**
	Intermediate	Zeus-2	1.00010 (80)	**0.99580 (40)**	**0.99394 (90)**	**0.99540 (84)**	**0.99490 (35)**
		UH3	1.00000 (470)	0.99520 (40)			
	Thermal	SB-5	1.00150 (280)	**0.99570 (50)**	-	0.99731 (102)	0.99797 (50)
		ORNL-10	1.00150 (260)	0.99890 (20)	-	0.99855 (37)	0.99874 (17)
IEU	Fast	IEU-MF-03	1.00000 (170)	1.00270 (30)	-	-	0.99897 (27)
		BIG-TEN	0.99480 (130)	0.99520 (20)	**1.00058 (28)**	**0.99798 (28)**	**0.99774 (23)**
		IEU-MF-04	1.00000 (300)	**1.00720 (30)**	-	-	1.00379 (28)
	Intermediate	Zebra-8H	1.03000 (250)	**1.01980 (20)**	-	-	**1.01579 (23)**
	Thermal	IEU-CT-02_c3	1.00170 (440)	1.00080 (30)	0.99987 (80)	0.99941 (82)	1.00081 (33)
		STACY-36	0.99880 (130)	0.99940 (30)	0.99920 (56)	1.00109 (67)	0.99860 (20)
LEU	Thermal	BaW XI_2	1.00070 (120)	1.00000 (30)	-	-	0.99984 (30)
		LEU-ST-02_c2	1.00240 (370)	0.99610 (30)	-	-	0.99630 (28)

*Cases with differences more than 2*σ are marked in red.

In conclusion:

- For PU:
  - Deficiencies in fast cases
- For U233:
  - Deficiencies in fast cases
- For HEU:
  - Deficiencies in fast and intermediate cases
  - Improvement in thermal case SB-5
- For IEU:
  - Deficiencies in fast and intermediate cases
  - Improvements in IEU-MF-03 (bare) and IEU-MF-04 (light reflector)
- For LEU:
  - Good approximation (need for ad hoc adjustment to 238U resonance integral may be eliminated)

5.1.2. Additional Validation

Some interesting Benchmark have been evaluated in [LA-UR-05-8430].

This Validation Suite is included in Reference [ICSBEP].

Most of them are not in electronic format, so a tedious hand-work has been performed to process these files.

Table 4.5. Additional criticality validation tests from ICSBEP.

		Case	Benchmark	ENDF/B-VII R. D. Mosteller	NEA JEFF3.1
PU	**Thermal**	PU-SOL-THERM-009 (48-inch sphere of plutonium nitrate solution)	1.00030 (330)	1.01910 (20)	1.01515 (49)
		• Same sphere as for ORNL-10 (HEU) and ORNL-11 (U233) Benchmarks • Very thermal spectra with vey little leakage • Cross sections for Pu239 should be re-examined in the deep thermal range			
HEU	**Fast**	HEU-MET-FAST-73 (Unmoderated ZEUS benchmark)	1.00120 (150)	1.00800 (30)	1.00849 (26)
		• Benchmark contains no moderator and therefore has a fast spectrum • Fast cross sections for Cu should be reviewed			
HEU	**Thermal**	HEU-SOL-THERM-004_case1 (Heavy water solutions, reflected spheres)	1.00000 (330)	0.98390 (40)	0.98438 (38)
		• Improvement for cases with deuterium d			
SPEC	**Thermal**	SPEC-MET-FAST-08 (Neptunium sphere reflected by HEU)	1.00190 (360)	0.99240 (30)	0.99177 (24)
		• Fast cross sections for Np-237 should be reviewed			

5.2. Radiation-Shielding validation Suite

The present benchmark calculations use specifications given in the SINBAD Database [SINBAD]. Other references have been used to compare these calculations [ALEPH-DLG , JEFDOC-1106].

5.2.1. EURAC-Fe

Ispra Iron Benchmark Experiment (EURACOS). Study of the neutron deep penetration in homogeneous materials commonly used in the construction of advanced reactors: Fe (and Na). Flux and spectra were measured up to 130 cm in Fe.

Table 4.6. Results for EURAC-Fe using different data libraries

Distance (cm)	**measured**	**cell**	**Endf60**	**NRG JEFF-3.1**	**Endf-602 + Fe56 (JEFF-3.1)**	**NEA JEFF-3.1**
54	2.872e+0	47	2.746E+00	2.742E+00	3.738E+00	3.997E+00
62	6.398e-1	48	6.717E-01	6.652E-01	9.503E-01	1.013E+00
70	1.338e-1	49	1.615E-01	1.595E-01	2.390E-01	2.537E-01
78	3.045e-2	50	3.880E-02	3.769E-02	5.991E-02	6.331E-02
86	7.025e-3	51	9.274E-03	9.115E-03	1.501E-02	1.577E-02
94	2.372e-3	52	2.227E-03	2.161E-03	3.780E-03	3.936E-03

Significant differences are obtained mainly due to Fe56.

5.2.2. KANT

KANT Spherical Shell Transmission Experiment on Beryllium. The purpose at the time of the experiment was mainly to clarify the discrepancies found by other researchers in the effective neutron multiplication of bulk beryllium assemblies with central 14 MeV neutron sources.

Recorded neutron leakage spectra from 5, 10 and 17 cm thick spherical beryllium shells from the source energy down to less than 10 eV is evaluated.

The KANT input included in SINBAD Database has a problem with the geomtry.

It stops before end with the message:

```
"run terminated because  10 particles got lost"
```

Finally, an updated input has been included in SINBAD Database by A.Serikov and D. Leichtle/U.Fischer in March 2006.

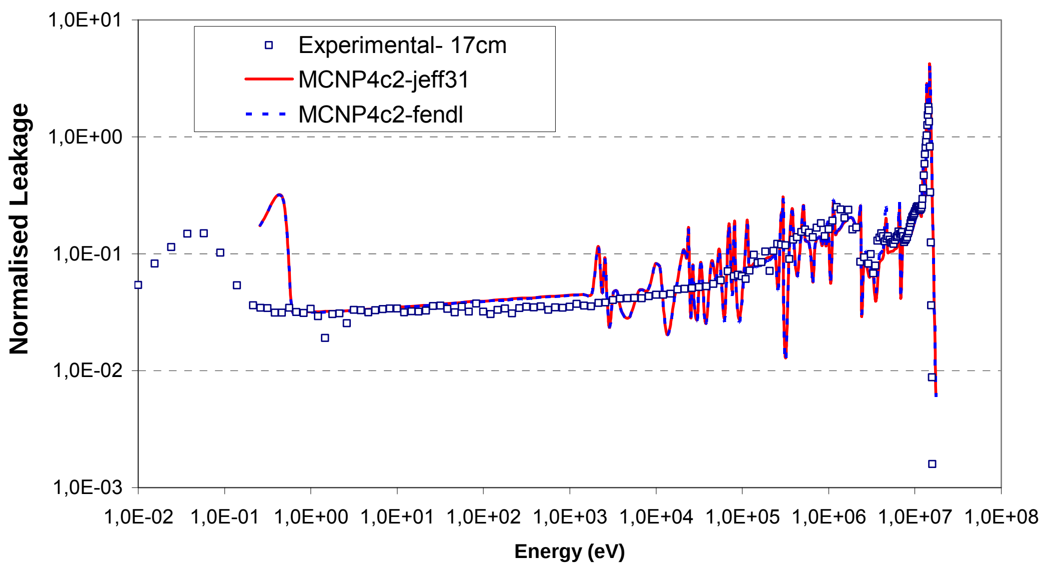

Figure 4.1. Normalized leakage neutron fluence from 17 cm Be shell. KANT Experiment.

5.2.3. VENUS

The VENUS Critical Facility is a zero power reactor located at CEN/SCK, Mol (Belgium).

There is a problem with the geometry: MCNP4C2 does not run this case.

5.2.4. NIST

A Cf source was placed at the centre of the experiment, and fission foils were placed at two, diametrically oposed positions. Between the source and the fission foils were several combinations of shielding materials.

5.2.4.1. NoCd+NoWater+2,0"

Table 4.7. C/E values for the fission rates in the NIST benchmark

Bare= NoCd+NoWater+2,0"									
	Exper.		Tally2		MCNP	MCNP*4*pi*r**2		LA-13675	
	(b)	(%)	<xs*flux>	error	Fission rates	Fission rates	MCNP-JEFF-3.1 C/E	MCNP-ENDFB-V C/E	
U235	1,279	1,6	1,73E-03	0,001	1,73E-03	1,27E+00	0,989	1,006	0,017
Pu239	1,924	1,5	2,55E-03	0,001	2,55E-03	1,86E+00	0,966	0,965	0,016
U238	0,334	1,7	4,33E-04	0,001	4,33E-04	3,16E-01	0,945	0,940	0,018
Np237	1,42	1,8	1,90E-03	0,001	1,90E-03	1,38E+00	0,975	0,969	0,019

5.2.4.2. Cd+Water+2,5"

Table 4.8. C/E values for the fission rates in the NIST benchmark

Cd+Water+2,5"									
	Exper.		Tally2		MCNP	MCNP*4*pi*r**2		LA-13675	
	(b)	(%)	<xs*flux>	error	Fission rates	Fission rates	MCNP-JEFF-3.1 C/E	MCNP-ENDFB-VI C/E	
U235	5,86	1,7	5,14E-03	0,005	5,14E-03	5,86E+00	1,000	1,048	0,035
Pu239	7,74	1,9	6,58E-03	0,006	6,58E-03	7,50E+00	0,969	0,977	0,042
U238	0,171	1,9	1,42E-04	0,004	1,42E-04	1,62E-01	0,946	0,941	0,03
Np237	0,748	1,9	6,34E-04	0,003	6,34E-04	7,22E-01	0,966	0,945	0,026

5.2.5. IPPE-FE

IPPE neutron transmission benchmark experiment with 14 MeV neutrons through iron shells. Neutron leakage spectra between 50 keV and 15 MeV from five iron shells were measured by the time-of-flight technique using a 14 MeV neutron generator. The spheres had radii from 4.5 to 30.0 cm and wall thicknesses from 2.5 to 28.0 cm.

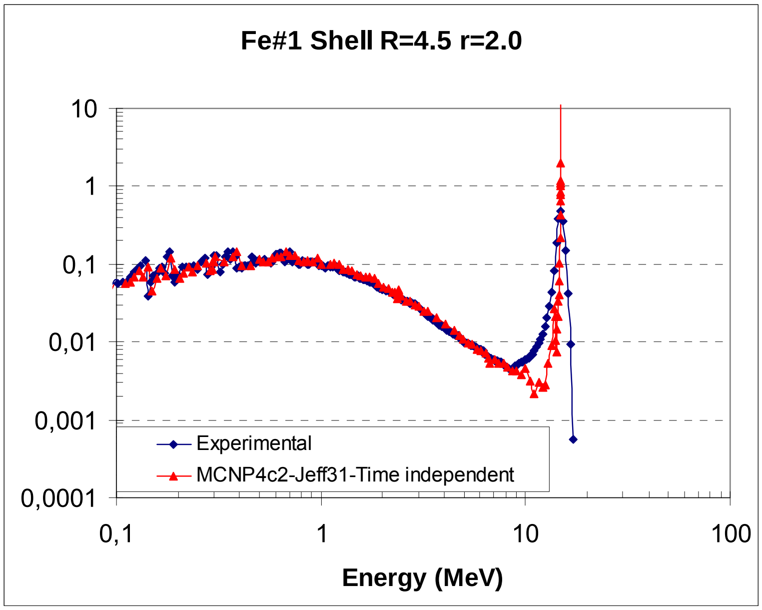

Figure 4.2. Neutron leakage spectra for iron shell No. 1: Experimental values versus MCNP4c2 calculation.

5.2.6. FNS: Oxygen

The neutron spectrum emerging from slabs of material of varying thickness, was measured at five different angles. The slabs were placed at 20 cm distance from a 14 MeV D-T neutron source.

The input included in SINBAD Database does not run with MCNP4c.

- A problem in soubroutine calcps.f, in line:
  `erg=eg0*(t1*(cs+sqrt(cs**2-t3)))**2`
  `where cs**2<t3`

This input runs with MCNP4c2.

The normalization factor used is: $Flux_{experimental} = Flux_{calculated} * L^2 / As$

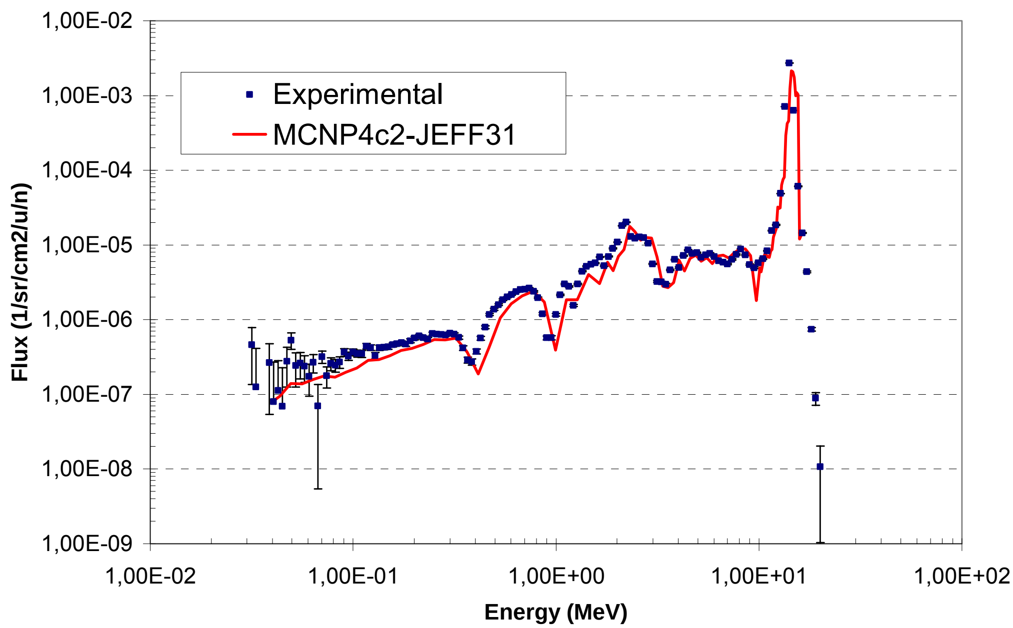

Figure 4.3. Neutron spectrum for the FNS, O, 20 cm, at 0 ºangle.

5.2.7. Oktavian: Al

In the Oktavian benchmark, the leakage current spectrum from the outer surface of a spherical pile of material is measured. At the centre of a pile a 14 MeV D-T neutron source was located.

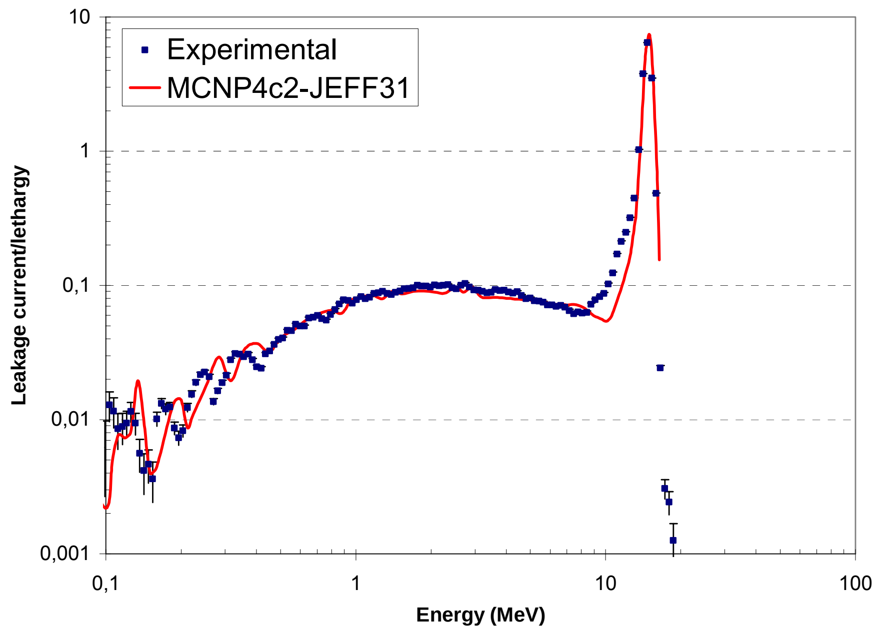

Figure 4.4. Result for the neutron leakage spectrum for the Oktavian Al benchmark

5.2.8. LLNL Pulsed Spheres: Iron, 4.8 MFP

These pulsed sphere experiments were performed by Lawrence Livermore National Laboratory (LLNL). Time-of-flight meausurements were performed for neutrons passing trough spherical shells of varying thickness, containing different materials. The source was a 14 MeV D-T neutron source. [LA-12885]

These experiments are more sensitive to cross section data and even angular distributions when compared to integral benchmarks.

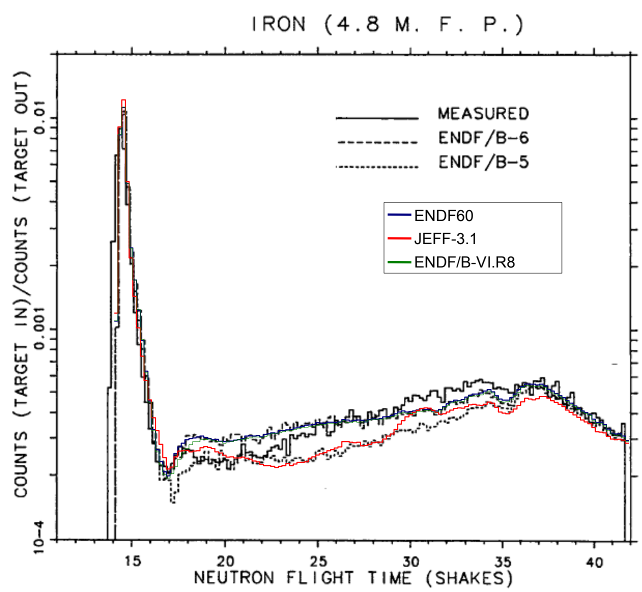

Figure 4.5. Neutron spectrum for the LLNL Pulsed sphere, iron, 4.8 mfp.

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APENDIX A

Inputs for Scattering Thermal Libraries

A.1 Be at 1200K

```
moder / Extract thermal Scattering Law
1 -61
' 4-Be     from JEFF3.1'/
60 26
0/
moder / Extract/convert neutron evaluated data
1 -21
'4-Be from JEFF3.1'/
20 425
0/
reconr / Reconstruct XS for neutrons
-21 -22
'JEFF3.1 PENDF for 4-Be'/
425 2/
0.001 0. 0.003/ err tempr errmax
'JEFF3.1: 4-Be from JEFF3.1'/
'Processed by NJOY99.90+NEA Oct2005'/
0/
broadr / Doppler broaden XS
-21 -22 -23
425 1 0 0 0./
0.001 2.0e6 0.003/ errthn thnmax errmax
1200.0
0/
thermr / Add thermal scattering data (free gas)
  0 -23 -62
0 425 12 1 1  2 1 221 1/
1200.0
0.001 5.0
thermr / Add thermal scattering data (bound)
 -61 -62 -27
26 425 16 1 4  2 1 231 1/
1200.0
0.001 5.0
acer / Prepare ACE files
-21 -27 0 28 29
2 0 1 .31/
'4-Be    1200.0 K from (JEFF3.1) NJOY99.90+NEA Oct2005'/
425 1200.0 'bena08' /
 4009    0    0 /
 231 64 232  0  1 4.0 0/
acer / Check ACE files
0 28 0 71 81
7 1 1 -1/
/
stop
```

A.2 Be in BeO at 1200K

```
moder / Extract thermal Scattering Law
1 -61
' 4-Be     from JEFF3.1'/
60 26
0/
moder / Extract/convert neutron evaluated data
1 -21
'4-Be from JEFF3.1'/
20 425
0/
reconr / Reconstruct XS for neutrons
-21 -22
'JEFF3.1 PENDF for 4-Be'/
425 2/
0.001 0. 0.003/ err tempr errmax
'JEFF3.1: 4-Be from JEFF3.1'/
'Processed by NJOY99.90+NEA Oct2005'/
0/
broadr / Doppler broaden XS
-21 -22 -23
425 1 0 0 0./
0.001 2.0e6 0.003/ errthn thnmax errmax
1200.0
0/
thermr / Add thermal scattering data (free gas)
  0 -23 -62
0 425 12 1 1  3 1 221 1/
1200.0
0.001 5.0
thermr / Add thermal scattering data (bound)
 -61 -62 -27
26 425 16 1 4  3 2 233 1/
1200.0
0.001 5.0
acer / Prepare ACE files
-21 -27 0 28 29
2 0 1 .31/
'4-Be    1200.0 K from (JEFF3.1) NJOY99.90+NEA Oct2005'/
425 1200.0 'beo08 ' /
 4009 8016    0 /
 233 64 234  0  2 4.0 0/
acer / Check ACE files
0 28 0 71 81
7 1 1 -1/
/
stop
```

A.3 D in D2O at 643.9K

```
moder / Extract thermal Scattering Law
1 -61
' D-D2O    from JEFF3.1'/
60 11
0/
moder / Extract/convert neutron evaluated data
1 -21
'1-H-2 from JEFF3.1'/
20 128
0/
reconr / Reconstruct XS for neutrons
-21 -22
'JEFF3.1 PENDF for 1-H-2'/
128 2/
0.001 0. 0.003/ err tempr errmax
'JEFF3.1: 1-H-2 from JEFF3.1'/
'Processed by NJOY99.90+NEA Oct2005'/
0/
broadr / Doppler broaden XS
-21 -22 -23
128 1 0 0 0./
0.001 2.0e6 0.003/ errthn thnmax errmax
643.9
0/
thermr / Add thermal scattering data (free gas)
  0 -23 -62
0 128 12 1 1  0 1 221 1/
643.9
0.001 5.0
thermr / Add thermal scattering data (bound)
 -61 -62 -27
11 128 16 1 4  0 2 228 1/
643.9
0.001 5.0
acer / Prepare ACE files
-21 -27 0 28 29
2 0 1 .31/
'D-D2O   643.9 K from (JEFF3.1) NJOY99.90+NEA Oct2005'/
128 643.9 'hwtr08' /
 1002    0    0 /
 228 64   0  0  1 4.0 0/
acer / Check ACE files
0 28 0 71 81
7 1 1 -1/
/
stop
```

A.4 H in H2O at 1000K

```
moder / Extract thermal Scattering Law
1 -61
' H-H2O    from JEFF3.1'/
60 1
0/
moder / Extract/convert neutron evaluated data
1 -21
'1-H-1 from JEFF3.1'/
20 125
0/
reconr / Reconstruct XS for neutrons
-21 -22
'JEFF3.1 PENDF for 1-H-1'/
125 2/
0.001 0. 0.003/ err tempr errmax
'JEFF3.1: 1-H-1 from JEFF3.1'/
'Processed by NJOY99.90+NEA Oct2005'/
0/
broadr / Doppler broaden XS
-21 -22 -23
125 1 0 0 0./
0.001 2.0e6 0.003/ errthn thnmax errmax
1000.0
0/
thermr / Add thermal scattering data (free gas)
  0 -23 -62
0 125 12 1 1  0 1 221 1/
1000.0
0.001 5.0
thermr / Add thermal scattering data (bound)
 -61 -62 -27
1 125 16 1 4  0 2 222 1/
1000.0
0.001 5.0
acer / Prepare ACE files
-21 -27 0 28 29
2 0 1 .31/
'H-H2O   1000.0 K from (JEFF3.1) NJOY99.90+NEA Oct2005'/
125 1000.0 'lwtr11' /
 1001    0    0 /
 222 64   0  0  1 4.0 0/
acer / Check ACE files
0 28 0 71 81
7 1 1 -1/
/
stop
```

A.5 H in HZr at 1200K

```
moder / Extract thermal Scattering Law
1 -61
' H-ZrH    from JEFF3.1'/
60 7
0/
moder / Extract/convert neutron evaluated data
1 -21
'1-H-1 from JEFF3.1'/
20 125
0/
reconr / Reconstruct XS for neutrons
-21 -22
'JEFF3.1 PENDF for 1-H-1'/
125 2/
0.001 0. 0.003/ err tempr errmax
'JEFF3.1: 1-H-1 from JEFF3.1'/
'Processed by NJOY99.90+NEA Oct2005'/
0/
broadr / Doppler broaden XS
-21 -22 -23
125 1 0 0 0./
0.001 2.0e6 0.003/ errthn thnmax errmax
1200.0
0/
thermr / Add thermal scattering data (free gas)
  0 -23 -62
0 125 12 1 1 12 1 221 1/
1200.0
0.001 5.0
thermr / Add thermal scattering data (bound)
 -61 -62 -27
7 125 16 1 4 12 2 225 1/
1200.0
0.001 5.0
acer / Prepare ACE files
-21 -27 0 28 29
2 0 1 .31/
'H-ZrH   1200.0 K from (JEFF3.1) NJOY99.90+NEA Oct2005'/
125 1200.0 'hzrh08' /
 1001    0    0 /
 225 64 226  1  1 4.0 0/
acer / Check ACE files
0 28 0 71 81
7 1 1 -1/
/
stop
```

A.6 H in CH2 at 350K

```
moder / Extract thermal Scattering Law
1 -61
' H-CH2    from JEFF3.1'/
60 37
0/
moder / Extract/convert neutron evaluated data
1 -21
'1-H-1 from JEFF3.1'/
20 125
0/
reconr / Reconstruct XS for neutrons
-21 -22
'JEFF3.1 PENDF for 1-H-1'/
125 2/
0.001 0. 0.003/ err tempr errmax
'JEFF3.1: 1-H-1 from JEFF3.1'/
'Processed by NJOY99.90+NEA Oct2005'/
0/
broadr / Doppler broaden XS
-21 -22 -23
125 1 0 0 0./
0.001 2.0e6 0.003/ errthn thnmax errmax
350.0
0/
thermr / Add thermal scattering data (free gas)
  0 -23 -62
0 125 12 1 1 11 1 221 1/
350.0
0.001 5.0
thermr / Add thermal scattering data (bound)
 -61 -62 -27
37 125 16 1 4 11 2 223 1/
350.0
0.001 5.0
acer / Prepare ACE files
-21 -27 0 28 29
2 0 1 .31/
'H-CH2   350.0 K from (JEFF3.1) NJOY99.90+NEA Oct2005'/
125 350.0 'poly02' /
 1001    0    0 /
 223 64 224  1  1 4.0 0/
acer / Check ACE files
0 28 0 71 81
7 1 1 -1/
/
stop
```

A.7 Graphite at 3000K

```
moder / Extract thermal Scattering Law
1 -61
' Graphi   from JEFF3.1'/
60 31
0/
moder / Extract/convert neutron evaluated data
1 -21
'6-C from JEFF3.1'/
20 600
0/
reconr / Reconstruct XS for neutrons
-21 -22
'JEFF3.1 PENDF for 6-C'/
600 2/
0.001 0. 0.003/ err tempr errmax
'JEFF3.1: 6-C from JEFF3.1'/
'Processed by NJOY99.90+NEA Oct2005'/
0/
broadr / Doppler broaden XS
-21 -22 -23
600 1 0 0 0./
0.001 2.0e6 0.003/ errthn thnmax errmax
3000.0
0/
thermr / Add thermal scattering data (free gas)
  0 -23 -62
0 600 12 1 1  1 1 221 1/
3000.0
0.001 5.0
thermr / Add thermal scattering data (bound)
 -61 -62 -27
31 600 16 1 4  1 1 229 1/
3000.0
0.001 5.0
acer / Prepare ACE files
-21 -27 0 28 29
2 0 1 .31/
'Graphi  3000.0 K from (JEFF3.1) NJOY99.90+NEA Oct2005'/
600 3000.0 'grph11' /
 6000    0    0 /
 229 64 230  0  1 4.0 0/
acer / Check ACE files
0 28 0 71 81
7 1 1 -1/
/
stop
```

APENDIX B

Inputs for NJOY processing

B.1 Ag109 at 1200K (without PURR module)

```
moder / Extract/convert neutron evaluated data
1 -21
'47-Ag-109 from JEFF3.1'/
20 4731
0/
reconr / Reconstruct XS for neutrons
-21 -22
'JEFF3.1 PENDF for 47-Ag-109'/
4731 2/
0.001 0. 0.003/ err tempr errmax
'JEFF3.1: 47-Ag-109 from JEFF3.1'/
'Processed by NJOY-99.90 at NEA Oct2005'/
0/
broadr / Doppler broaden XS
-21 -22 -23
4731 1 0 0 0./
0.001 2.0e6 0.003/ errthn thnmax errmax
1000.
0/
heatr / Add heating kerma and damage energy
-21 -23 -24/
4731 7 0 0 0 2/
302 303 304 318 402 443 444/
gaspr / Add gas production
-21 -24 -25
thermr / Add thermal scattering data
  0 -25 -26
0 4731 12 1 1 0 1 221 1/
1000.
0.001 4.0
1000.
1.E+10
0/
acer / Prepare ACE files
-21 -26 0 27 28
1 0 1 .38/
'47-Ag-109 from JEFF3.1(JEFF3.1) NJOY 99.90 NEA Oct2005'/
4731 1000.
1 1/
/
acer / Check ACE files
0 27 0 29 30
7 1 1 -1/
/
stop
```

B.2 U235 at 300K (with PURR module)

```
moder / Extract/convert neutron evaluated data
1 -21
'92-U-235 from JEFF3.1'/
20 9228
0/
reconr / Reconstruct XS for neutrons
-21 -22
'JEFF3.1 PENDF for 92-U-235'/
9228 2/
0.001 0. 0.003/ err tempr errmax
'JEFF3.1: 92-U-235 from JEFF3.1'/
'Processed by NJOY-99.90 at NEA Oct2005'/
0/
broadr / Doppler broaden XS
-21 -22 -23
9228 1 0 0 0./
0.001 2.0e6 0.003/ errthn thnmax errmax
1000.
0/
heatr / Add heating kerma and damage energy
-21 -23 -24/
9228 7 0 0 0 2/
302 303 304 318 402 443 444/
gaspr / Add gas production
-21 -24 -25
thermr / Add thermal scattering data
  0 -25 -41
0 9228 12 1 1 0 1 221 1/
1000.
0.001 4.0
purr / Process Unresolved Resonance Range if any
-21 -41 -26
9228 1 1 20 100/ matd ntemp nsigz nbin nladr
1000.
1.E+10
0/
acer / Prepare ACE files
-21 -26 0 27 28
1 0 1 .38/
'92-U-235 from JEFF3.1(JEFF3.1) NJOY 99.90 NEA Oct2005'/
9228 1000.
1 1/
/
acer / Check ACE files
0 27 0 29 30
7 1 1 -1/
/
stop
```

APENDIX C

NJOY patchs (the rest of the patch will be included in electronic format)

C.1 upn90_noup63_noup56

```
REM -----
REM upn90_noup63_noup56 : (included in upn_Hogenbirk)
REM                  - Include upn90 except for:
REM                  - up63 to treat delayed neutrons (updated in upn_Hogenbirk)
REM                  - up64, up72 and up75 do not include updates for up63
REM                  - up56: converting law7 into law1
REM                  - up64 does not include update for up56
REM
```

```
*cpl all
*set sw
*ident up1
*/ leapr -- 04apr00
*/ this fixes errors that destroy the calculation of s(alpha,beta)
*/ for cold para-hydrogen and for both cold deuteriums.  the first
*/ was introduced in 97.53 while making the constants symbolic,
*/ and the second was introduced in the cleanup process for njoy99.
*d leapr.1902
      if (law.gt.3) de=ded
*d leapr.2121
         sum2=(sjbes(jp,y)*cn(j,jp,jp))**2
*ident up2
*/ groupr -- 04apr00
*/ there is an error in the indexing for the xmas 172-group structure
*/ that throws all the group bounds off by one.  this structure is
*/ used in europe for thermal reactor calculations.
*d groupr.1835
            eg(ig)=eg18(174-ig)
*/ fix a problem introduced with the activation patch of 97.102.  the
*/ nk parameter is only used when doing mf values for activation
*/ products, and it is not appropriate for fission nubar values.
*d groupr.3824
      nk=0
      if (mf.gt.99) nk=nint(a(iyld+4))
*i groupr.3853
      if (nk.eq.0) go to 180
*/ don't strip off the upscatter groups for the neutron spectra
*/ coming from delayed neutron emission (mt=455).
*d groupr.8913
                  if (mfd.ne.15.and.mtd.ne.455) then
*/ add a missing save statement and fix an unset variable in anased.
*/ these problems affect delayed neutron spectra.
*d groupr.8983
      save new,theta,xc,rc,bot,ca,loct
*i groupr.9050
         np=nint(a(loct+6))
*ident up3
*/ acer -- 04apr00
*/ the acer consistency checks include an option to readjust
*/ eprime values that are greater than e, when appropriate.
*/ there are some problems with the logic, especially for
*/ cases that use histogram interpolation for the distribution.
*i acer.18017
                           ishift=j-nn-1
*d acer.18019
                           xss(j+loci)=sigfig(epmax,7,ishift)
*i acer.18022
```

```
                              xss(j-1+nn+loci)=p
                              xss(j+nn+loci)=p
*i acer.18026
                              xss(j+nn+loci)=p
*d acer.18028
*i acer.18131
                              xss(j-1+nn+loci)=p
                              xss(j+nn+loci)=p
*i acer.18135
                              xss(j+nn+loci)=p
*d acer.18137
*/ when using the old format (mcnp4b and earlier), some angle-energy
*/ distributions from file 6 are converted into the law 67 format,
*/ because these earlier versions of mcnp couldn't use all the
*/ file 6 representations.  when converting from the cm to the lab,
*/ the methods used in subroutine fix6 are a little crude.  they get
*/ confused when cm energies are so small that lab cosines of -1
*/ are not reached.  this patch tries to fix that in a rough way,
*/ but evaluations that use the cm frame in file 6 will work best
*/ if most of the cm energies are greater than e/(awr+1)**2 for
*/ each incident energy e.  for mcnp4c and later, the code can
*/ sample directly from tabulated cm representations, and the
*/ approximations of the fix6 routine are avoided.  this patch
*/ is needed for one evaluation from JEFF-3.
*d acer.3238
*i acer.3250
      data namax/1000/
*d acer.3353
                  if (lct.ne.1) then
*d acer.3372
                     if (ep.gt.zero) then
                        csn=clb*sqrt(elb/ep)-sqrt(ein/ep)/aw1
                     endif
*i acer.3398,3420
                  if (j.le.l2+8.or.elb.gt.a(j-2)) then
                     a(j)=elb
                     a(j+1)=fmu*drv
                     j=j+2
                  endif
                  if (j.ge.namax-1) call error('fix6',
     &              'storage in a exceeded',' ')
*i acer.3421
               nnep=(j-(l2+8))/2
               if (nnep.eq.1) then
                  a(l2+10)=2*a(l2+8)
                  a(l2+11)=0
                  nnep=2
               endif
               a(l2+5)=nnep
               a(l2+6)=nnep
               j2=l2
               call tab1io(0,nout,ndebug,a(j2),nb,nw)
               do while (nb.ne.0)
                  j2=j2+nw
                  call moreio(0,nout,ndebug,a(j2),nb,nw)
               enddo
*/ increase the available storage to handle the very large
*/ mf6/mt16 tabulation in JEFF-3 Be-9.
*d acer.226
      common/astore/a(80000)
*d acer.235
      data namax/80000/, nidmax/27/
*d acer.460
      common/astore/a(80000)
*d acer.2130
      data nwmaxn/65000/
*d acer.4672
      common/astore/a(80000)
```

```
*d acer.5604
      common/astore/a(80000)
*d acer.5765
      common/astore/a(80000)
*d acer.5954
      common/astore/a(80000)
*d acer.6326
      common/astore/a(80000)
*d acer.7385
      common/astore/a(80000)
*d acer.8058
      common/astore/a(80000)
*d acer.8068
      data namax/40000/
*d acer.9762
      common/astore/a(80000)
*d acer.10677
      common/astore/a(80000)
*d acer.13068
      common/astore/a(80000)
*d acer.13464
      common/astore/a(80000)
*d acer.14300
      common/astore/a(80000)
*d acer.14665
      common/astore/a(80000)
*d acer.15215
      common/astore/a(80000)
*d acer.21814
      common/astore/a(80000)
*/ increase the space available for discontinuities in convr
*/ to allow for JENDL-3.2 si-nat
*d acer.254
      nned=50
*ident up4
*/ reconr -- 05apr00
*/ be sure to count subsections of file 12 before allocating
*/ storage for the elements of the new directory.  otherwise,
*/ some materials with many sections of file 12 will overflow.
*/ this is a longstanding problem that we never noticed before.
*i reconr.419
            nxn=nxn+1
*ident up5
*/ purr -- 7may00
*/ fix a problem introduced while installing the heating part
*/ of the probability tables.  it shows up when doing elements
*/ that have unresolved data.  also, increase the number of
*/ resonance sections allowed to handle the very large cd-nat
*/ evaluation from JENDL.
*d purr.1076
                  e=abs(eunr(ie))
*d purr.1106,1108
      common/sigcon/e,t,cth(50),csz(50),cc2p(50),cs2p(50),
     &  cgn(50),cgg(50),cgf(50),cgx(50),cgt(50),dbar(50),
     &  spot,dbarin,sigi(4),ndfn(50),ndff(50),ndfx(50),nseq0
*d purr.1139
*d purr.1187,1189
*d purr.1247
                 if (nseq0.gt.50) call error('unresx',
*d purr.1501,1503
      common/sigcon/e,t,cth(50),csz(50),cc2p(50),cs2p(50),
     &  cgn(50),cgg(50),cgf(50),cgx(50),cgt(50),dbar(50),
     &  spot,dbarin,sigi(4),ndfn(50),ndff(50),ndfx(50),nseqz
*d purr.1621,1623
      common/sigcon/e,t,cth(50),csz(50),cc2p(50),cs2p(50),
     &  cgn(50),cgg(50),cgf(50),cgx(50),cgt(50),dbar(50),
     &  spot,dbarin,sigi(4),ndfn(50),ndff(50),ndfx(50),nseqz
*d purr.1739,1741
```

```
      common/sigcon/e,t,cth(50),csz(50),cc2p(50),cs2p(50),
     &  cgn(50),cgg(50),cgf(50),cgx(50),cgt(50),dbar(50),
     &  spot,dbarin,sigi(4),ndfn(50),ndff(50),ndfx(50),nseq0
*ident up6
*/ acer -- 30may00
*/ fix a typo in up3 (reported by bunde, anl)
*d up3.93
      data namax/80000/
*/ acer -- 30may00
*/   fix problems with converting cm distributions to law=7
*/   and problems reading law=7 into the ace file.  these problems
*/   show up when running newfor=0 with njoy2000, especially on
*/   some materials from jef-2.2.
*d acer.3342
*d acer.3347,3348
*d acer.3364
c                       if(imu.lt.nmu.and.amu(imu+1).le.cmn) drv=0
*i acer.3377
c                    include jacobian for cm-to-lab transformation
                     if (ep.ne.zero) drv=drv*sqrt(elb/ep)
*d up3.46,up3.50
                  if (j.le.l2+8) then
                     a(j)=elb
                     a(j+1)=fmu*drv
                     j=j+2
                  else if (elb.gt.a(j-2)) then
                     a(j)=elb
                     a(j+1)=fmu*drv
                     j=j+2
                  endif
*d acer.3399,3420
                  if (iep.eq.nep) idone=1
*d acer.6330
      external listio,terpa,terp1,bachaa,mess,fndar1,fndar2,skip6a
*d acer.6380
               call skip6a(nin,0,0,a(jscr),law)
*d acer.6412
               call skip6a(nin,0,0,a(jscr),law)
*d acer.6497
      call skip6a(nin,0,0,a(jscr),law)
*i acer.6935
c
      subroutine skip6a(nin,nout,nscr,a,law)
c     ******************************************************************
c     special version of skip6 for special version of File 6 used
c     in acer.  law=7 has a tab1 containing the angular distribution
c     instead of the normal tab2 for each incident energy.
c     skip the next subsection in the current section (mt).
c     ******************************************************************
*if sw
      implicit real*8 (a-h,o-z)
*endif
      common/cont/c1h,c2h,l1h,l2h,n1h,n2h,math,mfh,mth,nsh,nsp,nsc
      dimension a(*)
c
      if (law.eq.6) then
         call contio(nin,nout,nscr,a(1),nb,nw)
      else if (law.eq.1.or.law.eq.2.or.law.eq.5) then
         call tab2io(nin,nout,nscr,a(1),nb,nw)
         ne=n2h
         do ie=1,ne
            call listio(nin,nout,nscr,a(1),nb,nw)
            do while (nb.ne.0)
               call moreio(nin,nout,nscr,a(1),nb,nw)
            enddo
         enddo
      else if (law.eq.7) then
         call tab2io(nin,nout,nscr,a(1),nb,nw)
```

```
         ne=n2h
         do ie=1,ne
            call tab1io(nin,nout,nscr,a(1),nb,nw)
            nmu=n2h
            do imu=1,nmu
               call tab1io(nin,nout,nscr,a(1),nb,nw)
               do while (nb.ne.0)
                  call moreio(nin,nout,nscr,a(1),nb,nw)
               enddo
            enddo
         enddo
      endif
      return
      end
*ident up7
*/ viewr -- 30may00
*/ increase the allowed size of 3d plots.
*/ pushed by pb-nat from jef-2.2.
*d viewr.680
                        if (l+5000.ge.maxaa) then
*d viewr.1295
      dimension x(2000),y(2000),z(2000)
*d viewr.1304
      kmax=1999
*ident up8
*/ acer -- 3jun00
*/ subroutine ptleg2 does not need the dynamic array xat.
*/ this problem was first noted by Waclaw Gudowski for ENDF/B-VI
*/ si-nat.  it shows up as "id xat not defined".
*d acer.5628
*d acer.5632
                      call ptleg2(a(iscr))
*d acer.5646
                   call ptleg2(a(iscr))
*d acer.6838,6839
                   call ptleg2(a(jscr))
*d acer.6937
      subroutine ptleg2(a)
*d acer.6950
*d acer.8470,8471
                      call ptleg2(a(lld))
*d acer.8720
*d acer.8731
                            call ptleg2(a(lld))
*d acer.16034
*d acer.16037
                            call ptleg2(a(lld))
*ident up9
*/ acer -- 07jun00
*/  add the capability for processing anisotropic charged particle
*/  emission using tabulated legendre coefficients into the
*/  mcnp4c law61 format.  this is needed for jeff-3 cr-52.
*/  allow for multiple interpolation ranges in file 6.  this
*/  also occurs for jeff-3 cr-52.  currently, the neutron
*/  energy-angle distribution only allows for combinations of
*/  histogram and linear linear interpolation, but the
*/  charged-particle sections allow for general combinations of
*/  all allowed interpolation laws.
*d acer.6391
               jnt=nint(a(jscr+5+2*m))
*i acer.6456
                  if (idis.eq.1.and.xx.lt..9999*xn) xn=sigfig(xn,7,-1)
*d acer.8278,8285
                      next=next+2
                      nrint=nint(a(iscr+4))
                      if (nrint.eq.1.and.nint(a(iscr+7)).eq.2) then
                         xss(next)=0
                      else
```

```
                        xss(next)=nrint
                        do i=1,nrint
                           xss(next+i)=nint(a(iscr+4+2*i))
                           xss(next+nrint+i)=nint(a(iscr+5+2*i))
                        enddo
                        next=next+2*nrint
                     endif
                     next=next+1
                     ne=nint(a(iscr+5))
                     xss(next)=ne
                     do i=1,ne
                        xss(next+i)=
     &                    sigfig(a(iscr+4+2*nrint+2*i)/emev,7,0)
                        xss(next+i+ne)=
     &                    sigfig(a(iscr+5+2*nrint+2*i),7,0)
                     enddo
                     next=next+1+2*ne
*d acer.9031,9032
*i acer.9033
                     lang=nint(a(ll+2))
                     lawnow=0
                     if (law.eq.1.and.lang.eq.1) lawnow=61
                     if (law.eq.1.and.lang.eq.2) lawnow=44
                     if (law.eq.2) lawnow=33
                     if (lawnow.eq.0) call error('acelcp',
     &                 'unsupported law and lang',' ')
                     xss(last+1)=lawnow
*i acer.9090
                           nexcd=next+4*ng+2
*d acer.9121
c                             kalbach distribution
                              if (lang.eq.2) then
*i acer.9126
c                             legendre distribution
                              else if (lang.eq.1) then
                                 ep=xss(next+1+ig)
                                 a(ll)=0
                                 a(ll+1)=ep
                                 a(ll+2)=0
                                 a(ll+3)=0
                                 a(ll+4)=na
                                 a(ll+5)=0
                                 do ia=1,na
                                    lll=lld+7+ncyc*(ig-1)
                                    a(ll+5+ia)=0
                                    if (a(lll).ne.zero) then
                                       a(ll+5+ia)=a(lll+ia)/a(lll)
                                    endif
                                 enddo
                                 call ptleg2(a(ll))
                                 xss(next+1+3*ng+ig)=nexcd-dlwh+1
                                 intmu=2
                                 xss(nexcd)=intmu
                                 nmu=nint(a(ll+5))
                                 xss(nexcd+1)=nmu
                                 do imu=1,nmu
                                    xss(nexcd+1+imu)=sigfig(
     &                                a(ll+6+2*imu),7,0)
                                    xss(nexcd+1+nmu+imu)=sigfig(
     &                                a(ll+7+2*imu),7,0)
                                    if (imu.eq.1) then
                                       xss(nexcd+1+2*nmu+imu)=0
                                    else if (imu.eq.nmu) then
                                       xss(nexcd+1+2*nmu+imu)=1
                                    else
                                       del=a(ll+6+2*imu)
     &                                   -a(ll+4+2*imu)
                                       av=(a(ll+7+2*imu)
```

```
     &                                          +a(l1+5+2*imu))/2
                                              xss(nexcd+1+2*nmu+imu)
     &                                          =xss(nexcd+1+2*nmu+imu-1)
     &                                          +del*av
                                              xss(nexcd+1+2*nmu+imu)=sigfig
     &                                          (xss(nexcd+1+2*nmu+imu),7,0)
                                           endif
                                        enddo
                                        nexcd=nexcd+2+3*nmu
*d acer.9160
                              if (lang.eq.1) then
                                 next=nexcd
                              else
                                 next=next+2+(2*na+3)*ng
                              endif
*d acer.11158,11163
            l2=sigh+l1+1
            nrint=nint(xss(l2))
            write(nsyso,'(4x,''nr ='',i4)') nrint
            if (nrint.ne.0) then
               write(nsyso,'(4x,''nbt(i=1,nr) = '',20i5)')
     &           (nint(xss(l2+ii)),ii=1,nrint)
               l2=l2+nrint
               write(nsyso,'(4x,''int(i=1,nr) = '',20i5)')
     &           (nint(xss(l2+ii)),ii=1,nrint)
               l2=l2+nrint
            endif
            l2=l2+1
            ne=nint(xss(l2))
            write(nsyso,'(4x,''ne ='',i4)') ne
*d acer.11169
     &         xss(l2+ii),xss(l2+ne+ii)
*d acer.11255,11257
                  write(nsyso,'(4x,''nr ='',i4)') nrint
                  if (nrint.ne.0) then
                     write(nsyso,'(4x,''nbt(i=1,nr) = '',20i5)')
     &                 (nint(xss(l3+ii)),ii=1,nrint)
                     l3=l3+nrint
                     write(nsyso,'(4x,''int(i=1,nr) = '',20i5)')
     &                 (nint(xss(l3+ii)),ii=1,nrint)
                     l3=l3+nrint
                  endif
                  l3=l3+1
                  ne=nint(xss(l3))
                  write(nsyso,'(4x,''ne ='',i4)') ne
*d acer.11259,11260
                     e2=xss(l3+ie)
                     loci=nint(xss(l3+ne+ie))+dlwh-1
*d acer.11286,11288
                  write(nsyso,'(4x,''nr ='',i4)') nrint
                  if (nrint.ne.0) then
                     write(nsyso,'(4x,''nbt(i=1,nr) = '',20i5)')
     &                 (nint(xss(l3+ii)),ii=1,nrint)
                     l3=l3+nrint
                     write(nsyso,'(4x,''int(i=1,nr) = '',20i5)')
     &                 (nint(xss(l3+ii)),ii=1,nrint)
                     l3=l3+nrint
                  endif
                  l3=l3+1
                  ne=nint(xss(l3))
                  write(nsyso,'(4x,''ne ='',i4)') ne
*d acer.11290,11291
                     e2=xss(l3+ie)
                     loci=nint(xss(l3+ne+ie))+dlwh-1
*i acer.11311
c
c              ***law=61
               else if (law.eq.61) then
```

```
               nrint=nint(xss(l3))
               write(nsyso,'(4x,''nr ='',i4)') nrint
               if (nrint.ne.0) then
                  write(nsyso,'(4x,''nbt(i=1,nr) = '',20i5)')
     &              (nint(xss(l3+ii)),ii=1,nrint)
                  l3=l3+nrint
                  write(nsyso,'(4x,''int(i=1,nr) = '',20i5)')
     &              (nint(xss(l3+ii)),ii=1,nrint)
                  l3=l3+nrint
               endif
               l3=l3+1
               ne=nint(xss(l3))
               write(nsyso,'(4x,''ne ='',i4)') ne
               do ie=1,ne
                  e2=xss(ie+l3)
                  loci=nint(xss(ie+ne+l3)+dlwh-1)
                  intt=mod(nint(xss(loci)),10)
                  nd=nint(xss(loci)/10)
                  nn=nint(xss(loci+1))
                  loci=loci+1
                  write(nsyso,'(/6x,'' incident energy = '',
     &              1p,e14.6,''   intt ='',i2,''    nd ='',i4,
     &              ''    np ='',i3)') e2,intt,nd,nn
                  do ip=1,nn
                     locj=nint(xss(ip+3*nn+loci)+dlwh-1)
                     intmu=nint(xss(locj))
                     nmu=nint(xss(locj+1))
                     write(nsyso,'(/
     &                 6x,'' secondary energy = '',1p,e14.6/
     &                 6x,''              pdf = '',e14.6/
     &                 6x,''              cdf = '',e14.6/
     &                 6x,''            intmu = '',i8/
     &                 6x,''              nmu = '',i8/
     &              ''         cosine           pdf           cdf'',
     &              ''        cosine           pdf           cdf''/
     &              ''   ------------  ------------  ------------'',
     &              ''  ------------  ------------  ------------'')')
     &                 xss(ip+loci),xss(ip+nn+loci),
     &                 xss(ip+2*nn+loci),intmu,nmu
                     do imu=1,nmu,2
                        if (imu.eq.nmu) then
                           write(nsyso,'(1x,1p,3e14.6)')
     &                       xss(locj+1+imu),xss(locj+1+nmu+imu),
     &                       xss(locj+1+2*nmu+imu)
                        else
                           write(nsyso,'(1x,1p,6e14.6)')
     &                       xss(locj+1+imu),xss(locj+1+nmu+imu),
     &                       xss(locj+1+2*nmu+imu),xss(locj+1+imu+1),
     &                       xss(locj+1+nmu+imu+1),
     &                       xss(locj+1+2*nmu+imu+1)
                        endif
                     enddo
                  enddo
               enddo
*d acer.11333,11335
               write(nsyso,'(4x,''nr ='',i4)') nrint
               if (nrint.ne.0) then
                  write(nsyso,'(4x,''nbt(i=1,nr) = '',20i5)')
     &              (nint(xss(l3+ii)),ii=1,nrint)
                  l3=l3+nrint
                  write(nsyso,'(4x,''int(i=1,nr) = '',20i5)')
     &              (nint(xss(l3+ii)),ii=1,nrint)
                  l3=l3+nrint
               endif
               l3=l3+1
               ne=nint(xss(l3))
               write(nsyso,'(4x,''ne ='',i4)') ne
*d acer.11337,11339
```

```
                  e2=xss(l3+ie)
                  loci=nint(xss(l3+ne+ie))+dlwh-1
                  intmu=nint(xss(loci))
*i acer.12617
               if (nout.ne.1) nr=nint(xss(l))
               if (nout.eq.1) nr=iss(l)
*i acer.12619
               if (nr.gt.0) then
                  n=2*nr
                  do jj=1,n
                     call typen(l,nout,1)
                     l=l+1
                  enddo
               endif
*i acer.12791
                  else if (law.eq.61) then
                     if (nout.ne.1) nr=nint(xss(l))
                     if (nout.eq.1) nr=iss(l)
                     call typen(l,nout,1)
                     l=l+1
                     if (nr.ne.0) then
                        n=2*nr
                        do j=1,n
                           call typen(l,nout,1)
                           l=l+1
                        enddo
                     endif
                     if (nout.ne.1) ne=nint(xss(l))
                     if (nout.eq.1) ne=iss(l)
                     call typen(l,nout,1)
                     l=l+1
                     do j=1,ne
                        call typen(l,nout,2)
                        l=l+1
                     enddo
                     do j=1,ne
                        call typen(l,nout,1)
                        l=l+1
                     enddo
                     do j=1,ne
                        call typen(l,nout,1)
                        l=l+1
                        if (nout.ne.1) np=nint(xss(l))
                        if (nout.eq.1) np=iss(l)
                        call typen(l,nout,1)
                        l=l+1
                        n=3*np
                        do k=1,n
                           call typen(l,nout,2)
                           l=l+1
                        enddo
                        do k=1,np
                           call typen(l,nout,1)
                           l=l+1
                        enddo
                        do k=1,np
                           call typen(l,nout,1)
                           l=l+1
                           if (nout.ne.1) nmu=nint(xss(l))
                           if (nout.eq.1) nmu=iss(l)
                           call typen(l,nout,1)
                           l=l+1
                           nw=3*nmu
                           do kk=1,nw
                              call typen(l,nout,2)
                              l=l+1
                           enddo
                        enddo
```

```
                        enddo
*d acer.18174
                        locj=nint(xss(j+3*nn+loci)+dlw-1)
*d acer.18179
                           cc=xss(locj+1+2*nmu+k)
*d acer.18353
                  j=nint(xss(l3))
                  if (j.ne.0) then
                     l3=l3+2*j
                  endif
                  l3=l3+1
                  ne=nint(xss(l3))
*d acer.18355,18356
                     e=xss(l3+ie)
                     loci=nint(xss(l3+ne+ie))+dlwh-1
*d acer.18384
                  j=nint(xss(l3))
                  if (j.ne.0) then
                     l3=l3+2*j
                  endif
                  l3=l3+1
                  ne=nint(xss(l3))
*d acer.18386,18387
                     e=xss(l3+ie)
                     loci=nint(xss(l3+ne+ie))+dlwh-1
*d acer.18424
                  j=nint(xss(l3))
                  if (j.ne.0) then
                     l3=l3+2*j
                  endif
                  l3=l3+1
                  ne=nint(xss(l3))
*d acer.18426,18427
                     e=xss(l3+ie)
                     loci=nint(xss(l3+ne+ie))+dlwh-1
*d acer.18449
                        locj=nint(xss(j+3*nn+loci)+dlwh-1)
*d acer.18454
                          cc=xss(locj+1+2*nmu+k)
*d acer.18459
     &                          '' at'',1p,e14.6,'' ->'',e13.6,e14.6)')
*ident up10
*/ leapr -- 13jun00
*/  fix two incorrect constants in leapr.  one affects cases with
*/  diffusive effects, and it has been incorrect since njoy97.0
*/  (oct 97).  the other affects cold hydrogen calculations, and it
*/  has been incorrect since njoy97.53 (dec98).
*d leapr.1186
      data c0/.125d0/
*d leapr.1864
      data amassh/3.3465d-24/
*ident up11
*/ acer -- 26jun00
*/  fix an error in determinining which reactions have to be
*/  converted into law=7 format when using newfor=0.  because of
*/  overzealous code cleanup, acer is trying to convert sections
*/  with the kalbach representation in addition to sections with
*/  tabulated angular distributions.
*d acer.2324,2330
                  do while(nb.ne.0)
                     call moreio(nin,0,0,a(iscr),nb,nw)
                  enddo
                  if (lf.eq.6) then
                     call contio(nin,0,0,a(iscr),nb,nw)
                  else if (lf.eq.1.or.lf.eq.2.or.lf.eq.5) then
                     call tab2io(nin,0,0,a(iscr),nb,nw)
                     lang=l1h
                     if (dzap.le.test.and.lf.eq.1.and.lang.ne.2) new6=1
```

```
                     ne=n2h
                     do ie=1,ne
                        call listio(nin,0,0,a(iscr),nb,nw)
                        do while (nb.ne.0)
                           call moreio(nin,0,0,a(iscr),nb,nw)
                        enddo
                     enddo
                  else if (lf.eq.7) then
                     call tab2io(nin,0,0,a(iscr),nb,nw)
                     ne=n2h
                     do ie=1,ne
                        call tab1io(nin,0,0,a(iscr),nb,nw)
                        nmu=n2h
                        do imu=1,nmu
                           call tab1io(nin,0,0,a(iscr),nb,nw)
                           do while (nb.ne.0)
                              call moreio(nin,0,0,a(iscr),nb,nw)
                           enddo
                        enddo
                     enddo
                  endif
*/ acer -- 26jun00
*/  during the cleanup of the topfil routine, the logic to process
*/  sections of file 6 using law=2 (two-body distributions) into
*/  equally probable bins for newfor=0 was omitted.  this shows up
*/  for evaluations that use mf6/mt51, etc., to represent inelastic
*/  levels.
*d acer.2379
                     if (lf.eq.1) then
*d acer.2387,2388
c                    law=2 for newfor=1 - copy the subsection
                     else if (lf.eq.2.and.newfor.eq.1) then
*i acer.2394
c                    law=2 for newfor=0 - convert to probability bins
                     else if (lf.eq.2.and.newfor.eq.0) then
                        call listio(nin,0,0,a(iscr),nb,nw)
                        now=iscr+nw
                        do while (nb.ne.0)
                           call moreio(nin,0,0,a(now),nb,nw)
                           now=now+nw
                        enddo
                        now=now-1
                        lang=nint(a(iscr+2))
                        if (lang.eq.0) then
c                          legendre coefficients
                           call ptleg(nout,a)
                        else
c                          tabulated angular distribution
                           do i=iscr,now
                              a(now+2-i+iscr)=a(now-1+iscr)
                           enddo
                           np=nint(a(iscr+7))
                           a(iscr)=a(iscr+2)
                           a(iscr+1)=a(iscr+3)
                           a(iscr+2)=0
                           a(iscr+3)=0
                           a(iscr+4)=1
                           a(iscr+5)=np
                           a(iscr+6)=np
                           a(iscr+7)=lang-10
                           call pttab(ltt,a(iscr),nout)
                        endif
c                    law=5 for - copy the subsection
                     else if (lf.eq.5) then
                        call listio(nin,nout,0,a(iscr),nb,nw)
                        now=iscr+nw
                        do while (nb.ne.0)
                           call moreio(nin,nout,0,a(now),nb,nw)
```

```
                          now=now+nw
                       enddo
*/ acer -- 26jun00
*/  fix an error in the reaction naming.  it affects mt=44 (n,n2p) and
*/  mt=45 (n,npa).  this problem was introduced in may of 1995.
*/  examples of cases that use these reactions are later releases of
*/  endf/b-vi al-27.
*d acer.11415,11416
     &  '(n,x)      ', '(n,2np)    ', '(n,3np)    ', '(n,x)      ',
     &  '(n,n2p)    ', '(n,npa)    ', '(n,2/2*1) ', '(n,2/2*2) ',
*/ acer -- 26jun00
*/  add missing external statement.  reported by bokyun seo (kaeri)
*i acer.3250
      external error
*/ acer -- 26jun00
*/  add missing line for the sequential (n,2n) reactions for be-9.
*/  this line was accidentally removed in njoy 94.19 (jan96).  the
*/  error was continued through njoy 97 and 99.  discovered by
*/  bob little (lanl).
*i acer.5102
                 if (mth.ge.46.and.mth.le.49) s=sigfig(s/2,7,0)
*/ acer -- 26jun00
*/  fix anisotropic photon production (e.g., endf c,n,o)
*d acer.7559
         if (lff.le.1) then
*ident up12
*/ njoy -- 27jul00
*/  fix two typographical errors in the 64-bit version of the
*/  slatec math library.  reported by piet de leege (delft).
*d njoy.4617
         if (a.ge.(-0.5).or.aeps.ne.0.0) then
*d njoy.4935
         gamma=0.9375+csevl(2.*y-1.,gamcs,ngamcs)
*ident up13
*/ reconr -- 12jul00
*/  if a reaction uses histogram interpolation, reconr tries to
*/  change it to linear interpolation by moving each point down by
*/  one in the seventh place and and adding a point higher by one in
*/  the seventh place.  if there is already a point in the evaluator's
*/  grid higher by one in the seventh place, the algorithm gets
*/  confused.  this currently occurs for carbon from release 6 of
*/  endf/b-vi.  the symptom is an infinite loop while processing
*/  mf=12,mt=51.  we found this at los alamos, and skipped over the
*/  problem by temporarily patching the evaluation.  more recently,
*/  it was re-reported by waclaw gudowski, and now we are making a
*/  real fix for the problem.
*i reconr.1830
      if (er.lt.(1+small)*enl) go to 255
*ident up14
*/ acer -- 20jul00
*/  acer fails if you run it on a pendf tape that only has the
*/  single reaction mt=2 (elastic).  this can happen for he-4 if you
*/  don't run heatr, thermr, or gaspr first.  found by gudowski.
*d acer.5121
      mt=2
*/ acer -- 20jul00
*/  acer fails for mf=6, law=2, lang>0 (angular distribution with
*/  tabulated cosines).  the only known example is mt=51 for pb-208 from
*/  release 6 of endf/b-vi.  found by waclaw gudowski.
*d up11.67
                             a(now+2-i+iscr)=a(now-i+iscr)
*/ acer -- 21jul00
*/  an error was included in up9, which added a capability to handle
*/  anisotropic charged-particle emission represented using legendre
*/  polynomials.  the update disabled the case of isotropic
*/  charged-particle emission, which occurs in a number of important
*/  materials from release 6 of endf/b-vi.  the symptom is a serious
*/  clobbering of the ace file, such that it cannot even be read into
```

```
*/  mcnp or even printed using acer.  also reported by gudowski.
*d up9.56
                                 else if (lang.eq.1.and.na.gt.0) then
*d up9.100
                              if (lang.eq.1.and.na.gt.0) then
*ident up15
*/ heatr -- 31jul00
*/  incorrect initial value found by m.mattes (u.stuttgart).
*d heatr.2586
         ir=1
*/  increase the allowed number of legendre terms in h6ddx
*/  to handle the new jeff-3t fe-56 evaluation.
*d heatr.3284
      dimension cnow(*),p(15)
*i heatr.3292
      data nlmax/15/
*i heatr.3315
      if (nl.gt.nlmax) call error('h6ddx',
     &  'too many legendre terms',' ')
*/ watch for ill-defined vertical segments in distributions.  these
*/ have been seen in zr90 from cendl3 and fe56 from jeff3.  actually,
*/ the evaluations should be fixed to avoid such features, because
*/ we don't really know what y value to select in the vertical
*/ segment.  we choose to just move the second energy of the double
*/ point up a little.  we only print the diagnostic once to keep the
*/ output cleaner, but there could be more than one vertical segment.
*i heatr.3286
      external mess
*i heatr.3287
      save illdef
*i heatr.3318
         illdef=0
*d heatr.3352,3353
               x1=cnow(lnow-ncnow)
               x2=cnow(lnow)
               if (x1.eq.x2.and.lep.gt.1) then
                  x2=sigfig(x2,6,1)
                  if (illdef.eq.0) then
                     call mess('h6ddx',
     &                 'vertical segment(s) in distribution',
     &                 'y(x) is ill defined')
                     illdef=1
                  endif
               endif
               y1=cnow(lll-ncnow)
               y2=cnow(lll)
               call terp1(x1,y1,x2,y2,ep,tt,lep)
*d heatr.3364,3367
            x1=cnow(lnow-ncnow)
            x2=cnow(lnow)
            if (x1.eq.x2.and.lep.gt.1) then
               x2=sigfig(x2,6,1)
               if (illdef.eq.0) then
                  call mess('h6ddx',
     &              'vertical segment(s) in distribution',
     &              'y(x) is ill defined')
                  illdef=1
               endif
            endif
            y1=cnow(lnow-ncnow+1)
            y2=cnow(lnow+1)
            call terp1(x1,y1,x2,y2,ep,s,lep)
            y1=cnow(lnow-ncnow+2)
            y2=cnow(lnow+2)
            call terp1(x1,y1,x2,y2,ep,r,lep)
*d heatr.3380
         x1=cnow(ii)
         x2=cnow(jj)
```

```
         if (x1.eq.x2.and.lep.gt.1) then
            x2=sigfig(x2,6,1)
            if (illdef.eq.0) then
               call mess('h6ddx',
     &           'vertical segment(s) in distribution',
     &           'y(x) is ill defined')
               illdef=1
            endif
         endif
         y1=cnow(ii+1)
         y2=cnow(jj+1)
         call terp1(x1,y1,x2,y2,ep,s,lep)
*d heatr.3395
         call terp1(x1,tii,x2,tjj,ep,t,lep)
*ident up16
*/ groupr -- 31jul00
*/ watch for ill-defined vertical segments in distributions.  these
*/ have been seen in zr90 from cendl3 and fe56 from jeff3.  actually,
*/ the evaluations should be fixed to avoid such features, because
*/ we don't really know what y value to select in the vertical
*/ segment.  we choose to just move the second energy of the double
*/ point up a little.  we only print the diagnostic once to keep the
*/ output cleaner, but there could be more than one vertical segment.
*i groupr.5588
      save illdef
*i groupr.5591
      external mess
*i groupr.5633
         illdef=0
*d groupr.5675,5676
                  x1=cnow(lnow-ncnow)
                  x2=cnow(lnow)
                  if (x1.eq.x2.and.lep.gt.1) then
                     x2=sigfig(x2,6,1)
                     if (illdef.eq.0) then
                        call mess('h6ddx',
     &                    'vertical segment(s) in distribution',
     &                    'y(x) is ill defined')
                        illdef=1
                     endif
                  endif
                  y1=cnow(lll-ncnow)
                  y2=cnow(lll)
                  call terp1(x1,y1,x2,y2,ep,tt,lep)
*d groupr.5688,5691
               x1=cnow(lnow-ncnow)
               x2=cnow(lnow)
               if (x1.eq.x2.and.lep.gt.1) then
                  x2=sigfig(x2,6,1)
                  if (illdef.eq.0) then
                     call mess('h6ddx',
     &                 'vertical segment(s) in distribution',
     &                 'y(x) is ill defined')
                     illdef=1
                  endif
               endif
               y1=cnow(lnow-ncnow+1)
               y2=cnow(lnow+1)
               call terp1(x1,y1,x2,y2,ep,s,lep)
               y1=cnow(lnow-ncnow+2)
               y2=cnow(lnow+2)
               call terp1(x1,y1,x2,y2,ep,r,lep)
*d groupr.5722
            x1=cnow(ii)
            x2=cnow(jj)
            if (x1.eq.x2.and.lep.gt.1) then
               x2=sigfig(x2,6,1)
               if (illdef.eq.0) then
```

```
                  call mess('h6ddx',
     &              'vertical segment(s) in distribution',
     &              'y(x) is ill defined')
                  illdef=1
               endif
            endif
            y1=cnow(ii+1)
            y2=cnow(jj+1)
            call terp1(x1,y1,x2,y2,ep,s,lep)
*d groupr.5737
            call terp1(x1,tii,x2,tjj,ep,t,lep)
*ident up17
*/ acer -- 31jul00
*/ fix an incorrect index in the law=61 section for the primary
*/ particle.  the effect of this error is to give an incorrect
*/ angular distribution for the energy points with scattering
*/ probability zero (which should be isotropic).  this change
*/ is strictly cosmetic and shouldn't affect any results.
*d acer.6833
                        a(jscr+5+ia)=0
*/ acer -- 31jul00
*/ we want to use the compact law=4 for isotropic charged particle
*/ distributions, and the more general law=61 for anisotropic cp
*/ distributions.  unfortunately, we can't tell which is which
*/ without reading past the first few energies for some evaluations.
*/ the need for this patch was first noticed by jeff3 fe56.
*i acer.8982
c
c                 ***first check the subsection to see whether
c                 ***the distribution is isotropic or not.
                  isocp=1
                  call findf(matd,mf,mt,nin)
                  call contio(nin,0,0,a(iscr),nb,nw)
                  nk=n1h
                  ik=0
                  idone=0
                  do while (ik.lt.nk.and.idone.eq.0)
                     ik=ik+1
                     ll=iscr
                     lly=ll
                     call tab1io(nin,0,0,a(ll),nb,nw)
                     izap=nint(c1h)
                     awp=c2h
                     law=l2h
                     ll=ll+nw
                     do while (nb.ne.0)
                        call moreio(nin,0,0,a(ll),nb,nw)
                        ll=ll+nw
                     enddo
c
c                    ***if not the desired particle, skip the subsection
                     if (izap.ne.ip) then
                        call skip6(nin,0,0,a(iscr),law)
c
c                    ***we only need to check law 1 subsections
                     else if (law.eq.1) theN
                        call tab2io(nin,0,0,a(ll),nb,nw)
                        lang=nint(a(ll+2))
                        lep=nint(a(ll+3))
                        ne=nint(a(ll+5))
                        do ie=1,ne
                           ll=lld
                           call listio(nin,0,0,a(ll),nb,nw)
                           ll=ll+nw
                           do while (nb.ne.0)
                              call moreio(nin,0,0,a(ll),nb,nw)
                              ll=ll+nw
                           enddo
```

```
                           na=nint(a(lld+3))
                           if (na.gt.0) isocp=0
                        enddo
                     endif
                  enddo
c
c                 ***go back and process the subsection
*d up9.43
                        if (law.eq.1.and.lang.eq.1.and.isocp.eq.0)
     &                    lawnow=61
                        if (law.eq.1.and.lang.eq.1.and.isocp.eq.1)
     &                    lawnow=4
*i up9.48
                        if (law.eq.1.and.isocp.eq.1) xss(landh+jp-1)=0
*d acer.9079,9082
*d acer.9085
                              if (lawnow.eq.4) then
*d up14.23
                                 else if (lawnow.eq.61) then
*d up14.25
                              if (lawnow.eq.61) then
*ident up18
*/ acer -- 03aug00
*/ some jef, eff, and jeff evaluations contain a redundant reaction
*/ mt=10 that gives the continuum neutron production.  it is
*/ necessary to exclude this reaction from the reconstructed total
*/ cross section and to omit the associated energy-angle distribution.
*/ otherwise, the continuum neutron production will be counted twice.
*i acer.1941
               if (mt.eq.10) then
                  idone=0
                  call mess('unionx','redundant mt=10 found',
     &               'cross section and distribution excluded')
               endif
*i acer.2193
     &     (mf.eq.6.and.mt.eq.10).or.
*/ acer -- 03aug00
*/ this change can fix an infinite loop during acer plotting
*d acer.22571
      if (ep.lt.zero) then
*/ acer -- 03aug00
*/ for file 6 sections with only one subsection, the mt number is
*/ set to zero for the messages about energy-dependent yields.
*/ this is a trivial cosmetic patch and doesn't affect results.
*i acer.6414
         if (ikk.eq.nk) idone=1
*/ acer -- 03aug00
*/ this change is needed to handle nubar for jendl-3.2 u-235.  it
*/ was originally made at los alamos in april, but somehow didn't
*/ make it to the official update file.
*d acer.1090
         if (int.gt.2) nonlin=1
*ident up19
*/ heatr -- 03aug00
*/ as noted above, some jef, eff, and jeff evaluations use the
*/ redundant mt=10.  this value needs to be excluded from the
*/ heating and damage calculations.
*d heatr.639
                                 else if (mt.ne.10) then
*d heatr.690
                     else if (mt.ne.10) then
*i heatr.855
      if (mt.eq.10) go to 110
*ident up20
*/ acer -- 16aug00
*/ there is an error in processing angular distributions using ltt=3
*/ when newfor=0 (mcnp4b compatibility).  the extra tosend causes the
*/ code to skip over the first reaction after the elastic mf=4.
```

```
*/ this leads to a bad tyr=0 value in the ace file, which causes
*/ mcnp to issue a confusing error message about "sabcol," even
*/ when s(alpha,beta) is not being used.  this problem occurs only
*/ when processing the 150-mev evalutions from endf/b-vi.6.  it
*/ is probably best to use release 5 with mcnp4b anyway.  the
*/ release 5 and 6 data are identical below 20 mev.
*d acer.2292
*/ acer -- 16aug00
*/ the code is finding the wrong value for the lct parameter (lab
*/ or cm frame) when processing file 4 angular distributions if
*/ the section is fully isotropic.  this can result in an incorrect
*/ value for the ace tyr parameter, which can result in an apparent
*/ error from sabcol, even with no s(alpha,beta) data in the problem.
*/ this problem was introduced while the njoy97 coding was being
*/ converted to block structuring.
*d acer.5342
*i acer.5359
               lct=nint(a(iscr+3))
*d acer.5361
*/ acer -- 16aug00
*/ the consistency check for incorrect reference frame should take
*/ place for isotropic distributions also.  sometimes, this check is
*/ not a real error.  users should check the evaluation to see if the
*/ reference frame is really as intended by the evaluator.  as fixed,
*/ this check would have found the two problems above!
*d acer.17785
         if (na.ge.0) then
*/ acer-- 16aug00
*/ we are not currently handling law=5 for energy distributions.
*/ this occurs for u-233 fission from jef-2.2.  the evaluation can
*/ be patched by converting the lf=5 part of the distribution to
*/ lf=1, which is sampled much better by mcnp using cummulative
*/ probability distributions anyway.
*i acer.6098
            call error('acelf5','sorry. acer cannot handle lf=5.',
     &        'you will have to patch the evaluation to use lf=1.')
*/ acer -- 16aug00
*/ there are some additional places where skip6 should be skip6a.
*/ see up6 above.  this shows up for endf be-9 with newfor=1.
*d acer.8066
      external error,findex,skip6a,contio,listio,tab1io,moreio,tab2io
*d acer.8289
                  call skip6a(nin,0,0,a(iscr),law)
*d acer.8880
                     call skip6a(nin,0,0,a(iscr),law)
*d up17.42
                     call skip6a(nin,0,0,a(iscr),law)
*d acer.9004
                     call skip6a(nin,0,0,a(iscr),law)
*d acer.9027
                     call skip6a(nin,0,0,a(iscr),law)
*d acer.9725
               call skip6a(nin,0,0,a(iscr),law)
*/ acer -- 16aug00
*/ there is an error in the law=7 part of up11.  this shows up
*/ when processing endf be-9 using newfor=0
*d up11.29
                     call tab2io(nin,0,0,a(iscr),nb,nw)
*/ acer -- 16aug00
*/ there is an error in the new skip6a routine introduced by up6
*/ that shows up when processing sections with law=7 with newfor=0.
*d up6.69
            nmu=nint(a(4))
*/ acer -- 16aug00
*/ missing initialization in ptlegc (this could affect incident
*/ charged particles on some systems).
*i acer.2217
      dco=0
```

```
*ident up21
*/ groupr -- 28sep00
*/ the self-shielded cross sections are not being printed out
*/ correctly for the reactions, but total is ok.  the gendf
*/ file is ok, so libraries made with njoy99 are ok.
*d groupr.3613
                     call a10(ans(il,i,2),field(i))
*ident up22
*/ reconr -- 28sep00
*/ add capability to handle the new extension to the reich-moore
*/ resonance format that uses the sign of aj to designate which
*/ channel spin to use for a particular resonance.  based on
*/ coding provided by nancy larson, ornl.
*d reconr.2828,2942
c
c           ***loop over possible channel spins
            kchanl=0
            idone=0
            do while (kchanl.lt.2.and.idone.eq.0)
               kchanl=kchanl+1
               inow=inowb
               kpstv=0
               kngtv=0
c              initialize matrix
               do j=1,3
                  do i=1,3
                     s(j,i)=0
                     r(j,i)=0
                  enddo
               enddo
c
c              ***loop over resonances
               inow=inow+6
               in=inow+nrs*6
               do i=1,nrs
                  aj=abs(a(inow+1))
c                 select only resonances with current j value
                  if (abs(aj-ajc).le.quar) then
                     if (a(inow+1).lt.zero) kngtv=kngtv+1
                     if (a(inow+1).gt.zero) kpstv=kpstv+1
                     iskip=0
                     if (kchanl.eq.1.and.a(inow+1).lt.zero) iskip=1
                     if (kchanl.eq.2.and.a(inow+1).gt.zero) iskip=1
                     if (iskip.eq.0) then
c                       retrieve parameters
                        er=a(inow)
                        gn=a(inow+2)
                        gg=a(inow+3)
                        gfa=a(inow+4)
                        gfb=a(inow+5)
                        per=a(in+1)
c                       gc=a(in+2)
                        a1=sqrt(gn*pe/per)
                        a2=0
                        if (gfa.ne.zero) a2=sqrt(abs(gfa))
                        if (gfa.lt.zero) a2=-a2
                        a3=0
                        if (gfb.ne.zero) a3=sqrt(abs(gfb))
                        if (gfb.lt.zero) a3=-a3
c                       compute energy factors
                        diff=er-e
                        den=diff*diff+quar*gg*gg
                        de2=haf*diff/den
                        gg4=quar*gg/den
c                       calculate r-function, or
c                       calculate upper triangular matrix terms
                        r(1,1)=r(1,1)+gg4*a1*a1
                        s(1,1)=s(1,1)-de2*a1*a1
```

```
               if (gfa.ne.zero.or.gfb.ne.zero) then
                  r(1,2)=r(1,2)+gg4*a1*a2
                  s(1,2)=s(1,2)-de2*a1*a2
                  r(1,3)=r(1,3)+gg4*a1*a3
                  s(1,3)=s(1,3)-de2*a1*a3
                  r(2,2)=r(2,2)+gg4*a2*a2
                  s(2,2)=s(2,2)-de2*a2*a2
                  r(3,3)=r(3,3)+gg4*a3*a3
                  s(3,3)=s(3,3)-de2*a3*a3
                  r(2,3)=r(2,3)+gg4*a2*a3
                  s(2,3)=s(2,3)-de2*a2*a3
                  gf=1
               endif
            endif
         endif
         inow=inow+ncyc
         in=in+3
      enddo

c     ***take care of extra channel spin as defined
c     ***by the sign of aj:
c     *** kkkkkk = 0 => do not add anything in here
c     *** kkkkkk = 1 => add resonance contribution but
c     ***  not extra hard-sphere
c     *** kkkkkk = 2 => add resonance plus hard-sphere
c     ***  phase shift contribution
      kkkkkk = 0
      if (kchanl.eq.1) then
         if (kpstv.gt.0) then
            if (kngtv.eq.0) then
               if (jj.gt.jjl.and.jj.lt.numj) then
                  kkkkkk=2
               else
                  kkkkkk=1
               endif
            else if (kngtv.gt.0) then
               kkkkkk=1
            endif
         else if (kpstv.eq.0) then
            if (kngtv.eq.0) then
               if (jj.gt.jjl.and.jj.lt.numj) then
                  kkkkkk=2
               else
                  kkkkkk=1
               endif
            else if (kngtv.gt.0) then
               kkkkkk=0
            endif
         endif
      else if (kchanl.eq.2) then
         if (kpstv.gt.0) then
            if (kngtv.eq.0) then
            else if (kngtv.gt.0) then
               kkkkkk=1
            endif
         else if (kpstv.eq.0) then
            if (kngtv.eq.0) then
            else if (kngtv.gt.0) then
               if (jj.gt.jjl.and.jj.lt.numj) then
                  kkkkkk=2
               else
                  kkkkkk=1
               endif
            endif
         endif
      endif
      if (kkkkkk.ne.0) then
```

```
c                  ***r-matrix path -- make symmetric matrix
                   if (gf.ne.zero) then
                      r(1,1)=uno+r(1,1)
                      r(2,2)=uno+r(2,2)
                      r(3,3)=uno+r(3,3)
                      r(2,1)=r(1,2)
                      s(2,1)=s(1,2)
                      r(3,1)=r(1,3)
                      s(3,1)=s(1,3)
                      r(3,2)=r(2,3)
                      s(3,2)=s(2,3)
c                     invert the complex matrix
                      call frobns(r,s,ri,si)
c                     fission term for r-matrix path
                      t1=ri(1,2)
                      t2=si(1,2)
                      t3=ri(1,3)
                      t4=si(1,3)
                      termf=four*gj*(t1*t1+t2*t2+t3*t3+t4*t4)
                      u11r=p1*(two*ri(1,1)-uno)+two*p2*si(1,1)
                      u11i=p2*(uno-two*ri(1,1))+two*p1*si(1,1)
                      termt=two*gj*(uno-u11r)
                      termn=gj*((uno-u11r)**2+u11i**2)

c                  ***r-function path
                   else
                      dd=r(1,1)
                      rr=uno+dd
                      ss=s(1,1)
                      amag=rr**2+ss**2
                      rri=rr/amag
                      ssi=-ss/amag
                      uur=p1*(two*rri-uno)+two*p2*ssi
                      uui=p2*(uno-two*rri)+two*p1*ssi
                      if (abs(dd).lt.small.and.
     &                  abs(phid).lt.small) then
                         xx=2*dd
                         xx=xx+2*(dd*dd+ss*ss+phid*phid+p2*ss)
                         xx=xx-2*phid*phid*(dd*dd+ss*ss)
                         xx=xx/amag
                         termt=two*gj*xx
                         termn=gj*(xx**2+uui**2)
                      else
                         termt=two*gj*(uno-uur)
                         termn=gj*((uno-uur)**2+uui**2)
                      endif
                      termf=0
                   endif
c
c                  ***cross sections contributions
                   if (kkkkkk.eq.2) then
                      termn=termn+two*gj*(1-p1)
                      termt=termt+two*gj*(1-p1)
                   endif
                   termg=termt-termf-termn
                   sigp(2)=sigp(2)+termn
                   sigp(4)=sigp(4)+termg
                   sigp(3)=sigp(3)+termf
                   sigp(1)=sigp(1)+termt
                endif
             enddo
*ident up23
*/ gaminr -- 28sep00
*/  allow for up to 400 groups (added by request)
*d gaminr.78
      common/groupg/igg,ngg,egg(400)
*d gaminr.87
      dimension a(250000)
```

```
*d gaminr.91
      dimension ng2s(400),ig2s(400)
*d gaminr.455
      common/groupg/igg,ngg,egg(400)
*d gaminr.602
      data ngmax/400/
*d gaminr.521
      common/groupg/igg,ngg,egg(400)
*d gaminr.1138
      common/groupg/igg,ngg,egg(400)
*ident up24
*/ dtfr -- 28sep00
*/  allow for up to 400 groups (added by request)
*d dtfr.105,107
      common/dgrpn/egn(400),ngn
      common/dgrpg/egg(400),ngg
      common/dstore/a(20000),sig(200000)
*d dtfr.110,111
      dimension spect(400)
      dimension fcap(400),ffis(400)
*d dtfr.114
      data nwamax/20000/, nwsmax/200000/
*d dtfr.928
      common/dgrpn/egn(400),ngn
*d dtfr.932
      common/dstore/x(3500),y(3500),z(1000),a(212000)
*d dtfr.1262
      common/dgrpn/egn(400),ngn
*d dtfr.1409,1410
      common/dgrpn/egn(400),ngn
      common/dgrpg/egg(400),ngg
*d viewr.1294
      dimension lll(400)
*ident up25
*/ groupr -- 11oct00
*/  fix the section that reduces the number of sig figs in getdis.
*/  it was only acting on the in-group probabilities.  this helps
*/  to make the results for elastic and discrete inelastic matrices
*/  the same on different machines.  the basic idea is that these
*/  numbers are obtained by subtraction of numbers on the order of
*/  unity, so any results less than about 1e-7 are just random
*/  numbers and can be removed.
*d groupr.6637,6642
      ndig=7
      fact=ten**ndig
      do il=1,nl
         do ii=1,ng
            iii=nint(fact*ff(il,ii)+ten**(ndig-11))
            ff(il,ii)=iii/fact
         enddo
      enddo
*/ groupr -- 12oct00
*/  change the size of common groupg to agree with the changes
*/  made in gaminr above.
*d groupr.229
      common/groupg/igg,ngg,egg(400)
*d groupr.773
      common/groupg/igg,ngg,egg(400)
*d groupr.1919
      common/groupg/igg,ngg,egg(400)
*d groupr.3075
      common/groupg/igg,ngg,egg(400)
*d groupr.4275
      common/groupg/igg,ngg,egg(400)
*d groupr.7780
      common/groupg/igg,ngg,egg(400)
*ident up26
*/ acer -- 12oct00
```

```
*/  the current coding sometimes gets the threshold for charged
*/  particle production off by one point.
*i acer.8075
      data delt/1.d-10/
*i acer.8082
      data delt/1.e-10/
*d acer.8166
         do while (xss(esz+it-1).lt.thresh*(1-delt))
*ident up27
*/ dtfr -- 27oct00
*/  fix problem with finding right material and temperature
*/  on the pendf tape.  the goto loop was not translated correctly!
*d dtfr.220
      idone=0
      do while (idone.eq.0)
*i dtfr.239
         else
            idone=1
*/ dtfr -- 27oct00
*/  fix error made in up24
*d up24.21
      common/dgrpg/egg(400),ngp
*ident up28
*/ acer -- 05nov00
*/  the pointer into the a array is not being correctly incremented
*/  for the "call moreio" line.  this only affects the new JEFF
*/  evaluation for beryllium, which has exceptionally detailed
*/  angulur tabulations.  found by fischer (fzk).
*i acer.2439
                              l=l+nw
*/  fix an indexing error in adjusting the normalization and
*/  precision for the pdf of angular distributions for law67 charged
*/  particle production that causes the pdf to be the same as the
*/  cdf.  this problem shows up for beryllium (n,2n) alpha production
*/  in endf/b-vi, for example.  identified by konno (jaeri).
*d acer.8864
     &                          sigfig(renorm*xss(next+1+nx+ix),7,0)
*ident up29
*/ ccccr -- 05nov00
*/  the pointer in the e array for moreio is wrong.  the result of
*/  this is that larger group structures cannot be handled correctly
*/  for delayed neutrons.  found by broeders (karlsruhe).
*d ccccr.3140
         call moreio(nin,0,0,e(loc),nb,nw)
*ident up30
*/ heatr -- 05nov00
*/  the insert of the data value for nlmax was incorrectly done into
*/  the "sw" conditional block instead of after the conditional
*/  block was complete.  thus, it was only available to 32-bit
*/  versions of the code.  this was discovered by deleege (delft)
*/  when running in 64-bit mode on a vax/alpha.
*d up15.11
*i heatr.3298
      data nlmax/15/
*ident up31
*/ groupr -- 05nov00
*/  fix two problems with the ltt3 option for 150 mev evaluations.
*/  the incorrect index for the c array leads to findex problems
*/  caused by clobbering the index for the dynamic storage system.
*/  you also have to make sure that the "over" option that allows
*/  getfle to extrapolate to energies slightly higher than the
*/  upper limit of the table doesn't act at the break between
*/  the two energy ranges with ltt3.  this problem was reported
*/  by wienke (sck-cen).
*d groupr.6838
      if (nne.eq.ne.and.e.lt.over*ehi) then
         if (ltt3.eq.3.and.lttn.eq.1) go to 210
         go to 300
```

```
      endif
*d groupr.6850,6851
         call tab2io(nin,0,0,c(ifls),nb,nwc)
         ne=nint(c(ifls+5))
*ident up32
*/ reconr -- 05nov00
*/  some fission products from the jendl-3.2 library include
*/  an unresolved resonance range with no corresponding resolved
*/  range.  trkov (iaea) proposed the following fix.
*i reconr.672
      if (eresr.lt.eresl) eresr=eresl
*ident up33
*/ gaminr -- 18jan01
*/  the photoatomic group cross sections are not printed out
*/  correctly for a p-order greater than 5.
*d gaminr.1075
     &              write(nsyso,'(13x,1p,6a11)') (field(i),i=7,nl)
*ident up34
*/ groupr -- 29jan01
*/  need more storage in groupr to handle mt=91 for am243 from
*/  endf/b-vi release 5, which goes to 30 mev.  the symptom was
*/  "storage exceeded" from cm2lab.
*d groupr.248
      dimension a(150000)
*d groupr.273
      iamax=150000
*ident up35
*/ groupr -- 08feb01
*/  when we increased the common block for photon group structures
*/  to allow as many as 400 groups (see up25), we forgot to update
*/  the parameter ngmax.  this causes a "too many groups" error if
*/  you run with more than 150 gamma groups.
*d groupr.2000
      data ngmax/400/
*ident up36
*/ acer -- 08feb01
*/  in up17, we checked for isotropic distributions in order to use
*/  a more compact presentation.  the logic misses one special case,
*/  namely, pb208 from endf/b-vi release 6.
*d up17.41
                     if (izap.ne.ip.or.law.ne.1) then
*d up17.45
                     else
*ident up37
*/ reconr -- 09feb01
*/  all through njoy, we have been using 1e10 ev as our idea of
*/  an infinite energy.  progress happens, and red cullen at llnl
*/  is putting out an endf version of the evaluated photon data
*/  library (epdl97), which contains data to 100 gev.  the following
*/  change prevents reconr from going into an infinite loop in the
*/  emerge routine with 100 gev data.
*d reconr.4126
      data finity/.99d12/
*d reconr.4130
      data finity/.99e12/
*ident up38
*/ njoy -- 09feb01
*/  keep on increasing infinity for the 100 gev data.  the routines
*/  gety1, gety2, and terpa return an "infinite" energy at the end
*/  of the table, and we now increase that to 1e12 ev.  this doesn't
*/  seem to cause any problems in njoy modules (such as groupr) that
*/  still check for return values of 1e10 or more; all the standard
*/  test problems still work fine.
*d njoy.2204
      data xbig/1.d12/
*d njoy.2208
      data xbig/1.e12/
*d njoy.2418
```

```
      data xbig/1.d12/
*d njoy.2422
      data xbig/1.e12/
*d njoy.2532
      data xbig/1.d12/
*d njoy.2536
      data xbig/1.e12/
*ident up39
*/ gaminr -- 09feb01
*/  keep on increasing infinity for the 100 gev data.
*d gaminr.106
      data emax/1.d12/
*d gaminr.110
      data emax/1.e12/
*d gaminr.779
      data emax/1.d12/
*d gaminr.782
      data emax/1.e12/
*d gaminr.1164
      data emax/1.d12/
*d gaminr.1186
      data emax/1.e12/
*ident up40
*/ acer -- 23mar01
*/  due to a bad if clause, the contribution to heating from charged
*/  particles is not being included for mf=6, law 3 or 4.  this was
*/  noticed in the run for endf/b-vi be-9 by lanl/x-5.  the errors in
*/  this particular case are quite small because of the small cross
*/  sections for charged-particle emission.  this error will only
*/  effect mcnpx calculations for coupled neutron-proton transport.
*d acer.9220,9231
c                        add in contribution to heating
                         naa=nint(xss(hpd+1))
                         do ie=it,nes
                            e=xss(esz+ie-1)
                            ss=0
                            if (ie.ge.iaa) ss=xss(2+k+ie-iaa)
                            tt=xss(next+1)*(e-xss(next))*ss
                            xss(hpd+2+naa+ie-it)=xss(hpd+2+naa+ie-it)
     &                        +tt
                         enddo
*ident up41
*/ acer -- 27mar01
*/  the value "nr = 0", implying linear interpolation over all points,
*/  is not printed on the acer output listing for two cases, as reported
*/  by lanl/x-5.  these errors do not affect mcnp results, but the
*/  repair makes the printout for photon yields and energy distributions
*/  match those for other types of data.
*i acer.10808
               write(nsyso,'(12x,''nr ='',i4)') m
*d acer.10810
*i acer.10998
               write(nsyso,'(12x,''nr ='',i4)') m
*d acer.11000,11002
*ident up42
*/ purr -- 27mar01
*/  remove the timers that are given as each ladder is processed
*/  in order to reduce the number of diffs that show up when
*/  succesive runs are checked for qa purposes using the same
*/  sequence of random numbers.  for lanl/x-5.
*d purr.1746
      external fsort,ladr2,fsrch
*d purr.1798
     &  ''capture'')') e,spot,dbart,sigx
*d purr.2145,2147
      if (iprint.gt.0) write(nsyso,'(i6,1p,4e12.4)')
     &  iladr,totf,elsf,fisf,capf
*ident up43
```

```
*/ heatr -- 27mar01
*/  the roundup applied to the first energy grid point should
*/  be smaller now that we are routinely working with 7-digit
*/  energies.  the effect if this in current files is that the
*/  first energy in any of the heating and damage reactions is
*/  a little larger than the normal 1e-5.  this shows up as a
*/  zero heating or damage value for the first point in the mcnp
*/  ace files, which is strange looking, but of little significant
*/  impact on real calculations.  reported by lanl/x-5.
*d heatr.425
      data rup/1.0000001d0/
*ident up44
*/ acer -- 29mar01
*/  lanl/x-5 has requested that the main container array be increased
*/  in size to allow bigger ace files to be generated. it is also
*/  necessary to increase the i7 length field on the xsdir cards to i8
*/  to accomodate the larger ace files.
*d acer.257
      max3=1500000
*d acer.4662
      common/xsst/xss(1500000),n3
*d acer.5601
      common/xsst/xss(1500000),n3
*d acer.5762
      common/xsst/xss(1500000),n3
*d acer.5951
      common/xsst/xss(1500000),n3
*d acer.6322
      common/xsst/xss(1500000),n3
*d acer.7383
      common/xsst/xss(1500000),n3
*d acer.8055
      common/xsst/xss(1500000),n3
*d acer.9754
      common/xsst/xss(1500000),n3
*d acer.10202
      common/xsst/xss(1500000),n3
*d acer.10675
      common/xsst/xss(1500000),n3
*d acer.11068
      common/xsst/xss(1500000),n3
*d acer.11588
      common/xsst/xss(1500000),n3
*d acer.11649
     &        '(a10,f12.6,'' filename route'',i2,i4,i8,2i6,1p,e10.3,
*d acer.11653
     &        '(a10,f12.6,'' filename route'',i2,i4,i8,2i6,1p,e10.3)')
*d acer.11659
     &        '(a13,f12.6,'' file route'',i2,i4,i8,2i6,1p,e10.3,
*d acer.11663
     &        '(a13,f12.6,'' file route'',i2,i4,i8,2i6,1p,e10.3)')
*d acer.11689
      common/xsst/xss(1500000),n3
*d acer.12854
      common/xsst/xss(1500000),n3
*d acer.13452
      common/xsst/xss(1500000),n3
*d acer.13591
      common/xsst/xss(1500000),n3
*d acer.13771
      common/xsst/xss(1500000),n3
*d acer.14170
      common/xsst/xss(1500000),n3
*d acer.14274
     &     '(a10,f12.6,'' filename route'',i2,2h 1,i8,2i6,1p,e10.3)')
*d acer.14278
     &     '(a13,f12.6,'' filename route'',i2,2h 1,i8,2i6,1p,e10.3)')
*d acer.14305
```

```
      common/xsst/xss(1500000),n3
*d acer.14462
      common/xsst/xss(1500000),n3
*d acer.14548
      common/xsst/xss(1500000),n3
*d acer.14640
     &     '(a10,f12.6,'' filename route'',i2,2h 1,i8,2i6,1p,e10.3)')
*d acer.14644
     &     '(a13,f12.6,'' filename route'',i2,2h 1,i8,2i6,1p,e10.3)')
*d acer.14674
      common/xsst/xss(1500000),n3
*d acer.15012
      common/xsst/xss(1500000),n3
*d acer.15107
      common/xsst/xss(1500000),n3
*d acer.15187
     &     '(a10,f12.6,'' filename route'',i2,'' 1'',i8,2i6,1p,e10.3)')
*d acer.15191
     &     '(a13,f12.6,'' filename route'',i2,'' 1'',i8,2i6,1p,e10.3)')
*d acer.15216
      common/xsst/xss(1500000),n3
*d acer.16604
      common/xsst/xss(1500000),n3
*d acer.17057
      common/xsst/xss(1500000),n3
*d acer.17436
     &     '(a10,f12.6,'' filename route'',i2,'' 1'',i8,2i6,1p,e10.3)')
*d acer.17440
     &     '(a13,f12.6,'' filename route'',i2,'' 1'',i8,2i6,1p,e10.3)')
*d acer.17459
      common/xsst/xss(1500000),n3
*d acer.17727
      common/xsst/xss(1500000),n3
*d acer.18534
      common/xsst/xss(1500000),n3
*d acer.19545
      common/xsst/xss(1500000),n3
*d acer.19817
      common/xsst/xss(1500000),n3
*d acer.19934
      common/xsst/xss(1500000),n3
*d acer.20164
      common/xsst/xss(1500000),n3
*d acer.20610
      common/xsst/xss(1500000),n3
*d acer.21222
      common/xsst/xss(1500000),n3
*d acer.21815
      common/xsst/xss(1500000),n3
*ident up45
*/ acer -- 08apr01
*/  as discovered by jean christophe sublet, sun forte6 f95 is
*/  finiky about opening a scratch file that is already open,
*/  although all other compilers used for njoy thus far were more
*/  accepting.  we just have to be careful to close a unit used
*/  as a scratch file before reusing the unit for another purpose.
*i acer.2082
      call closz(nscr)
*ident up46
*/ gaspr -- 09apr01
*/  close another scratch unit.
*i gaspr.838
      call closz(nscr1)
*ident up47
*/ acer -- 09apr01
*/  the length published for thermal data files is too long by one
*/  for cases including incoherent elastic scattering.  for endf,
*/  this is poly, h(zrh), and cold solid methane.  discovered by
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*/  roberto orsi (enea-bologna).
*d acer.13517
*ident up48
*/ acer -- 09apr01
*/  the landh parameter should be zero (not -1) for isotropic
*/  subsections of mf=6 described using law=3.  this occurs for
*/  the reactions (n,p0) through (n,a0) in be-9 from endf/b-vi.
*/  Noted by bob little (lanl/x-5).
*i acer.9209
                        if (law.eq.3) xss(landh+jp-1)=0
*ident up49
*/ acer -- 09apr01
*/  the representation for ace law3/33 should use -q instead of
*/  abs(q) in order to handle two-body reactions for isomeric
*/  targets.  this change in the ace specifications was recommended
*/  by bob little (lanl/x-5) after a query by waclaw gudowski.  it
*/  only affects a small number of evaluations.
*d acer.5465
               xss(next+9)=sigfig(x*(-q),7,0)
*d acer.8964
                  xss(next)=sigfig((1+amass)*(-q)/amass,7,0)
*d acer.9167
                           xss(next)=sigfig((1+amass)*(-q)/amass,7,0)
*d acer.9216
                        xss(next)=sigfig((1+amass)*(-q)/amass,7,0)
*d acer.16168
               xss(nex)=sigfig(-q,7,0)
*d acer.16526
                           xss(nex)=sigfig(-q,7,0)
*ident up50
*/ acer -- 09apr01
*/  most of the jendl photonuclear evaluations currently available
*/  from http://iaeand.iaea.or.at/photonuclear/ crash with an i/o
*/  error because they use a non-conforming format where mf=6,
*/  mt=201-27 are used to represent particle production.  we are
*/  providing a clearer error message for the user's convenience.
*/  these evaluations cannot be used in njoy or mcnpx in their
*/  current form.
*i acer.15310
            if (mfd.eq.6.and.mtd.ge.201.and.mtd.le.207)
     &        call error('acephn','mf=6/mt=201-207 not supported.',
     &        'does not conform to endf format.')
*ident up51
*/ acer -- 12apr01
*/  add a capability to handle a two-body recoil subsection of mf=6
*/  for photonuclear files.  this may be useful for representing the
*/  photodisintegration of the deuteron with full distributions for
*/  both neutron and proton.  we tested the patch using a modified
*/  version of the g+2H evaluation from JENDL.
*d acer.16011
c
c                    ***special steps for two-body recoil
c                    ***back up to the corresponding law=2 distr.
                     izarec=0
                     awprec=0
                     if (izap.eq.ip.and.law.eq.4) then
                        izarec=izap
                        awprec=awp
                        mf=6
                        call findf(matd,mf,mt,nin)
                        call contio(nin,0,0,a(iscr),nb,nw)
                        call tab1io(nin,0,0,a(iscr),nb,nw)
                        izap=nint(c1h)
                        awp=c2h
                        law=l2h
                        jscr=iscr+nw
                        do while (nb.ne.0)
                           call moreio(nin,0,0,a(jscr),nb,nw)
```

```
                           jscr=jscr+nw
                        enddo
                     endif
c
c                    ***law2 angular distribution
c                    ***also used for law 4 two-body recoils
                     if ((izap.eq.ip.and.law.eq.2).or.
     &                 (izarec.eq.ip.and.law.eq.2)) then
                        lld=jscr
*i acer.16030
                        if (izarec.eq.0) then
                           awpp=awp
                        else
                           awpp=awprec
                        endif
*i acer.16036
                              if (izarec.ne.0) then
                                 nl=nint(a(lld+5))
                                 do iil=1,nl
                                    if (mod(iil,2).eq.1) then
                                       a(lld+5+iil)=-a(lld+5+iil)
                                    endif
                                 enddo
                              endif
*d acer.16104
                           a(llht+7+2*iie)=(awr-awpp)*(e+q)/awr
*d acer.16354
                        if (law.ne.1.and.law.ne.2.and.law.ne.4) then
*d acer.16356
     &                       'law=2, or law=4 currently')
*i acer.16540
                        else if (law.eq.4) then
                           xss(last+1)=33
                           xss(nex)=0
                           xss(nex+1)=2
                           nnr=nint(a(iscr+4))
                           nnp=nint(a(iscr+5))
                           xss(nex+2)=sigfig(a(iscr+6+2*nnr)/emev,7,0)
                           xss(nex+3)=
     &                        sigfig(a(iscr+4+2*nnr+2*nnp)/emev,7,0)
                           xss(nex+4)=1
                           xss(nex+5)=1
                           nex=nex+2+2*2
                           xss(last+2)=nex-dlwp+1
                           xss(nex)=sigfig(-q,7,0)
                           xss(nex+1)=sigfig(awr/(1+awr),7,0)
                           nex=nex+2
*ident up52
*/ acer -- 13apr01
*/  add a capability to handle tabulated sections of File 5 (lf=1)
*/  for photonuclear files.  Such sections are used in the Russian
*/  evaluations for three isotopes of plutonium included in the
*/  iaea photonuclear compilation.  this also fixes a bug in the
*/  storage of fission nubar.  the first point for energy distributions
*/  often has a nonrealistic sharp triangle given for the spectrum.
*/  this can cause problems with the vertical scale for plots
*/  because the emission probabilities get very large for small
*/  ranges of secondary energy.  therefore, we ignore the first
*/  incident energy in determining the vertical scale for the plot.
*d acer.15858,15859
                        xss(nex+3+j)=sigfig(fnubar(5+2*nr+2*j)/emev,7,0)
                        xss(nex+3+ne+j)=sigfig(fnubar(6+2*nr+2*j),7,0)
*d acer.16247
                  if (lf.eq.1) then
                     call tab2io(nin,0,0,a(iscr),nb,nw)
                     m=nint(a(iscr+4))
                     n=nint(a(iscr+5))
                     jnt=nint(a(iscr+7))
```

```
                     jnt=mod(jnt,10)
                     if (jnt.gt.2) jnt=2
                     if (m.ne.1.or.jnt.ne.2) then
                        xss(nex)=m
                        do j=1,m
                           xss(j+nex)=a(2*j+4+iscr)
                           jnt=nint(a(2*j+5+iscr))
                           jnt=mod(jnt,10)
                           if (jnt.gt.2) jnt=2
                           xss(j+m+nex)=jnt
                        enddo
                        nex=nex+1+2*m
                     else
                        xss(nex)=0
                        nex=nex+1
                     endif
                     xss(nex)=n
                     nexn=nex+n
                     nexd=nexn+n+1
                     ne=n
                     do j=1,ne
                        call tab1io(nin,0,0,a(iscr),nb,nw)
                        jscr=iscr
                        do while (nb.ne.0)
                           jscr=jscr+nw
                           call moreio(nin,0,0,a(jscr),nb,nw)
                        enddo
                        e=c2h
                        xss(nex+j)=sigfig(e/emev,6,0)
                        xss(nexn+j)=nexd-dlwp+1
                        m=n1h
                        n=n2h
                        jnt=nint(a(iscr+5+2*m))
                        xss(nexd)=jnt
                        xss(nexd+1)=n
                        nexd=nexd+1
                        xss(nexd+1+2*n)=0
                        do ki=1,n
                           ep=a(iscr+4+2*m+2*ki)
                           ll=iscr+4+2*m+2*ki
                           xss(ki+nexd)=sigfig(a(ll)/emev,7,0)
                           xss(ki+n+nexd)=sigfig(a(ll+1)*emev,7,0)
                           if (xss(ki+n+nexd).lt.rmin) xss(ki+n+nexd)=0
                           if (ki.gt.1.and.jnt.eq.1) xss(ki+2*n+nexd)=
     &                       xss(ki+2*n-1+nexd)+a(ll-1)*(a(ll)-a(ll-2))
                           if (ki.gt.1.and.jnt.eq.2) xss(ki+2*n+nexd)=
     &                       xss(ki+2*n-1+nexd)+((a(ll-1)
     &                       +a(ll+1))/2)*(a(ll)-a(ll-2))
                        enddo
c                       renormalize
                        renorm=1
                        if (xss(3*n+nexd).ne.zero)
     &                    renorm=1/xss(3*n+nexd)
                        do ki=1,n
                           xss(ki+n+nexd)=
     &                       sigfig(xss(ki+n+nexd)*renorm,7,0)
                           xss(ki+2*n+nexd)=
     &                       sigfig(xss(ki+2*n+nexd)*renorm,9,0)
                        enddo
                        nexd=nexd+3*n+1
                     enddo
                     nex=nexd
                  else if (lf.eq.7.or.lf.eq.9) then
*d acer.22424
               do ie=2,ne
*ident up53
*/ groupr -- 11jun01
*/  if the file6 distribution is fully isotropic (law=3), the getfle
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*/  routine doesn't realize that when doing a discrete recoil (law=4).
*/  we create a special flag of law=-4 to pass the fact of isotropy
*/  into getfle.  this problem only affects runs that compute a
*/  transfer matrix for the recoil particle when the first particle
*/  emitted is given as totally isotropic (for example, mt=701 for
*/  endf be-9).  the error message is "desired energy above highest
*/  given."  found by dieter leichtle (fzk).
*i groupr.4859
         lf=nint(c(l+3))
*i groupr.4860
         if (lf.eq.3) law=-4
*i groupr.4869
      if (law.eq.-4) go to 194
*i groupr.6786
         if (law.eq.-4) iso=1
*ident up54
*/ reconr -- 12jun01
*/  allow for the series of mt numbers 875-891 that can be used
*/  to represent different levels of the (n,2n) reaction in the
*/  same way that 600-649 are used to represent different levels
*/  of the (n,p) reaction.  the code expects that mf=3/mt=16
*/  contains the sum of mt=875 through 891 in the same way that
*/  mt=103 contains the sum of 600-649.  this representation is
*/  used for be-9 for eff-3.1 and jeff-3.0.
*d reconr.1696
         if (mth.ge.900) go to 150
*ident up55
*/ heatr -- 12jun01
*/  if mt=875-891 appears in the file, mt=16 is redundant.  this
*/  is analogous to the way mt=107 is redundant if mt=800-850
*/  is present.
*d heatr.412
      common/heat4/mt103,mt104,mt105,mt106,mt107,mt16
*i heatr.440
      mt16=0
*i heatr.499
                        if (mtd.ge.875.and.mtd.lt.891) mt16=1
*d heatr.783
      common/heat4/mt103,mt104,mt105,mt106,mt107,mt16
*i heatr.865
      if (mt.eq.16.and.mt16.gt.0) go to 110
*/  the integration over secondary energy for law 7 in getsix
*/  must allow for histogram interpolation as used in be-9
*/  from eff-3.1.  the effect of this is to get especially
*/  bad particle energies for the discrete neutron in mt=876.
*i heatr.3008
         iint=nint(c(l+7))
*d heatr.3020
            if (i.gt.1) then
               if (iint.eq.1) then
                  h=h+(xx-xl)*el
               else
                  h=h+(xx-xl)*(en+el)/2
               endif
            endif
*d heatr.3022
            if (i.gt.1) then
               if (iint.eq.1) then
                  d=d+(xx-xl)*fl
               else
                  d=d+(xx-xl)*(fn+fl)/2
               endif
            endif
*ident up57
*/ acer -- 12jun01
*/  changes to acer needed to support the eff-3.1/jeff-3.0
*/  representation for be-9.  we have to allow for the series
*/  of mt numbers 875-891.  if present, mt=16 is redundant and
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*/  must appear after the distributions in the reaction list.
*/  the section for mt=876 has two subsections for neutron
*/  emission.  this problem is handled by the previous update.
*i acer.551
      common/ace9/mt16
*i acer.642
      mt16=0
*i acer.663
               if (mtd.ge.875.and.mtd.le.891) mt16=1
*d acer.1939
     &           (iverf.ge.6.and.mt.gt.900)) then
*i acer.4671
      common/ace9/mt16
*i acer.4760
                     if (mt16.gt.0.and.mt.eq.16) nr=nr-1
*d acer.4759
                  if ((mt.ge.5.and.mt.le.91).or.
     &                (mt.ge.875.and.mt.le.899)) then
*i acer.5021
            if (mt.gt.91.and.mt.le.849) iskip=1
            if (mt16.gt.0.and.mt.eq.16) iskip=1
*d acer.5118,5120
      call findf(matd,3,2,nin)
*d acer.5127
            if (mt.gt.91.and.mt.le.849) iskip=0
            if (mt16.gt.0.and.mt.eq.16) iskip=0
*d acer.9481
                              renorm=1
                              if (xss(next+3*npep).ne.zero)
     &                          renorm=1/xss(next+3*npep)
*/  add the new reaction names to the mtname routine
*d acer.11389
      character*10 hndf(457)
*d acer.11393,11394
      character*10 hndf9(50)
      character*10 hndf10(7)
      character*10 hndf11(1)
*d acer.11403,11404
      equivalence (hndf9(1),hndf(400))
      equivalence (hndf10(1),hndf(450))
      equivalence (hndf11(1),hndf(457))
*i acer.11514
      data hndf9/'(n,x)     ',
     &  '(n,x)     ', '(n,x)     ', '(n,x)     ', '(n,x)     ',
     &  '(n,x)     ', '(n,x)     ', '(n,x)     ', '(n,x)     ',
     &  '(n,x)     ', '(n,x)     ', '(n,x)     ', '(n,x)     ',
     &  '(n,x)     ', '(n,x)     ', '(n,x)     ', '(n,x)     ',
     &  '(n,x)     ', '(n,x)     ', '(n,x)     ', '(n,x)     ',
     &  '(n,x)     ', '(n,x)     ', '(n,x)     ', '(n,x)     ',
     &  '(n,2n*0)  ',
     &  '(n,2n*1)  ', '(n,2n*2)  ', '(n,2n*3)  ', '(n,2n*4)  ',
     &  '(n,2n*5)  ', '(n,2n*6)  ', '(n,2n*7)  ', '(n,2n*8)  ',
     &  '(n,2n*9)  ', '(n,2n*10) ', '(n,2n*11) ', '(n,2n*12) ',
     &  '(n,2n*13) ', '(n,2n*14) ', '(n,2n*15) ', '(n,2n*c)  ',
     &  '(n,x)     ', '(n,x)     ', '(n,x)     ', '(n,x)     ',
     &  '(n,x)     ', '(n,x)     ', '(n,x)     ', '(n,x)     '/
*d acer.11520,11522
      data hndf10/'(n,xn)    ','(n,xgma)  ','(n,xp)    ',
     &  '(n,xd)    ','(n,xt)    ','(n,xhe3)  ','(n,xa)    '/
      data hndf11(1)/'damage    '/
*d acer.11526,11528
         if (i.ge.201.and.i.le.207) i=i+249
         if (i.ge.600) i=i-450
         if (mt.eq.444) i=457
*d acer.11534
            name=hndf(mt+250)
*d acer.11536
            name=hndf(457)
```

```
*/  need more storage for eff-3.1 be-9
*d up44.8
      max3=3000000
*d up44.10
      common/xsst/xss(3000000),n3
*d up44.12
      common/xsst/xss(3000000),n3
*d up44.14
      common/xsst/xss(3000000),n3
*d up44.16
      common/xsst/xss(3000000),n3
*d up44.18
      common/xsst/xss(3000000),n3
*d up44.20
      common/xsst/xss(3000000),n3
*d up44.22
      common/xsst/xss(3000000),n3
*d up44.24
      common/xsst/xss(3000000),n3
*d up44.26
      common/xsst/xss(3000000),n3
*d up44.28
      common/xsst/xss(3000000),n3
*d up44.30
      common/xsst/xss(3000000),n3
*d up44.32
      common/xsst/xss(3000000),n3
*d up44.42
      common/xsst/xss(3000000),n3
*d up44.44
      common/xsst/xss(3000000),n3
*d up44.46
      common/xsst/xss(3000000),n3
*d up44.48
      common/xsst/xss(3000000),n3
*d up44.50
      common/xsst/xss(3000000),n3
*d up44.52
      common/xsst/xss(3000000),n3
*d up44.58
      common/xsst/xss(3000000),n3
*d up44.60
      common/xsst/xss(3000000),n3
*d up44.62
      common/xsst/xss(3000000),n3
*d up44.68
      common/xsst/xss(3000000),n3
*d up44.70
      common/xsst/xss(3000000),n3
*d up44.72
      common/xsst/xss(3000000),n3
*d up44.78
      common/xsst/xss(3000000),n3
*d up44.80
      common/xsst/xss(3000000),n3
*d up44.82
      common/xsst/xss(3000000),n3
*d up44.88
      common/xsst/xss(3000000),n3
*d up44.90
      common/xsst/xss(3000000),n3
*d up44.92
      common/xsst/xss(3000000),n3
*d up44.94
      common/xsst/xss(3000000),n3
*d up44.96
      common/xsst/xss(3000000),n3
*d up44.98
```

```
      common/xsst/xss(3000000),n3
*d up44.100
      common/xsst/xss(3000000),n3
*d up44.102
      common/xsst/xss(3000000),n3
*d up44.104
      common/xsst/xss(3000000),n3
*d up44.106
      common/xsst/xss(3000000),n3
*ident up58
*/ broadr -- 10jul01
*/  increase the storage area in broadr to reduce paging and make
*/  comparisons between njoy99 and njoy2001 easier.  there will
*/  normally be a small difference in the grids produced by broadr
*/  each time paging takes place, and this makes it hard to compare
*/  files using diff.
*d broadr.113
      dimension a(95000)
*d broadr.137
      namax=95000
*ident up59
*/ acer -- 20jul01
*/  in charged-particle emission, the first point for energy
*/  distributions often has a nonrealistic sharp triangle given for
*/  the spectrum.  this can cause problems with the vertical scale
*/  incident energy in determining the vertical scale for the plot.
*d acer.21529
               do ie=2,ne
*ident up60
*/ reconr -- 24sep01
*/  occasionally, reactions are given with a nonzero cross section
*/  at threshold, even though this violates endf procedures.  reconr
*/  had some logic for handling this that was being overwritten by
*/  another change.  we fix it here by inserting an extra energy
*/  point just above the threshold and zeroing the cross section at
*/  the threshold.  a diagnostic message is provided.  one example
*/  of a place were this occurs is gd158 from endf/b-vi.  reported
*/  by frankle (lanl).
*i reconr.1588
      character*40 text
*d reconr.1716,1719
         write(text,'(''xsec nonzero at threshold for mt='',i3)') mth
         call mess('lunion',text,'adusted using jump in xsec')
*d reconr.1767
      er=sigfig(er,7,0)
*d reconr.1783
      enl=sigfig(er,7,0)
*d reconr.4204
*/ reconr -- 24sep01
*/  reconr contains some logic that tries to avoid doing work on
*/  very small charged-particle cross sections by defining a
*/  "pseudo-threshold" when the cross section rises to more than
*/  1e-15 barns.  however, this scheme isn't carried out completely,
*/  and it only results in the omission of the threshold energy for
*/  reactions that have less than this cross section just above
*/  the threshold.  this effect shows up for the (n,n't) reaction
*/  mt=33 for cd-110 from endf/b-vi.4.  at the request of bob
*/  little (lanl), we are changing the constant "ssmall" that
*/  triggers this effect to a smaller number.  in the long term,
*/  we should reconsider this logic.
*d reconr.1601
      ssmall=1.d-30
*d reconr.1614
      ssmall=1.e-30
*ident up61
*/ acer -- 25sep01
*/  kisako kazuaki (sumimoto) has observed that the common variable
*/  coeff in eval is not set.  actually, eval is not really used in
```

```
*/  tabize anymore.  it is just leftover as an intialization for a(iy).
*/  the only other place it is used is in islin2, and islin2 is not
*/  called anymore!  This update removes these leftover remnants.
*d acer.1019
*d acer.1022
      external loada,finda,error,sigfig
*d acer.1128
         a(iy)=0
*d acer.1216,1263
*/  kazuaki also noticed that the photoatomic heating value was
*/  being stored in ev instead of mev and that the atomic number
*/  aw0 was not being set.
*i acer.14730
      aw0=c2h
*d acer.14839
         xss(lhnm-1+i)=heat/emev
*ident up62
*/ purr -- 28sep01
*/  lanl group x-5 has noted that the conditional heating cross
*/  section in the mcnp probability tables is not quite what they
*/  expected.  we change the calculation here to get results that
*/  are consistently given as eV/reaction for lssf=0 and fluctuation
*/  factors for lssf=1.
*i purr.79
      zero=0
*d purr.454,458
            if (sigu(2,1,1).ne.zero) h=h*a(n1+j+2*nbin)/sigu(2,1,1)
*d purr.461,465
            if (sigu(3,1,1).ne.zero) h=h*a(n1+j+3*nbin)/sigu(3,1,1)
*d purr.468,472
            if (sigu(4,1,1).ne.zero) h=h*a(n1+j+4*nbin)/sigu(4,1,1)
*d purr.477
               if (a(n1+j+nbin).ne.zero) a(l)=a(l)/a(n1+j+nbin)
*ident up64
*/ acer -- 07dec01
*/  there was a mistake introduced with up57 that only affects
*/  64-bit compiles (when "*set sw" is not used).
*/ *d up56.16,17
*/ *i acer.2135
*/       zero=0
*/       one=1
*ident up65
*/ groupr -- 10dec01
*/  fix groupr to handle radionuclide production using the new
*/  endf file 8 and data from eaf2001.
*d groupr.501,502
      if (mfd.gt.36.and.mfd.lt.10000000) go to 381
*d groupr.516
      if (mfd.gt.10000000) izam=mod(mfd,10000000)
*d groupr.525
      if (mfd.le.10000000) go to 405
*d groupr.621,622
            if (mfd.lt.1000000) then
               write(nsyso,'('' for mf'',i3,'' and mt'',i3,1x,15a4)')
     &           mfd,mtd,(mtname(i),i=1,15)
            else
               mfdn=mfd/10000000
               jzam=mod(mfd,10000000)
               if (mfdn.eq.1) then
                  write(nsyso,
     &              '('' for mf3 mt'',i3,'' zam'',i8,1x,15a4)')
     &              mtd,jzam,(mtname(i),i=1,15)
               else if (mfdn.eq.2) then
                  write(nsyso,
     &              '('' for mf3*mf6 mt'',i3,'' zam'',i8,1x,15a4)')
     &              mtd,jzam,(mtname(i),i=1,15)
               else if (mfdn.eq.3) then
                  write(nsyso,
```

```
     &              '('' for mf3*mf9 mt'',i3,'' zam'',i8,1x,15a4)')
     &              mtd,jzam,(mtname(i),i=1,15)
               else if (mfdn.eq.4) then
                  write(nsyso,
     &              '('' for mf10 mt'',i3,'' zam'',i8,1x,15a4)')
     &              mtd,jzam,(mtname(i),i=1,15)
               endif
            endif
*i groupr.633
            if (mfd.gt.10000000) mfh=3
*i groupr.657
            if (mfd.gt.10000000) mfh=3
*d groupr.910
      mfd=mf10i(ir)
*d groupr.1163
      else if (mfd.gt.10000000) then
*d groupr.3123
      if (mfd.ne.3.and.mfd.ne.8.and.mfd.ne.18.and.mfd.lt.10000000) then
*d groupr.3857
      if (mft.eq.9.or.mft.eq.10) lfn=nint(a(iyld+3))
      if (mft.eq.6) lfn=nint(a(iyld+2))
*d groupr.3862,3871
      call skip6(itape,0,0,a(loc),law)
*d groupr.3859
      if (mft.gt.6.and.izn.eq.0.and.lfs.eq.lfn) go to 180
*d groupr.3975,3982
         if (mf.eq.10) then
            nfs=n1h
            jfs=-1
            do i=1,nfs
               call tab1io(nsig,0,0,a(isig),nb,nw)
               if (l2h.eq.lfs) jfs=i
               do while (nb.ne.0)
                  call moreio(nsig,0,0,a(isig),nb,nw)
               enddo
            enddo
            if (jfs.lt.0) call error('getsig',
     &        'desired lfs not found',' ')
            nskip=jfs-1
            call skiprz(nsig,-1)
            call findf(matd,mf,mt,nsig)
            call contio(nsig,0,0,a(isig),nb,nw)
            if (nskip.gt.0) then
               do i=1,nskip
                  call tab1io(nsig,0,0,a(isig),nb,nw)
                  do while (nb.ne.0)
                     call moreio(nsig,0,0,a(isig),nb,nw)
                  enddo
               enddo
            endif
*d groupr.4345
      if (mfd.eq.12.or.(mfd.gt.20000000.and.mfd.lt.40000000))
*ident up66
*/ groupr -- 12feb02
*/  if you mix automatic reactions with manual reactions where
*/  the mtname string is not given, the mtname on the manual
*/  reaction will have whatever string was left from the previous
*/  case.  we fix that here.
*d groupr.507
*/ groupr -- 13feb02
*/  there is an error in the calculation of the kalbach a factor
*/  for the photonuclear case.  it is necessary to convert e to
*/  mev for this formula.  the symptom is results for a that are
*/  so large that sinh(a) overflows with a floating point error.
*d groupr.5980
         bb=bb*sqrt((tomev*e)/(2*emc2))*fact
*ident up67
*/ matxsr -- 12feb02
```

```
*/  add photonuclear capability
*i matxsr.30
c     *   ngen8     photonuclear data from groupr (default=0)          *
*d matxsr.210
cd                      gscat     gamma scattering (atomic)            -
cd                      gg        gamma scattering (photonuclear)      -
*d matxsr.392
     &  nscrt5,nscrt6,nscrt7,ngen3,ngen4,ngen5,ngen6,ngen7,ngen8
*d matxsr.422
      ngen8=0
      read(nsysi,*)
     &  ngen1,ngen2,nmatx,ngen3,ngen4,ngen5,ngen6,ngen7,ngen8
*d matxsr.433,434
     &  '' incident alpha unit ................. '',i10/
     &  '' photonuclear unit ................... '',i10)')
     &  ngen3,ngen4,ngen5,ngen6,ngen7,ngen8
*d matxsr.441
      nscrt8=17
*i matxsr.448
      call openz(ngen8,0)
*i matxsr.475
      call closz(ngen8)
*d matxsr.495
     &  nscrt5,nscrt6,nscrt7,ngen3,ngen4,ngen5,ngen6,ngen7,ngen8
*d matxsr.892
     &  nscrt5,nscrt6,nscrt7,ngen3,ngen4,ngen5,ngen6,ngen7,ngen8
*i matxsr.909
      character*8 hgg
*d matxsr.917
      data hgsct/'gscat '/, hgg/'gg    '/, hnthr/'ntherm'/
*i matxsr.945
      if (nin.eq.0) nin=ngen8
*d matxsr.1012
      if (hprt(ip1).eq.hgm) nin=ngen8
      if (hprt(ip1).eq.hgm.and.htyp.eq.hgsct) nin=ngen2
*d matxsr.1027,1028
      if (hprt(ip2).eq.hgm.and.htyp.ne.hgg) mfv=13
      if (hprt(ip1).eq.hgm.and.htyp.eq.hgsct) mfv=23
*i matxsr.1035
      if (hprt(ip2).eq.hgm.and.htyp.eq.hgg) mfm=16
*d matxsr.1478
     &  nscrt5,nscrt6,nscrt7,ngen3,ngen4,ngen5,ngen6,ngen7,ngen8
*d matxsr.1809
     &  nscrt5,nscrt6,nscrt7,ngen3,ngen4,ngen5,ngen6,ngen7,ngen8
*ident up68
*/ reconr -- 18apr02
*/  the name "pi" is being used for both the imaginary part of
*/  p and the pi constant.  the former is changed to "pim" as
*/  used in the version of this subroutine in purr.  the symptom
*/  is a floating point error when sqrt(pi) is calculated with
*/  pi changed to a negative value.
*d reconr.4868
      pim=aimw
*d reconr.4873
      if (abs(aimw-pim).ge.eps) go to 380
*d reconr.4908
      pim=aimw
*d reconr.4912
      if (abs(aimw-pim).ge.eps) go to 470
*/  allow for more digits in the temperature printout to
*/  handle the usage of reconr being made for eaf-2001.  the
*/  temperature field is not being used for resonance
*/  reconstruction but only passed to the output file for
*/  later use.
*d reconr.348
     &  '' reconstruction temperature .......... '',f10.2,''k''/
*ident up69
*/ acer -- 07dec01
```

```
*/  add a capability to generate fluorescence data for mcnp using
*/  the existing cashwell-everett format with new numbers obtained
*/  from the endf versions of eadl and epdl.  the data produced with
*/  this method should give reasonable results for transport and
*/  heating for energies above 1 kev.  the new evaluations allow
*/  for lower incident photon energies and for more detail in photon
*/  and electron distributions from photoabsorption, and future
*/  versions of njoy and mcnp can take advantage of this.
*d acer.66
c     * data.  the input photoatomic data is mounted on nendf.         *
c     * fluorescence data can be generated from atomic relaxation      *
c     * data in endf format mounted on npend.                          *
*i acer.186
c     *             photoatomic data on nendf                          *
c     *             atomic relaxation data on npend                    *
*d acer.428
         call acepho(nendf,npend)
*d acer.14651
      subroutine acepho(nin,nlax)
*d acer.14690
      data emax/1.01d11/
*d acer.14702
      data emax/1.01e11/
*i acer.14780
c
c     ***set number of fluorescence lines
      iz=matd/100
      if (iz.lt.12) then
         nflo=0
      else if (iz.lt.20) then
         nflo=2
      else if (iz.lt.31) then
         nflo=4
      else if (iz.lt.37) then
         nflo=5
      else
         nflo=6
      endif
*d acer.14786
      lhnm=jflo+4*nflo
*d acer.14843
c     ***for fluorescence photons
*d acer.14845,14846
      if (nlax.eq.0) then
         call mess('acepho','no atomic relaxation data',
     &     'fluorescence data not processed')
      else if (nflo.gt.0) then
         call alax(nin,nlax,xss(jflo),a(iscr))
      endif
*i acer.14997
c
      subroutine alax(nin,nlax,fluor,a)
c     ******************************************************************
c     generate fluorescence data in the cashwell-everett format.
c     ******************************************************************
      implicit real*8 (a-h,o-z)
      common/util/npage,iverf
      common/cont/c1h,c2h,l1h,l2h,n1h,n2h,math,mfh,mth,nsh,nsp,nsc
      common/mainio/nsysi,nsyso,nsyse,ntty
      common/ace1/tempd,err,matd,nbina,nbinp,negn,iprint,iopt,ndigit
      dimension fluor(*)
      dimension a(*)
      dimension loc(50)
      dimension enl(3),rhol(3),wtl(3)
*if sw
      data dn/.9999d0/
      data up/1.0001d0/
      data emev/1.d6/
```

```
*else
      data dn/.9999e0/
      data up/1.0001e0/
      data emev/1.e6/
*endif
c
c     ***charge for desired material
      iz=matd/100
c
c     ***read in the atomic relaxation file for the desired material
      call openz(nlax,0)
      call tpidio(nlax,0,0,a,nw,nb)
  110 call contio(nlax,0,0,a,nw,nb)
      if (math.gt.0) go to 120
      call error('alax','mat not found',' ')
  120 if (math.eq.matd) go to 130
      call tomend(nlax,0,0,a)
      go to 110
  130 call tofend(nlax,0,0,a)
      call contio(nlax,0,0,a,nw,nb)
      nss=n1h
      ll=1
      do iss=1,nss
         loc(iss)=ll
         call listio(nlax,0,0,a(ll),nb,nw)
         ntr=n2h
         ll=ll+nw
         do while (nb.ne.0)
            call moreio(nlax,0,0,a(ll),nb,nw)
            ll=ll+nw
         enddo
      enddo
c
c     ***read in the photoionization cross section for the material
      kk=ll
      call openz(nin,0)
      call tpidio(nin,0,0,a(ll),nw,b)
  210 call contio(nin,0,0,a(ll),nw,b)
      if (math.gt.0) go to 220
      call error('spect','mat not found',' ')
  220 if (math.eq.matd) go to 230
      call tomend(nin,0,0,a(ll))
      go to 210
  230 call tofend(nin,0,0,a(ll))
      call findf(matd,23,522,nin)
      call contio(nin,0,0,a(ll),nw,nb)
      e=0
      call gety1(e,en,idis,sig,nin,a(ll))
c
c     ***for z>30, get the l1, l2, and l3 edges and jumps
      if (iz.gt.30) then
         do i=1,3
            jj=loc(5-i)
            enl(4-i)=a(jj+6)
            e=dn*enl(4-i)
            call gety1(e,en,idis,slo,nin,a(ll))
            e=up*enl(4-i)
            call gety1(e,en,idis,shi,nin,a(ll))
            rhol(4-i)=slo/shi
         enddo
      endif
c
c     ***get the energy and jump of the k edge
      ek=a(7)
      e=dn*ek
      call gety1(e,en,idis,slo,nin,a(ll))
      e=up*ek
      call gety1(e,en,idis,shi,nin,a(ll))
```

```
      rhok=slo/shi
c
c     ***case of 11<z<20
      if (iz.gt.11.and.iz.lt.20) then
c
c        ***average all the transitions to the k shell
         n=nint(a(6))
         sum1=0
         sum2=0
         do i=1,n
            jj=8+6*i
            if (nint(a(jj)).eq.0) then
               sum1=sum1+a(jj+2)
               sum2=sum2+a(jj+1)*a(jj+2)
            endif
         enddo
         sum2=sum2/sum1
c
c        ***store the results
         fluor(1)=ek/emev
         fluor(2)=ek/emev
         fluor(3)=rhok
         fluor(4)=1
         fluor(5)=0
         fluor(6)=(1-rhok)*sum1
         fluor(7)=0
         fluor(8)=sum2/emev
c
c     ***case of z>19 and z<31
      else if (iz.gt.19.and.iz.lt.31) then
c
c        ***extract l2, l3, and total for higher shells
         n=nint(a(6))
         sum1=0
         sum2=0
         do i=1,n
            jj=8+6*i
            if (nint(a(jj)).eq.0.and.nint(a(jj-1)).eq.3) then
               el2=a(jj+1)
               pl2=a(jj+2)
            else if (nint(a(jj)).eq.0.and.nint(a(jj-1)).eq.4) then
               el3=a(jj+1)
               pl3=a(jj+2)
            else if (nint(a(jj)).eq.0.and.nint(a(jj-1)).gt.4) then
               sum1=sum1+a(jj+2)
               sum2=sum2+a(jj+1)*a(jj+2)
            endif
         enddo
         sum2=sum2/sum1
c
c        ***store the results
         tot=(pl2+pl3+sum1)/(1-rhok)
         y=0
         phi=rhok
         fluor(1)=ek/emev
         fluor(5)=phi
         fluor(9)=y
         fluor(13)=0
         phi=phi+pl3/tot
         y=y+(1-rhok)*pl3
         fluor(2)=ek/emev
         fluor(6)=phi
         fluor(10)=y
         fluor(14)=el3/emev
         phi=phi+pl2/tot
         y=y+(1-rhok)*pl2
         fluor(3)=ek/emev
         fluor(7)=phi
```

```
         fluor(11)=y
         fluor(15)=el2/emev
         phi=1
         y=y+(1-rhok)*sum1
         fluor(4)=ek/emev
         fluor(8)=phi
         fluor(12)=y
         fluor(16)=sum2/emev
c
c     ***all other z values
      else
         rholt=rhol(1)*rhol(2)*rhol(3)
         elav=(enl(1)+enl(2)+enl(3))/3
         wtl(1)=1/rhol(1)
         wtl(2)=wtl(1)/rhol(2)
         wtl(3)=wtl(2)/rhol(3)
         denom=wtl(3)-1
         wtl(3)=(wtl(3)-wtl(2))/denom
         wtl(2)=(wtl(2)-wtl(1))/denom
         wtl(1)=(wtl(1)-1)/denom
c
c        ***compute the average yield and energy for l fluorescence
         sum1=0
         sum2=0
         do iss=2,4
            jj=loc(iss)
            n=nint(a(jj+5))
            wt=wtl(iss-1)
            do i=1,n
               if (nint(a(jj+7+6*i)).eq.0) then
                  sum1=sum1+a(jj+9+6*i)*wt
                  sum2=sum2+a(jj+8+6*i)*a(jj+9+6*i)*wt
               endif
            enddo
         enddo
         sum2=sum2/sum1
         ylt=sum1
         flt=sum2
         if (flt.gt.enl(1)) then
            write(nsyso,'('' L edge problem'')')
            write(nsyso,'(1x,3f10.4)') flt,enl(1),elav
         endif
c
c        ***extract kalpha1, kalpha2, kbeta1, and kbeta2
         n=nint(a(6))
         sum11=0
         sum12=0
         sum21=0
         sum22=0
         do i=1,n
            jj=8+6*i
            if (nint(a(jj)).eq.0) then
               mm=nint(a(jj-1))
               if (mm.eq.3) then
                  el2=a(jj+1)
                  pl2=a(jj+2)
               else if (mm.eq.4) then
                  el3=a(jj+1)
                  pl3=a(jj+2)
               else if (mm.ge.5.and.mm.le.9) then
                  sum11=sum11+a(jj+2)
                  sum12=sum12+a(jj+1)*a(jj+2)
               else if (mm.ge.10.and.mm.le.16) then
                  sum21=sum21+a(jj+2)
                  sum22=sum22+a(jj+1)*a(jj+2)
               endif
            endif
         enddo
```

```
         if (iz.ge.37) then
            sum22=sum22/sum21
         else
            sum11=sum11+sum21
            sum12=sum12+sum22
            sum21=0
         endif
         sum12=sum12/sum11
c
c        ***store the results
         n=5
         if (iz.gt.36) n=6
         fluor(1)=elav/emev
         fluor(1+n)=rholt
         fluor(1+2*n)=0
         fluor(1+3*n)=0
         y=(1-rholt)*ylt
         fluor(2)=elav/emev
         fluor(2+n)=1
         fluor(2+2*n)=y
         fluor(2+3*n)=flt/emev
         phi=1/rhok
         phik=phi-1
         tot=(pl2+pl3+sum11+sum21)/phik
         phi=1
         phi=phi+pl3/tot
         y=y+phik*pl3
         fluor(3)=ek/emev
         fluor(3+n)=phi
         fluor(3+2*n)=y
         fluor(3+3*n)=el3/emev
         phi=phi+pl2/tot
         y=y+phik*pl2
         fluor(4)=ek/emev
         fluor(4+n)=phi
         fluor(4+2*n)=y
         fluor(4+3*n)=el2/emev
         phi=phi+sum11/tot
         y=y+phik*sum11
         fluor(5)=ek/emev
         fluor(5+n)=phi
         fluor(5+2*n)=y
         fluor(5+3*n)=sum12/emev
         if (iz.ge.37) then
            phi=phi+sum21/tot
            y=y+phik*sum21
            fluor(6)=ek/emev
            fluor(6+n)=phi
            fluor(6+2*n)=y
            fluor(6+3*n)=sum22/emev
         endif
c
      endif
      return
      end
*i acer.15088
c
c     ***print the fluorescence data
      if (nflo.gt.0) then
         write(nsyso,'(//
     &     '' fluorescence data''/
     &     '' -----------------'')')
         write(nsyso,'(/
     &     ''          edge       phi         y           f''/
     &     ''    ----------   -------   -------   ---------'')')
         do i=1,nflo
            write(nsyso,'(3x,f11.7,f10.4,f10.4,2x,f10.6)')
     &        (xss(jflo+i-1+nflo*(j-1)),j=1,4)
```

```
         enddo
      endif
*i acer.15147
c
c        ***fluorescence data block
         l=jflo
         if (nflo.ne.0) then
            do i=1,4*nflo
               call typen(l,nout,2)
               l=l+1
            enddo
         endif
*ident up70
*/ acer -- 20feb02
*/  add consistency checks for delayed neutrons
*/  add plots for nubar and delayed neutron spectra
*d acer.17720
      integer dndat,dnd,ptype,ploct,hpd,sigh,dlwh
*d acer.17723
      common/nxst/len2,izaid,nes,ntr,nr,ntrp,ntyph,ndnf,nxsd(8)
*d acer.17726
     &  iurpt,nud,dndat,ldnd,dnd,jxsd(2),ptype,ntro,ploct
*i acer.18202
c
c     ***check delayed neutron data
      if (ndnf.gt.0) then
         write(nsyso,'(/'' check delayed neutron fractions'')')
         l=dndat
         sum=0
         do j=1,ndnf
            l=l+2
            nn=nint(xss(l))
            l=l+nn
            frac=xss(l+1)
            sum=sum+frac
            l=l+nn+1
         enddo
         if (abs(sum-1)*1000.gt.one) then
            write(nsyso,'(''   consis: delayed fractions do not'',
     &        '' sum to one'')')
            nerr=nerr+1
         endif
         write(nsyso,'(/'' check delayed neutron distributions'')')
         do i=1,ndnf
            nlaw=1
            loct=nint(xss(i-1+ldnd)+dnd-1)
            law=nint(xss(loct+1))
            m=nint(xss(loct+3))
            loct=loct+3+2*m
            loct=loct+1
            n=nint(xss(loct))
            loct=loct+1+2*n
            m=nint(xss(loct))
            loct=loct+2*m
            loct=loct+1
            ne=nint(xss(loct))
            loci=nint(xss(1+ne+loct))+dnd-1
            intt=nint(xss(loci))
            n=nint(xss(loci+1))
            loci=loci+1
            do j=1,n
               x=xss(j+loci)
               y=xss(j+loci+n)
               c=xss(j+loci+2*n)
               if (j.gt.1) then
                  if (x.lt.xlast) then
                     write(nsyso,'(''   consis: delayed spectrum'',
     &                 '' energies not monotonic'')')
```

```
                  nerr=nerr+1
               endif
               if (c.lt.clast) then
                  write(nsyso,'(''   consis: delayed spectrum'',
     &               '' cummulative probs not monotonic'')')
                  nerr=nerr+1
               endif
            endif
            xlast=x
            clast=c
         enddo
      enddo
   endif
*d acer.18530
      common/nxst/len2,izaid,nes,ntr,nr,ntrp,ntyph,ndnf,nxsd(8)
*i acer.19514
c
c     ***plot nubar
      if (nu.gt.0) call aplonu(nout,iwcol)
*i acer.19517
c
c     ***plot delayed-neutron data
      if (ndnf.gt.0) call aplodn(nout,iwcol)
*i acer.20148
c
      subroutine aplonu(nout,iwcol)
c     ******************************************************************
c     plot the total fission nubar curve
c     ******************************************************************
*if sw
      implicit real*8 (a-h,o-z)
*endif
      integer esz,sig,and,tyr,dlw,gpd,fis,sigp,andp,dlwp,yp,end
      common/nxst/len2,izaid,nes,ntr,nr,ntrp,ntype,nxsd(9)
      common/jxst/esz,nu,mtr,lqr,tyr,lsig,sig,land,and,ldlw,dlw,
     &  gpd,mtrp,lsigp,sigp,landp,andp,ldlwp,dlwp,yp,fis,end,jxsd(10)
      character hz*13,hd*10,hk*70,hm*10
      common/mis1/hz,hd,hk,hm
      common/xsst/xss(3000000),n3
      common/ace7/awi,izai,mcnpx,newfor
      character*1 qu
      character*10 name
      data qu/''''/
*if sw
      data big/1.d10/
      data small/1.d-12/
      data ten/10.d0/
      data step/0.2d0/
*else
      data big/1.e10/
      data ten/10.e0/
      data small/1.e-12/
      data step/0.2e0/
*endif
      zero=0
      one=1
c
c     ***set up the page for the total nubar curve
      xmin=big
      xmax=0
      ymin=big
      ymax=-big
      l=nu
      j=nint(xss(l))
      kf=j
      if (kf.lt.0) then
         l=l+iabs(kf)+1
         j=nint(xss(l))
```

```
      endif
      if (j.ne.2) then
         e=xss(esz)
         emax=xss(esz+nes-1)
         l=l+1
         n=nint(xss(l))
         ymin=xss(l+1)
         ymax=ymin
         do i=2,n
            ymax=ymax+xss(l+i)*e**(i-1)
         enddo
      else
         l=l+1
         nr=nint(xss(l))
         if (nr.gt.0) l=l+2*nr
         l=l+1
         ne=nint(xss(l))
         do i=1,ne
            x=xss(l+i)
            y=xss(l+i+ne)
            if (x.lt.xmin) xmin=x
            if (x.gt.xmax) xmax=x
            if (y.lt.ymin) ymin=y
            if (y.gt.ymax) ymax=y
         enddo
      endif
      call ascle(4,ymin,ymax,major,minor)
      ystep=(ymax-ymin)/major
      xstep=(xmax-xmin)/4
      write(nout,'(''1'',i3,''/'')') iwcol
      it=1
      do i=1,70
         if (hk(i:i).ne.' ') it=i
      enddo
      write(nout,'(a,''<'',a,''>'',a,''/'')') qu,hk(1:it),qu
      write(nout,'(a,''<t>otal fission nubar'',a,''/'')') qu,qu
      write(nout,'(''1 0 2/'')')
      write(nout,'(1p,3e12.3,''/'')') xmin,xmax,xstep
      write(nout,'(a,''<e>nergy (<m>e<v>)'',a,''/'')') qu,qu
      write(nout,'(1p,3e12.3,''/'')') ymin,ymax,ystep
      write(nout,'(a,''<f>ission nubar'',a,''/'')') qu,qu
      write(nout,'(''/'')')
      write(nout,'(''/'')')
      write(nout,'(''0/'')')
      l=nu
      j=nint(xss(l))
      kf=j
      if (kf.lt.0) then
         l=l+iabs(kf)+1
         j=nint(xss(l))
      endif
      if (j.ne.2) then
         e=xss(esz)
         emax=xss(esz+nes-1)
         l=l+1
         n=nint(xss(l))
         do while (e.lt.emax)
            sum=xss(l+1)
            do i=2,n
               sum=sum+xss(l+i)*e**(i-1)
            enddo
            write(nout,'(1p,2e14.6,''/'')') e,sum
            e=e+step
         enddo
      else
         l=l+1
         nr=nint(xss(l))
         if (nr.gt.0) l=l+2*nr
```

```
         l=l+1
         ne=nint(xss(l))
         do i=1,ne
            x=xss(l+i)
            y=xss(l+i+ne)
            write(nout,'(1p,2e14.6,''/'')') x,y
         enddo
      endif
      write(nout,'(''/'')')

      return
      end
*i acer.20593
c
      subroutine aplodn(nout,iwcol)
c     ******************************************************************
c     plot the delayed-neutron data
c     ******************************************************************
*if sw
      implicit real*8 (a-h,o-z)
*endif
      integer esz,sig,and,tyr,dlw,gpd,fis,sigp,andp,dlwp,yp,end
      integer dndat,dnd,ptype,ploct
      common/nxst/len2,izaid,nes,ntr,nr,ntrp,ntype,ndnf,nxsd(8)
      common/jxst/esz,nu,mtr,lqr,tyr,lsig,sig,land,and,ldlw,dlw,
     &  gpd,mtrp,lsigp,sigp,landp,andp,ldlwp,dlwp,yp,fis,end,
     &  iurpt,nud,dndat,ldnd,dnd,jxsd(2),ptype,ntro,ploct
      character hz*13,hd*10,hk*70,hm*10
      common/mis1/hz,hd,hk,hm
      common/xsst/xss(3000000),n3
      common/ace7/awi,izai,mcnpx,newfor
      character*1 qu
      character*10 name
      external ascll,ascle
      data qu/''''/
*if sw
      data big/1.d10/
      data small/1.d-12/
      data ten/10.d0/
      data step/1.2d0/
      data scale/1.d2/
*else
      data big/1.e10/
      data ten/10.e0/
      data small/1.e-12/
      data step/1.2e0/
      data scale/1.e2/
*endif
      zero=0
      one=1
c
c     ***set up the page for the delayed nubar curve
      xmin=big
      xmax=0
      ymin=big
      ymax=-big
      l=nud
      j=nint(xss(l))
      l=l+1
      nr=nint(xss(l))
      if (nr.gt.0) l=l+2*nr
      l=l+1
      ne=nint(xss(l))
      do i=1,ne
         x=xss(l+i)
         y=xss(l+i+ne)
         if (x.lt.xmin) xmin=x
         if (x.gt.xmax) xmax=x
```

```
         if (y.lt.ymin) ymin=y
         if (y.gt.ymax) ymax=y
      enddo
      ymin=ymin/step
      ymax=ymax*step
      call ascle(4,ymin,ymax,major,minor)
      ystep=(ymax-ymin)/major
      xstep=(xmax-xmin)/4
      write(nout,'(''1'',i3,''/'')') iwcol
      it=1
      do i=1,70
         if (hk(i:i).ne.' ') it=i
      enddo
      write(nout,'(a,''<'',a,''>'',a,''/'')') qu,hk(1:it),qu
      write(nout,'(a,''<d>elayed nubar'',a,''/'')') qu,qu
      write(nout,'(''1 0 2/'')')
      write(nout,'(1p,3e12.3,''/'')') xmin,xmax,xstep
      write(nout,'(a,''<e>nergy (<m>e<v>)'',a,''/'')') qu,qu
      write(nout,'(1p,3e12.3,''/'')') ymin,ymax,ystep
      write(nout,'(a,''<d>elayed nubar'',a,''/'')') qu,qu
      write(nout,'(''/'')')
      write(nout,'(''/'')')
      write(nout,'(''0/'')')
      l=nud
      j=nint(xss(l))
      l=l+1
      nr=nint(xss(l))
      if (nr.gt.0) l=l+2*nr
      l=l+1
      ne=nint(xss(l))
      do i=1,ne
         x=xss(l+i)
         y=xss(l+i+ne)
         write(nout,'(1p,2e14.6,''/'')') x,y
      enddo
      write(nout,'(''/'')')
c
c     ***set up the page for the delayed spectra curves
      xmin=big
      xmax=0
      ymin=big
      ymax=-big
      do i=1,ndnf
         nlaw=1
         loct=nint(xss(i-1+ldnd)+dnd-1)
         law=nint(xss(loct+1))
         m=nint(xss(loct+3))
         loct=loct+3+2*m
         loct=loct+1
         n=nint(xss(loct))
         loct=loct+1+2*n
         m=nint(xss(loct))
         loct=loct+2*m
         loct=loct+1
         ne=nint(xss(loct))
         loci=nint(xss(1+ne+loct))+dnd-1
         intt=nint(xss(loci))
         n=nint(xss(loci+1))
         loci=loci+1
         l=dndat
         do j=1,ndnf
            if (j.eq.i) decay=xss(l)
            l=l+2
            nn=nint(xss(l))
            l=l+nn
            if (j.eq.i) frac=xss(l+1)
            l=l+nn+1
         enddo
```

```
      do j=1,n
         x=xss(j+loci)
         if (x.eq.zero) x=xss(j+1+loci)/10
         y=frac*xss(j+loci+n)
         if (x.lt.xmin) xmin=x
         if (x.gt.xmax) xmax=x
         if (y.lt.ymin) ymin=y
         if (y.gt.ymax) ymax=y
      enddo
   enddo
   call ascll(xmin,xmax)
   if (ymin.lt.ymax/scale) ymin=ymax/scale
   call ascll(ymin,ymax)
   write(nout,'(''1'',i3,''/'')') iwcol
   it=1
   do i=1,70
      if (hk(i:i).ne.' ') it=i
   enddo
   write(nout,'(a,''<'',a,''>'',a,''/'')') qu,hk(1:it),qu
   write(nout,'(a,''<d>elayed neutron spectra'',a,''/'')') qu,qu
   xtag=step*xmin
   ytag=ymax/30
   write(nout,'(''4 0 2 1'',2e12.4,''/'')') xtag,ytag
   write(nout,'(1p,3e12.3,''/'')') xmin,xmax,one
   write(nout,'(a,''<e>nergy (<m>e<v>)'',a,''/'')') qu,qu
   write(nout,'(1p,3e12.3,''/'')') ymin,ymax,one
   write(nout,'(a,''<p>robability'',a,''/'')') qu,qu
   write(nout,'(''/'')')
   do i=1,ndnf
      if (i.gt.1) then
         write(nout,'(i2,''/'')') i
         write(nout,'(''/'')')
      endif
      if (iwcol.eq.0) then
         write(nout,'(''0 0'',i2,''/'')') i
      else
         write(nout,'(''0 0 0'',i2,''/'')') i
      endif
      l=dndat
      do j=1,ndnf
         if (j.eq.i) decay=xss(l)
         l=l+2
         n=nint(xss(l))
         l=l+n
         if (j.eq.i) frac=xss(l+1)
         l=l+n+1
      enddo
      write(nout,'(a,''group'',i2,'' frac'',f7.4,'' decay/shake'',
  &     1p,e10.3,a,''/'')') qu,i,frac,decay,qu
      write(nout,'(''0/'')')
      loct=nint(xss(i-1+ldnd)+dnd-1)
      law=nint(xss(loct+1))
      m=nint(xss(loct+3))
      loct=loct+3+2*m
      loct=loct+1
      n=nint(xss(loct))
      loct=loct+1+2*n
      m=nint(xss(loct))
      loct=loct+2*m
      loct=loct+1
      ne=nint(xss(loct))
      loci=nint(xss(1+ne+loct))+dnd-1
      intt=nint(xss(loci))
      n=nint(xss(loci+1))
      loci=loci+1
      m=n
      if (intt.eq.1) m=m-1
      do j=1,m
```

```
            x=xss(j+loci)
            if (x.eq.zero) x=xss(j+1+loci)/10
            y=frac*xss(j+loci+n)
            if (y.lt.ymin) y=ymin
            write(nout,'(1p,2e14.6,''/'')') x,y
            if (intt.eq.1) then
               x=xss(j+1+loci)
               y=frac*xss(j+loci+n)
               if (y.lt.ymin) y=ymin
               write(nout,'(1p,2e14.6,''/'')') x,y
            endif
         enddo
         write(nout,'(''/'')')
      enddo

      return
      end
*ident up71
*/ reconr -- 25aug02
*/  if the cross section or yield in a section is zero at all
*/  energies, the union grid is spoiled.  we fix lunion so the
*/  so called pseudo-threshold search cannot go past one less
*/  than the number of points in the section.  this problem was
*/  seen in n-15 of jendl-3.3 for 12/104 and 12/105.
*i reconr.1742
      npr=nint(a(iscr+5))
*d reconr.1764
      if (sr.lt.ssmall.and.srnext.lt.ssmall.and.ir.lt.npr-1) go to 205
*ident up72
*/ acer -- 3sep02
*/  watch for a special case in plotting
*d acer.21528
*d up59.8
               i1=1
               if (ne.gt.2) then
                  i1=2
                  if (ymax.gt.test*xss(l3+2+ne-2)) ymax=xss(l3+2+ne-2)
               endif
               do ie=i1,ne
*ident up73
*/ groupr -- 3sep02
*/  allow for up to 8 groups of delayed neutrons as used in some
*/  materials of jeff-3.
*d groupr.240
      common/delayg/ndelg
      common/delayn/dntc(8)
*d groupr.567
         do i=1,ndelg
*d groupr.570,571
         nll=ndelg
         l=ians+ndelg
*i groupr.3071
      common/delayg/ndelg
*d groupr.3100
      if (mfd.eq.5.and.mtd.eq.455) nl=ndelg
*d groupr.3391
      common/delayn/dntc(8)
*d groupr.3802
      common/delayn/dntc(8)
*d groupr.3842
      if (lnd.gt.8) call error('getyld','illegal lnd.',' ')
*i groupr.4272
      common/delayg/ndelg
*d groupr.4386
      if (mtd.eq.455) nk=ndelg
*i groupr.7934
      common/delayg/ndelg
*i groupr.7955
```

```
      ndelg=0
*i groupr.8380
      if (mth.eq.455) then
         call listio(nin,nout,nscr,a(iscr),nb,nw)
         ndelg=n1h
      endif
*ident up74
*/ groupr -- 03sep02
*/  fix editing error in the lwr epri weight function.
*/  reported by skip kahler (bechtel bettis).
*d groupr.2171
     & 1.407d7,1.154d-6,1.42d7,1.087d-6,1.43d7,9.5757d-7,1.44d7,
*d groupr.2234
     & 1.407e7,1.154e-6,1.42e7,1.087e-6,1.43e7,9.5757e-7,1.44e7,
*/  fix an incorrect boolean statement in the removal of upscatter
*/  in subroutine getsed.  reported by kazuaki (sae, japan).
*d groupr.8914
                     if (mtd.lt.18.or.(mtd.gt.21.and.mtd.ne.38)) then
*ident up75
*/ acer -- 09oct02
*/  fix some typographical errors in recent updates
*d up69.82,83
      call tpidio(nlax,0,0,a,nb,nw)
  110 call contio(nlax,0,0,a,nb,nw)
*d up69.90
      call contio(nlax,0,0,a,nb,nw)
*d up69.107,108
      call tpidio(nin,0,0,a(ll),nb,nw)
  210 call contio(nin,0,0,a(ll),nb,nw)
*d up69.116
      call contio(nin,0,0,a(ll),nb,nw)
*ident up76
*/ plotr -- 09oct02
*/  allow for more energy resolutions in plotr output
*/  for looking at the details of resonance reconstruction
*d plotr.1939
            write(nplt,'(1p,2e16.8,''/'')') x(i),y(i)
*d plotr.1941,1942
            write(nplt,'(1p,6e16.8,''/'')') x(i),y(i),
     &        dym(i),dyp(i),dxm(i),dxp(i)
*ident up77
*/ plotr -- 11oct02
*/  add a capability to plot percent difference or ratios
*i plotr.21
c     * percent difference and ratio plots can be requested.           *
*d plotr.178
c     *            ntp   special features                               *
c     *                  1 for regular plots (default)                  *
c     *                  2 for percent difference plots                 *
c     *                     read a second "card 8" for percent diff     *
c     *                     of second curve with respect to first       *
c     *                  3 for ratio plots                              *
c     *                     read a second "card 8" for ratio            *
c     *                     of second curve to first                    *
*i plotr.630
         if (mfd.eq.3.and.ntp.gt.1) then
            nin2=0
            matd2=0
            matd2=0
            mtd2=0
            temper2=0
            nth2=1
            ntp2=1
            nkh2=1
            read(nsysi,*)
     &        iverf2,nin2,matd2,mfd2,mtd2,temper2,nth2,ntp2,nkh2
            call openz(nin2,0)
            write(nsyso,'(/
```

```
     &        '' iverf2 .............................. '',i10/
     &        '' nin2 ................................ '',i10/
     &        '' matd2 ............................... '',i10/
     &        '' mfd2 ................................ '',i10/
     &        '' mtd2 ................................ '',i10/
     &        '' temp2 ............................... '',1p,e10.2/
     &        '' nth2 ................................ '',i10/
     &        '' ntp2 ................................ '',i10/
     &        '' nkh2 ................................ '',i10)')
     &        iverf2,nin2,matd2,mfd2,mtd2,temper2,nth2,ntp2,nkh2
         endif
*i plotr.702
      if (nin2.ne.0) call tpidio(nin2,0,0,a,nb,nw)
*i plotr.726
      if (nin2.eq.0) go to 320
      idone=0
      do while (idone.eq.0)
         call contio(nin2,0,0,a,nb,nw)
         if (math.lt.0) then
            write(strng,
     &        '(''desired mat2 and temp2 not found '',i4,f10.1)')
     &         matd2,temper2
            call error('plotr',strng,' ')
         endif
         if (math.eq.matd2) then
            if (mfd2.eq.7) then
               idone=1
            else
               if (iverf2.ge.5) call contio(nin2,0,0,a,nb,nw)
               if (iverf2.ge.6) call contio(nin2,0,0,a,nb,nw)
               call contio(nin2,0,0,a,nb,nw)
               tem=a(1)
               if (abs(tem-temper2).le.temper2/1000) idone=1
            endif
         endif
         if (idone.eq.0) call tomend(nin2,0,0,a)
      enddo
*i plotr.729
      if (nin2.ne.0) call findf(matd2,mfd2,mtd2,nin2)
*i plotr.730
      if (nin2.ne.0) call contio(nin2,0,0,a,nb,nw)
*i plotr.990
      else if (nin2.ne.0) then
         enext=big
         reset=-1
         loc2=50+npage
         call getz(reset,enxt,idis,zz,0,a)
         call getz(enow,enxt,idis,zz,nin,a)
         if (enxt.lt.enext) enext=enxt
         call getz(enow,enxt,idis,zz,nin2,a(loc2))
         if (enxt.lt.enext) enext=enxt
*i plotr.1072
      else if (nin2.ne.0) then
         enext=big
         call getz(enow,enxt,idis,zz,nin,a)
         if (enxt.lt.enext) enext=enxt
         call getz(enow,enxt,idis,z2,nin2,a(loc2))
         if (enxt.lt.enext) enext=enxt
         if (ntp.eq.2) then
            yf=100*(z2-zz)
            if (zz.ne.zero) yf=yf/zz
         else if (ntp.eq.3) then
            yf=z2
            if (zz.ne.zero) yf=yf/zz
         endif
*i plotr.1102
      else if (nin2.ne.0) then
         enext=big
```

```
         call getz(enow,enxt,idis,zz,nin,a)
         if (enxt.lt.enext) enext=enxt
         call getz(enow,enxt,idis,z2,nin2,a(loc2))
         if (enxt.lt.enext) enext=enxt
         if (ntp.eq.2) then
            yf=100*(z2-zz)
            if (zz.ne.zero) yf=yf/zz
         else if (ntp.eq.3) then
            yf=z2
            if (zz.ne.zero) yf=yf/zz
         endif
*i plotr.2104
c
      subroutine getz(x,xnext,idis,z,itape,a)
c     ******************************************************************
c     retrieve z(x) from an endf/b tab1 structure using paged bcd or
c     blocked binary formats.  call with x=0 to read in first page
c     or block of data and initialize pointers.  routine assumes
c     values will be called in ascending order.  xnext is the first
c     data grid point greater than x unless x is the last point.
c     this version will keep track of pointers for up to 10 units.
c     call with x=-1 to clear the pointers before each group of files.
c     based on gety from mixr.
c     ******************************************************************
*if sw
      implicit real*8 (a-h,o-z)
*endif
      dimension a(*)
      common/getzc/ntape,jtape(10),nrt(10),npt(10),irt(10),ipt(10),
     &  ip1t(10),ip2t(10),nbt(10),nwt(10)
      save lt
      external tab1io,error,moreio,terp1
*if sw
      data big/1.d10/
*else
      data big/1.e10/
*endif
      zero=0
c
c     ***branch on value of x
      idis=0
      if (x.eq.zero) go to 100
      if (x.gt.zero) go to 115
c
c     ***clear pointer storage
      ntape=0
      return
c
c     ***read first page or block of data and initialize
  100 ntape=ntape+1
      jtape(ntape)=itape
      call tab1io(itape,0,0,a,nb,nw)
      nwtot=nw
      nr=nint(a(5))
      np=nint(a(6))
      lt=6+2*nr
      ip1=1
      ip2=(nw-lt)/2
      if (nb.eq.0) ip2=ip2+2
      ir=1
      ip=2
      xnext=a(lt+1)
c
c     ***save pointers and return
      nrt(ntape)=nr
      npt(ntape)=np
      irt(ntape)=ir
      ipt(ntape)=ip
```

```
      ip1t(ntape)=ip1
      ip2t(ntape)=ip2
      nbt(ntape)=nb
      nwt(ntape)=nwtot
      return
c
c     ***restore pointers
  115 if (ntape.eq.0)
     &  call error('gety','not properly initialized',' ')
      do 120 i=1,ntape
      if (jtape(i).ne.itape) go to 120
      ktape=i
      nr=nrt(i)
      np=npt(i)
      ir=irt(i)
      ip=ipt(i)
      ip1=ip1t(i)
      ip2=ip2t(i)
      nb=nbt(i)
      nwtot=nwt(i)
      go to 125
  120 continue
      z=0
      xnext=big
      return
c
c     ***is x in this panel
  125 ln=2*(ip-ip1)+lt
      if (x.lt.a(ln-1)) go to 135
      if (x.lt.a(ln+1)) go to 130
      if (ip.eq.np) go to 140
c
c     ***no.  move up to next range.
c     ***read in new page of data if needed.
      ip=ip+1
      nbx=nint(a(5+2*ir))
      if (ip.gt.nbx) ir=ir+1
      if (ip.lt.ip2) go to 125
      if (nb.eq.0) go to 130
      a(lt+1)=a(nwtot-3)
      a(lt+2)=a(nwtot-2)
      a(lt+3)=a(nwtot-1)
      a(lt+4)=a(nwtot)
      call moreio(itape,0,0,a(lt+5),nb,nw)
      nwtot=nw+lt+4
      ip1=ip-1
      ip2=ip1+nw/2+1
      if (nb.eq.0) ip2=ip2+2
      go to 125
c
c     ***yes.  interpolate for desired value
  130 int=nint(a(6+2*ir))
      if (int.eq.1) idis=1
      call terp1(a(ln-1),a(ln),a(ln+1),a(ln+2),x,z,int)
      xnext=a(ln+1)
      if ((ln+3).gt.nwtot.and.nb.eq.0) return
      xn=a(ln+3)
      if (xn.eq.xnext) idis=1
      go to 150
c
c     ***special branch for x outside range of table
  135 z=0
      xnext=a(ln-1)
      go to 150
c
c     ***special branch for last point
  140 z=a(ln+2)
      xnext=big
```

```
c
c     ***save pointers and return
  150 nrt(ktape)=nr
      npt(ktape)=np
      irt(ktape)=ir
      ipt(ktape)=ip
      ip1t(ktape)=ip1
      ip2t(ktape)=ip2
      nbt(ktape)=nb
      nwt(ktape)=nwtot
      return
      end
*ident up78
*/ broadr -- 10oct02
*/  tighten up the tolerances for integral thinning a bit
*d broadr.56
c     *              (errmax.ge.errthn, default=10*errthn)              *
*d broadr.58
c     *              (usage as in reconr) (default=errthn/20000)        *
*d broadr.177,178
      if (errmax.eq.zero) errmax=10*errthn
      if (errint.eq.zero) errint=errthn/20000
*/ broadr -- 10oct02
*/  fix some problems related to keeping computed cross sections
*/  on printable 7- or 9-digit grids.  this was discovered when
*/  doing testing at 0.01% for u235 above 1 kev, and it doesn't
*/  usually make itself evident for easier cases.
*i broadr.1080
      xt=sqrt(alpha*es(2))
*d broadr.1087
      call bsigma(k,xt,ss(1,2),e,s,nx)
*d broadr.1120
      xt=sqrt(alpha*es(1))
      call bsigma(k,xt,ss(1,1),e,s,nx)
*ident up79
*/ reconr -- 10oct02
*/  tighten up the default tolerances for integral thinning a bit
*d reconr.63
c     *              (errmax.ge.err, default=10*err)                    *
*d reconr.65
c     *              per grid point (default=err/20000)                 *
*d reconr.314
      if (errmax.le.zero) errmax=10*err
*d reconr.316
      if (errint.le.zero) errint=err/20000
*/ reconr -- 10oct02
*/  make some improvements in grid generation to make sure that
*/  all cross sections are computed on printable 7- or 9-digit
*/  energies and that the original nodes for resonance reconstruction
*/  are reasonable.  these changes were made to remove some small
*/  artifacts on the order of 0.05% above 1 kev for some materials.
*i reconr.341
         do i=1,ngrid
            a(ienode+i-1)=sigfig(a(ienode+i-1),7,0)
         enddo
*d reconr.801
*d reconr.804
     &         hw=hw+(a(jnow+3)+abs(a(jnow+4))+abs(a(jnow+5)))/2
               ndig=5
               if (a(jnow).gt.zero) ndig=2+nint(log10(a(jnow)/(hw/10)))
               if (ndig.lt.5) ndig=5
               if (ndig.gt.9) ndig=9
               a(ienode+nodes-1)=sigfig(a(jnow),ndig,0)
*d reconr.810
                  a(ienode+nodes-1)=sigfig(ehalf,ndig,0)
*d reconr.817
                  a(ienode+nodes-1)=sigfig(ehalf,ndig,0)
*d reconr.900,901
```

```
                    hw=a(nloc+ien*jen+1)
                    ndig=5
                    if (ener.gt.zero) ndig=2+nint(log10(ener/(hw/10)))
                    if (ndig.lt.5) ndig=5
                    if (ndig.gt.9) ndig=9
                    a(ienode+nodes-1)=sigfig(ener,ndig,0)
*d reconr.907
                       a(ienode+nodes-1)=sigfig(ehalf,ndig,0)
*d reconr.914
                       a(ienode+nodes-1)=sigfig(ehalf,ndig,0)
*i reconr.993
                 ndig=5
                 if (enow.gt.zero) ndig=2+nint(log10(enow/(hw/10)))
                 if (ndig.lt.5) ndig=5
                 if (ndig.gt.9) ndig=9
*d reconr.998
                    a(ienode+nodes-1)=sigfig(enow,ndig,0)
*d reconr.1002
                       a(ienode+nodes-1)=sigfig(ehalf,ndig,0)
*d reconr.1007
                       a(ienode+nodes-1)=sigfig(ehalf,ndig,0)
*d reconr.1103
              a(ienode+nodes-1)=sigfig(ener,7,0)
*d reconr.1107
              a(ieunr+nunr-1)=sigfig(ener,7,0)
*d reconr.1176
           a(ienode+nodes-1)=sigfig(ener,7,0)
*d reconr.1180
           a(ieunr+nunr-1)=sigfig(ener,7,0)
*d reconr.1194
                 a(ienode+nodes-1)=sigfig(ener,7,0)
*d reconr.1198
                 a(ieunr+nunr-1)=sigfig(ener,7,0)
*d reconr.1303
                    a(ienode+nodes-1)=sigfig(ener,7,0)
*d reconr.1307
                    a(ieunr+nunr-1)=sigfig(ener,7,0)
*d reconr.1322
                          a(ienode+nodes-1)=sigfig(ener,7,0)
*d reconr.1326
                          a(ieunr+nunr-1)=sigfig(ener,7,0)
*/  the printout for errors caused by significant figure reduction
*/  are obsolete now that we can go to 9 digits when necessary.
*/  we remove them and add a column for the error introduced into
*/  the fission integral by integral thinning.
*d reconr.2044
*d reconr.2046
*d reconr.2050
*i reconr.2051
      fint=0
      fmax=0
*d reconr.2074,2078
     &  15x,''resonance integral check (errmax,errint)''//
     &  4x,''upper'',6x,''elastic'',3x,''percent'',3x,
     &  ''capture'',3x,''percent'',3x,''fission'',3x,''percent''/
     &  4x,''energy'',5x,''integral'',3x,''error'',4x,
     &  ''integral'',3x,''error'',4x,''integral'',3x,''error''/
     &  1p,e10.2)') elo
*d reconr.2113,2139
*i reconr.2177
      fmax=fmax+dm2*dx/(2*xm)
*i reconr.2202
      c1=a(isigs+3*(i-1)+1)
      c2=a(isigs+3*(i-2)+1)
      fint=fint+(c1+c2)*dx/(2*xm)
*d reconr.2207,2214
      if (cint.ne.zero) cmax=100*cmax/cint
      if (eint.ne.zero) emax=100*emax/eint
```

```
      if (fint.ne.zero) fmax=100*fmax/fint
      write(nsyso,'(1p,e10.2,1x,3(1p,e12.2,f8.3))')
     &  a(ix+i-2),eint,emax,cint,cmax,fint,fmax
*i reconr.2229
      fint=0
*d reconr.2232,2233
      fmax=0
*d reconr.2286
*d reconr.2288
     &  ngneg,nmax,nrtot
*ident up80
*/ acer -- 10dec02
*/   fix the photoatomic energy grid to include the discontinuities
*/   at the photo edges.  reported by morgan white (lanl x-5).
*d acer.14736
         e=sigfig(enext,7,0)
         if (idis.ne.0) then
            e=sigfig(e,7,-1)
            call gety1(e,enxt,idis,s,nin,a(iscr))
            l=l+1
            xss(l)=e
            e=sigfig(e,7,+2)
         endif
*/  fix the values of the production cross section and heating
*/  at the particle production thresholds.
*i acer.8264
                              if (y.lt.delt) y=0
*i acer.9533
            if (xss(hpd+2+naa+ie-it).lt.delt) xss(hpd+2+naa+ie-it)=0
*/  modify the acer listing to allow 6-digit energy indexes with
*/  the first column always blank.  this allows for materials with
*/  more than 99999 energy points.
*d acer.9863
     &        '(''1''/6x,''i'',5x,''energy'',11x,'' total  '',7x,
*d acer.9865
     &        ''gamma prod''/1x,''------'',3x,''--------------'',
*d acer.9868
     &        '(''1''/6x,''i'',5x,''energy'',11x,'' total  '',7x,
*d acer.9870
     &        1x,''------'',3x,''--------------'',
*d acer.9874
            write(nsyso,'(1x,i6,1p,e17.8,7e15.6)') i,xss(esz+i),
*d acer.9877
            write(nsyso,'(1x,i6,1p,e17.8,7e15.6)') i,xss(esz+i),
*d acer.9916
                  write(nsyso,'(''1''/6x,''i'',5x,''energy'',11x,a10,
*d acer.9918
                  write(nsyso,'(1x,''------'',3x,''--------------'',
*d acer.9929
               write(nsyso,'(1x,i6,1p,e17.8,7a15)')
*/  the global value of ntr is being overwritten when charged particle
*/  production is present.  allow both fission flags.  this only
*/  affects the plots.  it showed up when processing a high-energy
*/  u-238 case with proton production by causing a bad plot of capture
*/  and fission resonance contours.
*d acer.12592
               ntrh=nint(xss(ntro-1+i))
*d acer.12595
               do k=1,ntrh
*d acer.12601
               do k=1,ntrh
*d acer.12607
               do k=1,ntrh
*d acer.12613
               do j=1,ntrh
*d acer.12632
               do k=1,ntrh
*d acer.12638
```

```
               do ir=1,ntrh
*d acer.12682
               do k=1,ntrh
*d acer.12688
               do ii=1,ntrh
*d acer.18808
                  if (mt.eq.18.or.mt.eq.19) then
*ident up81
*/ moder -- 2dec02
*/   fix up the processing of the covariance sections to match
*/   the endf-6 format specifications.
*d moder.1282,1290
         ner=n1h
         do j=1,ner
            call contio(nin,nout,nscr,a,nb,nw)
            lru=l1h
            nro=n1h
            if (nro.gt.0) then
               call contio(nin,nout,nscr,a,nb,nw)
               ni=n2h
               do k=1,ni
                  call listio(nin,nout,nscr,a,nb,nw)
                  do while (nb.ne.0)
                     call moreio(nin,nout,nscr,a,nb,nw)
                  enddo
               enddo
            endif
            call contio(nin,nout,nscr,a,nb,nw)
            lcomp=l2h
            nls=n1h
            if (lru.eq.2) then
               do l=1,nls
                  call listio(nin,nout,nscr,a,nb,nw)
                  do while (nb.ne.0)
                     call moreio(nin,nout,nscr,a,nb,nw)
                  enddo
               enddo
               call listio(nin,nout,nscr,a,nb,nw)
               do while (nb.ne.0)
                  call moreio(nin,nout,nscr,a,nb,nw)
               enddo
            else if (lcomp.eq.0) then
               do l=1,nls
                  call listio(nin,nout,nscr,a,nb,nw)
                  do while (nb.ne.0)
                     call moreio(nin,nout,nscr,a,nb,nw)
                  enddo
               enddo
            else
               call contio(nin,nout,nscr,a,nb,nw)
               nsrs=n1h
               nlrs=n2h
               do k=1,nsrs
                  call listio(nin,nout,nscr,a,nb,nw)
                  do while (nb.ne.0)
                     call moreio(nin,nout,nscr,a,nb,nw)
                  enddo
               enddo
               if (nlrs.gt.0) then
                  do k=1,nsrs
                     call listio(nin,nout,nscr,a,nb,nw)
                     do while (nb.ne.0)
                        call moreio(nin,nout,nscr,a,nb,nw)
                     enddo
                  enddo
               endif
            endif
         enddo
```

```
*ident up82
*/ acer -- 28jan03
*/  the heating value in the photoatomic ace file is supposed to be
*/  used in an "f6" tally with the computed photon flux to compute
*/  the energy deposition from electrons, positrons, and atomic
*/  recoils.  the original heating value was designed to be used
*/  with an explicit calculation of heating during a coupled
*/  electron-photon calculation, and it only included the atomic
*/  recoil.  this update adds in the other parts of the heating.
*/  it was also necessary to modify the quadrature in iheat to
*/  handle the very high incident energies now given in endf.
*i up69.23
      data epair/1.022d0/
*i up69.25
      data epair/1.022e0/
*d acer.14745
      eszg=1
*d acer.14767
                  e=xss(eszg-1+i)
*d acer.14769
                  xss(l-1+i)=s
*d acer.14838
         call iheat(xss(i)*emev,en,idis,a(iscr),heat,siginc)
*d up61.20
         xss(lhnm-1+i)=xss(iinc-1+i)*heat/emev
*d acer.14778
         xss(eszg-1+i)=xss(eszg-1+i)/emev
*d acer.14780
*d acer.14783
      jinc=next
*i acer.14844
      do i=1,nes
         xss(lhnm-1+i)=xss(lhnm-1+i)+xss(eszg-1+i)*xss(iabs-1+i)
      enddo
*d up69.50
         call alax(nin,nlax,xss(jflo),xss(eszg),xss(iabs),xss(lhnm),
     1     a(iscr),nes)
*i up69.51
c
c     ***add in heating contribution from pair production
      do i=1,nes
         xss(lhnm-1+i)=xss(lhnm-1+i)
     1     +xss(ipair-1+i)*(xss(eszg-1+i)-epair)
      enddo
c
c     ***convert heating to a per collision basis
      do i=1,nes
         tot=xss(iinc-1+i)+xss(icoh-1+i)+xss(iabs-1+i)+xss(ipair-1+i)
         xss(lhnm-1+i)=xss(lhnm-1+i)/tot
      enddo
*i acer.14934
c     ***also limit panels by the fractional energy change.
*i acer.14956
         if (pnext.lt.pnow/2) pnext=pnow/2
*d acer.14993
      heat=e-ebar
*d up69.54
      subroutine alax(nin,nlax,fluor,ener,abs,heat,a,nes)
*i up69.63
      dimension ener(nes),abs(nes),heat(nes)
*i up69.155
c
c        ***subtract the photon energy from the heating
         do i=1,nes
            if (ener(i).gt.ek/emev) heat(i)=heat(i)
     1        -abs(i)*sum1*sum2/emev
         enddo
*i up69.187
```

```
c
c        ***subtract the photon energy from the heating
         do i=1,nes
            if (ener(i).gt.ek/emev) heat(i)=heat(i)-abs(i)
     1        *(sum1*sum2+el2*pl2+el3*pl3)/emev
         enddo
*i up69.282
c
c        ***subtract the photon energy from the heating
         do i=1,nes
            if (ener(i).gt.elav/emev) heat(i)=heat(i)
     1        -abs(i)*ylt*flt/emev
            if (ener(i).gt.ek/emev) heat(i)=heat(i)
     1        -abs(i)*(sum11*sum12+sum21*sum22
     2        +el2*pl2+el3*pl3)/emev
         enddo
*ident up83
*/ plotr -- 12feb03
*/  fixes an error in plotr that prevents it from printing out
*/  negative values of percent differences.  zero percent
*/  difference confuses the thinning logic, so we add a small
*/  amount to all the percent differences.
*d up77.88
            yf=100*(z2-zz)+small
*d up77.102
            yf=100*(z2-zz)+small
*d plotr.1113,1114
      if (itype.eq.1) then
         if (yf.eq.zero.and.y(n).gt.zero) go to 380
         if (yf.gt.zero.and.y(n).eq.zero) go to 380
      else
         test=ten**(-15)
         if (yf.le.test) yf=test
         if (yf.eq.test.and.y(n).gt.test) go to 380
         if (yf.gt.test.and.y(n).eq.test) go to 380
      endif
*d plotr.1118,1122
  375 if (idis.gt.0) go to 380
      if (itype.eq.3) then
         if (yf.eq.zero.and.y(n).gt.zero) go to 380
         if (yf.gt.zero.and.y(n).eq.zero) go to 380
      else
         test=ten**(-15)
         if (yf.le.test) yf=test
         if (yf.eq.test.and.y(n).gt.test) go to 380
         if (yf.gt.test.and.y(n).eq.test) go to 380
      endif
*d plotr.1136
      if (yf.ne.zero.and.itype.ne.2.and.itype.ne.4) nlast=n
*ident up84
*/ purr -- 30sep02
*/  change the sampling scheme to use a different set of total cross
*/  section bins for each temperature.  change the binning logic to
*/  use approximately equally probable bins over most of the range
*/  with two bins of lower probabilities on the low and high ends.
*d purr.56
      common/pustore/a(160000)
*d purr.72
      data namax/160000/, nidmax/24/, ipr/1/
*d purr.78
      nsamp=5000
*d purr.136
      nwds=5*ntemp*nbin
*d purr.138
      nwds=nbin*ntemp
      call reserv('tval',nwds,itval,a)
*d purr.228
         nw=1+5*ntemp*nbin
```

```
*d purr.409
      nw=1+5*ntemp*nbin
*d purr.415,424
      do i=1,5
         do j=1,nbin
            n=n+1
            a(n)=sigfig(a(itabl-1+j+nbin*(i-1)+5*(it-1)*nbin),7,0)
         enddo
      enddo
*d purr.1730,1731
      dimension bkg(4),sig0(nsig0),tval(nbin,ntemp)
      dimension sigf(5,10,10),tabl(nbin,5,ntemp)
*i purr.1743
      dimension tmin(10),tmax(10),tsum(10)
*i purr.1794
      do itemp=1,ntemp
         do i=1,nsig0
            do j=1,8
               bval(j,i,itemp)=0
            enddo
         enddo
      enddo

*i purr.2163
c
c     ***loop over temperatures
c     ***using a different total cross section bin structure for each
      do 140 itemp=1,ntemp
*d purr.2169
            es(ie)=els(itemp,ie)+fis(itemp,ie)+cap(itemp,ie)+bkg(1)
*d purr.2172,2173
         tmin(itemp)=es(1)
         tmax(itemp)=es(ne)
         nebin=nsamp/(nbin-3.375)
         ibin=nebin/16
         do i=1,nbin-1
            tval(i,itemp)=es(ibin)
            if (i.eq.1) ibin=ibin+nebin/4
            if (i.gt.1.and.i.lt.nbin-2) ibin=ibin+nebin
            if (i.eq.nbin-2) ibin=ibin+nebin/4
            if (i.eq.nbin-1) ibin=ibin+nebin/16
         enddo
         tval(nbin,itemp)=big
*d purr.2174
*d purr.2176,2177
            do j=1,5
               tabl(i,j,itemp)=0
*d purr.2180,2195
         tsum(itemp)=0
*d purr.2200
         tot=els(itemp,ie)+fis(itemp,ie)+cap(itemp,ie)+bkg(1)
*d purr.2201,2203
         if (tot.lt.tmin(itemp)) tmin(itemp)=tot
         if (tot.gt.tmax(itemp)) tmax(itemp)=tot
         call fsrch(tot,tval(1,itemp),nbin,ii,mfl)
*d purr.2206,2228
         tsum(itemp)=tsum(itemp)+1
         tabl(ii,1,itemp)=tabl(ii,1,itemp)+1
         tabl(ii,2,itemp)=tabl(ii,2,itemp)+tot
         tabl(ii,3,itemp)=tabl(ii,3,itemp)+els(itemp,ie)+bkg(2)
         tabl(ii,4,itemp)=tabl(ii,4,itemp)+fis(itemp,ie)+bkg(3)
         tabl(ii,5,itemp)=tabl(ii,5,itemp)+cap(itemp,ie)+bkg(4)
         do i=1,nsig0
            tem=sig0(i)/(sig0(i)+tot)
            bval(1,i,itemp)=bval(1,i,itemp)+tot*tem
            bval(2,i,itemp)=bval(2,i,itemp)
     &        +(els(itemp,ie)+bkg(2))*tem
            bval(3,i,itemp)=bval(3,i,itemp)
```

```
     &        +(fis(itemp,ie)+bkg(3))*tem
            bval(4,i,itemp)=bval(4,i,itemp)
     &        +(cap(itemp,ie)+bkg(4))*tem
            bval(5,i,itemp)=bval(5,i,itemp)+tot*tem*tem
            bval(6,i,itemp)=bval(6,i,itemp)+tem
            bval(7,i,itemp)=bval(7,i,itemp)+tem*tem
         enddo
*i purr.2229
c
c     ***close loop over temperatures
  140 continue
*d purr.2296,2299
*d purr.2301,2309
*d purr.2311,2315
            tmin(itemp)=tmin(itemp)+tnorm
            tval(nbin,itemp)=tmax(itemp)
            denom=tabl(i,1,itemp)
            if (denom.eq.zero) denom=1
            tabl(i,1,itemp)=tabl(i,1,itemp)/tsum(itemp)
            tabl(i,2,itemp)=tabl(i,2,itemp)/denom
            tabl(i,3,itemp)=tabl(i,3,itemp)/denom
            tabl(i,4,itemp)=tabl(i,4,itemp)/denom
            tabl(i,5,itemp)=tabl(i,5,itemp)/denom
            tabl(i,2,itemp)=tabl(i,2,itemp)-tnorm
            tabl(i,3,itemp)=tabl(i,3,itemp)-enorm
            tabl(i,4,itemp)=tabl(i,4,itemp)-fnorm
            tabl(i,5,itemp)=tabl(i,5,itemp)-cnorm
*d purr.2318,2321
*d purr.2325,2332
      do itemp=1,ntemp
         do ixx=1,4
            if (ixx.eq.1) then
               write(nsyso,
     &          '('' tmax'',1p,e11.3,1p,10e11.3/(16x,10e11.3))')
     &          temp(itemp),(tval(i,itemp),i=1,nbin)
               write(nsyso,
     &          '('' prob'',1p,e11.3,1p,10e11.3/(16x,10e11.3))')
     &          temp(itemp),(tabl(i,1,itemp),i=1,nbin)
            endif
            write(nsyso,'(1x,a,1x,1p,e11.3,10e11.3/(16x,10e11.3))')
     &        nmr(ixx),temp(itemp),(tabl(i,ixx+1,itemp),i=1,nbin)
         enddo
*d purr.2347
*d purr.2349,2357
               if (tabl(j,1,itemp).ne.zero) then
                  den=sig0(i)/(sig0(i)+tabl(j,2,itemp))
                  ttt=tabl(j,1,itemp)
                  bval(1,i,itemp)=bval(1,i,itemp)
     &              +ttt*tabl(j,2,itemp)*den
                  bval(2,i,itemp)=bval(2,i,itemp)
     &              +ttt*tabl(j,3,itemp)*den
                  bval(3,i,itemp)=bval(3,i,itemp)
     &              +ttt*tabl(j,4,itemp)*den
                  bval(4,i,itemp)=bval(4,i,itemp)
     &              +ttt*tabl(j,5,itemp)*den
                  bval(5,i,itemp)=bval(5,i,itemp)
     &              +ttt*tabl(j,2,itemp)*den*den
*d purr.2383
*d purr.2385
     &          tabl(j,i,itemp)=tabl(j,i,itemp)*sigi(i-1)
     &          /sigf(i-1,1,itemp)
*ident up85
*/ heatr -- 25feb02
*/  add mt=442 to hold the total photon production ev-barns
*i heatr.66
c     *               442   total photon ev-barns                        *
*i heatr.835
      npkkk=0
```

```
      do ipk=3,npk
         if (mtp(ipk).eq.442) npkkk=ipk
      enddo
*i heatr.1145
         if (izap.eq.0.and.npkkk.gt.0) c(npkkk)=c(npkkk)+h
*d heatr.1199
            if (mtp(index).lt.442) c(index)=c(index)+h+ebal6
*i heatr.1270
      if (mtp(index).eq.442) go to 286
*i heatr.1332
c         442=total photon ev-barns in kerma
*i heatr.1350
         if (mtpi.eq.442) iflag=1
*d heatr.4625
            if (mtp(index).lt.442) c(index)=c(index)+h
            if (mtp(index).eq.442) c(index)=c(index)-h
*d heatr.4657,4659
            if (mtp(index).lt.442) c(index)=c(index)+h
            if (mtp(index).eq.442) c(index)=c(index)-h
*d heatr.5041
         if (mtp(i).ge.442) then
*ident up86
*/ leapr -- 10dec02
*/   add the fcc lattices for aluminum and lead to the
*/   coherent scattering option.
*i leapr.97
c     *                   4  aluminum                                  *
c     *                   5  lead                                      *
c     *                   6  iron                                      *
*d leapr.380
         maxb=60000
*i leapr.2407
      data al1,al3,al4/4.04d-8,26.7495d0,1.495/
      data pb1,pb3,pb4/4.94d-8,207.d0,1.d0/
      data fe1,fe3,fe4/2.86d-8,55.454d0,12.9d0/
      data twothd/0.666666666667d0/
*i leapr.2414
      data al1,al3,al4/4.04e-8,26.7495e0,1.495/
      data pb1,pb3,pb4/4.94e-8,207.e0,1.e0/
      data fe1,fe3,fe4/2.86e-8,55.454e0,12.e0/
      data twothd/0.666666666667e0/
*i leapr.2419
      taufcc(m1,m2,m3)=c1*(m1*m1+m2*m2+m3*m3+twothd*m1*m2
     &  +twothd*m1*m3-twothd*m2*m3)*twopis
      taubcc(m1,m2,m3)=c1*(m1*m1+m2*m2+m3*m3+m1*m2+m2*m3+m1*m3)*twopis
*i leapr.2450
      else if (lat.eq.4) then
c        aluminum
         a=al1
         amsc=al3
         scoh=al4/natom
      else if (lat.eq.5) then
c        lead
         a=pb1
         amsc=pb3
         scoh=pb4/natom
      else if (lat.eq.6) then
c        iron
         a=fe1
         amsc=fe3
         scoh=fe4/natom
*d leapr.2454,2456
      if (lat.lt.4) then
         c1=4/(3*a*a)
         c2=1/(c*c)
         scon=scoh*(4*pi)**2/(2*a*a*c*sqrt3*econ)
      else if (lat.ge.4.and.lat.le.5) then
         c1=3/(a*a)
```

```
         scon=scoh*(4*pi)**2/(16*a*a*a*econ)
      else if (lat.eq.6) then
         c1=2/(a*a)
         scon=scoh*(4*pi)**2/(8*a*a*a*econ)
      endif
*d leapr.2463
c     ***compute lattice factors for hexagonal lattices
      if (lat.gt.3) go to 210
*i leapr.2553
      go to 220
c
c     ***compute lattice factors for fcc lattices
  210 if (lat.gt.5) go to 215
      phi=ulim/twopis
      i1m=int(a*sqrt(phi))
      i1m=15
      k=0
      do i1=-i1m,i1m
         i2m=i1m
         do i2=-i2m,i2m
            i3m=i1m
            do i3=-i3m,i3m
               tsq=taufcc(i1,i2,i3)
               if (tsq.gt.zero.and.tsq.le.ulim) then
                  tau=sqrt(tsq)
                  w=exp(-tsq*t2*wint)/tau
                  f=w*formf(lat,i1,i2,i3)
                  k=k+1
                  if ((2*k).gt.nw) call error('coh',
     &               'storage exceeded',' ')
                  b(ifl+2*k-2)=tsq
                  b(ifl+2*k-1)=f
               endif
            enddo
         enddo
      enddo
      imax=k-1
      go to 220
c
c     ***compute lattice factors for bcc lattices
  215 continue
      phi=ulim/twopis
      i1m=int(a*sqrt(phi))
      i1m=15
      k=0
      do i1=-i1m,i1m
         i2m=i1m
         do i2=-i2m,i2m
            i3m=i1m
            do i3=-i3m,i3m
               tsq=taubcc(i1,i2,i3)
               if (tsq.gt.zero.and.tsq.le.ulim) then
                  tau=sqrt(tsq)
                  w=exp(-tsq*t2*wint)/tau
                  f=w*formf(lat,i1,i2,i3)
                  k=k+1
                  if ((2*k).gt.nw) call error('coh',
     &               'storage exceeded',' ')
                  b(ifl+2*k-2)=tsq
                  b(ifl+2*k-1)=f
               endif
            enddo
         enddo
      enddo
      imax=k-1
c
c     ***sort lattice factors
  220 do i=1,imax
```

```
         jmin=i+1
         do j=jmin,k
            if (b(ifl+2*j-2).lt.b(ifl+2*i-2)) then
               st=b(ifl+2*i-2)
               sf=b(ifl+2*i-1)
               b(ifl+2*i-2)=b(ifl+2*j-2)
               b(ifl+2*i-1)=b(ifl+2*j-1)
               b(ifl+2*j-2)=st
               b(ifl+2*j-1)=sf
            endif
         enddo
      enddo
      k=k+1
      b(ifl+2*k-2)=ulim
      b(ifl+2*k-1)=b(ifl+2*k-3)
      nw=2*k
*i leapr.2600
c           lat=4,5  fcc lattice (aluminum, lead)
c           lat=6    bcc lattice (iron)
*i leapr.2626
      else if (lat.eq.4.or.lat.eq.5) then
c        fcc lattices.
         e1=2*pi*l1
         e2=2*pi*(l1+l2)
         e3=2*pi*(l1+l3)
         formf=(1+cos(e1)+cos(e2)+cos(e3))**2
     &     +(sin(e1)+sin(e2)+sin(e3))**2
      else if (lat.eq.6) then
c        bcc lattices.
         e1=2*pi*(l1+l2+l3)
         formf=(1+cos(e1))**2+(sin(e1))**2
*ident up87
*/ acer -- 2jul03
*/  the mt numbers used for determining charged particle production
*/  have some errors.  this affects some light-isotope runs for
*/  incident charged particles.
*d acer.4770,4771
                  if (mt.eq.5.or.mt.eq.28.or.mt.eq.41.or.
     &              mt.eq.42.or.mt.eq.44.or.mt.eq.45.or.
*d acer.4785
                  if (mt.eq.5.or.mt.eq.32.or.mt.eq.35.or.
*d acer.4798
                  if (mt.eq.5.or.mt.eq.33.or.mt.eq.36.or.
*d acer.4811
                  if (mt.eq.5.or.mt.eq.34.or.mt.eq.106.or.
*d acer.4823,4825
                  if (mt.eq.5.or.(mt.ge.22.and.mt.le.25).or.
     &              mt.eq.29.or.mt.eq.30.or.
     &              mt.eq.35.or.mt.eq.36.and.mt.eq.45.or.
*d acer.5024
            if (mt.eq.2.or.mt.eq.5.or.mt.eq.28.or.mt.eq.41.or.
     &        mt.eq.42.or.mt.eq.44.or.mt.eq.45.or.
*d acer.5031
            if (mt.eq.2.or.mt.eq.5.or.mt.eq.32.or.mt.eq.35.or.
*d acer.5036
            if (mt.eq.2.or.mt.eq.5.or.mt.eq.33.or.mt.eq.36.or.
*d acer.5041
            if (mt.eq.2.or.mt.eq.5.or.mt.eq.34.or.mt.eq.106.or.
*d acer.5045
            if (mt.eq.2.or.mt.eq.5.or.(mt.ge.22.and.mt.le.25).or.
*d acer.5047
     &        mt.eq.35.or.mt.eq.36.and.mt.eq.45.or.
*d acer.5130
            if (mt.eq.2.or.mt.eq.5.or.mt.eq.28.or.mt.eq.41.or.
     &        mt.eq.42.or.mt.eq.44.or.mt.eq.45.or.
*d acer.5137
            if (mt.eq.2.or.mt.eq.5.or.mt.eq.32.or.mt.eq.35.or.
*d acer.5142
```

```
            if (mt.eq.2.or.mt.eq.5.or.mt.eq.33.or.mt.eq.36.or.
*d acer.5147
            if (mt.eq.2.or.mt.eq.5.or.mt.eq.34.or.mt.eq.106.or.
*d acer.5153
     &        mt.eq.35.or.mt.eq.36.and.mt.eq.45.or.
*/ acer -- 02jul03
*/  for the particle production sections, the acer logic fails for
*/  some cases where two identical particles are produced by
*/  file 6, such as p+t->alpha+alpha.  the acer job seems to run
*/  ok, but it fails when the file is read back in for checking
*/  and plotting.  this patch fixes the problem.  this problem
*/  only shows up for a few light-isotope cases with incident
*/  charged particles.
*d acer.224
     &  nprod,kprod(300),mprod(300),iprod(300),lprod(300)
*d acer.551
     &  nprod,kprod(300),mprod(300),iprod(300),lprod(300)
*i acer.741
                     lprod(nprod)=0
*i acer.746
                     lprod(nprod)=0
*i acer.751
                     lprod(nprod)=0
*i acer.756
                     lprod(nprod)=0
*i acer.761
                     lprod(nprod)=0
*i acer.766
                     lprod(nprod)=0
*i acer.929
                  lprod(nprod)=ik
*i acer.937
                  lprod(nprod)=ik
*i acer.945
                  lprod(nprod)=ik
*i acer.953
                  lprod(nprod)=ik
*i acer.961
                  lprod(nprod)=ik
*i acer.969
                  lprod(nprod)=ik
*d acer.980,981
                  isort1=100000*mprod(i)+10*iprod(i)+lprod(j)
                  isort2=100000*mprod(j)+10*iprod(j)+lprod(j)
*i acer.985
                     isave4=lprod(j)
*i acer.991
                     lprod(i)=isave4
*d acer.8061
     &  nprod,kprod(300),mprod(300),iprod(300),lprod(300)
*d acer.8259
                     if (ik.eq.lprod(j)) then
*d acer.8662
                     if (ik.eq.lprod(j)) then
*d acer.8671
                     if (ik.eq.lprod(j).and.law.eq.4) then
*d acer.8691
                     if ((ik.eq.lprod(j).and.law.eq.2).or.
*d acer.8819
                     else if (ik.eq.lprod(j).and.law.eq.7) then
*d up36.7
                     if (ik.ne.lprod(j).or.law.ne.1) then
*i up20.56
c
c                    ***skip if not correct subsection
                     else if (ik.ne.lprod(j)) then
                        call skip6a(nin,0,0,a(iscr),law)
*/ acer -- 02jul03
```

```
*/  patch the phase-space option for the primary particle.  this
*/  problem showed up for the proton distribution for 3He(p,2p).
*d acer.6582,6583
         test1=one+one/100000
         test2=one/10-one/1000000
         test3=one-one/100000
         do while (xx.lt.test1)
*d acer.6585,6587
            if (xx.lt.test2) then
*d acer.6603,6604
         do while (xx.lt.test1)
*d acer.6606,6607
            if (xx.gt.test3) then
*d acer.6620,6622
            if (xx.lt.test2) then
*ident up88
*/ matxsr -- 28jul03
*/  the update that introduced a photonuclear capability for
*/  matxsr on 12feb02 accidently removed the assignment of the
*/  scratch file used for computing the self-shielding delta
*/  cross section values. any matxs files that include temperature
*/  and sigma-zero data and that were generated with versions of
*/  njoy99 from 99.67 up are incorrect.
*i matxsr.440
      nscrt7=16
*/  the read statement that brings in the group structures has a
*/  scale factor in it by mistake.  this distorts group energies
*/  that are written on the gendf tape in f format.  the result is
*/  an incorrect group structure on the matxs file.  this error
*/  has existed for many years without causing problems.
*d matxsr.2291
      read(nin,'(6e11.0)') (a(i+nw1),i=1,lim)
*/  more room is need to read in vector cross sections for
*/  187 group runs.  this shows up for delayed-neutron data.
*d matxsr.1488
      dimension b(2000)
*d matxsr.1501
      maxb=2000
*ident up89
*/ groupr -- 29jul03
*/  increase the main container array to allow for up to p5 for
*/  the lanl u233 evaluation proposed for endf/b-vii.
*d up34.7
      dimension a(200000)
*d up34.9
      iamax=200000
*/  increase the number of gammas allowed to handle w-182 and
*/  w-186 from endf/b-vi release 8.
*d groupr.7783
      dimension loca(550)
*d groupr.7791
      data nylmax/550/
*ident up90
*/ purr -- 6aug03
*/  the purr module is zeroing out the lssf and intunr flags in
*/  the section mt=152 that contains the bondarenko selfshielding
*/  information.  this has the dramatic effect giving different
*/  infinitely dilute cross sections when nsigz is one or greater
*/  than one, and incorrectly interpolated values.  note that purr
*/  is substituting its bondarenko values for the ones from unresr
*/  if both unresr and purr are run in that order.  these errors
*/  can have important effects on multigroup results from groupr.
*d purr.337
      a(l+2)=lssf
*d purr.340
      a(l+5)=2
*ident vers
*/ update the version name and date
```

```
*/ to reflect the date of the latest modifications
*d njoy.8,9
c     *    version 99.90                                            *
c     *    06 Aug 03                                                *
*d njoy.307
      data vers/'99.90   '/
*/
```

C.2 uplf95

```
REM uplf95       : for lahey95
```

```
*ident x86lf9
*/ ---------------------------------------
*/ machine-dependent changes to njoy99
*/ for x86 machines using
*/ Lahey LF95 with f77-style fixed lines
*/ be sure to use "*set sw"
*/ ---------------------------------------
*d njoy.308,309
      data lab/'lanl t-2'/
      data mx/'x86lf95'/
*/ provide machine-specific fatal error exit
*d njoy.365,366
      stop 77
*/ elapsed time
*d njoy.514
      call cpu_time(time)
*/ date
*d njoy.524
      character date*8,time*10,zone*5
      integer values(8)
      intrinsic date_and_time
      call date_and_time(date,time,zone,values)
      write(hdate,'(i2,''/'',i2,''/'',i2)')
     &  values(2),values(3),mod(values(1),100)
*/ wall clock time
*d njoy.537
      character date*8,time*10,zone*5
      integer values(8)
      intrinsic date_and_time
      call date_and_time(date,time,zone,values)
      write(htime,'(i2,'':'',i2,'':'',i2)')
     &  values(5),values(6),values(7)
*/ random numbers
*d njoy.6161
      call random_number(rr)
      rann=rr
*/ machine constants for slatec functions
*d njoy.5323,5334
*d njoy.5338,5746
c     for absoft f90 using f90 intrinsics
      dmach(1)=tiny(1.d0)
      dmach(2)=huge(1.d0)
      dmach(3)=2.d0**(-digits(1.d0))
      dmach(4)=2.d0**(1-digits(1.d0))
      dmach(5)=0.30103001d+0
```

C.3 upn_Trkov

```
REM upn_Trkov    : IAEA upn for fendl2.1
REM       - Include: upiaea1, upijs57,upijs59, upijs61, upijs62, upijs63, upijs64
REM         upiaea2 upiaea3, upfendl1,upfndl2, upfndl3, upfndl4, upfndl5, upfndl6
```

```
*/
*/ Updates from Trkov
*/
*ident upiaea1
*/ groupr - A.Trkov, IAEA
*/         Local updates from NJOY97 that were not implemented
*/ Need more space for the flux calculator (Case: U-238)
*d up89.6
      dimension a(400000)
*d up89.8
      iamax=400000
*/
*ident upijs57
*/ groupr  A.Trkov, 9-March-1999
*/ groupr is caught in an infinite loop for Be-9 from ENDF/B-VI
*/ on a PC with Lahey compiler.
*/ It seems the products inside an "if" statements are
*/ computed differently than outside. The program does not
*/ recognise that ep EQUALS "test" when written as a product.
*d groupr.6054
      test=shade*epn
      if (idis.gt.0.and.ep.lt.test) epn=test
*/
*/ Old proposal from C.Dean
*d groupr.2745,2746
               b(iz+3+li)=(sigz(iz)-sam)*wtf*(1-beta)
*/
*ident upijs59
*/ acer   A.Trkov 20-aug-1999
*/ If pointwise representation in CM system, csn should be used
*/ (pointed out by Harry Wienke).
*d acer.3394,3396
                          if (csn.ge.a(ll).and.csn.le.a(ll+2))
     &                      call terp1(a(ll),a(ll+1),a(ll+2),a(ll+3),
     &                      csn,fmu,lang-10)
*/
*ident upijs61
*/ acer   A.Trkov 3-dec-1999
*/        fix6 may run out of space without warning
*d acer.3247
      dimension a(2000)
*d up3.38
      data namax/2000/
*i acer.3262
      if(nw.gt.namax) call error('fix6','storage exceeded.',' ')
*i acer.3272
      if(nw.gt.namax) call error('fix6','storage exceeded.',' ')
*i acer.3278
      if(nw.gt.namax) call error('fix6','storage exceeded.',' ')
*i acer.3280
      if(nw.gt.namax) call error('fix6','storage exceeded.',' ')
*i acer.3282
      if(nw.gt.namax) call error('fix6','storage exceeded.',' ')
*i acer.3284
      if(nw.gt.namax) call error('fix6','storage exceeded.',' ')
*i acer.3290
```

```
      if(nw.gt.namax) call error('fix6','storage exceeded.',' ')
*i acer.3296
      if(nw+l.gt.namax) call error('fix6','storage exceeded.',' ')
*i acer.3299
      if(nw+l.gt.namax) call error('fix6','storage exceeded.',' ')
*/
*ident upijs62
*/ groupr  A.Trkov, 29-Apr-2002
*/         - Fix inconsistent usage of output weighting flux unit number
*/         - Fix logic when searching for the right flux point
*i groupr.80
c     *            note: weighting flux file is always written binary  *
*d groupr.99
c     *    ninwt   tape unit for flux parameters (binary)              *
*d groupr.272
*d groupr.2290
         ninwt=iabs( ninwt)
         call openz(-ninwt,1)
*d groupr.2294
     &     ehi,sigpot,nflmax,-ninwt,jsigz
*d groupr.2307,2308
         call openz(-ninwt,0)
         write(nsyso,'(/'' ninwt......'',i4)') -ninwt
*d groupr.3037
      if (e.gt.el*(1-small).and.e.lt.en*(1+small)) go to 230
*/
*ident upijs63
*/ purr  A.Trkov, May 2002
*/       Increase scratch space to process Pu-239 from JEF-2.2
*d purr.95
      maxscr=12000
*/
*ident upijs64
*/ groupr  A.Trkov, July 2002
*/         There is an error in Cl-37 in ENDF/B-VI Rev.8
*/         MAT 1731 MF 15 MT 102
*/         The first energy for the gamma yields is zero. It
*/         redefines enext in getsed to zero, which is
*/         interpreted as a flag to do initialisation in
*/         getgyl (called from getff). Since 'yl' is
*/         already reserved, groupr crashes.
*d groupr.8697
           if (elo.gt.0 .and. elo.lt.enext) enext=elo
*/
*ident upiaea2
*/ groupr - A.Trkov, IAEA, Feb-2003
*/          Increase array size for Legendre coefficients
*i groupr.4756
c     maximum legendre coefficients
      parameter (mxlg=65)
*d groupr.4764
      dimension term(mxlg),terml(mxlg)
*i groupr.5209
c     maximum legendre coefficients
      parameter (mxlg=65)
*d groupr.5212
      dimension term(mxlg),x(10),y(10,mxlg)
*d groupr.5329,5330
c     maximum legendre coefficients
      parameter (mxlg=65)
      dimension cnow(*),term(*),p(mxlg)
      dimension x(10),y(10,mxlg),yt(mxlg)
*d groupr.5333
      external f6ddx,f6psp,f6dis,legndr,error
*i groupr.5358
      if(nl.gt.mxlg) call error('f6cm','nl>mxlg',' ')
*d groupr.5586
c     maximum legendre coefficients
```

```
      parameter (mxlg=65)
      dimension cnow(*),p(mxlg)
*d groupr.5768
c     maximum legendre coefficients
      parameter (mxlg=65)
      dimension cnow(*),p(mxlg)
*i groupr.5630
         if(nl.gt.mxlg) call error('f6ddx','nl>mxlg',' ')
*i groupr.5992
c     maximum legendre coefficients
      parameter (mxlg=65)
*d groupr.5995
      dimension term(mxlg),p(mxlg),amu(50),fmu(50),qp(8),qw(8)
*i groupr.6130
c     maximum legendre coefficients
      parameter (mxlg=65)
*d groupr.6133,6134
      dimension term1(mxlg),term2(mxlg),p(mxlg)
      dimension qp(8),qw(8)
*i groupr.6733
c     maximum legendre coefficients
      parameter (mxlg=65)
*d groupr.6740
      dimension flo(mxlg),fhi(mxlg)
*i groupr.7314
c     maximum legendre coefficients
      parameter (mxlg=65)
*d groupr.7318
      dimension b(6),alo(mxlg),ahi(mxlg)
*i groupr.7929
c     maximum legendre coefficients
      parameter (mxlg=65)
*d groupr.7942
      dimension fl(mxlg)
*/
*ident upiaea3
*/ acer   - A.Trkov, IAEA, Feb-2003
*/          declare "error" external to avoid conflict with intrinsic function
*i up69.66
      external error
*/
*ident upfndl1
*/ matxsr - D. L. Aldama, NDS/IAEA Consultant, Nov-2004
*/ Need more space  (Case: 1-H-2 from JENDL-3.3)
*/  subroutine band
*d matxsr.1973
      dimension b(5000)
*d matxsr.1978
      maxb=5000
*/  subroutine shufl
*d matxsr.2078
      dimension b(5000)
*d matxsr.2080
      maxb=5000
*/
*ident upfndl2
*/ gaspr - D. L. Aldama, NDS/IAEA Consultant, Nov-2004
*/ Need more space (case Ni-058 from JEFF-3.0)
*d gaspr.28
      dimension egas(80000),sgas(5,80000)
*d gaspr.41
      maxg=80000
*ident upfndl3
*/ purr - D. L. Aldama, NDS/IAEA Consultant, Nov-2004
*/ to allow PT for multi-isotope materials when
*/ not all the isotopes have unresolved resonance data
*d purr.624
*i purr.651
```

```
      if (ier.eq.ner) go to 110
*/
*ident upfndl4
*/ acer - D. L. Aldama, NDS/IAEA Consultant, Nov-2004
*/ Format extension for negative energies (overlap)
*d acer.4947,4948
            write(nsyso,'(''   energy range: '',1p,e11.4,
     &         '' - '',e11.4,'' ev'')') urlo,urhi
*/
*ident upfndl5
*/ groupr - D. L. Aldama, NDS/IAEA Consultant, Nov-2004
*/ Needed to process Be-9 from JEFF-3.0 evaluation
*/  MT=875-891 for (n,2n) splitted reaction
*i groupr.1147
         else if (mtd.ge.875.and.mtd.le.884) then
            write(reac,'(''2n0'',i1)') mtd-875
         else if (mtd.ge.885.and.mtd.le.890) then
            write(reac,'(''2n'',i2)') mtd-875
         else if (mtd.eq.891) then
            reac='2nc'
*i groupr.3964
         if (iverf.ge.6.and.mtd.ge.875.and.mtd.le.891) mt=mtd
*i groupr.4331
      if (mfd.ge.31.and.mfd.le.36.and.iverf.ge.6.and.
     &   (mtd.ge.875.and.mtd.lt.891)) go to 400
*i groupr.8014
         if (mth.ge.875.and.mth.lt.891) za2=1
*i groupr.8330
      if (iverf.ge.6.and.mth.ge.875.and.mth.le.890) mt0=875
*/
*/ matxsr - D. L. Aldama, NDS/IAEA Consultant, Nov-2004
*/ Needed to process Be-9 from JEFF-3.0 evaluation
*/  MT=875-891 for (n,2n) splitted reaction
*d matxsr.1418
  290 if (mt.gt.891) go to 300
*i matxsr.1433
      if (mt.ge.875.and.mt.lt.885) write(strng,'(''2n0'',i1)') mt-875
      if (mt.ge.885.and.mt.lt.891) write(strng,'(''2n'',i2)') mt-875
      if (mt.eq.891) write(strng,'(''2ncn'')')
*i matxsr.1504
      k016=0
*i matxsr.1652
      if (mt.eq.16) k016=1
      if (k016.eq.1.and.mt.ge.875.and.mt.le.891) go to 310
*/
*ident upfndl6
*/ groupr - D. L. Aldama, NDS/IAEA Consultant, Nov-2004
*/ subroutine namer corrected for mt=659, reac=d09
*/ It's only affect groupr printout
*d groupr.1124
         else if (mtd.ge.650.and.mtd.le.659) then
*/
```

C.4 upn_Mattes

```
REM upn_Mattes   : Thermal Scattering Libraries
REM   - Include:  up3_thermr, up1_leapr, up2_leapr, up3_leapr, up4_leapr,
REM               up5_leapr, up_acer
REM                  Modifications in common/xsst/
REM                 - Do not include: up_thermr (updated in upn_Aldama)



*/ Additional updates needed to process JEFF-3.1T2
*/
*/ Updates from Mattes
*/
*ident up_thermr
*/ thermr - M. Mattes/IKE ---------------------------------------mm
*/    increase array size for IKE evaluations
*d thermr.101
         dimension a(800000)
*d thermr.131
       namax=800000
*/
*/ This section is included in upn_Aldama
*/
*/ */    fix reading long TAB1 records
*/ *i thermr.1543
*/       ll=loc
*/       do while (nb.ne.0)
*/         ll=ll+nw
*/         call moreio(nendf,0,0,a(ll),nb,nw)
*/       enddo
*/ *i thermr.1602
*/       ll=loc
*/       do while (nb.ne.0)
*/         ll=ll+nw
*/         call moreio(nendf,0,0,a(ll),nb,nw)
*/       enddo
*/ */
*/ ------------------------------------------------------------mm
*/ident up2_thermr
*/    maximum.energy transfer at higher temperatures (print only)
*i thermr.1622
      if (lat.eq.1) tmax=tmax*tevz/(bk*temp)
*/ ---------------------------------------------------end up2_thermr
*ident up3_thermr
*/   more incident energies necessary for ZrH for an adequate
*/   represention of the neutron scattering xs in comparison
*/   with experimental results (.1 < E_i < 1 eV)
*d thermr.1422,thermr.1423
       dimension egrid(79)
       dimension ubar(79)
*d thermr.1427
       data ngrid/79/
*d thermr.1433,thermr.1436
     &  .030613d0,.042757d0,.056925d0,.081972d0,
     *      .1d0, .111573d0, .12d0, .13d0, .145728d0, .16d0, .17d0,
     &  .184437d0,
     *    .195d0, .2277d0, .24d0, .2510392d0,.2705304d0,.2907501d0,
     &  .3011332d0,.3206421d0,.3576813d0,
     *   .38d0, .4d0, .4170351d0,  .44d0, .48d0, .5032575d0, .53d0,
     &   .56d0, .59d0,  .6249328d0, .65d0, .69d0, .72d0, .75d0,
     *   .7821141d0, .82d0, .89d0, .9506956d0,1.0137432d0,1.1664337d0,
*d thermr.1455,thermr.1458
     &  .030613e0,.042757e0,.056925e0,.081972e0,
     *      .1e0, .111573e0, .12e0, .13e0, .145728e0, .16e0, .17e0,
     &  .184437e0,
     *    .195e0, .2277e0, .24e0, .2510392e0,.2705304e0,.2907501e0,
```

```
     &  .3011332e0,.3206421e0,.3576813e0,
     *   .38e0, .4e0, .4170351e0,  .44e0, .48e0, .5032575e0, .53e0,
     &   .56e0, .59e0,  .6249328e0, .65e0, .69e0, .72e0, .75e0,
     *   .7821141e0, .82e0, .89e0, .9506956e0,1.0137432e0,1.1664337e0,
*/
*/ --------------------------------------------------end up3_thermr
*ident up1_leapr
*/
*/ if number(>200) for alpha and/or beta values then
*/           increase array sizes plus working buffers
*/    e.g. beta(200) -> beta(400) for H2O
*d leapr.164
       common/ab/nalpha,nbeta,naint,nbint,alpha(200),beta(400)
*d leapr.173
       common/lstore/a(7500000)
*d leapr.178
       data nbmax,namax/400,200/
*d leapr.189
       maxa=7500000
*d leapr.391
       mscr=4000
*d leapr.420
       common/ab/nalph1,nbeta1,naint,nbint,alph1(200),beta1(400)
*d leapr.426
       dimension maxt(400)
*d leapr.794
       common/ab/nalpha,nbeta,naint,nbint,alpha(200),beta1(400)
*d leapr.1252
       common/ab/nalpha1,nbeta1,naint,nbint,alpha(200),beta1(400)
*d leapr.1852
       common/ab/nalph1,nbeta1,naint,nbint,alpha(200),beta1(400)
*/
*/    IKE evaluation of H(H2O) creates more pairs of alpha
*/    and S(alpha,beta) than npage
*i leapr.3122
               l_mm=1+nw
               do while (nb.ne.0)
                    call moreio(0,nout,nprnt,scr(l_mm),nb,nw)
                    l_mm=l_mm+nw
               enddo
*/ -------------------------------------------------end up1_leapr
*ident up2_leapr
*/     for H(H2O), D(D2O) NS should be equal 1
*d leapr.2976,2977
      if(nss.gt.0) scr(5)=6*(nss+1)
      scr(6)=nss
*/ -------------------------------------------------end up2_leapr
*ident up3_leapr
*/  T-eff calculation
*d leapr.1557
       tempf(itemp)=(tbeta+twt)*tempf(itemp)+tsave
*/ -------------------------------------------------end up3_leapr
*ident up4_leapr
*/ generation of more than 10 temperatures
*d leapr.166,167
      common/te/tempr(20),tempf(20),tempf1(20)
      common/dw/dwpix(20),dwp1(20)
*d leapr.179
      data ntmax/20/
*d leapr.600,601
      common/te/tempr(20),tempf(20),tempf1(20)
      common/dw/dwpix(20),dwp1(20)
*d leapr.797
      common/te/tempr(20),tempf(20),tempf1(20)
*d leapr.1256
      common/te/tempr(20),tempf(20),tempf1(20)
*d leapr.1258
      common/dw/dwpix(20),dwp1(20)
```

```
*d leapr.1856
      common/te/tempr(20),tempf(20),tempf1(20)
*d leapr.2651.2652
      common/te/tempr(20),tempf(20),tempf1(20)
      common/dw/dbw(20),dbw1(20)
*/ --------------------------------------------------end up4_leapr
*ident up5_leapr
*/   correct directory
*i leapr.2797
         scr(5)=scr(5)+1
      if(iel.ne.0) scr(5)=scr(5)+1
*/ --------------------------------------------------end up5_leapr
*/
*ident up_acer
*/ id-name of thermal data set with 6 characters else blank
*i acer.358
         if (nch.eq.0) nch=6
*/
*/ more than 64 bins  wt(65)
*d acer.13079
      dimension wt(401)
*/
*/ increase of scratch buffer (?)
*d acer.13098
      ninmax=8000
*/
*/ ------------------------------------------------jan05------end
```

C.5 upn_Aldama

```
REM upn_Aldama   : up_therm1 update included in upn_Mattes (included in upn_ADS)
```

```
*/ Changes in up1_thermr by M.Mattes
*/
*/ Equivalent to up_thermr in upn_Mattes
*/
*ident wlup2
*/ */ thermr - D. L. Aldama, NDS/IAEA Consultant, Nov-2004
*/ */ More space for new scattering law
*/ *d thermr.101
*/       dimension a(800000)
*/ *d thermr.131
*/       namax=800000
*/
*/ subroutine calcem - D. L. Aldama, NDS/IAEA Consultant, Nov-2004
*/  TAB1 records are larger than npage=306
*/  moreio should be used
*/  required by thermal scattering law generated by NDS/IKE
*/
*d thermr.1543
      lmore=loc
      call tab1io(nendf,0,0,a(loc),nb,nw)
      do while (nb.ne.0)
        lmore=lmore+nw
        call moreio(nendf,0,0,a(lmore),nb,nw)
      enddo
*d thermr.1572
         lmore=loc
         call listio(nendf,0,0,a(loc),nb,nw)
         do while (nb.ne.0)
           lmore=lmore+nw
           call moreio(nendf,0,0,a(lmore),nb,nw)
         enddo
*d thermr.1598
         lmore=loc
         call listio(nendf,0,0,a(loc),nb,nw)
         do while (nb.ne.0)
           lmore=lmore+nw
           call moreio(nendf,0,0,a(lmore),nb,nw)
         enddo
*d thermr.1602
      lmore=loc
      call tab1io(nendf,0,0,a(loc),nb,nw)
      do while (nb.ne.0)
        lmore=lmore+nw
        call moreio(nendf,0,0,a(lmore),nb,nw)
      enddo
*/
```

C.6 upn_Hogenbirk

```
REM upn_Hogenbirk: Delayed neutrons in ACE format for JEFF31.
REM               - Include: nrg_a50, nrg_a52, nrg_a57, nrg_re15 (dla1 in upn_ADS)
```

```
*/
*/ NRG updates for ACER-processing of delayed neutron data
*/
*ident nrg_a50
*/ acer -- 21sep2001 A. Hogenbirk (NRG)
*/ ---------------------------------------------
*/          allow processing of delayed nu data
*/          for use in MCNP (version 4C onwards)
*/ ---------------------------------------------
*/
*d acer.2194
     &     (mf.eq.5.and.mt.gt.91.and.mt.ne.455)) then
*i acer.4671
      common/nud/nnud,nlambdel,nnfd,dlwnud,ldlwnud,ilambdel,bdd,dnu
      integer bdd,dlwnud,dnu
*i acer.4673
      dimension nus(3)
*i acer.4681
      nus(1)=452
      nus(2)=455
      nus(3)=456
*i acer.4744
      nnud=0
*d acer.4846
        nnus=1
        mta=nus(nnus)
*i acer.4856
               if (mta.eq.455) call reserv('nud',nw,inud,a)
*i acer.4858
               if (mta.eq.455) in=inud
*i acer.4866
               if (mta.eq.455) nnud=nw
*i acer.4869
               if (mta.eq.455) then
c
c read and store delayed data
c
                 call listio(nin,0,0,a(iscr),nb,nw)
                 nnfd=nint(a(iscr+4))
                 nw=nnfd
                 call reserv('lambdel',nw,ilambdel,a)
                 in=ilambdel
                 nlambdel=nw
                 do i=1,nlambdel
                   a(in+i-1)=a(iscr+i+5)
                 enddo
               endif
*i acer.4883
               if (mta.eq.455) call reserv('nud',nw,inud,a)
*i acer.4885
               if (mta.eq.455) in=inud
*i acer.4904
               if (mta.eq.455) nnud=nw
*d acer.4907
            if (mta.eq.456.or.kfis.eq.1) idone=1
            nnus=nnus+1
            if (nnus.gt.3) then
              idone=1
            else
```

```
              mta=nus(nnus)
            endif
*d acer.4908
*i acer.4909
c      write(nsyso,*)  'inu  = ', inu
c      write(nsyso,*)  'inud = ', inud
c      write(nsyso,*)  'inup = ', inup
*i acer.5275
c      write(nsyso,*)  'mtr  = ', mtr
c      write(nsyso,*)  'lqr  = ', lqr
c      write(nsyso,*)  'tyr  = ', tyr
c      write(nsyso,*)  'lsig = ', lsig
c      write(nsyso,*)  'ir   = ', ir
*i acer.5324
c      write(nsyso,*)  'land = ', land
c      write(nsyso,*)  'and  = ', and
*i acer.5515
c
c     ***store delayed fission energy distribution data
c     ***after unresolved-range probability tables and before
c     ***gamma data
c
c     ***this location is essential...
c
      if (nnud.ne.0) then
c
c store delayed nu
c
c        write(nsyso,*)  'next = ', next
        dnu=next
        do i=1,nnud
           xss(next)=a(i-1+inud)
           next=next+1
        enddo
c        write(nsyso,*)  'next = ', next
c
c store basic data
c
        bdd=next
c        write(nsyso,*)  'bdd =', bdd
        call acelf5bd(next,1,matd,455,q,nin)
c        write(nsyso,*)  'next = ', next
c
c
        ldlwnud=next
        next=ldlwnud+nnfd
        dlwnud=next
c        write(nsyso,*)  'ldlwnud =', ldlwnud
c        write(nsyso,*)  'dlwnud =', dlwnud
c
c process delayed neutron energy distributions
c
          call acelf5d(next,1,matd,455,q,nin)
c          write(nsyso,*)  'i    = ', i
c          write(nsyso,*)  'next = ', next
      endif
c
*i acer.5938
      subroutine acelf5bd(next,i,matd,mt,q,nin)
c     *****************************************************************
c     process basic delayed neutron data from file 5.
c     *****************************************************************
*if sw
      implicit real*8 (a-h,o-z)
*endif
      integer esz,sig,and,tyr,dlw,gpd,fis,sigp,andp,dlwp,yp,end
      common/jxst/esz,nu,mtr,lqr,tyr,lsig,sig,land,and,ldlw,dlw,
     &  gpd,mtrp,lsigp,sigp,landp,andp,ldlwp,dlwp,yp,fis,end,
```

```
     &  iurpt,jxsd(9)
      common/lsize/max1,max2,max3
      common/xsst/xss(4000000),n3   ! NEA changes
      common/mainio/nsysi,nsyso,nsyse,ntty
      common/cont/c1h,c2h,l1h,l2h,n1h,n2h,math,mfh,mth,nsh,nsp,nsc
      common/ace1/tempd,err,matdd,nbina,nbinp,negn,iprint,iopt,ndigit
      common/astore/a(80000)
      common/nud/nnud,nlambdel,nnfd,dlwnud,ldlwnud,ilambdel,bdd,dnu
      integer bdd,dlwnud,dnu
      character*60 strng
      character*26 messs
      dimension xs(20),ys(20),xxs(200),yys(200)
      external findex,findf,contio,tab1io,error,moreio,tosend
      external sigfig
      data ismax/20/, jsmax/200/
*if sw
      data emev/1.d6/
      data tshake/1.d8/
      data tol/.02d0/
      data tmin/1.d-12/
      data rmin/1.d-30/
*else
      data emev/1.e6/
      data tshake/1.e8/
      data tol/.02e0/
      data tmin/1.e-12/
      data rmin/1.e-30/
*endif
      zero=0
c
c     ***find desired reaction
      call findex('scr',iscr,a)
      call repoz(nin)
      call findf(matd,5,mt,nin)
      call contio(nin,0,0,a(iscr),nb,nw)
      nk=nint(a(iscr+4))
c
c      write(nsyso,*)  'nk =', nk
c
c     ***store each subsection
      do k=1,nk
c
c     ***store delay time of this group (per shake)
         xss(next)=sigfig(a(ilambdel+k-1)/tshake,ndigit,0)
c         write(nsyso,*)  'delay =', xss(next)
         next=next+1
         call tab1io(nin,0,0,a(iscr),nb,nw)
         u=a(iscr)
         lf=nint(a(iscr+3))
         m=nint(a(iscr+4))
         n=nint(a(iscr+5))
c
c         write(nsyso,*)  'k =', k
c         write(nsyso,*)  'u =', u
c         write(nsyso,*)  'lf =', lf
c         write(nsyso,*)  'm =', m
c         write(nsyso,*)  'n =', n
c
c
         if (next+2*m+2*n+3.gt.max3) then
            write(messs,'(a,i10,a,i10)') 'maximum = ',max3,
     &        ', needed: ',next+2*m+2*n+3
            call error('acelf5bd',
     &        'storage exceeded.',messs)
         endif
c
c
         jnt=nint(a(iscr+7))
```

```
         if (m.ne.1.or.jnt.ne.2) then
            ja=next
            xss(ja)=m
            jb=ja+m
            do j=1,m
               xss(ja+j)=a(iscr+4+2*j)
               xss(jb+j)=a(iscr+5+2*j)
            enddo
            next=jb+m+1
         else
            xss(next)=0
            next=next+1
         endif
         xss(next)=n
         l=iscr+4+2*m
         do j=1,n
            xss(j+next)=sigfig(a(2*j+l)/emev,ndigit,0)
            xss(j+n+next)=a(2*j+1+l)
         enddo
         next=next+2*n+1
c
c skip law-dependent data
c
         if (lf.eq.1) then
            call tab2io(nin,0,0,a(iscr),nb,nw)
            m=nint(a(iscr+4))
            n=nint(a(iscr+5))
            if (next+2*m+1.gt.max3) call error('acelf5bd',
     &        'insufficient space for energy distributions',' ')
            ne=n
            do j=1,ne
               call tab1io(nin,0,0,a(iscr),nb,nw)
               jscr=iscr
               do while (nb.ne.0)
                  jscr=jscr+nw
                  call moreio(nin,0,0,a(jscr),nb,nw)
               enddo
            enddo
c
c        ***law 5...generalized evaporation spectrum
         else if (lf.eq.5) then
c            call error('acelf5bd','sorry. acer cannot handle lf=5.',
c     &        'you will have to patch the evaluation to use lf=1.')
            call tab1io(nin,0,0,a(iscr),nb,nw)
            jscr=iscr
            do while (nb.ne.0)
               jscr=jscr+nw
               call moreio(nin,0,0,a(jscr),nb,nw)
            enddo
            m=nint(a(iscr+4))
            n=nint(a(iscr+5))
            if (next+2*m+2*n+2.gt.max3) call error('acelf5bd',
     &         'insufficient space for energy distributions',' ')
            jnt=nint(a(iscr+7))
            call tab1io(nin,0,0,a(iscr),nb,nw)
            jscr=iscr
            do while (nb.ne.0)
               jscr=jscr+nw
               call moreio(nin,0,0,a(jscr),nb,nw)
            enddo
c
c        ***law 7...simple fission spectrum
c        ***law 9...evaporation spectrum
         else if (lf.eq.7.or.lf.eq.9) then
            call tab1io(nin,0,0,a(iscr),nb,nw)
            m=nint(a(iscr+4))
            n=nint(a(iscr+5))
            if (next+2*m+2*n+2.gt.max3) call error('acelf5bd',
```

```
     &        'insufficient space for energy distributions',' ')
            jnt=nint(a(iscr+7))
c
c        ***law 11...watt fission spectrum
         else if (lf.eq.11) then
            call tab1io(nin,0,0,a(iscr),nb,nw)
            m=nint(a(iscr+4))
            n=nint(a(iscr+5))
            jnt=nint(a(iscr+7))
            if (next+2*m+2*n+2.gt.max3) call error('acelf5bd',
     &        'insufficient space for energy distributions',' ')
            call tab1io(nin,0,0,a(iscr),nb,nw)
            m=nint(a(iscr+4))
            n=nint(a(iscr+5))
            if (next+2*m+2*n+2.gt.max3) call error('acelf5bd',
     &        'insufficient space for energy distributions',' ')
            jnt=nint(a(iscr+7))
c
c        ***law 12...madland-nix fission spectrum
         else if (lf.eq.12) then
            call tab1io(nin,0,0,a(iscr),nb,nw)
c
c        ***illegal value of lf
         else
            write(strng,'(''illegal lf='',i2)') lf
            call error('acelf5bd',strng,' ')
         endif
c
      enddo
      call tosend(nin,0,0,a(iscr))
      return
      end
c
c
c
      subroutine acelf5d(next,i,matd,mt,q,nin)
c     ******************************************************************
c     process delayed neutron energy spectrum from file 5.
c     ******************************************************************
*if sw
      implicit real*8 (a-h,o-z)
*endif
      integer esz,sig,and,tyr,dlw,gpd,fis,sigp,andp,dlwp,yp,end
      common/jxst/esz,nu,mtr,lqr,tyr,lsig,sig,land,and,ldlw,dlw,
     &  gpd,mtrp,lsigp,sigp,landp,andp,ldlwp,dlwp,yp,fis,end,
     &  iurpt,jxsd(9)
      common/lsize/max1,max2,max3
      common/xsst/xss(4000000),n3    ! NEA changes
      common/mainio/nsysi,nsyso,nsyse,ntty
      common/cont/c1h,c2h,l1h,l2h,n1h,n2h,math,mfh,mth,nsh,nsp,nsc
      common/ace1/tempd,err,matdd,nbina,nbinp,negn,iprint,iopt,ndigit
      common/astore/a(80000)
      common/nud/nnud,nlambdel,nnfd,dlwnud,ldlwnud,ilambdel,bdd,dnu
      integer bdd,dlwnud,dnu
      character*60 strng
      dimension xs(20),ys(20),xxs(200),yys(200)
      dimension ein(1000)
      external findex,findf,contio,tab1io,error,moreio,tosend
      external sigfig
      data ismax/20/, jsmax/200/
*if sw
      data emev/1.d6/
      data tol/.02d0/
      data tmin/1.d-12/
      data rmin/1.d-30/
*else
      data emev/1.e6/
      data tol/.02e0/
```

```
      data tmin/1.e-12/
      data rmin/1.e-30/
*endif
      zero=0
c
c     ***find desired reaction
      call findex('scr',iscr,a)
      call repoz(nin)
      call findf(matd,5,mt,nin)
      call contio(nin,0,0,a(iscr),nb,nw)
      nk=nint(a(iscr+4))
c
c     ***store each subsection
      do k=1,nk
         xss(ldlwnud+k-1)=next-dlwnud+1
         call tab1io(nin,0,0,a(iscr),nb,nw)
         u=a(iscr)
         lf=nint(a(iscr+3))
         m=nint(a(iscr+4))
         n=nint(a(iscr+5))
         if (next+2*m+2*n+3.gt.max3) call error('acelf5d',
     &     'insufficient space for energy distributions',' ')
         jnt=nint(a(iscr+7))
         if (k.gt.1) xss(last)=next-dlwnud+1
         last=next
         xss(next)=0
         xss(next+1)=lf
         if (lf.eq.5) xss(next+1)=4
         if (lf.eq.1) xss(next+1)=4
         if (lf.eq.12) xss(next+1)=4
         if (m.ne.1.or.jnt.ne.2) then
            ja=next+3
            xss(ja)=m
            jb=ja+m
            do j=1,m
               xss(ja+j)=a(iscr+4+2*j)
               xss(jb+j)=a(iscr+5+2*j)
            enddo
            next=jb+m+1
         else
            xss(next+3)=0
            next=next+4
         endif
         xss(next)=n
         l=iscr+4+2*m
         do j=1,n
            xss(j+next)=sigfig(a(2*j+l)/emev,ndigit,0)
c            xss(j+n+next)=a(2*j+1+l)
c
c probability should be set to 1.0 at this location:
c it's already included in the bdd block!!
c
*if sw
            xss(j+n+next)=1.0d0
*else
            xss(j+n+next)=1.0e0
*endif
c
         enddo
         next=next+2*n+1
         xss(last+2)=next-dlwnud+1
c
c        ***store law data according to type
c        ***laws 1, 5, 7, 9, 11 only
c
c        ***law 1...tabulated distributions
         if (lf.eq.1) then
*if sw
```

```
            if (mt.eq.455) q=200.0d0
*else
            if (mt.eq.455) q=200.0e0
*endif
            call tab2io(nin,0,0,a(iscr),nb,nw)
            m=nint(a(iscr+4))
            n=nint(a(iscr+5))
            if (next+2*m+1.gt.max3) call error('acelf5d',
     &        'insufficient space for energy distributions',' ')
            jnt=nint(a(iscr+7))
            jnt=mod(jnt,10)
            if (jnt.gt.2) jnt=2
            if (m.ne.1.or.jnt.ne.2) then
               xss(next)=m
               do j=1,m
                  xss(j+next)=a(2*j+4+iscr)
                  jnt=nint(a(2*j+5+iscr))
                  jnt=mod(jnt,10)
                  if (jnt.gt.2) jnt=2
                  xss(j+m+next)=jnt
               enddo
               next=next+1+2*m
            else
               xss(next)=0
               next=next+1
            endif
            xss(next)=n
            nextn=next+n
            nexd=nextn+n+1
            ne=n
            do j=1,ne
               call tab1io(nin,0,0,a(iscr),nb,nw)
               jscr=iscr
               do while (nb.ne.0)
                  jscr=jscr+nw
                  call moreio(nin,0,0,a(jscr),nb,nw)
               enddo
               e=c2h
               xss(next+j)=sigfig(e/emev,ndigit,0)
               xss(nextn+j)=nexd-dlwnud+1
               m=n1h
               n=n2h
               jnt=nint(a(iscr+5+2*m))
               xss(nexd)=jnt
               xss(nexd+1)=n
               nexd=nexd+1
               xss(nexd+1+2*n)=0
               do ki=1,n
                  ep=a(iscr+4+2*m+2*ki)
                  if (ep.gt.e.and.q.lt.zero) then
                     write(nsyso,'(/'' ---warning from acelod---'',
     &                 6x,''mf5 ep.gt.e with negative q''/
     &                 6x,''mt='',i2,'' e='',1p,e12.4,'' ep='',e12.4/
     &                 6x,''patching...'')') mt,e/emev,ep/emev
                     ep=e-(n-ki)*1000
                     a(iscr+4+2*m+2*ki)=ep
                  endif
                  xss(ki+nexd)=sigfig(a(iscr+4+2*m+2*ki)/emev,ndigit,0)
                  xss(ki+n+nexd)=
     &              sigfig(a(iscr+5+2*m+2*ki)*emev,ndigit,0)
                  if (xss(ki+n+nexd).lt.rmin) xss(ki+n+nexd)=0
                  if (ki.gt.1.and.jnt.eq.1) xss(ki+2*n+nexd)=
     &              xss(ki+2*n-1+nexd)+a(iscr+5+2*m+2*(ki-1))
     &              *(a(iscr+4+2*m+2*ki)-a(iscr+4+2*m+2*(ki-1)))
                  if (ki.gt.1.and.jnt.eq.2) xss(ki+2*n+nexd)=
     &              xss(ki+2*n-1+nexd)+((a(iscr+5+2*m+2*(ki-1))
     &              +a(iscr+5+2*m+2*ki))/2)*(a(iscr+4+2*m+2*ki)
     &              -a(iscr+4+2*m+2*(ki-1)))
```

```
               enddo
c              renormalize
               renorm=1
               if (xss(3*n+nexd).ne.zero) renorm=1/xss(3*n+nexd)
               do ki=1,n
                  xss(ki+n+nexd)=sigfig(xss(ki+n+nexd)*renorm,ndigit,0)
                  ndig=min(9,ndigit+2)
                  xss(ki+2*n+nexd)=
     &              sigfig(xss(ki+2*n+nexd)*renorm,ndig,0)
               enddo
               nexd=nexd+3*n+1
            enddo
            next=nexd
c
c        ***law 5...generalized evaporation spectrum
         else if (lf.eq.5) then
*if sw
            if (mt.eq.455) q=200.0d0
*else
            if (mt.eq.455) q=200.0e0
*endif
c            call error('acelf5d','sorry. acer cannot handle lf=5.',
c     &        'you will have to patch the evaluation to use lf=1.')
            call tab1io(nin,0,0,a(iscr),nb,nw)
            jscr=iscr
            do while (nb.ne.0)
               jscr=jscr+nw
               call moreio(nin,0,0,a(jscr),nb,nw)
            enddo
            m=nint(a(iscr+4))
            n=nint(a(iscr+5))
            if (next+2*m+2*n+2.gt.max3) call error('acelf5d',
     &       'insufficient space for energy distributions',' ')
            jnt=nint(a(iscr+7))
            if (m.ne.1.or.jnt.ne.2) then
               xss(next)=m
               do j=1,m
                  xss(j+next)=a(2*j+4+iscr)
                  xss(j+m+next)=a(2*j+5+iscr)
               enddo
               next=next+1+2*m
            else
               xss(next)=0
               next=next+1
            endif
            do j=1,n
               ein(j)=a(2*j+2*m+4+iscr)
c
c conversion only possible for simple cases
c
*if sw
               if (a(2*j+2*m+5+iscr).ne.1.0d0) then
*else
               if (a(2*j+2*m+5+iscr).ne.1.0e0) then
*endif
                call error('acelf5d',
     &          'sorry. acer cannot handle complicated lf=5.',
     &          'you will have to patch the evaluation to use lf=1.')
               endif
            enddo
            xss(next)=n
            nextn=next+n
            nexd=nextn+n+1
            ne=n
c
c read x/g(x) pairs
c
            call tab1io(nin,0,0,a(iscr),nb,nw)
```

```
            jscr=iscr
            do while (nb.ne.0)
               jscr=jscr+nw
               call moreio(nin,0,0,a(jscr),nb,nw)
            enddo
            m=nint(a(iscr+4))
            n=nint(a(iscr+5))
c
            jnt=nint(a(iscr+5+2*m))
c
c            write(nsyso,*)  'ne =', ne
c            write(nsyso,*)  'm =', m
c            write(nsyso,*)  'n =', n
c            write(nsyso,*)  'jnt =', jnt
c
            do j=1,ne
               e=ein(j)
               xss(next+j)=sigfig(e/emev,ndigit,0)
               xss(nextn+j)=nexd-dlwnud+1
               xss(nexd)=jnt
               xss(nexd+1)=n
               nexd=nexd+1
               xss(nexd+1+2*n)=0
               do ki=1,n
                  ep=a(iscr+4+2*m+2*ki)
                  if (ep.gt.e.and.q.lt.zero) then
                      write(nsyso,'(/'' ---warning from acelod---'',
     &                  6x,''mf5 ep.gt.e with negative q''/
     &                  6x,''mt='',i2,'' e='',1p,e12.4,'' ep='',e12.4/
     &                  6x,''patching...'')') mt,e/emev,ep/emev
                      ep=e-(n-ki)*1000
                      a(iscr+4+2*m+2*ki)=ep
                  endif
                  xss(ki+nexd)=sigfig(a(iscr+4+2*m+2*ki)/emev,ndigit,0)
                  xss(ki+n+nexd)=
     &              sigfig(a(iscr+5+2*m+2*ki)*emev,ndigit,0)
                  if (xss(ki+n+nexd).lt.rmin) xss(ki+n+nexd)=0
                  if (ki.gt.1.and.jnt.eq.1) xss(ki+2*n+nexd)=
     &              xss(ki+2*n-1+nexd)+a(iscr+5+2*m+2*(ki-1))
     &              *(a(iscr+4+2*m+2*ki)-a(iscr+4+2*m+2*(ki-1)))
                  if (ki.gt.1.and.jnt.eq.2) xss(ki+2*n+nexd)=
     &              xss(ki+2*n-1+nexd)+((a(iscr+5+2*m+2*(ki-1))
     &              +a(iscr+5+2*m+2*ki))/2)*(a(iscr+4+2*m+2*ki)
     &              -a(iscr+4+2*m+2*(ki-1)))
               enddo
c              renormalize
               renorm=1
               if (xss(3*n+nexd).ne.zero) renorm=1/xss(3*n+nexd)
               do ki=1,n
                  xss(ki+n+nexd)=sigfig(xss(ki+n+nexd)*renorm,ndigit,0)
                  ndig=min(9,ndigit+2)
                  xss(ki+2*n+nexd)=
     &              sigfig(xss(ki+2*n+nexd)*renorm,ndig,0)
c                  write(nsyso,*)  'xss(ki+nexd) =', xss(ki+nexd)
c                  write(nsyso,*)  'xss(ki+n+nexd) =', xss(ki+n+nexd)
c                  write(nsyso,*)  'xss(ki+2*n+nexd) =', xss(ki+2*n+nexd)
               enddo
               nexd=nexd+3*n+1
            enddo
            next=nexd
c
c        ***law 7...simple fission spectrum
c        ***law 9...evaporation spectrum
         else if (lf.eq.7.or.lf.eq.9) then
            call tab1io(nin,0,0,a(iscr),nb,nw)
            m=nint(a(iscr+4))
            n=nint(a(iscr+5))
            if (next+2*m+2*n+2.gt.max3) call error('acelf5d',
```

```
     &       'insufficient space for energy distributions',' ')
            jnt=nint(a(iscr+7))
            if (m.ne.1.or.jnt.ne.2) then
               xss(next)=m
               do j=1,m
                  xss(j+next)=a(2*j+4+iscr)
                  xss(j+m+next)=a(2*j+5+iscr)
               enddo
               next=next+2*m+1
            else
               xss(next)=0
               next=next+1
            endif
            xss(next)=n
            do j=1,n
               xss(j+next)=sigfig(a(2*j+2*m+4+iscr)/emev,ndigit,0)
               xss(j+n+next)=sigfig(a(2*j+2*m+5+iscr)/emev,ndigit,0)
            enddo
            next=next+1+2*n
            xss(next)=u/emeV
            next=next+1
c
c        ***law 11...watt fission spectrum
         else if (lf.eq.11) then
            call tab1io(nin,0,0,a(iscr),nb,nw)
            m=nint(a(iscr+4))
            n=nint(a(iscr+5))
            jnt=nint(a(iscr+7))
            if (next+2*m+2*n+2.gt.max3) call error('acelf5d',
     &       'insufficient space for energy distributions',' ')
            if (m.ne.1.or.jnt.ne.2) then
               xss(next)=m
               do j=1,m
                  xss(j+next)=sigfig(a(2*j+4+iscr)/emev,ndigit,0)
                  xss(j+m+next)=sigfig(a(2*j+5+iscr)/emev,ndigit,0)
               enddo
               next=next+2*m+1
            else
               xss(next)=0
               next=next+1
            endif
            xss(next)=n
            do j=1,n
               xss(j+next)=sigfig(a(2*j+2*m+4+iscr)/emev,ndigit,0)
               xss(j+n+next)=sigfig(a(2*j+2*m+5+iscr)/emev,ndigit,0)
            enddo
            next=next+1+2*n
            call tab1io(nin,0,0,a(iscr),nb,nw)
            m=nint(a(iscr+4))
            n=nint(a(iscr+5))
            if (next+2*m+2*n+2.gt.max3) call error('acelf5d',
     &       'insufficient space for energy distributions',' ')
            jnt=nint(a(iscr+7))
            if (m.ne.1.or.jnt.ne.2) then
               xss(next)=m
               do j=1,m
                  xss(j+next)=sigfig(a(2*j+2*m+4+iscr)/emev,ndigit,0)
                  xss(j+n+next)=sigfig(a(2*j+2*m+5+iscr)/emev,ndigit,0)
               enddo
               next=next+1+2*m
            else
               xss(next)=0
               next=next+1
            endif
            xss(next)=n
            do j=1,n
               xss(j+next)=sigfig(a(2*j+2*m+4+iscr)/emev,ndigit,0)
               xss(j+n+next)=sigfig(a(2*j+2*m+5+iscr)*emev,ndigit,0)
```

```
            enddo
            next=next+1+2*n
            xss(next)=sigfig(u/emev,ndigit,0)
            next=next+1
c
c        ***law 12...madland-nix fission spectrum
         else if (lf.eq.12) then
            call tab1io(nin,0,0,a(iscr),nb,nw)
            efl=a(iscr)
            efh=a(iscr+1)
            m=nint(a(iscr+4))
            n=nint(a(iscr+5))
            jnt=nint(a(iscr+7))
            emin=a(iscr+6+2*m)
            emax=a(iscr+6+2*m+2*n-2)
            xss(next)=0
            next=next+1
            xss(next)=n
            nextn=next+n
            nexd=nextn+n+1
c           convert madland-nix to ace law=4 using the given e grid
c           and developing the e' grid adaptively.
            do ie=1,n
               tme=a(iscr+4+2*m+2*ie)
               tmt=a(iscr+5+2*m+2*ie)
c              prime the adaptive stack
               renorm=0
               js=0
               is=3
               xs(3)=emin
               ys(3)=fmn(emin,efl,efh,tmt)
               xs(2)=emev
               ys(2)=fmn(xs(2),efl,efh,tmt)
               xs(1)=emax
               ys(1)=fmn(emax,efl,efh,tmt)
c              carry out the adaptive linearization
               do while (is.gt.0)
                  dy=0
                  test=1
                  if (is.gt.1.and.is.lt.ismax) then
                     xm=(xs(is-1)+xs(is))/2
                     ym=(ys(is-1)+ys(is))/2
                     yt=fmn(xm,efl,efh,tmt)
                     test=tol*abs(yt)+tmin
                     dy=abs(yt-ym)
                  endif
                  if (dy.gt.test) then
c                    not converged.
c                    add midpoint to stack and continue.
                     is=is+1
                     xs(is)=xs(is-1)
                     ys(is)=ys(is-1)
                     xs(is-1)=xm
                     ys(is-1)=yt
                  else
c                    converged.
c                    move top point in stack to temporary spectrum.
                     js=js+1
                     if (js.gt.jsmax) js=jsmax
                     xxs(js)=xs(is)
                     yys(js)=ys(is)
                     if (js.gt.1) renorm=renorm
     &                  +(xxs(js)-xxs(js-1))*(yys(js)+yys(js-1))/2
                     is=is-1
                  endif
               enddo
c              transfer spectrum to law 4
               renorm=1/renorm
```

```
               jnt=2
               xss(next+ie)=sigfig(tme/emev,ndigit,0)
               xss(nextn+ie)=nexd-dlwnud+1
               xss(nexd)=jnt
               nexd=nexd+1
               xss(nexd)=js
               xss(nexd+1+2*js)=0
               do ki=1,js
                  xss(ki+nexd)=sigfig(xxs(ki)/emev,ndigit,0)
                  xss(ki+js+nexd)=sigfig(yys(ki)*renorm*emev,ndigit,0)
                  if (ki.gt.1.and.jnt.eq.1) xss(ki+2*js+nexd)=
     &              xss(ki+2*js-1+nexd)
     &              +renorm*yys(ki)*(xxs(ki)-xxs(ki-1))
                  if (ki.gt.1.and.jnt.eq.2) xss(ki+2*js+nexd)=
     &              xss(ki+2*js-1+nexd)+renorm*(yys(ki)+yys(ki-1))
     &              *(xxs(ki)-xxs(ki-1))/2
               enddo
               nexd=nexd+3*js+1
            enddo
            next=nexd
c
c        ***illegal value of lf
         else
            write(strng,'(''illegal lf='',i2)') lf
            call error('acelf5d',strng,' ')
         endif
c
c     ***end of loop over laws
c         write(nsyso,*)  'k (in acelf5d) =', k
c         write(nsyso,*)  'next =', next
      enddo
      call tosend(nin,0,0,a(iscr))
      return
      end
c
*i acer.9748
      common/nud/nnud,nlambdel,nnfd,dlwnud,ldlwnud,ilambdel,bdd,dnu
      integer bdd,dlwnud,dnu
*i acer.9771
c
c add pointers to delayed neutron data
c
          if (nnud.ne.0) then
             nxs(8)=nlambdel
             jxs(24)=dnu
             jxs(25)=bdd
             jxs(26)=ldlwnud
             jxs(27)=dlwnud
          endif
*d acer.9784,acer.9787
c
c print delayed-neutron relevant pointers
c
     &  6x,''*                     *'',9x,''npcr'',i10/
     &  6x,''*        njoy         *'',10x,''esz'',i10/
     &  6x,''*                     *'',11x,''nu'',i10/
     &  6x,''***********************'',10x,''mtr'',i10/
     &  39x,''lqr'',i10/
*d acer.9794
c
c print delayed-neutron relevant pointers
c
     &  37x,''iurpt'',i10/37x,''  dnu'',i10/38x,'' bdd'',i10/
     &  37x,''dnedl'',i10/37x,'' dned'',i10/37x,''ptype'',i10/
     &  38x,''ntro'',i10/
*d acer.9796,acer.9797
c
c print delayed-neutron relevant pointers
```

```
c
     &  hz,aw0,tz,hd,hm,nxs(1),(nxs(i),i=3,8),
     &  (jxs(i),i=1,27),(jxs(i),i=30,32),hk
*i acer.10065
              if (jnu.eq.3) write(nsyso,
     &           '('' delayed nu''/'' --------''/)')
*i acer.10066
            if (jnu.eq.3) then
              l=dnu
              j=nint(xss(l))
            endif
*d acer.10106
            if (nnud.eq.0.and.jnu.eq.1.and.kf.lt.0) idone=0
            if (nnud.ne.0.and.jnu.ne.3.and.kf.lt.0) idone=0
*i acer.10203
      common/ace1/tempd,err,matd,nbina,nbinp,negn,iprint,iopt,ndigit
      common/nud/nnud,nlambdel,nnfd,dlwnud,ldlwnud,ilambdel,bdd,dnu
      integer bdd,dlwnud,dnu
      common/astore/a(80000)
*if sw
      data tshake/1.d8/
*else
      data tshake/1.e8/
*endif
*d acer.10211
      nr1=nr
      if (nnud.ne.0) then
c
c delayed neutron data present
c
        nr1=nr+1
      endif
      do n=1,nr1
c
c
*i acer.10213
        if (n.eq.nr1.and.nnud.ne.0) then
          title(1)='del. fiss.'
          mtrn=455
        endif
*i acer.10224
      if (n.eq.nr1.and.nnud.ne.0) then
         l=nint(xss(ldlwnud)+dlwnud-1)
c         write(nsyso,*)  'l =', l
c         write(nsyso,*)  'xss(l) =', xss(l)
         loc(1)=l
         do while (nint(xss(l)).ne.0)
            l=nint(xss(l))+dlwnud-1
            nlaw=nlaw+1
            loc(nlaw)=l
         enddo
       else
*i acer.10231
       endif
*i acer.10374
             if (n.eq.nr1.and.nnud.ne.0) then
               delay=sigfig(a(ilambdel+m-1)/tshake,ndigit,0)
               write(nsyso,'(12x,''decay constant = '',1p,e14.6,
     &            '' (per shake)'')')delay
             endif
*d acer.10390
                  if (n.eq.nr1.and.nnud.ne.0) then
                     loci=nint(xss(ie+ne+l)+dlwnud-1)
                  else
                     loci=nint(xss(ie+ne+l)+dlw)
                  endif
*i acer.11592
      common/nud/nnud,nlambdel,nnfd,dlwnud,ldlwnud,ilambdel,bdd,dnu
```

```
      integer bdd,dlwnud,dnu
*i acer.11688
      common/nud/nnud,nlambdel,nnfd,dlwnud,ldlwnud,ilambdel,bdd,dnu
      integer bdd,dlwnud,dnu
*i acer.12302
c
c     ***delayed fission neutron energy distributions
      if (nnfd.ne.0) then
c
c        ***nud block
         l=dnu
         if (nout.ne.1) lnu=nint(xss(l))
         if (nout.eq.1) lnu=iss(l)
         call typen(l,nout,1)
         l=l+1
         if (lnu.ne.2) then
            if (nout.ne.1) nc=nint(xss(l))
            if (nout.eq.1) nc=iss(l)
            call typen(l,nout,1)
            l=l+1
            do j=1,nc
               call typen(l,nout,2)
               l=l+1
            enddo
         else
            if (nout.ne.1) nr=nint(xss(l))
            if (nout.eq.1) nr=iss(l)
            call typen(l,nout,1)
            l=l+1
            if (nr.ne.0) then
               n=2*nr
               do j=1,n
                  call typen(l,nout,1)
                  l=l+1
               enddo
            endif
            if (nout.ne.1) ne=nint(xss(l))
            if (nout.eq.1) ne=iss(l)
            call typen(l,nout,1)
            l=l+1
            n=2*ne
            do j=1,n
               call typen(l,nout,2)
               l=l+1
            enddo
         endif
c
c        ***bdd block
         l=bdd
         do while (l.lt.ldlwnud)
            call typen(l,nout,2)
            l=l+1
            if (nout.ne.1) nr=nint(xss(l))
            if (nout.eq.1) nr=iss(l)
            call typen(l,nout,1)
            l=l+1
            if (nr.gt.0) then
               n=2*nr
               do j=1,n
                  call typen(l,nout,1)
                  l=l+1
               enddo
            endif
            if (nout.ne.1) ne=nint(xss(l))
            if (nout.eq.1) ne=iss(l)
            call typen(l,nout,1)
            l=l+1
            n=2*ne
```

```
            do j=1,n
               call typen(l,nout,2)
               l=l+1
            enddo
         enddo
c
c        ***ldlwnud block
         l=ldlwnud
         do i=1,nnfd
            call typen(l,nout,1)
            l=l+1
         enddo
c
c        ***dlwnud block
         l=dlwnud
         do i=1,nnfd
c
c           ***loop over laws
               if (nout.ne.1) lnw=nint(xss(l))
               if (nout.eq.1) lnw=iss(l)
               call typen(l,nout,1)
               l=l+1
               if (nout.ne.1) law=nint(xss(l))
               if (nout.eq.1) law=iss(l)
               call typen(l,nout,1)
               l=l+1
               call typen(l,nout,1)
               l=l+1
               if (nout.ne.1) nr=nint(xss(l))
               if (nout.eq.1) nr=iss(l)
               call typen(l,nout,1)
               l=l+1
               if (nr.gt.0) then
                  n=2*nr
                  do j=1,n
                     call typen(l,nout,1)
                     l=l+1
                  enddo
               endif
               if (nout.ne.1) ne=nint(xss(l))
               if (nout.eq.1) ne=iss(l)
               call typen(l,nout,1)
               l=l+1
               n=2*ne
               do j=1,n
                  call typen(l,nout,2)
                  l=l+1
               enddo
c
c              ***law 1
               if (law.eq.1) then
                  if (nout.ne.1) nr=nint(xss(l))
                  if (nout.eq.1) nr=iss(l)
                  call typen(l,nout,1)
                  l=l+1
                  if (nr.gt.0) then
                     n=2*nr
                     do j=1,n
                        call typen(l,nout,1)
                        l=l+1
                     enddo
                  endif
                  if (nout.ne.1) ne=nint(xss(l))
                  if (nout.eq.1) ne=iss(l)
                  call typen(l,nout,1)
                  l=l+1
                  do j=1,ne
                     call typen(l,nout,2)
```

```
                l=l+1
             enddo
             if (nout.ne.1) net=nint(xss(l))
             if (nout.eq.1) net=iss(l)
             call typen(l,nout,1)
             l=l+1
             do j=1,ne
                do k=1,net
                   call typen(l,nout,2)
                   l=l+1
                enddo
             enddo
c
c         ***law 3
          else if (law.eq.3) then
             call typen(l,nout,2)
             l=l+1
             call typen(l,nout,2)
             l=l+1
c
c         ***law 4
          else if (law.eq.4) then
             if (nout.ne.1) nr=nint(xss(l))
             if (nout.eq.1) nr=iss(l)
             call typen(l,nout,1)
             l=l+1
             if (nr.gt.0) then
                n=2*nr
                do j=1,n
                   call typen(l,nout,1)
                   l=l+1
                enddo
             endif
             if (nout.ne.1) ne=nint(xss(l))
             if (nout.eq.1) ne=iss(l)
             call typen(l,nout,1)
             l=l+1
             do j=1,ne
                call typen(l,nout,2)
                l=l+1
             enddo
             do j=1,ne
                call typen(l,nout,1)
                l=l+1
             enddo
             do j=1,ne
                call typen(l,nout,1)
                l=l+1
                if (nout.ne.1) np=nint(xss(l))
                if (nout.eq.1) np=iss(l)
                call typen(l,nout,1)
                l=l+1
                n=3*np
                do k=1,n
                   call typen(l,nout,2)
                   l=l+1
                enddo
             enddo
c
c         ***law 5
          else if (law.eq.5) then
             if (nout.ne.1) nr=nint(xss(l))
             if (nout.eq.1) nr=iss(l)
             call typen(l,nout,1)
             l=l+1
             if (nr.gt.0) then
                n=2*nr
                do j=1,n
```

```
                    call typen(l,nout,1)
                    l=l+1
                 enddo
              endif
              if (nout.ne.1) ne=nint(xss(l))
              if (nout.eq.1) ne=iss(l)
              call typen(l,nout,1)
              l=l+1
              n=2*ne
              do j=1,n
                 call typen(l,nout,2)
                 l=l+1
              enddo
              if (nout.ne.1) net=nint(xss(l))
              if (nout.eq.1) net=iss(l)
              call typen(l,nout,1)
              l=l+1
              do j=1,net
                    call typen(l,nout,2)
                 l=l+1
              enddo
c
c          ***law 7 or law 9
           else if (law.eq.7.or.law.eq.9) then
              if (nout.ne.1) nr=nint(xss(l))
              if (nout.eq.1) nr=iss(l)
              call typen(l,nout,1)
              l=l+1
              if (nr.gt.0) then
                 n=2*nr
                 do j=1,n
                    call typen(l,nout,1)
                    l=l+1
                 enddo
              endif
              if (nout.ne.1) ne=nint(xss(l))
              if (nout.eq.1) ne=iss(l)
              call typen(l,nout,1)
              l=l+1
              n=2*ne
              do j=1,n
                 call typen(l,nout,2)
                 l=l+1
              enddo
              call typen(l,nout,2)
              l=l+1
c
c          ***law 11
           else if (law.eq.11) then
              if (nout.ne.1) nr=nint(xss(l))
              if (nout.eq.1) nr=iss(l)
              call typen(l,nout,1)
              l=l+1
              if (nr.gt.0) then
                 n=2*nr
                 do j=1,n
                    call typen(l,nout,1)
                    l=l+1
                 enddo
              endif
              if (nout.ne.1) ne=nint(xss(l))
              if (nout.eq.1) ne=iss(l)
              call typen(l,nout,1)
              l=l+1
              n=2*ne
              do j=1,n
                 call typen(l,nout,2)
                 l=l+1
```

```
                  enddo
                  if (nout.ne.1) nr=nint(xss(l))
                  if (nout.eq.1) nr=iss(l)
                  call typen(l,nout,1)
                  l=l+1
                  if (nr.gt.0) then
                     n=2*nr
                     do j=1,n
                        call typen(l,nout,1)
                        l=l+1
                     enddo
                  endif
                  if (nout.ne.1) ne=nint(xss(l))
                  if (nout.eq.1) ne=iss(l)
                  call typen(l,nout,1)
                  l=l+1
                  n=2*ne
                  do j=1,n
                     call typen(l,nout,2)
                     l=l+1
                  enddo
                  call typen(l,nout,2)
                  l=l+1
c
c              ***law 44
               else if (law.eq.44) then
                  if (nout.ne.1) nr=nint(xss(l))
                  if (nout.eq.1) nr=iss(l)
                  call typen(l,nout,1)
                  l=l+1
                  if (nr.gt.0) then
                     n=2*nr
                     do j=1,n
                        call typen(l,nout,1)
                        l=l+1
                     enddo
                  endif
                  if (nout.ne.1) ne=nint(xss(l))
                  if (nout.eq.1) ne=iss(l)
                  call typen(l,nout,1)
                  l=l+1
                  do j=1,ne
                     call typen(l,nout,2)
                     l=l+1
                  enddo
                  do j=1,ne
                     call typen(l,nout,1)
                     l=l+1
                  enddo
                  do j=1,ne
                     call typen(l,nout,1)
                     l=l+1
                     if (nout.ne.1) np=nint(xss(l))
                     if (nout.eq.1) np=iss(l)
                     call typen(l,nout,1)
                     l=l+1
                     n=5*np
                     do k=1,n
                        call typen(l,nout,2)
                        l=l+1
                     enddo
                  enddo
c
c              ***law 61
               else if (law.eq.61) then
                  if (nout.ne.1) nr=nint(xss(l))
                  if (nout.eq.1) nr=iss(l)
                  call typen(l,nout,1)
```

```
            l=l+1
            if (nr.ne.0) then
               n=2*nr
               do j=1,n
                  call typen(l,nout,1)
                  l=l+1
               enddo
            endif
            if (nout.ne.1) ne=nint(xss(l))
            if (nout.eq.1) ne=iss(l)
            call typen(l,nout,1)
            l=l+1
               do j=1,ne
               call typen(l,nout,2)
               l=l+1
            enddo
            do j=1,ne
               call typen(l,nout,1)
               l=l+1
            enddo
            do j=1,ne
               call typen(l,nout,1)
               l=l+1
               if (nout.ne.1) np=nint(xss(l))
               if (nout.eq.1) np=iss(l)
               call typen(l,nout,1)
               l=l+1
               n=3*np
               do k=1,n
                  call typen(l,nout,2)
                  l=l+1
               enddo
               do k=1,np
                  call typen(l,nout,1)
                  l=l+1
               enddo
               do k=1,np
                  call typen(l,nout,1)
                  l=l+1
                  if (nout.ne.1) nmu=nint(xss(l))
                  if (nout.eq.1) nmu=iss(l)
                  call typen(l,nout,1)
                  l=l+1
                  nw=3*nmu
                  do kk=1,nw
                     call typen(l,nout,2)
                     l=l+1
                  enddo
               enddo
            enddo
c
c        ***law 66
         else if (law.eq.66) then
            call typen(l,nout,1)
            l=l+1
            call typen(l,nout,2)
            l=l+1
            call typen(l,nout,1)
            l=l+1
            if (nout.ne.1) nn=nint(xss(l))
            if (nout.eq.1) nn=iss(l)
            n=3*nn
            call typen(l,nout,1)
            l=l+1
            do k=1,n
               call typen(l,nout,2)
               l=l+1
            enddo
```

```
c
c              ***law 67
               else if (law.eq.67) then
                  if (nout.ne.1) nr=nint(xss(l))
                  if (nout.eq.1) nr=iss(l)
                  call typen(l,nout,1)
                  l=l+1
                  if (nr.gt.0) then
                     n=2*nr
                     do j=1,n
                        call typen(l,nout,1)
                        l=l+1
                     enddo
                  endif
                  if (nout.ne.1) ne=nint(xss(l))
                  if (nout.eq.1) ne=iss(l)
                  call typen(l,nout,1)
                  l=l+1
                  do j=1,ne
                     call typen(l,nout,2)
                     l=l+1
                  enddo
                  do j=1,ne
                     call typen(l,nout,1)
                     l=l+1
                  enddo
                  do j=1,ne
                     call typen(l,nout,1)
                     l=l+1
                     if (nout.ne.1) nmu=nint(xss(l))
                     if (nout.eq.1) nmu=iss(l)
                     call typen(l,nout,1)
                     l=l+1
                     do k=1,nmu
                        call typen(l,nout,2)
                        l=l+1
                        enddo
                     do k=1,nmu
                        call typen(l,nout,1)
                        l=l+1
                     enddo
                     do k=1,nmu
                        call typen(l,nout,1)
                        l=l+1
                        if (nout.ne.1) nep=nint(xss(l))
                        if (nout.eq.1) nep=iss(l)
                        call typen(l,nout,1)
                        l=l+1
                        nn=3*nep
                        do n=1,nn
                           call typen(l,nout,2)
                           l=l+1
                        enddo
                     enddo
                  enddo
               endif
         enddo
      endif
c
*/
*ident nrg_a52
*/ acer -- 14feb2002 A. Hogenbirk (NRG)
*/ -----------------------------------------------
*/         Allow presence of MF1,MT455 data
*/         while energy distributions in MF5 are lacking.
*/         However, print relevant warning message!
*/ -----------------------------------------------
*/
```

```
*d up57.10
      common/ace9/mt16,mt455
*i up57.12
      mt455=0
*i up57.14
               if (mfd.eq.5.and.mtd.eq.455) mt455=1
*d up57.18
      common/ace9/mt16,mt455
*d nrg_a50.9
     &     (mf.eq.5.and.mt.gt.900)) then
*d nrg_a50.81
      if (nnud.gt.0.and.mt455.eq.0) write(nsyso,
     &  '(/''   A delayed nubar section was found in MF1, but''/
     &     ''   no delayed neutron spectra were found in MF5:''/
     &     ''   Only the total spectrum will be output to the''
     &     '' ace library'')')
      if (nnud.gt.0.and.mt455.eq.1) then
         write(nsyso,'(/''  adding delayed neutron data'')')
*/
*/ Included in upn_ADS changed to ads03.33
*/ *i up57.102
*/      common/ace9/mt16,mt455
*i acer.11688
      common/ace9/mt16,mt455
*/
*d nrg_a50.880
      if (nnfd.gt.0.and.mt455.eq.1) then
c
c only print delayed information if spectrum is given on evaluation
*/
*/ Included in upn_ADS changed to ads03.33
*/ *i up57.92
*/       common/ace9/mt16,mt455
*i acer.9753
      common/ace9/mt16,mt455
*/
*i nrg_a50.818
            if (nnud.gt.0.and.jnu.eq.2.and.mt455.eq.0) idone=1
c
c no delayed spectrum on evaluation!
c
*i nrg_a50.823
      common/ace9/mt16,mt455
*d nrg_a50.831
      if (nnud.gt.0.and.mt455.eq.1) then
*d nrg_a50.841
        if (n.eq.nr1.and.nnud.gt.0.and.mt455.eq.1) then
*d nrg_a50.846
      if (n.eq.nr1.and.nnud.gt.0.and.mt455.eq.1) then
*d nrg_a50.860
             if (n.eq.nr1.and.nnud.gt.0.and.mt455.eq.1) then
*d nrg_a50.866
                  if (n.eq.nr1.and.nnud.gt.0.and.mt455.eq.1) then
*/
*ident nrg_a57
*/ acer -- 07mar2002 A. Hogenbirk (NRG)
*/ -----------------------------------------------
*/          do not output delayed neutron information at all
*/          when energy distributions are lacking...
*/ -----------------------------------------------
*/
*d nrg_a50.779
           if (nnud.gt.0.and.mt455.eq.1) then
*/
*ident nrg_re15
*/ reconr -- 25feb2005 A. Hogenbirk (NRG)
*/ -----------------------------------------------
*/  Add forgotten initialisation of zero
```

```
*/ ---------------------------------------------
*/
*i reconr.853
      zero=0
*i reconr.937
      zero=0
*/
```

C.7 upn_Sublet

```
REM upn_Sublet   : upki (included in upn_Hogenbirk)
```

```
*/ Updates Sublet
*/
*/  J.C. Sublet, Feb. 2005
*/  increase the allowed number of legendre terms in h6ddx
*/  to handle the new ENDF/B-VII (Mo95) evaluation.
*/
*ident upki
*d up15.9
      dimension cnow(*),p(65)
*d up30.10
*i heatr.3298
      data nlmax/65/
```

C.8 upn_ADS

```
REM upn_ADS      :
REM                 - Include: ads01, ads02, ads03
REM                 - Do not include:
REM               1) upiaea1, upijs57, upijs59, upijs61, upijs62, upijs63, upijs64
REM                  upiaea2 upiaea3, upfendl1, upfndl2, upfndl3, upfndl4,
REM                  upfndl5, upfndl6: included in upn_Trkov
REM               2) wlup2: included in upn_Aldama
REM               3) up3_thermr, up1_leapr, up2_leapr, up3_leapr, up4_leapr,
REM                  up5_leapr, up_acer : included in upn_Mattes
REM               4) upshim: included in upn_Shimizu
REM               5) upcad: included in upn_CAD
```

```
*/
*ident ads01
*/ matxsr - D. L. Aldama, NDS/IAEA Consultant, July 2005
*/ Need more space  (for processing ORNL 421 energy group structure)
*/  subroutine vector
*d up88.21
      dimension b(30000)
*d up88.23
      maxb=30000
*ident ads02
*/ matxsr - D. L. Aldama, NDS/IAEA Consultant, July 2005
*/ Remove a problem in case of multi-temperature matxs files processing.
*/ Scratch tapes iref and nscr should be simultaneously forwarded.
*/ The problem seems to affect only multi-temperature runs, if the mf=6
*/ of gendf tape was not ordered by mt numbers.
*/
*i matxsr.1870
            if (iref.ne.0) call contio(iref,0,0,b(1),nb,nw)
*d matxsr.1878
            if (iskip.eq.0) then
              if (iref.ne.0) call tosend(iref,0,0,b(1))
              call tosend(nscr,0,0,b(1))
            endif
*/
*ident ads03
*/ acer - D. L. Aldama, NDS/IAEA Consultant, July 2005
*/ need more storage for processing jeff-3.1 U-238
*/ ADS library
*/
*d up57.76
      max3=4000000
*d up57.78
      common/xsst/xss(4000000),n3
*d up57.80
      common/xsst/xss(4000000),n3
*d up57.82
      common/xsst/xss(4000000),n3
*d up57.84
      common/xsst/xss(4000000),n3
*d up57.86
      common/xsst/xss(4000000),n3
*d up57.88
      common/xsst/xss(4000000),n3
*d up57.90
      common/xsst/xss(4000000),n3
*d up57.92
      common/xsst/xss(4000000),n3
*d up57.94
      common/xsst/xss(4000000),n3
*d up57.96
      common/xsst/xss(4000000),n3
*d up57.98
      common/xsst/xss(4000000),n3
```

```
*d up57.100
      common/xsst/xss(4000000),n3
*d up57.102
      common/xsst/xss(4000000),n3
*d up57.104
      common/xsst/xss(4000000),n3
*d up57.106
      common/xsst/xss(4000000),n3
*d up57.108
      common/xsst/xss(4000000),n3
*d up57.110
      common/xsst/xss(4000000),n3
*d up57.112
      common/xsst/xss(4000000),n3
*d up57.114
      common/xsst/xss(4000000),n3
*d up57.116
      common/xsst/xss(4000000),n3
*d up57.118
      common/xsst/xss(4000000),n3
*d up57.120
      common/xsst/xss(4000000),n3
*d up57.122
      common/xsst/xss(4000000),n3
*d up57.124
      common/xsst/xss(4000000),n3
*d up57.126
      common/xsst/xss(4000000),n3
*d up57.128
      common/xsst/xss(4000000),n3
*d up57.130
      common/xsst/xss(4000000),n3
*d up57.132
      common/xsst/xss(4000000),n3
*d up57.134
      common/xsst/xss(4000000),n3
*d up57.136
      common/xsst/xss(4000000),n3
*d up57.138
      common/xsst/xss(4000000),n3
*d up57.140
      common/xsst/xss(4000000),n3
*d up57.142
      common/xsst/xss(4000000),n3
*d up70.95
      common/xsst/xss(4000000),n3
*d up57.144
      common/xsst/xss(4000000),n3
*d up70.222
      common/xsst/xss(4000000),n3
*d up57.146
      common/xsst/xss(4000000),n3
*d up57.148
      common/xsst/xss(4000000),n3
*d up57.150
      common/xsst/xss(4000000),n3
*/
```

C.9 upn_CAD

```
REM upn_CAD      : upcad (included in ADS)



*/
*ident upcad
*/ groupr -- 11oct2002
*/   add the ecco33, ecco1968, tripoli315, xmas172 and Vitamin-J
*/   group structures with 7 significant decimal digits. those
*/   group structures are used in Europe for fast breeder and
*/   thermal reactor neutronics calculations. for compatibility
*/   with Calendf and Apollo
*b groupr.132
c     *     18           xmas NEA-LANL
c     *     All new additional group structure with 7 significant
c     *     decimal digits compatible with CALENDF
c     *     19           ecco  33-group structure
c     *     20           ecco 1968-group structure
c     *     21           tripoli 315-group structure
c     *     22           xmas LWPC 172-group structure
c     *     23           vit-J LWPC 175-group structure
*b groupr.1297
c        19      ecco  33-group structure
c        20      ecco 1968-group structure
c        21      tripoli 315-group structure
c        22      xmas LWPC 172-group structure
c        23      vit-J LWPC 175-group structure
*b groupr.1312
      dimension eg19(34)
      dimension eg20(1969)
      dimension eg20a(95),eg20b(95),eg20c(95),eg20d(95),
     *          eg20e(95),eg20f(95),eg20g(95),eg20h(95),
     *          eg20i(95),eg20j(95),eg20k(95),eg20l(95),
     *          eg20m(95),eg20n(95),eg20o(95),eg20p(95),
     *          eg20q(95),eg20r(95),eg20s(95),eg20t(95),
     *          eg20u(69)
      dimension eg21(316)
      dimension eg21a(95),eg21b(95),eg21c(95),eg21d(31)
      dimension eg22(173)
      dimension eg22a(95),eg22b(78)
      dimension eg23(176)
      dimension eg23a(95),eg23b(81)
      equivalence (eg20a(1),eg20(1)),(eg20b(1),eg20(96)),
     *            (eg20c(1),eg20(191)),(eg20d(1),eg20(286)),
     *            (eg20e(1),eg20(381)),(eg20f(1),eg20(476)),
     *            (eg20g(1),eg20(571)),(eg20h(1),eg20(666)),
     *            (eg20i(1),eg20(761)),(eg20j(1),eg20(856)),
     *            (eg20k(1),eg20(951)),(eg20l(1),eg20(1046)),
     *            (eg20m(1),eg20(1141)),(eg20n(1),eg20(1236)),
     *            (eg20o(1),eg20(1331)),(eg20p(1),eg20(1426)),
     *            (eg20q(1),eg20(1521)),(eg20r(1),eg20(1616)),
     *            (eg20s(1),eg20(1711)),(eg20t(1),eg20(1806)),
     *            (eg20u(1),eg20(1901))
      equivalence (eg21a(1),eg21(1)),(eg21b(1),eg21(96)),
     *            (eg21c(1),eg21(191)),(eg21d(1),eg21(286))
      equivalence (eg22a(1),eg22(1)),(eg22b(1),eg22(96))
      equivalence (eg23a(1),eg23(1)),(eg23b(1),eg23(96))
*b groupr.1470
      data eg19/
     &1.000010d-05,1.000000d-01,5.400000d-01,4.000000d+00,8.315287d+00,
     &1.370959d+01,2.260329d+01,4.016900d+01,6.790405d+01,9.166088d+01,
     &1.486254d+02,3.043248d+02,4.539993d+02,7.485183d+02,1.234098d+03,
     &2.034684d+03,3.354626d+03,5.530844d+03,9.118820d+03,1.503439d+04,
     &2.478752d+04,4.086771d+04,6.737947d+04,1.110900d+05,1.831564d+05,
```

```
&3.019738d+05,4.978707d+05,8.208500d+05,1.353353d+06,2.231302d+06,
&3.678794d+06,6.065307d+06,1.000000d+07,1.964033d+07/
 data eg20a/
&1.000010d-05,3.000000d-03,5.000000d-03,6.900000d-03,1.000000d-02,
&1.500000d-02,2.000000d-02,2.500000d-02,3.000000d-02,3.500000d-02,
&4.200000d-02,5.000000d-02,5.800000d-02,6.700000d-02,7.700000d-02,
&8.000000d-02,9.500000d-02,1.000000d-01,1.150000d-01,1.340000d-01,
&1.400000d-01,1.463700d-01,1.530300d-01,1.600000d-01,1.697100d-01,
&1.800000d-01,1.890000d-01,1.988100d-01,2.091400d-01,2.200000d-01,
&2.335800d-01,2.480000d-01,2.635100d-01,2.800000d-01,3.000000d-01,
&3.145000d-01,3.200000d-01,3.346600d-01,3.500000d-01,3.699300d-01,
&3.910000d-01,4.000000d-01,4.139900d-01,4.330000d-01,4.496800d-01,
&4.670100d-01,4.850000d-01,5.000000d-01,5.196200d-01,5.315800d-01,
&5.400000d-01,5.669600d-01,5.952800d-01,6.250000d-01,6.531500d-01,
&6.825600d-01,7.050000d-01,7.415500d-01,7.800000d-01,7.900000d-01,
&8.194500d-01,8.500000d-01,8.600000d-01,8.764250d-01,9.100000d-01,
&9.300000d-01,9.500000d-01,9.720000d-01,9.860000d-01,9.960000d-01,
&1.020000d+00,1.035000d+00,1.045000d+00,1.071000d+00,1.080000d+00,
&1.097000d+00,1.110000d+00,1.123000d+00,1.150000d+00,1.170000d+00,
&1.202060d+00,1.235000d+00,1.267080d+00,1.300000d+00,1.337500d+00,
&1.370000d+00,1.404560d+00,1.440000d+00,1.475000d+00,1.500000d+00,
&1.544340d+00,1.590000d+00,1.629510d+00,1.670000d+00,1.711970d+00/
 data eg20b/
&1.755000d+00,1.797000d+00,1.840000d+00,1.855390d+00,1.884460d+00,
&1.930000d+00,1.974490d+00,2.020000d+00,2.059610d+00,2.100000d+00,
&2.130000d+00,2.185310d+00,2.242050d+00,2.300270d+00,2.360000d+00,
&2.382370d+00,2.421710d+00,2.485030d+00,2.550000d+00,2.600000d+00,
&2.659320d+00,2.720000d+00,2.767920d+00,2.837990d+00,2.909830d+00,
&2.983490d+00,3.059020d+00,3.137330d+00,3.217630d+00,3.300000d+00,
&3.380750d+00,3.466330d+00,3.554080d+00,3.644050d+00,3.736300d+00,
&3.830880d+00,3.927860d+00,4.000000d+00,4.129250d+00,4.233782d+00,
&4.340961d+00,4.450853d+00,4.563526d+00,4.679053d+00,4.797503d+00,
&4.918953d+00,5.043477d+00,5.085681d+00,5.128239d+00,5.171153d+00,
&5.214426d+00,5.258061d+00,5.302061d+00,5.346430d+00,5.391169d+00,
&5.436284d+00,5.481775d+00,5.527647d+00,5.573904d+00,5.620547d+00,
&5.667581d+00,5.715008d+00,5.762832d+00,5.811056d+00,5.859684d+00,
&5.908719d+00,5.958164d+00,6.008022d+00,6.058298d+00,6.108995d+00,
&6.160116d+00,6.211665d+00,6.263645d+00,6.316060d+00,6.368914d+00,
&6.422210d+00,6.475952d+00,6.530144d+00,6.584789d+00,6.639892d+00,
&6.695455d+00,6.751484d+00,6.807981d+00,6.864952d+00,6.922399d+00,
&6.980326d+00,7.038739d+00,7.097640d+00,7.157034d+00,7.216925d+00,
&7.277317d+00,7.338215d+00,7.399622d+00,7.461544d+00,7.523983d+00/
 data eg20c/
&7.586945d+00,7.650434d+00,7.714454d+00,7.779009d+00,7.844105d+00,
&7.909746d+00,7.975936d+00,8.042680d+00,8.109982d+00,8.177848d+00,
&8.246281d+00,8.315287d+00,8.384871d+00,8.455037d+00,8.525790d+00,
&8.597135d+00,8.669077d+00,8.741621d+00,8.814772d+00,8.888536d+00,
&8.962916d+00,9.037919d+00,9.113550d+00,9.189814d+00,9.266715d+00,
&9.344261d+00,9.422455d+00,9.501303d+00,9.580812d+00,9.660985d+00,
&9.741830d+00,9.823351d+00,9.905554d+00,9.988446d+00,1.007203d+01,
&1.015631d+01,1.024130d+01,1.032701d+01,1.041342d+01,1.050056d+01,
&1.058843d+01,1.067704d+01,1.076639d+01,1.085648d+01,1.094733d+01,
&1.103894d+01,1.113132d+01,1.122446d+01,1.131839d+01,1.141311d+01,
&1.150861d+01,1.160492d+01,1.170203d+01,1.179995d+01,1.189870d+01,
&1.199827d+01,1.209867d+01,1.219991d+01,1.230201d+01,1.240495d+01,
&1.250876d+01,1.261343d+01,1.271898d+01,1.282542d+01,1.293274d+01,
&1.304097d+01,1.315010d+01,1.326014d+01,1.337110d+01,1.348299d+01,
&1.359582d+01,1.370959d+01,1.382431d+01,1.394000d+01,1.405665d+01,
&1.417428d+01,1.429289d+01,1.441250d+01,1.453310d+01,1.465472d+01,
&1.477735d+01,1.490101d+01,1.502570d+01,1.515144d+01,1.527823d+01,
&1.540608d+01,1.553500d+01,1.566500d+01,1.579609d+01,1.592827d+01,
&1.606156d+01,1.619597d+01,1.633150d+01,1.646816d+01,1.660597d+01/
 data eg20d/
&1.674493d+01,1.688506d+01,1.702635d+01,1.716883d+01,1.731250d+01,
&1.745738d+01,1.760346d+01,1.775077d+01,1.789931d+01,1.804910d+01,
&1.820013d+01,1.835244d+01,1.850601d+01,1.866087d+01,1.881703d+01,
&1.897449d+01,1.913328d+01,1.929339d+01,1.945484d+01,1.961764d+01,
&1.978180d+01,1.994734d+01,2.011426d+01,2.028258d+01,2.045231d+01,
```

```
&2.062345d+01,2.079603d+01,2.097006d+01,2.114554d+01,2.132249d+01,
&2.150092d+01,2.168084d+01,2.186227d+01,2.204522d+01,2.222969d+01,
&2.241572d+01,2.260329d+01,2.279244d+01,2.298317d+01,2.317550d+01,
&2.336944d+01,2.356499d+01,2.376219d+01,2.396104d+01,2.416154d+01,
&2.436373d+01,2.456761d+01,2.477320d+01,2.498050d+01,2.518954d+01,
&2.540033d+01,2.561289d+01,2.582722d+01,2.604335d+01,2.626128d+01,
&2.648104d+01,2.670264d+01,2.692609d+01,2.715141d+01,2.737862d+01,
&2.760773d+01,2.783875d+01,2.807171d+01,2.830662d+01,2.854349d+01,
&2.878235d+01,2.902320d+01,2.926607d+01,2.951098d+01,2.975793d+01,
&3.000695d+01,3.025805d+01,3.051126d+01,3.076658d+01,3.102404d+01,
&3.128365d+01,3.154544d+01,3.180942d+01,3.207560d+01,3.234401d+01,
&3.261467d+01,3.288760d+01,3.316281d+01,3.344032d+01,3.372015d+01,
&3.400233d+01,3.428686d+01,3.457378d+01,3.486310d+01,3.515484d+01,
&3.544902d+01,3.574566d+01,3.604479d+01,3.634642d+01,3.665057d+01/
 data eg20e/
&3.695727d+01,3.726653d+01,3.757838d+01,3.789285d+01,3.820994d+01,
&3.852969d+01,3.885211d+01,3.917723d+01,3.950507d+01,3.983565d+01,
&4.016900d+01,4.050514d+01,4.084410d+01,4.118589d+01,4.153054d+01,
&4.187807d+01,4.222851d+01,4.258189d+01,4.293822d+01,4.329753d+01,
&4.365985d+01,4.402521d+01,4.439361d+01,4.476511d+01,4.513971d+01,
&4.551744d+01,4.589834d+01,4.628243d+01,4.666972d+01,4.706026d+01,
&4.745407d+01,4.785117d+01,4.825160d+01,4.865538d+01,4.906253d+01,
&4.947309d+01,4.988709d+01,5.030456d+01,5.072551d+01,5.114999d+01,
&5.157802d+01,5.200963d+01,5.244486d+01,5.288373d+01,5.332626d+01,
&5.377251d+01,5.422248d+01,5.467623d+01,5.513376d+01,5.559513d+01,
&5.606036d+01,5.652948d+01,5.700253d+01,5.747954d+01,5.796053d+01,
&5.844556d+01,5.893464d+01,5.942781d+01,5.992511d+01,6.042657d+01,
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&1.227700d+05,1.290700d+05,1.356900d+05,1.426400d+05,1.499600d+05,
&1.576400d+05,1.657300d+05,1.742200d+05,1.831600d+05,1.925500d+05,
&2.024200d+05,2.128000d+05,2.237100d+05,2.351800d+05,2.472400d+05,
&2.732400d+05,2.872500d+05,2.945200d+05,2.972000d+05,2.985000d+05,
&3.019700d+05,3.337300d+05,3.688300d+05,3.877400d+05,4.076200d+05,
&4.504900d+05,5.234000d+05,5.502300d+05,5.784400d+05,6.081000d+05,
&6.392800d+05,6.720600d+05,7.065100d+05,7.427400d+05,7.808200d+05,
&8.208500d+05,8.629400d+05,9.071800d+05,9.616400d+05,1.002600d+06,
&1.108000d+06,1.164800d+06,1.224600d+06,1.287300d+06,1.353400d+06,
&1.422700d+06,1.495700d+06,1.572400d+06,1.653000d+06,1.737700d+06,
&1.826800d+06,1.920500d+06,2.019000d+06,2.122500d+06,2.231300d+06,
&2.306900d+06,2.345700d+06,2.365300d+06,2.385200d+06,2.466000d+06,
&2.592400d+06,2.725300d+06,2.865000d+06,3.011900d+06,3.166400d+06,
```

```
&3.328700d+06,3.678800d+06,4.065700d+06,4.493300d+06,4.723700d+06/
 data eg21d/
&4.965900d+06,5.220500d+06,5.488100d+06,5.769500d+06,6.065300d+06,
&6.376300d+06,6.592400d+06,6.703200d+06,7.046900d+06,7.408200d+06,
&7.788000d+06,8.187300d+06,8.607100d+06,9.048400d+06,9.512300d+06,
&1.000000d+07,1.051300d+07,1.105200d+07,1.161800d+07,1.221400d+07,
&1.284000d+07,1.349900d+07,1.384000d+07,1.419100d+07,1.455000d+07,
&1.491800d+07,1.568300d+07,1.648700d+07,1.690500d+07,1.733300d+07,
&1.964000d+07/
 data eg22a/
&1.000010d-05,3.000000d-03,5.000000d-03,6.900000d-03,1.000000d-02,
&1.500000d-02,2.000000d-02,2.500000d-02,3.000000d-02,3.500000d-02,
&4.200000d-02,5.000000d-02,5.800000d-02,6.700000d-02,7.700000d-02,
&8.000000d-02,9.500000d-02,1.000000d-01,1.150000d-01,1.340000d-01,
&1.400000d-01,1.600000d-01,1.800000d-01,1.890000d-01,2.200000d-01,
&2.480000d-01,2.800000d-01,3.000000d-01,3.145000d-01,3.200000d-01,
&3.500000d-01,3.910000d-01,4.000000d-01,4.330000d-01,4.850000d-01,
&5.000000d-01,5.400000d-01,6.250000d-01,7.050000d-01,7.800000d-01,
&7.900000d-01,8.500000d-01,8.600000d-01,9.100000d-01,9.300000d-01,
&9.500000d-01,9.720000d-01,9.860000d-01,9.960000d-01,1.020000d+00,
&1.035000d+00,1.045000d+00,1.071000d+00,1.097000d+00,1.110000d+00,
&1.123000d+00,1.150000d+00,1.170000d+00,1.235000d+00,1.300000d+00,
&1.337500d+00,1.370000d+00,1.440000d+00,1.475000d+00,1.500000d+00,
&1.590000d+00,1.670000d+00,1.755000d+00,1.840000d+00,1.930000d+00,
&2.020000d+00,2.100000d+00,2.130000d+00,2.360000d+00,2.550000d+00,
&2.600000d+00,2.720000d+00,2.767920d+00,3.300000d+00,3.380750d+00,
&4.000000d+00,4.129250d+00,5.043477d+00,5.346430d+00,6.160116d+00,
&7.523983d+00,8.315287d+00,9.189814d+00,9.905554d+00,1.122446d+01,
&1.370959d+01,1.592827d+01,1.945484d+01,2.260329d+01,2.498050d+01/
 data eg22b/
&2.760773d+01,3.051126d+01,3.372015d+01,3.726653d+01,4.016900d+01,
&4.551744d+01,4.825160d+01,5.157802d+01,5.559513d+01,6.790405d+01,
&7.567357d+01,9.166088d+01,1.367420d+02,1.486254d+02,2.039950d+02,
&3.043248d+02,3.717032d+02,4.539993d+02,6.772874d+02,7.485183d+02,
&9.142423d+02,1.010394d+03,1.234098d+03,1.433817d+03,1.507331d+03,
&2.034684d+03,2.248673d+03,3.354626d+03,3.526622d+03,5.004514d+03,
&5.530844d+03,7.465858d+03,9.118820d+03,1.113775d+04,1.503439d+04,
&1.661557d+04,2.478752d+04,2.739445d+04,2.928300d+04,3.697864d+04,
&4.086771d+04,5.516564d+04,6.737947d+04,8.229747d+04,1.110900d+05,
&1.227734d+05,1.831564d+05,2.472353d+05,2.732372d+05,3.019738d+05,
&4.076220d+05,4.504920d+05,4.978707d+05,5.502322d+05,6.081006d+05,
&8.208500d+05,9.071795d+05,1.002588d+06,1.108032d+06,1.224564d+06,
&1.353353d+06,1.652989d+06,2.018965d+06,2.231302d+06,2.465970d+06,
&3.011942d+06,3.678794d+06,4.493290d+06,5.488116d+06,6.065307d+06,
&6.703200d+06,8.187308d+06,1.000000d+07,1.1618343d+07,
&1.3840307d+07,1.4918247d+07,1.733253d+07,1.964033d+07/
 data eg23a/
&1.000010d-05,1.000010d-01,4.139940d-01,5.315790d-01,6.825600d-01,
&8.764250d-01,1.123000d+00,1.440000d+00,1.855390d+00,2.382370d+00,
&3.059020d+00,3.927860d+00,5.043480d+00,6.475950d+00,8.315290d+00,
&1.067700d+01,1.370960d+01,1.760350d+01,2.260330d+01,2.902320d+01,
&3.726650d+01,4.785120d+01,6.144210d+01,7.889320d+01,1.013010d+02,
&1.300730d+02,1.670170d+02,2.144540d+02,2.753640d+02,3.535750d+02,
&4.539990d+02,5.829470d+02,7.485180d+02,9.611170d+02,1.234100d+03,
&1.584610d+03,2.034680d+03,2.248670d+03,2.485170d+03,2.612590d+03,
&2.746540d+03,3.035390d+03,3.354630d+03,3.707440d+03,4.307420d+03,
&5.530840d+03,7.101740d+03,9.118820d+03,1.059460d+04,1.170880d+04,
&1.503440d+04,1.930450d+04,2.187490d+04,2.357860d+04,2.417550d+04,
&2.478750d+04,2.605840d+04,2.700010d+04,2.850110d+04,3.182780d+04,
&3.430670d+04,4.086770d+04,4.630920d+04,5.247520d+04,5.656220d+04,
&6.737950d+04,7.202450d+04,7.949870d+04,8.250340d+04,8.651700d+04,
&9.803650d+04,1.110900d+05,1.167860d+05,1.227730d+05,1.290680d+05,
&1.356860d+05,1.426420d+05,1.499560d+05,1.576440d+05,1.657270d+05,
&1.742240d+05,1.831560d+05,1.925470d+05,2.024190d+05,2.127970d+05,
&2.237080d+05,2.351770d+05,2.472350d+05,2.732370d+05,2.872460d+05,
&2.945180d+05,2.972110d+05,2.984910d+05,3.019740d+05,3.337330d+05/
 data eg23b/
&3.688320d+05,3.877420d+05,4.076220d+05,4.504920d+05,4.978710d+05,
```

```
     &5.233970d+05,5.502320d+05,5.784430d+05,6.081010d+05,6.392790d+05,
     &6.720550d+05,7.065120d+05,7.427360d+05,7.808170d+05,8.208500d+05,
     &8.629360d+05,9.071800d+05,9.616720d+05,1.002590d+06,1.108030d+06,
     &1.164840d+06,1.224560d+06,1.287350d+06,1.353350d+06,1.422740d+06,
     &1.495690d+06,1.572370d+06,1.652990d+06,1.737740d+06,1.826840d+06,
     &1.920500d+06,2.018970d+06,2.122480d+06,2.231300d+06,2.306930d+06,
     &2.345700d+06,2.365330d+06,2.385130d+06,2.465970d+06,2.592400d+06,
     &2.725320d+06,2.865050d+06,3.011940d+06,3.166370d+06,3.328710d+06,
     &3.678790d+06,4.065700d+06,4.493290d+06,4.723670d+06,4.965850d+06,
     &5.220460d+06,5.488120d+06,5.769500d+06,6.065310d+06,6.376280d+06,
     &6.592410d+06,6.703200d+06,7.046880d+06,7.408180d+06,7.788010d+06,
     &8.187310d+06,8.607080d+06,9.048370d+06,9.512290d+06,1.000000d+07,
     &1.051270d+07,1.105170d+07,1.161830d+07,1.221400d+07,1.252320d+07,
     &1.284030d+07,1.349860d+07,1.384030d+07,1.419070d+07,1.454990d+07,
     &1.491820d+07,1.568310d+07,1.648720d+07,1.690460d+07,1.733250d+07,
     &1.964030d+07/
*b groupr.1837
c
c     ***ecco  33-group structure
      else if (ign.eq.19) then
         ng=33
         do ig=1,34
            eg(ig)=eg19(ig)
         enddo
c
c     ***ecco 1968-group structure
      else if (ign.eq.20) then
         ng=1968
         do ig=1,1969
            eg(ig)=eg20(ig)
         enddo
c
c     ***tripoli 315-group structure
      else if (ign.eq.21) then
         ng=315
         do ig=1,316
          eg(ig)=eg21(ig)
         enddo
c
c     ***xmas LWPC 172-group structure
      else if (ign.eq.22) then
         ng=172
         do ig=1,173
            eg(ig)=eg22(ig)
         enddo
c
c     ***vit-J LWPC 175-group structure
      else if (ign.eq.23) then
         ng=175
         do ig=1,176
            eg(ig)=eg23(ig)
         enddo
*b groupr.1888
      if (ign.eq.19) write(nsyso,'(/
     &  '' neutron group structure......ecco  33-group'')')
      if (ign.eq.20) write(nsyso,'(/
     &  '' neutron group structure......ecco  1968-group'')')
      if (ign.eq.21) write(nsyso,'(/
     &  '' neutron group structure......tripoli 315-group'')')
      if (ign.eq.22) write(nsyso,'(/
     &  '' neutron group structure......xmas LWPC 172-group'')')
      if (ign.eq.23) write(nsyso,'(/
     &  '' neutron group structure......vit-J LWPC 175-group'')')
*/
*/ increase the size of egn from 641 to 15000 i.e DICE 13193 APOLLO 11276
*/
*d groupr.1643
      data ngmax/15000/
```

```
*d groupr.228
      common/groupn/ign,ngn,egn(15000)
*d groupr.772
      common/groupn/ign,ngn,egn(15000)
*d groupr.1303
      common/groupn/ign,ng,eg(15000)
*d groupr.2643
      common/groupn/ig,ngn,egn(15000)
*d groupr.3074
      common/groupn/ign,ngn,egn(15000)
*d groupr.4274
      common/groupn/ign,ngn,egn(15000)
*d groupr.6415
      common/groupn/ign,ngn,egn(15000)
*d groupr.6918
      common/groupn/ign,ngn,egn(15000)
*/
```

C.10 upn_Shimizu

```
REM upn_Shimizu  : upshim (included in ADS)
```

```
*/
*/ Kazuaki Kosako, Shimizu Corporation
*/ MF5 and MF6 INT=21-25 laws modifications
*/ in groupr
*/
*ident upshim
*/
*i groupr.548
      ee=0
*d groupr.550
*/
*/*d groupr.5586
*/      dimension cnow(*),p(64)
*i groupr.5668
            if (na.gt.64)  call error('f6ddx',
     &                   'order of legendre expansion > 64  ','  ')
*/*d groupr.5768
*/      dimension cnow(*),p(64)
*i groupr.5811
            if (na.gt.64)  call error('f6dis',
     &                   'order of legendre expansion > 64  ','  ')
*i groupr.8641
      parameter (npmax=15001,npmax0=npmax-1,mxset=200,mxnrf1=50)
      common/mainio/nsysi,nsyso,nsyse,ntty
      common/nalf5a/npf1(mxset),nbtf1(mxnrf1),intf1(mxnrf1)
      common/nalf5b/eintf1(mxset),xdatwk(npmax),xdatf1(npmax,mxset),
     1              ansf1(npmax),ydatwk(npmax),ydatf1(npmax,mxset),
     2              epmax(mxset)
*i groupr.8647
      external f5xlin,f5xint
*i groupr.8750
               nr=nint(c(l+4))
               intchk=0
               do k=1,nr
                  intnow=nint(c(nnt+ic-1+2*k))
                  if (intnow.le.0.or.(intnow.gt.6.and.intnow.le.20).or.
     &                intnow.gt.25) then
                     write(strng,'(a,i6)') 'int=',intnow
                     call error('getsed','interplation error',strng)
                  endif
                  if (intnow.gt.intchk) intchk=intnow
               enddo
*i groupr.8767
               if (intchk.ge.21.and.intchk.le.25) then
                  if (nne.gt.mxset)
     &               call error('getsed','storage exceeded - nne',' ')
                  eintf1(nne)=c(iraw+1)
                  npnow=nint(c(iraw+5))
                  nrf1=nint(c(iraw+4))
                  if (npnow.gt.npmax0)
     &               call error('getsed','storage exceeded - npnow',' ')
                  if (nrf1.gt.mxnrf1)
     &               call error('getsed','storage exceeded - nrf1',' ')
                  intone=0
                  do j=1,nrf1
                     nbtf1(j)=nint(c(iraw+4+2*j))
                     intf1(j)=nint(c(iraw+5+2*j))
                     if (intf1(j).eq.1) intone=1
                  enddo
                  do i=1,npmax
```

```
                  xdatwk(i)=0
                  ydatwk(i)=0
               enddo
               ipos=iraw+6+2*nrf1
               do j=1,npnow
                  isw1=ipos+2*(j-1)
                  xdatwk(j)=c(isw1)
                  ydatwk(j)=c(isw1+1)
               enddo
               emaxf1=xdatwk(npnow)
               epmax(nne)=emaxf1
               do j=1,npnow
                  xdatwk(j)=xdatwk(j)/emaxf1
                  ydatwk(j)=ydatwk(j)*emaxf1
               enddo
               if (xdatwk(1).gt.zero.and.intf1(1).eq.1) then
                  if (ydatwk(1).eq.zero) xdatwk(1)=0
               endif
c
               npnew=0
               call f5xlin(nbtf1,intf1,nrf1,xdatwk,ydatwk,npnow,
     &                     xdatf1(1,nne),ydatf1(1,nne),npmax0,npnew,
     &                     nsyso)
               sumf1=0
               npf1(nne)=npnew
               if (intone.eq.1) then
                  do j=2,npf1(nne)-2
                     if (xdatf1(j,nne).eq.xdatf1(j+1,nne)) then
                        s1=xdatf1(j,nne)*0.999995d+0
                        s2=xdatf1(j,nne)*1.000005d+0
                        if (xdatf1(j-1,nne).lt.s1) xdatf1(j,nne)=s1
                        if (xdatf1(j+2,nne).gt.s2) xdatf1(j+1,nne)=s2
                     endif
                  enddo
               endif
               do j=2,npf1(nne)
                  sumf1=sumf1+(xdatf1(j,nne)-xdatf1(j-1,nne))*
     &                  (ydatf1(j,nne)+ydatf1(j-1,nne))/2
               enddo
               xdatf1(npnew+1,nne)=0
               ydatf1(npnew+1,nne)=0
               anorm=1
               if (sumf1.gt.zero) anorm=1/sumf1
               do j=1,npf1(nne)
                  ydatf1(j,nne)=anorm*ydatf1(j,nne)
               enddo
            endif
*i groupr.8782
            if (intchk.ge.21.and.intchk.le.25) then
               econst=0
            else
*i groupr.8813
            endif
*i groupr.8903
               if (int.ge.21.and.int.le.25) then
                  call f5xint(ed,sed,eg,ng,nk,matd,mfd,ne,int,nne,
     &                        ikt,elo,ehi,pe,nsyso)
               else
*i groupr.8907
               endif
*i groupr.8966
      subroutine f5xlin(nbt,int,n1,xin,yin,n2,xout,yout,npmax,npout,
     1                  nsyso)
c     ***************************************************************
c     convert data to linear-linear form.
c     originality of this routine is subroutine filex in the linear-2000
c     code.
c     ***************************************************************
```

```
*if sw
      implicit real*8 (a-h,o-z)
*endif
      external error,terp1,sigfig
      save xcmin,errx,half
      dimension xin(n2),yin(n2),xout(npmax),yout(npmax)
      dimension nbt(n1),int(n1)
*if sw
      data xcmin/1.0d-15/
      data errx/5.0d-4/
      data half/0.5d0/
*else
      data xcmin/1.0e-15/
      data errx/5.0e-4/
      data half/0.5e0/
*endif
c
c-----initialize count of points in core and on scratch.
      n2core=1
      zero=0
c-----define first point in table.
      xout(1)=xin(1)
      yout(1)=yin(1)
c-----set flag to indicate if this is a threshold reaction.
      ithres=0
      if (yout(1).le.xcmin) ithres=1
      n2p1=2
      n2p2=3
c-----set up loop over interpolation ranges.
      nr2=1
      do 400 ir=1,n1
c-----define points in interpolation range and type of interpolation.
      nr1=nr2+1
      nr2=nbt(ir)
      intype=int(ir)
c-----data check
      minus=0
      do i=nr1,nr2
         if (yin(i).le.zero) minus=1
      enddo
c
      if (intype.gt.3.and.minus.eq.1) intype=2
c
c     non-linear interpolation law requires sub-division. set up loop
c     over points in current interpolation region.
c
c     interpolation law branch.
      if (intype-2) 50,80,100
c
c     for histogram replace each energy point that is internal to the
c     interpolation energy range by two energy points and replace each
c     end point of the interpolation energy range by a single energy
c     point (start of interval has already been stored).
c
   50 continue
      do 70 npt=nr1,nr2
      n2core=n2core+2
      if (n2core.gt.npmax) call error('f5xlin','storage exceeded',' ')
      xout(n2core)=xin(npt)
      yout(n2core)=yin(npt)
c-----eliminate duplicate points.
      if (xout(n2core).ne.xout(n2core-2)) go to 60
      xout(n2core-1)=xout(n2core)
      yout(n2core-1)=yout(n2core)
      n2core=n2core-1
      n2p1=n2core+1
      n2p2=n2p1+1
      go to 70
```

```
   60 continue
      xout(n2core-1)=xout(n2core)
      yout(n2core-1)=yout(n2core-2)
   70 continue
      n2core=n2core-1
      if (ir.lt.n1) then
         n2core=n2core+1
         if (n2core.gt.npmax)
     &      call error('f5xlin','storage exceeded - n2core',' ')
         xout(n2core)=xin(nr2)
         yout(n2core)=yin(nr2)
      endif
      n2p1=n2core+1
      n2p2=n2p1+1
      go to 400
c
c     for linear-linear interpolation just copy points to output array.
c
   80 continue
      do 90 npt=nr1,nr2
c-----core space for one more point required. if no room in core, thin
      n2core=n2core+1
      if (n2core.gt.npmax)
     &   call error('f5xlin','storage exceeded - n2core',' ')
      xout(n2core)=xin(npt)
      yout(n2core)=yin(npt)
   90 continue
      n2p1=n2core+1
      n2p2=n2p1+1
      go to 400
c
c     non-linear interpolation law requires sub-division. set up loop
c     over points in current interpolation region.
c
  100 continue
      do 300 npt=nr1,nr2
c-----initialize to range not saved
      imsaved=0
c-----define upper energy limit of interval.
      xend=xin(npt)
      yend=yin(npt)
c     if necessary insert max. energy or thermal point
  130 continue
      xtop=xend
      if (xout(n2core).le.zero) go to 150
      if (xtop.gt.2*xout(n2core)) xtop=2*xout(n2core)
      if (xtop.ge.xend) go to 150
c-----interpolate cross section to new end
      call terp1(xout(n2core),yout(n2core),xend,yend,xtop,ytop,intype)
c-----save end and set range saved flag
      imsaved=1
      xsave=xend
      ysave=yend
c-----define end of interval at thermal
      xend=xtop
      yend=ytop
c-----define energy and cross section at two ends of interval.
  150 continue
      xn2p2=xend
      yn2p2=yend
      xn2=xout(n2core)
      yn2=yout(n2core)
c-----do not subdivide if cross section is constant.
      if (yn2.eq.yn2p2) go to 220
c
c     do not sub-divide intervals within which the absolute value of
c     the cross section is less than the minimum cross section of
c     interest, accept near thresholds.
```

```
c
c-----if this is a threshold reaction do not use low cross section
c-----cutoff criteria in the vacinity of the threshold.
      if (ithres.eq.0) go to 160
      if (abs(yn2).lt.xcmin) go to 170
      ithres=0
      go to 170
c-----assume convergence if the absolute value of the cross section
c-----at both ends of the interval is less than the minimum cross
c-----section of interest.
  160 continue
      if (abs(yn2).le.xcmin.and.abs(yn2p2).le.xcmin) go to 220
c
c     define energy at middle of interval.
c
c-----intype is now 3, 4, 5 or 6.
  170 continue
      if (intype-4) 190,180,190
c-----linear energy.
  180 continue
      xn2p1=half*(xn2+xn2p2)
      go to 200
  190 continue
      xn2p1=sqrt(xn2*xn2p2)
c-----round midpoint.
  200 continue
      xn2p1=sigfig(xn2p1,7,0)
c
c     small energy interval convergence tests.
c
c-----if energy at middle of interval is less than allowable energy
c-----spacing only keep the two ends of the interval.
      if (xn2p1.le.xn2.or.xn2p1.ge.xn2p2) go to 220
c
c     define cross section at middle of interval by interpolation law
c     and linear-linear interpolation.
c
      call terp1(xn2,yn2,xn2p2,yn2p2,xn2p1,yn2p1,intype)
      call terp1(xn2,yn2,xn2p2,yn2p2,xn2p1,yaprox,2)
c
c-----test for convergence. if convergence keep midpoint of interval
c-----in order to allow accurate backward thinning before output.
      if (abs(yn2p1-yaprox).le.abs(yn2p1*errx)) go to 210
c
c     no convergence. shorten interval.
c
      xn2p2=xn2p1
      yn2p2=yn2p1
      go to 170
c
c     convergence. keep interval midpoint if backward thinning will be
c     performed. otherwise only keep ends of interval.
c
  210 continue
      if (n2p2.gt.npmax)
     &   call error('f5xlin','storage exceeded - n2p2',' ')
c-----keep interval midpoint and endpoint.
      xout(n2p1)=xn2p1
      yout(n2p1)=yn2p1
      xout(n2p2)=xn2p2
      yout(n2p2)=yn2p2
      n2core=n2p2
      n2p1=n2core+1
      n2p2=n2p1+1
      go to 230
c-----core space for one more point required. if no room in core, thin
c-----and unload one page of points to scratch.
  220 continue
```

```
      if(n2p1.gt.npmax)
     &  call error('f5xlin','storage exceeded - n2p1',' ')
c-----midpoint of interval is not required. only keep endpoint of
c-----interval.
      xout(n2p1)=xn2p2
      yout(n2p1)=yn2p2
      n2core=n2p1
      n2p1=n2core+1
      n2p2=n2p1+1
c-----if not end of current interval continue. otherwise
c-----move to next interval.
  230 continue
      if (xout(n2core).lt.xend) go to 150
c-----if range saved, restore point and reset flag
      if (imsaved.le.0) go to 300
      imsaved=0
      xend=xsave
      yend=ysave
      go to 130
  300 continue
c
  400 continue
      npout=n2core
      return
      end
c
      subroutine f5xint(ed,sed,eg,ng,nk,matd,mfd,ne,int,nne,ikt,elo,ehi,
     &                  pe,nsyso )
c     *****************************************************************
c     compute secondary energy distribution for all sink groups
c     simultaneously.  laws 1 with int=21-25 is coded.
c     *****************************************************************
*if sw
      implicit real*8 (a-h,o-z)
*endif
      parameter (npmax=15001,npmax0=npmax-1,mxset=200,mxnrf1=50)
      parameter (mxwork=10+2*npmax)
      common/nalf5a/npf1(mxset),nbtf1(mxnrf1),intf1(mxnrf1)
      common/nalf5b/eintf1(mxset),xdatwk(npmax),xdatf1(npmax,mxset),
     1              ansf1(npmax),ydatwk(npmax),ydatf1(npmax,mxset),
     2              epmax(mxset)
      dimension sed(nk,*),eg(*),c(mxwork)
      character strng*60
      external error,terp1,intega
      save ist,jst1,jst2
*if sw
      data small/1.d-10/
      data ebig/1.d8/
      data zero/0.d0/
*else
      data small/1.e-10/
      data ebig/1.e8/
      data zero/0.e0/
*endif
c
      if (nne.ge.ne) nne=ne-1
      nne1=nne+1
      npnow=npf1(nne)
      ist=2
      if (xdatf1(1,nne).ne.zero) then
         write(strng,'(a,i6)') 'xdatf1(1,nne).ne.0  nne=',nne
         call error('f5xint','invalid evaluation data',strng)
      elseif (xdatf1(1,nne1).ne.zero) then
         write(strng,'(a,i6)') 'xdatf1(1,nne1).ne.0  nne1=',nne1
         call error('f5xint','invalid evaluation data',strng)
      endif
c
c     make union relative secondary nuetron energy mesh
```

```
c     at requested energy range ( eintf1(nne) & eintf1(nne1) )
c
      do i=1,npmax
         xdatwk(i)=0
         ydatwk(i)=0
      enddo
      do i=1,npnow
         xdatwk(i)=xdatf1(i,nne)
      enddo
c
      do 170 j=2,npf1(nne1)-1
      enow=xdatf1(j,nne1)
      iadd=0
      do i=ist,npnow
         ehinow=xdatwk(i)
         elonow=xdatwk(i-1)
         ratio=1
         if (ehinow.gt.zero) ratio=enow/ehinow-1
         if (abs(ratio).lt.1.000d-5) go to 150
         if (enow.gt.elonow.and.enow.lt.ehinow) then
            iadd=i
            go to 150
         endif
      enddo
  150 continue
      if (iadd.ge.ist) then
         ratio=xdatwk(iadd)/enow
         if (npnow+1.gt.npmax)
     &      call error('f5xint','storage exceeded - npnow+1',' ')
         do k=iadd,npnow
            i=npnow-k+iadd
            xdatwk(i+1)=xdatwk(i)
         enddo
         xdatwk(iadd)=enow
         npnow=npnow+1
         ist=iadd
      endif
  170 continue
c
c     interpolate secondary neutron energy distribution at ed energy
c
      itype=int-20
      np1=npf1(nne)-1
      np2=npf1(nne1)-1
      jst1=1
      jst2=1
      eint1=eintf1(nne)
      eint2=eintf1(nne1)
c
c  *** set maximum energy of secondary neutron
c
      epmax1=epmax(nne)
      epmax2=epmax(nne1)
      epmaxn=0
      call terp1(eint1,epmax1,eint2,epmax2,ed,epmaxn,2)
      sumf1=0
      eold=0
      yold=0
c
      do 200 i=1,npnow
      enow=xdatwk(i)
      ynow1=0
      ynow2=0
      do j=jst1,np1
         jpos=j
         if (enow.ge.xdatf1(j,nne).and.enow.lt.xdatf1(j+1,nne))
     &      go to 180
      enddo
```

```
      jpos=np1
  180 continue
      jpos1=jpos+1
      jst1=jpos
      x1=xdatf1(jpos,nne)
      y1=ydatf1(jpos,nne)
      x2=xdatf1(jpos1,nne)
      y2=ydatf1(jpos1,nne)
      call terp1(x1,y1,x2,y2,enow,ynow1,2)
      do j=jst2,np2
         jpos=j
         if (enow.ge.xdatf1(j,nne1).and.enow.lt.xdatf1(j+1,nne1))
     &      go to 190
      enddo
      jpos=np2
  190 continue
      jpos1=jpos+1
      jst2=jpos
      x1=xdatf1(jpos,nne1)
      y1=ydatf1(jpos,nne1)
      x2=xdatf1(jpos1,nne1)
      y2=ydatf1(jpos1,nne1)
      call terp1(x1,y1,x2,y2,enow,ynow2,2)
      ynow=0
      call terp1(eint1,ynow1,eint2,ynow2,ed,ynow,itype)
      ydatwk(i)=ynow
      if (i.gt.1) sumf1=sumf1+(ynow+yold)*(enow-eold)/2
      eold=enow
      yold=ynow
  200 continue
c
c     define final secondary nuetron energy distribution data
c
      anorm=1
      if (sumf1.gt.zero) anorm=1/sumf1
      do i=1,npnow
         xdatwk(i)=xdatwk(i)*epmaxn
         ydatwk(i)=anorm*ydatwk(i)/epmaxn
      enddo
c
c     calculates groupwise secondary nuetron energy distribution data
c
      do ig=1,ng
         ansf1(ig)=0
      enddo
      if (xdatwk(npnow).le.eg(2)) then
         ansf1(1)=1
         factn=1
         go to 320
      endif
      c(1)=0
      c(2)=0
      c(3)=0
      c(4)=0
      c(5)=1
      c(6)=npnow
      c(7)=npnow
      c(8)=2
      isw=8
      do i=1,npnow
         isw=isw+1
         c(isw)=xdatwk(i)
         isw=isw+1
         c(isw)=ydatwk(i)
      enddo
      ip=2
      ir=1
      do ig=1,ng
```

```
         e1=eg(ig)
         if (ig.eq.1) e1=0
         e2=eg(ig+1)
         if (ig.eq.ng) e2=ebig
         call intega(ansf1(ig),e1,e2,c(1),ip,ir)
      enddo
      sump=zero
      do ig=1,ng
         sump=sump+ansf1(ig)
      enddo
      factn=1
      if (sump.gt.zero) factn=1/sump
c
c     store final result to sed array
c
  320 continue
      do ig=1,ng
         sed(ikt,ig)=sed(ikt,ig)+ansf1(ig)*pe*factn
      enddo
c
      return
      end
*/
*/ Included in upn_Sublet
*/
*/  increase the allowed number of legendre terms in h6ddx
*/  to handle the new ENDF/B-VII mo95 evaluation.
*/
*/ *d up15.9
*/       dimension cnow(*),p(65)
*/ *d up30.10
*/ *i heatr.3298
*/       data nlmax/65/
*/
*/ Kazuaki Kosako, Shimizu Corporation
*/ kinematic method
*/
*i heatr.55
c     *    kkerma   0/1=total (mt301) is energy balance / kinematic    *
c     *             (default=0)                                        *
*i heatr.91
      common/heat6/kkerma
*d heatr.139
      kkerma=0
      read(nsysi,*) matd,npk,nqa,ntemp,local,iprint,break,kkerma
*i heatr.151
      if (kkerma.eq.1) then
         if (npk.gt.0) then
            mtkk=0
            do i=1,npk
               if (mtk(i).eq.443) mtkk=i
            enddo
            if (mtkk.eq.0) then
               npk=npk+1
               if (kchk.eq.1) then
                  npkk=3*npk+7
               else
                  npkk=npk+3
               endif
               if (npkk.gt.npkmax) call error('heatr',
     &           'requested too many kerma mt-s (6+mt301 allowed).',' ')
               mtk(npk)=443
            endif
         else
            npk=1
            mtk(npk)=443
         endif
      endif
```

```
*i heatr.4997
      common/heat6/kkerma
*i heatr.5045
      if (kkerma.eq.1) then
         do i=2,npk
            if (mtp(i).eq.443) mtkk=i
         enddo
      endif
*i heatr.5121
      if (mt.eq.301.and.kkerma.eq.1) a(ibase+i)=c(mtkk)
*i heatr.5146
      if (kkerma.eq.1) write(nsyso,'(/'' total kerma (mt=301) was '',
     &  ''replaced to kinematic kerma (mt=443).'')')
*/
```

C.11 upn_Cabellos

```
REM upn_Cabellos : JEFF31 update
REM               -llf



*/ acer - O. Cabellos, NEA Data Bank Consultant, Sep-2005
*/ Error in acer for processing Al-27, Cl-35,I-129,Rh-103
*ident upNEA1
*d acer.4220
      if (nethr.gt.1) call aordr(nethr,200,a(iethr))
*/
*/ Additional updates needed to process JEFF-3.1
*/
*/ Updates from Cabellos
*/
*ident upNEA2
*/ Error when processing Thermal Scattering for H-1(in H2O) at 293.6K (llf=0)
*/ Consultant: O. Cabellos, NEA Data Bank
*d broadr.503
*/       sf=slf+(tt(llf)-slf)*(enow-elast)/(tt(1)-elast)
         if(llf.gt.0) then
         sf=slf+(tt(llf)-slf)*(enow-elast)/(tt(1)-elast)
         else
         sf=slf
         endif
*/
*d broadr.506
*/       sf=tt(llf)
         if(llf.gt.0) sf=tt(llf)
*/
*/ ------------------------------------------------Sep05------end
```

C.12 upn_Leichtle_Mod

```
REM upn_Leichtle_Mod : Be-9 and others (Li7)
REM                - Include: upac1, upac2 (with some modifications because it
REM                  corresponds with up57)
REM                - Do not include:
REM                  - upre1 (equivalent to up54)
REM                  - upac3 (equivalent to up57)
```

```
*/ UPN Leichtle + NEA update
*/
*ident upac1
*/ acer -- 05jun01
*/ corrections by I. Schmuck (FZK)
*/ some of them are redundant due to later up's; only nonredundant (till up50)
*/ are included in this upacer1
*/
*/ some error in subroutine acensd when processing d-Li evaluation by
*/ INPE Obninsk
*d acer.5621
            if (mfh.eq.6 .and. law.eq.7.) then
*/ problem with amu=1 when processing d-Li evaluations
*i acer.5837
            if (amu .eq. 1.) amu=0.999
*/ Equivalent to up54
*/ *ident upre1
*/ */ reconr -- 05jun01
*/ */ corrections by D. Leichtle, I. Schmuck (FZK)
*/ */ allow for processing of EFF3.0/NMOD=3 9Be with (n,2n) subsections in
MT875-
*/ */ 890. reconr needs no know these MT-numbers.
*/ *d reconr.1696
*/          if (mth.ge.900) go to 150
*/
*/ Equivalent to up57
*ident upac2
*/ */ acer -- 05jun01
*/ */ corrections by D. Leichtle, I. Schmuck (FZK)
*/ */ allow for processing of EFF3.0/NMOD=3 9Be with (n,2n) subsections in
MT875-
*/ */ 890.
*/ */
*/ */ mt up to 900 may be processed in unionx
*/ *d acer.1939
*/ */      &           (iverf.ge.6.and.mt.gt.900)) then
*/ */ temporary storage for unified grids used in multiple angular
distributions
*i acer.4673
      dimension etemp(200),amutmp(200)
*/ */ include mt>=875 in counting neutron emitting reactions
*/ *d acer.4759
*/                   if ((mt.ge.5.and.mt.le.91). or.
*/      &                (mt.ge.875 .and. mt.le.899)) then
*/ skip over mt92-849 for production of incident particle
*i acer.5021
            if(mt.ge.92 .and. mt.le.849) iskip=1
*/ */ rewind file 3 to check all cross sections again
*/ *d acer.5118,5120
*/       call findf(matd,3,2,nin)
*/ */ neutron absorption for mt92-849, above 849 neutron emission possible
*/ *d acer.5127
*/             if (mt.gt.91 .and. mt.le.849) iskip=0
*/ get number of subsections in mf6
*i acer.5341
            nk=a(iscr+4)
```

```
            if (mf.eq.4) nk=0
*/ store pointer to yield-record and read it completely
*i acer.5370
               iyield=iscr
               iscr=iscr+nw
               do while (nb.ne.0)
                  call moreio(nin,0,0,a(iscr),nb,nw)
                  iscr=iscr+nw
               enddo
*/ store interpolation law for energies
*i acer.5374
               ilne=nint(a(iscr+7))
*/ treat multiple neutron angular distributions (mf=6, law=7, newfor=1).
*/ find common energy and angular grids for all subsections.
*i acer.5410
                  ik=1
                  iik=0
                  mne=ne
                  if (mf.eq.6 .and. law.eq.7 .and. newfor.ne.0 .and.
     &                      izai.eq.1) then
                     ine=ne
                     mne=ne
                     intne=1
                     inmu=nmu
                     mnmu=nmu
                     intnmu=1
                     do while (ik.lt.nk .and. awp.eq.1)
                        iik=iik+1
                        do iie=1,ne
                           call tab1io(nin,0,0,a(iscr),nb,nw)
                           ein=sigfig(a(iscr+1),7,0)
                           if (law.eq.7.) nmu=nint(a(iscr+3))
                           m=nint(a(iscr+4))
                           n=nint(a(iscr+5))
                           jscr=iscr+nw
                           do while (nb.ne.0)
                              call moreio(nin,0,0,a(jscr),nb,nw)
                              jscr=jscr+nw
                           enddo
c
c                          ***process mu-grid
                           do i=1,n
                              amuin=a(iscr+4+2*m+2*i)
                              if (ik.eq.1) then
                                 amutmp(i)=amuin
                              else
                                 i2=1
                                 idone=0
                                 do while(i2.le.mnmu .and. idone.eq.0)
                                    if (amuin.lt.amutmp(i2)-0.001)
     &                                 then
c
C                                      ***new angular grid point found
                                       do j=mnmu,i2,-1
                                          amutmp(j+1)=amutmp(j)
                                       enddo
                                       amutmp(i2)=amuin
                                       mnmu=mnmu+1
                                       idone=1
                                    else if (amuin.lt.amutmp(i2)+0.001)
     &                                 then
c
C                                       ***this angle already exists
                                        idone=1
                                    endif
                                    i2=i2+1
                                 enddo
                              endif
```

```
                           enddo
c
c                          ***process e-grid
                           if (ik.eq.1) then
                              etemp(iie)=ein
                           else
                              i2=1
                              idone=0
                              do while(i2.lt.mne .and. idone.eq.0)
                                 if (ein.lt.etemp(i2)*0.9999) then
c
C                                   ***new energy grid point found
                                    do j=mne,i2,-1
                                       etemp(j+1)=etemp(j)
                                    enddo
                                    etemp(i2)=ein
                                    mne=mne+1
                                    idone=1
                                 else if (ein.lt.etemp(i2)*1.0001) then
c
C                                   ***this energy already exists
                                    idone=1
                                 endif
                                 i2=i2+1
                              enddo
                           endif
c
c                          ***skip energy distribution
                           do i=1,n
                              call tab1io(nin,0,0,a(iscr),nb,nw)
                              do while (nb.ne.0)
                                 call moreio(nin,0,0,a(iscr),nb,nw)
                              enddo
                           enddo
                        enddo
c
C                       ***proceed with next subsection
                        ik=ik+1
                        call tab1io(nin,0,0,a(iscr),nb,nw)
                        awp=c2h
                        if (awp.eq.1 .and. l2h.ne.law)
     &                     call error('acelod',
     &                     'different angular distributions laws',' ')
                        do while (nb.ne.0)
                           call moreio(nin,0,0,a(iscr),nb,nw)
                        enddo
                        call tab2io(nin,0,0,a(iscr),nb,nw)
                        ne=nint(a(iscr+5))
                     enddo
c
c                    ***no energy interpolation needed?
                     if (mne.eq.ine) intne=0
c
c                    ***no angle interpolation needed?
                     if (mnmu.eq.inmu) intnmu=0
                     call findf(matd,mf,mt,nin)
                     call contio(nin,0,0,a(iscr),nb,mw)
                     call tab1io(nin,0,0,a(iscr),nb,nw)
                     do while (nb.ne.0)
                        call moreio(nin,0,0,a(iscr),nb,nw)
                     enddo
                     call tab2io(nin,0,0,a(iscr),nb,nw)
                     ne=nint(a(iscr+5))
                  endif
*d acer.5411
                  xss(next)=mne
*d acer.5413,5414
                  il=ie+mne
```

```
                  next=il+mne+1
*/ process now multiple angular distributions (if actually found)
*d acer.5419,5420
                     if (iik.gt.1) then
c
c                       ***multiple angular distributions found
                        do i=1,ne
                           a(iscr+i-1)=etemp(i)
                        enddo
                        iegrid=iscr
                        iscr=iscr+ne
                        do i=1,mnmu
                           a(iscr+i-1)=amutmp(i)
                        enddo
                        imugrid=iscr
                        iscr=iscr+mnmu
                        call acend2(ir,next,iscr,nin,last,law,ne,ie,il,
     &                  iso,iik,mne,mnmu,iyield,iegrid,imugrid,ilne,
     &                  intne,intmu)
                     else
                        call acensd(ir,next,iscr,nin,awp,ltt3,lttn,
     &                  ltt,last,law,ne,ie,il,iso)
                     endif
*/ subroutine acend2: combination of multiple angular distributions
*i acer.5749
      subroutine acend2(ir,next,iscr,nin,last,law,ne,ie,il,iso,iik,
     &  mne,mnmu,iyield,iegrid,imugrid,ilne,intne,intmu)
c     ******************************************************************
c     process this neutron scattering distribution.
c     ******************************************************************
*if sw
      implicit real*8 (a-h,o-z)
*endif
      integer esz,sig,and,tyr,dlw,gpd,fis,sigp,andp,dlwp,yp,end
      common/jxst/esz,nu,mtr,lqr,tyr,lsig,sig,land,and,ldlw,dlw,
     &  gpd,mtrp,lsigp,sigp,landp,andp,ldlwp,dlwp,yp,fis,end,
     &  iurpt,jxsd(9)
      common/lsize/max1,max2,max3
      common/xsst/xss(4000000),n3 ! NEA changes
      common/mainio/nsysi,nsyso,nsyse,ntty
      common/cont/c1h,c2h,l1h,l2h,n1h,n2h,math,mfh,mth,nsh,nsp,nsc
      common/astore/a(80000)
      common/ace7/awi,izai,mcnpx,newfor
      dimension xxmu(mnmu),xfmu(mnmu),x2fmu(mnmu)
      external error,tab1io,listio,moreio,tab2io,findex
      external pttab2,ptleg2,ptlegc
c NEA, 5-Oct-2005
      external intega
c NEA, 5-Oct-2005
      data emev/1.d6/
      data etop/1.d10/
      data rmin/1.d-30/
      ik=1
      next0=next
c
c     ***initialize xss-array
      if (next+2+3*mnmu.gt.max3) call error('acend2',
     &   'insufficient storage for angular distributions.',' ')
      do i=0,(2+3*mnmu)*mne
         xss(next+i)=0.0
      enddo
c
c     ***loop over particle subsections
      do while (ik.le.iik)
         ieinold=1
         next=next0
c
c        ***loop over incident energies
```

```
         do j=1,ne
            call tab1io(nin,0,0,a(iscr),nb,nw)
            jscr=iscr+nw
            do while (nb.ne.0)
               call moreio(nin,0,0,a(jscr),nb,nw)
               jscr=jscr+nw
            enddo
            ein=sigfig(a(iscr+1),7,0)
            ilnmu=nint(a(iscr+7))
c
c           ***find position of present energy in common grid
            idone=0
            ieinold=0
            do while (ieinold.lt.mne .and. idone.eq.0)
               ieinold=ieinold+1
               if (abs(ein-a(iegrid+ieinold-1)).lt.ein/1000.) idone=1
            enddo
            next=next0+(2+3*mnmu)*(ieinold-1)
            xss(next)=ilnmu
            xss(next+1)=mnmu
            lastfmu=next+1+mnmu
            x1=-1
            x2=1
c NEA, 5-Oct-2005
            i_IP=2
            i_IR=1
c           call intega(renorm,x1,x2,a(iscr),2,1)
            call intega(renorm,x1,x2,a(iscr),i_IP,i_IR)
c NEA, 5-Oct-2005
c
c           ***transformation to unified angular grid, normalization,
c           ***put in temporary storage
            do i=1,mnmu
               xmu=a(imugrid+i-1)
c NEA, 5-Oct-2005
               i_IP=2
               i_IR=1
c              call terpa(fmu,xmu,xmu1,idis,a(iscr),2,1)
               call terpa(fmu,xmu,xmu1,idis,a(iscr),i_IP,i_IR)
c NEA, 5-Oct-2005
               xxmu(i)=xmu
               xfmu(i)=fmu/renorm
            enddo
c
c           ***check for energies not covered
            if (j.gt.1) then
               i=ieinold+1
               einold=a(iegrid+ieinold-1)
               do while (i.le.mne)
                  ei=a(iegrid+i-1)
                  if (ei.lt.ein) then
c
c                    ***set interpolation scheme (assume ilnmu)
                     next=next0+(2+3*mnmu)*(i-1)
                     xss(next)=ilnmu
                     xss(next+1)=mnmu
c NEA, 5-Oct-2005
                    i_IP=2
                    i_IR=1
c                   call terpa(yield,ei,xnext,idis,a(iyield),2,1)
                    call terpa(yield,ei,xnext,idis,a(iyield),i_IP,i_IR)
c NEA, 5-Oct-2005
c
c                    ***interpolate angular distribution to that energy
                     renorm=0.0
                     do k=1,mnmu
                        call terp1(einold,xss(lastfmu+k),ein,
     &                             xfmu(k),ei,fmu,ilne)
```

```
                     xss(next+1+k)=sigfig(xxmu(k),7,0)
                     x2fmu(k)=fmu
                     renorm=renorm+fmu
                  enddo
                  do k=1,mnmu
                     x2fmu(k)=x2fmu(k)/renorm*yield
                     xss(next+1+mnmu+k)=xss(next+1+mnmu+k)+x2fmu(k)
                  enddo
                  i=i+1
               else
                  i=mne+1
               endif
            enddo
         endif
c
c        ***store and add now present distribution
c NEA, 5-Oct-2005
         i_IP=2
         i_IR=1
c        call terpa(yield,ein,xnext,idis,a(iyield),2,1)
         call terpa(yield,ein,xnext,idis,a(iyield),i_IP,i_IR)
c NEA, 5-Oct-2005
         next=next0+(2+3*mnmu)*(ieinold-1)
         do i=1,mnmu
            xss(next+1+i)=sigfig(xxmu(i),7,0)
            xss(next+1+mnmu+i)=xss(next+1+mnmu+i)+xfmu(i)*yield
         enddo
         do i=1,mnmu
            call tab1io(nin,0,0,a(iscr),nb,nw)
            do while (nb.ne.0)
               call moreio(nin,0,0,a(iscr),nb,nw)
            enddo
         enddo
c
c     ***next incident energy
      enddo
      ik=ik+1
      iyield=iscr
      call tab1io(nin,0,0,a(iscr),nb,nw)
      iscr=iscr+nw
      do while (nb.ne.0)
         call moreio(nin,0,0,a(iscr),nb,nw)
         iscr=iscr+nw
      enddo
      call tab2io(nin,0,0,a(iscr),nb,nw)
      ne=nint(a(iscr+5))
c
c  ***next particle subsection
   enddo
c
c  ***do now final processing
   next=next0
   do j=1,mne
      xss(ie+j)=sigfig(a(iegrid+j-1)/emev,7,0)
      xss(il+j)=-(next-and+1)
      do i=1,mnmu
         xss(next+1+mnmu+i)=sigfig(xss(next+1+mnmu+i),7,0)
         if (xss(next+1+mnmu+i).lt.rmin) xss(next+1+mnmu+i)=0
         if (i.eq.1) then
            xss(next+1+2*mnmu+i)=0
         else
            sum=xss(next+1+2*mnmu+i-1)+
  &             gral(xss(next+1+i-1),xss(next+1+mnmu+i-1),
  &                  xss(next+1+i),xss(next+1+mnmu+i),
  &                  xss(next+1+i-1),xss(next+1+i),ilnmu)
            xss(next+1+2*mnmu+i)=sigfig(sum,7,0)
         endif
      enddo
```

```
         renorm=1/xss(next+1+3*mnmu)
         do i=1,mnmu
            xss(next+1+2*mnmu+i)=renorm*xss(next+1+2*mnmu+i)
            xss(next+1+2*mnmu+i)=sigfig(xss(next+1+2*mnmu+i),9,0)
         enddo
         next=next+2+3*mnmu
      enddo
      iso=0
      return
      end
c
*/ read complete tab1-record
*i acer.9401
                           do while (nb.ne.0)
                              call moreio(nin,0,0,a(ll),nb,nw)
                           enddo
*/ Defined in up57
*/ */ set reaction name "MT" if out of defined region
*/ *d acer.11529
*/          if (i .gt. 408) then
*/             write(name,'(''MT'',i3)') mt
*/          else
*/             name=hndf(i)
*/          end if
*/
*/ Equivalent to up57
*/ *ident upac3
*/ */ acer -- 05jun01
*/ */ enlarge xss-array to fit the large ace-files. In addition, the output to
*/ */ xsdir has to be modified. cf up44
*/ *d up44.8
*/       max3=2000000
*/ *d up44.10
*/       common/xsst/xss(2000000),n3
*/ *d up44.12
*/       common/xsst/xss(2000000),n3
*/ *d up44.14
*/       common/xsst/xss(2000000),n3
*/ *d up44.16
*/       common/xsst/xss(2000000),n3
*/ *d up44.18
*/       common/xsst/xss(2000000),n3
*/ *d up44.20
*/       common/xsst/xss(2000000),n3
*/ *d up44.22
*/       common/xsst/xss(2000000),n3
*/ *d up44.24
*/       common/xsst/xss(2000000),n3
*/ *d up44.26
*/       common/xsst/xss(2000000),n3
*/ *d up44.28
*/       common/xsst/xss(2000000),n3
*/ *d up44.30
*/       common/xsst/xss(2000000),n3
*/ *d up44.32
*/       common/xsst/xss(2000000),n3
*/ *d up44.42
*/       common/xsst/xss(2000000),n3
*/ *d up44.44
*/       common/xsst/xss(2000000),n3
*/ *d up44.46
*/       common/xsst/xss(2000000),n3
*/ *d up44.48
*/       common/xsst/xss(2000000),n3
*/ *d up44.50
*/       common/xsst/xss(2000000),n3
*/ *d up44.52
*/       common/xsst/xss(2000000),n3
```

```
*/ *d up44.58
*/       common/xsst/xss(2000000),n3
*/ *d up44.60
*/       common/xsst/xss(2000000),n3
*/ *d up44.62
*/       common/xsst/xss(2000000),n3
*/ *d up44.68
*/       common/xsst/xss(2000000),n3
*/ *d up44.70
*/       common/xsst/xss(2000000),n3
*/ *d up44.72
*/       common/xsst/xss(2000000),n3
*/ *d up44.78
*/       common/xsst/xss(2000000),n3
*/ *d up44.80
*/       common/xsst/xss(2000000),n3
*/ *d up44.82
*/       common/xsst/xss(2000000),n3
*/ *d up44.88
*/       common/xsst/xss(2000000),n3
*/ *d up44.90
*/       common/xsst/xss(2000000),n3
*/ *d up44.92
*/       common/xsst/xss(2000000),n3
*/ *d up44.94
*/       common/xsst/xss(2000000),n3
*/ *d up44.96
*/       common/xsst/xss(2000000),n3
*/ *d up44.98
*/       common/xsst/xss(2000000),n3
*/ *d up44.100
*/       common/xsst/xss(2000000),n3
*/ *d up44.102
*/       common/xsst/xss(2000000),n3
*/ *d up44.104
*/       common/xsst/xss(2000000),n3
*/ *d up44.106
*/       common/xsst/xss(2000000),n3
*/
*/ Inlcuded in up57
*/ *ident up_NEA
*/*/ acer -- 05-Oct-20051
*/*/ bug in renorm
*/*d acer.9481
*/*/                            renorm=1/xss(next+3*npep)
acer.9481
*/                              renorm=1.0
*/                              if(xss(next+3*npep).ne.0.0)
*/     &                        renorm=1/xss(next+3*npep)
*/*/
*/ bug for processing Li-7
*d acer.6917
*/                            renorm=1/xss(nexd+3*npep)
acer.6917
                              renorm=1.0
                              if(xss(nexd+3*npep).ne.0.0)
     &                        renorm=1/xss(nexd+3*npep)
```

C.13 upn_Pescarini

```
REM upn_Pescarini: JEFF31 corrections.
REM             - Does not include updates equivalents to upfndl2, upki,
REM               up_thermr,nrg_re15
REM -----

*/ UPN Pescarini
*/
*/ Equivalent to fendl2 in upn_Trkov
*ident pesca
*/ */ --------- correction in gaspr (case Tc-99)
*/ *d gaspr.28
*/ */    dimension egas(50000),sgas(5,50000)
*/       dimension egas(60000),sgas(5,60000)
*/ *d gaspr.41
*/ */    maxg=50000
*/       maxg=60000
*/
*/ Equivalent to upki in upn_Hogenbirk
*/ */ --------- correction in heatr/h6ddx (case Mo-95)
*/ *d up30.10
*/ */    data nlmax/15/
*/       data nlmax/20/
*/ --------- correction in heatr/gambar (case Eu-151)
*d heatr.4845
*/    if (ehi.lt.e*(1-small).and.nne.lt.ne) go to 120
      if (ehi.lt.e*(1+small).and.nne.lt.ne) go to 120
*/
*/ Equivalent to up_thermr in upn_Mattes
*/ -------- correction in thermr
*/ *d thermr.101
*/ */    dimension a(80000)
*/       dimension a(100000)
*/ *d thermr.131
*/ */    namax=80000
*/       namax=100000
*/ */  thermr/calcem
*/ -------- correction in thermr/coh (Be_TH,C_GPH cases)
*i thermr.782
      if (enext.lt.e*(1+small)) go to 230
*/
*/ Equivalent to upn_Aldama
*/ */ corrections in thermr/calcem (H_H2O,D_D2O cases)
*/ *i thermr.1572
*/       loci=loc
*/       do while (nb.ne.0)
*/          loci=loci+nw
*/          call moreio(nendf,0,0,a(loci),nb,nw)
*/       enddo
*/ *i thermr.1598
*/       loci=loc
*/       do while (nb.ne.0)
*/          loci=loci+nw
*/          call moreio(nendf,0,0,a(loci),nb,nw)
*/       enddo
*/ -------- correction in purr/rdf3un (case Es-253)
*i purr.978
      if (mth.eq.mtx(ix)) go to 130
*/
*/ Equivalent to nrg_re15 in Hogenbirk
*/ -------- corrections in reconr to prevent compiler warning
*/ */ correction in reconr/rdf2aa
*/ *i reconr.853
*/       zero=0.
*/ */ correction in reconr/rdf2hy
*/ *i reconr.937
```

```
*/        zero=0.
```

APENDIX D. LANL Validation Suite

This Validation Suite is included in Reference [ICSBEP].

Most of them are not in electronic format, so a tedious hand-work has been performed to process these files.

D.1 Jezebel: PU-MET-FAST-001

```
Bare Pu-239 Jezebel, ref. PU-MET-FAST-001
1    1    0.04029014 -1 imp:n=1
2    0     1  imp:n=0

1    so   6.3849

m1      94239.31c  3.7047E-02
        94240.31c  1.7512E-03
        94241.31c  1.1674E-04
        31000.31c  1.3752E-03
kcode 5000 1.0 200 1200
ksrc 0 0 0
print
```

D.2 Jezebel-240: PU-MET-FAST-002

```
Bare Pu-240 Jezebel, ref. PU-MET-FAST-002
1    1    0.04055292 -1 imp:n=1
2    0     1  imp:n=0

1    so   6.6595

m1      94239.31c  2.9934E-02
        94240.31c  7.8754E-03
        94241.31c  1.2146E-03
        94242.31c  1.5672E-04
        31000.31c  1.3722E-03
kcode 5000 1.0 200 1200
ksrc 0 0 0
print
```

D3. Pu Buttons: PU-MET-FAST-003, case 103

```
PU-MET-UNMOD-HET-001 103.b <<Benchmark case>>
1 4 3.70511-02 -102 -5 u=2 imp:n=1 $ mocked-up shoe
2 0 102 -103 -1 u=2 imp:n=1 $ btm. spacer vd.
3 2 6.0263-02 102 -103 1 -2 u=2 imp:n=1 $ btm. spacer
4 0 102 -103 2 -5 u=2 imp:n=1 $ btm. spacer gap
c
10 2 2.8861-02 103 -104 -4 u=2 imp:n=1 $ PU#1 btm. Ht snk
11 3 8.4122-02 104 -105 -4 u=2 imp:n=1 $ PU#1 steel lid
12 1 4.9163-02 105 -106 -3 u=2 imp:n=1 $ PU#1 Pu core
13 2 6.0263-02 105 -106 3 -4 u=2 imp:n=1 $ PU#1 Al shell
14 2 6.0263-02 106 -107 -4 u=2 imp:n=1 $ PU#1 Al bottom
15 2 3.6744-02 107 -108 -4 u=2 imp:n=1 $ PU#1 top Ht snk
16 0 108 -109 -1 u=2 imp:n=1 $ PU#1/PU#2 spacer vd.
17 2 6.0263-02 108 -109 1 -2 u=2 imp:n=1 $ PU#1/PU#2 spacer
18 0 108 -109 2 -5 u=2 imp:n=1 $ PU#1/PU#2 spacer gap
19 0 103 -108 4 -5 u=2 imp:n=1 $ PU#1 gap
c
20 2 2.8861-02 109 -110 -4 u=2 imp:n=1 $ PU#2 btm. Ht snk
21 3 8.4122-02 110 -111 -4 u=2 imp:n=1 $ PU#2 steel lid
22 1 4.9163-02 111 -112 -3 u=2 imp:n=1 $ PU#2 Pu core
23 2 6.0263-02 111 -112 3 -4 u=2 imp:n=1 $ PU#2 Al shell
24 2 6.0263-02 112 -113 -4 u=2 imp:n=1 $ PU#2 Al bottom
25 2 3.6744-02 113 -114 -4 u=2 imp:n=1 $ PU#2 top Ht snk
26 0 114 -115 -1 u=2 imp:n=1 $ PU#2/PU#3 spacer vd.
27 2 6.0263-02 114 -115 1 -2 u=2 imp:n=1 $ PU#2/PU#3 spacer
28 0 114 -115 2 -5 u=2 imp:n=1 $ PU#2/PU#3 spacer gap
29 0 109 -114 4 -5 u=2 imp:n=1 $ PU#2 gap
c
30 2 2.8861-02 115 -116 -4 u=2 imp:n=1 $ PU#3 btm. Ht snk
31 3 8.4122-02 116 -117 -4 u=2 imp:n=1 $ PU#3 steel lid
32 1 4.9163-02 117 -118 -3 u=2 imp:n=1 $ PU#3 Pu core
33 2 6.0263-02 117 -118 3 -4 u=2 imp:n=1 $ PU#3 Al shell
34 2 6.0263-02 118 -119 -4 u=2 imp:n=1 $ PU#3 Al bottom
35 2 3.6744-02 119 -120 -4 u=2 imp:n=1 $ PU#3 top Ht snk
39 0 115 -120 4 -5 u=2 imp:n=1 $ PU#2 gap
40 0 120 -5 u=2 imp:n=1 $ vd. above sink
41 2 6.0263-02 5 u=2 imp:n=1 $ tube shell
c
140 0 -6 fill=2 u=1 imp:n=1 $ X+ Y+ tube
141 like 140 but trcl=( 0 9.60 0) imp:n=1 $ X+ Y- tube
142 like 140 but trcl=( 0 -9.60 0) imp:n=1 $ X- Y+ tube
143 like 140 but trcl=( 9.60 0 0) imp:n=1 $ X+ Y- tube
144 like 140 but trcl=( 9.60 9.60 0) imp:n=1 $ X- Y+ tube
145 like 140 but trcl=( 9.60 -9.60 0) imp:n=1 $ X+ Y- tube
146 like 140 but trcl=(-9.60 0 0) imp:n=1 $ X+ Y- tube
147 like 140 but trcl=(-9.60 9.60 0) imp:n=1 $ X- Y+ tube
148 like 140 but trcl=(-9.60 -9.60 0) imp:n=1 $ X+ Y- tube
150 0       #140 #141 #142 #143 #144
           #145 #146 #147 #148 u=1 imp:n=1 $ on table-fuel
155 0 101 -121 150 -151 152 -153 fill=1 imp:n=1 $ rgn. abv. top
156 2 -2.376 100 -101 150 -151 152 -153 imp:n=1 $ Al tbl. top
157 3 5.8945-03 99 -100 150 -151 152 -153 imp:n=1 $ stl. tbl. prt
999 0 -99:121:-150:151:-152:153 imp:n=0 $ universe

1 cz 3.1040
2 cz 3.3260
3 cz 3.2625
4 cz 3.2995
5 cz 3.4250
6 cz 3.6090
99 pz -32.54
100 pz -2.54
101 pz 0.0
102 pz 8.30
103 pz 14.529
```

```
104 pz 15.164
105 pz 15.185
106 pz 19.818
107 pz 19.905
108 pz 20.384
109 pz 22.239
110 pz 22.874
111 pz 22.895
112 pz 27.528
113 pz 27.615
114 pz 28.094
115 pz 29.949
116 pz 30.584
117 pz 30.605
118 pz 35.238
119 pz 35.325
120 pz 35.804
121 pz 45.733
150 px -66.00
151 px 66.00
152 py -23.00
153 py 23.00

mode n
totnu
phys:n 30 1e-08
cut:n 1.0e16 0 -0.50 -0.25
print -10 -20 -30 -60 -85 -110 -120 -150 -170 -198
kcode 10000 1.0 50 550
sdef axs 0 0 1 ext d2 rad d1 pos d3
si1 3.2624
si2 2.3164
sp3 1 26r
si3 l 0.00 0.00 17.5015 0.00 9.60 17.5015
      0.00 -9.60 17.5015
      9.60 0.00 17.5015 9.60 9.60 17.5015
      9.60 -9.60 17.5015
     -9.60 0.00 17.5015 -9.60 9.60 17.5015
     -9.60 -9.60 17.5015
      0.00 0.00 25.2115 0.00 9.60 25.2115
      0.00 -9.60 25.2115
      9.60 0.00 25.2115 9.60 9.60 25.2115
      9.60 -9.60 25.2115
     -9.60 0.00 25.2115 -9.60 9.60 25.2115
     -9.60 -9.60 25.2115
      0.00 0.00 32.9215 0.00 9.60 32.9215
      0.00 -9.60 32.9215
      9.60 0.00 32.9215 9.60 9.60 32.9215
      9.60 -9.60 32.9215
     -9.60 0.00 32.9215 -9.60 9.60 32.9215
     -9.60 -9.60 32.9215
m1      94239.31c  4.6010E-02
        94240.31c  2.9236E-03
        94241.31c  2.2433E-04
        94242.31c  4.8566E-06
m2      13027.31c  1.0000E+00
m3    26054.31c   4.91693E-03
      26056.31c   7.71853E-02
      26057.31c   1.78255E-03
      26058.31c   2.37224E-04
m4      13027.31c  2.9260E-02
      26054.31c   4.55390E-04
      26056.31c   7.14865E-03
      26057.31c   1.65093E-04
      26058.31c   2.19709E-05
```

D4. Flattop-Pu : PU-MET-FAST-006

```
K-EFF CALCULATION FOR U(nat) REFLECTED PU SPHERE
1 1 0.04015889 -1    imp:n=1
2 2 0.048069744 1 -2 imp:n=1
3 0             2    imp:n=0

1 so 4.5332
2 so 24.142

m1      94239.31c  3.6697E-02
        94240.31c  1.8700E-03
        94241.31c  1.1639E-04
        31000.31c  1.4755E-03
m2      92234.31c  2.6438E-06
        92235.31c  3.4610E-04
        92238.31c  4.7721E-02
kcode 5000 1.0 200 1200
ksrc 0 0 0
print
```

D5. THOR: PU-MET-FAST-008

```
Delta phase Pu sphere thorium reflector, Ref PU-MET-FAST-008
1    1    0.03945359 -1 imp:n=1
2    2    0.030054    1 -2 imp:n=1
3    0     2  imp:n=0

1    so    5.310
2    so    29.88

m1      94239.31c  3.6049E-02
        94240.31c  1.9562E-03
        94241.31c  1.1459E-04
        31000.31c  1.3338E-03
m2      90232.31c  3.0054E-02
kcode 5000 1.0 200 1200
ksrc 0 0 0
print
```

D6. PU-MET-FAST-011

```
Water reflected alpha-phase Pu sphere, ref. PU-MET-FAST-011
1    1    0.049716393  -1 imp:n=1
2    2    0.100149      1 -2 imp:n=1
3    0     2  imp:n=0

1    so   4.1217
2    so   29.5217

m1      94239.31c  4.6982E-02
        94240.31c  2.5753E-03
        94241.31c  1.4915E-04
        94242.31c  9.9432E-06
m2       1001.31c  6.6766E-02
         8016.31c  3.3383E-02
mt2     lwtr01.31t
kcode 5000 1.0 200 1200
ksrc 0 0 0
print
```

D7. HISS/HPG : PU-COMP-INTER-001

```
HISS HPG Infinite Homogeneous Mixture ENDF/B-V
1 1 0.07534292 1 -2 3 -4 5 -6
2              0 -1:2:-3:4:-5:6

*1 px -1.0
*2 px 1.0
*3 py -1.0
*4 py 1.0
*5 pz -1.0
*6 pz 1.0

mode n
imp:n 1 0
kcode 5000 1.0 50 250
sdef cel=1 erg=d1 sur=0
sp1 -3
prdmp j 300
m1       1001.31c  1.0770E-04
         5010.31c  1.0150E-04
         5011.31c   4.086e-04
         6000.31c  7.0900E-02
         8016.31c  2.7070E-03
      20040.31c   8.02671E-04
      20042.31c   5.35716E-06
      20043.31c   1.11780E-06
      20044.31c   1.72721E-05
      20046.31c   3.31200E-08
      20048.31c   1.54836E-06
        94239.31c  2.7350E-04
        94240.31c  1.5490E-05
        94241.31c  1.0720E-06
        94242.31c  5.8000E-08
mt1  grph01.31t
totnu
print
```

D8. PNL-2: PU-SOL-THERM-021, case 3

```
PS1288BY, 172.3 gPu/l,1.429g/cc, 4.9N,482.55gNO3/l,Bare Sph., 4.57% Pu240
C   Changed total atoms/cc from 9.92712-02 to 9.927121-02
  1  0                5                     imp:n=0 $ Outside Everything
  2  1  9.927121-02  -1   -3                imp:n=1 $ Pu(NO3)4 Solution
  3  2  8.62396-02    1   -2  #6  #7        imp:n=1 $ SS347 Sphere
  4  0                2    4  -5  #6 #7 #8 imp:n=1 $ Void Upper In. Hemisphere
  5  0                2   -4  -5  #9 #10   imp:n=1 $ Void Lower In. Hemisphere
  6  1  9.927121-02    1   -3   4  -7        imp:n=1 $ Liquid in Support Tube
  7  0                3    4  -5  -7        imp:n=1 $ Air in Support Tube
  8  2  8.62396-02    2    4  -5  -6   7   imp:n=1 $ SS347 Top Support Tube
  9  0                2   -4  -5  -9        imp:n=1 $ Air in Bottom Tube
 10  2  8.62396-02    2   -4  -5  -8   9   imp:n=1 $ SS347 Bottom Tube

  1   so    19.3163           $ Sphere Inner Radius
  2   so    19.4382           $ Sphere Outer Radius
  3   px    19.3163           $ Liquid Level
  4   px     0.0              $ Model Middle
  5   so    49.4382           $ Outer Surface
  6  c/x   0.0  3.811  2.8575 $ Top Support Tube OD
  7  c/x   0.0  3.811  2.6924 $ Top Support Tube ID
  8   cx     2.86             $ Bottom Tube OD
  9   cx     2.555            $ Bottom Tube ID

mode n
kcode    10000 1.0   50  550
sdef pos 0.0 0.0 0.0 rad d1
sc1  Spherical Source about origin
si1    19.31
m1      94238.31c  2.6153E-08
        94239.31c  4.1249E-04
        94240.31c  2.0181E-05
        94241.31c  1.2181E-06
        94242.31c  3.8579E-08
         7014.31c  4.6867E-03
         1001.31c  5.4377E-02
         8016.31c  3.9773E-02
m2    26054.31c   3.46930E-03
      26056.31c   5.44606E-02
      26057.31c   1.25773E-03
      26058.31c   1.67381E-04
      24050.31c   7.57247E-04
      24052.31c   1.46027E-02
      24053.31c   1.65583E-03
      24054.31c   4.12172E-04
      28058.31c   5.25575E-03
      28060.31c   2.02449E-03
      28061.31c   8.80114E-05
      28062.31c   2.80556E-04
      28064.31c   7.14900E-05
        25055.31c  1.7363E-03
mt1  lwtr01.31t                           $S(Alpha,Beta)
totnu
prdmp
print    40 50 60 -175 -178
```

D9. Jezebel-233:U233-MET-FAST-001

```
K-EFF CALCULATION FOR U-233 JEZEBEL
1    1     0.04760215 -1 imp:n=1
2    0     1             imp:n=0

1 so   5.9838

m1   92233.31c 4.6712-2 92234.31c 5.9026-4 92235.31c 1.4281-5
     92238.31c 2.8561-4
kcode   5000 1.0 200 1200
ksrc    0. 0. 0.
print
```

D10. Flattop-23: U233-MET-FAST-006

```
U-233 SPHERE Reflected by Normal Uranium
1    1      0.047591468 -1 imp:n=1
2    2      0.0480675    1 -2 imp:n=1
3    0      2  imp:n=0

1    so    4.2058
2    so    24.1194

m1   92233.31c 0.046710
     92234.31c 0.00058772
     92235.31c 0.000014158
     92238.31c 0.00027959
m2   92235.31c 0.00035050
     92238.31c 0.047717
kcode   5000  1.0 200 1200
ksrc    0. 0. 0.
print
```

D11. U233-MF-05: U233-MET-FAST-005, case 2

```
U233 sphere Be reflector, Ref u233-met-fast-xxx
1    1     0.04816985  -1 imp:n=1
2    2     0.1212076    1 -2 imp:n=1
3    0     2  imp:n=0

1    so    4.5999
2    so    8.7960

m1   92233.31c 0.047312
     92234.31c 0.00052770
     92238.31c 0.00033015
m2   4009.31c  0.11983
     8016.31c  0.0013776
mt2  beo01.31t
kcode   5000  1.0 200 1200
ksrc    0. 0. 0.
print
```

D12. Falstaff-1: U233-SOL-INTER-001, case 1

```
FALSTAFF; Sol'n No. 1; Sphere No. 1; 8.00 cm Be
1 1 -1.9712 -1
2 2 -8.00    1 -2
3 3 -1.82    2 -3
4 0          3

1 so 7.8726
2 so 7.9209
3 so 15.9209

imp:n 1 1 1 0
m1   92232.31c 4.5608-8 92233.31c 2.2379-3 92234.31c 2.4316-5 &
     92235.31c 8.9598-7 92238.31c 7.1284-6 1001.31c 5.5183-2 &
      8016.31c 3.2043-2  9019.31c 4.7182-3
mt1  lwtr01.31t
m2   26054.31c 0.3552-2 26056.31c 5.6226-2 26057.31c 0.1286-2 &
     26058.31c 0.0184-2 24050.31c 0.0726-2 24052.31c 1.3974-2 &
     24053.31c 0.1584-2 24054.31c 0.0394-2 28058.31c 6.1623-3 &
     28060.31c 2.3560-3 28061.31c 0.1020-3 28062.31c 0.3240-3 &
     28064.31c 0.0821-3
m3   4009.31c 1.
mt3  bena01.31t
kcode 5000 1. 200 1200
ksrc 0. 0. 0.
```

D13. SB-2½:U233-COMP-THERM-001, case 3

```
full LWBR SB-2.5 benchmark
c  rectangular array
c  U233, 340 UO2-ZrO2 seed rods (18x16)
c  no blanket
c
c  Cells
c  surface order:  pz1 ... cz1 ... (axial, then radial)
c  seed rod, infinitely long
11   5   4.3036-2    1     -21               u=1  imp:n=1  $ top zircaloy plug
12   1   8.0898-2    2  -1 -21               u=1  imp:n=1  $ 233UO2-ZrO2 seed
13   5   4.3036-2   -2 -21                   u=1  imp:n=1  $ bot.zircaloy plug
14   0                  21 -22               u=1  imp:n=1  $ void around meat
15   5   4.3036-2       22 -23               u=1  imp:n=1  $ zircaloy clad
16   6   1.0010-1          23                u=1  imp:n=1  $ surrounding water
31   0         -31 32 -33 34  lat=1  fill=1  u=3  imp:n=1  $ seed rod array
32   0         -99           trcl=1  fill=3  u=4  imp:n=1  $ c. seed rod array
75   0         -66 67 -68 69         fill=4  u=6  imp:n=1  $ cut arr. +-x, +-y
76   6   1.0010-1     66:-67:68:-69          u=6  imp:n=1  $ water around core
c  rod array with control blade bank
78  10  8.8821-2  -73 74 -76 75             u=13  imp:n=1  $ control blade a
79  10  8.8821-2  -73 74 -78 77             u=13  imp:n=1  $ control blade b
80  10  8.8821-2  -73 74 -79 80             u=13  imp:n=1  $ control blade c
81  10  8.8821-2  -73 74 -81 82             u=13  imp:n=1  $ control blade d
82   0         -5  #78 #79 #80 #81  fill=6  u=13  imp:n=1  $ core
83   6  1.0010-1    5  #78 #79 #80 #81      u=13  imp:n=1  $ water above core
c  rod without control blade bank
93   0             +6               fill=6  u=14  imp:n=1  $ core
96   6  1.0010-1   -6                       u=14  imp:n=1  $ water below core
c  put it all together
97   0             -91 12 -15       fill=13       imp:n=1  $
98   0             -91 16 -12       fill=14       imp:n=1  $
101  0              91:15:-16                     imp:n=0  $ outside

c
c  Surfaces
c  fixed elevations, pz, 0.00 = middle of fuel region
1   pz    19.05     $ fuel top (half of 15in fuel length)
2   pz   -19.05     $ fuel bottom
5   pz    25.8191   $ rod top (half of 20.83-.25in rod length)
6   pz   -25.8191   $ rod bottom
12  pz    16.05     $ control blade bank lower edge
15  pz    56.30     $ 1 ft above fuel
16  pz   -56.30     $ 1 ft below fuel
c  233U seed radial surfaces
21  cz     0.26797  $ 0.211in. OD Seed fuel pellet/zirc plug
22  cz     0.27940  $ 0.220in. ID Seed clad
23  cz     0.32385  $ 0.255in. OD Seed clad
c  seed rod window (square cell) surfaces
31  px     0.45974  $ pitch = 0.362in. = 0.91948cm
32  px    -0.45974
33  py     0.45974
34  py    -0.45974
c  core window (rectangular cell) surfaces
66  px     8.2753199   $ 9*pitch = 9*0.91948 - tad
67  px    -8.2753199
68  py     7.3558399   $ 8*pitch = 8*0.91948 - tad
69  py    -7.3558399
c  control blades
73  px     3.81     $ bank right edge (half of 3in. width)
74  px    -3.81     $ bank left edge (half of 3in. width)
75  py     5.42798  $ blade a inner edge (-12seedpitch + .5[.07in])
76  py     5.60578  $ blade a outer edge (-12seedpitch - .5[.07in])
```

```
77  py     1.75006  $ blade b inner edge (-4seedpitch + .5[.07in])
78  py     1.92786  $ blade b outer edge (-4seedpitch - .5[.07in])
79  py    -1.75006  $ blade c inner edge (-4seedpitch + .5[.07in])
80  py    -1.92786  $ blade c outer edge (-4seedpitch - .5[.07in])
81  py    -5.42798  $ blade d inner edge (-12seedpitch + .5[.07in])
82  py    -5.60578  $ blade d outer edge (-12seedpitch - .5[.07in])
c  model boundaries
91  cz    42.18     $ core + 1ft
99  cz   259.08     $ 17ft diameter containment tank (neglected)

c
c  Materials Data, Avogadro's number = 6.0221+23 particles/g-mole
m1   $ 233UO2-ZrO2 Seed, Ntot = 8.0898-2
         8016.31c  5.3932E-02
      40090.31c   1.17651E-02
      40091.31c   2.56568E-03
      40092.31c   3.92169E-03
      40094.31c   3.97428E-03
      40096.31c   6.40276E-04
        92233.31c  3.9891E-03
        92234.31c  6.3690E-05
        92238.31c  4.5759E-05
m5   $ zircaloy-2 cladding plugs etc, Ntot=4.3036-2
      40090.31c   2.18853E-02
      40091.31c   4.77265E-03
      40092.31c   7.29510E-03
      40094.31c   7.39293E-03
      40096.31c   1.19104E-03
      50112.31c   4.84205E-06
      50114.31c   3.24467E-06
      50115.31c   1.69721E-06
      50116.31c   7.25808E-05
      50117.31c   3.83370E-05
      50118.31c   1.20901E-04
      50119.31c   4.28296E-05
      50120.31c   1.62683E-04
      50122.31c   2.31120E-05
      50124.31c   2.89025E-05
m6   $ water, 0.9982 g/cc, Ntot=1.0010-1
         1001.31c  6.6735E-02
         8016.31c  3.3368E-02
mt6  lwtr01.31t
m10  $ borated SS control blades, Ntot=8.8821-2
      26054.31c   3.46369E-03
      26056.31c   5.43725E-02
      26057.31c   1.25570E-03
      26058.31c   1.67110E-04
         5010.31c  3.7488E-03
      24050.31c   7.57247E-04
      24052.31c   1.46027E-02
      24053.31c   1.65583E-03
      24054.31c   4.12172E-04
        25055.31c  8.6816E-04
      28058.31c   5.11742E-03
      28060.31c   1.97121E-03
      28061.31c   8.56949E-05
      28062.31c   2.73171E-04
      28064.31c   6.96083E-05
c  translate coordinates to center core array
*tr1        -0.45974    0.45974     0.0     0 90 90     90 0 90    90 90 0   1
mode n
kcode       5000    1.0  200  1200
print
ksrc      0.5    -0.5     0          0.5    -7.75    0
          0.5    -0.5    19          0.5    -7.75   19
          0.5    -0.5   -19          0.5    -7.75  -19
          0.5    -2.2     0          0.5    -5       0
          2.2    -0.5     0          5      -0.5     0
```

2.2	-2.2	0	5	-5	0
7.75	-0.5	0	7.75	-7.75	0
7.75	-0.5	19	7.75	-7.75	19
7.75	-0.5	-19	7.75	-7.75	-19
9.75	-0.5	0			
9.75	-0.5	19			
9.75	-0.5	-19			
-0.5	-0.5	0	-0.5	-7.75	0
-0.5	-0.5	19	-0.5	-7.75	19
-0.5	-0.5	-19	-0.5	-7.75	-19
-0.5	-2.2	0	-0.5	-5	0
-2.2	-0.5	0	-5	-0.5	0
-2.2	-2.2	0	-5	-5	0
-7.75	-0.5	0	-7.75	-7.75	0
-7.75	-0.5	19	-7.75	-7.75	19
-7.75	-0.5	-19	-7.75	-7.75	-19
-9.75	-0.5	0			
-9.75	-0.5	19			
-9.75	-0.5	-19			
0.5	2.2	0	0.5	5	0
2.2	0.5	0	5	0.5	0
2.2	2.2	0	5	5	0
7.75	0.5	0	7.75	7.75	0
7.75	0.5	19	7.75	7.75	19
7.75	0.5	-19	7.75	7.75	-19
-0.5	2.2	0	-0.5	5	0
-2.2	0.5	0	-5	0.5	0
-2.2	2.2	0	-5	5	0
-7.75	0.5	0	-7.75	7.75	0
-7.75	0.5	19	-7.75	7.75	19
-7.75	0.5	-19	-7.75	7.75	-19

D14. ORNL-11: U233-SOL-THERM-008

```
orl1 u233 expt 11 in nse
c
c cell cards
1 1 9.9935322e-02 -1
2 2 6.0274697e-02 -2 1
3 0                2

c surface cards
1 so 61.011
2 so 61.786

c importance card
imp:n 1.0 1.0 0.0
c material cards
m1      92233.31c  3.3441E-05
        92234.31c  5.2503E-07
        92235.31c  1.0184E-08
        92238.31c  2.5474E-07
         7014.31c  7.4943E-05
         8016.31c  3.3469E-02
         1001.31c  6.6357E-02
        90232.31c  1.4756E-07
mt1    lwtr01.31t
c
c al 1100
c
m2      13027.31c  5.9881E-02
      14028.31c   2.00969E-04
      14029.31c   1.01759E-05
      14030.31c   6.75490E-06
      26054.31c   6.40495E-06
      26056.31c   1.00544E-04
      26057.31c   2.32200E-06
      26058.31c   3.09016E-07
      29063.31c   3.55285E-05
      29065.31c   1.58355E-05
        25055.31c  1.4853E-05
kcode 5000 1.0 200 1200
ksrc 0. 0. 0.
prdmp j 250
print
```

D15. Godiva: HEU-MET-FAST-001

```
Godiva solid bare HEU sphere. CSB Data used. 05/12/93.
1 1 4.7984E-02 -1 imp:n=1
2 0 1 imp:n=0

1 so 8.7407

m1      92235.31c  4.4994E-02
        92238.31c  2.4984E-03
        92234.31c  4.9184E-04
kcode 5000 1.0 200 1200
ksrc 0. 0. 0.
print
```

D16. Flattop-25: HEU-MET-FAST-028

```
K-EFF U(nat) REFLECTED HEU SPHERE
1 1 0.04767449 -1 imp:n=1
2 2 0.048069744 1 -2 imp:n=1
3 0 2 imp:n=0

1 so 6.1156
2 so 24.1242

m1      92234.31c  4.8869E-04
        92235.31c  4.4482E-02
        92238.31c  2.7038E-03
m2      92234.31c  2.6438E-06
        92235.31c  3.4610E-04
        92238.31c  4.7721E-02
kcode 5000 1.0 200 1200
ksrc 0 0 0
print
```

D17. Godiver: HEU-MET-FAST-004

```
Idealized HEU sphere (97.675 w/o) in sphere of H2O TANS 27, 412 (11/77)
1 1 0.048143 -1 $ HEU sphere
2 2 0.10021 1 -2 $ water sphere
3 0 2

1 so 6.5537 $ radius of HEU sphere
2 so 33.471 $ radius of water sphere

mode n
kcode 10000 1.0 50 550
imp:n 1.0 1.0 0.0
sdef cel=1 erg=d1 rad=d2 pos=0.0 0.0 0.0
sp1    -3
si2    0.0 0.65537
sp2    -21 2
vol    1179.1 155891. 0.0
area   539.74 14078.
c HEU (97.675 w/o)
m1   92234.31c 0.011150
     92235.31c 0.97694
     92236.31c 0.0019919
     92238.31c 0.0099250
c Water
m2   1001.31c 0.66667
     8016.31c 0.33333
mt2  lwtr01.31t
totnu
prdmp j 110
print

end of input
```

D18. Zeus-2: HEU-MET-INTER-006, case 2

```
ZEUS  9 Units, 6 C Plates/Unit  Final Benchmark Model  ENDF/B-VI.4+PT
c        Comet Hardware
1        2    0.059114     11  -12   47  -48              $ Platen
2        2    0.059114      9  -19   44  -45              $ Alignment Tube
c        Reflector Regions
3        4    0.082780      1   -4    5   -8   10  -41
                           49                           $ Below Top Reflector
4        4    0.082780      1   -4    5   -8   41  -42  $ Upper Reflector
5        4    0.082780      1   -4    5   -8   42  -43
                          #40                           $ Hollow Reflector
6        4    0.082780     12  -13   46  -48            $ Bottom Reflector
c        Column of Platters
7        3    0.085821     13  -14   46  -48            $ Unit 1, Lwr Gr
8        1    0.048176     14  -15   46  -48            $ Unit 1, Inner HEU
9        3    0.085821     15  -16   46  -48            $ Unit 1, Upr Gr
10       3    0.085821     16  -17   46  -48            $ Unit 2, Lwr Gr
11       1    0.048176     17  -18   46  -48            $ Unit 2, Inner HEU
12       3    0.085821     18  -19   46  -48            $ Unit 2, Upr Gr
13       3    0.085821     19  -20  -48                 $ Unit 3, Lwr
14       1    0.048176     20  -21  -48                 $ Unit 3, Inner HEU
15       3    0.085821     21  -22  -48                 $ Unit 3, Upr Gr
16       3    0.085821     22  -23  -48                 $ Unit 4, Lwr Gr
17       1    0.048176     23  -24  -48                 $ Unit 4, Inner HEU
18       3    0.085821     24  -25  -48                 $ Unit 4, Upr Gr
19       3    0.085821     25  -26  -48                 $ Unit 5, Lwr Gr
20       1    0.048176     26  -27  -48                 $ Unit 5, Inner HEU
21       3    0.085821     27  -28  -48                 $ Unit 5, Upr Gr
22       3    0.085821     28  -29  -48                 $ Unit 6, Lwr Gr
23       1    0.048176     29  -30  -48                 $ Unit 6, Inner HEU
24       3    0.085821     30  -31  -48                 $ Unit 6, Upr Gr
25       3    0.085821     31  -32  -48                 $ Unit 7, Lwr Gr
26       1    0.048176     32  -33  -48                 $ Unit 7, Inner HEU
27       3    0.085821     33  -34  -48                 $ Unit 7, Upr Gr
28       3    0.085821     34  -35  -48                 $ Unit 8, Lwr Gr
29       1    0.048176     35  -36  -48                 $ Unit 8, Inner HEU
30       3    0.085821     36  -37  -48                 $ Unit 8, Upr Gr
31       3    0.085821     37  -38  -48                 $ Unit 9, Lwr Gr
32       1    0.048176     38  -39  -48                 $ Unit 9, Inner HEU
33       3    0.085821     39  -40  -48                 $ Unit 9, Upr Gr
c        Internal Voids
34       0                 11  -12   45  -47            $ A-Tube - Platen Gap
35       0                 10  -11   45  -49            $ A-Tube - Refl Gap
36       0                  9  -19  -44                 $ Inside Alig. Tube
37       0                 12  -19   45  -46            $ Tube-Platter Gap
38       0                 11  -41   48  -49            $ Platter-Rfl Gap
39       0                 40  -41  -48                 $ Column-Upr Rfl Gap
40       0                  2   -3    6   -7   42  -43  $ Above Top Reflector
c        External Voids
41       0                 -1   10                      $ Left of Side Rfls
42       0                  4   10                      $ Right of Side Rfls
43       0                  1   -4   -5   10            $ Front of Side Rfls
44       0                  1   -4    8   10            $ Behind Side Rfls
45       0                  1   -4    5   -8   43       $ Above Side Reflect
46       0                -10   #2  #36                 $ Below Reflectors

1       px           -44.14520                          $ Left Rfl Edge
2       px           -27.94000                          $ Left Int Rfl Edge
3       px            27.94000                          $ Right Int Rfl Edge
4       px            44.14520                          $ Right Rfl Edge
5       py           -44.14520                          $ Front Rfl Edge
6       py           -27.94000                          $ Front Int Rfl Edge
7       py            27.94000                          $ Back Int Rfl Edge
```

```
8       py             44.14520                              $ Back Rfl Edge
9       pz             -5.79120                              $ Bottom of Align. Tube
10      pz              0.0                                  $ Bottom of Reflectors
11      pz             26.78384                              $ Bottom of Platen
12      pz             30.59384                              $ Top of Platen
13      pz             45.02104                              $ Column Reflector
14      pz             48.04312                              $ 1st Unit: Lwr Gr
15      pz             48.34284                              $ 1st Unit: HEU
16      pz             51.36492                              $ 1st Unit: Upr Gr
17      pz             54.38700                              $ 2nd Unit: Lwr Gr
18      pz             54.68672                              $ 2nd Unit: HEU
19      pz             57.70880                              $ 2nd Unit: Upr Gr
20      pz             60.73088                              $ 3rd Unit: Lwr Gr
21      pz             61.03060                              $ 3rd Unit: HEU
22      pz             64.05268                              $ 3rd Unit: Upr Gr
23      pz             67.07476                              $ 4th Unit: Lwr Gr
24      pz             67.37448                              $ 4th Unit: HEU
25      pz             70.39656                              $ 4th Unit: Upr Gr
26      pz             73.41864                              $ 5th Unit: Lwr Gr
27      pz             73.71836                              $ 5th Unit: HEU
28      pz             76.74044                              $ 5th Unit: Upr Gr
29      pz             79.76252                              $ 6th Unit: Lwr Gr
30      pz             80.06224                              $ 6th Unit: HEU
31      pz             83.08432                              $ 6th Unit: Upr Gr
32      pz             86.10640                              $ 7th Unit: Lwr Gr
33      pz             86.40612                              $ 7th Unit: HEU
34      pz             89.42820                              $ 7th Unit: Upr Gr
35      pz             92.45028                              $ 8th Unit: Lwr Gr
36      pz             92.75000                              $ 8th Unit: HEU
37      pz             95.77208                              $ 8th Unit: Upr Gr
38      pz             98.79416                              $ 9th Unit: Lwr Gr
39      pz             99.09388                              $ 9th Unit: HEU
40      pz            102.11596                              $ 9th Unit: Upr Gr
41      pz            102.89540                              $ Top of Crnr Refls
42      pz            117.32260                              $ Top Reflector
43      pz            123.90120                              $ Top of Side Refls
44      cz              2.5400                               $ 1.0-in Radius
45      cz              3.1496                               $ 1.24-in. Radius
46      cz              3.1750                               $ 1.25-in. Radius
47      cz              4.7625                               $ 1.875-in. Radius
48      cz             26.6700                               $ Platter OR
49      cz             26.7970                               $ Corner Rfl IR

mode     n
kcode    10000    1.0     50    550
imp:n    1.0      39r   0.0     5r
ksrc       0.0  -15.0   48.17287       0.0   15.0   48.17287
         -15.0    0.0   48.17287      15.0    0.0   48.17287
           0.0  -15.0   54.52084       0.0   15.0   52.52084
         -15.0    0.0   54.52084      15.0    0.0   52.52084
           0.0  -15.0   61.15252       0.0   15.0   61.15252
         -15.0    0.0   61.15252      15.0    0.0   61.15252
           0.0  -15.0   67.51164       0.0   15.0   67.51164
         -15.0    0.0   67.51164      15.0    0.0   67.51164
           0.0  -15.0   73.85198       0.0   15.0   73.85198
         -15.0    0.0   73.85198      15.0    0.0   73.85198
           0.0  -15.0   80.19334       0.0   15.0   80.19334
         -15.0    0.0   80.19334      15.0    0.0   80.19334
           0.0  -15.0   86.53822       0.0   15.0   86.53822
         -15.0    0.0   86.53822      15.0    0.0   86.53822
           0.0  -15.0   92.87829       0.0   15.0   92.87829
         -15.0    0.0   92.87829      15.0    0.0   92.87829
           0.0  -15.0   99.21454       0.0   15.0   99.21454
         -15.0    0.0   99.21454      15.0    0.0   99.21454
vol          8242.27      691.91
           569966.67  112462.83    30739.30   31781.3
             6657.37      660.26    6657.37
             6657.37      660.26    6657.37
```

```
              6753.08     669.75    6753.08
              6753.08     669.75    6753.08
              6753.08     669.75    6753.08
              6753.08     669.75    6753.08
              6753.08     669.75    6753.08
              6753.08     669.75    6753.08
              6753.08     669.75    6753.08
               152.75   59587.30    1287.04      13.68
              1623.64    1741.72   20542.20
                 0.0        5r
area         10939.29     367.61     367.61   10939.29
             10939.29     367.61     367.61   10939.29
                31.16   10630.76
              2224.75    2203.42    2202.91
              2202.91    2202.91    2202.91
              2202.91    2202.91    2234.58
              2234.58    2234.58    2234.58
              2234.58    2234.58    2234.58
              2234.58    2234.58    2234.58
              2234.58    2234.58    2234.58
              2234.58    2234.58    2234.58
              2234.58    2234.58    2234.58
              2234.58    2234.58    2234.58
              7795.19    7715.19    7795.19    1013.41
              1256.63     540.92     114.01
             12754.20   17324.60
c        Average HEU (93.22 wt.%)
m1      92234.31c  4.9576E-04
        92235.31c  4.4941E-02
        92236.31c  1.5931E-04
        92238.31c  2.5799E-03
c        Aluminum 6061 (2.70 g/cc)
m2    12024.31c   5.21721E-04
      12025.31c   6.60490E-05
      12026.31c   7.27200E-05
        13027.31c  5.7816E-02
      14028.31c   3.16303E-04
      14029.31c   1.60158E-05
      14030.31c   1.06314E-05
      22046.31c   2.07455E-06
      22047.31c   1.87086E-06
      22048.31c   1.85376E-05
      22049.31c   1.36040E-06
      22050.31c   1.30256E-06
        24050.31c  3.3536E-06
        24052.31c  6.4673E-05
        24053.31c  7.3325E-06
        24054.31c  1.8254E-06
        25055.31c  2.1915E-05
        26054.31c  5.9360E-06
        26056.31c  9.2280E-05
        26057.31c  2.1128E-06
        26058.31c  2.8171E-07
        29063.31c  4.8053E-05
        29065.31c  2.1418E-05
c        Graphite (1.7117 g/cc)
m3       6000.31c  8.5821E-02
c        Pure Copper (Average:  8.7351 g/cc)
m4      29063.31c  5.7259E-02
        29065.31c  2.5521E-02
mt3      grph01.31t
totnu
prdmp     j   1275
print

 end of input
```

D19. SB-5: U233-COMP-THERM-001, case 6

```
full LWBR SB-5 benchmark
c  hexagonal array
c  U235, 217 UO2-ZrO2 seed rods
c  ThO2 blanket rods
c
c  Cells
c  surface order:  pz1 ... cz1 ... (axial, then radial)
c  seed rod, infinitely long
11   5   4.3036-2    1     -21               u=1  imp:n=1  $ top zircaloy plug
12   2   8.2231-2    2  -1 -21               u=1  imp:n=1  $ 235UO2-ZrO2 seed
13   5   4.3036-2   -2 -21                   u=1  imp:n=1  $ bott. Zircal.plug
14   0                  21 -22               u=1  imp:n=1  $ void around meat
15   5   4.3036-2       22 -23               u=1  imp:n=1  $ zircaloy clad
16  12   1.1828-1  -200 201 23 -202          u=1  imp:n=1  $ poly ring
17   6   1.0010-1  -200 201 202              u=1  imp:n=1  $ water around ring
18   6   1.0010-1   200     23               u=1  imp:n=1  $ water above ring
19   6   1.0010-1  -201     23               u=1  imp:n=1  $ water below ring
21   6   1.0010-1      -99                   u=2  imp:n=1  $ water "rod"
c  blanket rod, infinitely long
51   5   4.3036-2    1     -41               u=9  imp:n=1  $ top zircaloy plug
52   3   6.4923-2    2  -1 -41               u=9  imp:n=1  $ ThO2 blanket
53   5   4.3036-2   -2 -41                   u=9  imp:n=1  $ bott. Zircal.plug
54   0                  41 -42               u=9  imp:n=1  $ void around meat
55   5   4.3036-2       42 -43               u=9  imp:n=1  $ zircaloy clad
56   6   1.0010-1           43               u=9  imp:n=1  $ surrounding water
c  core array
61   0        -52 55 -51 54 -56 53   lat=2   u=8  imp:n=1
                 fill=-24:24 -24:24 0:0
                                     2 27R 2 16R 2  3R
                                    2 26R  2 17R  2  3R
                                   2 25R   2 18R   2  3R
                                  2 24R    2 19R    2  3R
                                 2 23R   9 20R       2  3R
                                2 22R   9 21R         2  3R
                               2 21R   9 22R           2  3R
                              2 20R   9 23R             2  3R
                             2 19R   9 24R               2  3R
                            2 18R   9 25R                 2  3R
                           2 17R   9 26R                   2  3R
                          2 16R   9 27R                     2  3R
                         2 15R   9 28R                       2  3R
                        2 14R   9 29R                         2  3R
                       2 13R   9 30R                           2  3R
                      2 12R   9 31R                             2  3R
                     2 11R   9 11R   1 1 1 1 1 1 1 1 1   9 11R   2  3R
                    2 10R   9 11R   1 1 1 1 1 1 1 1 1 1   9 11R   2  3R
                   2  9R   9 11R   1 1 1 1 1 1 1 1 1 1 1   9 11R   2  3R
                  2  8R   9 11R   1 1 1 1 1 1 1 1 1 1 1 1   9 11R   2  3R
                 2  7R   9 11R   1 1 1 1 1 1 1 1 1 1 1 1 1   9 11R   2  3R
                2  6R   9 11R   1 1 1 1 1 1 1 1 1 1 1 1 1 1   9 11R   2  3R
               2  5R   9 11R   1 1 1 1 1 1 1 1 1 1 1 1 1 1 1   9 11R   2  3R
              2  4R   9 11R   1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1   9 11R   2  3R
             2  3R   9 11R   1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1   9 11R   2  3R
              2  3R   9 11R   1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1   9 11R   2  4R
               2  3R   9 11R   1 1 1 1 1 1 1 1 1 1 1 1 1 1 1   9 11R   2  5R
                2  3R   9 11R   1 1 1 1 1 1 1 1 1 1 1 1 1 1   9 11R   2  6R
                 2  3R   9 11R   1 1 1 1 1 1 1 1 1 1 1 1 1   9 11R   2  7R
                  2  3R   9 11R   1 1 1 1 1 1 1 1 1 1 1 1   9 11R   2  8R
                   2  3R   9 11R   1 1 1 1 1 1 1 1 1 1 1   9 11R   2  9R
                    2  3R   9 11R   1 1 1 1 1 1 1 1 1 1   9 11R   2 10R
                     2  3R   9 11R   1 1 1 1 1 1 1 1 1   9 11R   2 11R
                      2  3R   9 31R                             2 12R
                       2  3R   9 30R                           2 13R
                        2  3R   9 29R                         2 14R
```

```
                         2  3R   9 28R                    2 15R
                          2  3R   9 27R                  2 16R
                           2  3R   9 26R                2 17R
                            2  3R   9 25R              2 18R
                             2  3R   9 24R            2 19R
                              2  3R   9 23R          2 20R
                               2  3R   9 22R        2 21R
                                2  3R   9 21R      2 22R
                                 2  3R   9 20R    2 23R
                                  2  3R   2 19R  2 24R
                                   2  3R  2 18R  2 25R
                                    2  3R 2 17R 2 26R
                                     2  3R 2 16R 2 27R
75   0                 -69          fill=8  u=6   imp:n=1  $ cut array
76   6   1.0010-1      69                   u=6   imp:n=1  $ wat.outside core
c  rod array with control blade bank
78  10  8.8821-2  -73 74 -76 75             u=13  imp:n=1  $ control blade a
79  10  8.8821-2  -73 74 -78 77             u=13  imp:n=1  $ control blade b
80  10  8.8821-2  -73 74 -79 80             u=13  imp:n=1  $ control blade c
81  10  8.8821-2  -73 74 -81 82             u=13  imp:n=1  $ control blade d
82   0         -5  #78 #79 #80 #81  fill=6  u=13  imp:n=1  $ core
83   6  1.0010-1    5  #78 #79 #80 #81      u=13  imp:n=1  $ water above core
c  rod array without control blade bank
93   0             +6               fill=6  u=14  imp:n=1  $ core
96   6  1.0010-1   -6                       u=14  imp:n=1  $ water below core
c  put it all together
97   0             -91  12 -15   fill=13          imp:n=1  $
98   0             -91  16 -12   fill=14          imp:n=1  $
101  0              91:15:-16                     imp:n=0  $ outside

c
c  Surfaces
c  fixed elevations, pz, 0.00 = middle of fuel region
1   pz    19.05     $ fuel top (half of 15in fuel length)
2   pz   -19.05     $ fuel bottom
5   pz    25.8191   $ rod top (half of 20.83-.25in rod length)
6   pz   -25.8191   $ rod bott., bott. of bott. rod spac. plate,top base plate
12  pz    15.765    $ control blade bank lower edge
15  pz    56.30     $ 1 ft above fuel
16  pz   -56.30     $ 1 ft below fuel
200 pz     0.3175   $ poly ring top (1/8 in.)
201 pz    -0.3175   $ bottom of poly rings (1/8 in.)
202 cz     0.72517  $ assumed poly ring R (=blanket pitch/2)
c  235U seed radial surfaces
21  cz     0.26797  $ 0.211in. OD Seed fuel pellet/zirc plug
22  cz     0.27940  $ 0.220in. ID Seed clad
23  cz     0.32385  $ 0.255in. OD Seed clad
c  ThO2 Blanket radial surfaces
41  cz     0.62103  $ 0.489in. OD blanket pellet/zirc plug
42  cz     0.63373  $ 0.499in. ID blanket clad
43  cz     0.72390  $ 0.570in. OD blanket clad
c  blanket rod window (hex cell) surfaces
51  p   1  1.73205  0    1.45034  $ pitch = 0.571in. = 1.45034cm
52  px                   0.72517
53  p  -1  1.73205  0   -1.45034
54  p   1  1.73205  0   -1.45034
55  px                  -0.72517
56  p  -1  1.73205  0    1.45034
c  core window surfaces
69  cz    29.8     $ 20.5*pitch=29.7320 but round up
c  control blades
73  px     3.81     $ bank right edge (half of 3in. width)
74  px    -3.81     $ bank left edge (half of 3in. width)
75  py     5.42798  $ blade a inner edge (from core SB-2.5)
76  py     5.60578  $ blade a outer edge (from core SB-2.5)
77  py     1.75006  $ blade b inner edge (from core SB-2.5)
78  py     1.92786  $ blade b outer edge (from core SB-2.5)
79  py    -1.75006  $ blade c inner edge (from core SB-2.5)
```

```
80  py    -1.92786  $ blade c outer edge (from core SB-2.5)
81  py    -5.42798  $ blade d inner edge (from core SB-2.5)
82  py    -5.60578  $ blade d outer edge (from core SB-2.5)
c  model boundaries
91  cz    60.28     $ core + 1ft
99  cz   259.08     $ 17ft diameter containment tank (neglected)

c
c  Materials Data, Avogadro's number = 6.0221+23 particles/g-mole
m2   $ 235UO2-ZrO2 Seed, Ntot = 8.2231
         8016.31c  5.4821E-02
      40090.31c   1.19580E-02
      40091.31c   2.60775E-03
      40092.31c   3.98600E-03
      40094.31c   4.03946E-03
      40096.31c   6.50776E-04
        92234.31c  3.7302E-05
        92235.31c  3.8783E-03
        92238.31c  2.5273E-04
m3   $ ThO2 blanket, Ntot = 6.4923-2
         8016.31c  4.3282E-02
        90232.31c  2.1641E-02
      64152.31c   1.85214E-10
      64154.31c   2.01883E-09
      64155.31c   1.37058E-08
      64156.31c   1.89567E-08
      64157.31c   1.44930E-08
      64158.31c   2.30036E-08
      64160.31c   2.02439E-08
m5   $ zircaloy-2 cladding plugs etc, Ntot=4.3036-2
      40090.31c   2.18853E-02
      40091.31c   4.77265E-03
      40092.31c   7.29510E-03
      40094.31c   7.39293E-03
      40096.31c   1.19104E-03
      50112.31c   4.84205E-06
      50114.31c   3.24467E-06
      50115.31c   1.69721E-06
      50116.31c   7.25808E-05
      50117.31c   3.83370E-05
      50118.31c   1.20901E-04
      50119.31c   4.28296E-05
      50120.31c   1.62683E-04
      50122.31c   2.31120E-05
      50124.31c   2.89025E-05
m6   $ water, 0.9982 g/cc, Ntot=1.0010-1
         1001.31c  6.6735E-02
         8016.31c  3.3368E-02
mt6  lwtr01.31t
m10  $ borated SS control blades, Ntot=8.8821-2
      26054.31c   3.46369E-03
      26056.31c   5.43725E-02
      26057.31c   1.25570E-03
      26058.31c   1.67110E-04
         5010.31c  3.7488E-03
      24050.31c   7.57247E-04
      24052.31c   1.46027E-02
      24053.31c   1.65583E-03
      24054.31c   4.12172E-04
        25055.31c  8.6816E-04
      28058.31c   5.11742E-03
      28060.31c   1.97121E-03
      28061.31c   8.56949E-05
      28062.31c   2.73171E-04
      28064.31c   6.96083E-05
m12  $ polyethelene rings, Ntot=1.1828-1
         1001.31c  7.8854E-02
         6000.31c  3.9427E-02
```

```
mt12 poly01.31t
mode n
kcode      10000    1.0  50  350
print
ksrc       0    -0.1     0         0    -5       0
           0    -0.1    19         0    -5      19
           0    -0.1   -19         0    -5     -19
           0    -7.5     0         0    -15      0
           0    -7.5    19         0    -15     19
           0    -7.5   -19         0    -15    -19
           0    -25      0
           0    -25     19
           0    -25    -19
           3     -2.5    0        -3     -2.5    0
           5     -6.2    0        -5     -6.2    0
           5     -6.2   19        -5     -6.2   19
           5     -6.2  -19        -5     -6.2  -19
           7.1    -.1     0        -7.1    -.1    0
           7.1    -.1    19        -7.1    -.1   19
           7.1    -.1   -19        -7.1    -.1  -19
           7.1   -7.5     0        -7.1   -7.5    0
          14.5  -15       0       -14.5  -15      0
          14.5  -25       0       -14.5  -25      0
          14.5  -25      19       -14.5  -25     19
          14.5  -25     -19       -14.5  -25    -19
          16      -.1     0       -16      -.1    0
          29      -.1     0       -29      -.1    0
          29      -.1    19       -29      -.1   19
          29      -.1   -19       -29      -.1  -19
           0     5       0
           0     5      19
           0     5     -19
           0     15      0         0     25      0
           0     15     19         0     25     19
           0     15    -19         0     25    -19
           3      2.5    0        -3      2.5    0
           5      6.2    0        -5      6.2    0
           5      6.2   19        -5      6.2   19
           5      6.2  -19        -5      6.2  -19
           7.1    7.5     0        -7.1    7.5    0
          14.5   15       0       -14.5   15      0
          14.5   25       0       -14.5   25      0
          14.5   25      19       -14.5   25     19
          14.5   25     -19       -14.5   25    -19
```

D20. ORNL-10: HEU-SOL-THERM-032

```
or2511 u235 expt 10 in nse
c ICSBEP HEU-SOL-THERM-032 (ORNL-10) ENDF/B-VI.2
c
c cell cards
1 1 1.0016089e-01 -1
2 2 6.0274697e-02 -2 1
3 0 2

c surface cards
1 so 61.011
2 so 61.786

c importance card
imp:n 1.0 1.0 0.0
c material cards
m1      92233.31c  3.9124E-09
        92234.31c  4.0905E-07
        92235.31c  3.6157E-05
        92236.31c  2.0858E-07
        92238.31c  1.9878E-06
         1001.31c  6.6409e-02
         7014.31c  1.1212E-04
         8016.31c  3.3601e-02
mt1 lwtr01.31t
c
c al 1100
c
m2      13027.31c  5.9881E-02
      14028.31c   2.00969E-04
      14029.31c   1.01759E-05
      14030.31c   6.75490E-06
        25055.31c  1.4853E-05
        26054.31c  6.4652E-06
        26056.31c  1.0051E-04
        26057.31c  2.3012E-06
        26058.31c  3.0682E-07
        29063.31c  3.5529E-05
        29065.31c  1.5836E-05
kcode 5000 1.0 200 1200
ksrc 0.0 0.0 0.0
prdmp j 250
print
```

D21. IEU-MF-03: IEU-MET-FAST-003

```
IEU-MET-FAST-003 Layered Uranium Bare Sphere
C ENDF/B-V cross sections, W split by atomic abundance
C W-180 fraction added to w-182 because of cross sections
C Cell Cards
1 1 4.9881e-2 -1
2 2 4.8244e-2 1 -2
3 3 4.7972e-2 2 -3
4 4 4.7722e-2 3 -4
5 5 4.7964e-2 4 -5
6 6 4.7796e-2 5 -6
7 7 4.7702e-2 6 -7
8 8 4.6950e-2 7 -8
9 9 4.8536e-2 8 -9
10 10 4.9395e-2 9 -10
11 0 10

C Surface Cards
1 so 2.000
2 so 6.000
3 so 7.550
4 so 9.150
5 so 11.00
6 so 12.25
7 so 13.25
8 so 14.00
9 so 15.00
10 so 15.324

C Data Cards
imp:n 1 1 1 1 1 1 1 1 1 1 0
kcode 5000 1.0 200 1200
ksrc 0.0 0.0 0.0
prdmp 3j 1 j
m1        92234.31c  1.2743E-04
          92235.31c  1.7093E-02
          92238.31c  2.9308E-02
        26054.31c   1.50292E-05
        26056.31c   2.35927E-04
        26057.31c   5.44859E-06
        26058.31c   7.25107E-07
           6000.31c  5.5181E-04
        29063.31c   8.42698E-04
        29065.31c   3.75602E-04
        28058.31c   8.98004E-04
        28060.31c   3.45908E-04
        28061.31c   1.50377E-05
        28062.31c   4.79361E-05
        28064.31c   1.22149E-05
          74182.31c  1.5874E-06
          74183.31c  8.5799E-07
          74184.31c  1.8445E-06
          74186.31c  1.7184E-06
m2        92234.31c  1.5814E-04
          92235.31c  1.7321E-02
          92238.31c  2.9785E-02
        26054.31c   9.39058E-06
        26056.31c   1.47412E-04
        26057.31c   3.40439E-06
        26058.31c   4.53061E-07
           6000.31c  4.6687E-04
        29063.31c   1.12851E-04
        29065.31c   5.02991E-05
        28058.31c   1.20258E-04
        28060.31c   4.63229E-05
```

```
      28061.31c   2.01381E-06
      28062.31c   6.41946E-06
      28064.31c   1.63578E-06
        74182.31c  3.2232E-06
        74183.31c  1.7422E-06
        74184.31c  3.7454E-06
        74186.31c  3.4892E-06
m3      92234.31c  1.5677E-04
        92235.31c  1.7194E-02
        92238.31c  2.9508E-02
      26054.31c   9.30875E-06
      26056.31c   1.46127E-04
      26057.31c   3.37472E-06
      26058.31c   4.49113E-07
         6000.31c  3.7026E-04
      29063.31c   1.89802E-04
      29065.31c   8.45975E-05
      28058.31c   2.02257E-04
      28060.31c   7.79085E-05
      28061.31c   3.38694E-06
      28062.31c   1.07966E-05
      28064.31c   2.75115E-06
        74182.31c  3.1955E-06
        74183.31c  1.7272E-06
        74184.31c  3.7132E-06
        74186.31c  3.4592E-06
m4      92234.31c  1.5581E-04
        92235.31c  1.7174E-02
        92238.31c  2.9235E-02
      26054.31c   9.25205E-06
      26056.31c   1.45237E-04
      26057.31c   3.35417E-06
      26058.31c   4.46378E-07
         6000.31c  5.5201E-04
      29063.31c   1.44517E-04
      29065.31c   6.44131E-05
      28058.31c   1.53997E-04
      28060.31c   5.93191E-05
      28061.31c   2.57879E-06
      28062.31c   8.22047E-06
      28064.31c   2.09470E-06
        74182.31c  3.1759E-06
        74183.31c  1.7166E-06
        74184.31c  3.6904E-06
        74186.31c  3.4380E-06
m5      92234.31c  1.3256E-04
        92235.31c  1.7141E-02
        92238.31c  2.9417E-02
      26054.31c   6.95789E-06
      26056.31c   1.09224E-04
      26057.31c   2.52246E-06
      26058.31c   3.35693E-07
         6000.31c  7.3802E-04
      29063.31c   1.34349E-04
      29065.31c   5.98811E-05
      28058.31c   1.43166E-04
      28060.31c   5.51470E-05
      28061.31c   2.39742E-06
      28062.31c   7.64230E-06
      28064.31c   1.94738E-06
        74182.31c  3.1847E-06
        74183.31c  1.7213E-06
        74184.31c  3.7006E-06
        74186.31c  3.4474E-06
m6      92234.31c  1.6004E-04
        92235.31c  1.7121E-02
        92238.31c  2.9159E-02
      26054.31c   5.76492E-06
```

```
      26056.31c   9.04970E-05
      26057.31c   2.08997E-06
      26058.31c   2.78137E-07
         6000.31c  5.5031E-04
      29063.31c   2.32916E-04
      29065.31c   1.03814E-04
      28058.31c   2.48202E-04
      28060.31c   9.56064E-05
      28061.31c   4.15633E-06
      28062.31c   1.32492E-05
      28064.31c   3.37610E-06
        74182.31c  1.5831E-06
        74183.31c  8.5566E-07
        74184.31c  1.8395E-06
        74186.31c  1.7137E-06
m7      92234.31c  1.7235E-04
        92235.31c  1.6958E-02
        92238.31c  2.8806E-02
      26054.31c   5.70513E-06
      26056.31c   8.95583E-05
      26057.31c   2.06829E-06
      26058.31c   2.75252E-07
         6000.31c  9.0767E-04
      29063.31c   2.48555E-04
      29065.31c   1.10785E-04
      28058.31c   2.64867E-04
      28060.31c   1.02026E-04
      28061.31c   4.43540E-06
      28062.31c   1.41388E-05
      28064.31c   3.60279E-06
        74182.31c  3.1334E-06
        74183.31c  1.6936E-06
        74184.31c  3.6410E-06
        74186.31c  3.3920E-06
m8      92234.31c  1.4729E-04
        92235.31c  1.6779E-02
        92238.31c  2.8482E-02
      26054.31c   5.63721E-06
      26056.31c   8.84921E-05
      26057.31c   2.04367E-06
      26058.31c   2.71975E-07
         6000.31c  6.2781E-04
      29063.31c   2.69687E-04
      29065.31c   1.20203E-04
      28058.31c   2.87387E-04
      28060.31c   1.10700E-04
      28061.31c   4.81251E-06
      28062.31c   1.53409E-05
      28064.31c   3.90911E-06
        74182.31c  1.5480E-06
        74183.31c  8.3671E-07
        74184.31c  1.7988E-06
        74186.31c  1.6758E-06
m9      92234.31c  1.4996E-04
        92235.31c  1.7018E-02
        92238.31c  2.9013E-02
      26054.31c   8.03571E-06
      26056.31c   1.26143E-04
      26057.31c   2.91320E-06
      26058.31c   3.87694E-07
         6000.31c  1.3697E-03
      29063.31c   2.77766E-04
      29065.31c   1.23804E-04
      28058.31c   2.95992E-04
      28060.31c   1.14015E-04
      28061.31c   4.95661E-06
      28062.31c   1.58003E-05
      28064.31c   4.02616E-06
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```
        74182.31c  3.1522E-06
        74183.31c  1.7037E-06
        74184.31c  3.6628E-06
        74186.31c  3.4123E-06
m10     92234.31c  1.3891E-04
        92235.31c  1.6796E-02
        92238.31c  2.8748E-02
      26054.31c   4.53677E-06
      26056.31c   7.12176E-05
      26057.31c   1.64473E-06
      26058.31c   2.18883E-07
         6000.31c  6.3157E-04
      29063.31c   9.95287E-04
      29065.31c   4.43613E-04
      28058.31c   1.06057E-03
      28060.31c   4.08528E-04
      28061.31c   1.77601E-05
      28062.31c   5.66141E-05
      28064.31c   1.44262E-05
        74182.31c  1.5573E-06
        74183.31c  8.4172E-07
        74184.31c  1.8096E-06
        74186.31c  1.6858E-06
```

D22. BIG TEN: IEU-MET-FAST-007

```
Big Ten Detailed Benchmark IEU-MET-FAST-007
c
c cell cards
1 3 4.8195662E-02 103 -108 4 -3 imp:n=1 $p1 nat
2 1 4.8270100E-02 103 -108 5 -4 imp:n=1 $p2 (93)
3 3 4.8195662E-02 103 -108 6 -5 imp:n=1 $p3 nat
4 1 4.8270100E-02 103 -108 7 -6 imp:n=1 $p4 (93)
5 3 4.8195662E-02 103 -108 8 -7 imp:n=1 $p5 nat
6 1 4.8270100E-02 103 -108 9 -8 imp:n=1 $p6 (93)
7 3 4.8195662E-02 103 -108 10 -9 imp:n=1 $p7 nat
8 1 4.8270100E-02 103 -108 11 -10 imp:n=1 $p8 (93)
9 3 4.8195662E-02 103 -108 12 -11 imp:n=1 $p9 nat
10 1 4.8270100E-02 103 -108 13 -12 imp:n=1 $p10 (93)
11 0 103 -107 14 -13 imp:n=1 $p11 void
12 3 4.8195662E-02 107 -108 15 -13 imp:n=1 $p12 nat
13 1 4.8270100E-02 107 -108 16 -15 imp:n=1 $p13 (93)
14 4 4.7779014E-02 106 -108 18 -16 imp:n=1 $p14 dep
15 0 107 -108 19 -18 imp:n=1 $p15 void
16 1 4.8270100E-02 107 -108 20 -19 imp:n=1 $p16 (93)
17 3 4.8195662E-02 107 -108 21 -20 imp:n=1 $p17 nat
18 0 107 -108 22 -21 imp:n=1 $p18 void
19 3 4.8195662E-02 107 -108 23 -22 imp:n=1 $p19 nat
20 1 4.8270100E-02 107 -108 24 -23 imp:n=1 $p20 (93)
21 3 4.8195662E-02 107 -108 25 -24 imp:n=1 $p21 nat
22 0 107 -108 26 -25 imp:n=1 $p22 void
23 3 4.8195662E-02 107 -108 27 -26 imp:n=1 $p23 nat
24 1 4.8270100E-02 107 -108 28 -27 imp:n=1 $p24 (93)
25 3 4.8195662E-02 107 -108 29 -28 imp:n=1 $p25 nat
26 0 107 -108 30 -29 imp:n=1 $p26 void
27 3 4.8195662E-02 107 -108 31 -30 imp:n=1 $p27 nat
28 1 4.8270100E-02 107 -108 32 -31 imp:n=1 $p28 (93)
29 3 4.8195662E-02 107 -108 33 -32 imp:n=1 $p29 nat
30 0 107 -108 34 -33 imp:n=1 $p30 void
31 3 4.8195662E-02 107 -108 35 -34 imp:n=1 $p31 nat
32 1 4.8270100E-02 107 -108 36 -35 imp:n=1 $p32 (93)
33 3 4.8195662E-02 107 -108 37 -36 imp:n=1 $p33 nat
34 0 107 -108 38 -37 imp:n=1 $p34 void
35 3 4.8195662E-02 107 -108 39 -38 imp:n=1 $p35 nat
36 1 4.8270100E-02 107 -108 40 -39 imp:n=1 $p36 (93)
37 3 4.8195662E-02 107 -108 41 -40 imp:n=1 $p37 nat
38 0 107 -108 42 -41 imp:n=1 $p38 void
39 3 4.8195662E-02 107 -108 43 -42 imp:n=1 $p39 nat
40 1 4.8270100E-02 107 -108 44 -43 imp:n=1 $p40 (93)
41 3 4.8195662E-02 107 -108 45 -44 imp:n=1 $p41 nat
42 0 107 -108 46 -45 imp:n=1 $p42 void
43 3 4.8195662E-02 107 -108 47 -46 imp:n=1 $p43 nat
44 0 107 -108 48 -47 imp:n=1 $p44 void
45 1 4.8270100E-02 105 -108 49 -48 imp:n=1 $p45 (93)
46 3 4.8195662E-02 105 -108 50 -49 imp:n=1 $p46 nat
47 0 105 -108 51 -50 imp:n=1 $p47 void
48 3 4.8195662E-02 105 -108 52 -51 imp:n=1 $p48 nat
49 1 4.8270100E-02 105 -108 53 -52 imp:n=1 $p49 (93)
50 3 4.8195662E-02 105 -108 54 -53 imp:n=1 $p50 nat
51 0 105 -108 55 -54 imp:n=1 $p51 void
52 3 4.8195662E-02 105 -108 56 -55 imp:n=1 $p52 nat
53 1 4.8270100E-02 105 -108 57 -56 imp:n=1 $p53 (93)
54 3 4.8195662E-02 105 -108 58 -57 imp:n=1 $p54 nat
55 0 105 -108 59 -58 imp:n=1 $p55 void
56 3 4.8195662E-02 105 -108 60 -59 imp:n=1 $p56 nat
57 1 4.8270100E-02 105 -108 61 -60 imp:n=1 $p57 (93)
58 3 4.8195662E-02 105 -108 62 -61 imp:n=1 $p58 nat
59 0 105 -108 63 -62 imp:n=1 $p59 void
```

```
60 3 4.8195662E-02 105 -108 64 -63 imp:n=1 $p60 nat
61 1 4.8270100E-02 105 -108 65 -64 imp:n=1 $p61 (93)
62 3 4.8195662E-02 105 -108 66 -65 imp:n=1 $p62 nat
63 0 105 -108 67 -66 imp:n=1 $p63 void
64 3 4.8195662E-02 105 -108 68 -67 imp:n=1 $p64 nat
65 1 4.8270100E-02 105 -108 69 -68 imp:n=1 $p65 (93)
66 5 4.8086876E-02 105 -108 71 -69 imp:n=1 $p66 mix
67 0 100 -101 17 -1 imp:n=1 $CV void
68 7 8.7974300E-02 101 -102 17 -1 imp:n=1 $CL ss304
69 2 4.7609209E-02 -105 70 -48 imp:n=1 $C1 (10)
70 2 4.7609209E-02 -107 48 -18 imp:n=1 $C2 (10)
71 2 4.7609209E-02 -106 18 -17 imp:n=1 $C3 (10)
72 2 4.7609209E-02 103 -106 17 -16 imp:n=1 $C4 (10)
73 2 4.7609209E-02 103 -107 16 -14 imp:n=1 $C5 (10)
74 2 4.7609209E-02 -100 17 -1 imp:n=1 $C6 (10)
75 2 4.7609209E-02 102 -103 17 -3 imp:n=1 $C7 (10)
76 2 4.7609209E-02 102 -104 3 -2 imp:n=1 $C8 (10)
77 4 4.7779014E-02 -105 72 -70 imp:n=1 $R1 dep
78 4 4.7779014E-02 105 -108 72 -71 imp:n=1 $R2 dep
79 4 4.7779014E-02 108 -109 72 -1 112 115 118 121 124 127 imp:n=1 $R3 dep
80 4 4.7779014E-02 105 -108 3 -1 imp:n=1 $R4 dep
81 4 4.7779014E-02 102 -105 2 -1 imp:n=1 $R5 dep
82 4 4.7779014E-02 104 -105 3 -2 imp:n=1 $R6 dep
83 4 4.7779014E-02 -110 72 -1 imp:n=1 $rrod1 dep
84 0 110 -111 72 -1 imp:n=1 $rv1 void
85 6 8.7493450E-02 111 -112 72 -1 imp:n=1 $rl1 ss347
86 4 4.7779014E-02 -113 72 -1 imp:n=1 $rrod2 dep
87 0 113 -114 72 -1 imp:n=1 $rv2 void
88 6 8.7493450E-02 114 -115 72 -1 imp:n=1 $rl2 ss347
89 4 4.7779014E-02 -116 72 -1 imp:n=1 $rrod3 dep
90 0 116 -117 72 -1 imp:n=1 $rv3 void
91 6 8.7493450E-02 117 -118 72 -1 imp:n=1 $rl3 ss347
92 4 4.7779014E-02 -119 72 -1 imp:n=1 $rrod4 dep
93 0 119 -120 72 -1 imp:n=1 $rv4 void
94 6 8.7493450E-02 120 -121 72 -1 imp:n=1 $rl4 ss347
95 4 4.7779014E-02 -122 72 -1 imp:n=1 $rrod5 dep
96 0 122 -123 72 -1 imp:n=1 $rv5 void
97 6 8.7493450E-02 123 -124 72 -1 imp:n=1 $rl5 ss347
98 4 4.7779014E-02 -125 72 -1 imp:n=1 $rrod6 dep
99 0 125 -126 72 -1 imp:n=1 $rv6 void
100 6 8.7493450E-02 126 -127 72 -1 imp:n=1 $rl6 ss347
101 0 (109:-72:1) imp:n=0

c surface cards
1 pz 39.05250 $top of C6, CV CL R5 R4 R3
2 pz 25.71750 $top of C8 R6
3 pz 23.81250 $top of P1 C7
4 pz 16.66240 $top of P2
5 pz 16.36268 $top of P3
6 pz 13.66012 $top of P4
7 pz 13.36040 $top of P5
8 pz 10.65784 $top of P6
9 pz 10.35812 $top of P7
10 pz 7.65556 $top of P8
11 pz 7.35584 $top of P9
12 pz 4.65328 $top of P10
13 pz 4.35356 $top of P11 and P12
14 pz 4.35102 $top of C5
15 pz 1.65100 $top of P13
16 pz 1.35128 $top of P14 C4
17 pz 0.00000 $top of C3
18 pz -1.35128 $top of P15 C2
19 pz -1.35382 $top of P16
20 pz -1.65354 $top of P17
21 pz -3.15468 $top of P18
22 pz -3.15722 $top of P19
23 pz -4.35864 $top of P20
24 pz -4.65836 $top of P21
```

```
25 pz -6.15950 $top of P22
26 pz -6.16204 $top of P23
27 pz -7.36346 $top of P24
28 pz -7.66318 $top of P25
29 pz -9.16432 $top of P26
30 pz -9.16686 $top of P27
31 pz -10.36828 $top of P28
32 pz -10.66800 $top of P29
33 pz -12.16914 $top of P30
34 pz -12.17168 $top of P31
35 pz -13.37310 $top of P32
36 pz -13.67282 $top of P33
37 pz -15.17396 $top of P34
38 pz -15.17650 $top of P35
39 pz -16.37792 $top of P36
40 pz -16.67764 $top of P37
41 pz -18.17878 $top of P38
42 pz -18.18132 $top of P39
43 pz -19.38274 $top of P40
44 pz -19.68246 $top of P41
45 pz -21.18360 $top of P42
46 pz -21.18614 $top of P43
47 pz -22.38756 $top of P44
48 pz -22.39010 $top of P45 C1
49 pz -22.68982 $top of P46
50 pz -24.19096 $top of P47
51 pz -24.19350 $top of P48
52 pz -25.39492 $top of P49
53 pz -25.69464 $top of P50
54 pz -27.19578 $top of P51
55 pz -27.19832 $top of P52
56 pz -28.39974 $top of P53
57 pz -28.69946 $top of P54
58 pz -30.20060 $top of P55
59 pz -30.20314 $top of P56
60 pz -31.40456 $top of P57
61 pz -31.70428 $top of P58
62 pz -33.20542 $top of P59
63 pz -33.20796 $top of P60
64 pz -34.40938 $top of P61
65 pz -34.70910 $top of P62
66 pz -36.21024 $top of P63
67 pz -36.21278 $top of P64
68 pz -37.41420 $top of P65
69 pz -37.71392 $top of P66
70 pz -41.73361 $top of R1
71 pz -42.22750 $bot of P66 top of R2
72 pz -57.46750 $bottom of R1 R2 R3
100 cz 1.79451 $o.r. C6 i.r. CV
101 cz 1.81610 $o.r. cv i.r. CL
102 cz 1.90500 $o.r. Cl i.r. C7, C8, R5
103 cz 3.17500 $o.r. c7 i.r. C4, C5, P1-P11
104 cz 4.28625 $o.r. c8 i.r. R6
105 cz 7.62000 $o.r. C1, R1, R5, R6 i.r. P45 - P66, R2, R4
106 cz 11.11250 $o.r. c3, c4 i.r. P14
107 cz 12.70000 $o.r. C2, C5, P11 i.r. P12, P13, P15-P44
108 cz 26.67000 $o.r. R2, R4, P1-66 i.r. R3
109 cz 41.91000 $o.r. R3
110 c/z 0.00000 -33.49752 4.43865 $o.r. rrod1
111 c/z 0.00000 -33.49752 4.52501 $o.r. rv1
112 c/z 0.00000 -33.49752 4.60375 $o.r. rl1
113 c/z -29.00970 -16.74876 4.43865 $o.r.1 rrod2
114 c/z -29.00970 -16.74876 4.52501 $o.r.1 rv2
115 c/z -29.00970 -16.74876 4.60375 $o.r.1 rl2
116 c/z 29.00970 -16.74876 4.43865 $o.r.1 rrod3
117 c/z 29.00970 -16.74876 4.52501 $o.r.1 rv3
118 c/z 29.00970 -16.74876 4.60375 $o.r.1 rl3
119 c/z -29.00970 16.74876 4.43865 $o.r.1 rrod4
```

```
120 c/z -29.00970 16.74876 4.52501 $o.r.1 rv4
121 c/z -29.00970 16.74876 4.60375 $o.r.1 rl4
122 c/z 29.00970 16.74876 4.43865 $o.r.1 rrod5
123 c/z 29.00970 16.74876 4.52501 $o.r.1 rv5
124 c/z 29.00970 16.74876 4.60375 $o.r.1 rl5
125 c/z 0.00000 33.49752 4.43865 $o.r. rrod6
126 c/z 0.00000 33.49752 4.52501 $o.r. rv6
127 c/z 0.00000 33.49752 4.60375 $o.r. rl6

c material cards
m1   $ U(93)
        92234.31c  4.9814E-04
        92235.31c  4.5034E-02
        92236.31c  1.3236E-04
        92238.31c  2.6056E-03
m2   $ U(10)
        92234.31c  2.4761E-05
        92235.31c  4.8461E-03
        92236.31c  4.3348E-05
        92238.31c  4.2695E-02
m3   $ U(nat)
        92234.31c  2.6518E-06
        92235.31c  3.4701E-04
        92238.31c  4.7846E-02
m4   $ U(dep)
        92234.31c  2.8672E-07
        92235.31c  1.0058E-04
        92236.31c  1.1468E-06
        92238.31c  4.7677E-02
m5   $ P66
        92234.31c  2.6458E-06
        92235.31c  3.4623E-04
        92238.31c  4.7738E-02
m6   $ steel 347
      14028.31c   1.58211E-03
      14029.31c   8.01092E-05
      14030.31c   5.31774E-05
      24050.31c   7.24659E-04
      24052.31c   1.39743E-02
      24053.31c   1.58458E-03
      24054.31c   3.94435E-04
        25055.31c  1.7539E-03
      26054.31c   3.37829E-03
      26056.31c   5.30320E-02
      26057.31c   1.22474E-03
      26058.31c   1.62990E-04
      28058.31c   6.14708E-03
      28060.31c   2.36783E-03
      28061.31c   1.02937E-04
      28062.31c   3.28136E-04
      28064.31c   8.36141E-05
        41093.31c  5.1855E-04
m7   $ steel 304
      14028.31c   1.58211E-03
      14029.31c   8.01092E-05
      14030.31c   5.31774E-05
      24050.31c   7.64894E-04
      24052.31c   1.47502E-02
      24053.31c   1.67256E-03
      24054.31c   4.16335E-04
        25055.31c  1.7539E-03
      26054.31c   3.46655E-03
      26056.31c   5.44175E-02
      26057.31c   1.25674E-03
      26058.31c   1.67249E-04
      28058.31c   5.16909E-03
      28060.31c   1.99111E-03
      28061.31c   8.65602E-05
```

```
      28062.31c   2.75930E-04
      28064.31c   7.03112E-05
kcode 5000 1.00 200 1200
prdmp j -60 j 2
ksrc   .1 0. -39.6 .1 0. -33.5 .1 0. -27.0 .1 0. -21.0 .1 0. -15.0
       .1 0. -9.0 .1 0. -3.0 .1 0. -0.68 .1 0. 6.0 .1 0. 15.
       .1 0. 32.3
      7.1 .1 0.68 .1 7.1 0.68 -7.1 .1 0.68 .1 -7.1 0.68
      8.5 .1 2.85 .1 8.5 2.85 -8.5 .1 2.85 .1 -8.5 2.85
      2.5 .1 9.00 .1 2.5 9.00 -2.5 .1 9.00 .1 -2.5 9.00
      2.5 .1 20.2 .1 2.5 20.2 -2.5 .1 20.2 .1 -2.5 20.2
      3.1 .1 24.8 .1 3.1 24.8 -3.1 .1 24.8 .1 -3.1 24.8
     17.1 .1 -37.6 .1 17.1 -37.6 -17.1 .1 -37.6 .1 -17.1 -37.6
     17.1 .1 -34.6 .1 17.1 -34.6 -17.1 .1 -34.6 .1 -17.1 -34.6
     17.1 .1 -32.5 .1 17.1 -32.5 -17.1 .1 -32.5 .1 -17.1 -32.5
     17.1 .1 -28.6 .1 17.1 -28.6 -17.1 .1 -28.6 .1 -17.1 -28.6
     17.1 .1 -25.5 .1 17.1 -25.5 -17.1 .1 -25.5 .1 -17.1 -25.5
     17.1 .1 -22.5 .1 17.1 -22.5 -17.1 .1 -22.5 .1 -17.1 -22.5
     19.7 .1 -19.5 .1 19.7 -19.5 -19.7 .1 -19.5 .1 -19.7 -19.5
     19.7 .1 -16.5 .1 19.7 -16.5 -19.7 .1 -16.5 .1 -19.7 -16.5
     19.7 .1 -13.5 .1 19.7 -13.5 -19.7 .1 -13.5 .1 -19.7 -13.5
     19.7 .1 -10.5 .1 19.7 -10.5 -19.7 .1 -10.5 .1 -19.7 -10.5
     19.7 .1 -7.5 .1 19.7 -7.5 -19.7 .1 -7.5 .1 -19.7 -7.5
     19.7 .1 -4.5 .1 19.7 -4.5 -19.7 .1 -4.5 .1 -19.7 -4.5
     19.7 .1 -1.5 .1 19.7 -1.5 -19.7 .1 -1.5 .1 -19.7 -1.5
     19.7 .1 1.5 .1 19.7 1.5 -19.7 .1 1.5 .1 -19.7 1.5
     14.9 .1 4.5 .1 14.9 4.5 -14.9 .1 4.5 .1 -14.9 4.5
     14.9 .1 7.5 .1 14.9 7.5 -14.9 .1 7.5 .1 -14.9 7.5
     14.9 .1 10.5 .1 14.9 10.5 -14.9 .1 10.5 .1 -14.9 10.5
     14.9 .1 13.5 .1 14.9 13.5 -14.9 .1 13.5 .1 -14.9 13.5
     14.9 .1 16.5
```

D23. IEU-MF-04: IEU-MET-FAST-004

```
IEU-MET-FAST-004 Layered Uranium Sphere, Graphite Reflected
C ENDF/B-V cross sections, W split by atomic abundance
C W-180 fraction added to W-182 because of cross sections
C Graphite thermal S(alpha,beta) treatment applied at 300K
C Cell Cards
1 0 -1
2 1 4.8243e-2 1 -2
3 2 4.8009e-2 2 -3
4 3 4.7960e-2 3 -4
5 4 4.8156e-2 4 -5
6 5 4.7909e-2 5 -6
7 6 4.7973e-2 6 -7
8 7 4.7478e-2 7 -8
9 8 7.7716e-2 8 -9
10 0 9

C Surface Cards
1 so 2.788
2 so 6.000
3 so 7.550
4 so 9.150
5 so 11.00
6 so 12.25
7 so 13.25
8 so 14.00
9 so 17.2

C Data Cards
imp:n 1 1 1 1 1 1 1 1 1 0
kcode 5000 1.0 200 1200
ksrc 5 0 0
prdmp j 350 j 1
C Material Cards
m1       92234.31c  1.5926E-04
         92235.31c  1.7443E-02
         92238.31c  2.9996E-02
       26054.31c   9.45721E-06
       26056.31c   1.48458E-04
       26057.31c   3.42854E-06
       26058.31c   4.56276E-07
          6000.31c  4.7018E-04
         74182.31c  3.2462E-06
         74183.31c  1.7546E-06
         74184.31c  3.7721E-06
         74186.31c  3.5141E-06
m2       92234.31c  1.5878E-04
         92235.31c  1.7415E-02
         92238.31c  2.9887E-02
       26054.31c   9.42857E-06
       26056.31c   1.48008E-04
       26057.31c   3.41816E-06
       26058.31c   4.54894E-07
          6000.31c  3.7502E-04
         74182.31c  3.2365E-06
         74183.31c  1.7493E-06
         74184.31c  3.7608E-06
         74186.31c  3.5035E-06
m3       92234.31c  1.5803E-04
         92235.31c  1.7418E-02
         92238.31c  2.9651E-02
       26054.31c   9.38356E-06
       26056.31c   1.47302E-04
```

```
       26057.31c   3.40184E-06
       26058.31c   4.52723E-07
          6000.31c  5.5986E-04
         74182.31c  3.2211E-06
         74183.31c  1.7410E-06
         74184.31c  3.7429E-06
         74186.31c  3.4869E-06
m4       92234.31c  1.3423E-04
         92235.31c  1.7356E-02
         92238.31c  2.9786E-02
       26054.31c   7.04556E-06
       26056.31c   1.10600E-04
       26057.31c   2.55424E-06
       26058.31c   3.39923E-07
          6000.31c  7.4727E-04
         74182.31c  3.2246E-06
         74183.31c  1.7429E-06
         74184.31c  3.7469E-06
         74186.31c  3.4906E-06
m5       92234.31c  1.6281E-04
         92235.31c  1.7417E-02
         92238.31c  2.9663E-02
       26054.31c   5.86487E-06
       26056.31c   9.20660E-05
       26057.31c   2.12620E-06
       26058.31c   2.82959E-07
          6000.31c  5.5983E-04
         74182.31c  1.6105E-06
         74183.31c  8.7045E-07
         74184.31c  1.8713E-06
         74186.31c  1.7433E-06
m6       92234.31c  1.7609E-04
         92235.31c  1.7326E-02
         92238.31c  2.9432E-02
       26054.31c   5.82893E-06
       26056.31c   9.15017E-05
       26057.31c   2.11317E-06
       26058.31c   2.81225E-07
          6000.31c  9.2737E-04
         74182.31c  3.2013E-06
         74183.31c  1.7303E-06
         74184.31c  3.7199E-06
         74186.31c  3.4655E-06
m7       92234.31c  1.5156E-04
         92235.31c  1.7266E-02
         92238.31c  2.9309E-02
       26054.31c   5.80087E-06
       26056.31c   9.10613E-05
       26057.31c   2.10300E-06
       26058.31c   2.79871E-07
          6000.31c  6.4604E-04
         74182.31c  1.5930E-06
         74183.31c  8.6100E-07
         74184.31c  1.8510E-06
         74186.31c  1.7244E-06
m8        6000.31c  7.7716E-02
mt8    grph01.31t
```

D24. Zebra-8H: MIX-MET-FAST-008, case 7

```
ZEBRA 8H
c U nat
  41 1 4.713345E-02 1 -2 -103 104 -203 204 imp:n=1
c U enriched
  42 2 4.740186E-02 2 -3 -103 104 -203 204 imp:n=1
c U nat
  43 1 4.713345E-02 3 -4 -103 104 -203 204 imp:n=1
c void
  3 0 1 -4 -105 106 -205 206 (103:-104:203:-204) imp:n=1
c Sheath
  4 3 8.567983E-02 1 -4 -107 108 -207 208 (105:-106:205:-206) imp:n=1
c supercell
  5 0 -1:4:107:-108:207:-208 imp:n=0

1 -4 pz 0
2 pz 0.9525
3 pz 1.27
4 -1 pz 2.2225
c
103 px 2.5335 $ Can and other pellets
104 px -2.5335 $ Can and other pellets
105 px 2.5510 $ Air gap
106 px -2.5510 $ Air gap
107 -108 px 2.6272 $ Sheath
108 -107 px -2.6272 $ Sheath
c
203 py 2.5335 $ Can and other pellets
204 py -2.5335 $ Can and other pellets
205 py 2.5510 $ Air gap
206 py -2.5510 $ Air gap
*207 py 2.6272 $ Sheath
*208 py -2.6272 $ Sheath

m1      92235.31c  3.3316E-04
        92238.31c  4.5948E-02
         6000.31c  4.9205E-04
      26054.31c   6.18576E-06
      26056.31c   9.71033E-05
      26057.31c   2.24254E-06
      26058.31c   2.98441E-07
      14028.31c   1.94080E-04
      14029.31c   9.82708E-06
      14030.31c   6.52333E-06
         1001.31c  4.3978E-05
m2      92235.31c  1.7730E-02
        92238.31c  2.8957E-02
         6000.31c  1.8452E-04
      26054.31c   3.47935E-06
      26056.31c   5.46184E-05
      26057.31c   1.26138E-06
      26058.31c   1.67866E-07
        13027.31c  4.1070E-05
      14028.31c   3.63903E-05
      14029.31c   1.84260E-06
      14030.31c   1.22314E-06
         1001.31c  4.3978E-05
         8016.31c  3.4631E-04
m3       6000.31c  7.7829E-04
      26054.31c   3.30967E-03
      26056.31c   5.19548E-02
      26057.31c   1.19986E-03
      26058.31c   1.59680E-04
```

```
      24050.31c   6.99849E-04
      24052.31c   1.34959E-02
      24053.31c   1.53033E-03
      24054.31c   3.80931E-04
      28058.31c   6.12972E-03
      28060.31c   2.36115E-03
      28061.31c   1.02647E-04
      28062.31c   3.27209E-04
      28064.31c   8.33780E-05
      42092.31c   2.17183E-05
      42094.31c   1.35374E-05
      42095.31c   2.32989E-05
      42096.31c   2.44112E-05
      42097.31c   1.39764E-05
      42098.31c   3.53143E-05
      42100.31c   1.40935E-05
        25055.31c  1.1918E-03
        13027.31c  3.4646E-04
      29063.31c   5.10841E-05
      29065.31c   2.27689E-05
      22046.31c   2.41940E-05
      22047.31c   2.18185E-05
      22048.31c   2.16191E-04
      22049.31c   1.58654E-05
      22050.31c   1.51909E-05
      14028.31c   9.22189E-04
      14029.31c   4.66944E-05
      14030.31c   3.09963E-05
        23000.31c  9.2127E-05
         1001.31c  2.2714E-05
kcode 10000 1. 50 350
ksrc 0 0 1.1
prdmp 3j 1
print
```

D25. IEU-CT-02: IEU-COMP-THERM-002, case 3

```
MATR 17% - Gd
c                                                                          core
    1  0                 -4  5 -3 (101:-121) (102:-121) (103:-121) (104:-121)
                                 imp:n=1  fill=100
c                                    water between core and envelope cylinder
    2  3 1.001640E-01  4 -6  5 -3  imp:n=1
c                                                             envelope cylinder
    3  2 8.699752E-02  6 -7  2 -3  imp:n=1
c                                                                 outside water
    4  3 1.001640E-01  7 -1  2 -3  imp:n=1
c                                                        bottom water reflector
    5  3 1.001640E-01    -8  2 -5  imp:n=1
c                                                              support cylinder
    6  2 8.699752E-02  8 -9  2 -5  imp:n=1
c                       water between support cylinder and envelope cylinder
    7  3 1.001640E-01  9 -6  2 -5  imp:n=1
c                                              empty tubes for the control rods
    8  0               -111 122 -3  imp:n=1
    9  2 8.699752E-02  -101 121 -3 (111:-122)  imp:n=1
   10  0               -112 122 -3  imp:n=1
   11  2 8.699752E-02  -102 121 -3 (112:-122)  imp:n=1
   12  0               -113 122 -3  imp:n=1
   13  2 8.699752E-02  -103 121 -3 (113:-122)  imp:n=1
   14  0               -114 122 -3  imp:n=1
   15  2 8.699752E-02  -104 121 -3 (114:-122)  imp:n=1
c
  100  0  -201 202 -203 204  imp:n=1  lat=1  u=100
c  100  0  -201 202 -203 204 -205 206  imp:n=1  lat=2  u=100
          fill=-7:7 -7:7 0:0
                                                 4 36r
                         2 2 1 1 2 2             4  7r
                        2 1 1 1 1 1 2            4  6r
                       1 1 1 1 1 1 1 1           4  5r
                      1 1 1 1 1 1 1 1 1          4  4r
                     2 1 1 1 1 1 1 1 1 1         4  3r
                    2 1 1 1 1 3 1 1 1 1 2        4  3r
                     1 1 1 1 1 1 1 1 1 2         4  4r
                      1 1 1 1 1 1 1 1 1          4  5r
                       1 1 1 1 1 1 1 1           4  6r
                        2 1 1 1 1 1 2            4  7r
                         2 2 1 1 2 2             4 36r
c
c                                                         universe 1 - fuel rod
c
c
c                                                                    1-st tube
 1020  2 8.699752E-02  301 -302  402 -407  imp:n=1  u=-1
c                                                      1-st annular fuel element
11030  3 1.001640E-01  302 -304  402 -403  imp:n=1  u=-1
21030  2 8.699752E-02  302 -304  403 -404  imp:n=1  u=-1
 1030  1 3.335478E-02  302 -303  404 -405  imp:n=1  u=-1
31030  2 8.699752E-02  302 -304  405 -406  imp:n=1  u=-1
41030  3 1.001640E-01  302 -304  406 -407  imp:n=1  u=-1
c                                                                    2-nd tube
 1040  2 8.699752E-02  303 -304  404 -405  imp:n=1  u=-1
c                                                                    water gap
 1050  3 1.001640E-01  304 -305  402 -407  imp:n=1  u=-1
c                                                                    3-rd tube
 1060  2 8.699752E-02  305 -306  402 -407  imp:n=1  u=-1
c                                                      2-nd annular fuel element
11070  3 1.001640E-01  306 -308  402 -403  imp:n=1  u=-1
21070  2 8.699752E-02  306 -308  403 -404  imp:n=1  u=-1
```

```
 1070  1 3.335478E-02  306 -307  404 -405  imp:n=1  u=-1
31070  2 8.699752E-02  306 -308  405 -406  imp:n=1  u=-1
41070  3 1.001640E-01  306 -308  406 -407  imp:n=1  u=-1
c                                                                  4-th tube
 1080  2 8.699752E-02  307 -308  404 -405  imp:n=1  u=-1
c                                                                  water gap
 1090  3 1.001640E-01  308 -309  402 -407  imp:n=1  u=-1
c                                                                  5-th tube
 1100  2 8.699752E-02  309 -310  402 -407  imp:n=1  u=-1
c                                                                bottom plug
 1110  2 8.699752E-02      -310  401 -402  imp:n=1  u=-1
c                                                                   top plug
 1120  2 8.699752E-02  301 -310  407 -408  imp:n=1  u=-1
c                                                water outside of fuel rod
 1130  3 1.001640E-01  310       401 -603  imp:n=1  u=1
c                                                     water above fuel rod
 1140  3 1.001640E-01            419       imp:n=1  u=1
c                                  water between fuel rod and support plate
 1150  3 1.001640E-01  300       602 -401  imp:n=1  u=1
c                                                        lower lattice plate
 1160  3 1.001640E-01      -502      -601  imp:n=1  u=1
 1170  2 8.699752E-02  502           -601  imp:n=1  u=1
c                                                              support plate
 1180  3 1.001640E-01      -501  601 -602  #1500  imp:n=1  u=-1
 1190  2 8.699752E-02  501       601 -602  imp:n=1  u=1
c                                                        upper lattice plate
 1200  3 1.001640E-01  310 -502  603 -604  imp:n=1  u=-1
 1210  2 8.699752E-02  502       603 -604  imp:n=1  u=1
c                                         water around top end of fuel rod
 1220  3 1.001640E-01  310       604 -408  imp:n=1  u=1
c                                                               absorber rod
 1230  5 6.026200E-02      -311  402 -409  imp:n=1  u=-1
 1240  3 1.001640E-01  311 -301  402 -409  imp:n=1  u=-1
c
 1250  5 6.026200E-02      -314  409 -410  imp:n=1  u=-1
 1260  3 1.001640E-01  314 -301  409 -410  imp:n=1  u=-1
c
 1270  5 6.026200E-02      -313  410 -411  imp:n=1  u=-1
 1280  3 1.001640E-01  313 -301  410 -411  imp:n=1  u=-1
c
 1290  2 8.699752E-02      -311  411 -412  imp:n=1  u=-1
 1300  5 6.026200E-02  311 -313  411 -412  imp:n=1  u=-1
 1310  3 1.001640E-01  313 -301  411 -412  imp:n=1  u=-1
c
 1320  2 8.699752E-02      -313  412 -413  imp:n=1  u=-1
 1330  3 1.001640E-01  313 -301  412 -413  imp:n=1  u=-1
c
 1340  4 4.233530E-02      -312  413 -414  imp:n=1  u=-1
 1350  2 8.699752E-02  312 -313  413 -414  imp:n=1  u=-1
 1360  3 1.001640E-01  313 -301  413 -414  imp:n=1  u=-1
c
 1370  2 8.699752E-02      -313  414 -415  imp:n=1  u=-1
 1380  3 1.001640E-01  313 -301  414 -415  imp:n=1  u=-1
c
 1390  2 8.699752E-02      -311  415 -416  imp:n=1  u=-1
 1400  5 6.026200E-02  311 -313  415 -416  imp:n=1  u=-1
 1410  3 1.001640E-01  313 -301  415 -416  imp:n=1  u=-1
c
 1420  5 6.026200E-02      -313  416 -417  imp:n=1  u=-1
 1430  3 1.001640E-01  313 -301  416 -417  imp:n=1  u=-1
c
 1440  5 6.026200E-02      -314  417 -418  imp:n=1  u=-1
 1450  3 1.001640E-01  314 -301  417 -418  imp:n=1  u=-1
c
 1460  5 6.026200E-02      -311  418 -419  imp:n=1  u=-1
 1470  3 1.001640E-01  311 -301  418 -408  imp:n=1  u=-1
 1490  3 1.001640E-01  311       408 -419  imp:n=1  u=1
c                                                                       cone
```

```
 1500  2 8.699752E-02      -300  400 -401  imp:n=1  u=-1
c
c                               universe 2 - steel plates with holes and water
c                                                          lower lattice plate
  201  3 1.001640E-01      -502      -601  imp:n=1  u=2
  202  2 8.699752E-02  502           -601  imp:n=1  u=2
c                                                                support plate
  203  3 1.001640E-01      -501  601 -602  imp:n=1  u=-2
  204  2 8.699752E-02  501       601 -602  imp:n=1  u=2
c                                                                        water
  205  3 1.001640E-01            602 -603  imp:n=1  u=2
c                                                          upper lattice plate
  206  3 1.001640E-01      -502  603 -604  imp:n=1  u=-2
  207  2 8.699752E-02  502       603 -604  imp:n=1  u=2
c                                                                        water
  208  3 1.001640E-01            604       imp:n=1  u=2
c
c                                    universe 3 - central water-cooled channel
c                                                          lower lattice plate
  301  3 1.001640E-01      -511      -601  imp:n=1  u=3
  302  2 8.699752E-02  511           -601  imp:n=1  u=3
c                                                                support plate
  303  3 1.001640E-01      -501  601 -602  imp:n=1  u=-3
  304  2 8.699752E-02  501       601 -602  imp:n=1  u=3
c                         water between support plate and water-cooled channel
  305  3 1.001640E-01            602 -401  imp:n=1  u=3
c                                                                central space
  306  0                   -503  401       imp:n=1  u=3
c                                                                    1-st tube
  307  2 8.699752E-02  503 -504  401       imp:n=1  u=3
c                                                                        water
  308  3 1.001640E-01  504 -505  401       imp:n=1  u=3
c                                                                    2-nd tube
  309  2 8.699752E-02  505 -506  401       imp:n=1  u=3
c                                                                        water
  310  3 1.001640E-01  506 -507  401       imp:n=1  u=3
c                                                                    3-rd tube
  311  2 8.699752E-02  507 -508  401       imp:n=1  u=3
c                                                                     void gap
  312  0               508 -509  401       imp:n=1  u=3
c                                                                    4-th tube
  313  2 8.699752E-02  509 -510  401       imp:n=1  u=3
c                                                                        water
  314  3 1.001640E-01  510       401 -603  imp:n=1  u=3
c                                                          upper lattice plate
  315  3 1.001640E-01  510 -511  603 -604  imp:n=1  u=-3
  316  2 8.699752E-02  511       603 -604  imp:n=1  u=3
c                                                                        water
  317  3 1.001640E-01  510       604       imp:n=1  u=3
c
c                                         universe 4 - steel plates and water
  401  2 8.699752E-02                -602  imp:n=1  u=4
  402  3 1.001640E-01            602 -603  imp:n=1  u=4
  403  2 8.699752E-02            603 -604  imp:n=1  u=4
  404  3 1.001640E-01            604       imp:n=1  u=4
c                                                                    supercell
 9999  0 1:-2:3 imp:n=0

    1  cz  60        $ water reflector outer radius
    2  pz -19        $ water reflector (envelope cylinder) lower level
    3  pz 106        $ water reflector (envelope cylinder) upper level
    4  cz  41        $ support/lattice plates radius
    5  pz   0        $ bottom support plate lower level
    6  cz  42        $ envelope cylinder inner radius
    7  cz  44        $ envelope cylinder outer radius
    8  cz  40        $ support cylinder inner radius
    9  cz  40.5      $ support cylinder outer radius
c
```

```
  101  c/z  -13.74093640671   3.4  1.5
  102  c/z   13.74093640671  -3.4  1.5
  103  c/z  -3.925981830489  13.6  1.5
  104  c/z   3.925981830489 -13.6  1.5
c
  111  c/z  -13.74093640671   3.4  1.2
  112  c/z   13.74093640671  -3.4  1.2
  113  c/z  -3.925981830489  13.6  1.2
  114  c/z   3.925981830489 -13.6  1.2
c
  121  pz   4.000000000001
  122  pz   4.3
c
  201  px  2.944486372867
  202  px -2.944486372867
  203  p  -1  1.732050807569  0   5.888972745734
  204  p  -1  1.732050807569  0  -5.888972745734
c
c  201  p   1.732050807569  1  0   6.8
c  202  p   1.732050807569  1  0  -6.8
c  203  py  3.4
c  204  py -3.4
c  205  p  -1.732050807569  1  0   6.8
c  206  p  -1.732050807569  1  0  -6.8
c
  300  kz  2 0.25 1  $ cone
  301  cz  1.17      $ 1-st tube inner radius
  302  cz  1.2       $ 1-st tube outer radius
  303  cz  1.43      $ 2-nd tube inner radius
  304  cz  1.4640    $ 2-nd tube outer radius
  305  cz  1.7968    $ 3-rd tube inner radius
  306  cz  1.83      $ 3-rd tube outer radius
  307  cz  2.06      $ 4-th tube inner radius
  308  cz  2.09      $ 4-th tube outer radius
  309  cz  2.26      $ 5-th tube inner radius
  310  cz  2.29      $ 5-th tube outer radius
c
  311  cz  0.3       $ tail outer radius
  312  cz  0.52      $ absorber element tube inner radius
  313  cz  0.55      $ absorber element tube outer radius
  314  cz  1.15      $ flange outer radius
c
  400  pz  3         $ lower cone plane
  401  pz  4         $ lower surface of fuel rod bottom plug
  402  pz  4.3       $ upper surface of fuel rod bottom plug
  403  pz  5.7       $ lower surface of fuel bottom plug
  404  pz  5.9       $ upper surface of fuel bottom plug
  405  pz 65.9       $ lower surface of fuel top plug
  406  pz 66.2       $ upper surface of fuel top plug
  407  pz 68.6       $ lower surface of fuel rod top plug
  408  pz 68.9       $ upper surface of fuel rod top plug
c
  409  pz  6.3
  410  pz  6.8
  411  pz  9.9
  412  pz 10.9
  413  pz 11.9       $ lower surface of absorber element
  414  pz 59.9       $ upper surface of absorber element
  415  pz 60.9
  416  pz 61.9
  417  pz 67.4
  418  pz 67.9
  419  pz 70.4
c
  501  cz  0.75      $ radius of hole in support plate
  502  cz  2.35      $ radius of hole in lattice plate
  503  cz  1.05      $ inner radius of 1-st tube in central channel
  504  cz  1.1       $ outer radius of 1-st tube in central channel
```

```
  505  cz  1.3       $ inner radius of 2-nd tube in central channel
  506  cz  1.5       $ outer radius of 2-nd tube in central channel
  507  cz  1.7       $ inner radius of 3-rd tube in central channel
  508  cz  1.9       $ outer radius of 3-rd tube in central channel
  509  cz  2.2       $ inner radius of 4-th tube in central channel
  510  cz  2.5       $ outer radius of 4-th tube in central channel
  511  cz  2.53      $ radius of hole for central channel
c
  601  pz  1.5       $ upper surface of bottom lattice plate
  602  pz  3.5       $ upper surface of support plate
  603  pz 66.8       $ lower surface of top lattice plate
  604  pz 68.8       $ upper surface of top lattice plate

m1      92234.31c  1.6683E-05
        92235.31c  1.8827E-03
        92238.31c  9.0594E-03
         8016.31c  2.2396E-02
m2    26054.31c   3.50618E-03
      26056.31c   5.50396E-02
      26057.31c   1.27110E-03
      26058.31c   1.69161E-04
      24050.31c   6.83208E-04
      24052.31c   1.31750E-02
      24053.31c   1.49394E-03
      24054.31c   3.71873E-04
      28058.31c   5.78859E-03
      28060.31c   2.22974E-03
      28061.31c   9.69342E-05
      28062.31c   3.08999E-04
      28064.31c   7.87378E-05
        25055.31c  1.0431E-03
      14028.31c   7.84121E-04
      14029.31c   3.97034E-05
      14030.31c   2.63556E-05
      22046.31c   3.90852E-05
      22047.31c   3.52477E-05
      22048.31c   3.49256E-04
      22049.31c   2.56304E-05
      22050.31c   2.45408E-05
         6000.31c  4.1748E-04
m3       1001.31c  6.6776E-02
         8016.31c  3.3388E-02
  mt3 lwtr01.31t
m4      64152.31c  4.3186E-06
        64154.31c  4.7073E-05
        64155.31c  3.1958E-04
        64156.31c  4.4201E-04
        64157.31c  3.3793E-04
        64158.31c  5.3637E-04
        64160.31c  4.7202E-04
        13027.31c  1.4775E-02
         8016.31c  2.5401E-02
m5      13027.31c  6.0262E-02
kcode  5000 1.0 200 1200
 sdef  pos=0 0 35.9 axs=0 0 1 rad=d1 ext=d2
  si1  0 10
  si2  10
prdmp  3j 1
print
```

D26. STACY-36: LEU-SOL-THERM-007, case 36

```
file name=run032 ; STACY ( model 2 )
c    R036(bare)   ;U=253.9(g/lit) A=2.23(mol/lit) D=1.4102(g/cc)
c    Critical level  83.55(cm)
c
c    cellcard
c
1    1  9.89471078E-02          1  -2 -10        imp:n=1 u=1
2    3  4.94250000E-05          2  -3 -10        imp:n=1 u=1
3    2  8.68449842E-02   #1 #2                   imp:n=1 u=1
4    0                         -4   5 -20        imp:n=1 fill=1
5    0              #1 #2 #4                     imp:n=0

c    surface cards (origin x=0.0 y=0.0 z=0.0)
c    cylinder
 1   pz      0.0
 2   pz     83.55
 3   pz    150.0
 4   pz    152.5
 5   pz     -2.0
10   cz     29.5
20   cz     29.8

c
c    data cards
c
mode  n                    $ transport neutrons only
c
c    material cards
c    atomic density =  9.89471078E-02
m1       1001.31c  5.8115E-02
         7014.31c  2.6292E-03
         8016.31c  3.7560E-02
        92234.31c  5.2265E-07
        92235.31c  6.4857E-05
        92236.31c  6.4776E-08
        92238.31c  5.7769E-04
mt1 lwtr01.31t    $  300K
c
c    sus304 7.93g/cm3 ; atomic density  8.68449842E-02
m2       6000.31c  4.3736E-05
      14028.31c   9.80128E-04
      14029.31c   4.96281E-05
      14030.31c   3.29437E-05
        25055.31c  1.1561E-03
        15031.31c  4.3170E-05
      16032.31c   2.82721E-06
      16033.31c   2.26343E-08
      16034.31c   1.27765E-07
      16036.31c   5.95640E-10
      28058.31c   5.67783E-03
      28060.31c   2.18708E-03
      28061.31c   9.50794E-05
      28062.31c   3.03086E-04
      28064.31c   7.72312E-05
      24050.31c   7.28874E-04
      24052.31c   1.40556E-02
      24053.31c   1.59379E-03
      24054.31c   3.96729E-04
      26054.31c   3.47316E-03
      26056.31c   5.45211E-02
      26057.31c   1.25913E-03
      26058.31c   1.67567E-04
```

```
c
c     Air (0.001184 g/cm3)
c     atomic density  4.9425E-05
m3        7014.31c  3.9016E-05
          8016.31c  1.0409E-05
c
c    criticality cards
c
kcode    5000 1.0 50 2000
sdef  cel=d1 pos=0 0 0 axs=0 0 1 rad=d2 ext=d3 erg=d4
c
si1  l 4:1
sp1        1
c
si2    h   0.0   29.50
sp2   -21  1
c
si3    h   0.0   83.55
sp3   -21  0
c
sp4    -3
c
prdmp  j -100 1 3
c
print -175
```

D27. B&W XI-2: LEU-COMP-THERM-008, case 2

```
B&W Criticals  Core XI Load 2  1335.5 PPM  Axially Uniform Octant  ENDF/B-VI
c    Central Assembly
1     3   0.10018      1   -2     3     4   -88              $ Water Hole
2     3   0.10018      1   -2     3     4    88   -89        $ Water Hole
3     3   0.10018      1   -2     3     4    89   -47        $ Water Hole
4     1   0.068525     1   -2     3   -90                    $ Fuel
5     2   0.055323     1   -2     3    90   -91              $ Clad
6     3   0.10018      1   -2     3    -6    47   -48    91  $ Water
7     1   0.068525     1   -2     3   -92                    $ Fuel
8     2   0.055323     1   -2     3    92   -93              $ Clad
9     3   0.10018      1   -2     3    -6    48   -49    93  $ Water
10    1   0.068525     1   -2     3   -94                    $ Fuel
11    2   0.055323     1   -2     3    94   -95              $ Clad
12    3   0.10018      1   -2     3    -6    49   -50    95  $ Water
13    1   0.068525     1   -2     3   -96                    $ Fuel
14    2   0.055323     1   -2     3    96   -97              $ Clad
15    3   0.10018      1   -2     3    -6    50   -51    97  $ Water
16    1   0.068525     1   -2     3   -98                    $ Fuel
17    2   0.055323     1   -2     3    98   -99              $ Clad
18    3   0.10018      1   -2     3    -6    51   -52    99  $ Water
19    1   0.068525     1   -2     3  -100                    $ Fuel
20    2   0.055323     1   -2     3   100  -101              $ Clad
21    3   0.10018      1   -2     3    -6    52   -53   101  $ Water
22    1   0.068525     1   -2     3  -102                    $ Fuel
23    2   0.055323     1   -2     3   102  -103              $ Clad
24    3   0.10018      1   -2     3    -6    53   -54   103  $ Water
25    1   0.068525     1   -2     4  -104                    $ Fuel
26    2   0.055323     1   -2     4   104  -105              $ Clad
27    3   0.10018      1   -2     4     6    -7   -48   105  $ Water
28    1   0.068525     1   -2  -106                          $ Fuel
29    2   0.055323     1   -2   106  -107                    $ Clad
30    3   0.10018      1   -2     6    -7    48   -49   107  $ Water
31    1   0.068525     1   -2  -108                          $ Fuel
32    2   0.055323     1   -2   108  -109                    $ Clad
33    3   0.10018      1   -2     6    -7    49   -50   109  $ Water
34    1   0.068525     1   -2  -110                          $ Fuel
35    2   0.055323     1   -2   110  -111                    $ Clad
36    3   0.10018      1   -2     6    -7    50   -51   111  $ Water
37    1   0.068525     1   -2  -112                          $ Fuel
38    2   0.055323     1   -2   112  -113                    $ Clad
39    3   0.10018      1   -2     6    -7    51   -52   113  $ Water
40    1   0.068525     1   -2  -114                          $ Fuel
41    2   0.055323     1   -2   114  -115                    $ Clad
42    3   0.10018      1   -2     6    -7    52   -53   115  $ Water
43    1   0.068525     1   -2  -116                          $ Fuel
44    2   0.055323     1   -2   116  -117                    $ Clad
45    3   0.10018      1   -2     6    -7    53   -54   117  $ Water
46    3   0.10018      1   -2     4  -118                    $ Water Hole
47    3   0.10018      1   -2     4   118  -119              $ Water Hole
48    3   0.10018      1   -2     4     7    -8   -49   119  $ Water Hole
49    1   0.068525     1   -2  -120                          $ Fuel
50    2   0.055323     1   -2   120  -121                    $ Clad
51    3   0.10018      1   -2     7    -8    49   -50   121  $ Water
52    1   0.068525     1   -2  -122                          $ Fuel
53    2   0.055323     1   -2   122  -123                    $ Clad
54    3   0.10018      1   -2     7    -8    50   -51   123  $ Water
55    3   0.10018      1   -2  -124                          $ Water Hole
56    3   0.10018      1   -2   124  -125                    $ Water Hole
57    3   0.10018      1   -2     7    -8    51   -52   125  $ Water Hole
58    1   0.068525     1   -2  -126                          $ Fuel
59    2   0.055323     1   -2   126  -127                    $ Clad
60    3   0.10018      1   -2     7    -8    52   -53   127  $ Water
```

```
61    1   0.068525     1   -2  -128                              $ Fuel
62    2   0.055323     1   -2   128  -129                        $ Clad
63    3   0.10018      1   -2     7    -8    53   -54   129      $ Water
64    1   0.068525     1   -2     4  -130                        $ Fuel
65    2   0.055323     1   -2     4   130  -131                  $ Clad
66    3   0.10018      1   -2     4     8    -9   -50   131      $ Water
67    1   0.068525     1   -2  -132                              $ Fuel
68    2   0.055323     1   -2   132  -133                        $ Clad
69    3   0.10018      1   -2     8    -9    50   -51   133      $ Water
70    1   0.068525     1   -2  -134                              $ Fuel
71    2   0.055323     1   -2   134  -135                        $ Clad
72    3   0.10018      1   -2     8    -9    51   -52   135      $ Water
73    1   0.068525     1   -2  -136                              $ Fuel
74    2   0.055323     1   -2   136  -137                        $ Clad
75    3   0.10018      1   -2     8    -9    52   -53   137      $ Water
76    1   0.068525     1   -2  -138                              $ Fuel
77    2   0.055323     1   -2   138  -139                        $ Clad
78    3   0.10018      1   -2     8    -9    53   -54   139      $ Water
79    3   0.10018      1   -2     4  -140                        $ Water Hole
80    3   0.10018      1   -2     4   140  -141                  $ Water Hole
81    3   0.10018      1   -2     4     9   -10   -51   141      $ Water Hole
82    1   0.068525     1   -2  -142                              $ Fuel
83    2   0.055323     1   -2   142  -143                        $ Clad
84    3   0.10018      1   -2     9   -10    51   -52   143      $ Water
85    1   0.068525     1   -2  -144                              $ Fuel
86    2   0.055323     1   -2   144  -145                        $ Clad
87    3   0.10018      1   -2     9   -10    52   -53   145      $ Water
88    1   0.068525     1   -2  -146                              $ Fuel
89    2   0.055323     1   -2   146  -147                        $ Clad
90    3   0.10018      1   -2     9   -10    53   -54   147      $ Water
91    1   0.068525     1   -2     4  -148                        $ Fuel
92    2   0.055323     1   -2     4   148  -149                  $ Clad
93    3   0.10018      1   -2     4    10   -11   -52   149      $ Water
94    1   0.068525     1   -2  -150                              $ Fuel
95    2   0.055323     1   -2   150  -151                        $ Clad
96    3   0.10018      1   -2    10   -11    52   -53   151      $ Water
97    1   0.068525     1   -2  -152                              $ Fuel
98    2   0.055323     1   -2   152  -153                        $ Clad
99    3   0.10018      1   -2    10   -11    53   -54   153      $ Water
100   1   0.068525     1   -2     4  -154                        $ Fuel
101   2   0.055323     1   -2     4   154  -155                  $ Clad
102   3   0.10018      1   -2     4    11   -12   -53   155      $ Water
103   1   0.068525     1   -2  -156                              $ Fuel
104   2   0.055323     1   -2   156  -157                        $ Clad
105   3   0.10018      1   -2    11   -12    53   -54   157      $ Water
106   1   0.068525     1   -2     4  -158                        $ Fuel
107   2   0.055323     1   -2     4   158  -159                  $ Clad
108   3   0.10018      1   -2     4    12   -13   -54   159      $ Water
c    Right Central Assembly
109   1   0.068525     1   -2     3  -160                        $ Fuel
110   2   0.055323     1   -2     3   160  -161                  $ Clad
111   3   0.10018      1   -2     3    -6    54   -55   161      $ Water
112   1   0.068525     1   -2     3  -162                        $ Fuel
113   2   0.055323     1   -2     3   162  -163                  $ Clad
114   3   0.10018      1   -2     3    -6    55   -56   163      $ Water
115   1   0.068525     1   -2     3  -164                        $ Fuel
116   2   0.055323     1   -2     3   164  -165                  $ Clad
117   3   0.10018      1   -2     3    -6    56   -57   165      $ Water
118   1   0.068525     1   -2     3  -166                        $ Fuel
119   2   0.055323     1   -2     3   166  -167                  $ Clad
120   3   0.10018      1   -2     3    -6    57   -58   167      $ Water
121   1   0.068525     1   -2     3  -168                        $ Fuel
122   2   0.055323     1   -2     3   168  -169                  $ Clad
123   3   0.10018      1   -2     3    -6    58   -59   169      $ Water
124   1   0.068525     1   -2     3  -170                        $ Fuel
125   2   0.055323     1   -2     3   170  -171                  $ Clad
126   3   0.10018      1   -2     3    -6    59   -60   171      $ Water
127   1   0.068525     1   -2     3  -172                        $ Fuel
```

128	2	0.055323	1	-2	3	172	-173			$ Clad
129	3	0.10018	1	-2	3	-6	60	-61	173	$ Water
130	3	0.10018	1	-2	3	-174				$ Water Hole
131	3	0.10018	1	-2	3	174	-175			$ Water Hole
132	3	0.10018	1	-2	3	-6	61	-62	175	$ Water Hole
133	1	0.068525	1	-2	3	-176				$ Fuel
134	2	0.055323	1	-2	3	176	-177			$ Clad
135	3	0.10018	1	-2	3	-6	62	-63	177	$ Water
136	1	0.068525	1	-2	3	-178				$ Fuel
137	2	0.055323	1	-2	3	178	-179			$ Clad
138	3	0.10018	1	-2	3	-6	63	-64	179	$ Water
139	1	0.068525	1	-2	3	-180				$ Fuel
140	2	0.055323	1	-2	3	180	-181			$ Clad
141	3	0.10018	1	-2	3	-6	64	-65	181	$ Water
142	1	0.068525	1	-2	3	-182				$ Fuel
143	2	0.055323	1	-2	3	182	-183			$ Clad
144	3	0.10018	1	-2	3	-6	65	-66	183	$ Water
145	1	0.068525	1	-2	3	-184				$ Fuel
146	2	0.055323	1	-2	3	184	-185			$ Clad
147	3	0.10018	1	-2	3	-6	66	-67	185	$ Water
148	1	0.068525	1	-2	3	-186				$ Fuel
149	2	0.055323	1	-2	3	186	-187			$ Clad
150	3	0.10018	1	-2	3	-6	67	-68	187	$ Water
151	1	0.068525	1	-2	3	-188				$ Fuel
152	2	0.055323	1	-2	3	188	-189			$ Clad
153	3	0.10018	1	-2	3	-6	68	-69	189	$ Water
154	1	0.068525	1	-2	-190					$ Fuel
155	2	0.055323	1	-2	190	-191				$ Clad
156	3	0.10018	1	-2	6	-7	54	-55	191	$ Water
157	1	0.068525	1	-2	-192					$ Fuel
158	2	0.055323	1	-2	192	-193				$ Clad
159	3	0.10018	1	-2	6	-7	55	-56	193	$ Water
160	1	0.068525	1	-2	-194					$ Fuel
161	2	0.055323	1	-2	194	-195				$ Clad
162	3	0.10018	1	-2	6	-7	56	-57	195	$ Water
163	1	0.068525	1	-2	-196					$ Fuel
164	2	0.055323	1	-2	196	-197				$ Clad
165	3	0.10018	1	-2	6	-7	57	-58	197	$ Water
166	1	0.068525	1	-2	-198					$ Fuel
167	2	0.055323	1	-2	198	-199				$ Clad
168	3	0.10018	1	-2	6	-7	58	-59	199	$ Water
169	1	0.068525	1	-2	-200					$ Fuel
170	2	0.055323	1	-2	200	-201				$ Clad
171	3	0.10018	1	-2	6	-7	59	-60	201	$ Water
172	1	0.068525	1	-2	-202					$ Fuel
173	2	0.055323	1	-2	202	-203				$ Clad
174	3	0.10018	1	-2	6	-7	60	-61	203	$ Water
175	1	0.068525	1	-2	-204					$ Fuel
176	2	0.055323	1	-2	204	-205				$ Clad
177	3	0.10018	1	-2	6	-7	61	-62	205	$ Water
178	1	0.068525	1	-2	-206					$ Fuel
179	2	0.055323	1	-2	206	-207				$ Clad
180	3	0.10018	1	-2	6	-7	62	-63	207	$ Water
181	1	0.068525	1	-2	-208					$ Fuel
182	2	0.055323	1	-2	208	-209				$ Clad
183	3	0.10018	1	-2	6	-7	63	-64	209	$ Water
184	1	0.068525	1	-2	-210					$ Fuel
185	2	0.055323	1	-2	210	-211				$ Clad
186	3	0.10018	1	-2	6	-7	64	-65	211	$ Water
187	1	0.068525	1	-2	-212					$ Fuel
188	2	0.055323	1	-2	212	-213				$ Clad
189	3	0.10018	1	-2	6	-7	65	-66	213	$ Water
190	1	0.068525	1	-2	-214					$ Fuel
191	2	0.055323	1	-2	214	-215				$ Clad
192	3	0.10018	1	-2	6	-7	66	-67	215	$ Water
193	1	0.068525	1	-2	-216					$ Fuel
194	2	0.055323	1	-2	216	-217				$ Clad
195	3	0.10018	1	-2	6	-7	67	-68	217	$ Water

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196   1   0.068525      1   -2  -218                                   $ Fuel
197   2   0.055323      1   -2   218  -219                             $ Clad
198   3   0.10018       1   -2     6    -7    68   -69   219           $ Water
199   1   0.068525      1   -2  -220                                   $ Fuel
200   2   0.055323      1   -2   220  -221                             $ Clad
201   3   0.10018       1   -2     7    -8    54   -55   221           $ Water
202   1   0.068525      1   -2  -222                                   $ Fuel
203   2   0.055323      1   -2   222  -223                             $ Clad
204   3   0.10018       1   -2     7    -8    55   -56   223           $ Water
205   3   0.10018       1   -2  -224                                   $ Water Hole
206   3   0.10018       1   -2   224  -225                             $ Water Hole
207   3   0.10018       1   -2     7    -8    56   -57   225           $ Water Hole
208   1   0.068525      1   -2  -226                                   $ Fuel
209   2   0.055323      1   -2   226  -227                             $ Clad
210   3   0.10018       1   -2     7    -8    57   -58   227           $ Water
211   1   0.068525      1   -2  -228                                   $ Fuel
212   2   0.055323      1   -2   228  -229                             $ Clad
213   3   0.10018       1   -2     7    -8    58   -59   229           $ Water
214   3   0.10018       1   -2  -230                                   $ Water Hole
215   3   0.10018       1   -2   230  -231                             $ Water Hole
216   3   0.10018       1   -2     7    -8    59   -60   231           $ Water Hole
217   1   0.068525      1   -2  -232                                   $ Fuel
218   2   0.055323      1   -2   232  -233                             $ Clad
219   3   0.10018       1   -2     7    -8    60   -61   233           $ Water
220   1   0.068525      1   -2  -234                                   $ Fuel
221   2   0.055323      1   -2   234  -235                             $ Clad
222   3   0.10018       1   -2     7    -8    61   -62   235           $ Water
223   1   0.068525      1   -2  -236                                   $ Fuel
224   2   0.055323      1   -2   236  -237                             $ Clad
225   3   0.10018       1   -2     7    -8    62   -63   237           $ Water
226   3   0.10018       1   -2  -238                                   $ Water Hole
227   3   0.10018       1   -2   238  -239                             $ Water Hole
228   3   0.10018       1   -2     7    -8    63   -64   239           $ Water Hole
229   1   0.068525      1   -2  -240                                   $ Fuel
230   2   0.055323      1   -2   240  -241                             $ Clad
231   3   0.10018       1   -2     7    -8    64   -65   241           $ Water
232   1   0.068525      1   -2  -242                                   $ Fuel
233   2   0.055323      1   -2   242  -243                             $ Clad
234   3   0.10018       1   -2     7    -8    65   -66   243           $ Water
235   3   0.10018       1   -2  -244                                   $ Water Hole
236   3   0.10018       1   -2   244  -245                             $ Water Hole
237   3   0.10018       1   -2     7    -8    66   -67   245           $ Water Hole
238   1   0.068525      1   -2  -246                                   $ Fuel
239   2   0.055323      1   -2   246  -247                             $ Clad
240   3   0.10018       1   -2     7    -8    67   -68   247           $ Water
241   1   0.068525      1   -2  -248                                   $ Fuel
242   2   0.055323      1   -2   248  -249                             $ Clad
243   3   0.10018       1   -2     7    -8    68   -69   249           $ Water
244   1   0.068525      1   -2  -250                                   $ Fuel
245   2   0.055323      1   -2   250  -251                             $ Clad
246   3   0.10018       1   -2     8    -9    54   -55   251           $ Water
247   1   0.068525      1   -2  -252                                   $ Fuel
248   2   0.055323      1   -2   252  -253                             $ Clad
249   3   0.10018       1   -2     8    -9    55   -56   253           $ Water
250   1   0.068525      1   -2  -254                                   $ Fuel
251   2   0.055323      1   -2   254  -255                             $ Clad
252   3   0.10018       1   -2     8    -9    56   -57   255           $ Water
253   1   0.068525      1   -2  -256                                   $ Fuel
254   2   0.055323      1   -2   256  -257                             $ Clad
255   3   0.10018       1   -2     8    -9    57   -58   257           $ Water
256   1   0.068525      1   -2  -258                                   $ Fuel
257   2   0.055323      1   -2   258  -259                             $ Clad
258   3   0.10018       1   -2     8    -9    58   -59   259           $ Water
259   1   0.068525      1   -2  -260                                   $ Fuel
260   2   0.055323      1   -2   260  -261                             $ Clad
261   3   0.10018       1   -2     8    -9    59   -60   261           $ Water
262   1   0.068525      1   -2  -262                                   $ Fuel
263   2   0.055323      1   -2   262  -263                             $ Clad
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264	3	0.10018	1	-2	8	-9	60	-61	263	$ Water
265	1	0.068525	1	-2	-264					$ Fuel
266	2	0.055323	1	-2	264	-265				$ Clad
267	3	0.10018	1	-2	8	-9	61	-62	265	$ Water
268	1	0.068525	1	-2	-266					$ Fuel
269	2	0.055323	1	-2	266	-267				$ Clad
270	3	0.10018	1	-2	8	-9	62	-63	267	$ Water
271	1	0.068525	1	-2	-268					$ Fuel
272	2	0.055323	1	-2	268	-269				$ Clad
273	3	0.10018	1	-2	8	-9	63	-64	269	$ Water
274	1	0.068525	1	-2	-270					$ Fuel
275	2	0.055323	1	-2	270	-271				$ Clad
276	3	0.10018	1	-2	8	-9	64	-65	271	$ Water
277	1	0.068525	1	-2	-272					$ Fuel
278	2	0.055323	1	-2	272	-273				$ Clad
279	3	0.10018	1	-2	8	-9	65	-66	273	$ Water
280	1	0.068525	1	-2	-274					$ Fuel
281	2	0.055323	1	-2	274	-275				$ Clad
282	3	0.10018	1	-2	8	-9	66	-67	275	$ Water
283	1	0.068525	1	-2	-276					$ Fuel
284	2	0.055323	1	-2	276	-277				$ Clad
285	3	0.10018	1	-2	8	-9	67	-68	277	$ Water
286	1	0.068525	1	-2	-278					$ Fuel
287	2	0.055323	1	-2	278	-279				$ Clad
288	3	0.10018	1	-2	8	-9	68	-69	279	$ Water
289	1	0.068525	1	-2	-280					$ Fuel
290	2	0.055323	1	-2	280	-281				$ Clad
291	3	0.10018	1	-2	9	-10	54	-55	281	$ Water
292	1	0.068525	1	-2	-282					$ Fuel
293	2	0.055323	1	-2	282	-283				$ Clad
294	3	0.10018	1	-2	9	-10	55	-56	283	$ Water
295	1	0.068525	1	-2	-284					$ Fuel
296	2	0.055323	1	-2	284	-285				$ Clad
297	3	0.10018	1	-2	9	-10	56	-57	285	$ Water
298	3	0.10018	1	-2	-286					$ Water Hole
299	3	0.10018	1	-2	286	-287				$ Water Hole
300	3	0.10018	1	-2	9	-10	57	-58	287	$ Water Hole
301	1	0.068525	1	-2	-288					$ Fuel
302	2	0.055323	1	-2	288	-289				$ Clad
303	3	0.10018	1	-2	9	-10	58	-59	289	$ Water
304	1	0.068525	1	-2	-290					$ Fuel
305	2	0.055323	1	-2	290	-291				$ Clad
306	3	0.10018	1	-2	9	-10	59	-60	291	$ Water
307	1	0.068525	1	-2	-292					$ Fuel
308	2	0.055323	1	-2	292	-293				$ Clad
309	3	0.10018	1	-2	9	-10	60	-61	293	$ Water
310	1	0.068525	1	-2	-294					$ Fuel
311	2	0.055323	1	-2	294	-295				$ Clad
312	3	0.10018	1	-2	9	-10	61	-62	295	$ Water
313	1	0.068525	1	-2	-296					$ Fuel
314	2	0.055323	1	-2	296	-297				$ Clad
315	3	0.10018	1	-2	9	-10	62	-63	297	$ Water
316	1	0.068525	1	-2	-298					$ Fuel
317	2	0.055323	1	-2	298	-299				$ Clad
318	3	0.10018	1	-2	9	-10	63	-64	299	$ Water
319	1	0.068525	1	-2	-300					$ Fuel
320	2	0.055323	1	-2	300	-301				$ Clad
321	3	0.10018	1	-2	9	-10	64	-65	301	$ Water
322	3	0.10018	1	-2	-302					$ Water Hole
323	3	0.10018	1	-2	302	-303				$ Water Hole
324	3	0.10018	1	-2	9	-10	65	-66	303	$ Water Hole
325	1	0.068525	1	-2	-304					$ Fuel
326	2	0.055323	1	-2	304	-305				$ Clad
327	3	0.10018	1	-2	9	-10	66	-67	305	$ Water
328	1	0.068525	1	-2	-306					$ Fuel
329	2	0.055323	1	-2	306	-307				$ Clad
330	3	0.10018	1	-2	9	-10	67	-68	307	$ Water
331	1	0.068525	1	-2	-308					$ Fuel

332	2	0.055323	1	-2	308	-309				$ Clad
333	3	0.10018	1	-2	9	-10	68	-69	309	$ Water
334	1	0.068525	1	-2	-310					$ Fuel
335	2	0.055323	1	-2	310	-311				$ Clad
336	3	0.10018	1	-2	10	-11	54	-55	311	$ Water
337	1	0.068525	1	-2	-312					$ Fuel
338	2	0.055323	1	-2	312	-313				$ Clad
339	3	0.10018	1	-2	10	-11	55	-56	313	$ Water
340	1	0.068525	1	-2	-314					$ Fuel
341	2	0.055323	1	-2	314	-315				$ Clad
342	3	0.10018	1	-2	10	-11	56	-57	315	$ Water
343	1	0.068525	1	-2	-316					$ Fuel
344	2	0.055323	1	-2	316	-317				$ Clad
345	3	0.10018	1	-2	10	-11	57	-58	317	$ Water
346	1	0.068525	1	-2	-318					$ Fuel
347	2	0.055323	1	-2	318	-319				$ Clad
348	3	0.10018	1	-2	10	-11	58	-59	319	$ Water
349	3	0.10018	1	-2	-320					$ Water Hole
350	3	0.10018	1	-2	320	-321				$ Water Hole
351	3	0.10018	1	-2	10	-11	59	-60	321	$ Water Hole
352	1	0.068525	1	-2	-322					$ Fuel
353	2	0.055323	1	-2	322	-323				$ Clad
354	3	0.10018	1	-2	10	-11	60	-61	323	$ Water
355	1	0.068525	1	-2	-324					$ Fuel
356	2	0.055323	1	-2	324	-325				$ Clad
357	3	0.10018	1	-2	10	-11	61	-62	325	$ Water
358	1	0.068525	1	-2	-326					$ Fuel
359	2	0.055323	1	-2	326	-327				$ Clad
360	3	0.10018	1	-2	10	-11	62	-63	327	$ Water
361	3	0.10018	1	-2	-328					$ Water Hole
362	3	0.10018	1	-2	328	-329				$ Water Hole
363	3	0.10018	1	-2	10	-11	63	-64	329	$ Water Hole
364	1	0.068525	1	-2	-330					$ Fuel
365	2	0.055323	1	-2	330	-331				$ Clad
366	3	0.10018	1	-2	10	-11	64	-65	331	$ Water
367	1	0.068525	1	-2	-332					$ Fuel
368	2	0.055323	1	-2	332	-333				$ Clad
369	3	0.10018	1	-2	10	-11	65	-66	333	$ Water
370	1	0.068525	1	-2	-334					$ Fuel
371	2	0.055323	1	-2	334	-335				$ Clad
372	3	0.10018	1	-2	10	-11	66	-67	335	$ Water
373	1	0.068525	1	-2	-336					$ Fuel
374	2	0.055323	1	-2	336	-337				$ Clad
375	3	0.10018	1	-2	10	-11	67	-68	337	$ Water
376	1	0.068525	1	-2	-338					$ Fuel
377	2	0.055323	1	-2	338	-339				$ Clad
378	3	0.10018	1	-2	10	-11	68	-69	339	$ Water
379	1	0.068525	1	-2	-340					$ Fuel
380	2	0.055323	1	-2	340	-341				$ Clad
381	3	0.10018	1	-2	11	-12	54	-55	341	$ Water
382	1	0.068525	1	-2	-342					$ Fuel
383	2	0.055323	1	-2	342	-343				$ Clad
384	3	0.10018	1	-2	11	-12	55	-56	343	$ Water
385	1	0.068525	1	-2	-344					$ Fuel
386	2	0.055323	1	-2	344	-345				$ Clad
387	3	0.10018	1	-2	11	-12	56	-57	345	$ Water
388	1	0.068525	1	-2	-346					$ Fuel
389	2	0.055323	1	-2	346	-347				$ Clad
390	3	0.10018	1	-2	11	-12	57	-58	347	$ Water
391	1	0.068525	1	-2	-348					$ Fuel
392	2	0.055323	1	-2	348	-349				$ Clad
393	3	0.10018	1	-2	11	-12	58	-59	349	$ Water
394	1	0.068525	1	-2	-350					$ Fuel
395	2	0.055323	1	-2	350	-351				$ Clad
396	3	0.10018	1	-2	11	-12	59	-60	351	$ Water
397	1	0.068525	1	-2	-352					$ Fuel
398	2	0.055323	1	-2	352	-353				$ Clad
399	3	0.10018	1	-2	11	-12	60	-61	353	$ Water

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400   1   0.068525     1   -2   -354                            $ Fuel
401   2   0.055323     1   -2    354  -355                      $ Clad
402   3   0.10018      1   -2     11   -12    61   -62   355    $ Water
403   1   0.068525     1   -2   -356                            $ Fuel
404   2   0.055323     1   -2    356  -357                      $ Clad
405   3   0.10018      1   -2     11   -12    62   -63   357    $ Water
406   1   0.068525     1   -2   -358                            $ Fuel
407   2   0.055323     1   -2    358  -359                      $ Clad
408   3   0.10018      1   -2     11   -12    63   -64   359    $ Water
409   1   0.068525     1   -2   -360                            $ Fuel
410   2   0.055323     1   -2    360  -361                      $ Clad
411   3   0.10018      1   -2     11   -12    64   -65   361    $ Water
412   1   0.068525     1   -2   -362                            $ Fuel
413   2   0.055323     1   -2    362  -363                      $ Clad
414   3   0.10018      1   -2     11   -12    65   -66   363    $ Water
415   1   0.068525     1   -2   -364                            $ Fuel
416   2   0.055323     1   -2    364  -365                      $ Clad
417   3   0.10018      1   -2     11   -12    66   -67   365    $ Water
418   1   0.068525     1   -2   -366                            $ Fuel
419   2   0.055323     1   -2    366  -367                      $ Clad
420   3   0.10018      1   -2     11   -12    67   -68   367    $ Water
421   1   0.068525     1   -2   -368                            $ Fuel
422   2   0.055323     1   -2    368  -369                      $ Clad
423   3   0.10018      1   -2     11   -12    68   -69   369    $ Water
424   1   0.068525     1   -2   -370                            $ Fuel
425   2   0.055323     1   -2    370  -371                      $ Clad
426   3   0.10018      1   -2     12   -13    54   -55   371    $ Water
427   1   0.068525     1   -2   -372                            $ Fuel
428   2   0.055323     1   -2    372  -373                      $ Clad
429   3   0.10018      1   -2     12   -13    55   -56   373    $ Water
430   1   0.068525     1   -2   -374                            $ Fuel
431   2   0.055323     1   -2    374  -375                      $ Clad
432   3   0.10018      1   -2     12   -13    56   -57   375    $ Water
433   1   0.068525     1   -2   -376                            $ Fuel
434   2   0.055323     1   -2    376  -377                      $ Clad
435   3   0.10018      1   -2     12   -13    57   -58   377    $ Water
436   1   0.068525     1   -2   -378                            $ Fuel
437   2   0.055323     1   -2    378  -379                      $ Clad
438   3   0.10018      1   -2     12   -13    58   -59   379    $ Water
439   1   0.068525     1   -2   -380                            $ Fuel
440   2   0.055323     1   -2    380  -381                      $ Clad
441   3   0.10018      1   -2     12   -13    59   -60   381    $ Water
442   1   0.068525     1   -2   -382                            $ Fuel
443   2   0.055323     1   -2    382  -383                      $ Clad
444   3   0.10018      1   -2     12   -13    60   -61   383    $ Water
445   1   0.068525     1   -2   -384                            $ Fuel
446   2   0.055323     1   -2    384  -385                      $ Clad
447   3   0.10018      1   -2     12   -13    61   -62   385    $ Water
448   1   0.068525     1   -2   -386                            $ Fuel
449   2   0.055323     1   -2    386  -387                      $ Clad
450   3   0.10018      1   -2     12   -13    62   -63   387    $ Water
451   1   0.068525     1   -2   -388                            $ Fuel
452   2   0.055323     1   -2    388  -389                      $ Clad
453   3   0.10018      1   -2     12   -13    63   -64   389    $ Water
454   1   0.068525     1   -2   -390                            $ Fuel
455   2   0.055323     1   -2    390  -391                      $ Clad
456   3   0.10018      1   -2     12   -13    64   -65   391    $ Water
457   1   0.068525     1   -2   -392                            $ Fuel
458   2   0.055323     1   -2    392  -393                      $ Clad
459   3   0.10018      1   -2     12   -13    65   -66   393    $ Water
460   1   0.068525     1   -2   -394                            $ Fuel
461   2   0.055323     1   -2    394  -395                      $ Clad
462   3   0.10018      1   -2     12   -13    66   -67   395    $ Water
463   1   0.068525     1   -2   -396                            $ Fuel
464   2   0.055323     1   -2    396  -397                      $ Clad
465   3   0.10018      1   -2     12   -13    67   -68   397    $ Water
466   1   0.068525     1   -2   -398                            $ Fuel
467   2   0.055323     1   -2    398  -399                      $ Clad
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468   3   0.10018       1   -2    12   -13    68   -69   399     $ Water
c    Upper Right Assembly
469   1   0.068525      1   -2     4  -400                       $ Fuel
470   2   0.055323      1   -2     4   400  -401                 $ Clad
471   3   0.10018       1   -2     4    13    54   -55   401     $ Water
472   1   0.068525      1   -2  -402                             $ Fuel
473   2   0.055323      1   -2   402  -403                       $ Clad
474   3   0.10018       1   -2    13   -14    55   -56   403     $ Water
475   1   0.068525      1   -2  -404                             $ Fuel
476   2   0.055323      1   -2   404  -405                       $ Clad
477   3   0.10018       1   -2    13   -14    56   -57   405     $ Water
478   1   0.068525      1   -2  -406                             $ Fuel
479   2   0.055323      1   -2   406  -407                       $ Clad
480   3   0.10018       1   -2    13   -14    57   -58   407     $ Water
481   1   0.068525      1   -2  -408                             $ Fuel
482   2   0.055323      1   -2   408  -409                       $ Clad
483   3   0.10018       1   -2    13   -14    58   -59   409     $ Water
484   1   0.068525      1   -2  -410                             $ Fuel
485   2   0.055323      1   -2   410  -411                       $ Clad
486   3   0.10018       1   -2    13   -14    59   -60   411     $ Water
487   1   0.068525      1   -2  -412                             $ Fuel
488   2   0.055323      1   -2   412  -413                       $ Clad
489   3   0.10018       1   -2    13   -14    60   -61   413     $ Water
490   1   0.068525      1   -2  -414                             $ Fuel
491   2   0.055323      1   -2   414  -415                       $ Clad
492   3   0.10018       1   -2    13   -14    61   -62   415     $ Water
493   1   0.068525      1   -2  -416                             $ Fuel
494   2   0.055323      1   -2   416  -417                       $ Clad
495   3   0.10018       1   -2    13   -14    62   -63   417     $ Water
496   1   0.068525      1   -2  -418                             $ Fuel
497   2   0.055323      1   -2   418  -419                       $ Clad
498   3   0.10018       1   -2    13   -14    63   -64   419     $ Water
499   1   0.068525      1   -2  -420                             $ Fuel
500   2   0.055323      1   -2   420  -421                       $ Clad
501   3   0.10018       1   -2    13   -14    64   -65   421     $ Water
502   1   0.068525      1   -2  -422                             $ Fuel
503   2   0.055323      1   -2   422  -423                       $ Clad
504   3   0.10018       1   -2    13   -14    65   -66   423     $ Water
505   1   0.068525      1   -2  -424                             $ Fuel
506   2   0.055323      1   -2   424  -425                       $ Clad
507   3   0.10018       1   -2    13   -14    66   -67   425     $ Water
508   1   0.068525      1   -2  -426                             $ Fuel
509   2   0.055323      1   -2   426  -427                       $ Clad
510   3   0.10018       1   -2    13   -14    67   -68   427     $ Water
511   1   0.068525      1   -2  -428                             $ Fuel
512   2   0.055323      1   -2   428  -429                       $ Clad
513   3   0.10018       1   -2    13   -14    68   -69   429     $ Water
514   1   0.068525      1   -2     4  -430                       $ Fuel
515   2   0.055323      1   -2     4   430  -431                 $ Clad
516   3   0.10018       1   -2     4    14    55   -56   431     $ Water
517   1   0.068525      1   -2  -432                             $ Fuel
518   2   0.055323      1   -2   432  -433                       $ Clad
519   3   0.10018       1   -2    14   -15    56   -57   433     $ Water
520   1   0.068525      1   -2  -434                             $ Fuel
521   2   0.055323      1   -2   434  -435                       $ Clad
522   3   0.10018       1   -2    14   -15    57   -58   435     $ Water
523   1   0.068525      1   -2  -436                             $ Fuel
524   2   0.055323      1   -2   436  -437                       $ Clad
525   3   0.10018       1   -2    14   -15    58   -59   437     $ Water
526   1   0.068525      1   -2  -438                             $ Fuel
527   2   0.055323      1   -2   438  -439                       $ Clad
528   3   0.10018       1   -2    14   -15    59   -60   439     $ Water
529   1   0.068525      1   -2  -440                             $ Fuel
530   2   0.055323      1   -2   440  -441                       $ Clad
531   3   0.10018       1   -2    14   -15    60   -61   441     $ Water
532   1   0.068525      1   -2  -442                             $ Fuel
533   2   0.055323      1   -2   442  -443                       $ Clad
534   3   0.10018       1   -2    14   -15    61   -62   443     $ Water
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535   1   0.068525      1   -2  -444                                 $ Fuel
536   2   0.055323      1   -2   444  -445                           $ Clad
537   3   0.10018       1   -2    14   -15    62   -63   445         $ Water
538   1   0.068525      1   -2  -446                                 $ Fuel
539   2   0.055323      1   -2   446  -447                           $ Clad
540   3   0.10018       1   -2    14   -15    63   -64   447         $ Water
541   1   0.068525      1   -2  -448                                 $ Fuel
542   2   0.055323      1   -2   448  -449                           $ Clad
543   3   0.10018       1   -2    14   -15    64   -65   449         $ Water
544   1   0.068525      1   -2  -450                                 $ Fuel
545   2   0.055323      1   -2   450  -451                           $ Clad
546   3   0.10018       1   -2    14   -15    65   -66   451         $ Water
547   1   0.068525      1   -2  -452                                 $ Fuel
548   2   0.055323      1   -2   452  -453                           $ Clad
549   3   0.10018       1   -2    14   -15    66   -67   453         $ Water
550   1   0.068525      1   -2  -454                                 $ Fuel
551   2   0.055323      1   -2   454  -455                           $ Clad
552   3   0.10018       1   -2    14   -15    67   -68   455         $ Water
553   1   0.068525      1   -2  -456                                 $ Fuel
554   2   0.055323      1   -2   456  -457                           $ Clad
555   3   0.10018       1   -2    14   -15    68   -69   457         $ Water
556   1   0.068525      1   -2     4  -458                           $ Fuel
557   2   0.055323      1   -2     4   458  -459                     $ Clad
558   3   0.10018       1   -2     4    15    56   -57   459         $ Water
559   1   0.068525      1   -2  -460                                 $ Fuel
560   2   0.055323      1   -2   460  -461                           $ Clad
561   3   0.10018       1   -2    15   -16    57   -58   461         $ Water
562   1   0.068525      1   -2  -462                                 $ Fuel
563   2   0.055323      1   -2   462  -463                           $ Clad
564   3   0.10018       1   -2    15   -16    58   -59   463         $ Water
565   3   0.10018       1   -2  -464                                 $ Water Hole
566   3   0.10018       1   -2   464  -465                           $ Water Hole
567   3   0.10018       1   -2    15   -16    59   -60   465         $ Water Hole
568   1   0.068525      1   -2  -466                                 $ Fuel
569   2   0.055323      1   -2   466  -467                           $ Clad
570   3   0.10018       1   -2    15   -16    60   -61   467         $ Water
571   1   0.068525      1   -2  -468                                 $ Fuel
572   2   0.055323      1   -2   468  -469                           $ Clad
573   3   0.10018       1   -2    15   -16    61   -62   469         $ Water
574   1   0.068525      1   -2  -470                                 $ Fuel
575   2   0.055323      1   -2   470  -471                           $ Clad
576   3   0.10018       1   -2    15   -16    62   -63   471         $ Water
577   3   0.10018       1   -2  -472                                 $ Water Hole
578   3   0.10018       1   -2   472  -473                           $ Water Hole
579   3   0.10018       1   -2    15   -16    63   -64   473         $ Water Hole
580   1   0.068525      1   -2  -474                                 $ Fuel
581   2   0.055323      1   -2   474  -475                           $ Clad
582   3   0.10018       1   -2    15   -16    64   -65   475         $ Water
583   1   0.068525      1   -2  -476                                 $ Fuel
584   2   0.055323      1   -2   476  -477                           $ Clad
585   3   0.10018       1   -2    15   -16    65   -66   477         $ Water
586   1   0.068525      1   -2  -478                                 $ Fuel
587   2   0.055323      1   -2   478  -479                           $ Clad
588   3   0.10018       1   -2    15   -16    66   -67   479         $ Water
589   1   0.068525      1   -2  -480                                 $ Fuel
590   2   0.055323      1   -2   480  -481                           $ Clad
591   3   0.10018       1   -2    15   -16    67   -68   481         $ Water
592   1   0.068525      1   -2  -482                                 $ Fuel
593   2   0.055323      1   -2   482  -483                           $ Clad
594   3   0.10018       1   -2    15   -16    68   -69   483         $ Water
595   3   0.10018       1   -2     4  -484                           $ Water Hole
596   3   0.10018       1   -2     4   484  -485                     $ Water Hole
597   3   0.10018       1   -2     4    16    57   -58   485         $ Water Hole
598   1   0.068525      1   -2  -486                                 $ Fuel
599   2   0.055323      1   -2   486  -487                           $ Clad
600   3   0.10018       1   -2    16   -17    58   -59   487         $ Water
601   1   0.068525      1   -2  -488                                 $ Fuel
602   2   0.055323      1   -2   488  -489                           $ Clad
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603   3   0.10018       1   -2    16   -17    59   -60   489     $ Water
604   1   0.068525      1   -2  -490                             $ Fuel
605   2   0.055323      1   -2   490  -491                       $ Clad
606   3   0.10018       1   -2    16   -17    60   -61   491     $ Water
607   1   0.068525      1   -2  -492                             $ Fuel
608   2   0.055323      1   -2   492  -493                       $ Clad
609   3   0.10018       1   -2    16   -17    61   -62   493     $ Water
610   1   0.068525      1   -2  -494                             $ Fuel
611   2   0.055323      1   -2   494  -495                       $ Clad
612   3   0.10018       1   -2    16   -17    62   -63   495     $ Water
613   1   0.068525      1   -2  -496                             $ Fuel
614   2   0.055323      1   -2   496  -497                       $ Clad
615   3   0.10018       1   -2    16   -17    63   -64   497     $ Water
616   1   0.068525      1   -2  -498                             $ Fuel
617   2   0.055323      1   -2   498  -499                       $ Clad
618   3   0.10018       1   -2    16   -17    64   -65   499     $ Water
619   3   0.10018       1   -2  -500                             $ Water Hole
620   3   0.10018       1   -2   500  -501                       $ Water Hole
621   3   0.10018       1   -2    16   -17    65   -66   501     $ Water Hole
622   1   0.068525      1   -2  -502                             $ Fuel
623   2   0.055323      1   -2   502  -503                       $ Clad
624   3   0.10018       1   -2    16   -17    66   -67   503     $ Water
625   1   0.068525      1   -2  -504                             $ Fuel
626   2   0.055323      1   -2   504  -505                       $ Clad
627   3   0.10018       1   -2    16   -17    67   -68   505     $ Water
628   1   0.068525      1   -2  -506                             $ Fuel
629   2   0.055323      1   -2   506  -507                       $ Clad
630   3   0.10018       1   -2    16   -17    68   -69   507     $ Water
631   1   0.068525      1   -2     4  -508                       $ Fuel
632   2   0.055323      1   -2     4   508  -509                 $ Clad
633   3   0.10018       1   -2     4    17    58   -59   509     $ Water
634   1   0.068525      1   -2  -510                             $ Fuel
635   2   0.055323      1   -2   510  -511                       $ Clad
636   3   0.10018       1   -2    17   -18    59   -60   511     $ Water
637   1   0.068525      1   -2  -512                             $ Fuel
638   2   0.055323      1   -2   512  -513                       $ Clad
639   3   0.10018       1   -2    17   -18    60   -61   513     $ Water
640   1   0.068525      1   -2  -514                             $ Fuel
641   2   0.055323      1   -2   514  -515                       $ Clad
642   3   0.10018       1   -2    17   -18    61   -62   515     $ Water
643   1   0.068525      1   -2  -516                             $ Fuel
644   2   0.055323      1   -2   516  -517                       $ Clad
645   3   0.10018       1   -2    17   -18    62   -63   517     $ Water
646   1   0.068525      1   -2  -518                             $ Fuel
647   2   0.055323      1   -2   518  -519                       $ Clad
648   3   0.10018       1   -2    17   -18    63   -64   519     $ Water
649   1   0.068525      1   -2  -520                             $ Fuel
650   2   0.055323      1   -2   520  -521                       $ Clad
651   3   0.10018       1   -2    17   -18    64   -65   521     $ Water
652   1   0.068525      1   -2  -522                             $ Fuel
653   2   0.055323      1   -2   522  -523                       $ Clad
654   3   0.10018       1   -2    17   -18    65   -66   523     $ Water
655   1   0.068525      1   -2  -524                             $ Fuel
656   2   0.055323      1   -2   524  -525                       $ Clad
657   3   0.10018       1   -2    17   -18    66   -67   525     $ Water
658   1   0.068525      1   -2  -526                             $ Fuel
659   2   0.055323      1   -2   526  -527                       $ Clad
660   3   0.10018       1   -2    17   -18    67   -68   527     $ Water
661   1   0.068525      1   -2  -528                             $ Fuel
662   2   0.055323      1   -2   528  -529                       $ Clad
663   3   0.10018       1   -2    17   -18    68   -69   529     $ Water
664   3   0.10018       1   -2     4  -530                       $ Water Hole
665   3   0.10018       1   -2     4   530  -531                 $ Water Hole
666   3   0.10018       1   -2     4    18    59   -60   531     $ Water Hole
667   1   0.068525      1   -2  -532                             $ Fuel
668   2   0.055323      1   -2   532  -533                       $ Clad
669   3   0.10018       1   -2    18   -19    60   -61   533     $ Water
670   1   0.068525      1   -2  -534                             $ Fuel
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671   2   0.055323      1   -2   534  -535                      $ Clad
672   3   0.10018       1   -2    18   -19    61   -62   535    $ Water
673   1   0.068525      1   -2  -536                            $ Fuel
674   2   0.055323      1   -2   536  -537                      $ Clad
675   3   0.10018       1   -2    18   -19    62   -63   537    $ Water
676   3   0.10018       1   -2  -538                            $ Water Hole
677   3   0.10018       1   -2   538  -539                      $ Water Hole
678   3   0.10018       1   -2    18   -19    63   -64   539    $ Water Hole
679   1   0.068525      1   -2  -540                            $ Fuel
680   2   0.055323      1   -2   540  -541                      $ Clad
681   3   0.10018       1   -2    18   -19    64   -65   541    $ Water
682   1   0.068525      1   -2  -542                            $ Fuel
683   2   0.055323      1   -2   542  -543                      $ Clad
684   3   0.10018       1   -2    18   -19    65   -66   543    $ Water
685   3   0.10018       1   -2  -544                            $ Water Hole
686   3   0.10018       1   -2   544  -545                      $ Water Hole
687   3   0.10018       1   -2    18   -19    66   -67   545    $ Water Hole
688   1   0.068525      1   -2  -546                            $ Fuel
689   2   0.055323      1   -2   546  -547                      $ Clad
690   3   0.10018       1   -2    18   -19    67   -68   547    $ Water
691   1   0.068525      1   -2  -548                            $ Fuel
692   2   0.055323      1   -2   548  -549                      $ Clad
693   3   0.10018       1   -2    18   -19    68   -69   549    $ Water
694   1   0.068525      1   -2     4  -550                      $ Fuel
695   2   0.055323      1   -2     4   550  -551                $ Clad
696   3   0.10018       1   -2     4    19    60   -61   551    $ Water
697   1   0.068525      1   -2  -552                            $ Fuel
698   2   0.055323      1   -2   552  -553                      $ Clad
699   3   0.10018       1   -2    19   -20    61   -62   553    $ Water
700   1   0.068525      1   -2  -554                            $ Fuel
701   2   0.055323      1   -2   554  -555                      $ Clad
702   3   0.10018       1   -2    19   -20    62   -63   555    $ Water
703   1   0.068525      1   -2  -556                            $ Fuel
704   2   0.055323      1   -2   556  -557                      $ Clad
705   3   0.10018       1   -2    19   -20    63   -64   557    $ Water
706   1   0.068525      1   -2  -558                            $ Fuel
707   2   0.055323      1   -2   558  -559                      $ Clad
708   3   0.10018       1   -2    19   -20    64   -65   559    $ Water
709   1   0.068525      1   -2  -560                            $ Fuel
710   2   0.055323      1   -2   560  -561                      $ Clad
711   3   0.10018       1   -2    19   -20    65   -66   561    $ Water
712   1   0.068525      1   -2  -562                            $ Fuel
713   2   0.055323      1   -2   562  -563                      $ Clad
714   3   0.10018       1   -2    19   -20    66   -67   563    $ Water
715   1   0.068525      1   -2  -564                            $ Fuel
716   2   0.055323      1   -2   564  -565                      $ Clad
717   3   0.10018       1   -2    19   -20    67   -68   565    $ Water
718   1   0.068525      1   -2  -566                            $ Fuel
719   2   0.055323      1   -2   566  -567                      $ Clad
720   3   0.10018       1   -2    19   -20    68   -69   567    $ Water
721   3   0.10018       1   -2     4  -568                      $ Water Hole
722   3   0.10018       1   -2     4   568  -569                $ Water Hole
723   3   0.10018       1   -2     4    20    61   -62   569    $ Water Hole
724   1   0.068525      1   -2  -570                            $ Fuel
725   2   0.055323      1   -2   570  -571                      $ Clad
726   3   0.10018       1   -2    20   -21    62   -63   571    $ Water
727   1   0.068525      1   -2  -572                            $ Fuel
728   2   0.055323      1   -2   572  -573                      $ Clad
729   3   0.10018       1   -2    20   -21    63   -64   573    $ Water
730   1   0.068525      1   -2  -574                            $ Fuel
731   2   0.055323      1   -2   574  -575                      $ Clad
732   3   0.10018       1   -2    20   -21    64   -65   575    $ Water
733   1   0.068525      1   -2  -576                            $ Fuel
734   2   0.055323      1   -2   576  -577                      $ Clad
735   3   0.10018       1   -2    20   -21    65   -66   577    $ Water
736   1   0.068525      1   -2  -578                            $ Fuel
737   2   0.055323      1   -2   578  -579                      $ Clad
738   3   0.10018       1   -2    20   -21    66   -67   579    $ Water
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739	1	0.068525	1	-2	-580					$ Fuel
740	2	0.055323	1	-2	580	-581				$ Clad
741	3	0.10018	1	-2	20	-21	67	-68	581	$ Water
742	1	0.068525	1	-2	-582					$ Fuel
743	2	0.055323	1	-2	582	-583				$ Clad
744	3	0.10018	1	-2	20	-21	68	-69	583	$ Water
745	1	0.068525	1	-2	4	-584				$ Fuel
746	2	0.055323	1	-2	4	584	-585			$ Clad
747	3	0.10018	1	-2	4	21	62	-63	585	$ Water
748	1	0.068525	1	-2	-586					$ Fuel
749	2	0.055323	1	-2	586	-587				$ Clad
750	3	0.10018	1	-2	21	-22	63	-64	587	$ Water
751	1	0.068525	1	-2	-588					$ Fuel
752	2	0.055323	1	-2	588	-589				$ Clad
753	3	0.10018	1	-2	21	-22	64	-65	589	$ Water
754	1	0.068525	1	-2	-590					$ Fuel
755	2	0.055323	1	-2	590	-591				$ Clad
756	3	0.10018	1	-2	21	-22	65	-66	591	$ Water
757	1	0.068525	1	-2	-592					$ Fuel
758	2	0.055323	1	-2	592	-593				$ Clad
759	3	0.10018	1	-2	21	-22	66	-67	593	$ Water
760	1	0.068525	1	-2	-594					$ Fuel
761	2	0.055323	1	-2	594	-595				$ Clad
762	3	0.10018	1	-2	21	-22	67	-68	595	$ Water
763	1	0.068525	1	-2	-596					$ Fuel
764	2	0.055323	1	-2	596	-597				$ Clad
765	3	0.10018	1	-2	21	-22	68	-69	597	$ Water
766	3	0.10018	1	-2	4	-598				$ Water Hole
767	3	0.10018	1	-2	4	598	-599			$ Water Hole
768	3	0.10018	1	-2	4	22	63	-64	599	$ Water Hole
769	1	0.068525	1	-2	-600					$ Fuel
770	2	0.055323	1	-2	600	-601				$ Clad
771	3	0.10018	1	-2	22	-23	64	-65	601	$ Water
772	1	0.068525	1	-2	-602					$ Fuel
773	2	0.055323	1	-2	602	-603				$ Clad
774	3	0.10018	1	-2	22	-23	65	-66	603	$ Water
775	3	0.10018	1	-2	-604					$ Water Hole
776	3	0.10018	1	-2	604	-605				$ Water Hole
777	3	0.10018	1	-2	22	-23	66	-67	605	$ Water Hole
778	1	0.068525	1	-2	-606					$ Fuel
779	2	0.055323	1	-2	606	-607				$ Clad
780	3	0.10018	1	-2	22	-23	67	-68	607	$ Water
781	1	0.068525	1	-2	-608					$ Fuel
782	2	0.055323	1	-2	608	-609				$ Clad
783	3	0.10018	1	-2	22	-23	68	-69	609	$ Water
784	1	0.068525	1	-2	4	-610				$ Fuel
785	2	0.055323	1	-2	4	610	-611			$ Clad
786	3	0.10018	1	-2	4	23	64	-65	611	$ Water
787	1	0.068525	1	-2	-612					$ Fuel
788	2	0.055323	1	-2	612	-613				$ Clad
789	3	0.10018	1	-2	23	-24	65	-66	613	$ Water
790	1	0.068525	1	-2	-614					$ Fuel
791	2	0.055323	1	-2	614	-615				$ Clad
792	3	0.10018	1	-2	23	-24	66	-67	615	$ Water
793	1	0.068525	1	-2	-616					$ Fuel
794	2	0.055323	1	-2	616	-617				$ Clad
795	3	0.10018	1	-2	23	-24	67	-68	617	$ Water
796	1	0.068525	1	-2	-618					$ Fuel
797	2	0.055323	1	-2	618	-619				$ Clad
798	3	0.10018	1	-2	23	-24	68	-69	619	$ Water
799	3	0.10018	1	-2	4	-620				$ Water Hole
800	3	0.10018	1	-2	4	620	-621			$ Water Hole
801	3	0.10018	1	-2	4	24	65	-66	621	$ Water Hole
802	1	0.068525	1	-2	-622					$ Fuel
803	2	0.055323	1	-2	622	-623				$ Clad
804	3	0.10018	1	-2	24	-25	66	-67	623	$ Water
805	1	0.068525	1	-2	-624					$ Fuel
806	2	0.055323	1	-2	624	-625				$ Clad

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807   3   0.10018      1   -2    24   -25    67   -68   625    $ Water
808   1   0.068525     1   -2  -626                             $ Fuel
809   2   0.055323     1   -2   626  -627                       $ Clad
810   3   0.10018      1   -2    24   -25    68   -69   627    $ Water
811   1   0.068525     1   -2     4  -628                       $ Fuel
812   2   0.055323     1   -2     4   628  -629                 $ Clad
813   3   0.10018      1   -2     4    25    66   -67   629    $ Water
814   1   0.068525     1   -2  -630                             $ Fuel
815   2   0.055323     1   -2   630  -631                       $ Clad
816   3   0.10018      1   -2    25   -26    67   -68   631    $ Water
817   1   0.068525     1   -2  -632                             $ Fuel
818   2   0.055323     1   -2   632  -633                       $ Clad
819   3   0.10018      1   -2    25   -26    68   -69   633    $ Water
820   1   0.068525     1   -2     4  -634                       $ Fuel
821   2   0.055323     1   -2     4   634  -635                 $ Clad
822   3   0.10018      1   -2     4    26    67   -68   635    $ Water
823   1   0.068525     1   -2  -636                             $ Fuel
824   2   0.055323     1   -2   636  -637                       $ Clad
825   3   0.10018      1   -2    26   -27    68   -69   637    $ Water
826   1   0.068525     1   -2     4  -638                       $ Fuel
827   2   0.055323     1   -2     4   638  -639                 $ Clad
828   3   0.10018      1   -2     4    27    68   -69   639    $ Water
c    Buffer Cells and Reflector
829   1   0.068525     1   -2     3  -640                       $ Fuel
830   2   0.055323     1   -2     3   640  -641                 $ Clad
831   3   0.10018      1   -2     3    -6    69   -70   641    $ Water
832   1   0.068525     1   -2     3  -642                       $ Fuel
833   2   0.055323     1   -2     3   642  -643                 $ Clad
834   3   0.10018      1   -2     3    -6    70   -71   643    $ Water
835   1   0.068525     1   -2     3  -644                       $ Fuel
836   2   0.055323     1   -2     3   644  -645                 $ Clad
837   3   0.10018      1   -2     3    -6    71   -72   645    $ Water
838   1   0.068525     1   -2     3  -646                       $ Fuel
839   2   0.055323     1   -2     3   646  -647                 $ Clad
840   3   0.10018      1   -2     3    -6    72   -73   647    $ Water
841   1   0.068525     1   -2     3  -648                       $ Fuel
842   2   0.055323     1   -2     3   648  -649                 $ Clad
843   3   0.10018      1   -2     3    -6    73   -74   649    $ Water
844   1   0.068525     1   -2     3  -650                       $ Fuel
845   2   0.055323     1   -2     3   650  -651                 $ Clad
846   3   0.10018      1   -2     3    -6    74   -75   651    $ Water
847   1   0.068525     1   -2     3  -652                       $ Fuel
848   2   0.055323     1   -2     3   652  -653                 $ Clad
849   3   0.10018      1   -2     3    -6    75   -76   653    $ Water
850   1   0.068525     1   -2     3  -654                       $ Fuel
851   2   0.055323     1   -2     3   654  -655                 $ Clad
852   3   0.10018      1   -2     3    -6    76   -77   655    $ Water
853   1   0.068525     1   -2     3  -656                       $ Fuel
854   2   0.055323     1   -2     3   656  -657                 $ Clad
855   3   0.10018      1   -2     3    -6    77   -78   657    $ Water
856   1   0.068525     1   -2     3  -658                       $ Fuel
857   2   0.055323     1   -2     3   658  -659                 $ Clad
858   3   0.10018      1   -2     3    -6    78   -79   659    $ Water
859   1   0.068525     1   -2     3  -660                       $ Fuel
860   2   0.055323     1   -2     3   660  -661                 $ Clad
861   3   0.10018      1   -2     3    -6    79   -80   661    $ Water
862   1   0.068525     1   -2     3  -662                       $ Fuel
863   2   0.055323     1   -2     3   662  -663                 $ Clad
864   3   0.10018      1   -2     3    -6    80   -81   663    $ Water
865   1   0.068525     1   -2     3  -664                       $ Fuel
866   2   0.055323     1   -2     3   664  -665                 $ Clad
867   3   0.10018      1   -2     3    -6    81   -82   665    $ Water
868   1   0.068525     1   -2     3  -666                       $ Fuel
869   2   0.055323     1   -2     3   666  -667                 $ Clad
870   3   0.10018      1   -2     3    -6    82   -83   667    $ Water
871   1   0.068525     1   -2     3  -668                       $ Fuel
872   2   0.055323     1   -2     3   668  -669                 $ Clad
873   3   0.10018      1   -2     3    -6    83   -84   669    $ Water
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874   1   0.068525      1   -2      3  -670                        $ Fuel
875   2   0.055323      1   -2      3   670  -671                  $ Clad
876   3   0.10018       1   -2      3    -6    84   -85   671      $ Water
877   1   0.068525      1   -2      3  -672                        $ Fuel
878   2   0.055323      1   -2      3   672  -673                  $ Clad
879   3   0.10018       1   -2      3    -6    85   -86   673      $ Water
880   1   0.068525      1   -2      3  -674                        $ Fuel
881   2   0.055323      1   -2      3   674  -675                  $ Clad
882   3   0.10018       1   -2      3    -6    86   -87   675      $ Water
883   3   0.10018       1   -2      3    -6    87    -5            $ Reflector
884   1   0.068525      1   -2   -676                              $ Fuel
885   2   0.055323      1   -2    676  -677                        $ Clad
886   3   0.10018       1   -2      6    -7    69   -70   677      $ Water
887   1   0.068525      1   -2   -678                              $ Fuel
888   2   0.055323      1   -2    678  -679                        $ Clad
889   3   0.10018       1   -2      6    -7    70   -71   679      $ Water
890   1   0.068525      1   -2   -680                              $ Fuel
891   2   0.055323      1   -2    680  -681                        $ Clad
892   3   0.10018       1   -2      6    -7    71   -72   681      $ Water
893   1   0.068525      1   -2   -682                              $ Fuel
894   2   0.055323      1   -2    682  -683                        $ Clad
895   3   0.10018       1   -2      6    -7    72   -73   683      $ Water
896   1   0.068525      1   -2   -684                              $ Fuel
897   2   0.055323      1   -2    684  -685                        $ Clad
898   3   0.10018       1   -2      6    -7    73   -74   685      $ Water
899   1   0.068525      1   -2   -686                              $ Fuel
900   2   0.055323      1   -2    686  -687                        $ Clad
901   3   0.10018       1   -2      6    -7    74   -75   687      $ Water
902   1   0.068525      1   -2   -688                              $ Fuel
903   2   0.055323      1   -2    688  -689                        $ Clad
904   3   0.10018       1   -2      6    -7    75   -76   689      $ Water
905   1   0.068525      1   -2   -690                              $ Fuel
906   2   0.055323      1   -2    690  -691                        $ Clad
907   3   0.10018       1   -2      6    -7    76   -77   691      $ Water
908   1   0.068525      1   -2   -692                              $ Fuel
909   2   0.055323      1   -2    692  -693                        $ Clad
910   3   0.10018       1   -2      6    -7    77   -78   693      $ Water
911   1   0.068525      1   -2   -694                              $ Fuel
912   2   0.055323      1   -2    694  -695                        $ Clad
913   3   0.10018       1   -2      6    -7    78   -79   695      $ Water
914   1   0.068525      1   -2   -696                              $ Fuel
915   2   0.055323      1   -2    696  -697                        $ Clad
916   3   0.10018       1   -2      6    -7    79   -80   697      $ Water
917   1   0.068525      1   -2   -698                              $ Fuel
918   2   0.055323      1   -2    698  -699                        $ Clad
919   3   0.10018       1   -2      6    -7    80   -81   699      $ Water
920   1   0.068525      1   -2   -700                              $ Fuel
921   2   0.055323      1   -2    700  -701                        $ Clad
922   3   0.10018       1   -2      6    -7    81   -82   701      $ Water
923   1   0.068525      1   -2   -702                              $ Fuel
924   2   0.055323      1   -2    702  -703                        $ Clad
925   3   0.10018       1   -2      6    -7    82   -83   703      $ Water
926   1   0.068525      1   -2   -704                              $ Fuel
927   2   0.055323      1   -2    704  -705                        $ Clad
928   3   0.10018       1   -2      6    -7    83   -84   705      $ Water
929   1   0.068525      1   -2   -706                              $ Fuel
930   2   0.055323      1   -2    706  -707                        $ Clad
931   3   0.10018       1   -2      6    -7    84   -85   707      $ Water
932   1   0.068525      1   -2   -708                              $ Fuel
933   2   0.055323      1   -2    708  -709                        $ Clad
934   3   0.10018       1   -2      6    -7    85   -86   709      $ Water
935   1   0.068525      1   -2   -710                              $ Fuel
936   2   0.055323      1   -2    710  -711                        $ Clad
937   3   0.10018       1   -2      6    -7    86   -87   711      $ Water
938   3   0.10018       1   -2      6    -7    87    -5            $ Reflector
939   1   0.068525      1   -2   -712                              $ Fuel
940   2   0.055323      1   -2    712  -713                        $ Clad
941   3   0.10018       1   -2      7    -8    69   -70   713      $ Water
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942   1   0.068525    1   -2   -714                            $ Fuel
943   2   0.055323    1   -2    714  -715                      $ Clad
944   3   0.10018     1   -2      7    -8    70   -71   715    $ Water
945   1   0.068525    1   -2   -716                            $ Fuel
946   2   0.055323    1   -2    716  -717                      $ Clad
947   3   0.10018     1   -2      7    -8    71   -72   717    $ Water
948   1   0.068525    1   -2   -718                            $ Fuel
949   2   0.055323    1   -2    718  -719                      $ Clad
950   3   0.10018     1   -2      7    -8    72   -73   719    $ Water
951   1   0.068525    1   -2   -720                            $ Fuel
952   2   0.055323    1   -2    720  -721                      $ Clad
953   3   0.10018     1   -2      7    -8    73   -74   721    $ Water
954   1   0.068525    1   -2   -722                            $ Fuel
955   2   0.055323    1   -2    722  -723                      $ Clad
956   3   0.10018     1   -2      7    -8    74   -75   723    $ Water
957   1   0.068525    1   -2   -724                            $ Fuel
958   2   0.055323    1   -2    724  -725                      $ Clad
959   3   0.10018     1   -2      7    -8    75   -76   725    $ Water
960   1   0.068525    1   -2   -726                            $ Fuel
961   2   0.055323    1   -2    726  -727                      $ Clad
962   3   0.10018     1   -2      7    -8    76   -77   727    $ Water
963   1   0.068525    1   -2   -728                            $ Fuel
964   2   0.055323    1   -2    728  -729                      $ Clad
965   3   0.10018     1   -2      7    -8    77   -78   729    $ Water
966   1   0.068525    1   -2   -730                            $ Fuel
967   2   0.055323    1   -2    730  -731                      $ Clad
968   3   0.10018     1   -2      7    -8    78   -79   731    $ Water
969   1   0.068525    1   -2   -732                            $ Fuel
970   2   0.055323    1   -2    732  -733                      $ Clad
971   3   0.10018     1   -2      7    -8    79   -80   733    $ Water
972   1   0.068525    1   -2   -734                            $ Fuel
973   2   0.055323    1   -2    734  -735                      $ Clad
974   3   0.10018     1   -2      7    -8    80   -81   735    $ Water
975   1   0.068525    1   -2   -736                            $ Fuel
976   2   0.055323    1   -2    736  -737                      $ Clad
977   3   0.10018     1   -2      7    -8    81   -82   737    $ Water
978   1   0.068525    1   -2   -738                            $ Fuel
979   2   0.055323    1   -2    738  -739                      $ Clad
980   3   0.10018     1   -2      7    -8    82   -83   739    $ Water
981   1   0.068525    1   -2   -740                            $ Fuel
982   2   0.055323    1   -2    740  -741                      $ Clad
983   3   0.10018     1   -2      7    -8    83   -84   741    $ Water
984   1   0.068525    1   -2   -742                            $ Fuel
985   2   0.055323    1   -2    742  -743                      $ Clad
986   3   0.10018     1   -2      7    -8    84   -85   743    $ Water
987   1   0.068525    1   -2   -744                            $ Fuel
988   2   0.055323    1   -2    744  -745                      $ Clad
989   3   0.10018     1   -2      7    -8    85   -86   745    $ Water
990   1   0.068525    1   -2   -746                            $ Fuel
991   2   0.055323    1   -2    746  -747                      $ Clad
992   3   0.10018     1   -2      7    -8    86   -87   747    $ Water
993   3   0.10018     1   -2      7    -8    87    -5          $ Reflector
994   1   0.068525    1   -2   -748                            $ Fuel
995   2   0.055323    1   -2    748  -749                      $ Clad
996   3   0.10018     1   -2      8    -9    69   -70   749    $ Water
997   1   0.068525    1   -2   -750                            $ Fuel
998   2   0.055323    1   -2    750  -751                      $ Clad
999   3   0.10018     1   -2      8    -9    70   -71   751    $ Water
1000  1   0.068525    1   -2   -752                            $ Fuel
1001  2   0.055323    1   -2    752  -753                      $ Clad
1002  3   0.10018     1   -2      8    -9    71   -72   753    $ Water
1003  1   0.068525    1   -2   -754                            $ Fuel
1004  2   0.055323    1   -2    754  -755                      $ Clad
1005  3   0.10018     1   -2      8    -9    72   -73   755    $ Water
1006  1   0.068525    1   -2   -756                            $ Fuel
1007  2   0.055323    1   -2    756  -757                      $ Clad
1008  3   0.10018     1   -2      8    -9    73   -74   757    $ Water
1009  1   0.068525    1   -2   -758                            $ Fuel
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1010	2	0.055323	1	-2	758	-759				$ Clad
1011	3	0.10018	1	-2	8	-9	74	-75	759	$ Water
1012	1	0.068525	1	-2	-760					$ Fuel
1013	2	0.055323	1	-2	760	-761				$ Clad
1014	3	0.10018	1	-2	8	-9	75	-76	761	$ Water
1015	1	0.068525	1	-2	-762					$ Fuel
1016	2	0.055323	1	-2	762	-763				$ Clad
1017	3	0.10018	1	-2	8	-9	76	-77	763	$ Water
1018	1	0.068525	1	-2	-764					$ Fuel
1019	2	0.055323	1	-2	764	-765				$ Clad
1020	3	0.10018	1	-2	8	-9	77	-78	765	$ Water
1021	1	0.068525	1	-2	-766					$ Fuel
1022	2	0.055323	1	-2	766	-767				$ Clad
1023	3	0.10018	1	-2	8	-9	78	-79	767	$ Water
1024	1	0.068525	1	-2	-768					$ Fuel
1025	2	0.055323	1	-2	768	-769				$ Clad
1026	3	0.10018	1	-2	8	-9	79	-80	769	$ Water
1027	1	0.068525	1	-2	-770					$ Fuel
1028	2	0.055323	1	-2	770	-771				$ Clad
1029	3	0.10018	1	-2	8	-9	80	-81	771	$ Water
1030	1	0.068525	1	-2	-772					$ Fuel
1031	2	0.055323	1	-2	772	-773				$ Clad
1032	3	0.10018	1	-2	8	-9	81	-82	773	$ Water
1033	1	0.068525	1	-2	-774					$ Fuel
1034	2	0.055323	1	-2	774	-775				$ Clad
1035	3	0.10018	1	-2	8	-9	82	-83	775	$ Water
1036	1	0.068525	1	-2	-776					$ Fuel
1037	2	0.055323	1	-2	776	-777				$ Clad
1038	3	0.10018	1	-2	8	-9	83	-84	777	$ Water
1039	1	0.068525	1	-2	-778					$ Fuel
1040	2	0.055323	1	-2	778	-779				$ Clad
1041	3	0.10018	1	-2	8	-9	84	-85	779	$ Water
1042	1	0.068525	1	-2	-780					$ Fuel
1043	2	0.055323	1	-2	780	-781				$ Clad
1044	3	0.10018	1	-2	8	-9	85	-86	781	$ Water
1045	1	0.068525	1	-2	-782					$ Fuel
1046	2	0.055323	1	-2	782	-783				$ Clad
1047	3	0.10018	1	-2	8	-9	86	-87	783	$ Water
1048	3	0.10018	1	-2	8	-9	87	-5		$ Reflector
1049	1	0.068525	1	-2	-784					$ Fuel
1050	2	0.055323	1	-2	784	-785				$ Clad
1051	3	0.10018	1	-2	9	-10	69	-70	785	$ Water
1052	1	0.068525	1	-2	-786					$ Fuel
1053	2	0.055323	1	-2	786	-787				$ Clad
1054	3	0.10018	1	-2	9	-10	70	-71	787	$ Water
1055	1	0.068525	1	-2	-788					$ Fuel
1056	2	0.055323	1	-2	788	-789				$ Clad
1057	3	0.10018	1	-2	9	-10	71	-72	789	$ Water
1058	1	0.068525	1	-2	-790					$ Fuel
1059	2	0.055323	1	-2	790	-791				$ Clad
1060	3	0.10018	1	-2	9	-10	72	-73	791	$ Water
1061	1	0.068525	1	-2	-792					$ Fuel
1062	2	0.055323	1	-2	792	-793				$ Clad
1063	3	0.10018	1	-2	9	-10	73	-74	793	$ Water
1064	1	0.068525	1	-2	-794					$ Fuel
1065	2	0.055323	1	-2	794	-795				$ Clad
1066	3	0.10018	1	-2	9	-10	74	-75	795	$ Water
1067	1	0.068525	1	-2	-796					$ Fuel
1068	2	0.055323	1	-2	796	-797				$ Clad
1069	3	0.10018	1	-2	9	-10	75	-76	797	$ Water
1070	1	0.068525	1	-2	-798					$ Fuel
1071	2	0.055323	1	-2	798	-799				$ Clad
1072	3	0.10018	1	-2	9	-10	76	-77	799	$ Water
1073	1	0.068525	1	-2	-800					$ Fuel
1074	2	0.055323	1	-2	800	-801				$ Clad
1075	3	0.10018	1	-2	9	-10	77	-78	801	$ Water
1076	1	0.068525	1	-2	-802					$ Fuel
1077	2	0.055323	1	-2	802	-803				$ Clad

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1078  3   0.10018      1   -2     9   -10    78   -79   803     $ Water
1079  1   0.068525     1   -2  -804                             $ Fuel
1080  2   0.055323     1   -2   804  -805                       $ Clad
1081  3   0.10018      1   -2     9   -10    79   -80   805     $ Water
1082  1   0.068525     1   -2  -806                             $ Fuel
1083  2   0.055323     1   -2   806  -807                       $ Clad
1084  3   0.10018      1   -2     9   -10    80   -81   807     $ Water
1085  1   0.068525     1   -2  -808                             $ Fuel
1086  2   0.055323     1   -2   808  -809                       $ Clad
1087  3   0.10018      1   -2     9   -10    81   -82   809     $ Water
1088  1   0.068525     1   -2  -810                             $ Fuel
1089  2   0.055323     1   -2   810  -811                       $ Clad
1090  3   0.10018      1   -2     9   -10    82   -83   811     $ Water
1091  1   0.068525     1   -2  -812                             $ Fuel
1092  2   0.055323     1   -2   812  -813                       $ Clad
1093  3   0.10018      1   -2     9   -10    83   -84   813     $ Water
1094  1   0.068525     1   -2  -814                             $ Fuel
1095  2   0.055323     1   -2   814  -815                       $ Clad
1096  3   0.10018      1   -2     9   -10    84   -85   815     $ Water
1097  1   0.068525     1   -2  -816                             $ Fuel
1098  2   0.055323     1   -2   816  -817                       $ Clad
1099  3   0.10018      1   -2     9   -10    85   -86   817     $ Water
1100  1   0.068525     1   -2  -818                             $ Fuel
1101  2   0.055323     1   -2   818  -819                       $ Clad
1102  3   0.10018      1   -2     9   -10    86   -87   819     $ Water
1103  3   0.10018      1   -2     9   -10    87    -5           $ Reflector
1104  1   0.068525     1   -2  -820                             $ Fuel
1105  2   0.055323     1   -2   820  -821                       $ Clad
1106  3   0.10018      1   -2    10   -11    69   -70   821     $ Water
1107  1   0.068525     1   -2  -822                             $ Fuel
1108  2   0.055323     1   -2   822  -823                       $ Clad
1109  3   0.10018      1   -2    10   -11    70   -71   823     $ Water
1110  1   0.068525     1   -2  -824                             $ Fuel
1111  2   0.055323     1   -2   824  -825                       $ Clad
1112  3   0.10018      1   -2    10   -11    71   -72   825     $ Water
1113  1   0.068525     1   -2  -826                             $ Fuel
1114  2   0.055323     1   -2   826  -827                       $ Clad
1115  3   0.10018      1   -2    10   -11    72   -73   827     $ Water
1116  1   0.068525     1   -2  -828                             $ Fuel
1117  2   0.055323     1   -2   828  -829                       $ Clad
1118  3   0.10018      1   -2    10   -11    73   -74   829     $ Water
1119  1   0.068525     1   -2  -830                             $ Fuel
1120  2   0.055323     1   -2   830  -831                       $ Clad
1121  3   0.10018      1   -2    10   -11    74   -75   831     $ Water
1122  1   0.068525     1   -2  -832                             $ Fuel
1123  2   0.055323     1   -2   832  -833                       $ Clad
1124  3   0.10018      1   -2    10   -11    75   -76   833     $ Water
1125  1   0.068525     1   -2  -834                             $ Fuel
1126  2   0.055323     1   -2   834  -835                       $ Clad
1127  3   0.10018      1   -2    10   -11    76   -77   835     $ Water
1128  1   0.068525     1   -2  -836                             $ Fuel
1129  2   0.055323     1   -2   836  -837                       $ Clad
1130  3   0.10018      1   -2    10   -11    77   -78   837     $ Water
1131  1   0.068525     1   -2  -838                             $ Fuel
1132  2   0.055323     1   -2   838  -839                       $ Clad
1133  3   0.10018      1   -2    10   -11    78   -79   839     $ Water
1134  1   0.068525     1   -2  -840                             $ Fuel
1135  2   0.055323     1   -2   840  -841                       $ Clad
1136  3   0.10018      1   -2    10   -11    79   -80   841     $ Water
1137  1   0.068525     1   -2  -842                             $ Fuel
1138  2   0.055323     1   -2   842  -843                       $ Clad
1139  3   0.10018      1   -2    10   -11    80   -81   843     $ Water
1140  1   0.068525     1   -2  -844                             $ Fuel
1141  2   0.055323     1   -2   844  -845                       $ Clad
1142  3   0.10018      1   -2    10   -11    81   -82   845     $ Water
1143  1   0.068525     1   -2  -846                             $ Fuel
1144  2   0.055323     1   -2   846  -847                       $ Clad
1145  3   0.10018      1   -2    10   -11    82   -83   847     $ Water
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1146  1   0.068525      1   -2  -848                               $ Fuel
1147  2   0.055323      1   -2   848  -849                         $ Clad
1148  3   0.10018       1   -2    10   -11    83   -84   849       $ Water
1149  1   0.068525      1   -2  -850                               $ Fuel
1150  2   0.055323      1   -2   850  -851                         $ Clad
1151  3   0.10018       1   -2    10   -11    84   -85   851       $ Water
1152  1   0.068525      1   -2  -852                               $ Fuel
1153  2   0.055323      1   -2   852  -853                         $ Clad
1154  3   0.10018       1   -2    10   -11    85   -86   853       $ Water
1155  1   0.068525      1   -2  -854                               $ Fuel
1156  2   0.055323      1   -2   854  -855                         $ Clad
1157  3   0.10018       1   -2    10   -11    86   -87   855       $ Water
1158  3   0.10018       1   -2    10   -11    87    -5             $ Reflector
1159  1   0.068525      1   -2  -856                               $ Fuel
1160  2   0.055323      1   -2   856  -857                         $ Clad
1161  3   0.10018       1   -2    11   -12    69   -70   857       $ Water
1162  1   0.068525      1   -2  -858                               $ Fuel
1163  2   0.055323      1   -2   858  -859                         $ Clad
1164  3   0.10018       1   -2    11   -12    70   -71   859       $ Water
1165  1   0.068525      1   -2  -860                               $ Fuel
1166  2   0.055323      1   -2   860  -861                         $ Clad
1167  3   0.10018       1   -2    11   -12    71   -72   861       $ Water
1168  1   0.068525      1   -2  -862                               $ Fuel
1169  2   0.055323      1   -2   862  -863                         $ Clad
1170  3   0.10018       1   -2    11   -12    72   -73   863       $ Water
1171  1   0.068525      1   -2  -864                               $ Fuel
1172  2   0.055323      1   -2   864  -865                         $ Clad
1173  3   0.10018       1   -2    11   -12    73   -74   865       $ Water
1174  1   0.068525      1   -2  -866                               $ Fuel
1175  2   0.055323      1   -2   866  -867                         $ Clad
1176  3   0.10018       1   -2    11   -12    74   -75   867       $ Water
1177  1   0.068525      1   -2  -868                               $ Fuel
1178  2   0.055323      1   -2   868  -869                         $ Clad
1179  3   0.10018       1   -2    11   -12    75   -76   869       $ Water
1180  1   0.068525      1   -2  -870                               $ Fuel
1181  2   0.055323      1   -2   870  -871                         $ Clad
1182  3   0.10018       1   -2    11   -12    76   -77   871       $ Water
1183  1   0.068525      1   -2  -872                               $ Fuel
1184  2   0.055323      1   -2   872  -873                         $ Clad
1185  3   0.10018       1   -2    11   -12    77   -78   873       $ Water
1186  1   0.068525      1   -2  -874                               $ Fuel
1187  2   0.055323      1   -2   874  -875                         $ Clad
1188  3   0.10018       1   -2    11   -12    78   -79   875       $ Water
1189  1   0.068525      1   -2  -876                               $ Fuel
1190  2   0.055323      1   -2   876  -877                         $ Clad
1191  3   0.10018       1   -2    11   -12    79   -80   877       $ Water
1192  1   0.068525      1   -2  -878                               $ Fuel
1193  2   0.055323      1   -2   878  -879                         $ Clad
1194  3   0.10018       1   -2    11   -12    80   -81   879       $ Water
1195  1   0.068525      1   -2  -880                               $ Fuel
1196  2   0.055323      1   -2   880  -881                         $ Clad
1197  3   0.10018       1   -2    11   -12    81   -82   881       $ Water
1198  1   0.068525      1   -2  -882                               $ Fuel
1199  2   0.055323      1   -2   882  -883                         $ Clad
1200  3   0.10018       1   -2    11   -12    82   -83   883       $ Water
1201  1   0.068525      1   -2  -884                               $ Fuel
1202  2   0.055323      1   -2   884  -885                         $ Clad
1203  3   0.10018       1   -2    11   -12    83   -84   885       $ Water
1204  1   0.068525      1   -2  -886                               $ Fuel
1205  2   0.055323      1   -2   886  -887                         $ Clad
1206  3   0.10018       1   -2    11   -12    84   -85   887       $ Water
1207  1   0.068525      1   -2  -888                               $ Fuel
1208  2   0.055323      1   -2   888  -889                         $ Clad
1209  3   0.10018       1   -2    11   -12    85   -86   889       $ Water
1210  1   0.068525      1   -2  -890                               $ Fuel
1211  2   0.055323      1   -2   890  -891                         $ Clad
1212  3   0.10018       1   -2    11   -12    86   -87   891       $ Water
1213  3   0.10018       1   -2    11   -12    87    -5             $ Reflector
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1214  1   0.068525     1   -2  -892                           $ Fuel
1215  2   0.055323     1   -2   892  -893                     $ Clad
1216  3   0.10018      1   -2    12   -13    69   -70   893   $ Water
1217  1   0.068525     1   -2  -894                           $ Fuel
1218  2   0.055323     1   -2   894  -895                     $ Clad
1219  3   0.10018      1   -2    12   -13    70   -71   895   $ Water
1220  1   0.068525     1   -2  -896                           $ Fuel
1221  2   0.055323     1   -2   896  -897                     $ Clad
1222  3   0.10018      1   -2    12   -13    71   -72   897   $ Water
1223  1   0.068525     1   -2  -898                           $ Fuel
1224  2   0.055323     1   -2   898  -899                     $ Clad
1225  3   0.10018      1   -2    12   -13    72   -73   899   $ Water
1226  1   0.068525     1   -2  -900                           $ Fuel
1227  2   0.055323     1   -2   900  -901                     $ Clad
1228  3   0.10018      1   -2    12   -13    73   -74   901   $ Water
1229  1   0.068525     1   -2  -902                           $ Fuel
1230  2   0.055323     1   -2   902  -903                     $ Clad
1231  3   0.10018      1   -2    12   -13    74   -75   903   $ Water
1232  1   0.068525     1   -2  -904                           $ Fuel
1233  2   0.055323     1   -2   904  -905                     $ Clad
1234  3   0.10018      1   -2    12   -13    75   -76   905   $ Water
1235  1   0.068525     1   -2  -906                           $ Fuel
1236  2   0.055323     1   -2   906  -907                     $ Clad
1237  3   0.10018      1   -2    12   -13    76   -77   907   $ Water
1238  1   0.068525     1   -2  -908                           $ Fuel
1239  2   0.055323     1   -2   908  -909                     $ Clad
1240  3   0.10018      1   -2    12   -13    77   -78   909   $ Water
1241  1   0.068525     1   -2  -910                           $ Fuel
1242  2   0.055323     1   -2   910  -911                     $ Clad
1243  3   0.10018      1   -2    12   -13    78   -79   911   $ Water
1244  1   0.068525     1   -2  -912                           $ Fuel
1245  2   0.055323     1   -2   912  -913                     $ Clad
1246  3   0.10018      1   -2    12   -13    79   -80   913   $ Water
1247  1   0.068525     1   -2  -914                           $ Fuel
1248  2   0.055323     1   -2   914  -915                     $ Clad
1249  3   0.10018      1   -2    12   -13    80   -81   915   $ Water
1250  1   0.068525     1   -2  -916                           $ Fuel
1251  2   0.055323     1   -2   916  -917                     $ Clad
1252  3   0.10018      1   -2    12   -13    81   -82   917   $ Water
1253  1   0.068525     1   -2  -918                           $ Fuel
1254  2   0.055323     1   -2   918  -919                     $ Clad
1255  3   0.10018      1   -2    12   -13    82   -83   919   $ Water
1256  1   0.068525     1   -2  -920                           $ Fuel
1257  2   0.055323     1   -2   920  -921                     $ Clad
1258  3   0.10018      1   -2    12   -13    83   -84   921   $ Water
1259  1   0.068525     1   -2  -922                           $ Fuel
1260  2   0.055323     1   -2   922  -923                     $ Clad
1261  3   0.10018      1   -2    12   -13    84   -85   923   $ Water
1262  1   0.068525     1   -2  -924                           $ Fuel
1263  2   0.055323     1   -2   924  -925                     $ Clad
1264  3   0.10018      1   -2    12   -13    85   -86   925   $ Water
1265  1   0.068525     1   -2  -926                           $ Fuel
1266  2   0.055323     1   -2   926  -927                     $ Clad
1267  3   0.10018      1   -2    12   -13    86   -87   927   $ Water
1268  3   0.10018      1   -2    12   -13    87    -5         $ Reflector
1269  1   0.068525     1   -2  -928                           $ Fuel
1270  2   0.055323     1   -2   928  -929                     $ Clad
1271  3   0.10018      1   -2    13   -14    69   -70   929   $ Water
1272  1   0.068525     1   -2  -930                           $ Fuel
1273  2   0.055323     1   -2   930  -931                     $ Clad
1274  3   0.10018      1   -2    13   -14    70   -71   931   $ Water
1275  1   0.068525     1   -2  -932                           $ Fuel
1276  2   0.055323     1   -2   932  -933                     $ Clad
1277  3   0.10018      1   -2    13   -14    71   -72   933   $ Water
1278  1   0.068525     1   -2  -934                           $ Fuel
1279  2   0.055323     1   -2   934  -935                     $ Clad
1280  3   0.10018      1   -2    13   -14    72   -73   935   $ Water
1281  1   0.068525     1   -2  -936                           $ Fuel
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1282  2   0.055323      1   -2   936  -937                        $ Clad
1283  3   0.10018       1   -2    13   -14   73   -74   937       $ Water
1284  1   0.068525      1   -2  -938                              $ Fuel
1285  2   0.055323      1   -2   938  -939                        $ Clad
1286  3   0.10018       1   -2    13   -14   74   -75   939       $ Water
1287  1   0.068525      1   -2  -940                              $ Fuel
1288  2   0.055323      1   -2   940  -941                        $ Clad
1289  3   0.10018       1   -2    13   -14   75   -76   941       $ Water
1290  1   0.068525      1   -2  -942                              $ Fuel
1291  2   0.055323      1   -2   942  -943                        $ Clad
1292  3   0.10018       1   -2    13   -14   76   -77   943       $ Water
1293  1   0.068525      1   -2  -944                              $ Fuel
1294  2   0.055323      1   -2   944  -945                        $ Clad
1295  3   0.10018       1   -2    13   -14   77   -78   945       $ Water
1296  1   0.068525      1   -2  -946                              $ Fuel
1297  2   0.055323      1   -2   946  -947                        $ Clad
1298  3   0.10018       1   -2    13   -14   78   -79   947       $ Water
1299  1   0.068525      1   -2  -948                              $ Fuel
1300  2   0.055323      1   -2   948  -949                        $ Clad
1301  3   0.10018       1   -2    13   -14   79   -80   949       $ Water
1302  1   0.068525      1   -2  -950                              $ Fuel
1303  2   0.055323      1   -2   950  -951                        $ Clad
1304  3   0.10018       1   -2    13   -14   80   -81   951       $ Water
1305  1   0.068525      1   -2  -952                              $ Fuel
1306  2   0.055323      1   -2   952  -953                        $ Clad
1307  3   0.10018       1   -2    13   -14   81   -82   953       $ Water
1308  1   0.068525      1   -2  -954                              $ Fuel
1309  2   0.055323      1   -2   954  -955                        $ Clad
1310  3   0.10018       1   -2    13   -14   82   -83   955       $ Water
1311  1   0.068525      1   -2  -956                              $ Fuel
1312  2   0.055323      1   -2   956  -957                        $ Clad
1313  3   0.10018       1   -2    13   -14   83   -84   957       $ Water
1314  1   0.068525      1   -2  -958                              $ Fuel
1315  2   0.055323      1   -2   958  -959                        $ Clad
1316  3   0.10018       1   -2    13   -14   84   -85   959       $ Water
1317  1   0.068525      1   -2  -960                              $ Fuel
1318  2   0.055323      1   -2   960  -961                        $ Clad
1319  3   0.10018       1   -2    13   -14   85   -86   961       $ Water
1320  1   0.068525      1   -2  -962                              $ Fuel
1321  2   0.055323      1   -2   962  -963                        $ Clad
1322  3   0.10018       1   -2    13   -14   86   -87   963       $ Water
1323  3   0.10018       1   -2    13   -14   87    -5             $ Reflector
1324  1   0.068525      1   -2  -964                              $ Fuel
1325  2   0.055323      1   -2   964  -965                        $ Clad
1326  3   0.10018       1   -2    14   -15   69   -70   965       $ Water
1327  1   0.068525      1   -2  -966                              $ Fuel
1328  2   0.055323      1   -2   966  -967                        $ Clad
1329  3   0.10018       1   -2    14   -15   70   -71   967       $ Water
1330  1   0.068525      1   -2  -968                              $ Fuel
1331  2   0.055323      1   -2   968  -969                        $ Clad
1332  3   0.10018       1   -2    14   -15   71   -72   969       $ Water
1333  1   0.068525      1   -2  -970                              $ Fuel
1334  2   0.055323      1   -2   970  -971                        $ Clad
1335  3   0.10018       1   -2    14   -15   72   -73   971       $ Water
1336  1   0.068525      1   -2  -972                              $ Fuel
1337  2   0.055323      1   -2   972  -973                        $ Clad
1338  3   0.10018       1   -2    14   -15   73   -74   973       $ Water
1339  1   0.068525      1   -2  -974                              $ Fuel
1340  2   0.055323      1   -2   974  -975                        $ Clad
1341  3   0.10018       1   -2    14   -15   74   -75   975       $ Water
1342  1   0.068525      1   -2  -976                              $ Fuel
1343  2   0.055323      1   -2   976  -977                        $ Clad
1344  3   0.10018       1   -2    14   -15   75   -76   977       $ Water
1345  1   0.068525      1   -2  -978                              $ Fuel
1346  2   0.055323      1   -2   978  -979                        $ Clad
1347  3   0.10018       1   -2    14   -15   76   -77   979       $ Water
1348  1   0.068525      1   -2  -980                              $ Fuel
1349  2   0.055323      1   -2   980  -981                        $ Clad
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1350  3   0.10018       1   -2    14   -15    77   -78   981     $ Water
1351  1   0.068525      1   -2  -982                             $ Fuel
1352  2   0.055323      1   -2   982  -983                       $ Clad
1353  3   0.10018       1   -2    14   -15    78   -79   983     $ Water
1354  1   0.068525      1   -2  -984                             $ Fuel
1355  2   0.055323      1   -2   984  -985                       $ Clad
1356  3   0.10018       1   -2    14   -15    79   -80   985     $ Water
1357  1   0.068525      1   -2  -986                             $ Fuel
1358  2   0.055323      1   -2   986  -987                       $ Clad
1359  3   0.10018       1   -2    14   -15    80   -81   987     $ Water
1360  1   0.068525      1   -2  -988                             $ Fuel
1361  2   0.055323      1   -2   988  -989                       $ Clad
1362  3   0.10018       1   -2    14   -15    81   -82   989     $ Water
1363  1   0.068525      1   -2  -990                             $ Fuel
1364  2   0.055323      1   -2   990  -991                       $ Clad
1365  3   0.10018       1   -2    14   -15    82   -83   991     $ Water
1366  1   0.068525      1   -2  -992                             $ Fuel
1367  2   0.055323      1   -2   992  -993                       $ Clad
1368  3   0.10018       1   -2    14   -15    83   -84   993     $ Water
1369  1   0.068525      1   -2  -994                             $ Fuel
1370  2   0.055323      1   -2   994  -995                       $ Clad
1371  3   0.10018       1   -2    14   -15    84   -85   995     $ Water
1372  1   0.068525      1   -2  -996                             $ Fuel
1373  2   0.055323      1   -2   996  -997                       $ Clad
1374  3   0.10018       1   -2    14   -15    85   -86   997     $ Water
1375  1   0.068525      1   -2  -998                             $ Fuel
1376  2   0.055323      1   -2   998  -999                       $ Clad
1377  3   0.10018       1   -2    14   -15    86   -87   999     $ Water
1378  3   0.10018       1   -2    14   -15    87    -5           $ Reflector
1379  1   0.068525      1   -2 -1000                             $ Fuel
1380  2   0.055323      1   -2  1000 -1001                       $ Clad
1381  3   0.10018       1   -2    15   -16    69   -70  1001     $ Water
1382  1   0.068525      1   -2 -1002                             $ Fuel
1383  2   0.055323      1   -2  1002 -1003                       $ Clad
1384  3   0.10018       1   -2    15   -16    70   -71  1003     $ Water
1385  1   0.068525      1   -2 -1004                             $ Fuel
1386  2   0.055323      1   -2  1004 -1005                       $ Clad
1387  3   0.10018       1   -2    15   -16    71   -72  1005     $ Water
1388  1   0.068525      1   -2 -1006                             $ Fuel
1389  2   0.055323      1   -2  1006 -1007                       $ Clad
1390  3   0.10018       1   -2    15   -16    72   -73  1007     $ Water
1391  1   0.068525      1   -2 -1008                             $ Fuel
1392  2   0.055323      1   -2  1008 -1009                       $ Clad
1393  3   0.10018       1   -2    15   -16    73   -74  1009     $ Water
1394  1   0.068525      1   -2 -1010                             $ Fuel
1395  2   0.055323      1   -2  1010 -1011                       $ Clad
1396  3   0.10018       1   -2    15   -16    74   -75  1011     $ Water
1397  1   0.068525      1   -2 -1012                             $ Fuel
1398  2   0.055323      1   -2  1012 -1013                       $ Clad
1399  3   0.10018       1   -2    15   -16    75   -76  1013     $ Water
1400  1   0.068525      1   -2 -1014                             $ Fuel
1401  2   0.055323      1   -2  1014 -1015                       $ Clad
1402  3   0.10018       1   -2    15   -16    76   -77  1015     $ Water
1403  1   0.068525      1   -2 -1016                             $ Fuel
1404  2   0.055323      1   -2  1016 -1017                       $ Clad
1405  3   0.10018       1   -2    15   -16    77   -78  1017     $ Water
1406  1   0.068525      1   -2 -1018                             $ Fuel
1407  2   0.055323      1   -2  1018 -1019                       $ Clad
1408  3   0.10018       1   -2    15   -16    78   -79  1019     $ Water
1409  1   0.068525      1   -2 -1020                             $ Fuel
1410  2   0.055323      1   -2  1020 -1021                       $ Clad
1411  3   0.10018       1   -2    15   -16    79   -80  1021     $ Water
1412  1   0.068525      1   -2 -1022                             $ Fuel
1413  2   0.055323      1   -2  1022 -1023                       $ Clad
1414  3   0.10018       1   -2    15   -16    80   -81  1023     $ Water
1415  1   0.068525      1   -2 -1024                             $ Fuel
1416  2   0.055323      1   -2  1024 -1025                       $ Clad
1417  3   0.10018       1   -2    15   -16    81   -82  1025     $ Water
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1418  1   0.068525      1   -2 -1026                               $ Fuel
1419  2   0.055323      1   -2  1026 -1027                         $ Clad
1420  3   0.10018       1   -2    15   -16    82   -83  1027       $ Water
1421  1   0.068525      1   -2 -1028                               $ Fuel
1422  2   0.055323      1   -2  1028 -1029                         $ Clad
1423  3   0.10018       1   -2    15   -16    83   -84  1029       $ Water
1424  1   0.068525      1   -2 -1030                               $ Fuel
1425  2   0.055323      1   -2  1030 -1031                         $ Clad
1426  3   0.10018       1   -2    15   -16    84   -85  1031       $ Water
1427  1   0.068525      1   -2 -1032                               $ Fuel
1428  2   0.055323      1   -2  1032 -1033                         $ Clad
1429  3   0.10018       1   -2    15   -16    85   -86  1033       $ Water
1430  1   0.068525      1   -2 -1034                               $ Fuel
1431  2   0.055323      1   -2  1034 -1035                         $ Clad
1432  3   0.10018       1   -2    15   -16    86   -87  1035       $ Water
1433  3   0.10018       1   -2    15   -16    87    -5             $ Reflector
1434  1   0.068525      1   -2 -1036                               $ Fuel
1435  2   0.055323      1   -2  1036 -1037                         $ Clad
1436  3   0.10018       1   -2    16   -17    69   -70  1037       $ Water
1437  1   0.068525      1   -2 -1038                               $ Fuel
1438  2   0.055323      1   -2  1038 -1039                         $ Clad
1439  3   0.10018       1   -2    16   -17    70   -71  1039       $ Water
1440  1   0.068525      1   -2 -1040                               $ Fuel
1441  2   0.055323      1   -2  1040 -1041                         $ Clad
1442  3   0.10018       1   -2    16   -17    71   -72  1041       $ Water
1443  1   0.068525      1   -2 -1042                               $ Fuel
1444  2   0.055323      1   -2  1042 -1043                         $ Clad
1445  3   0.10018       1   -2    16   -17    72   -73  1043       $ Water
1446  1   0.068525      1   -2 -1044                               $ Fuel
1447  2   0.055323      1   -2  1044 -1045                         $ Clad
1448  3   0.10018       1   -2    16   -17    73   -74  1045       $ Water
1449  1   0.068525      1   -2 -1046                               $ Fuel
1450  2   0.055323      1   -2  1046 -1047                         $ Clad
1451  3   0.10018       1   -2    16   -17    74   -75  1047       $ Water
1452  1   0.068525      1   -2 -1048                               $ Fuel
1453  2   0.055323      1   -2  1048 -1049                         $ Clad
1454  3   0.10018       1   -2    16   -17    75   -76  1049       $ Water
1455  1   0.068525      1   -2 -1050                               $ Fuel
1456  2   0.055323      1   -2  1050 -1051                         $ Clad
1457  3   0.10018       1   -2    16   -17    76   -77  1051       $ Water
1458  1   0.068525      1   -2 -1052                               $ Fuel
1459  2   0.055323      1   -2  1052 -1053                         $ Clad
1460  3   0.10018       1   -2    16   -17    77   -78  1053       $ Water
1461  1   0.068525      1   -2 -1054                               $ Fuel
1462  2   0.055323      1   -2  1054 -1055                         $ Clad
1463  3   0.10018       1   -2    16   -17    78   -79  1055       $ Water
1464  1   0.068525      1   -2 -1056                               $ Fuel
1465  2   0.055323      1   -2  1056 -1057                         $ Clad
1466  3   0.10018       1   -2    16   -17    79   -80  1057       $ Water
1467  1   0.068525      1   -2 -1058                               $ Fuel
1468  2   0.055323      1   -2  1058 -1059                         $ Clad
1469  3   0.10018       1   -2    16   -17    80   -81  1059       $ Water
1470  1   0.068525      1   -2 -1060                               $ Fuel
1471  2   0.055323      1   -2  1060 -1061                         $ Clad
1472  3   0.10018       1   -2    16   -17    81   -82  1061       $ Water
1473  3   0.10018       1   -2    16   -17    82    -5             $ Reflector
1474  1   0.068525      1   -2 -1062                               $ Fuel
1475  2   0.055323      1   -2  1062 -1063                         $ Clad
1476  3   0.10018       1   -2    17   -18    69   -70  1063       $ Water
1477  1   0.068525      1   -2 -1064                               $ Fuel
1478  2   0.055323      1   -2  1064 -1065                         $ Clad
1479  3   0.10018       1   -2    17   -18    70   -71  1065       $ Water
1480  1   0.068525      1   -2 -1066                               $ Fuel
1481  2   0.055323      1   -2  1066 -1067                         $ Clad
1482  3   0.10018       1   -2    17   -18    71   -72  1067       $ Water
1483  1   0.068525      1   -2 -1068                               $ Fuel
1484  2   0.055323      1   -2  1068 -1069                         $ Clad
1485  3   0.10018       1   -2    17   -18    72   -73  1069       $ Water
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1486  1   0.068525       1   -2 -1070                                  $ Fuel
1487  2   0.055323       1   -2  1070 -1071                            $ Clad
1488  3   0.10018        1   -2    17   -18    73   -74  1071          $ Water
1489  1   0.068525       1   -2 -1072                                  $ Fuel
1490  2   0.055323       1   -2  1072 -1073                            $ Clad
1491  3   0.10018        1   -2    17   -18    74   -75  1073          $ Water
1492  1   0.068525       1   -2 -1074                                  $ Fuel
1493  2   0.055323       1   -2  1074 -1075                            $ Clad
1494  3   0.10018        1   -2    17   -18    75   -76  1075          $ Water
1495  1   0.068525       1   -2 -1076                                  $ Fuel
1496  2   0.055323       1   -2  1076 -1077                            $ Clad
1497  3   0.10018        1   -2    17   -18    76   -77  1077          $ Water
1498  1   0.068525       1   -2 -1078                                  $ Fuel
1499  2   0.055323       1   -2  1078 -1079                            $ Clad
1500  3   0.10018        1   -2    17   -18    77   -78  1079          $ Water
1501  1   0.068525       1   -2 -1080                                  $ Fuel
1502  2   0.055323       1   -2  1080 -1081                            $ Clad
1503  3   0.10018        1   -2    17   -18    78   -79  1081          $ Water
1504  1   0.068525       1   -2 -1082                                  $ Fuel
1505  2   0.055323       1   -2  1082 -1083                            $ Clad
1506  3   0.10018        1   -2    17   -18    79   -80  1083          $ Water
1507  1   0.068525       1   -2 -1084                                  $ Fuel
1508  2   0.055323       1   -2  1084 -1085                            $ Clad
1509  3   0.10018        1   -2    17   -18    80   -81  1085          $ Water
1510  1   0.068525       1   -2 -1086                                  $ Fuel
1511  2   0.055323       1   -2  1086 -1087                            $ Clad
1512  3   0.10018        1   -2    17   -18    81   -82  1087          $ Water
1513  3   0.10018        1   -2    17   -18    82    -5                $ Reflector
1514  1   0.068525       1   -2 -1088                                  $ Fuel
1515  2   0.055323       1   -2  1088 -1089                            $ Clad
1516  3   0.10018        1   -2    18   -19    69   -70  1089          $ Water
1517  1   0.068525       1   -2 -1090                                  $ Fuel
1518  2   0.055323       1   -2  1090 -1091                            $ Clad
1519  3   0.10018        1   -2    18   -19    70   -71  1091          $ Water
1520  1   0.068525       1   -2 -1092                                  $ Fuel
1521  2   0.055323       1   -2  1092 -1093                            $ Clad
1522  3   0.10018        1   -2    18   -19    71   -72  1093          $ Water
1523  1   0.068525       1   -2 -1094                                  $ Fuel
1524  2   0.055323       1   -2  1094 -1095                            $ Clad
1525  3   0.10018        1   -2    18   -19    72   -73  1095          $ Water
1526  1   0.068525       1   -2 -1096                                  $ Fuel
1527  2   0.055323       1   -2  1096 -1097                            $ Clad
1528  3   0.10018        1   -2    18   -19    73   -74  1097          $ Water
1529  1   0.068525       1   -2 -1098                                  $ Fuel
1530  2   0.055323       1   -2  1098 -1099                            $ Clad
1531  3   0.10018        1   -2    18   -19    74   -75  1099          $ Water
1532  1   0.068525       1   -2 -1100                                  $ Fuel
1533  2   0.055323       1   -2  1100 -1101                            $ Clad
1534  3   0.10018        1   -2    18   -19    75   -76  1101          $ Water
1535  1   0.068525       1   -2 -1102                                  $ Fuel
1536  2   0.055323       1   -2  1102 -1103                            $ Clad
1537  3   0.10018        1   -2    18   -19    76   -77  1103          $ Water
1538  1   0.068525       1   -2 -1104                                  $ Fuel
1539  2   0.055323       1   -2  1104 -1105                            $ Clad
1540  3   0.10018        1   -2    18   -19    77   -78  1105          $ Water
1541  1   0.068525       1   -2 -1106                                  $ Fuel
1542  2   0.055323       1   -2  1106 -1107                            $ Clad
1543  3   0.10018        1   -2    18   -19    78   -79  1107          $ Water
1544  1   0.068525       1   -2 -1108                                  $ Fuel
1545  2   0.055323       1   -2  1108 -1109                            $ Clad
1546  3   0.10018        1   -2    18   -19    79   -80  1109          $ Water
1547  1   0.068525       1   -2 -1110                                  $ Fuel
1548  2   0.055323       1   -2  1110 -1111                            $ Clad
1549  3   0.10018        1   -2    18   -19    80   -81  1111          $ Water
1550  1   0.068525       1   -2 -1112                                  $ Fuel
1551  2   0.055323       1   -2  1112 -1113                            $ Clad
1552  3   0.10018        1   -2    18   -19    81   -82  1113          $ Water
1553  3   0.10018        1   -2    18   -19    82    -5                $ Reflector
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1554  1   0.068525      1   -2 -1114                                  $ Fuel
1555  2   0.055323      1   -2  1114 -1115                            $ Clad
1556  3   0.10018       1   -2    19   -20    69   -70  1115          $ Water
1557  1   0.068525      1   -2 -1116                                  $ Fuel
1558  2   0.055323      1   -2  1116 -1117                            $ Clad
1559  3   0.10018       1   -2    19   -20    70   -71  1117          $ Water
1560  1   0.068525      1   -2 -1118                                  $ Fuel
1561  2   0.055323      1   -2  1118 -1119                            $ Clad
1562  3   0.10018       1   -2    19   -20    71   -72  1119          $ Water
1563  1   0.068525      1   -2 -1120                                  $ Fuel
1564  2   0.055323      1   -2  1120 -1121                            $ Clad
1565  3   0.10018       1   -2    19   -20    72   -73  1121          $ Water
1566  1   0.068525      1   -2 -1122                                  $ Fuel
1567  2   0.055323      1   -2  1122 -1123                            $ Clad
1568  3   0.10018       1   -2    19   -20    73   -74  1123          $ Water
1569  1   0.068525      1   -2 -1124                                  $ Fuel
1570  2   0.055323      1   -2  1124 -1125                            $ Clad
1571  3   0.10018       1   -2    19   -20    74   -75  1125          $ Water
1572  1   0.068525      1   -2 -1126                                  $ Fuel
1573  2   0.055323      1   -2  1126 -1127                            $ Clad
1574  3   0.10018       1   -2    19   -20    75   -76  1127          $ Water
1575  1   0.068525      1   -2 -1128                                  $ Fuel
1576  2   0.055323      1   -2  1128 -1129                            $ Clad
1577  3   0.10018       1   -2    19   -20    76   -77  1129          $ Water
1578  1   0.068525      1   -2 -1130                                  $ Fuel
1579  2   0.055323      1   -2  1130 -1131                            $ Clad
1580  3   0.10018       1   -2    19   -20    77   -78  1131          $ Water
1581  1   0.068525      1   -2 -1132                                  $ Fuel
1582  2   0.055323      1   -2  1132 -1133                            $ Clad
1583  3   0.10018       1   -2    19   -20    78   -79  1133          $ Water
1584  1   0.068525      1   -2 -1134                                  $ Fuel
1585  2   0.055323      1   -2  1134 -1135                            $ Clad
1586  3   0.10018       1   -2    19   -20    79   -80  1135          $ Water
1587  1   0.068525      1   -2 -1136                                  $ Fuel
1588  2   0.055323      1   -2  1136 -1137                            $ Clad
1589  3   0.10018       1   -2    19   -20    80   -81  1137          $ Water
1590  1   0.068525      1   -2 -1138                                  $ Fuel
1591  2   0.055323      1   -2  1138 -1139                            $ Clad
1592  3   0.10018       1   -2    19   -20    81   -82  1139          $ Water
1593  3   0.10018       1   -2    19   -20    82    -5                $ Reflector
1594  1   0.068525      1   -2 -1140                                  $ Fuel
1595  2   0.055323      1   -2  1140 -1141                            $ Clad
1596  3   0.10018       1   -2    20   -21    69   -70  1141          $ Water
1597  1   0.068525      1   -2 -1142                                  $ Fuel
1598  2   0.055323      1   -2  1142 -1143                            $ Clad
1599  3   0.10018       1   -2    20   -21    70   -71  1143          $ Water
1600  1   0.068525      1   -2 -1144                                  $ Fuel
1601  2   0.055323      1   -2  1144 -1145                            $ Clad
1602  3   0.10018       1   -2    20   -21    71   -72  1145          $ Water
1603  1   0.068525      1   -2 -1146                                  $ Fuel
1604  2   0.055323      1   -2  1146 -1147                            $ Clad
1605  3   0.10018       1   -2    20   -21    72   -73  1147          $ Water
1606  1   0.068525      1   -2 -1148                                  $ Fuel
1607  2   0.055323      1   -2  1148 -1149                            $ Clad
1608  3   0.10018       1   -2    20   -21    73   -74  1149          $ Water
1609  1   0.068525      1   -2 -1150                                  $ Fuel
1610  2   0.055323      1   -2  1150 -1151                            $ Clad
1611  3   0.10018       1   -2    20   -21    74   -75  1151          $ Water
1612  1   0.068525      1   -2 -1152                                  $ Fuel
1613  2   0.055323      1   -2  1152 -1153                            $ Clad
1614  3   0.10018       1   -2    20   -21    75   -76  1153          $ Water
1615  1   0.068525      1   -2 -1154                                  $ Fuel
1616  2   0.055323      1   -2  1154 -1155                            $ Clad
1617  3   0.10018       1   -2    20   -21    76   -77  1155          $ Water
1618  1   0.068525      1   -2 -1156                                  $ Fuel
1619  2   0.055323      1   -2  1156 -1157                            $ Clad
1620  3   0.10018       1   -2    20   -21    77   -78  1157          $ Water
1621  1   0.068525      1   -2 -1158                                  $ Fuel
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1622  2   0.055323      1   -2  1158 -1159                          $ Clad
1623  3   0.10018       1   -2    20   -21    78   -79  1159        $ Water
1624  1   0.068525      1   -2 -1160                                $ Fuel
1625  2   0.055323      1   -2  1160 -1161                          $ Clad
1626  3   0.10018       1   -2    20   -21    79   -80  1161        $ Water
1627  1   0.068525      1   -2 -1162                                $ Fuel
1628  2   0.055323      1   -2  1162 -1163                          $ Clad
1629  3   0.10018       1   -2    20   -21    80   -81  1163        $ Water
1630  1   0.068525      1   -2 -1164                                $ Fuel
1631  2   0.055323      1   -2  1164 -1165                          $ Clad
1632  3   0.10018       1   -2    20   -21    81   -82  1165        $ Water
1633  3   0.10018       1   -2    20   -21    82    -5              $ Reflector
1634  1   0.068525      1   -2 -1166                                $ Fuel
1635  2   0.055323      1   -2  1166 -1167                          $ Clad
1636  3   0.10018       1   -2    21   -22    69   -70  1167        $ Water
1637  1   0.068525      1   -2 -1168                                $ Fuel
1638  2   0.055323      1   -2  1168 -1169                          $ Clad
1639  3   0.10018       1   -2    21   -22    70   -71  1169        $ Water
1640  1   0.068525      1   -2 -1170                                $ Fuel
1641  2   0.055323      1   -2  1170 -1171                          $ Clad
1642  3   0.10018       1   -2    21   -22    71   -72  1171        $ Water
1643  1   0.068525      1   -2 -1172                                $ Fuel
1644  2   0.055323      1   -2  1172 -1173                          $ Clad
1645  3   0.10018       1   -2    21   -22    72   -73  1173        $ Water
1646  1   0.068525      1   -2 -1174                                $ Fuel
1647  2   0.055323      1   -2  1174 -1175                          $ Clad
1648  3   0.10018       1   -2    21   -22    73   -74  1175        $ Water
1649  1   0.068525      1   -2 -1176                                $ Fuel
1650  2   0.055323      1   -2  1176 -1177                          $ Clad
1651  3   0.10018       1   -2    21   -22    74   -75  1177        $ Water
1652  1   0.068525      1   -2 -1178                                $ Fuel
1653  2   0.055323      1   -2  1178 -1179                          $ Clad
1654  3   0.10018       1   -2    21   -22    75   -76  1179        $ Water
1655  1   0.068525      1   -2 -1180                                $ Fuel
1656  2   0.055323      1   -2  1180 -1181                          $ Clad
1657  3   0.10018       1   -2    21   -22    76   -77  1181        $ Water
1658  1   0.068525      1   -2 -1182                                $ Fuel
1659  2   0.055323      1   -2  1182 -1183                          $ Clad
1660  3   0.10018       1   -2    21   -22    77   -78  1183        $ Water
1661  1   0.068525      1   -2 -1184                                $ Fuel
1662  2   0.055323      1   -2  1184 -1185                          $ Clad
1663  3   0.10018       1   -2    21   -22    78   -79  1185        $ Water
1664  1   0.068525      1   -2 -1186                                $ Fuel
1665  2   0.055323      1   -2  1186 -1187                          $ Clad
1666  3   0.10018       1   -2    21   -22    79   -80  1187        $ Water
1667  1   0.068525      1   -2 -1188                                $ Fuel
1668  2   0.055323      1   -2  1188 -1189                          $ Clad
1669  3   0.10018       1   -2    21   -22    80   -81  1189        $ Water
1670  1   0.068525      1   -2 -1190                                $ Fuel
1671  2   0.055323      1   -2  1190 -1191                          $ Clad
1672  3   0.10018       1   -2    21   -22    81   -82  1191        $ Water
1673  3   0.10018       1   -2    21   -22    82    -5              $ Reflector
1674  1   0.068525      1   -2 -1192                                $ Fuel
1675  2   0.055323      1   -2  1192 -1193                          $ Clad
1676  3   0.10018       1   -2    22   -23    69   -70  1193        $ Water
1677  1   0.068525      1   -2 -1194                                $ Fuel
1678  2   0.055323      1   -2  1194 -1195                          $ Clad
1679  3   0.10018       1   -2    22   -23    70   -71  1195        $ Water
1680  1   0.068525      1   -2 -1196                                $ Fuel
1681  2   0.055323      1   -2  1196 -1197                          $ Clad
1682  3   0.10018       1   -2    22   -23    71   -72  1197        $ Water
1683  1   0.068525      1   -2 -1198                                $ Fuel
1684  2   0.055323      1   -2  1198 -1199                          $ Clad
1685  3   0.10018       1   -2    22   -23    72   -73  1199        $ Water
1686  1   0.068525      1   -2 -1200                                $ Fuel
1687  2   0.055323      1   -2  1200 -1201                          $ Clad
1688  3   0.10018       1   -2    22   -23    73   -74  1201        $ Water
1689  1   0.068525      1   -2 -1202                                $ Fuel
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1690  2   0.055323      1   -2  1202 -1203                          $ Clad
1691  3   0.10018       1   -2    22   -23    74   -75  1203        $ Water
1692  1   0.068525      1   -2 -1204                                $ Fuel
1693  2   0.055323      1   -2  1204 -1205                          $ Clad
1694  3   0.10018       1   -2    22   -23    75   -76  1205        $ Water
1695  1   0.068525      1   -2 -1206                                $ Fuel
1696  2   0.055323      1   -2  1206 -1207                          $ Clad
1697  3   0.10018       1   -2    22   -23    76   -77  1207        $ Water
1698  1   0.068525      1   -2 -1208                                $ Fuel
1699  2   0.055323      1   -2  1208 -1209                          $ Clad
1700  3   0.10018       1   -2    22   -23    77   -78  1209        $ Water
1701  1   0.068525      1   -2 -1210                                $ Fuel
1702  2   0.055323      1   -2  1210 -1211                          $ Clad
1703  3   0.10018       1   -2    22   -23    78   -79  1211        $ Water
1704  1   0.068525      1   -2 -1212                                $ Fuel
1705  2   0.055323      1   -2  1212 -1213                          $ Clad
1706  3   0.10018       1   -2    22   -23    79   -80  1213        $ Water
1707  1   0.068525      1   -2 -1214                                $ Fuel
1708  2   0.055323      1   -2  1214 -1215                          $ Clad
1709  3   0.10018       1   -2    22   -23    80   -81  1215        $ Water
1710  1   0.068525      1   -2 -1216                                $ Fuel
1711  2   0.055323      1   -2  1216 -1217                          $ Clad
1712  3   0.10018       1   -2    22   -23    81   -82  1217        $ Water
1713  3   0.10018       1   -2    22   -23    82    -5             $ Reflector
1714  1   0.068525      1   -2 -1218                                $ Fuel
1715  2   0.055323      1   -2  1218 -1219                          $ Clad
1716  3   0.10018       1   -2    23   -24    69   -70  1219        $ Water
1717  1   0.068525      1   -2 -1220                                $ Fuel
1718  2   0.055323      1   -2  1220 -1221                          $ Clad
1719  3   0.10018       1   -2    23   -24    70   -71  1221        $ Water
1720  1   0.068525      1   -2 -1222                                $ Fuel
1721  2   0.055323      1   -2  1222 -1223                          $ Clad
1722  3   0.10018       1   -2    23   -24    71   -72  1223        $ Water
1723  1   0.068525      1   -2 -1224                                $ Fuel
1724  2   0.055323      1   -2  1224 -1225                          $ Clad
1725  3   0.10018       1   -2    23   -24    72   -73  1225        $ Water
1726  1   0.068525      1   -2 -1226                                $ Fuel
1727  2   0.055323      1   -2  1226 -1227                          $ Clad
1728  3   0.10018       1   -2    23   -24    73   -74  1227        $ Water
1729  1   0.068525      1   -2 -1228                                $ Fuel
1730  2   0.055323      1   -2  1228 -1229                          $ Clad
1731  3   0.10018       1   -2    23   -24    74   -75  1229        $ Water
1732  1   0.068525      1   -2 -1230                                $ Fuel
1733  2   0.055323      1   -2  1230 -1231                          $ Clad
1734  3   0.10018       1   -2    23   -24    75   -76  1231        $ Water
1735  1   0.068525      1   -2 -1232                                $ Fuel
1736  2   0.055323      1   -2  1232 -1233                          $ Clad
1737  3   0.10018       1   -2    23   -24    76   -77  1233        $ Water
1738  1   0.068525      1   -2 -1234                                $ Fuel
1739  2   0.055323      1   -2  1234 -1235                          $ Clad
1740  3   0.10018       1   -2    23   -24    77   -78  1235        $ Water
1741  1   0.068525      1   -2 -1236                                $ Fuel
1742  2   0.055323      1   -2  1236 -1237                          $ Clad
1743  3   0.10018       1   -2    23   -24    78   -79  1237        $ Water
1744  1   0.068525      1   -2 -1238                                $ Fuel
1745  2   0.055323      1   -2  1238 -1239                          $ Clad
1746  3   0.10018       1   -2    23   -24    79   -80  1239        $ Water
1747  1   0.068525      1   -2 -1240                                $ Fuel
1748  2   0.055323      1   -2  1240 -1241                          $ Clad
1749  3   0.10018       1   -2    23   -24    80   -81  1241        $ Water
1750  1   0.068525      1   -2 -1242                                $ Fuel
1751  2   0.055323      1   -2  1242 -1243                          $ Clad
1752  3   0.10018       1   -2    23   -24    81   -82  1243        $ Water
1753  3   0.10018       1   -2    23   -24    82    -5             $ Reflector
1754  1   0.068525      1   -2 -1244                                $ Fuel
1755  2   0.055323      1   -2  1244 -1245                          $ Clad
1756  3   0.10018       1   -2    24   -25    69   -70  1245        $ Water
1757  1   0.068525      1   -2 -1246                                $ Fuel
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1758  2   0.055323      1   -2  1246 -1247                         $ Clad
1759  3   0.10018       1   -2    24   -25    70   -71  1247       $ Water
1760  1   0.068525      1   -2 -1248                               $ Fuel
1761  2   0.055323      1   -2  1248 -1249                         $ Clad
1762  3   0.10018       1   -2    24   -25    71   -72  1249       $ Water
1763  1   0.068525      1   -2 -1250                               $ Fuel
1764  2   0.055323      1   -2  1250 -1251                         $ Clad
1765  3   0.10018       1   -2    24   -25    72   -73  1251       $ Water
1766  1   0.068525      1   -2 -1252                               $ Fuel
1767  2   0.055323      1   -2  1252 -1253                         $ Clad
1768  3   0.10018       1   -2    24   -25    73   -74  1253       $ Water
1769  1   0.068525      1   -2 -1254                               $ Fuel
1770  2   0.055323      1   -2  1254 -1255                         $ Clad
1771  3   0.10018       1   -2    24   -25    74   -75  1255       $ Water
1772  1   0.068525      1   -2 -1256                               $ Fuel
1773  2   0.055323      1   -2  1256 -1257                         $ Clad
1774  3   0.10018       1   -2    24   -25    75   -76  1257       $ Water
1775  1   0.068525      1   -2 -1258                               $ Fuel
1776  2   0.055323      1   -2  1258 -1259                         $ Clad
1777  3   0.10018       1   -2    24   -25    76   -77  1259       $ Water
1778  1   0.068525      1   -2 -1260                               $ Fuel
1779  2   0.055323      1   -2  1260 -1261                         $ Clad
1780  3   0.10018       1   -2    24   -25    77   -78  1261       $ Water
1781  1   0.068525      1   -2 -1262                               $ Fuel
1782  2   0.055323      1   -2  1262 -1263                         $ Clad
1783  3   0.10018       1   -2    24   -25    78   -79  1263       $ Water
1784  1   0.068525      1   -2 -1264                               $ Fuel
1785  2   0.055323      1   -2  1264 -1265                         $ Clad
1786  3   0.10018       1   -2    24   -25    79   -80  1265       $ Water
1787  1   0.068525      1   -2 -1266                               $ Fuel
1788  2   0.055323      1   -2  1266 -1267                         $ Clad
1789  3   0.10018       1   -2    24   -25    80   -81  1267       $ Water
1790  1   0.068525      1   -2 -1268                               $ Fuel
1791  2   0.055323      1   -2  1268 -1269                         $ Clad
1792  3   0.10018       1   -2    24   -25    81   -82  1269       $ Water
1793  3   0.10018       1   -2    24   -25    82    -5             $ Reflector
1794  1   0.068525      1   -2 -1270                               $ Fuel
1795  2   0.055323      1   -2  1270 -1271                         $ Clad
1796  3   0.10018       1   -2    25   -26    69   -70  1271       $ Water
1797  1   0.068525      1   -2 -1272                               $ Fuel
1798  2   0.055323      1   -2  1272 -1273                         $ Clad
1799  3   0.10018       1   -2    25   -26    70   -71  1273       $ Water
1800  1   0.068525      1   -2 -1274                               $ Fuel
1801  2   0.055323      1   -2  1274 -1275                         $ Clad
1802  3   0.10018       1   -2    25   -26    71   -72  1275       $ Water
1803  1   0.068525      1   -2 -1276                               $ Fuel
1804  2   0.055323      1   -2  1276 -1277                         $ Clad
1805  3   0.10018       1   -2    25   -26    72   -73  1277       $ Water
1806  1   0.068525      1   -2 -1278                               $ Fuel
1807  2   0.055323      1   -2  1278 -1279                         $ Clad
1808  3   0.10018       1   -2    25   -26    73   -74  1279       $ Water
1809  1   0.068525      1   -2 -1280                               $ Fuel
1810  2   0.055323      1   -2  1280 -1281                         $ Clad
1811  3   0.10018       1   -2    25   -26    74   -75  1281       $ Water
1812  1   0.068525      1   -2 -1282                               $ Fuel
1813  2   0.055323      1   -2  1282 -1283                         $ Clad
1814  3   0.10018       1   -2    25   -26    75   -76  1283       $ Water
1815  1   0.068525      1   -2 -1284                               $ Fuel
1816  2   0.055323      1   -2  1284 -1285                         $ Clad
1817  3   0.10018       1   -2    25   -26    76   -77  1285       $ Water
1818  1   0.068525      1   -2 -1286                               $ Fuel
1819  2   0.055323      1   -2  1286 -1287                         $ Clad
1820  3   0.10018       1   -2    25   -26    77   -78  1287       $ Water
1821  1   0.068525      1   -2 -1288                               $ Fuel
1822  2   0.055323      1   -2  1288 -1289                         $ Clad
1823  3   0.10018       1   -2    25   -26    78   -79  1289       $ Water
1824  1   0.068525      1   -2 -1290                               $ Fuel
1825  2   0.055323      1   -2  1290 -1291                         $ Clad
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1826  3   0.10018       1   -2    25   -26    79   -80  1291     $ Water
1827  1   0.068525      1   -2 -1292                             $ Fuel
1828  2   0.055323      1   -2  1292 -1293                       $ Clad
1829  3   0.10018       1   -2    25   -26    80   -81  1293     $ Water
1830  1   0.068525      1   -2 -1294                             $ Fuel
1831  2   0.055323      1   -2  1294 -1295                       $ Clad
1832  3   0.10018       1   -2    25   -26    81   -82  1295     $ Water
1833  3   0.10018       1   -2    25   -26    82    -5           $ Reflector
1834  1   0.068525      1   -2 -1296                             $ Fuel
1835  2   0.055323      1   -2  1296 -1297                       $ Clad
1836  3   0.10018       1   -2    26   -27    69   -70  1297     $ Water
1837  1   0.068525      1   -2 -1298                             $ Fuel
1838  2   0.055323      1   -2  1298 -1299                       $ Clad
1839  3   0.10018       1   -2    26   -27    70   -71  1299     $ Water
1840  1   0.068525      1   -2 -1300                             $ Fuel
1841  2   0.055323      1   -2  1300 -1301                       $ Clad
1842  3   0.10018       1   -2    26   -27    71   -72  1301     $ Water
1843  1   0.068525      1   -2 -1302                             $ Fuel
1844  2   0.055323      1   -2  1302 -1303                       $ Clad
1845  3   0.10018       1   -2    26   -27    72   -73  1303     $ Water
1846  1   0.068525      1   -2 -1304                             $ Fuel
1847  2   0.055323      1   -2  1304 -1305                       $ Clad
1848  3   0.10018       1   -2    26   -27    73   -74  1305     $ Water
1849  1   0.068525      1   -2 -1306                             $ Fuel
1850  2   0.055323      1   -2  1306 -1307                       $ Clad
1851  3   0.10018       1   -2    26   -27    74   -75  1307     $ Water
1852  1   0.068525      1   -2 -1308                             $ Fuel
1853  2   0.055323      1   -2  1308 -1309                       $ Clad
1854  3   0.10018       1   -2    26   -27    75   -76  1309     $ Water
1855  1   0.068525      1   -2 -1310                             $ Fuel
1856  2   0.055323      1   -2  1310 -1311                       $ Clad
1857  3   0.10018       1   -2    26   -27    76   -77  1311     $ Water
1858  3   0.10018       1   -2    26   -27    77    -5           $ Reflector
1859  1   0.068525      1   -2 -1312                             $ Fuel
1860  2   0.055323      1   -2  1312 -1313                       $ Clad
1861  3   0.10018       1   -2    27   -28    69   -70  1313     $ Water
1862  1   0.068525      1   -2 -1314                             $ Fuel
1863  2   0.055323      1   -2  1314 -1315                       $ Clad
1864  3   0.10018       1   -2    27   -28    70   -71  1315     $ Water
1865  1   0.068525      1   -2 -1316                             $ Fuel
1866  2   0.055323      1   -2  1316 -1317                       $ Clad
1867  3   0.10018       1   -2    27   -28    71   -72  1317     $ Water
1868  1   0.068525      1   -2 -1318                             $ Fuel
1869  2   0.055323      1   -2  1318 -1319                       $ Clad
1870  3   0.10018       1   -2    27   -28    72   -73  1319     $ Water
1871  1   0.068525      1   -2 -1320                             $ Fuel
1872  2   0.055323      1   -2  1320 -1321                       $ Clad
1873  3   0.10018       1   -2    27   -28    73   -74  1321     $ Water
1874  1   0.068525      1   -2 -1322                             $ Fuel
1875  2   0.055323      1   -2  1322 -1323                       $ Clad
1876  3   0.10018       1   -2    27   -28    74   -75  1323     $ Water
1877  1   0.068525      1   -2 -1324                             $ Fuel
1878  2   0.055323      1   -2  1324 -1325                       $ Clad
1879  3   0.10018       1   -2    27   -28    75   -76  1325     $ Water
1880  1   0.068525      1   -2 -1326                             $ Fuel
1881  2   0.055323      1   -2  1326 -1327                       $ Clad
1882  3   0.10018       1   -2    27   -28    76   -77  1327     $ Water
1883  3   0.10018       1   -2    27   -28    77    -5           $ Reflector
1884  1   0.068525      1   -2     4 -1328                       $ Fuel
1885  2   0.055323      1   -2     4  1328 -1329                 $ Clad
1886  3   0.10018       1   -2     4    28    69   -70  1329     $ Water
1887  1   0.068525      1   -2 -1330                             $ Fuel
1888  2   0.055323      1   -2  1330 -1331                       $ Clad
1889  3   0.10018       1   -2    28   -29    70   -71  1331     $ Water
1890  1   0.068525      1   -2 -1332                             $ Fuel
1891  2   0.055323      1   -2  1332 -1333                       $ Clad
1892  3   0.10018       1   -2    28   -29    71   -72  1333     $ Water
1893  1   0.068525      1   -2 -1334                             $ Fuel
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1894  2   0.055323      1   -2  1334 -1335                          $ Clad
1895  3   0.10018       1   -2    28   -29    72   -73  1335        $ Water
1896  1   0.068525      1   -2 -1336                                $ Fuel
1897  2   0.055323      1   -2  1336 -1337                          $ Clad
1898  3   0.10018       1   -2    28   -29    73   -74  1337        $ Water
1899  1   0.068525      1   -2 -1338                                $ Fuel
1900  2   0.055323      1   -2  1338 -1339                          $ Clad
1901  3   0.10018       1   -2    28   -29    74   -75  1339        $ Water
1902  1   0.068525      1   -2 -1340                                $ Fuel
1903  2   0.055323      1   -2  1340 -1341                          $ Clad
1904  3   0.10018       1   -2    28   -29    75   -76  1341        $ Water
1905  1   0.068525      1   -2 -1342                                $ Fuel
1906  2   0.055323      1   -2  1342 -1343                          $ Clad
1907  3   0.10018       1   -2    28   -29    76   -77  1343        $ Water
1908  3   0.10018       1   -2    28   -29    77    -5             $ Reflector
1909  1   0.068525      1   -2     4 -1344                          $ Fuel
1910  2   0.055323      1   -2     4  1344 -1345                    $ Clad
1911  3   0.10018       1   -2     4    29    70   -71  1345        $ Water
1912  1   0.068525      1   -2 -1346                                $ Fuel
1913  2   0.055323      1   -2  1346 -1347                          $ Clad
1914  3   0.10018       1   -2    29   -30    71   -72  1347        $ Water
1915  1   0.068525      1   -2 -1348                                $ Fuel
1916  2   0.055323      1   -2  1348 -1349                          $ Clad
1917  3   0.10018       1   -2    29   -30    72   -73  1349        $ Water
1918  1   0.068525      1   -2 -1350                                $ Fuel
1919  2   0.055323      1   -2  1350 -1351                          $ Clad
1920  3   0.10018       1   -2    29   -30    73   -74  1351        $ Water
1921  1   0.068525      1   -2 -1352                                $ Fuel
1922  2   0.055323      1   -2  1352 -1353                          $ Clad
1923  3   0.10018       1   -2    29   -30    74   -75  1353        $ Water
1924  1   0.068525      1   -2 -1354                                $ Fuel
1925  2   0.055323      1   -2  1354 -1355                          $ Clad
1926  3   0.10018       1   -2    29   -30    75   -76  1355        $ Water
1927  1   0.068525      1   -2 -1356                                $ Fuel
1928  2   0.055323      1   -2  1356 -1357                          $ Clad
1929  3   0.10018       1   -2    29   -30    76   -77  1357        $ Water
1930  3   0.10018       1   -2    29   -30    77    -5             $ Reflector
1931  1   0.068525      1   -2     4 -1358                          $ Fuel
1932  2   0.055323      1   -2     4  1358 -1359                    $ Clad
1933  3   0.10018       1   -2     4    30    71   -72  1359        $ Water
1934  1   0.068525      1   -2 -1360                                $ Fuel
1935  2   0.055323      1   -2  1360 -1361                          $ Clad
1936  3   0.10018       1   -2    30   -31    72   -73  1361        $ Water
1937  1   0.068525      1   -2 -1362                                $ Fuel
1938  2   0.055323      1   -2  1362 -1363                          $ Clad
1939  3   0.10018       1   -2    30   -31    73   -74  1363        $ Water
1940  1   0.068525      1   -2 -1364                                $ Fuel
1941  2   0.055323      1   -2  1364 -1365                          $ Clad
1942  3   0.10018       1   -2    30   -31    74   -75  1365        $ Water
1943  1   0.068525      1   -2 -1366                                $ Fuel
1944  2   0.055323      1   -2  1366 -1367                          $ Clad
1945  3   0.10018       1   -2    30   -31    75   -76  1367        $ Water
1946  1   0.068525      1   -2 -1368                                $ Fuel
1947  2   0.055323      1   -2  1368 -1369                          $ Clad
1948  3   0.10018       1   -2    30   -31    76   -77  1369        $ Water
1949  3   0.10018       1   -2    30   -31    77    -5             $ Reflector
1950  1   0.068525      1   -2     4 -1370                          $ Fuel
1951  2   0.055323      1   -2     4  1370 -1371                    $ Clad
1952  3   0.10018       1   -2     4    31    72   -73  1371        $ Water
1953  1   0.068525      1   -2 -1372                                $ Fuel
1954  2   0.055323      1   -2  1372 -1373                          $ Clad
1955  3   0.10018       1   -2    31   -32    73   -74  1373        $ Water
1956  1   0.068525      1   -2 -1374                                $ Fuel
1957  2   0.055323      1   -2  1374 -1375                          $ Clad
1958  3   0.10018       1   -2    31   -32    74   -75  1375        $ Water
1959  1   0.068525      1   -2 -1376                                $ Fuel
1960  2   0.055323      1   -2  1376 -1377                          $ Clad
1961  3   0.10018       1   -2    31   -32    75   -76  1377        $ Water
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1962  1   0.068525      1   -2 -1378                               $ Fuel
1963  2   0.055323      1   -2  1378 -1379                         $ Clad
1964  3   0.10018       1   -2    31   -32    76   -77  1379       $ Water
1965  3   0.10018       1   -2    31   -32    77    -5             $ Reflector
1966  1   0.068525      1   -2     4 -1380                         $ Fuel
1967  2   0.055323      1   -2     4  1380 -1381                   $ Clad
1968  3   0.10018       1   -2     4    32    73   -74  1381       $ Water
1969  1   0.068525      1   -2 -1382                               $ Fuel
1970  2   0.055323      1   -2  1382 -1383                         $ Clad
1971  3   0.10018       1   -2    32   -33    74   -75  1383       $ Water
1972  1   0.068525      1   -2 -1384                               $ Fuel
1973  2   0.055323      1   -2  1384 -1385                         $ Clad
1974  3   0.10018       1   -2    32   -33    75   -76  1385       $ Water
1975  1   0.068525      1   -2 -1386                               $ Fuel
1976  2   0.055323      1   -2  1386 -1387                         $ Clad
1977  3   0.10018       1   -2    32   -33    76   -77  1387       $ Water
1978  3   0.10018       1   -2    32   -33    77    -5             $ Reflector
1979  1   0.068525      1   -2     4 -1388                         $ Fuel
1980  2   0.055323      1   -2     4  1388 -1389                   $ Clad
1981  3   0.10018       1   -2     4    33    74   -75  1389       $ Water
1982  1   0.068525      1   -2 -1390                               $ Fuel
1983  2   0.055323      1   -2  1390 -1391                         $ Clad
1984  3   0.10018       1   -2    33   -34    75   -76  1391       $ Water
1985  1   0.068525      1   -2 -1392                               $ Fuel
1986  2   0.055323      1   -2  1392 -1393                         $ Clad
1987  3   0.10018       1   -2    33   -34    76   -77  1393       $ Water
1988  3   0.10018       1   -2    33   -34    77    -5             $ Reflector
1989  1   0.068525      1   -2     4 -1394                         $ Fuel
1990  2   0.055323      1   -2     4  1394 -1395                   $ Clad
1991  3   0.10018       1   -2     4    34    75   -76  1395       $ Water
1992  1   0.068525      1   -2 -1396                               $ Fuel
1993  2   0.055323      1   -2  1396 -1397                         $ Clad
1994  3   0.10018       1   -2    34   -35    76   -77  1397       $ Water
1995  3   0.10018       1   -2    34   -35    77    -5             $ Reflector
1996  1   0.068525      1   -2     4 -1398                         $ Fuel
1997  2   0.055323      1   -2     4  1398 -1399                   $ Clad
1998  3   0.10018       1   -2     4    35    76   -77  1399       $ Water
1999  3   0.10018       1   -2     4    35   -36    77    -5       $ Reflector
2000  3   0.10018       1   -2     4    -5    36   -37    77       $ Reflector
2001  3   0.10018       1   -2     4    -5    37   -38    77       $ Reflector
2002  3   0.10018       1   -2     4    -5    38    77             $ Reflector
2003  0                 -1:2:-3:-4:5

1     pz    -81.662
2     pz     81.662
*3    py      0.0
*4    p       1.0    -1.0     0.0     0.0
5     cz     76.200
c    Cell Boundaries
6     py      0.81788
7     py      2.45364
8     py      4.08940
9     py      5.72516
10    py      7.36092
11    py      8.99668
12    py     10.63244
13    py     12.26820
14    py     13.90396
15    py     15.53972
16    py     17.17548
17    py     18.81124
18    py     20.44700
19    py     22.08276
20    py     23.71852
21    py     25.35428
22    py     26.99004
23    py     28.62580
24    py     30.26156
```

```
25    py     31.89732
26    py     33.53308
27    py     35.16884
28    py     36.80460
29    py     38.44036
30    py     40.07612
31    py     41.71188
32    py     43.34764
33    py     44.98340
34    py     46.61916
35    py     48.25492
36    py     49.89068
37    py     51.52644
38    py     53.16220
39    py     54.79796
40    py     56.43372
41    py     58.06948
42    py     59.70524
43    py     61.34100
44    py     62.97676
45    py     64.61252
46    py     66.24828
47    px      0.81788
48    px      2.45364
49    px      4.08940
50    px      5.72516
51    px      7.36092
52    px      8.99668
53    px     10.63244
54    px     12.26820
55    px     13.90396
56    px     15.53972
57    px     17.17548
58    px     18.81124
59    px     20.44700
60    px     22.08276
61    px     23.71852
62    px     25.35428
63    px     26.99004
64    px     28.62580
65    px     30.26156
66    px     31.89732
67    px     33.53308
68    px     35.16884
69    px     36.80460
70    px     38.44036
71    px     40.07612
72    px     41.71188
73    px     43.34764
74    px     44.98340
75    px     46.61916
76    px     48.25492
77    px     49.89068
78    px     51.52644
79    px     53.16220
80    px     54.79796
81    px     56.43372
82    px     58.06948
83    px     59.70524
84    px     61.34100
85    px     62.97676
86    px     64.61252
87    px     66.24828
c    Pins and Clad for Central Assembly
88    cz      0.514858
89    cz      0.602996
90    c/z     1.63576   0.0       0.514858
91    c/z     1.63576   0.0       0.602996
```

92	c/z	3.27152	0.0	0.514858
93	c/z	3.27152	0.0	0.602996
94	c/z	4.90728	0.0	0.514858
95	c/z	4.90728	0.0	0.602996
96	c/z	6.54304	0.0	0.514858
97	c/z	6.54304	0.0	0.602996
98	c/z	8.17880	0.0	0.514858
99	c/z	8.17880	0.0	0.602996
100	c/z	9.81456	0.0	0.514858
101	c/z	9.81456	0.0	0.602996
102	c/z	11.45032	0.0	0.514858
103	c/z	11.45032	0.0	0.602996
104	c/z	1.63576	1.63576	0.514858
105	c/z	1.63576	1.63576	0.602996
106	c/z	3.27152	1.63576	0.514858
107	c/z	3.27152	1.63576	0.602996
108	c/z	4.90728	1.63576	0.514858
109	c/z	4.90728	1.63576	0.602996
110	c/z	6.54304	1.63576	0.514858
111	c/z	6.54304	1.63576	0.602996
112	c/z	8.17880	1.63576	0.514858
113	c/z	8.17880	1.63576	0.602996
114	c/z	9.81456	1.63576	0.514858
115	c/z	9.81456	1.63576	0.602996
116	c/z	11.45032	1.63576	0.514858
117	c/z	11.45032	1.63576	0.602996
118	c/z	3.27152	3.27152	0.514858
119	c/z	3.27152	3.27152	0.602996
120	c/z	4.90728	3.27152	0.514858
121	c/z	4.90728	3.27152	0.602996
122	c/z	6.54304	3.27152	0.514858
123	c/z	6.54304	3.27152	0.602996
124	c/z	8.17880	3.27152	0.514858
125	c/z	8.17880	3.27152	0.602996
126	c/z	9.81456	3.27152	0.514858
127	c/z	9.81456	3.27152	0.602996
128	c/z	11.45032	3.27152	0.514858
129	c/z	11.45032	3.27152	0.602996
130	c/z	4.90728	4.90728	0.514858
131	c/z	4.90728	4.90728	0.602996
132	c/z	6.54304	4.90728	0.514858
133	c/z	6.54304	4.90728	0.602996
134	c/z	8.17880	4.90728	0.514858
135	c/z	8.17880	4.90728	0.602996
136	c/z	9.81456	4.90728	0.514858
137	c/z	9.81456	4.90728	0.602996
138	c/z	11.45032	4.90728	0.514858
139	c/z	11.45032	4.90728	0.602996
140	c/z	6.54304	6.54304	0.514858
141	c/z	6.54304	6.54304	0.602996
142	c/z	8.17880	6.54304	0.514858
143	c/z	8.17880	6.54304	0.602996
144	c/z	9.81456	6.54304	0.514858
145	c/z	9.81456	6.54304	0.602996
146	c/z	11.45032	6.54304	0.514858
147	c/z	11.45032	6.54304	0.602996
148	c/z	8.17880	8.17880	0.514858
149	c/z	8.17880	8.17880	0.602996
150	c/z	9.81456	8.17880	0.514858
151	c/z	9.81456	8.17880	0.602996
152	c/z	11.45032	8.17880	0.514858
153	c/z	11.45032	8.17880	0.602996
154	c/z	9.81456	9.81456	0.514858
155	c/z	9.81456	9.81456	0.602996
156	c/z	11.45032	9.81456	0.514858
157	c/z	11.45032	9.81456	0.602996
158	c/z	11.45032	11.45032	0.514858
159	c/z	11.45032	11.45032	0.602996

```
c    Pins and Clad for Right Central Assembly
160   c/z    13.08608   0.0        0.514858
161   c/z    13.08608   0.0        0.602996
162   c/z    14.72184   0.0        0.514858
163   c/z    14.72184   0.0        0.602996
164   c/z    16.35760   0.0        0.514858
165   c/z    16.35760   0.0        0.602996
166   c/z    17.99336   0.0        0.514858
167   c/z    17.99336   0.0        0.602996
168   c/z    19.62912   0.0        0.514858
169   c/z    19.62912   0.0        0.602996
170   c/z    21.26488   0.0        0.514858
171   c/z    21.26488   0.0        0.602996
172   c/z    22.90064   0.0        0.514858
173   c/z    22.90064   0.0        0.602996
174   c/z    24.53640   0.0        0.514858
175   c/z    24.53640   0.0        0.602996
176   c/z    26.17216   0.0        0.514858
177   c/z    26.17216   0.0        0.602996
178   c/z    27.80792   0.0        0.514858
179   c/z    27.80792   0.0        0.602996
180   c/z    29.44368   0.0        0.514858
181   c/z    29.44368   0.0        0.602996
182   c/z    31.07944   0.0        0.514858
183   c/z    31.07944   0.0        0.602996
184   c/z    32.71520   0.0        0.514858
185   c/z    32.71520   0.0        0.602996
186   c/z    34.35096   0.0        0.514858
187   c/z    34.35096   0.0        0.602996
188   c/z    35.98672   0.0        0.514858
189   c/z    35.98672   0.0        0.602996
190   c/z    13.08608   1.63576    0.514858
191   c/z    13.08608   1.63576    0.602996
192   c/z    14.72184   1.63576    0.514858
193   c/z    14.72184   1.63576    0.602996
194   c/z    16.35760   1.63576    0.514858
195   c/z    16.35760   1.63576    0.602996
196   c/z    17.99336   1.63576    0.514858
197   c/z    17.99336   1.63576    0.602996
198   c/z    19.62912   1.63576    0.514858
199   c/z    19.62912   1.63576    0.602996
200   c/z    21.26488   1.63576    0.514858
201   c/z    21.26488   1.63576    0.602996
202   c/z    22.90064   1.63576    0.514858
203   c/z    22.90064   1.63576    0.602996
204   c/z    24.53640   1.63576    0.514858
205   c/z    24.53640   1.63576    0.602996
206   c/z    26.17216   1.63576    0.514858
207   c/z    26.17216   1.63576    0.602996
208   c/z    27.80792   1.63576    0.514858
209   c/z    27.80792   1.63576    0.602996
210   c/z    29.44368   1.63576    0.514858
211   c/z    29.44368   1.63576    0.602996
212   c/z    31.07944   1.63576    0.514858
213   c/z    31.07944   1.63576    0.602996
214   c/z    32.71520   1.63576    0.514858
215   c/z    32.71520   1.63576    0.602996
216   c/z    34.35096   1.63576    0.514858
217   c/z    34.35096   1.63576    0.602996
218   c/z    35.98672   1.63576    0.514858
219   c/z    35.98672   1.63576    0.602996
220   c/z    13.08608   3.27152    0.514858
221   c/z    13.08608   3.27152    0.602996
222   c/z    14.72184   3.27152    0.514858
223   c/z    14.72184   3.27152    0.602996
224   c/z    16.35760   3.27152    0.514858
225   c/z    16.35760   3.27152    0.602996
226   c/z    17.99336   3.27152    0.514858
```

227	c/z	17.99336	3.27152	0.602996
228	c/z	19.62912	3.27152	0.514858
229	c/z	19.62912	3.27152	0.602996
230	c/z	21.26488	3.27152	0.514858
231	c/z	21.26488	3.27152	0.602996
232	c/z	22.90064	3.27152	0.514858
233	c/z	22.90064	3.27152	0.602996
234	c/z	24.53640	3.27152	0.514858
235	c/z	24.53640	3.27152	0.602996
236	c/z	26.17216	3.27152	0.514858
237	c/z	26.17216	3.27152	0.602996
238	c/z	27.80792	3.27152	0.514858
239	c/z	27.80792	3.27152	0.602996
240	c/z	29.44368	3.27152	0.514858
241	c/z	29.44368	3.27152	0.602996
242	c/z	31.07944	3.27152	0.514858
243	c/z	31.07944	3.27152	0.602996
244	c/z	32.71520	3.27152	0.514858
245	c/z	32.71520	3.27152	0.602996
246	c/z	34.35096	3.27152	0.514858
247	c/z	34.35096	3.27152	0.602996
248	c/z	35.98672	3.27152	0.514858
249	c/z	35.98672	3.27152	0.602996
250	c/z	13.08608	4.90728	0.514858
251	c/z	13.08608	4.90728	0.602996
252	c/z	14.72184	4.90728	0.514858
253	c/z	14.72184	4.90728	0.602996
254	c/z	16.35760	4.90728	0.514858
255	c/z	16.35760	4.90728	0.602996
256	c/z	17.99336	4.90728	0.514858
257	c/z	17.99336	4.90728	0.602996
258	c/z	19.62912	4.90728	0.514858
259	c/z	19.62912	4.90728	0.602996
260	c/z	21.26488	4.90728	0.514858
261	c/z	21.26488	4.90728	0.602996
262	c/z	22.90064	4.90728	0.514858
263	c/z	22.90064	4.90728	0.602996
264	c/z	24.53640	4.90728	0.514858
265	c/z	24.53640	4.90728	0.602996
266	c/z	26.17216	4.90728	0.514858
267	c/z	26.17216	4.90728	0.602996
268	c/z	27.80792	4.90728	0.514858
269	c/z	27.80792	4.90728	0.602996
270	c/z	29.44368	4.90728	0.514858
271	c/z	29.44368	4.90728	0.602996
272	c/z	31.07944	4.90728	0.514858
273	c/z	31.07944	4.90728	0.602996
274	c/z	32.71520	4.90728	0.514858
275	c/z	32.71520	4.90728	0.602996
276	c/z	34.35096	4.90728	0.514858
277	c/z	34.35096	4.90728	0.602996
278	c/z	35.98672	4.90728	0.514858
279	c/z	35.98672	4.90728	0.602996
280	c/z	13.08608	6.54304	0.514858
281	c/z	13.08608	6.54304	0.602996
282	c/z	14.72184	6.54304	0.514858
283	c/z	14.72184	6.54304	0.602996
284	c/z	16.35760	6.54304	0.514858
285	c/z	16.35760	6.54304	0.602996
286	c/z	17.99336	6.54304	0.514858
287	c/z	17.99336	6.54304	0.602996
288	c/z	19.62912	6.54304	0.514858
289	c/z	19.62912	6.54304	0.602996
290	c/z	21.26488	6.54304	0.514858
291	c/z	21.26488	6.54304	0.602996
292	c/z	22.90064	6.54304	0.514858
293	c/z	22.90064	6.54304	0.602996
294	c/z	24.53640	6.54304	0.514858

295	c/z	24.53640	6.54304	0.602996
296	c/z	26.17216	6.54304	0.514858
297	c/z	26.17216	6.54304	0.602996
298	c/z	27.80792	6.54304	0.514858
299	c/z	27.80792	6.54304	0.602996
300	c/z	29.44368	6.54304	0.514858
301	c/z	29.44368	6.54304	0.602996
302	c/z	31.07944	6.54304	0.514858
303	c/z	31.07944	6.54304	0.602996
304	c/z	32.71520	6.54304	0.514858
305	c/z	32.71520	6.54304	0.602996
306	c/z	34.35096	6.54304	0.514858
307	c/z	34.35096	6.54304	0.602996
308	c/z	35.98672	6.54304	0.514858
309	c/z	35.98672	6.54304	0.602996
310	c/z	13.08608	8.17880	0.514858
311	c/z	13.08608	8.17880	0.602996
312	c/z	14.72184	8.17880	0.514858
313	c/z	14.72184	8.17880	0.602996
314	c/z	16.35760	8.17880	0.514858
315	c/z	16.35760	8.17880	0.602996
316	c/z	17.99336	8.17880	0.514858
317	c/z	17.99336	8.17880	0.602996
318	c/z	19.62912	8.17880	0.514858
319	c/z	19.62912	8.17880	0.602996
320	c/z	21.26488	8.17880	0.514858
321	c/z	21.26488	8.17880	0.602996
322	c/z	22.90064	8.17880	0.514858
323	c/z	22.90064	8.17880	0.602996
324	c/z	24.53640	8.17880	0.514858
325	c/z	24.53640	8.17880	0.602996
326	c/z	26.17216	8.17880	0.514858
327	c/z	26.17216	8.17880	0.602996
328	c/z	27.80792	8.17880	0.514858
329	c/z	27.80792	8.17880	0.602996
330	c/z	29.44368	8.17880	0.514858
331	c/z	29.44368	8.17880	0.602996
332	c/z	31.07944	8.17880	0.514858
333	c/z	31.07944	8.17880	0.602996
334	c/z	32.71520	8.17880	0.514858
335	c/z	32.71520	8.17880	0.602996
336	c/z	34.35096	8.17880	0.514858
337	c/z	34.35096	8.17880	0.602996
338	c/z	35.98672	8.17880	0.514858
339	c/z	35.98672	8.17880	0.602996
340	c/z	13.08608	9.81456	0.514858
341	c/z	13.08608	9.81456	0.602996
342	c/z	14.72184	9.81456	0.514858
343	c/z	14.72184	9.81456	0.602996
344	c/z	16.35760	9.81456	0.514858
345	c/z	16.35760	9.81456	0.602996
346	c/z	17.99336	9.81456	0.514858
347	c/z	17.99336	9.81456	0.602996
348	c/z	19.62912	9.81456	0.514858
349	c/z	19.62912	9.81456	0.602996
350	c/z	21.26488	9.81456	0.514858
351	c/z	21.26488	9.81456	0.602996
352	c/z	22.90064	9.81456	0.514858
353	c/z	22.90064	9.81456	0.602996
354	c/z	24.53640	9.81456	0.514858
355	c/z	24.53640	9.81456	0.602996
356	c/z	26.17216	9.81456	0.514858
357	c/z	26.17216	9.81456	0.602996
358	c/z	27.80792	9.81456	0.514858
359	c/z	27.80792	9.81456	0.602996
360	c/z	29.44368	9.81456	0.514858
361	c/z	29.44368	9.81456	0.602996
362	c/z	31.07944	9.81456	0.514858

```
363   c/z    31.07944   9.81456   0.602996
364   c/z    32.71520   9.81456   0.514858
365   c/z    32.71520   9.81456   0.602996
366   c/z    34.35096   9.81456   0.514858
367   c/z    34.35096   9.81456   0.602996
368   c/z    35.98672   9.81456   0.514858
369   c/z    35.98672   9.81456   0.602996
370   c/z    13.08608  11.45032   0.514858
371   c/z    13.08608  11.45032   0.602996
372   c/z    14.72184  11.45032   0.514858
373   c/z    14.72184  11.45032   0.602996
374   c/z    16.35760  11.45032   0.514858
375   c/z    16.35760  11.45032   0.602996
376   c/z    17.99336  11.45032   0.514858
377   c/z    17.99336  11.45032   0.602996
378   c/z    19.62912  11.45032   0.514858
379   c/z    19.62912  11.45032   0.602996
380   c/z    21.26488  11.45032   0.514858
381   c/z    21.26488  11.45032   0.602996
382   c/z    22.90064  11.45032   0.514858
383   c/z    22.90064  11.45032   0.602996
384   c/z    24.53640  11.45032   0.514858
385   c/z    24.53640  11.45032   0.602996
386   c/z    26.17216  11.45032   0.514858
387   c/z    26.17216  11.45032   0.602996
388   c/z    27.80792  11.45032   0.514858
389   c/z    27.80792  11.45032   0.602996
390   c/z    29.44368  11.45032   0.514858
391   c/z    29.44368  11.45032   0.602996
392   c/z    31.07944  11.45032   0.514858
393   c/z    31.07944  11.45032   0.602996
394   c/z    32.71520  11.45032   0.514858
395   c/z    32.71520  11.45032   0.602996
396   c/z    34.35096  11.45032   0.514858
397   c/z    34.35096  11.45032   0.602996
398   c/z    35.98672  11.45032   0.514858
399   c/z    35.98672  11.45032   0.602996
c    Pins and Clad for Upper Right Assembly
400   c/z    13.08608  13.08608   0.514858
401   c/z    13.08608  13.08608   0.602996
402   c/z    14.72184  13.08608   0.514858
403   c/z    14.72184  13.08608   0.602996
404   c/z    16.35760  13.08608   0.514858
405   c/z    16.35760  13.08608   0.602996
406   c/z    17.99336  13.08608   0.514858
407   c/z    17.99336  13.08608   0.602996
408   c/z    19.62912  13.08608   0.514858
409   c/z    19.62912  13.08608   0.602996
410   c/z    21.26488  13.08608   0.514858
411   c/z    21.26488  13.08608   0.602996
412   c/z    22.90064  13.08608   0.514858
413   c/z    22.90064  13.08608   0.602996
414   c/z    24.53640  13.08608   0.514858
415   c/z    24.53640  13.08608   0.602996
416   c/z    26.17216  13.08608   0.514858
417   c/z    26.17216  13.08608   0.602996
418   c/z    27.80792  13.08608   0.514858
419   c/z    27.80792  13.08608   0.602996
420   c/z    29.44368  13.08608   0.514858
421   c/z    29.44368  13.08608   0.602996
422   c/z    31.07944  13.08608   0.514858
423   c/z    31.07944  13.08608   0.602996
424   c/z    32.71520  13.08608   0.514858
425   c/z    32.71520  13.08608   0.602996
426   c/z    34.35096  13.08608   0.514858
427   c/z    34.35096  13.08608   0.602996
428   c/z    35.98672  13.08608   0.514858
429   c/z    35.98672  13.08608   0.602996
```

430	c/z	14.72184	14.72184	0.514858
431	c/z	14.72184	14.72184	0.602996
432	c/z	16.35760	14.72184	0.514858
433	c/z	16.35760	14.72184	0.602996
434	c/z	17.99336	14.72184	0.514858
435	c/z	17.99336	14.72184	0.602996
436	c/z	19.62912	14.72184	0.514858
437	c/z	19.62912	14.72184	0.602996
438	c/z	21.26488	14.72184	0.514858
439	c/z	21.26488	14.72184	0.602996
440	c/z	22.90064	14.72184	0.514858
441	c/z	22.90064	14.72184	0.602996
442	c/z	24.53640	14.72184	0.514858
443	c/z	24.53640	14.72184	0.602996
444	c/z	26.17216	14.72184	0.514858
445	c/z	26.17216	14.72184	0.602996
446	c/z	27.80792	14.72184	0.514858
447	c/z	27.80792	14.72184	0.602996
448	c/z	29.44368	14.72184	0.514858
449	c/z	29.44368	14.72184	0.602996
450	c/z	31.07944	14.72184	0.514858
451	c/z	31.07944	14.72184	0.602996
452	c/z	32.71520	14.72184	0.514858
453	c/z	32.71520	14.72184	0.602996
454	c/z	34.35096	14.72184	0.514858
455	c/z	34.35096	14.72184	0.602996
456	c/z	35.98672	14.72184	0.514858
457	c/z	35.98672	14.72184	0.602996
458	c/z	16.35760	16.35760	0.514858
459	c/z	16.35760	16.35760	0.602996
460	c/z	17.99336	16.35760	0.514858
461	c/z	17.99336	16.35760	0.602996
462	c/z	19.62912	16.35760	0.514858
463	c/z	19.62912	16.35760	0.602996
464	c/z	21.26488	16.35760	0.514858
465	c/z	21.26488	16.35760	0.602996
466	c/z	22.90064	16.35760	0.514858
467	c/z	22.90064	16.35760	0.602996
468	c/z	24.53640	16.35760	0.514858
469	c/z	24.53640	16.35760	0.602996
470	c/z	26.17216	16.35760	0.514858
471	c/z	26.17216	16.35760	0.602996
472	c/z	27.80792	16.35760	0.514858
473	c/z	27.80792	16.35760	0.602996
474	c/z	29.44368	16.35760	0.514858
475	c/z	29.44368	16.35760	0.602996
476	c/z	31.07944	16.35760	0.514858
477	c/z	31.07944	16.35760	0.602996
478	c/z	32.71520	16.35760	0.514858
479	c/z	32.71520	16.35760	0.602996
480	c/z	34.35096	16.35760	0.514858
481	c/z	34.35096	16.35760	0.602996
482	c/z	35.98672	16.35760	0.514858
483	c/z	35.98672	16.35760	0.602996
484	c/z	17.99336	17.99336	0.514858
485	c/z	17.99336	17.99336	0.602996
486	c/z	19.62912	17.99336	0.514858
487	c/z	19.62912	17.99336	0.602996
488	c/z	21.26488	17.99336	0.514858
489	c/z	21.26488	17.99336	0.602996
490	c/z	22.90064	17.99336	0.514858
491	c/z	22.90064	17.99336	0.602996
492	c/z	24.53640	17.99336	0.514858
493	c/z	24.53640	17.99336	0.602996
494	c/z	26.17216	17.99336	0.514858
495	c/z	26.17216	17.99336	0.602996
496	c/z	27.80792	17.99336	0.514858
497	c/z	27.80792	17.99336	0.602996

498	c/z	29.44368	17.99336	0.514858
499	c/z	29.44368	17.99336	0.602996
500	c/z	31.07944	17.99336	0.514858
501	c/z	31.07944	17.99336	0.602996
502	c/z	32.71520	17.99336	0.514858
503	c/z	32.71520	17.99336	0.602996
504	c/z	34.35096	17.99336	0.514858
505	c/z	34.35096	17.99336	0.602996
506	c/z	35.98672	17.99336	0.514858
507	c/z	35.98672	17.99336	0.602996
508	c/z	19.62912	19.62912	0.514858
509	c/z	19.62912	19.62912	0.602996
510	c/z	21.26488	19.62912	0.514858
511	c/z	21.26488	19.62912	0.602996
512	c/z	22.90064	19.62912	0.514858
513	c/z	22.90064	19.62912	0.602996
514	c/z	24.53640	19.62912	0.514858
515	c/z	24.53640	19.62912	0.602996
516	c/z	26.17216	19.62912	0.514858
517	c/z	26.17216	19.62912	0.602996
518	c/z	27.80792	19.62912	0.514858
519	c/z	27.80792	19.62912	0.602996
520	c/z	29.44368	19.62912	0.514858
521	c/z	29.44368	19.62912	0.602996
522	c/z	31.07944	19.62912	0.514858
523	c/z	31.07944	19.62912	0.602996
524	c/z	32.71520	19.62912	0.514858
525	c/z	32.71520	19.62912	0.602996
526	c/z	34.35096	19.62912	0.514858
527	c/z	34.35096	19.62912	0.602996
528	c/z	35.98672	19.62912	0.514858
529	c/z	35.98672	19.62912	0.602996
530	c/z	21.26488	21.26488	0.514858
531	c/z	21.26488	21.26488	0.602996
532	c/z	22.90064	21.26488	0.514858
533	c/z	22.90064	21.26488	0.602996
534	c/z	24.53640	21.26488	0.514858
535	c/z	24.53640	21.26488	0.602996
536	c/z	26.17216	21.26488	0.514858
537	c/z	26.17216	21.26488	0.602996
538	c/z	27.80792	21.26488	0.514858
539	c/z	27.80792	21.26488	0.602996
540	c/z	29.44368	21.26488	0.514858
541	c/z	29.44368	21.26488	0.602996
542	c/z	31.07944	21.26488	0.514858
543	c/z	31.07944	21.26488	0.602996
544	c/z	32.71520	21.26488	0.514858
545	c/z	32.71520	21.26488	0.602996
546	c/z	34.35096	21.26488	0.514858
547	c/z	34.35096	21.26488	0.602996
548	c/z	35.98672	21.26488	0.514858
549	c/z	35.98672	21.26488	0.602996
550	c/z	22.90064	22.90064	0.514858
551	c/z	22.90064	22.90064	0.602996
552	c/z	24.53640	22.90064	0.514858
553	c/z	24.53640	22.90064	0.602996
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555	c/z	26.17216	22.90064	0.602996
556	c/z	27.80792	22.90064	0.514858
557	c/z	27.80792	22.90064	0.602996
558	c/z	29.44368	22.90064	0.514858
559	c/z	29.44368	22.90064	0.602996
560	c/z	31.07944	22.90064	0.514858
561	c/z	31.07944	22.90064	0.602996
562	c/z	32.71520	22.90064	0.514858
563	c/z	32.71520	22.90064	0.602996
564	c/z	34.35096	22.90064	0.514858
565	c/z	34.35096	22.90064	0.602996

566	c/z	35.98672	22.90064	0.514858
567	c/z	35.98672	22.90064	0.602996
568	c/z	24.53640	24.53640	0.514858
569	c/z	24.53640	24.53640	0.602996
570	c/z	26.17216	24.53640	0.514858
571	c/z	26.17216	24.53640	0.602996
572	c/z	27.80792	24.53640	0.514858
573	c/z	27.80792	24.53640	0.602996
574	c/z	29.44368	24.53640	0.514858
575	c/z	29.44368	24.53640	0.602996
576	c/z	31.07944	24.53640	0.514858
577	c/z	31.07944	24.53640	0.602996
578	c/z	32.71520	24.53640	0.514858
579	c/z	32.71520	24.53640	0.602996
580	c/z	34.35096	24.53640	0.514858
581	c/z	34.35096	24.53640	0.602996
582	c/z	35.98672	24.53640	0.514858
583	c/z	35.98672	24.53640	0.602996
584	c/z	26.17216	26.17216	0.514858
585	c/z	26.17216	26.17216	0.602996
586	c/z	27.80792	26.17216	0.514858
587	c/z	27.80792	26.17216	0.602996
588	c/z	29.44368	26.17216	0.514858
589	c/z	29.44368	26.17216	0.602996
590	c/z	31.07944	26.17216	0.514858
591	c/z	31.07944	26.17216	0.602996
592	c/z	32.71520	26.17216	0.514858
593	c/z	32.71520	26.17216	0.602996
594	c/z	34.35096	26.17216	0.514858
595	c/z	34.35096	26.17216	0.602996
596	c/z	35.98672	26.17216	0.514858
597	c/z	35.98672	26.17216	0.602996
598	c/z	27.80792	27.80792	0.514858
599	c/z	27.80792	27.80792	0.602996
600	c/z	29.44368	27.80792	0.514858
601	c/z	29.44368	27.80792	0.602996
602	c/z	31.07944	27.80792	0.514858
603	c/z	31.07944	27.80792	0.602996
604	c/z	32.71520	27.80792	0.514858
605	c/z	32.71520	27.80792	0.602996
606	c/z	34.35096	27.80792	0.514858
607	c/z	34.35096	27.80792	0.602996
608	c/z	35.98672	27.80792	0.514858
609	c/z	35.98672	27.80792	0.602996
610	c/z	29.44368	29.44368	0.514858
611	c/z	29.44368	29.44368	0.602996
612	c/z	31.07944	29.44368	0.514858
613	c/z	31.07944	29.44368	0.602996
614	c/z	32.71520	29.44368	0.514858
615	c/z	32.71520	29.44368	0.602996
616	c/z	34.35096	29.44368	0.514858
617	c/z	34.35096	29.44368	0.602996
618	c/z	35.98672	29.44368	0.514858
619	c/z	35.98672	29.44368	0.602996
620	c/z	31.07944	31.07944	0.514858
621	c/z	31.07944	31.07944	0.602996
622	c/z	32.71520	31.07944	0.514858
623	c/z	32.71520	31.07944	0.602996
624	c/z	34.35096	31.07944	0.514858
625	c/z	34.35096	31.07944	0.602996
626	c/z	35.98672	31.07944	0.514858
627	c/z	35.98672	31.07944	0.602996
628	c/z	32.71520	32.71520	0.514858
629	c/z	32.71520	32.71520	0.602996
630	c/z	34.35096	32.71520	0.514858
631	c/z	34.35096	32.71520	0.602996
632	c/z	35.98672	32.71520	0.514858
633	c/z	35.98672	32.71520	0.602996

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634   c/z    34.35096  34.35096   0.514858
635   c/z    34.35096  34.35096   0.602996
636   c/z    35.98672  34.35096   0.514858
637   c/z    35.98672  34.35096   0.602996
638   c/z    35.98672  35.98672   0.514858
639   c/z    35.98672  35.98672   0.602996
c    Pins and Clad for Buffer
640   c/z    37.62248   0.0       0.514858
641   c/z    37.62248   0.0       0.602996
642   c/z    39.25824   0.0       0.514858
643   c/z    39.25824   0.0       0.602996
644   c/z    40.89400   0.0       0.514858
645   c/z    40.89400   0.0       0.602996
646   c/z    42.52976   0.0       0.514858
647   c/z    42.52976   0.0       0.602996
648   c/z    44.16552   0.0       0.514858
649   c/z    44.16552   0.0       0.602996
650   c/z    45.80128   0.0       0.514858
651   c/z    45.80128   0.0       0.602996
652   c/z    47.43704   0.0       0.514858
653   c/z    47.43704   0.0       0.602996
654   c/z    49.07280   0.0       0.514858
655   c/z    49.07280   0.0       0.602996
656   c/z    50.70856   0.0       0.514858
657   c/z    50.70856   0.0       0.602996
658   c/z    52.34432   0.0       0.514858
659   c/z    52.34432   0.0       0.602996
660   c/z    53.98008   0.0       0.514858
661   c/z    53.98008   0.0       0.602996
662   c/z    55.61584   0.0       0.514858
663   c/z    55.61584   0.0       0.602996
664   c/z    57.25160   0.0       0.514858
665   c/z    57.25160   0.0       0.602996
666   c/z    58.88736   0.0       0.514858
667   c/z    58.88736   0.0       0.602996
668   c/z    60.52312   0.0       0.514858
669   c/z    60.52312   0.0       0.602996
670   c/z    62.15888   0.0       0.514858
671   c/z    62.15888   0.0       0.602996
672   c/z    63.79464   0.0       0.514858
673   c/z    63.79464   0.0       0.602996
674   c/z    65.43040   0.0       0.514858
675   c/z    65.43040   0.0       0.602996
676   c/z    37.62248   1.63576   0.514858
677   c/z    37.62248   1.63576   0.602996
678   c/z    39.25824   1.63576   0.514858
679   c/z    39.25824   1.63576   0.602996
680   c/z    40.89400   1.63576   0.514858
681   c/z    40.89400   1.63576   0.602996
682   c/z    42.52976   1.63576   0.514858
683   c/z    42.52976   1.63576   0.602996
684   c/z    44.16552   1.63576   0.514858
685   c/z    44.16552   1.63576   0.602996
686   c/z    45.80128   1.63576   0.514858
687   c/z    45.80128   1.63576   0.602996
688   c/z    47.43704   1.63576   0.514858
689   c/z    47.43704   1.63576   0.602996
690   c/z    49.07280   1.63576   0.514858
691   c/z    49.07280   1.63576   0.602996
692   c/z    50.70856   1.63576   0.514858
693   c/z    50.70856   1.63576   0.602996
694   c/z    52.34432   1.63576   0.514858
695   c/z    52.34432   1.63576   0.602996
696   c/z    53.98008   1.63576   0.514858
697   c/z    53.98008   1.63576   0.602996
698   c/z    55.61584   1.63576   0.514858
699   c/z    55.61584   1.63576   0.602996
700   c/z    57.25160   1.63576   0.514858
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702	c/z	58.88736	1.63576	0.514858
703	c/z	58.88736	1.63576	0.602996
704	c/z	60.52312	1.63576	0.514858
705	c/z	60.52312	1.63576	0.602996
706	c/z	62.15888	1.63576	0.514858
707	c/z	62.15888	1.63576	0.602996
708	c/z	63.79464	1.63576	0.514858
709	c/z	63.79464	1.63576	0.602996
710	c/z	65.43040	1.63576	0.514858
711	c/z	65.43040	1.63576	0.602996
712	c/z	37.62248	3.27152	0.514858
713	c/z	37.62248	3.27152	0.602996
714	c/z	39.25824	3.27152	0.514858
715	c/z	39.25824	3.27152	0.602996
716	c/z	40.89400	3.27152	0.514858
717	c/z	40.89400	3.27152	0.602996
718	c/z	42.52976	3.27152	0.514858
719	c/z	42.52976	3.27152	0.602996
720	c/z	44.16552	3.27152	0.514858
721	c/z	44.16552	3.27152	0.602996
722	c/z	45.80128	3.27152	0.514858
723	c/z	45.80128	3.27152	0.602996
724	c/z	47.43704	3.27152	0.514858
725	c/z	47.43704	3.27152	0.602996
726	c/z	49.07280	3.27152	0.514858
727	c/z	49.07280	3.27152	0.602996
728	c/z	50.70856	3.27152	0.514858
729	c/z	50.70856	3.27152	0.602996
730	c/z	52.34432	3.27152	0.514858
731	c/z	52.34432	3.27152	0.602996
732	c/z	53.98008	3.27152	0.514858
733	c/z	53.98008	3.27152	0.602996
734	c/z	55.61584	3.27152	0.514858
735	c/z	55.61584	3.27152	0.602996
736	c/z	57.25160	3.27152	0.514858
737	c/z	57.25160	3.27152	0.602996
738	c/z	58.88736	3.27152	0.514858
739	c/z	58.88736	3.27152	0.602996
740	c/z	60.52312	3.27152	0.514858
741	c/z	60.52312	3.27152	0.602996
742	c/z	62.15888	3.27152	0.514858
743	c/z	62.15888	3.27152	0.602996
744	c/z	63.79464	3.27152	0.514858
745	c/z	63.79464	3.27152	0.602996
746	c/z	65.43040	3.27152	0.514858
747	c/z	65.43040	3.27152	0.602996
748	c/z	37.62248	4.90728	0.514858
749	c/z	37.62248	4.90728	0.602996
750	c/z	39.25824	4.90728	0.514858
751	c/z	39.25824	4.90728	0.602996
752	c/z	40.89400	4.90728	0.514858
753	c/z	40.89400	4.90728	0.602996
754	c/z	42.52976	4.90728	0.514858
755	c/z	42.52976	4.90728	0.602996
756	c/z	44.16552	4.90728	0.514858
757	c/z	44.16552	4.90728	0.602996
758	c/z	45.80128	4.90728	0.514858
759	c/z	45.80128	4.90728	0.602996
760	c/z	47.43704	4.90728	0.514858
761	c/z	47.43704	4.90728	0.602996
762	c/z	49.07280	4.90728	0.514858
763	c/z	49.07280	4.90728	0.602996
764	c/z	50.70856	4.90728	0.514858
765	c/z	50.70856	4.90728	0.602996
766	c/z	52.34432	4.90728	0.514858
767	c/z	52.34432	4.90728	0.602996
768	c/z	53.98008	4.90728	0.514858

769	c/z	53.98008	4.90728	0.602996
770	c/z	55.61584	4.90728	0.514858
771	c/z	55.61584	4.90728	0.602996
772	c/z	57.25160	4.90728	0.514858
773	c/z	57.25160	4.90728	0.602996
774	c/z	58.88736	4.90728	0.514858
775	c/z	58.88736	4.90728	0.602996
776	c/z	60.52312	4.90728	0.514858
777	c/z	60.52312	4.90728	0.602996
778	c/z	62.15888	4.90728	0.514858
779	c/z	62.15888	4.90728	0.602996
780	c/z	63.79464	4.90728	0.514858
781	c/z	63.79464	4.90728	0.602996
782	c/z	65.43040	4.90728	0.514858
783	c/z	65.43040	4.90728	0.602996
784	c/z	37.62248	6.54304	0.514858
785	c/z	37.62248	6.54304	0.602996
786	c/z	39.25824	6.54304	0.514858
787	c/z	39.25824	6.54304	0.602996
788	c/z	40.89400	6.54304	0.514858
789	c/z	40.89400	6.54304	0.602996
790	c/z	42.52976	6.54304	0.514858
791	c/z	42.52976	6.54304	0.602996
792	c/z	44.16552	6.54304	0.514858
793	c/z	44.16552	6.54304	0.602996
794	c/z	45.80128	6.54304	0.514858
795	c/z	45.80128	6.54304	0.602996
796	c/z	47.43704	6.54304	0.514858
797	c/z	47.43704	6.54304	0.602996
798	c/z	49.07280	6.54304	0.514858
799	c/z	49.07280	6.54304	0.602996
800	c/z	50.70856	6.54304	0.514858
801	c/z	50.70856	6.54304	0.602996
802	c/z	52.34432	6.54304	0.514858
803	c/z	52.34432	6.54304	0.602996
804	c/z	53.98008	6.54304	0.514858
805	c/z	53.98008	6.54304	0.602996
806	c/z	55.61584	6.54304	0.514858
807	c/z	55.61584	6.54304	0.602996
808	c/z	57.25160	6.54304	0.514858
809	c/z	57.25160	6.54304	0.602996
810	c/z	58.88736	6.54304	0.514858
811	c/z	58.88736	6.54304	0.602996
812	c/z	60.52312	6.54304	0.514858
813	c/z	60.52312	6.54304	0.602996
814	c/z	62.15888	6.54304	0.514858
815	c/z	62.15888	6.54304	0.602996
816	c/z	63.79464	6.54304	0.514858
817	c/z	63.79464	6.54304	0.602996
818	c/z	65.43040	6.54304	0.514858
819	c/z	65.43040	6.54304	0.602996
820	c/z	37.62248	8.17880	0.514858
821	c/z	37.62248	8.17880	0.602996
822	c/z	39.25824	8.17880	0.514858
823	c/z	39.25824	8.17880	0.602996
824	c/z	40.89400	8.17880	0.514858
825	c/z	40.89400	8.17880	0.602996
826	c/z	42.52976	8.17880	0.514858
827	c/z	42.52976	8.17880	0.602996
828	c/z	44.16552	8.17880	0.514858
829	c/z	44.16552	8.17880	0.602996
830	c/z	45.80128	8.17880	0.514858
831	c/z	45.80128	8.17880	0.602996
832	c/z	47.43704	8.17880	0.514858
833	c/z	47.43704	8.17880	0.602996
834	c/z	49.07280	8.17880	0.514858
835	c/z	49.07280	8.17880	0.602996
836	c/z	50.70856	8.17880	0.514858

837	c/z	50.70856	8.17880	0.602996
838	c/z	52.34432	8.17880	0.514858
839	c/z	52.34432	8.17880	0.602996
840	c/z	53.98008	8.17880	0.514858
841	c/z	53.98008	8.17880	0.602996
842	c/z	55.61584	8.17880	0.514858
843	c/z	55.61584	8.17880	0.602996
844	c/z	57.25160	8.17880	0.514858
845	c/z	57.25160	8.17880	0.602996
846	c/z	58.88736	8.17880	0.514858
847	c/z	58.88736	8.17880	0.602996
848	c/z	60.52312	8.17880	0.514858
849	c/z	60.52312	8.17880	0.602996
850	c/z	62.15888	8.17880	0.514858
851	c/z	62.15888	8.17880	0.602996
852	c/z	63.79464	8.17880	0.514858
853	c/z	63.79464	8.17880	0.602996
854	c/z	65.43040	8.17880	0.514858
855	c/z	65.43040	8.17880	0.602996
856	c/z	37.62248	9.81456	0.514858
857	c/z	37.62248	9.81456	0.602996
858	c/z	39.25824	9.81456	0.514858
859	c/z	39.25824	9.81456	0.602996
860	c/z	40.89400	9.81456	0.514858
861	c/z	40.89400	9.81456	0.602996
862	c/z	42.52976	9.81456	0.514858
863	c/z	42.52976	9.81456	0.602996
864	c/z	44.16552	9.81456	0.514858
865	c/z	44.16552	9.81456	0.602996
866	c/z	45.80128	9.81456	0.514858
867	c/z	45.80128	9.81456	0.602996
868	c/z	47.43704	9.81456	0.514858
869	c/z	47.43704	9.81456	0.602996
870	c/z	49.07280	9.81456	0.514858
871	c/z	49.07280	9.81456	0.602996
872	c/z	50.70856	9.81456	0.514858
873	c/z	50.70856	9.81456	0.602996
874	c/z	52.34432	9.81456	0.514858
875	c/z	52.34432	9.81456	0.602996
876	c/z	53.98008	9.81456	0.514858
877	c/z	53.98008	9.81456	0.602996
878	c/z	55.61584	9.81456	0.514858
879	c/z	55.61584	9.81456	0.602996
880	c/z	57.25160	9.81456	0.514858
881	c/z	57.25160	9.81456	0.602996
882	c/z	58.88736	9.81456	0.514858
883	c/z	58.88736	9.81456	0.602996
884	c/z	60.52312	9.81456	0.514858
885	c/z	60.52312	9.81456	0.602996
886	c/z	62.15888	9.81456	0.514858
887	c/z	62.15888	9.81456	0.602996
888	c/z	63.79464	9.81456	0.514858
889	c/z	63.79464	9.81456	0.602996
890	c/z	65.43040	9.81456	0.514858
891	c/z	65.43040	9.81456	0.602996
892	c/z	37.62248	11.45032	0.514858
893	c/z	37.62248	11.45032	0.602996
894	c/z	39.25824	11.45032	0.514858
895	c/z	39.25824	11.45032	0.602996
896	c/z	40.89400	11.45032	0.514858
897	c/z	40.89400	11.45032	0.602996
898	c/z	42.52976	11.45032	0.514858
899	c/z	42.52976	11.45032	0.602996
900	c/z	44.16552	11.45032	0.514858
901	c/z	44.16552	11.45032	0.602996
902	c/z	45.80128	11.45032	0.514858
903	c/z	45.80128	11.45032	0.602996
904	c/z	47.43704	11.45032	0.514858

905	c/z	47.43704	11.45032	0.602996
906	c/z	49.07280	11.45032	0.514858
907	c/z	49.07280	11.45032	0.602996
908	c/z	50.70856	11.45032	0.514858
909	c/z	50.70856	11.45032	0.602996
910	c/z	52.34432	11.45032	0.514858
911	c/z	52.34432	11.45032	0.602996
912	c/z	53.98008	11.45032	0.514858
913	c/z	53.98008	11.45032	0.602996
914	c/z	55.61584	11.45032	0.514858
915	c/z	55.61584	11.45032	0.602996
916	c/z	57.25160	11.45032	0.514858
917	c/z	57.25160	11.45032	0.602996
918	c/z	58.88736	11.45032	0.514858
919	c/z	58.88736	11.45032	0.602996
920	c/z	60.52312	11.45032	0.514858
921	c/z	60.52312	11.45032	0.602996
922	c/z	62.15888	11.45032	0.514858
923	c/z	62.15888	11.45032	0.602996
924	c/z	63.79464	11.45032	0.514858
925	c/z	63.79464	11.45032	0.602996
926	c/z	65.43040	11.45032	0.514858
927	c/z	65.43040	11.45032	0.602996
928	c/z	37.62248	13.08608	0.514858
929	c/z	37.62248	13.08608	0.602996
930	c/z	39.25824	13.08608	0.514858
931	c/z	39.25824	13.08608	0.602996
932	c/z	40.89400	13.08608	0.514858
933	c/z	40.89400	13.08608	0.602996
934	c/z	42.52976	13.08608	0.514858
935	c/z	42.52976	13.08608	0.602996
936	c/z	44.16552	13.08608	0.514858
937	c/z	44.16552	13.08608	0.602996
938	c/z	45.80128	13.08608	0.514858
939	c/z	45.80128	13.08608	0.602996
940	c/z	47.43704	13.08608	0.514858
941	c/z	47.43704	13.08608	0.602996
942	c/z	49.07280	13.08608	0.514858
943	c/z	49.07280	13.08608	0.602996
944	c/z	50.70856	13.08608	0.514858
945	c/z	50.70856	13.08608	0.602996
946	c/z	52.34432	13.08608	0.514858
947	c/z	52.34432	13.08608	0.602996
948	c/z	53.98008	13.08608	0.514858
949	c/z	53.98008	13.08608	0.602996
950	c/z	55.61584	13.08608	0.514858
951	c/z	55.61584	13.08608	0.602996
952	c/z	57.25160	13.08608	0.514858
953	c/z	57.25160	13.08608	0.602996
954	c/z	58.88736	13.08608	0.514858
955	c/z	58.88736	13.08608	0.602996
956	c/z	60.52312	13.08608	0.514858
957	c/z	60.52312	13.08608	0.602996
958	c/z	62.15888	13.08608	0.514858
959	c/z	62.15888	13.08608	0.602996
960	c/z	63.79464	13.08608	0.514858
961	c/z	63.79464	13.08608	0.602996
962	c/z	65.43040	13.08608	0.514858
963	c/z	65.43040	13.08608	0.602996
964	c/z	37.62248	14.72184	0.514858
965	c/z	37.62248	14.72184	0.602996
966	c/z	39.25824	14.72184	0.514858
967	c/z	39.25824	14.72184	0.602996
968	c/z	40.89400	14.72184	0.514858
969	c/z	40.89400	14.72184	0.602996
970	c/z	42.52976	14.72184	0.514858
971	c/z	42.52976	14.72184	0.602996
972	c/z	44.16552	14.72184	0.514858

973	c/z	44.16552	14.72184	0.602996
974	c/z	45.80128	14.72184	0.514858
975	c/z	45.80128	14.72184	0.602996
976	c/z	47.43704	14.72184	0.514858
977	c/z	47.43704	14.72184	0.602996
978	c/z	49.07280	14.72184	0.514858
979	c/z	49.07280	14.72184	0.602996
980	c/z	50.70856	14.72184	0.514858
981	c/z	50.70856	14.72184	0.602996
982	c/z	52.34432	14.72184	0.514858
983	c/z	52.34432	14.72184	0.602996
984	c/z	53.98008	14.72184	0.514858
985	c/z	53.98008	14.72184	0.602996
986	c/z	55.61584	14.72184	0.514858
987	c/z	55.61584	14.72184	0.602996
988	c/z	57.25160	14.72184	0.514858
989	c/z	57.25160	14.72184	0.602996
990	c/z	58.88736	14.72184	0.514858
991	c/z	58.88736	14.72184	0.602996
992	c/z	60.52312	14.72184	0.514858
993	c/z	60.52312	14.72184	0.602996
994	c/z	62.15888	14.72184	0.514858
995	c/z	62.15888	14.72184	0.602996
996	c/z	63.79464	14.72184	0.514858
997	c/z	63.79464	14.72184	0.602996
998	c/z	65.43040	14.72184	0.514858
999	c/z	65.43040	14.72184	0.602996
1000	c/z	37.62248	16.35760	0.514858
1001	c/z	37.62248	16.35760	0.602996
1002	c/z	39.25824	16.35760	0.514858
1003	c/z	39.25824	16.35760	0.602996
1004	c/z	40.89400	16.35760	0.514858
1005	c/z	40.89400	16.35760	0.602996
1006	c/z	42.52976	16.35760	0.514858
1007	c/z	42.52976	16.35760	0.602996
1008	c/z	44.16552	16.35760	0.514858
1009	c/z	44.16552	16.35760	0.602996
1010	c/z	45.80128	16.35760	0.514858
1011	c/z	45.80128	16.35760	0.602996
1012	c/z	47.43704	16.35760	0.514858
1013	c/z	47.43704	16.35760	0.602996
1014	c/z	49.07280	16.35760	0.514858
1015	c/z	49.07280	16.35760	0.602996
1016	c/z	50.70856	16.35760	0.514858
1017	c/z	50.70856	16.35760	0.602996
1018	c/z	52.34432	16.35760	0.514858
1019	c/z	52.34432	16.35760	0.602996
1020	c/z	53.98008	16.35760	0.514858
1021	c/z	53.98008	16.35760	0.602996
1022	c/z	55.61584	16.35760	0.514858
1023	c/z	55.61584	16.35760	0.602996
1024	c/z	57.25160	16.35760	0.514858
1025	c/z	57.25160	16.35760	0.602996
1026	c/z	58.88736	16.35760	0.514858
1027	c/z	58.88736	16.35760	0.602996
1028	c/z	60.52312	16.35760	0.514858
1029	c/z	60.52312	16.35760	0.602996
1030	c/z	62.15888	16.35760	0.514858
1031	c/z	62.15888	16.35760	0.602996
1032	c/z	63.79464	16.35760	0.514858
1033	c/z	63.79464	16.35760	0.602996
1034	c/z	65.43040	16.35760	0.514858
1035	c/z	65.43040	16.35760	0.602996
1036	c/z	37.62248	17.99336	0.514858
1037	c/z	37.62248	17.99336	0.602996
1038	c/z	39.25824	17.99336	0.514858
1039	c/z	39.25824	17.99336	0.602996
1040	c/z	40.89400	17.99336	0.514858

1041	c/z	40.89400	17.99336	0.602996
1042	c/z	42.52976	17.99336	0.514858
1043	c/z	42.52976	17.99336	0.602996
1044	c/z	44.16552	17.99336	0.514858
1045	c/z	44.16552	17.99336	0.602996
1046	c/z	45.80128	17.99336	0.514858
1047	c/z	45.80128	17.99336	0.602996
1048	c/z	47.43704	17.99336	0.514858
1049	c/z	47.43704	17.99336	0.602996
1050	c/z	49.07280	17.99336	0.514858
1051	c/z	49.07280	17.99336	0.602996
1052	c/z	50.70856	17.99336	0.514858
1053	c/z	50.70856	17.99336	0.602996
1054	c/z	52.34432	17.99336	0.514858
1055	c/z	52.34432	17.99336	0.602996
1056	c/z	53.98008	17.99336	0.514858
1057	c/z	53.98008	17.99336	0.602996
1058	c/z	55.61584	17.99336	0.514858
1059	c/z	55.61584	17.99336	0.602996
1060	c/z	57.25160	17.99336	0.514858
1061	c/z	57.25160	17.99336	0.602996
1062	c/z	37.62248	19.62912	0.514858
1063	c/z	37.62248	19.62912	0.602996
1064	c/z	39.25824	19.62912	0.514858
1065	c/z	39.25824	19.62912	0.602996
1066	c/z	40.89400	19.62912	0.514858
1067	c/z	40.89400	19.62912	0.602996
1068	c/z	42.52976	19.62912	0.514858
1069	c/z	42.52976	19.62912	0.602996
1070	c/z	44.16552	19.62912	0.514858
1071	c/z	44.16552	19.62912	0.602996
1072	c/z	45.80128	19.62912	0.514858
1073	c/z	45.80128	19.62912	0.602996
1074	c/z	47.43704	19.62912	0.514858
1075	c/z	47.43704	19.62912	0.602996
1076	c/z	49.07280	19.62912	0.514858
1077	c/z	49.07280	19.62912	0.602996
1078	c/z	50.70856	19.62912	0.514858
1079	c/z	50.70856	19.62912	0.602996
1080	c/z	52.34432	19.62912	0.514858
1081	c/z	52.34432	19.62912	0.602996
1082	c/z	53.98008	19.62912	0.514858
1083	c/z	53.98008	19.62912	0.602996
1084	c/z	55.61584	19.62912	0.514858
1085	c/z	55.61584	19.62912	0.602996
1086	c/z	57.25160	19.62912	0.514858
1087	c/z	57.25160	19.62912	0.602996
1088	c/z	37.62248	21.26488	0.514858
1089	c/z	37.62248	21.26488	0.602996
1090	c/z	39.25824	21.26488	0.514858
1091	c/z	39.25824	21.26488	0.602996
1092	c/z	40.89400	21.26488	0.514858
1093	c/z	40.89400	21.26488	0.602996
1094	c/z	42.52976	21.26488	0.514858
1095	c/z	42.52976	21.26488	0.602996
1096	c/z	44.16552	21.26488	0.514858
1097	c/z	44.16552	21.26488	0.602996
1098	c/z	45.80128	21.26488	0.514858
1099	c/z	45.80128	21.26488	0.602996
1100	c/z	47.43704	21.26488	0.514858
1101	c/z	47.43704	21.26488	0.602996
1102	c/z	49.07280	21.26488	0.514858
1103	c/z	49.07280	21.26488	0.602996
1104	c/z	50.70856	21.26488	0.514858
1105	c/z	50.70856	21.26488	0.602996
1106	c/z	52.34432	21.26488	0.514858
1107	c/z	52.34432	21.26488	0.602996
1108	c/z	53.98008	21.26488	0.514858

1109	c/z	53.98008	21.26488	0.602996
1110	c/z	55.61584	21.26488	0.514858
1111	c/z	55.61584	21.26488	0.602996
1112	c/z	57.25160	21.26488	0.514858
1113	c/z	57.25160	21.26488	0.602996
1114	c/z	37.62248	22.90064	0.514858
1115	c/z	37.62248	22.90064	0.602996
1116	c/z	39.25824	22.90064	0.514858
1117	c/z	39.25824	22.90064	0.602996
1118	c/z	40.89400	22.90064	0.514858
1119	c/z	40.89400	22.90064	0.602996
1120	c/z	42.52976	22.90064	0.514858
1121	c/z	42.52976	22.90064	0.602996
1122	c/z	44.16552	22.90064	0.514858
1123	c/z	44.16552	22.90064	0.602996
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1126	c/z	47.43704	22.90064	0.514858
1127	c/z	47.43704	22.90064	0.602996
1128	c/z	49.07280	22.90064	0.514858
1129	c/z	49.07280	22.90064	0.602996
1130	c/z	50.70856	22.90064	0.514858
1131	c/z	50.70856	22.90064	0.602996
1132	c/z	52.34432	22.90064	0.514858
1133	c/z	52.34432	22.90064	0.602996
1134	c/z	53.98008	22.90064	0.514858
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1150	c/z	45.80128	24.53640	0.514858
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1152	c/z	47.43704	24.53640	0.514858
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1154	c/z	49.07280	24.53640	0.514858
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1168	c/z	39.25824	26.17216	0.514858
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1198	c/z	42.52976	27.80792	0.514858
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1201	c/z	44.16552	27.80792	0.602996
1202	c/z	45.80128	27.80792	0.514858
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1220	c/z	39.25824	29.44368	0.514858
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1222	c/z	40.89400	29.44368	0.514858
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1230	c/z	47.43704	29.44368	0.514858
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mode      n
kcode     5000     1.0     200     1200
imp:n     1.0    2001r    0.0
f4:n        4   7  10  13  16  19  22  25  28  31  34  37  40  43  49
           52  58  61  64  67  70  73  76  82  85  88  91  94  97 100
          103 106   t
fm4       0.068525  1  -6
vol        17.001    6.319   31.306    68.006   25.277  125.222
           68.006   25.277  125.222    68.006   25.277  125.222
           68.006   25.277  125.222    68.006   25.277  125.222
           68.006   25.277  125.222    68.006   25.277  125.222
           68.006   25.277  125.222   136.011   50.553  250.444
          136.011   50.553  250.444   136.011   50.553  250.444
          136.011   50.553  250.444   136.011   50.553  250.444
          136.011   50.553  250.444    68.006   25.277  125.222
          136.011   50.553  250.444   136.011   50.553  250.444
          136.011   50.553  250.444   136.011   50.553  250.444
          136.011   50.553  250.444    68.006   25.277  125.222
          136.011   50.553  250.444   136.011   50.553  250.444
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           68.006   25.277  125.222   136.011   50.553  250.444
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           68.006   25.277  125.222   136.011   50.553  250.444
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            1.0     1893r     0.0
ksrc      0.0001   0.0001  -70.0     1.63576  0.0001  -70.0
          3.27152  0.0001  -70.0     4.90728  0.0001  -70.0
          6.54304  0.0001  -70.0     8.17880  0.0001  -70.0
          9.81456  0.0001  -70.0    11.45032  0.0001  -70.0
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         16.35760  0.0001  -70.0    17.99336  0.0001  -70.0
         19.62912  0.0001  -70.0    21.26488  0.0001  -70.0
         22.90064  0.0001  -70.0    24.53640  0.0001  -70.0
         26.17216  0.0001  -70.0    27.80792  0.0001  -70.0
         29.44368  0.0001  -70.0    31.07944  0.0001  -70.0
         32.71520  0.0001  -70.0    34.35096  0.0001  -70.0
         35.98672  0.0001  -70.0    37.62248  0.0001  -70.0
         39.25824  0.0001  -70.0    40.89400  0.0001  -70.0
         42.52976  0.0001  -70.0    44.16552  0.0001  -70.0
         45.80128  0.0001  -70.0    47.43704  0.0001  -70.0
         49.07280  0.0001  -70.0
          0.0001   0.0001    0.0     1.63576  0.0001    0.0
          3.27152  0.0001    0.0     4.90728  0.0001    0.0
          6.54304  0.0001    0.0     8.17880  0.0001    0.0
          9.81456  0.0001    0.0    11.45032  0.0001    0.0
         13.08608  0.0001    0.0    14.72184  0.0001    0.0
         16.35760  0.0001    0.0    17.99336  0.0001    0.0
```

19.62912	0.0001	0.0	21.26488	0.0001	0.0
22.90064	0.0001	0.0	24.53640	0.0001	0.0
26.17216	0.0001	0.0	27.80792	0.0001	0.0
29.44368	0.0001	0.0	31.07944	0.0001	0.0
32.71520	0.0001	0.0	34.35096	0.0001	0.0
35.98672	0.0001	0.0	37.62248	0.0001	0.0
39.25824	0.0001	0.0	40.89400	0.0001	0.0
42.52976	0.0001	0.0	44.16552	0.0001	0.0
45.80128	0.0001	0.0	47.43704	0.0001	0.0
49.07280	0.0001	0.0			
0.0001	0.0001	70.0	1.63576	0.0001	70.0
3.27152	0.0001	70.0	4.90728	0.0001	70.0
6.54304	0.0001	70.0	8.17880	0.0001	70.0
9.81456	0.0001	70.0	11.45032	0.0001	70.0
13.08608	0.0001	70.0	14.72184	0.0001	70.0
16.35760	0.0001	70.0	17.99336	0.0001	70.0
19.62912	0.0001	70.0	21.26488	0.0001	70.0
22.90064	0.0001	70.0	24.53640	0.0001	70.0
26.17216	0.0001	70.0	27.80792	0.0001	70.0
29.44368	0.0001	70.0	31.07944	0.0001	70.0
32.71520	0.0001	70.0	34.35096	0.0001	70.0
35.98672	0.0001	70.0	37.62248	0.0001	70.0
39.25824	0.0001	70.0	40.89400	0.0001	70.0
42.52976	0.0001	70.0	44.16552	0.0001	70.0
45.80128	0.0001	70.0	47.43704	0.0001	70.0
49.07280	0.0001	70.0			
1.63576	1.63500	-70.0	3.27152	3.27100	-70.0
4.90728	4.90700	-70.0	6.54304	6.54200	-70.0
8.17880	8.17800	-70.0	9.81456	9.81400	-70.0
11.45032	11.45000	-70.0	13.08608	13.08500	-70.0
14.72184	14.72100	-70.0	16.35760	16.35700	-70.0
17.99336	17.99300	-70.0	19.62912	19.62800	-70.0
21.26488	21.26400	-70.0	22.90064	22.90000	-70.0
24.53640	24.53600	-70.0	26.17216	26.17200	-70.0
27.80792	27.80700	-70.0	29.44368	29.44300	-70.0
31.07944	31.07900	-70.0	32.71520	32.71500	-70.0
34.35096	34.35000	-70.0	35.98672	35.98600	-70.0
37.62248	37.62200	-70.0	39.25824	39.25800	-70.0
40.89400	40.89390	-70.0	42.52976	42.52900	-70.0
44.16552	44.16500	-70.0	45.80128	45.80100	-70.0
47.43704	47.43600	-70.0	49.07280	49.07200	-70.0
1.63576	1.63500	0.0	3.27152	3.27100	0.0
4.90728	4.90700	0.0	6.54304	6.54200	0.0
8.17880	8.17800	0.0	9.81456	9.81400	0.0
11.45032	11.45000	0.0	13.08608	13.08500	0.0
14.72184	14.72100	0.0	16.35760	16.35700	0.0
17.99336	17.99300	0.0	19.62912	19.62900	0.0
21.26488	21.26400	0.0	22.90064	22.90000	0.0
24.53640	24.53600	0.0	26.17216	26.17200	0.0
27.80792	27.80700	0.0	29.44368	29.44300	0.0
31.07944	31.07900	0.0	32.71520	32.71500	0.0
34.35096	34.35000	0.0	35.98672	35.98600	0.0
37.62248	37.62200	0.0	39.25824	39.25800	0.0
40.89400	40.89300	0.0	42.52976	42.52900	0.0
44.16552	44.16500	0.0	45.80128	45.80100	0.0
47.43704	47.43600	0.0	49.07280	49.07200	0.0
1.63576	1.63500	70.0	3.27152	3.27100	70.0
4.90728	4.90700	70.0	6.54304	6.54200	70.0
8.17880	8.17800	70.0	9.81456	9.81400	70.0
11.45032	11.45000	70.0	13.08608	13.08500	70.0
14.72184	14.72100	70.0	16.35760	16.35700	70.0
17.99336	17.99300	70.0	19.62912	19.62900	70.0
21.26488	21.26400	70.0	22.90064	22.90000	70.0
24.53640	24.53600	70.0	26.17216	26.17200	70.0
27.80792	27.80700	70.0	29.44368	29.44300	70.0
31.07944	31.07900	70.0	32.71520	32.71500	70.0
34.35096	34.35000	70.0	35.98672	35.98600	70.0
37.62248	37.62200	70.0	39.25824	39.25800	70.0

```
         40.89400 40.89300  70.0    42.52976 42.52900  70.0
         44.16552 44.16500  70.0    45.80128 45.80100  70.0
         47.43704 47.43600  70.0    49.07280 49.07200  70.0
c         Fuel (2.459 w/o with B-10 for impurities)
m1       5010.31c  2.6055E-07
         8016.31c  4.5683E-02
        92234.31c  4.5689E-06
        92235.31c  5.6868E-04
        92238.31c  2.2268E-02
c         Aluminum 6061 cladding
m2    12024.31c   4.90307E-04
      12025.31c   6.20720E-05
      12026.31c   6.83413E-05
        13027.31c  5.3985E-02
      14028.31c   2.97257E-04
      14029.31c   1.50514E-05
      14030.31c   9.99130E-06
      22046.31c   3.89920E-06
      22047.31c   3.51637E-06
      22048.31c   3.48423E-05
      22049.31c   2.55693E-06
      22050.31c   2.44822E-06
        24050.31c  2.5214E-06
        24052.31c  4.8622E-05
        24053.31c  5.5128E-06
        24054.31c  1.3724E-06
        25055.31c  4.1191E-05
        26054.31c  1.1157E-05
        26056.31c  1.7344E-04
        26057.31c  3.9711E-06
        26058.31c  5.2948E-07
        29063.31c  4.1054E-05
        29065.31c  1.8299E-05
c         Water with 1335.5 PPM
m3       1001.31c  6.6737E-02
         8016.31c  3.3369E-02
         5010.31c  1.4821E-05
         5011.31c  5.9657E-05
mt3     lwtr01.31t
totnu
prdmp     j     150
print

 end of input
```

D28. LEU-ST-02: LEU-SOL-THERM-002, case 2

```
Case 27.3-inch, Bare 1-D sphere, no impurities
c
c cell cards
1 1 9.8748e-2 -1 imp:n=1 $fuel
2 2 6.0317e-2 1 -2 imp:n=1 $Al sphere
3 0 2 imp:n=0 $outside system

c surface cards
1 so 34.4995
2 so 34.6583

mode n
kcode 5000 1.0 200 1200
ksrc 0.0 0.0 0.0
c material cards
m1      92234.31c  2.5304E-07
        92235.31c  6.1604E-05
        92238.31c  1.1828E-03
         9019.31c  2.4893E-03
         1001.31c  6.1683e-2
         8016.31c 3.3331e-2
m2      13027.31c  5.9699E-02
      14028.31c   5.09128E-04
      14029.31c   2.57793E-05
      14030.31c   1.71126E-05
      29063.31c   3.55285E-05
      29065.31c   1.58355E-05
        25055.31c  1.4853E-05
mt1   lwtr01.31t
totnu
prdmp 320 2 0 2
print
```

APENDIX E. Additional Criticality Validation

E.1 PU-SOL-THERM-009

```
Case 1A, 48" Sphere 10.02 g Pu/l, 2.52 wt% Pu-240, No Imp.
1 0 2 imp:n=0                $ Outside Everything
2 1 1.005446-01 -1 -3 imp:n=1 $ Pu(NO3)4 Solution
3 2 6.03350-02 1 -2 imp:n=1   $ Aluminum Sphere
4 0 -1 3 imp:n=1              $ Void Above Solution

1 so 60.964                   $ Sphere Inner Radius
2 so 61.734                   $ Sphere Outer Radius
3 pz 15.9558                  $ Liquid Level in Sphere

mode n
kcode 1000 1.0 10 810
ksrc     0.0 0.0 0.0 $ Point Source at origin
m1      94239.31c  2.4582E-05
        94240.31c  6.3369E-07
        94238.31c  1.0139E-09
        94241.31c  1.8774E-08
        94242.31c  3.4900E-09
         8016.31c  3.4558E-02
         7014.31c  7.6339E-04
         1001.31c  6.5198E-02
m2      13027.31c  5.9881E-02
      14028.31c   3.48353E-04
      14029.31c   1.76386E-05
      14030.31c   1.17087E-05
      29063.31c   3.55285E-05
      29065.31c   1.58355E-05
        25055.31c  1.4853E-05
mt1  lwtr01.31t $ S(Alpha,Beta)
totnu
prdmp
print
```

E.2 HEU-MET-FAST-73

```
5th Zeus Experiment 8 HEU Plates Benchmark Model (Rev) ENDF/B-VI
c Comet Hardware
1 2 0.059114 13 -16 18 -19    $ Platen & Adapter
2 2 0.059114 9 -10 -22 25     $ Alignment Tube
3 1 0.085376 2 -3 6 -7 22 -23 $ Diaphragm
c Side Reflectors
4 3 0.082784 1 -3 5 -6 26 -27 $ Front, 1st Layer
5 3 0.082784 1 -2 6 -8 26 -27 $ Left, 1st Layer
6 3 0.082784 2 -4 7 -8 26 -27 $ Back, 1st Layer
7 3 0.082784 3 -4 5 -7 26 -27 $ Right, 1st Layer
c Corner Reflectors
8 3 0.082953 2 -3 6 -7 17 -22 26 $ Below Diaphragm
9 3 0.082953 2 -3 6 -7 17 23 -28 $ Above Diaphragm
10 3 0.083394 2 -3 6 -7 28 -29   $ Top Reflector
c Column of Platters
11 3 0.083315 11 -16 19 -20      $ Bottom Reflector
12 4 0.048622 12 -15 20 -21      $ Disks w/ 1.255" Hole
13 4 0.048622 14 -15 21 -22      $ Disk w/ 3.0025" Hole
14 5 0.047810 15 -16 20 -22      $ Otr Rings, below Dia
15 4 0.048620 -15 23 -24         $ Solid Disks
16 5 0.047810 15 -16 23 -24      $ Otr Rings, above Dia
c Internal Voids
17 0 10 -17 -18 26        $ A-Tube - Refl Gap
18 0 10 -13 18 -19        $ A-Tube - Platen Gap
19 0 -9 -22 25            $ Inside Alignment Tube
20 0 10 -11 19 -22        $ A-Tube - Platter Gap
21 0 16 -17 18 -20        $ Platter-Rfl Gap (Lwr)
22 0 -16 24 -28           $ Platter - Upr Rfl Gap
23 0 2 -3 6 -7 -27 29     $ Above Top Reflector
24 0 11 -12 20 -21        $ Inside HEU Disks
25 0 11 -14 21 -22        $ Inside HEU Disk
26 0 16 -17 20 -22        $ Ring - Rfl Gap (Lwr)
27 0 16 -17 23 -28        $ Ring - Rfl Gap (Upr)
c External Voids
28 0 -1                  $ Left of Side Rfls
29 0 4                   $ Right of Side Rfls
30 0 1 -4 -5             $ Front of Side Rfls
31 0 1 -4 8              $ Behind Side Rfls
32 0 1 -4 5 -8 27        $ Above Reflectors
33 0 1 -4 5 -8 -26 #2 #19  $ Below Reflectors

1 px -44.14520           $ Left Rfl Edge
2 px -27.94000           $ Left Int Rfl Edge
3 px 27.94000            $ Right Int Rfl Edge
4 px 44.14520            $ Right Rfl Edge
5 py -44.14520           $ Front Rfl Edge
6 py -27.94000           $ Front Int Rfl Edge
7 py 27.94000            $ Back Int Rfl Edge
8 py 44.14520            $ Back Rfl Edge
9 cz 2.5400              $ 1.0-in Radius
10 cz 3.1496             $ 1.24-in. Radius
11 cz 3.1750             $ 1.25-in. Radius
12 cz 3.18770            $ 1.255-in. Radius
13 cz 4.7625             $ 1.875-in. Radius
14 cz 7.62635            $ 3.0025-in. Radius
15 cz 19.0500            $ Disk Outer Radius
16 cz 26.6700            $ Platter OR
17 cz 26.7970            $ Corner Rfl IR
c column, bottom to top
18 pz 35.73272 $ Bottom of Platen Spt
19 pz 42.08272 $ Top of Platen
20 pz 56.50992 $ Column Reflector
21 pz 57.40908 $ Lower HEU Disks & Rings
22 pz 57.70880 $ Disk with Wide Hole
23 pz 57.97296 $ Diaphragm
```

```
24 pz 59.17184 $ Upper HEU Disks & Rings
c support structure
25 pz -5.79120 $ Bottom of Alignment Tube
26 pz 0.0      $ Bottom of Reflectors
c side reflectors
27 pz 103.25100 $ Top of Side Reflectors
c corner and top reflectors
28 pz 59.24296 $ Top of Corner Reflectors
29 pz 73.67016 $ Top Reflector

mode    n
kcode   10000 1.0 50 650
c rand    hist=14285714
imp:n   1.0 26r 0.0 5r
ksrc     0.0 -15.0 56.62168  0.0 15.0 56.62168
      -15.0   0.0 56.62168 15.0  0.0 56.62168
        0.0 -15.0 56.92140  0.0 15.0 56.92140
      -15.0   0.0 56.92140 15.0  0.0 56.92140
        0.0 -15.0 57.22112  0.0 15.0 57.22112
      -15.0   0.0 57.22112 15.0  0.0 57.22112
        0.0 -15.0 57.55894  0.0 15.0 57.55894
      -15.0   0.0 57.55894 15.0  0.0 57.55894
        0.0 -15.0 58.12282  0.0 15.0 58.12282
      -15.0   0.0 58.12282 15.0  0.0 58.12282
        0.0 -15.0 58.42254  0.0 15.0 58.42254
      -15.0   0.0 58.42254 15.0  0.0 58.42254
        0.0 -15.0 58.72226  0.0 15.0 58.72226
      -15.0   0.0 58.72226 15.0  0.0 58.72226
        0.0 -15.0 59.02198  0.0 15.0 59.02198
      -15.0   0.0 59.02198 15.0  0.0 59.02198
c SS 304
m1     6000.31c 2.0637e-4
      7014.31c 1.6966e-4 7015.31c 6.3007e-7
      14028.31c 9.3687e-4 14029.31c 4.7438e-5
      14030.31c 3.1490e-5
      15031.31c 4.2278e-5
      16032.31c   5.53746E-06
      16033.31c   4.43323E-08
      16034.31c   2.50244E-07
      16036.31c   1.16664E-09
      24050.31c 7.1440e-4 24052.31c 1.3777e-2
      24053.31c 1.5620e-3 24054.31c 3.8885e-4
      25055.31c 1.4557e-3
      26054.31c 3.5137e-3 26056.31c 5.4623e-2
      26057.31c 1.2506e-3 26058.31c 1.6675e-4
      28058.31c 4.4066e-3 28060.31c 1.6847e-3
      28061.31c 7.2937e-5 28062.31c 2.3172e-4
      28064.31c 5.8737e-5
      29063.31c 1.0690e-5 29065.31c 4.7648e-6
      42092.31c   2.02551E-06
      42094.31c   1.26253E-06
      42095.31c   2.17292E-06
      42096.31c   2.27665E-06
      42097.31c   1.30348E-06
      42098.31c   3.29350E-06
      42100.31c   1.31440E-06
c Aluminum 6061 (2.70 g/cc)
m2    12024.31c   5.21721E-04
      12025.31c   6.60490E-05
      12026.31c   7.27200E-05
      13027.31c 5.7816e-2
      14028.31c 3.1630e-4 14029.31c 1.6016e-5
      14030.31c 1.0631e-5
      22046.31c   2.07455E-06
      22047.31c   1.87086E-06
      22048.31c   1.85376E-05
      22049.31c   1.36040E-06
      22050.31c   1.30256E-06
```

```
      24050.31c 3.3536e-6 24052.31c 6.4673e-5
      24053.31c 7.3325e-6 24054.31c 1.8254e-6
      25055.31c 2.1915e-5
      26054.31c 5.9360e-6 26056.31c 9.2280e-5
      26057.31c 2.1128e-6 26058.31c 2.8171e-7
      29063.31c 4.8053e-5 29065.31c 2.1418e-5
c Copper (8.7447 g/cc)
m3    29063.31c 5.7322e-2 29065.31c 2.5549e-2
c Average Pure Inner Fuel Disks (93.28 wt.% enriched)
m4    92234.31c 5.0377e-4 92235.31c 4.5384e-2
      92236.31c 1.1337e-4 92238.31c 2.6211e-3
c Average Pure Outer Fuel Rings (93.17 wt.% enriched)
m5    92234.31c 4.8707e-4 92235.31c 4.4574e-2
      92236.31c 2.0675e-4 92238.31c 2.5424e-3
totnu
prdmp j 675
print

end of input
```

E.3 HEU-SOL-THERM-004_case1

```
ol1ne 13.5 inch refl sphere based on critical volume and
c steel and refl thicknesses. enr=.9365 d sol=.997d refl=.994
c change d sigma to 1002.50 and ss to 26000.50 outer wall= 0.1 in.
c cell cards
1 1 .098526880 -1
2 3 8.7021e-02 -2 1
3 2 9.9715e-02 -3 2
4 3 8.7021e-02 -4 3
5 0 4

c surface cards
1 so 17.088
2 so 17.189
3 so 44.367
4 so 44.621

c importance card
imp:n 1.0 1.0 1.0 1.0 0.0
c material cards
m1      92234.31c  1.9029E-05
        92235.31c  1.7397E-03
        92238.31c  9.7761E-05
         8016.31c  3.3461E-02
         1001.31c  1.7849E-04
         1002.31c  5.9318E-02
         9019.31c  3.7129E-03
mt1    hwtr01.31t
c
c d20
m2       1001.31c  3.9886E-04
         1002.31c  6.6078E-02
         8016.31c  3.3238E-02
mt2    hwtr01.31t
c
c ss321
c
m3    26054.31c   3.46930E-03
      26056.31c   5.44606E-02
      26057.31c   1.25773E-03
      26058.31c   1.67381E-04
      24050.31c   7.17403E-04
      24052.31c   1.38344E-02
      24053.31c   1.56871E-03
      24054.31c   3.90485E-04
      28058.31c   5.25575E-03
      28060.31c   2.02449E-03
      28061.31c   8.80114E-05
      28062.31c   2.80556E-04
      28064.31c   7.14900E-05
        25055.31c  1.7363E-03
      14028.31c   1.56625E-03
      14029.31c   7.93059E-05
      14030.31c   5.26442E-05
sdef cel=1 rad=d2 erg=d1
sp1 -3
si2 0.0 17.088
sp2 -21 2
kcode 10000 1.0 50 550
prdmp j 100
print
```

E.4 SPEC-MET-FAST-08

```
 Np-237 sphere with HEU shells SPEC-MET-FAST-008 Simplified Bmark ENDF/B-VI
1 1 0.051054 -1             $ Np Sphere
2 2 0.059714 1 -2           $ W Clad
3 3 0.085344 2 -3           $ Ni Clad
4 4 0.052098 3 -4 -18       $ Lower Al Spacer
5 4 0.056781 6 -7 19        $ Upper Al Spacer
6 5 0.046309 4 -5 -18       $ Lower HEU Shells
7 5 0.046309 7 -8 19        $ Upper HEU Shells
8 4 0.061798 9 -11 18 -19   $ Al Shim
9 4 0.061798 5 9 -10 14 -16 $ Pedestal Ring
10 4 0.061798 -9 14 -15     $ Pedestal Center
11 4 0.061798 12 -13 17 -20 $ Homog Al Ring
c Void regions
12 0 3 -6 19
13 0 3 -9 18 -19
14 0 5 -9 15 -18
15 0 5 -12 17 -18
16 0 11 -12 18 -19
17 0 8 -12 19 -20
18 0 5 -13 16 -17
19 0 10 -13 14 -16
20 0 8 -13 20 -21
21 0 13:-14:21

1 so 4.14909        $ Radius of Np Sphere
2 so 4.42722        $ OR of W Cladding
3 so 4.81838        $ OR of Ni Cladding
4 so 5.017          $ OR of Lwr Al Liner
5 so 10.000         $ OR of Lwr HEU Shells
6 sz 0.3175 4.83108 $ IR of Upr Al Liner
7 sz 0.3175 5.013   $ OR of Upr Al Liner
8 sz 0.3175 9.668   $ OR of Upr HEU Shells
9 cz 5.080          $ IR of Al Shim
10 cz 7.620         $ IR of Al Pedestal
11 cz 10.000        $ OR of Al Shim
12 cz 10.4775       $ IR of Al Ring
13 cz 16.51         $ OR of Al Ring
14 pz -15.0622      $ Bottom of Pedestal
15 pz -10.2997      $ Top of Pedestal Ctr
16 pz -7.7597       $ Top of Pedestal Lip
17 pz -2.2225       $ Bottom of Al Ring
18 pz 0.0           $ Bottom of Al Shim
19 pz 0.3175        $ Top of Al Shim
20 pz 1.5875        $ Top of Al Ring
21 pz 10.10         $ Top Boundary

mode n
totnu
kcode 10000 1. 50 650
imp:n 1.0 19r 0.0
sdef cel=1 erg=d1
sp1 -3
c Np Sphere
m1      92233.31c 1.8577e-6 92234.31c 2.9633e-7
        92235.31c 1.4074e-5 92236.31c 7.8349e-8
        92238.31c 1.5626e-6
        93237.31c 5.0926e-2
        94238.31c 8.2304e-7 94239.31c 1.6271e-5
        94240.31c 1.1619e-6 94241.31c 3.1166e-8
        94242.31c 1.6032e-7
        95241.31c 3.3375e-7 95243.31c 9.1575e-5
c Tungsten
m2      74182.31c 1.4057e-2 74183.31c 7.5931e-3
        74184.31c 1.6254e-2 74186.31c 1.5079e-2
```

```
       26054.31c 2.0349e-4 26056.31c 3.1635e-3
       26057.31c 7.2430e-5 26058.31c 9.6573e-6
       28058.31c 2.2406e-3 28060.31c 8.5659e-4
       28061.31c 3.7086e-5 28062.31c 1.1782e-4
       28064.31c 2.9865e-5
c Nickel
m3     28058.31c 5.8264e-2 28060.31c 2.2275e-2
       28061.31c 9.6437e-4 28062.31c 3.0638e-3
       28064.31c 7.7662e-4
c Aluminum
m4    12024.31c   5.62409E-04
      12025.31c   7.12000E-05
      12026.31c   7.83912E-05
      13027.31c 5.5475e-2
      14028.31c 3.0308e-4 14029.31c 1.5346e-5
      14030.31c 1.0187e-5
      22046.31c   1.98842E-06
      22047.31c   1.79319E-06
      22048.31c   1.77680E-05
      22049.31c   1.30392E-06
      22050.31c   1.24848E-06
      24050.31c 2.5065e-6 24052.31c 4.8337e-5
      24053.31c 5.4804e-6 24054.31c 1.3644e-6
      25055.31c 2.1000e-5
      26054.31c 5.6878e-6 26056.31c 8.8421e-5
      26057.31c 2.0244e-6 26058.31c 2.6993e-7
      29063.31c 4.6046e-5 29065.31c 2.0523e-5
c HEU
m5    92234.31c 4.7468e-4 92235.31c 4.3169e-2
      92236.31c 2.1687e-4 92238.31c 2.4478e-3
prdmp j 750
print

end of input
```

APENDIX F. Radiation-Shielding validation Suite

F1. EURAC-Fe

```
euracos ferro
c
c  This is the input for the mcnp-3 simulation of the euracos2 iron
c  benchmark experiment.
c  Attention of Mr Sartori from Mr Rief (JRC-Ispra)   18.06.1987
c  Sent by H. de Sadeleer   JRC-Ispra   liaison officer
c
c  Several changes    Jan 2003, Steven van der Marck, NRG
c
1        0 +1
2        0 #(+2 -35 +36 -43 +44 -51)  -1
3        1 0.06294 ((+2 -3 +36 -43 +44 -51) #(+2 -3 +39 -40 +47 -48)):
           ((+3 -13 +36 -43 +44 -51) #(+3 -13 +38 -41 +46 -49))
4        2 0.0802 (+2 -3 +39 -40 +47 -48)
5        0 (+3 -4 +38 -41 +46 -49)
6        0 (+4 -11 +38 -41 +46 -49) #(+4 -11 -52)
7        5 0.0602 (+4 -5 -52)
8        0 (+5 -6 -52)
9        5 0.0602 (+6 -7 -52)
10       3 0.05676922 (+7 -8 -52)
11       5 0.0602 (+8 -9 -52)
12       0 (+9 -10 -52)
13       5 0.0602 (+10 -11 -52)
14       0 (+11 -12 -52)
15       0 (+11 -12 +38 -41 +46 -49) +52
16       4 0.0302177 (+12 -13 -52)
17       4 0.0302177 (+12 -13 +38 -41 +46 -49) +52
18       6 8.48765e-02  (-52 +13 -14) +53
19       6 8.48765e-02  (-52 +14 -15) +53
20       6 8.48765e-02  (-52 +15 -16) +53
21       6 8.48765e-02  (-52 +16 -17) +53
22       6 8.48765e-02  (-52 +17 -28) +53
23       6 8.48765e-02  (-52 +28 -29) +53
24       6 8.48765e-02  (-52 +29 -30) +53
25       6 8.48765e-02  (-52 +30 -31) +53
26       6 8.48765e-02  (-52 +31 -32) +53
27       6 8.48765e-02  (-52 +32 -33) +53
28       6 8.48765e-02  (-52 +33 -34) +53
29       6 8.48765e-02  (-53 +13 -14)
30       6 8.48765e-02  (-53 +14 -15)
31       6 8.48765e-02  (-53 +15 -16)
32       6 8.48765e-02  (-53 +16 -17)
33       6 8.48765e-02  (-53 +17 -28)
34       6 8.48765e-02  (-53 +28 -29) #47
35       6 8.48765e-02  (-53 +29 -30) #48
36       6 8.48765e-02  (-53 +30 -31) #49
37       6 8.48765e-02  (-53 +31 -32) #50
38       6 8.48765e-02  (-53 +32 -33) #51
39       6 8.48765e-02  (-53 +33 -34) #52
40       6 8.48765e-02 (13 -28 +38 -41 +46 -49) +52
41       6 8.48765e-02 (+28 -34 +37 -42 +45 -50) +52
42       6 8.48765e-02 (+34 -35 +37 -42 +45 -50) +52
43       6 8.48765e-02 (+34 -35 +53 -52 )
44       6 8.48765e-02 (+34 -35  -53 )
45       1 0.06294 ((+13 -28 +36 -43 +44 -51) #(13 -28 +38 -41 +46 -49))
46       1 0.06294 ((+28 -35 +36 -43 +44 -51) #(28 -35 +37 -42 +45 -50))
47       7 0.0254 (70 -71 72 -73 74 -75)
48       7 0.0254 (70 -71 72 -73 76 -77)
```

```
49      7 0.0254 (70 -71 72 -73 78 -79)
50      7 0.0254 (70 -71 72 -73 80 -81)
51      7 0.0254 (70 -71 72 -73 82 -83)
52      7 0.0254 (70 -71 72 -73 84 -85)

1       sx  100.0 400.0
2       px      -61.5
3       px      -41.0
4       px      -11.0
5       px      -10.2
6       px       -7.0
7       px       -6.8
8       px       -5.0
9       px       -4.8
10      px       -1.6
11      px       -0.8
12      px       -0.3
13      px        0.0
14      px       10.0
15      px       20.0
16      px       30.0
17      px       40.0
28      px       50.0
29      px       58.0
30      px       66.0
31      px       74.0
32      px       82.0
33      px       90.0
34      px       98.0
35      px      150.0
36      py     -120.0
37      py      -77.5
38      py      -72.5
39      py      -60.0
40      py       60.0
41      py       72.5
42      py       77.5
43      py      120.0
44      pz     -120.0
45      pz      -77.5
46      pz      -72.5
47      pz      -60.0
48      pz       60.0
49      pz       72.5
50      pz       77.5
51      pz      120.0
52      cx      40.0
53      cx      20.0
70      py      -10
71      py       10
72      pz      -10
73      pz       10
74      px       53.5
75      px       54.5
76      px       61.5
77      px       62.5
78      px       69.5
79      px       70.5
80      px       77.5
81      px       78.5
82      px       85.5
83      px       86.5
84      px       93.5
85      px       94.5
c
c  For sdef purposes (16-1-2003, SvdM)
c
101     px       -6
```

```
c  concrete
m1
            1001.31c  0.0127730     $   H 1
            8016.31c  0.0398531     $   O 16
            5010.31c  0.000345001   $   B 10
            5011.31c  0.00150100    $   B 11
           20040.31c  0.00262223    $  Ca 40
           20042.31c  0.0000175014  $  Ca 42
           20043.31c  0.00000365176 $  Ca 43
           20044.31c  0.0000565346  $  Ca 44
           20046.31c  0.0000001082  $  Ca 46
           20048.31c  0.00000505836 $  Ca 48
           14028.31c  0.000582895   $  Si 28
           14029.31c  0.0000295966  $  Si 29
           14030.31c  0.0000195099  $  Si 30
           13027.31c  0.000213000   $  Al
           26054.31c  0.000287458   $  Fe 54
           26056.31c  0.00451247    $  Fe 56
           26057.31c  0.000104213   $  Fe 57
           26058.31c  0.0000138688  $  Fe 58
c
c  graphite
m2
            6000.31c  1            $   C
c  al-u alloy
m3
           13027.31c  0.055435     $  Al
           92235.31c  0.0012008    $   U 5
           92238.31c  0.000133420  $   U 8
c  boral
m4
           13027.31c  0.0219044    $  Al
            6000.31c  0.00166186   $   C
            5011.31c  0.0054043    $   B 11
            5010.31c  0.00124707   $   B 10
c  al
m5
           13027.31c  1            $  Al
c  fe
m6
           26054.31c  0.0580      $  Fe 54
           26056.31c  0.9172      $  Fe 56
           26057.31c  0.0220      $  Fe 57
           26058.31c  0.0028      $  Fe 58
c
c  sulphur detectors
m7         16032.31c  0.9502      $   S 32
           16033.31c  0.0075      $   S 33
           16034.31c  0.0421      $   S 34
           16036.31c  0.0002      $   S 36
m8         16032.30y  1           $   S 32
c
c   in ---> imp:n  to set importances in MCNP-4C  (15-1-2003, SvdM)
c
imp:n    0     0     1.e-04    0.05    0.05    0.075            $  1- 6
         0.1   0.2  0.2   1     1     1     1   1  0.1  1  0.1   $  7-17
         1  4  19 84 370 1.2e+03 3.9e+03 1.3e+04 4.2e+04        $ 18-26
         8.2e+04 1.4e+05                                        $ 27-28
         1  7 53 390 2846 2.1e+04 1.0e+05 5.1e+05 2.5e+06       $ 29-37
         1.2e+07 6.0e+7                                         $ 38-39
         1 100 10 13400 1.0e+07 0.1 0.1                         $ 40-46
         2.1e+04 1.0e+05 5.1e+05 2.5e+06 1.2e+07 6.0e+07        $ 47-52
c
c  I do not know what this MCNP-3 command would translate into
c  for MCNP-4C3. (15-1-2003, SvdM)
c
c src     40. -6.0 .029  0. 6. 7.  8.  9. 10. 11. -1. 1. 0. 0. 100.
```

```
c
c  sdef card inserted 16-1-2003 by SvdM
c
sdef  sur=101  rad=d6  erg=d1  pos=-6 0 0
c
c  The probability distribution for the radius sampling was
c  generated by 'awk', using:
c        BEGIN{ alpha = 0.029; Rmax=40.0; N=40;
c           for (i=1;i<=N;i++) {
c              r0 = (i-1)/N*Rmax; r1 = (i  )/N*Rmax;
c              p0 = ( alpha*r0*sin(alpha*r0) + cos(alpha*r0) )/(alpha**2);
c              p1 = ( alpha*r1*sin(alpha*r1) + cos(alpha*r1) )/(alpha**2);
c              printf " %10.3f %10.5g\n", r1, p1-p0;
c           }}{}END{}
c  This is because (alpha*r*sin(alpha*r) + cos(alpha*r) is the
c  primitive function of the probability function r*cos(alpha*r)
c  for the radius. (See EUR-6, pp. 26, 31, 32)
c
c  (outer) radius   probability
c
#          si6          sp6
            0           0
            1           0.49989
            2           1.4984
            3           2.4932
            4           3.4816
            5           4.4613
            6           5.4296
            7           6.3842
            8           7.3225
            9           8.2422
           10           9.1408
           11           10.016
           12           10.865
           13           11.686
           14           12.477
           15           13.235
           16           13.959
           17           14.645
           18           15.293
           19           15.899
           20           16.462
           21           16.981
           22           17.453
           23           17.876
           24           18.249
           25           18.57
           26           18.837
           27           19.05
           28           19.206
           29           19.305
           30           19.345
           31           19.325
           32           19.243
           33           19.1
           34           18.893
           35           18.623
           36           18.289
           37           17.889
           38           17.424
           39           16.892
           40           16.295
c
si1     0.003355 0.004307 0.005531 0.007102 0.009119 0.01171 0.01503
        0.019310 0.021870 0.023570 0.024790 0.02605  0.03183 0.04087
        0.052480 0.067380 0.086520 0.1111   0.1228   0.1357  0.15
        0.1657   0.1832   0.2024   0.2237   0.2472   0.2732  0.3020
        0.3337   0.3688   0.4076   0.4505   0.4979   0.5502  0.6081
```

```
        0.6721   0.7427   0.8209   0.9072   1.003    1.108   1.225
        1.353    1.496    1.653    1.827    2.019    2.231   2.346
        2.466    2.725    3.011    3.329    3.679    4.066   4.493
        4.724    4.966    5.488    6.065    6.376    6.703   7.047
        7.408    8.187    9.048   10.000   11.050   12.210   13.500
       14.92
c
sp1    0.0 0.00003876 0.00005633 0.00008193 0.0001190 0.0001730
           0.00025110 0.00036470 0.00023980 0.0001670 0.0001223
           0.00013130 0.00063460 0.00111000 0.0016020 0.0023140
           0.00332900 0.00477500 0.00244600 0.0028130 0.0032420
           0.00373800 0.00428800 0.00492300 0.0056470
           0.00647200 0.00738500 0.00843800 0.0096170 0.0109200
           0.01239000 0.01400000 0.01580000 0.0177600 0.0198900
           0.02219000 0.02464000 0.02723000 0.0299200 0.0326900
           0.03544000 0.03812000 0.04070000 0.0431700 0.0449300
           0.04660000 0.04753000 0.04772000 0.0237100 0.0235000
           0.04584000 0.04361000 0.04046000 0.0366900 0.0322800
           0.02757000 0.01191000 0.01072000 0.0179300 0.0135500
           0.00532100 0.00445800 0.00366600 0.0029930 0.0042730
           0.00256200 0.00142700 0.00072810 0.0003398 0.0001427
           0.00005343
c
c erg:n      0. 20. j         $ is default in MCNP-4C ??? (15-1-2003, SvdM)
c
mode        n
cut:n       j  2.01          $ 2 MeV cut-off changed to 0.01 MeV, to allow
                             $ flux tallies down to 0.01 (16-1-2003, SvdM)
c
nps         1e7              $   250000
c
f4:n        47 48 49 50 51 52
fm4         (0.018836  8  103)       $  0.0188 *10^{24} atoms / gram sulphur
                             $      m8 is sulphur (activation data)
                             $  mt=103 is (n,p) activiation
print
prdmp       2j 1 2           $  get an mctal file; 2 dumps on runtpe (SvdM)
c
c  Normalise to  6.12 x 10^{11}  source neutrons per second;
c
c  tm0  6.12e11/Pi
  tm0  1.948e11
  t0   1e30
c
```

F2. KANT

```
c  This is the input for the mcnp-4 simulation of the fzk kant be
c  benchmark experiment. Provided by U. Fischer, fzk
c
1     1 -8.91      (-4   9  -18) : (-9 -24)
2     2 -2.65       -4  18  -10   -1
3     1 -8.91      (-1   4    9) : (-1   7  -9   8  24)
4     0            (-1 -8 -7 24) : (1  -8 -27 -9) : (8  -7  -3  -9)
                 : (-1 -8  7 24)
5     0            (-7  29  3  -15) : (-30  -29  -34)
6     0             (1  27 -15  -2 -14) : (-1 10) : (1 -14 -22 -19 15)
                 :  (-14  22  15  -16) : (-2 14 -8 -9)
                 :  (-5  27 -9  2  -3) : (-8  2  -3 -9)
7     0             -5  27 -9  3 -34
8     0             (-38 -35 -34) : (-8  3  38  -9)
9     1 -8.91       (7   -6   8  1  -9  -3) : (6  8  1  -9  28 -27)
                 :  (26  -3  -9  -28  -27)
10    1 -8.91       (7   -6   3  -9  29)
                 :  (26  -34  -9   3  -27) : (30  -6  -29  -34)
11    0             (-26   6  -9  -28  -3)
12    0             (-26   6  -9   3  -34)
13    3 -7.9        (2  -3  8  5  -15  -14) : (14  -3  -11  -15  8)
                 :  (12 -11  -3  15  -17) : (11 -23  8 -3 -9)
14    4 -8.3         13 -12 16 -17
15    3 -7.9        (13 -12 15 -16) : (22 -21 -19 17) : (-14 22 16 -17)
                 :  (14 -13 15 22 -17) :(14 -22)  : (19 -20 -21)
                 :  (17 -2 21 -13 -20)
16    3 -7.9        (8 -23 -9 3 37) : (38 -37 8 -36) : (35 -36 -38 -34)
17    3 -7.9        5 -31 -9  3  -34
18    6 -8.90       -41  20  -44
c     --- Correction of tiny geometry error (A. Serikov, FZK, 03/08/2006)
19    8 -1.293e-3  ((11 -3 23 -9) : (11 -3 9) : (13 17 -3 -10)
                 :  (21 -13 44 -3) : (2 -13 -20  25  -3  17)
                 :  (-25  21 -20 -3  17) : (-41  44  -21)
                 :  (41  -3  -44  20) : (41  44  -21)
                 :  (13  17  -3  -20  10) : (13  44  -3)) #15
c     --- Correction of tiny geometry error (A. Serikov, FZK, 03/08/2006)
20    8 -1.293e-3  (23  31  -9  3  -33) : (9  3  -33)
                 :  (23  31  -9  -36  37  33) : (36  31 -39 -9 33 -34)
21    5 0.117       (36  39  -9  33  -34) : (9  33  -34)
22    0             34
c     22    8 -1.293e-3   34  -32
c     23    8 -1.293e-3   32  -40
c     24    0             40

1     so         2.7
2     so         4.5
3     so         4.9
4     cx         2.0
5     1 cx         2.8
6     1 cx         1.7
7     1 cx         1.4
8     2 cx         1.5
9     px             0
10    px           2.43
11    1 cx         4.7
12    1 cx         4.4
13    1 cx         3.9
14    1 cx         3.75
15    p   1.732  -1  0    0
16    p   1.732  -1  0  1.4
17    p   1.732  -1  0  3.2
18    px           0.55
19    px           3.8
20    px           4.0
```

```
21    s   0.693  -0.4   0.0    3.9115
22    s   0.693  -0.4   0.0    3.7583
23    2 cx         1.7
24    sx         6.7082   7.0
25    1 cx         2.836
26    1 cx         1.9
27    1 cx         2.0
28    p   1.732  -1  0   -6.8
29    p   1.732  -1  0  -10.8
30    1 cx         1.5
31    1 cx         2.95
32    so          25.
33    so           5.
34    so          22.
35    2 cx         2.3
36    2 cx         2.5
37    p   1.732   1  0  -13.8
38    p   1.732   1  0  -15.0
39    1 cx         3.0
40    so         300.
41    kx            0  0.250     +1
42    kx            0  0.06250   +1
43    p   1.732  -1  0  4.4
44    px           4.1

*tr1  0 0 0  30 120 90  60 30 90  90 90  0
*tr2  0 0 0  30  60 90 120 30 90  90 90  0
cut:n 4.0e+05 1.0e-09  0.0
c  -----------------------------------
c  FENDL-2.1 cross-section everywhere
c  in material section:
c  ----------------------------------
c     cu
m1      29063.31c    6.9170E-01
        29065.31c    3.0830E-01
c     al                   mg-nat(FENDL-2.1)
m2      13027.31c   -9.7000E-01
c        12000.31c   -3.0000E-02
      12024.31c  -2.36970E-02
      12025.31c  -3.00000E-03
      12026.31c  -3.30300E-03
c     M3: edelstahl
m3      26056.31c   -6.9930E-01
        28058.31c   -9.0000E-02
        24052.31c   -1.8000E-01
        25055.31c   -2.0000E-02
c        6012.31c   -7.0000E-04
         6000.31c   -7.0000E-04
        14028.31c   -0.01
c
c     m4: 3messing ms58: 58% cu, 2% pb, 40% zn, dichte 8.3 g/cm**3
c     29000.10c -0.98    82000.60c -0.02
m4      29063.31c    6.8734E-01
        29065.31c    3.0638E-01
        82206.31c    1.5200E-03
        82207.31c    1.3940E-03
        82208.31c    3.3059E-03
c     Be EFF-3
m5       4009.31c    1.0000E+00
c     ni
m6      28058.31c    6.8270E-01
        28060.31c    2.6100E-01
        28061.31c    1.1300E-02
        28062.31c    3.5900E-02
        28064.31c    9.1000E-03
c     ni-58
m7      28058.31c    1.0000E+00
c     m8: luft ----> n-14,15 gibt nicht in FENDL deshalb: bmccs2!
```

```
c     8016.60c 0.2    7014.60c 0.8
m8       8016.31c    2.0000E-01
         7014.31c    8.0000E-01
mode  n
tmp1  2.53e-8 2.53e-8 2.53e-8 2.53e-8 2.53-8 2.53-8 2.53-8 2.53-8
      2.53e-8 2.53e-8 2.53e-8 2.53e-8 2.53-8 2.53-8 2.53-8 2.53-8
      2.53e-8 2.53e-8 2.53e-8 2.53e-8 2.53-8 2.53-8
thtme 1.0e10
phys:n   1.4988e+01
imp:n 1 20r  0
sc1   central neutron point source in a single starting cell,
      anisotropic distribution from livermore pulsed sphere setup,
      table a1 in la-12212 (nov. 1991) report
      for dt neutrons
sdef  pos=-0.29  0  0   cel=1 dir=d1 erg fdir d2  vec=0.866 -0.5 0
si1   a -1.0000   -0.99619  -0.98481  -0.96593  -0.93969  -0.90631
        -0.86603  -0.81915  -0.76604  -0.70711  -0.64279  -0.57358
        -0.50000  -0.42262  -0.34202  -0.25882  -0.17365  -0.08716
         0.00000   0.08716   0.17365   0.25882   0.34202   0.42262
         0.50000   0.57358   0.64279   0.70711   0.76604   0.81915
         0.86603   0.90631   0.93969   0.96593   0.98481   0.99619
         1.0000
sp1      0.874     0.874     0.875     0.876     0.877     0.879
         0.882     0.884     0.888     0.891     0.895     0.899
         0.904     0.909     0.914     0.919     0.924     0.930
         0.935     0.941     0.946     0.952     0.957     0.962
         0.967     0.972     0.976     0.981     0.985     0.988
         0.991     0.994     0.996     0.998     0.999     1.000
         1.000
ds2   q -0.99619 180 -0.98481 175 -0.96593 170 -0.93969 165 -0.90631 160
        -0.86603 155 -0.81915 150 -0.76604 145 -0.70711 140 -0.64279 135
        -0.57358 130 -0.50000 125 -0.42262 120 -0.34202 115 -0.25882 110
        -0.17365 105 -0.08716 100  0.00000  95  0.08716  90  0.17365  85
         0.25882  80  0.34202  75  0.42262  70  0.50000  65  0.57358  60
         0.64279  55  0.70711  50  0.76604  45  0.81915  40  0.86603  35
         0.90631  30  0.93969  25  0.96593  20  0.98481  15  0.99619  10
         1.0000    5
c     si-werte fuer n-energie bei d-energie von 150kev ( heft b, s.44 )
si5   h 14.985   14.988
sp5   d   0  1
si10  h 14.975   14.985
sp10  d   0  1
si15  h 14.958   14.975
sp15  d   0  1
si20  h 14.936   14.958
sp20  d   0  1
si25  h 14.907   14.936
sp25  d   0  1
si30  h 14.872   14.907
sp30  d   0  1
si35  h 14.831   14.872
sp35  d   0  1
si40  h 14.785   14.831
sp40  d   0  1
si45  h 14.735   14.785
sp45  d   0  1
si50  h 14.680   14.735
sp50  d   0  1
si55  h 14.620   14.680
sp55  d   0  1
si60  h 14.558   14.620
sp60  d   0  1
si65  h 14.492   14.558
sp65  d   0  1
si70  h 14.425   14.492
sp70  d   0  1
si75  h 14.355   14.425
sp75  d   0  1
```

```
si80  h 14.284   14.355
sp80  d   0  1
si85  h 14.212   14.284
sp85  d   0  1
si90  h 14.140   14.212
sp90  d   0  1
si95  h 14.068   14.140
sp95  d   0  1
si100 h 13.998   14.068
sp100 d   0  1
si105 h 13.928   13.998
sp105 d   0  1
si110 h 13.861   13.928
sp110 d   0  1
si115 h 13.796   13.861
sp115 d   0  1
si120 h 13.734   13.796
sp120 d   0  1
si125 h 13.675   13.734
sp125 d   0  1
si130 h 13.620   13.675
sp130 d   0  1
si135 h 13.569   13.620
sp135 d   0  1
si140 h 13.523   13.569
sp140 d   0  1
si145 h 13.481   13.523
sp145 d   0  1
si150 h 13.444   13.481
sp150 d   0  1
si155 h 13.413   13.444
sp155 d   0  1
si160 h 13.387   13.413
sp160 d   0  1
si165 h 13.366   13.387
sp165 d   0  1
si170 h 13.352   13.366
sp170 d   0  1
si175 h 13.343   13.352
sp175 d   0  1
si180 h 13.340   13.343
sp180 d   0  1
fc11  current through surfaces  34
f11:n  34
c     grobeinteilung fuer leakage-integrale 15Mev bis 1.e-09Mev
c      f. 5/4/95
E11              1.000E-07  4.140E-07  5.316E-07  6.826E-07  8.764E-07
       1.125E-06  1.445E-06  1.855E-06  2.382E-06  3.059E-06  3.928E-06
       5.044E-06  6.476E-06  8.315E-06  1.068E-05  1.371E-05  1.760E-05
       2.260E-05  2.902E-05  3.727E-05  4.785E-05  6.144E-05  7.889E-05
       1.013E-04  1.301E-04  1.670E-04  2.145E-04  2.754E-04  3.536E-04
       4.540E-04  5.829E-04  7.485E-04  9.611E-04  1.234E-03  1.585E-03
       2.035E-03  2.249E-03  2.485E-03  2.613E-03  2.747E-03  3.035E-03
       3.355E-03  3.707E-03  4.307E-03  5.531E-03  7.102E-03  9.119E-03
       1.060E-02  1.171E-02  1.503E-02  1.931E-02  2.188E-02  2.358E-02
       2.418E-02  2.479E-02  2.606E-02  2.700E-02  2.850E-02  3.183E-02
       3.431E-02  4.087E-02  4.631E-02  5.248E-02  5.656E-02  6.738E-02
       7.200E-02  7.950E-02  8.250E-02  8.652E-02  9.804E-02  1.111E-01
       1.168E-01  1.228E-01  1.291E-01  1.357E-01  1.426E-01  1.500E-01
       1.576E-01  1.657E-01  1.742E-01  1.832E-01  1.926E-01  2.024E-01
       2.128E-01  2.237E-01  2.352E-01  2.472E-01  2.732E-01  2.873E-01
       2.945E-01  2.972E-01  2.985E-01  3.020E-01  3.337E-01  3.688E-01
       3.877E-01  4.076E-01  4.505E-01  4.979E-01  5.234E-01  5.502E-01
       5.784E-01  6.081E-01  6.393E-01  6.721E-01  7.065E-01  7.427E-01
       7.808E-01  8.209E-01  8.629E-01  9.072E-01  9.616E-01  1.003E+00
       1.108E+00  1.165E+00  1.225E+00  1.287E+00  1.353E+00  1.423E+00
       1.496E+00  1.572E+00  1.653E+00  1.738E+00  1.827E+00  1.920E+00
       2.019E+00  2.123E+00  2.231E+00  2.307E+00  2.346E+00  2.365E+00
```

```
       2.385E+00  2.466E+00  2.592E+00  2.725E+00  2.865E+00  3.012E+00
       3.166E+00  3.329E+00  3.679E+00  4.066E+00  4.493E+00  4.724E+00
       4.966E+00  5.221E+00  5.488E+00  5.770E+00  6.065E+00  6.376E+00
       6.592E+00  6.703E+00  7.047E+00  7.408E+00  7.788E+00  8.187E+00
       8.607E+00  9.048E+00  9.512E+00  1.000E+01  1.051E+01  1.105E+01
       1.162E+01  1.221E+01  1.252E+01  1.284E+01  1.350E+01  1.384E+01
       1.419E+01  1.455E+01  1.492E+01  1.568E+01  1.649E+01  1.690E+01
       1.733E+01  1.964E+01
print
prdmp  j -30 1 5
c     dbcn  2j 1 100
nps   10000000
ctme  360.
```

F3. NIST

F3.1 NoCd+NoWater+2,0"

```
det at 3 inch model  no cadmium except bucket; no water
c     two fission chambers and stems, source and holder included
c     support structure, bucket, steel sphere and weld
c    fission chamber on +z side
    1 1 -21.45  -1 2 -3
    2 2 -2.700   3 -5 -1 4
    3 2 -2.700   6 -3 -2 4
    4 3 -2.2     7 -5 -4 8
    5 2 -2.700  10 -11 -8 9
    6 2 -2.700  13 -10 -12 14
    7 2 -2.700     -11 -9 15
    8 3 -2.2    16 -5 -15 17
    9 3 -2.2    11 -5  -19 15
   10 3 -2.2    22 -5 -23 1
   11 3 -2.2    11 -5 -24 23
   12 2 -2.700  10 -11 -25 23
   13 2 -2.700  13 -10 -26 27
   14 3 -2.2    16 -11 -29 28
   15 3 -2.2    11  -5 -29 30
   16 2 -2.700     -11 -28 25
   21 2 -2.700  18 -32 -33 31
   22 2 -2.700     -32 -34 33
   24 2 -2.700   5 -18 -33 21
   25 2 -2.700      -5 -20 21
   26 2 -2.700 -35 18 501 -502   $ stem (I think)
c     following cells are void cells
   50 0 (-6 -2 9):(6 -7 -4 9)
   51 0 (-16 -15 20):(16 -5 -17 20)
   52 0 11 -5 -8 19
   53 0 (7 -13 -8 9):(13 -10 -14 9):(13 -10 -8 12)
   54 0 11 -5  -30 24
   55 0 (-22 -25 1) : (22 -13 -25 23)
   56 0 (-16 -33 28) : (16 -5 -33 29)
   57 0 13 -10 -25 26
   58 0 13 -10 -27 23
c
c    cells in source
   60 4 -1.85    -50 -51 52  $ cf2o2so4
   61 5 -2.00    -53 -54 51  $ al powder
   62 0        50 -53 -51 52  $ air-filled cell
   63 2 -2.700 53 -55 -54 52
   64 2 -2.700    -55 -52 56
   65 0        55 -57 -54 56  $ air-filled cell
   66 6 -7.92 57 -58 -54 56  $ stainless steel
   67 6 -7.92    -58 -56 59  $ stainless steel
   68 6 -7.92 60 -58 -61 54  $ stainless steel
   69 0           -60 -61 54 $ air-filled cell
   70 6 -7.92    -58 -62 61  $ ss
   71 6 -7.92    -63 -64 62  $ ss
   72 6 -7.92 65 -58 -66 62  $ ss
c    cells in source holder
   73 6 -7.92 63 -67 -68 69   $ ss
   74 6 -7.92 70 -55 -71 68   $ ss
   75 6 -7.92 72 -55 -73 71   $ ss
   76 6 -7.92 72 -74 -75 73   $ ss
   77 6 -7.92 72 -76 -77 75   $ ss
   78 6 -7.92    -76 -78 77   $ ss
   79 6 -7.92    -53 -79 78   $ ss
   80 6 -7.92    -80 -81 79   $ ss chain
   81 0        63 -70 -64 68   $ no water
   82 0           -70 -71 64   $ no water
```

```
   83 0           -72 -73 71   $ no water
   84 0           -72 -77 73 $ air-filled void
   85 2 -2.700 -92 -90 91 80  $ item W al plate,preamps,cable
   86 2 -2.700 -95 -93 94 80  $ item V support ring & attachments Al
   87 9 -2.717 96 -97 -98 99  $ item U fission chamber brace Al+H
   88 6 -7.92  82 -83 -73     $ ss sphere shell
c    cd and al bucket cells
   89 8 -8.65  151 -152 157 -156
   90 8 -8.65  150 -152 156 -155
   91 8 -8.65      -152 158 -157
   92 2 -2.700 152 -153 158 -155
   93 2 -2.700 150 -153 155 -154
   94 2 -2.700     -153 159 -158
c    end of bucket
c    bead weld on ss sphere
   95 6 -7.92 83 -160 -161 162  $ ss weld
   96 0 (83 -160 161 74):(83 -160 -162) $ void outside weld
c    end of weld
c    outside world to make it easier to add source and holder to big file
  800 0     (58 -74 -62 59):(58 -74 -66 62):(63 -65 -66 62) $ no h2o in sphere
  801 0        63 -74 -69 66          $ no h2o in sphere
  802 0        (67 -74 -68 69):(55 -74 -73 -82 68) $ no h2o in sphere
  803 0 (76 -74 -78 75):(53 -74 -79 78):(80 -74 -94 79)
  804 0 80 -74 -91 93
  805 0 80 -74 -81 90
  806 0 -73 -74 83 501
c
c    cells for fission chamber on -z side
  101 1 -21.45  101 -102 -3
  102 2 -2.700   3 -5 101 -104
  103 2 -2.700   6 -3 102 -104
  104 3 -2.2     7 -5 104 -108
  105 2 -2.700  10 -11 108 -109
  106 2 -2.700  13 -10 112 -114
  107 2 -2.700     -11 109 -115
  108 3 -2.2    16 -5 115 -117
  109 3 -2.2    11 -5  119 -115
  110 3 -2.2    22 -5 123 -101
  111 3 -2.2    11 -5 124 -123
  112 2 -2.700  10 -11 125 -123
  113 2 -2.700  13 -10 126 -127
  114 3 -2.2    16 -11 129 -128
  115 3 -2.2    11  -5 129 -130
  116 2 -2.700     -11 128 -125
  121 2 -2.700  18 -32 133 -131
  122 2 -2.700     -32 134 -133
  124 2 -2.700   5 -18 133 -121
  125 2 -2.700      -5 120 -121
  126 2 -2.700 -135 18 501 -502
c     following cells are void cells
  150 0 (-6 102 -109):(6 -7 104 -109)
  151 0 (-16 115 -120):(16 -5 117 -120)
  152 0 11 -5 108 -119
  153 0 (7 -13 108 -109):(13 -10 114 -109):(13 -10 108 -112)
  154 0 11 -5  130 -124
  155 0 (-22 125 -101) : (22 -13 125 -123)
  156 0 (-16 133 -128) : (16 -5 133 -129)
  157 0 13 -10 125 -126
  158 0 13 -10 127 -123
c    outside world cells 1000s are +z and + and -y
 1000 0 ((32:34:-21)(35:502) 501 500 74 -156 -151 160) #87 $ +z +y with stem
 1001 0 (-21:32:34) -501 500 160 -151 157 $ +z -y w/o stem +160
 1002 0 18 -32 -31 21 -501  $fission chamber cutout +z -y without stem
 1003 0 -32 18 35 21 -31 501       $fission chamber +z +y with stem
 1004 0 ((-91 93 74 500):(-93 94 95 500)) -1000  $ between cell 85 and 86
 1005 0 ((-81 90 74 500):(-90 91 92 500):(81 500)) -1000  $ above cell 85
 1006 0        501 500 74 -82          $+z +y inside sphere no water
 1007 0        (-59:74) 500 -501 -82   $ +z -y inside sphere no water
```

```
 1008 0 ((156 -154 74 -150):(154 -94 74)) 500 -1000 $ above bucket +z
c    outside world cells 1050s are -z and + and -y
 1050 0 ((32:-134:121) (135:502) 501 -500 74 -156 -151 160) #87 $-z +y stem
 1051 0 (121:32:-134) -501 -500 160 -151 157 $ -z -y w/o stem
 1052 0 18 -32 131 -121 -501  $ fission chamber cutout -z -y without stem
 1053 0 18 -32 135 -121 131 501      $ fission chamber -z +y with stem
 1054 0 ((-91 93 74 -500):(-93 94 95 -500)) -1000 $ between cell 85 and 86
 1055 0 ((-90 91 92 -500):(-81 90 74 -500):(81 -500)) -1000 $ above cell 85
 1056 0        501 -500 74 -82         $-z +y inside sphere no water
 1057 0        (-59:74) -500 -501 -82  $ -z -y inside sphere no water
 1058 0 ((156 -154 74 -150):(154 -94 74)) -500 -1000 $ above bucket -z
 2000 0 (153:-159) -154 -1000
 2001 0 1000  $outside world

    1 pz 7.634
    2 pz 7.606
    3 cz 0.953
    4 pz 7.558
    5 cz 1.193
    6 cz 0.921
    7 cz 1.016
    8 pz 7.507
    9 pz 7.126
   10 cz 1.101
   11 cz 1.149
   12 pz 7.471
   13 cz 1.063
   14 pz 7.253
   15 pz 7.113
   16 cz 0.874
   17 pz 7.075
   18 cz 1.247
   19 pz 7.329
   20 pz 7.056
   21 pz 7.005
   22 cz 0.857
   23 pz 7.710
   24 pz 7.837
   25 pz 8.091
   26 pz 7.964
   27 pz 7.746
   28 pz 8.104
   29 pz 8.142
   30 pz 7.888
   31 pz 8.432
   32 cz 1.786
   33 pz 8.529
   34 pz 8.583
   35 c/y 0 7.62 .21035
c    surfaces of source and source holder
   50 cy  0.10
   51 py  0.04
   52 py -0.04
   53 cy  0.127
   54 py  0.506
   55 cy  0.318
   56 py -0.154
   57 cy  0.330
   58 cy  0.381
   59 py -0.205
   60 cy  0.152
   61 py  0.563
   62 py  0.608
   63 cy  0.114
   64 py  2.289
   65 cy  0.277
   66 py  0.659
   67 cy  0.366
```

```
   68 py  2.108
   69 py  1.613
   70 cy  0.254
   71 py  2.616
   72 cy  0.300
   73 py  5.048
   74 cy  1.270
   75 py  5.174
   76 cy  0.445
   77 py  5.428
   78 py  5.555
   79 py  6.190
   80 cy  0.159
   81 py 79.000
c      end of surfaces for source and holder
c     surfaces of water filled sphere
   82 so 5.080
   83 so 5.126
c     end of sphere
c     surfaces for miscellaneous support stuff
   90 py 74.79
   91 py 73.66
   92 cy 20.01
   93 py 30.665
   94 py 30.480
   95 cy 14.446
   96 cy 7.858
   97 cy 8.493
   98 py 11.667
   99 py 11.430
c     end of misc support surfaces
c     following surfaces are for fission chamber on -z side
  101 pz -7.634
  102 pz -7.606
  104 pz -7.558
  108 pz -7.507
  109 pz -7.126
  112 pz -7.471
  114 pz -7.253
  115 pz -7.113
  117 pz -7.075
  119 pz -7.329
  120 pz -7.056
  121 pz -7.005
  123 pz -7.710
  124 pz -7.837
  125 pz -8.091
  126 pz -7.964
  127 pz -7.746
  128 pz -8.104
  129 pz -8.142
  130 pz -7.888
  131 pz -8.432
  133 pz -8.529
  134 pz -8.583
  135 c/y 0 -7.62 .21035
c     bucket surfaces
  150 cy 2.54
  151 cy 34.290
  152 cy 34.341
  153 cy 34.376
  154 py 22.946
  155 py 22.911
  156 py 22.86
  157 py -22.86
  158 py -22.911
  159 py -22.946
c     end of bucket
```

```
c    weld surfaces
  160 so 5.276
  161 1 pz 0.08
  162 1 pz -0.08
c    end of weld
  500 pz 0
  501 py 0
  502 py 21.59   $ top of stem
 1000 s 0 27 0 65
 1001 cz 0.635

m1      78000.31c    1.0000E+00
m2      13027.31c    1.0000E+00
m3       6000.31c    2.0000E+00
         9019.31c    3.0000E+00
      17035.31c   7.57700E-01
      17037.31c   2.42300E-01
m4      98252.31c    2.0000E+00
         8016.31c    6.0000E+00
        16032.31c    1.0000E+00
m5      13027.31c    1.0000E+00
m6    26054.31c   4.06227E-02
      26056.31c   6.37690E-01
      26057.31c   1.47271E-02
      26058.31c   1.95990E-03
      24050.31c   8.25550E-03
      24052.31c   1.59199E-01
      24053.31c   1.80519E-02
      24054.31c   4.49350E-03
      28058.31c   6.46731E-02
      28060.31c   2.49119E-02
      28061.31c   1.08300E-03
      28062.31c   3.45230E-03
      28064.31c   8.79700E-04
        25055.31c    2.0000E-02
c       m7 1001.50c 2 8016.50c 1            $  no water
c      mt7 lwtr.07
m8    48106.31c   1.25000E-02
      48108.31c   8.90000E-03
      48110.31c   1.24900E-01
      48111.31c   1.28000E-01
      48112.31c   2.41300E-01
      48113.31c   1.22200E-01
      48114.31c   2.87300E-01
      48116.31c   7.49000E-02
m9      13027.31c    1.0000E+00
         1001.31c    1.7000E-01
 mode n
*tr1  0 0 0   0 90 90 90 45 135 90 45 45
 sdef erg=d1 pos 0 0 0 cel=60 rad=d2 ext=d3 axs 0 1 0
  si1 0. 0.05 0.1 0.2 0.25 0.3 0.4 0.5 0.6 0.7 0.8
      1.0 1.2 1.4 1.5 1.6 1.8 2.0 2.2 2.3 2.4 2.6 2.8 3.0
      3.4 3.7 4.2 4.6 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5
      9.0 9.5 10. 11. 12. 13. 14. 16. 18.
  sp1 0 0.0039 0.0074 0.0219 0.0140 0.0152 0.0323 0.0337 0.0343 0.0343
      0.0338 0.0664 0.0641 0.0608 0.0290 0.0279 0.0527 0.0484
      0.0442 0.0206 0.0196 0.0364 0.0328 0.0296 0.0503 0.0310
      0.0413 0.0253 0.0200 0.0190 0.0140 0.0102 0.00734 0.00527
      0.00378 0.00270 0.00193 0.00137 0.00098 0.00118 0.00059
      0.00030 0.00015 0.00011 0.00003
  si2 0 .1
  si3 0.04
c     low energy reactions
  fc2 low energy reactions
 f2:n (1 101) (2 102)
  fs2 -1001
  fm2 (1 101 -6)(1 102 -6)
  tf2 1 1 j 1 1 3j  $ 1st cell,total,j,1st seg,1st mult,j,last energy
```

```
c     high energy reaction rates
 fc12  high energy reactions
 f12:n (1 101) (2 102)
 fs12 -1001
 fm12 (1 103 -6)(1 104 -6)
 tf12 1 1 j 1 1 3j  $  1st cell,total,j,1st seg,1st mult,j,last energy,j
m101    92235.31c    1.0000E+00
m102    94239.31c    1.0000E+00
m103    92238.31c    1.0000E+00
m104    93237.31c    1.0000E+00
imp:n 1 122r 0
prdmp j -60
 ctme 180
print
```

F3.2 Cd+Water+2,5"

```
5-inch diam water sphere; cadmium-covered with lite water; all 4 foil
materials
c     file run for nist calculation; 27- and 4-group bins; also flux
c     surfaces 1&101, 2&102 added in tally; imp set by hand; split 100-1
c     two fission chambers and stems, source and holder included
c     support structure, bucket, steel sphere and weld
c    fission chamber on +z side
    1 1 -21.45  -1 2 -3      imp:n=800
    2 2 -2.700   3 -5 -1 4   imp:n=800
    3 2 -2.700   6 -3 -2 4   imp:n=800
    4 3 -2.2     7 -5 -4 8   imp:n=800
    5 2 -2.700  10 -11 -8 9  imp:n=800
    6 2 -2.700  13 -10 -12 14   imp:n=800
    7 2 -2.700     -11 -9 15  imp:n=800
    8 3 -2.2    16 -5 -15 17  imp:n=800
    9 3 -2.2    11 -5  -19 15   imp:n=800
   10 3 -2.2    22 -5 -23 1  imp:n=800
   11 3 -2.2    11 -5 -24 23  imp:n=800
   12 2 -2.700  10 -11 -25 23  imp:n=800
   13 2 -2.700  13 -10 -26 27  imp:n=800
   14 3 -2.2    16 -11 -29 28  imp:n=800
   15 3 -2.2    11  -5 -29 30  imp:n=800
   16 2 -2.700     -11 -28 25  imp:n=800
   22 2 -2.700      -5 -34 29  imp:n=800  $ changed for cd covered
   24 2 -2.700   5 -18 -29 21  imp:n=800
   25 2 -2.700      -5 -20 21  imp:n=800
   26 2 -2.700     -31 -21 38  imp:n=800 $ cd cover fission chamber cells
   27 2 -2.700  18 -31 -20 21  imp:n=800 $ cd cover fission chamber cells
   28 8 -8.65      -31 -38 39  imp:n=800 $ cd cover fission chamber cells
   29 8 -8.65   31 -32 -37 39 501  imp:n=800 $ cd cover fission chamber cells
   30 8 -8.65   31 -32 -37 39 -501  imp:n=800 $below stem
   31 8 -8.65      -31 -37 36  imp:n=800 $ cd cover fission chamber cells
   32 2 -2.700 -35 32 501 -502   imp:n=8 $ stem +z+y
   33 8 -8.865   41 -40 32 -43 501   imp:n=800 $cd liner on stem
   34 8 -8.865   41 -42 43 -44 501   imp:n=8 $cd liner on stem
c     following cells are void cells
   50 0 (-6 -2 9):(6 -7 -4 9)    imp:n=800
   51 0 (-16 -15 20):(16 -5 -17 20)    imp:n=800
   52 0 11 -5 -8 19    imp:n=800
   53 0 (7 -13 -8 9):(13 -10 -14 9):(13 -10 -8 12)    imp:n=800
   54 0 11 -5  -30 24    imp:n=800
   55 0 (-22 -25 1) : (22 -13 -25 23)    imp:n=800
   56 0 (-16 -29 28)    imp:n=800
   57 0 13 -10 -25 26    imp:n=800
   58 0 13 -10 -27 23    imp:n=800
c
c    cells in source
   60 4 -1.85    -50 -51 52  imp:n=1  $ cf2o2so4
   61 5 -2.00    -53 -54 51  imp:n=1  $ al powder
   62 0        50 -53 -51 52  imp:n=1  $ air-filled cell
   63 2 -2.700 53 -55 -54 52  imp:n=1
   64 2 -2.700    -55 -52 56  imp:n=1
   65 0        55 -57 -54 56  imp:n=1  $ air-filled cell
   66 6 -7.92 57 -58 -54 56  imp:n=1  $ stainless steel
   67 6 -7.92    -58 -56 59  imp:n=1  $ stainless steel
   68 6 -7.92 60 -58 -61 54  imp:n=1  $ stainless steel
   69 0          -60 -61 54 imp:n=1  $ air-filled cell
   70 6 -7.92    -58 -62 61  imp:n=1  $ ss
   71 6 -7.92    -63 -64 62  imp:n=1  $ ss
   72 6 -7.92 65 -58 -66 62  imp:n=1  $ ss
c    cells in source holder
   73 6 -7.92 63 -67 -68 69   imp:n=1  $ ss
   74 6 -7.92 70 -55 -71 68   imp:n=1  $ ss
   75 6 -7.92 72 -55 -73 71   imp:n=1  $ ss
```

```
   76 6 -7.92 72 -74 -75 73   imp:n=1  $ ss
   77 6 -7.92 72 -76 -77 75   imp:n=1  $ ss
   78 6 -7.92    -76 -78 77   imp:n=1  $ ss
   79 6 -7.92    -53 -79 78   imp:n=1  $ ss
   80 6 -7.92    -80 -81 79   imp:n=1  $ ss chain
   81 7 -1.000 63 -70 -64 68   imp:n=1  $ water
   82 7 -1.000    -70 -71 64   imp:n=1  $ water
   83 7 -1.000    -72 -73 71   imp:n=1  $ water
   84 0           -72 -77 73 imp:n=1  $ air-filled void
   85 2 -2.700 -92 -90 91 80  imp:n=1  $ item W al plate,preamps,cable
   86 2 -2.700 -95 -93 94 80  imp:n=1  $ item V support ring & attachments Al
   87 9 -2.717 96 -97 -98 99  imp:n=1  $ item U fission chamber brace Al+H
   88 6 -7.92  82 -83 -73     imp:n=8  $ ss sphere shell
c    cd and al bucket cells
   89 8 -8.65  151 -152 157 -156  imp:n=1
   90 8 -8.65  150 -152 156 -155  imp:n=1
   91 8 -8.65      -152 158 -157  imp:n=1
   92 2 -2.700 152 -153 158 -155  imp:n=1
   93 2 -2.700 150 -153 155 -154  imp:n=1
   94 2 -2.700     -153 159 -158  imp:n=1
c    end of bucket
c    bead weld on ss sphere
   95 6 -7.92 83 -160 -161 162  imp:n=1  $ ss weld
   96 0 (83 -160 161 74):(83 -160 -162) imp:n=8  $ void outside weld
c    end of weld
c    outside world to make it easier to add source and holder to big file
  800 7 -1.000 (58 -74 -62 59):(58 -74 -66 62):(63 -65 -66 62)
                               imp:n=1$h20 in sphere
  801 7 -1.000 63 -74 -69 66          imp:n=1 $ h20 in sphere
  802 7 -1.000 (67 -74 -68 69):(55 -74 -73 -82 68) imp:n=1 $ h20 in sphere
  803 0 (76 -74 -78 75):(53 -74 -79 78):(80 -74 -94 79)  imp:n=1
  804 0 80 -74 -91 93  imp:n=1
  805 0 80 -74 -81 90  imp:n=1
  806 0 -73 -74 83 501  imp:n=1
c
c    cells for fission chamber on -z side
  101 1 -21.45  101 -102 -3     imp:n=800
  102 2 -2.700   3 -5 101 -104     imp:n=800
  103 2 -2.700   6 -3 102 -104     imp:n=800
  104 3 -2.2     7 -5 104 -108     imp:n=800
  105 2 -2.700  10 -11 108 -109     imp:n=800
  106 2 -2.700  13 -10 112 -114     imp:n=800
  107 2 -2.700     -11 109 -115     imp:n=800
  108 3 -2.2    16 -5 115 -117     imp:n=800
  109 3 -2.2    11 -5  119 -115     imp:n=800
  110 3 -2.2    22 -5 123 -101     imp:n=800
  111 3 -2.2    11 -5 124 -123     imp:n=800
  112 2 -2.700  10 -11 125 -123     imp:n=800
  113 2 -2.700  13 -10 126 -127     imp:n=800
  114 3 -2.2    16 -11 129 -128     imp:n=800
  115 3 -2.2    11  -5 129 -130     imp:n=800
  116 2 -2.700     -11 128 -125     imp:n=800
  122 2 -2.700      -5 134 -129     imp:n=800
  124 2 -2.700   5 -18 129 -121     imp:n=800
  125 2 -2.700      -5 120 -121     imp:n=800
  126 2 -2.700     -31 121 -138     imp:n=800
  127 2 -2.700  18 -31 120 -121     imp:n=800
  128 8 -8.65      -31 138 -139     imp:n=800
  129 8 -8.65   31 -32 137 -139 501     imp:n=800
  130 8 -8.65   31 -32 137 -139 -501     imp:n=800
  131 8 -8.65      -31 137 -136     imp:n=800
  132 2 -2.700 -135 32 501 -502  imp:n=8 $ stem -z+y
  133 8 -8.865  141 -140 32 -43 501   imp:n=800 $cd liner on stem -z+y
  134 8 -8.865  141 -142 43 -44 501   imp:n=8 $cd liner on stem -z+y
c     following cells are void cells
  150 0 (-6 102 -109):(6 -7 104 -109)                  imp:n=800
  151 0 (-16 115 -120):(16 -5 117 -120)                 imp:n=800
  152 0 11 -5 108 -119                                      imp:n=800
```

```
  153 0 (7 -13 108 -109):(13 -10 114 -109):(13 -10 108 -112)   imp:n=800
  154 0 11 -5  130 -124                                       imp:n=800
  155 0 (-22 125 -101) : (22 -13 125 -123)                     imp:n=800
  156 0 (-16 129 -128)                                     imp:n=800
  157 0 13 -10 125 -126                                     imp:n=800
  158 0 13 -10 127 -123                                     imp:n=800
c     splitting cells in water
  200 7 -1.000 170 -171 501 -82   imp:n=4
  201 7 -1.000 171 -172 501 -82   imp:n=4
  202 7 -1.000 172 -173 501 -82   imp:n=8
  203 7 -1.000 173      501 -82   imp:n=8
  204 7 -1.000 170 -171 -501 -82   imp:n=4
  205 7 -1.000 171 -172 -501 -82   imp:n=4
  206 7 -1.000 172 -173 -501 -82   imp:n=8
  207 7 -1.000 173      -501 -82   imp:n=8
  208 7 -1.000 -174 175 501 -82   imp:n=4
  209 7 -1.000 -175 176 501 -82   imp:n=4
  210 7 -1.000 -176 177 501 -82   imp:n=8
  211 7 -1.000 -177     501 -82   imp:n=8
  212 7 -1.000 -174 175 -501 -82   imp:n=4
  213 7 -1.000 -175 176 -501 -82   imp:n=4
  214 7 -1.000 -176 177 -501 -82   imp:n=8
  215 7 -1.000 -177     -501 -82   imp:n=8
c    end of splitting cells
c    outside world cells 1000s are +z and + and -y
 1000 0 ((32:37:-39)(35:502) 501 500 74 -156 -151 160) #87 $ +z +y with stem
                 #33 #34            imp:n=8
 1001 0 (-39:32:37) -501 500 160 -151 157
                                    imp:n=8  $ +z -y w/o stem +160
 1002 0 ((18 -31 -36 20):(5 -18 -36 29):(-5 -36 34)) -501
                                 imp:n=800  $ cutout +z-y wo stem
 1003 0 ((-31 18 20 -29):(-31 5 -36 29):(-5 -36 34)) 501
                                  imp:n=800  $ fc +z+y with stem
 1004 0 ((-91 93 74 500):(-93 94 95 500)) -1000
                                   imp:n=1  $ between cell 85 and 86
 1005 0 ((-81 90 74 500):(-90 91 92 500):(81 500)) -1000
                                  imp:n=1  $ above cell 85
 1006 7 -1.000 501 500 74 -82 -170 imp:n=2  $+z +y inside sphere water
 1007 7 -1.000 (-59:74) 500 -501 -82 -170
                                    imp:n=2  $ +z -y inside sphere water
 1008 0 ((156 -154 74 -150):(154 -94 74)) 500 -1000
                                    imp:n=1  $ above bucket +z
c    outside world cells 1050s are -z and + and -y
 1050 0 ((32:-137:139) (135:502) 501 -500 74 -156 -151 160) #87 $-z +y stem
              #133 #134                    imp:n=8
 1051 0 (139:32:-137) -501 -500 160 -151 157
                                       imp:n=8  $ -z -y w/o stem
 1052 0 ((18 -31 136 -120):(5 -18 136 -129):(-5 136 -134)) -501 $
                                             imp:n=800
 1053 0 ((-31 18 -120 129):(-31 5 136 -129):(-5 136 -134)) 501
                                             imp:n=800
 1054 0 ((-91 93 74 -500):(-93 94 95 -500)) -1000
                                  imp:n=1  $ between cell 85 and 86
 1055 0 ((-90 91 92 -500):(-81 90 74 -500):(81 -500)) -1000
                                  imp:n=1  $ above cell 85
 1056 7 -1.000 501 -500 74 -82 174
                                  imp:n=2  $-z +y inside sphere water
 1057 7 -1.000 (-59:74) -500 -501 -82 174
                                   imp:n=2   $ -z -y inside sphere water
 1058 0 ((156 -154 74 -150):(154 -94 74)) -500 -1000
                                     imp:n=1 $ above bucket -z
 2000 0 (153:-159) -154 -1000              imp:n=1
 2001 0 1000                    imp:n=0  $  outside world

    1 pz 9.539
    2 pz 9.511
    3 cz 0.953
    4 pz 9.463
```

```
    5 cz 1.193
    6 cz 0.921
    7 cz 1.016
    8 pz 9.412
    9 pz 9.031
   10 cz 1.101
   11 cz 1.149
   12 pz 9.376
   13 cz 1.063
   14 pz 9.158
   15 pz 9.018
   16 cz 0.874
   17 pz 8.980
   18 cz 1.247
   19 pz 9.234
   20 pz 8.961
   21 pz 8.910
   22 cz 0.857
   23 pz 9.615
   24 pz 9.742
   25 pz 9.996
   26 pz 9.869
   27 pz 9.651
   28 pz 10.009
   29 pz 10.047
   30 pz 9.793
   31 cz 1.511
   32 cz 1.588
   34 pz 10.100
   35 c/y 0 9.525 .21035
   36 pz 10.470
   37 pz 10.549
   38 pz 8.882
   39 pz 8.804
   40 c/y 0 9.525 0.820
   41 c/y 0 9.525 0.238
   42 c/y 0 9.525 0.318
   43 py 1.689
   44 py 7.582
c    surfaces of source and source holder
   50 cy  0.10
   51 py  0.04
   52 py -0.04
   53 cy  0.127
   54 py  0.506
   55 cy  0.318
   56 py -0.154
   57 cy  0.330
   58 cy  0.381
   59 py -0.205
   60 cy  0.152
   61 py  0.563
   62 py  0.608
   63 cy  0.114
   64 py  2.289
   65 cy  0.277
   66 py  0.659
   67 cy  0.366
   68 py  2.108
   69 py  1.613
   70 cy  0.254
   71 py  2.616
   72 cy  0.300
   73 py  6.334
   74 cy  1.270
   75 py  6.460
   76 cy  0.445
   77 py  6.714
```

```
   78 py  6.841
   79 py  7.476
   80 cy  0.159
   81 py 80.286
c      end of surfaces for source and holder
c     surfaces of water filled sphere
   82 so 6.350
   83 so 6.396
c     end of sphere
c     surfaces for miscellaneous support stuff
   90 py 74.79
   91 py 73.66
   92 cy 20.01
   93 py 30.665
   94 py 30.480
   95 cy 14.446
   96 cy 7.858
   97 cy 8.493
   98 py 11.667
   99 py 11.430
c     end of misc support surfaces
c     following surfaces are for fission chamber on -z side
  101 pz -9.539
  102 pz -9.511
  104 pz -9.463
  108 pz -9.412
  109 pz -9.031
  112 pz -9.376
  114 pz -9.158
  115 pz -9.018
  117 pz -8.980
  119 pz -9.234
  120 pz -8.961
  121 pz -8.910
  123 pz -9.615
  124 pz -9.742
  125 pz -9.996
  126 pz -9.869
  127 pz -9.651
  128 pz -10.009
  129 pz -10.047
  130 pz -9.793
  134 pz -10.100
  135 c/y 0 -9.525 .21035
  136 pz -10.470
  137 pz -10.549
  138 pz -8.882
  139 pz -8.804
  140 c/y 0 -9.525 0.820
  141 c/y 0 -9.525 0.238
  142 c/y 0 -9.525 0.318
c     bucket surfaces
  150 cy 2.54
  151 cy 34.290
  152 cy 34.341
  153 cy 34.376
  154 py 22.946
  155 py 22.911
  156 py 22.86
  157 py -22.86
  158 py -22.911
  159 py -22.946
c     end of bucket
c     weld surfaces
  160 so 6.546
  161 1 pz 0.08
  162 1 pz -0.08
c     end of weld
```

```
c    surfaces for variance reduction
  170 pz  1.3
  171 pz  2.54
  172 pz  3.81
  173 pz  5.08
  174 pz -1.3
  175 pz -2.54
  176 pz -3.81
  177 pz -5.08
c    end of splitting surfaces
  500 pz 0
  501 py 0
  502 py 21.59   $ top of stem
 1000 s 0 27 0 65
 1001 cz 0.635

m1      78000.31c    1.0000E+00
m2      13027.31c    1.0000E+00
m3       6000.31c    2.0000E+00
         9019.31c    3.0000E+00
      17035.31c   7.57700E-01
      17037.31c   2.42300E-01
m4      98252.31c    2.0000E+00
         8016.31c    6.0000E+00
        16032.31c    1.0000E+00
m5      13027.31c    1.0000E+00
m6    26054.31c   4.06227E-02
      26056.31c   6.37690E-01
      26057.31c   1.47271E-02
      26058.31c   1.95990E-03
      24050.31c   8.25550E-03
      24052.31c   1.59199E-01
      24053.31c   1.80519E-02
      24054.31c   4.49350E-03
      28058.31c   6.46731E-02
      28060.31c   2.49119E-02
      28061.31c   1.08300E-03
      28062.31c   3.45230E-03
      28064.31c   8.79700E-04
        25055.31c    2.0000E-02
m7       1001.31c    2.0000E+00
         8016.31c    1.0000E+00
mt7 lwtr01.31t
m8    48106.31c   1.25000E-02
      48108.31c   8.90000E-03
      48110.31c   1.24900E-01
      48111.31c   1.28000E-01
      48112.31c   2.41300E-01
      48113.31c   1.22200E-01
      48114.31c   2.87300E-01
      48116.31c   7.49000E-02
m9      13027.31c    1.0000E+00
         1001.31c    1.7000E-01
 mode n
*tr1  0 0 0   0 90 90 90 45 135 90 45 45
 sdef erg=d1 pos 0 0 0 cel=60 rad=d2 ext=d3 axs 0 1 0
  si1 0. 0.05 0.1 0.2 0.25 0.3 0.4 0.5 0.6 0.7 0.8
      1.0 1.2 1.4 1.5 1.6 1.8 2.0 2.2 2.3 2.4 2.6 2.8 3.0
      3.4 3.7 4.2 4.6 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5
      9.0 9.5 10. 11. 12. 13. 14. 16. 18.
  sp1 0 0.0039 0.0074 0.0219 0.0140 0.0152 0.0323 0.0337 0.0343 0.0343
      0.0338 0.0664 0.0641 0.0608 0.0290 0.0279 0.0527 0.0484
      0.0442 0.0206 0.0196 0.0364 0.0328 0.0296 0.0503 0.0310
      0.0413 0.0253 0.0200 0.0190 0.0140 0.0102 0.00734 0.00527
      0.00378 0.00270 0.00193 0.00137 0.00098 0.00118 0.00059
      0.00030 0.00015 0.00011 0.00003
  si2 0 .1
  si3 0.04
```

```
c
  fc2  4-group reaction rates all 4 materials
 f2:n (1 101) (2 102)
  fs2 -1001
  fm2 (1 101 -6)(1 102 -6) (1 103 -6) (1 104 -6)
   e2 0.4e-6  0.4  1.4  20
  tf2 1 1 j 1 1 j 1 j  $ 1st cell,total,j,1st seg,1st mult,j,1st energy
c
 fc12  27-group reaction rates all 4 materials
f12:n (1 101) (2 102)
 fs12 -1001
 fm12 (1 101 -6)(1 102 -6) (1 103 -6) (1 104 -6)
  e12 1.e-11 .01e-6 .03e-6 .05e-6 0.1e-6 0.225e-6 0.325e-6 0.4e-6 0.8e-6
      1.e-6 1.13e-6 1.3e-6 1.77e-6 3.05e-6
      1e-5 3e-5 1e-4 5.5e-4 3e-3 1.7e-2
      .1 .4 .9 1.4 1.85 3.0 6.434 20
 tf12 1 1 j 1 1 j 1 j  $ 1st cell,total,j,1st seg,1st mult,j,1st energy
c
 fc22  plain flux
f22:n (1 101) (2 102)
 fs22 -1001
  e22 1e-8 1e-7 1e-6 1e-4 1e-2 1 18
 tf22 1 1 j 1 1 j 1 j  $ 1st cell,total,j,1st seg,1st mult,j,1st energy
c
m101    92235.31c    1.0000E+00
m102    94239.31c    1.0000E+00
m103    92238.31c    1.0000E+00
m104    93237.31c    1.0000E+00
print
prdmp j -60
 ctme 300
```

F4. IPPE-FE

```
Fe#1 Shell R=4.5 r=2.0 (modeling of shell and n-source by S.Simakov)
C    -------- CELL CARDS -----------------
C    Fe - shell with cylinder hole
2    1    0.084018   (1 -2) #(1 -2 -41 -3)    imp:n=1
C    outside shell (void) + hole
c 3    0              (2 -5) :(1 -2 -4 -3)
C    ========== Target Assembly =======
C     :: TiT Target on Cu Radiator
11    3  -8.96 -40 41 -38                    imp:n=1
C     .. 1ST FLANGE + CONICAL TUBE + BOTTOM (ALUMINIUM)
12    4  -2.7  (-43 44 45 -46):(38 -39 -40 43):
               (38 -39 -44 47):(-39 40 -42)  imp:n=1
C     .. 2ND FLANGE (EDEL STALL)
13    2  -7.9  (-47 48 49 -50)               imp:n=1
c    *** Outside target and shell ***
21    0          (-5)  #11 #12 #13 #2        imp:n=1
C     =============  Outside Welt ===========
100   0           5                          imp:n=0

C    ======     SURFACE CARDS ==================
C    -----  SPHERES AROUND ORIGIN ---------------
1    SO    2.0
2    SO    4.5
3    CX    2.0
c 4    PX    0.0
5    SO  680.0
C      =======  SURFACES For Target Assembly =======
c 35     SO       700.0
C     ** TIT TARGET
39    KX   8.381 0.0043066 -1
38    KX   7.598 0.0043066 -1
40    PX   0.1
41    PX   0.0
42    PX   0.15
C     ** 1st Al FLANGE/SCREW
43    PX  -2.8
44    PX  -3.5
45    CX   0.65
46    CX   1.15
C     ** 2nd SS FLANGE
47    PX  -32
48    PX  -32.7
49    CX    0.6
50    CX    2.65

C    ======== MATERIAL CARDS ================
C    Fe
M1      26054.31c    5.8900E-02
        26056.31c    9.1520E-01
        26057.31c    2.0900E-02
        26058.31c    2.8000E-03
         6000.31c    2.2000E-03
C     EDELSTAHL
M2      26056.31c   -6.9930E-01
        28058.31c   -9.0000E-02
        24052.31c   -1.8000E-01
        25055.31c   -2.0000E-02
      14028.31c  -9.22300E-03
      14029.31c  -4.67000E-04
      14030.31c  -3.10000E-04
         6000.31c   -7.0000E-04
C      CUPPER
M3      29063.31c    6.9200E-01
        29065.31c    3.0800E-01
```

```
C     ALUMINIUM
M4       13027.31c    1.0000E+00
C
MODE N
C      ======  Source ===============
SDEF  SUR=41 POS=0 0 0 RAD=D2 VEC=1 0 0 DIR=D3 ERG FDIR=D4
SI2  0.30
SI3  A -1.0000 -0.9962 -0.9848 -0.9659 -0.9397 -0.9063 -0.8660 -0.8192
       -0.7660 -0.7071 -0.6428 -0.5736 -0.5000 -0.4226 -0.3420 -0.2588
       -0.1737 -0.0872  0.0000  0.0872  0.1737  0.2588  0.3420  0.4226
        0.5000  0.5736  0.6428  0.7071  0.7660  0.8192  0.8660  0.9063
        0.9397  0.9659  0.9848  0.9962  1.0000
SP3     0.874   0.874   0.875   0.876   0.877   0.879   0.882   0.884
        0.888   0.891   0.895   0.899   0.904   0.909   0.914   0.919
        0.924   0.930   0.935   0.941   0.946   0.952   0.957   0.962
        0.967   0.972   0.976   0.981   0.985   0.988   0.991   0.994
        0.996   0.998   0.999   1.000   1.000
DS4     13.36   13.365  13.37   13.385  13.40   13.225  13.45   13.49
        13.53   13.58   13.62   13.67   13.71   13.80   13.88   13.92
        13.97   14.04   14.10   14.165  14.23   14.32   14.40   14.44
        14.48   14.54   14.60   14.65   14.70   14.74   14.78   14.81
        14.84   14.86   14.88   14.885  14.89
C    -------------------------------------------------------------------
C    CUT NEUTRON ENERGY RANGE
CUT:N 1J 1.0E-8  0.   0.
FC5   Ring (R=2.5) Detector at 679.0cm (175 bins)
F5X:N  679.0  2.5 0 ND
FM5    5.7936121E+06
E5                1.000E-07  4.140E-07  5.316E-07  6.826E-07  8.764E-07
       1.125E-06  1.445E-06  1.855E-06  2.382E-06  3.059E-06  3.928E-06
       5.044E-06  6.476E-06  8.315E-06  1.068E-05  1.371E-05  1.760E-05
       2.260E-05  2.902E-05  3.727E-05  4.785E-05  6.144E-05  7.889E-05
       1.013E-04  1.301E-04  1.670E-04  2.145E-04  2.754E-04  3.536E-04
       4.540E-04  5.829E-04  7.485E-04  9.611E-04  1.234E-03  1.585E-03
       2.035E-03  2.249E-03  2.485E-03  2.613E-03  2.747E-03  3.035E-03
       3.355E-03  3.707E-03  4.307E-03  5.531E-03  7.102E-03  9.119E-03
       1.060E-02  1.171E-02  1.503E-02  1.931E-02  2.188E-02  2.358E-02
       2.418E-02  2.479E-02  2.606E-02  2.700E-02  2.850E-02  3.183E-02
       3.431E-02  4.087E-02  4.631E-02  5.248E-02  5.656E-02  6.738E-02
       7.200E-02  7.950E-02  8.250E-02  8.652E-02  9.804E-02  1.111E-01
       1.168E-01  1.228E-01  1.291E-01  1.357E-01  1.426E-01  1.500E-01
       1.576E-01  1.657E-01  1.742E-01  1.832E-01  1.926E-01  2.024E-01
       2.128E-01  2.237E-01  2.352E-01  2.472E-01  2.732E-01  2.873E-01
       2.945E-01  2.972E-01  2.985E-01  3.020E-01  3.337E-01  3.688E-01
       3.877E-01  4.076E-01  4.505E-01  4.979E-01  5.234E-01  5.502E-01
       5.784E-01  6.081E-01  6.393E-01  6.721E-01  7.065E-01  7.427E-01
       7.808E-01  8.209E-01  8.629E-01  9.072E-01  9.616E-01  1.003E+00
       1.108E+00  1.165E+00  1.225E+00  1.287E+00  1.353E+00  1.423E+00
       1.496E+00  1.572E+00  1.653E+00  1.738E+00  1.827E+00  1.920E+00
       2.019E+00  2.123E+00  2.231E+00  2.307E+00  2.346E+00  2.365E+00
       2.385E+00  2.466E+00  2.592E+00  2.725E+00  2.865E+00  3.012E+00
       3.166E+00  3.329E+00  3.679E+00  4.066E+00  4.493E+00  4.724E+00
       4.966E+00  5.221E+00  5.488E+00  5.770E+00  6.065E+00  6.376E+00
       6.592E+00  6.703E+00  7.047E+00  7.408E+00  7.788E+00  8.187E+00
       8.607E+00  9.048E+00  9.512E+00  1.000E+01  1.051E+01  1.105E+01
       1.162E+01  1.221E+01  1.252E+01  1.284E+01  1.350E+01  1.384E+01
       14.0       14.1       14.2       14.3       14.4       14.5
       14.6       14.65      14.70      14.75      14.80      14.81
       14.82      14.83      14.84      14.85      14.86      14.87
       14.88      14.89      14.90      14.91      14.92      14.93
       14.94      14.95      14.96      14.97      14.98      14.99
       15.00
PRINT
prdmp  -10000 -10000 1 5
c
NPS    1.E6
CTME   1000.
```

F5. FNS_Oxygen

```
fns-tof/ lo2 slab-tof                JENDL-3.2             '94-08-18
c    *****************************************************
c    *                  cell carad                        *
c    *****************************************************
c    ***************** external void ********************
 1    0     -13 : +13 -2 +14 : +34 : +2 -34 +29 +30 +31 +32 +33
 2    0           -21 -2 -19
c    ************** source vacuum region *****************
 3    1 4.9210-5     -14 +13  -1 : -27  +1 -20
c    **************** naterial region ********************
c     ----sus316
 4    2 8.5979-2  +1  -3 -14 +20 :  +4  -2 -14 +19 :  +3  -4 -14 +15
 5    2 8.5979-2 +27 -28 -20     : +21 -22 -19
 6    2 8.5979-2  +9 -11 -17 +20 : +12 -10 -17 +20 : +11 -12 -17 +18
 7    2 8.5979-2 +25 -26 -20     : +23 -24 -20
c     ---- vacuum
 8    0           +3  -5 -15 +20 :  +6  -4 -15 +19 :  +5  -6 -15 +16
 9    0          +28  -5 -20     : +22  +6 -19
10    0           +7  -9 -17 +20 : +10  -8 -17 +20
11    0          +26  +7 -20     : +24  -8 -20
c     ---- al
12    3 3.6244-3   +5  -7 -16     :  +8  -6 -16     :  +7  -8 -16 +17
c     ---- o
13    4 4.2947-2 +11 -12 -18     : -25 -11 -20     : -23 +12 -20
c    ******* detector vacuum region *******
14    0  +2 -34 -29 : +2 -34 -30 : +2 -34 -31 : +2 -34 -32 : +2 -34 -33
c    ------- the following is a blank delimeter

c    **************************************
c    * surface card                       *
c    **************************************
 1          pz         -28.0
 2          pz           0.0
 3          pz         -27.5
 4          pz          -0.5
 5          pz         -25.90
 6          pz          -2.10
 7          pz         -25.20
 8          pz          -2.80
 9          pz         -24.80
10          pz          -3.20
11          pz         -24.0
12          pz          -4.0
13          pz         -70.0
c     ------------------------------
14          cz          35.0
15          cz          34.7
16          cz          30.8
17          cz          30.0
18          cz          29.8
19          cz          23.25
20          cz          15.0
c     -----     test      ----------
21          sz          134.146   136.146
22          sz          134.096   136.146
23          sz         -105.7227  102.8227
24          sz         -105.6727  102.8227
25          sz           77.7227  102.8227
26          sz           77.6727  102.8227
27          sz         -129.7227  102.8227
28          sz         -129.6727  102.8227
c     21          pz          -0.05
c     22          pz          -0.10
c     23          sz       -105.7227  102.8227
c     24          sz       -105.6727  102.8227
```

```
c     25             pz           -24.05
c     26             pz           -24.10
c     27             sz        -129.7227  102.8227
c     28             sz        -129.6727  102.8227
c     ------------------------------
29            cz           4.977
30          1 cz           4.985
31          2 cz           5.012
32          3 cz           5.074
33          4 cz           5.212
34            so        1000.0
c     ------- the following is a blank delimeter

c    **************************************
c    *  mode card       - neutron only    *
c    **************************************
mode   n
c    **************************************
c    *  transformation cards              *
c    *  rotation about the y axis by theta*
c    **************************************
*tr1   0  0  0        12.2  90  102.2   90   0  90
                      77.8  90   12.2   +1
*tr2   0  0  0        24.9  90  114.9   90   0  90
                      65.1  90   24.9   +1
*tr3   0  0  0        41.8  90  131.8   90   0  90
                      48.2  90   41.8   +1
*tr4   0  0  0        66.8  90  156.8   90   0  90
                      23.2  90   66.8   +1
c    **************************************
c    *   cell parameter cards             *
c    **************************************
imp:n   0     1     1     1     1     1     1
        1     1     1     1     1     1     1
c    ****************************************************
c    *  source specification cards                      *
c    *  src1=point isotropic option                     *
c    *  sdir dirc. biasing - height reduction considered*
c    *  si(eng.) and sp(prob.) taken from betof source  *
c    *  expt. data                                      *
c    ****************************************************
sdef  erg=d1  pos=0 0 -44.0  vec=0 0 1  dir=d2  wgt=1.0
sb2   -31   4.0
si1   4.0867-02  4.6308-02
      5.2474-02  5.9461-02  6.7378-02  7.6349-02  8.6515-02
      9.8035-02  1.1109-01  1.2588-01  1.4264-01  1.6163-01
      1.8315-01  2.0754-01  2.3517-01  2.6649-01  3.0197-01
      3.4217-01  3.8774-01  4.3936-01  4.9786-01  5.6415-01
      6.3927-01  7.2438-01  8.2084-01  9.3013-01  1.0540+00
      1.1943+00  1.3533+00  1.5335+00  1.7377+00  1.8498+00
      1.9691+00  2.0961+00  2.2313+00  2.3752+00  2.5284+00
      2.6914+00  2.8650+00  3.0498+00  3.2465+00  3.4559+00
      3.6787+00  3.9160+00  4.1686+00  4.4374+00  4.7236+00
      5.0282+00  5.3525+00  5.6978+00  6.0652+00  6.4564+00
      6.8728+00  7.3161+00  7.7879+00  8.2902+00  8.8249+00
      9.3940+00  9.9999+00  1.0157+01  1.0317+01  1.0480+01
      1.0645+01  1.0812+01  1.0983+01  1.1156+01  1.1331+01
      1.1510+01  1.1691+01  1.1875+01  1.2062+01  1.2252+01
      1.2445+01  1.2641+01  1.2840+01  1.3042+01  1.3248+01
      1.3456+01  1.3668+01  1.3883+01  1.4102+01  1.4324+01
      1.4550+01  1.4779+01  1.5012+01  1.5248+01  1.5488+01
      1.5732+01  1.5980+01  1.6231+01  1.6487+01
sp1   0          1.4214-04
      2.1261-04  2.3162-04  2.1327-04  2.7087-04  2.6032-04
      3.1949-04  3.7848-04  4.3099-04  4.4082-04  5.6289-04
      6.0267-04  7.5334-04  8.3566-04  1.0281-03  1.1620-03
      1.3881-03  1.5339-03  1.8001-03  2.0387-03  2.3534-03
      2.6401-03  2.9843-03  3.2787-03  3.4783-03  3.7189-03
```

```
      3.8514-03  4.0062-03  4.1197-03  1.9596-03  2.0343-03
      2.0484-03  2.0263-03  1.9854-03  2.0112-03  2.0467-03
      2.1441-03  2.2558-03  2.4800-03  2.0399-03  1.7933-03
      1.6234-03  1.5383-03  1.4642-03  1.4261-03  1.3083-03
      1.3177-03  1.1970-03  1.1469-03  1.0180-03  1.0084-03
      1.0841-03  9.6395-04  9.2930-04  9.1702-04  1.1141-03
      1.1989-03  3.0970-04  3.1532-04  3.2121-04  3.2516-04
      3.9020-04  4.3484-04  4.3993-04  4.9814-04  5.7884-04
      5.8531-04  7.1724-04  1.1255-03  1.1435-03  1.2050-03
      2.3468-03  2.3827-03  2.4186-03  5.2339-03  5.8254-03
      5.9374-03  2.4164-02  3.5089-02  3.5570-02  9.9593-02
      1.8264-01  1.8583-01  1.6377-01  8.7669-02  8.9130-02
      8.7095-02  1.0017-03  1.0217-03  0
c     *********************************************
c     *  material specification cards             *
c     *********************************************
c     ----- iron (fe) ---------------------------
c     --- air
m1    7014.31c 3.8810-5        8016.31c  1.0400-5
c     --- sus316: Cr=1.6787-2, Mn55=1.3420-3, Fe-6.0507-2, Ni=7.3429-3
m2   24050.31c 7.2940-4  24052.31c 1.4066-2  24053.31c 1.5948-3
     24054.31c 3.9701-4
     25055.31c 1.3420-3
     26054.31c 3.5699-3  26056.31c 5.5497-2  26057.31c 1.2706-3
     26058.31c 1.6942-4
     28058.31c 5.0130-3  28060.31c 1.9165-3  28061.31c 8.2975-5
     28062.31c 2.6361-4  28064.31c 6.6820-5
c     --- al
m3   13027.31c 3.6244-3
c     --- o
m4    8016.31c 4.2947-2
c     drxs
c     *********************************************
c     *  tally specification cards                *
c     *********************************************
fc5  --//fluxes at 5 pt dts(th=0.0, 12.2, 24.9, 41.8, 66.8 deg)
f5:n        0.0         0     703.0000       1
          148.7973      0     688.2148       1
          298.0163      0     642.0212       1
          477.4981      0     534.0526       1
          676.2307      0     289.8328       1
dd    0.5   100
e0    4.0867-02  4.6308-02
      5.2474-02  5.9461-02  6.7378-02  7.6349-02  8.6515-02
      9.8035-02  1.1109-01  1.2588-01  1.4264-01  1.6163-01
      1.8315-01  2.0754-01  2.3517-01  2.6649-01  3.0197-01
      3.4217-01  3.8774-01  4.3936-01  4.9786-01  5.6415-01
      6.3927-01  7.2438-01  8.2084-01  9.3013-01  1.0540+00
      1.1943+00  1.3533+00  1.5335+00  1.7377+00  1.8498+00
      1.9691+00  2.0961+00  2.2313+00  2.3752+00  2.5284+00
      2.6914+00  2.8650+00  3.0498+00  3.2465+00  3.4559+00
      3.6787+00  3.9160+00  4.1686+00  4.4374+00  4.7236+00
      5.0282+00  5.3525+00  5.6978+00  6.0652+00  6.4564+00
      6.8728+00  7.3161+00  7.7879+00  8.2902+00  8.8249+00
      9.3940+00  9.9999+00  1.0157+01  1.0317+01  1.0480+01
      1.0645+01  1.0812+01  1.0983+01  1.1156+01  1.1331+01
      1.1510+01  1.1691+01  1.1875+01  1.2062+01  1.2252+01
      1.2445+01  1.2641+01  1.2840+01  1.3042+01  1.3248+01
      1.3456+01  1.3668+01  1.3883+01  1.4102+01  1.4324+01
      1.4550+01  1.4779+01  1.5012+01  1.5248+01  1.5488+01
      1.5732+01  1.5980+01  1.6231+01  1.6487+01
fq0    e    f
c    **********************************************
c    * problem cutoff cards                       *
c    **********************************************
cut:n        0     4.0000-02   -10    -0.01
nps      2000000
c ctme      180
```

```
c    *********************************************
c    * peripheral crads                            *
c    *********************************************
prdmp      1000000    1000000
lost     10        10
print
```

F6. Oktavian Al

```
LEAKAGE FROM ALUMINIUM (40 CM DIA) SPHERE 3-D SURFACE TALLY (ENDF/B-VI)
c    *** Cell cards ***
 1     3  -0.0012  -3
 2     2  -7.824   -4 3
 3     1  -1.223   -5 4
 4     2  -7.824   -6 5
 5     3  -0.0012  -7 6
 6     0            7

c    *** Surface cards ***
 3    so  10.0
 4    so  10.2
 5    so  19.75
 6    so  19.95
 7    so 580.0

c    *** Material cards ***
c Aluminium (0.2% Fe-56, ignore Si, Cu)
m1      13027.31c   -9.9800E-01
        26056.31c   -2.0000E-03
c Steel (Cr 18.5%, Fe-56 70.4%, Ni 11.1%)
m2    24050.31c  -8.03825E-03
      24052.31c  -1.55010E-01
      24053.31c  -1.75768E-02
      24054.31c  -4.37525E-03
        26056.31c   -7.0400E-01
      28058.31c  -7.55655E-02
      28060.31c  -2.91075E-02
      28061.31c  -1.26540E-03
      28062.31c  -4.03374E-03
      28064.31c  -1.02786E-03
c  Air
m3    8016.31c  0.208
      7014.31c  0.792
c    *** Data cards ***
mode n
imp:n 1 1 1 1 1 0
sdef pos=0. 0. 0. cel=1 erg=d1
c    *** Energy bin for source neutron ***
si1  h 1.000e-1 1.120e-1 1.260e-1 1.410e-1 1.590e-1
       1.780e-1 2.000e-1 2.240e-1 2.520e-1 2.830e-1
       3.170e-1 3.560e-1 4.000e-1 4.490e-1 5.040e-1
       5.660e-1 6.350e-1 7.130e-1 8.000e-1 8.780e-1
       9.640e-1 1.058e+0 1.162e+0 1.275e+0 1.400e+0
       1.542e+0 1.698e+0 1.871e+0 2.061e+0 2.270e+0
       2.500e+0 2.704e+0 2.924e+0 3.162e+0 3.419e+0
       3.699e+0 4.000e+0 4.165e+0 4.337e+0 4.516e+0
       4.703e+0 4.897e+0 5.099e+0 5.310e+0 5.529e+0
       5.757e+0 5.995e+0 6.242e+0 6.500e+0 6.765e+0
       7.041e+0 7.327e+0 7.627e+0 7.938e+0 8.261e+0
       8.598e+0 8.949e+0 9.314e+0 9.693e+0 1.009e+1
       1.050e+1 1.082e+1 1.114e+1 1.148e+1 1.183e+1
       1.218e+1 1.255e+1 1.277e+1 1.300e+1 1.324e+1
       1.348e+1 1.372e+1 1.397e+1 1.422e+1 1.447e+1
       1.474e+1 1.500e+1 1.527e+1 1.554e+1 1.583e+1
       1.611e+1 1.640e+1
c    *** Source distribution ***
sp1    0.000e-4 0.000e-0 0.000e-0 1.270e-4 5.774e-5
       2.536e-4 2.722e-4 2.076e-4 4.366e-4 3.873e-4
       4.756e-4 6.161e-4 6.727e-4 6.648e-4 8.581e-4
       1.098e-3 1.184e-3 1.412e-3 1.616e-3 1.546e-3
       1.556e-3 1.631e-3 1.771e-3 1.804e-3 1.823e-3
       1.891e-3 1.935e-3 2.002e-3 2.052e-3 2.004e-3
       2.068e-3 2.091e-3 3.354e-3 1.492e-3 1.322e-3
```

```
       1.451e-3 1.401e-3 7.112e-4 6.423e-4 6.514e-4
       6.195e-4 6.428e-4 6.209e-4 5.788e-4 5.227e-4
       5.250e-4 5.456e-4 5.106e-4 5.789e-4 5.391e-4
       4.998e-4 4.813e-4 5.300e-4 5.756e-4 5.230e-4
       5.394e-4 6.256e-4 7.047e-4 7.729e-4 7.951e-4
       8.659e-4 8.106e-4 8.923e-4 1.022e-3 1.281e-3
       1.687e-3 2.286e-3 1.825e-3 2.479e-3 3.794e-3
       7.010e-3 1.565e-2 3.634e-2 7.492e-2 1.279e-1
       1.768e-1 1.916e-1 1.500e-1 8.676e-2 3.950e-2
       1.430e-2 4.269e-3
c    *** Tally cards ***
fc21 Neutron current through the outer surface
f21:n 7
c    *** Energy bin ***
e21           1.290e-3 1.670e-3 2.150e-3
     2.780e-3 3.590e-3 4.640e-3 5.990e-3 7.740e-3
     1.000e-2 1.290e-2 1.670e-2 2.150e-2 2.780e-2
     3.590e-2 4.640e-2 5.990e-2 7.740e-2
     1.000e-1 1.060e-1 1.120e-1 1.190e-1
     1.260e-1 1.340e-1 1.410e-1 1.500e-1 1.590e-1
     1.680e-1 1.780e-1 1.890e-1 2.000e-1 2.120e-1
     2.240e-1 2.520e-1 2.830e-1 3.170e-1 3.560e-1
     4.000e-1 4.490e-1 5.040e-1 5.660e-1 6.350e-1
     7.130e-1 8.000e-1 8.780e-1 9.640e-1 1.058e+0
     1.162e+0 1.275e+0 1.400e+0 1.542e+0 1.698e+0
     1.871e+0 2.061e+0 2.270e+0 2.500e+0 2.704e+0
     2.924e+0 3.162e+0 3.419e+0 3.699e+0 4.000e+0
     4.165e+0 4.337e+0 4.516e+0 4.703e+0 4.897e+0
     5.099e+0 5.310e+0 5.529e+0 5.757e+0 5.995e+0
     6.242e+0 6.500e+0 6.765e+0 7.041e+0 7.327e+0
     7.627e+0 7.938e+0 8.261e+0 8.598e+0 8.949e+0
     9.314e+0 9.693e+0 1.009e+1 1.050e+1 1.082e+1
     1.114e+1 1.148e+1 1.183e+1 1.218e+1 1.255e+1
     1.277e+1 1.300e+1 1.324e+1 1.348e+1 1.372e+1
     1.397e+1 1.422e+1 1.447e+1 1.474e+1 1.500e+1
     1.527e+1 1.554e+1 1.583e+1 1.611e+1 1.640e+1
fc32 Photon current through the outer surface
f32:p 7
fm32 4227327.1             $ 4*Pi * R7
fq32 e t
c    *** Energy bin ***
e32  0.3  56i  6.0  19i  10.0  24i  20
t32  8.8  1e6  t
c
phys:n 20.0  0
phys:p 20.0  0  0
phys:e 20.0  0  0  0  0  1  0  1  1
c    *** Cut off card ***
c cut:n 1.0e16 1.0e-3 0.01
cut:n 1.0e6  0.0    -0.5  -0.25  0
cut:p 1.0e6  0.299  -0.5  -0.25  0
cut:e 1.0e6  0.3    -0.5  -0.25  0
c    *** Neutron history ***
nps  5000000
print
```

F7. LLNL Pulsed Spheres: Iron, 4.8 MFP

```
IRON SPHERE WITH 4.8 M.F.P ENDF/B-VI AND JEFF-3.1
1 1 -7.85    -1 -3
2 1 -7.85     1  2 -3
3 2 -.001288  1 -2 -3
4 1 -7.85    -1  3 -4
5 1 -7.85     1  2  3 -4
6 2 -.001288  1 -2  3 -4
7 1 -7.85    -1  4 -5
8 1 -7.85     1  2  4 -5
9 2 -.001288  1 -2  4 -5
10 1 -7.85   -1  5 -6
11 1 -7.85    1  2  5 -6
12 2 -.001288 1 -2 5 -6
13 2 -.001288 6 -7
14 0 7

1   px -.475
2   x 0.0 1.11 22.3 2.67
3   so 6
4   so 12
5   so 18
6   so 22.3
7   so 1000
100 px 0.0

IMP:N 1 1 1 2 2 2 4 4 4 8 8 8 8 0
c data cards - source (as given by LA-12212 and LA-12885)
sdef pos=0 0 0 dir=d1 erg=fdir=d2 rad=d3 vec=-1 0 0
     sur=100 tme=d4
si1 a -1.00000 -0.99619 -0.98481 -0.96593 -0.93969
      -0.90631 -0.86603 -0.81915 -0.76604 -0.70711
      -0.64279 -0.57358 -0.50000 -0.42262 -0.34202
      -0.25882 -0.17365 -0.08716  0.00000  0.08716
       0.17365  0.25882  0.34202  0.42262  0.50000
       0.57358  0.64279  0.70711  0.76604  0.81915
       0.86603  0.90631  0.93969  0.96593  0.98481
       0.99519 1.00000
sp1    0.874 0.874 0.875 0.876 0.877
       0.879 0.882 0.884 0.888 0.891
       0.895 0.899 0.904 0.909 0.914
       0.919 0.924 0.930 0.935 0.941
       0.946 0.952 0.957 0.962 0.967
       0.972 0.976 0.981 0.985 0.988
       0.991 0.994 0.996 0.998 0.999
       1.000 1.000
ds2 q  -0.99619 180 -0.98481 175 -0.96593 170 -0.93962 165
       -0.90631 160 -0.86603 155 -0.81915 150 -0.76604 145
       -0.70711 140 -0.64279 135 -0.57358 130 -0.50000 125
       -0.42262 120 -0.34202 115 -0.25882 110 -0.17365 105
       -0.08716 100 0.00000 95 0.08716 90 0.17365 85
        0.25882 80 0.34202 75 0.42262 70 0.50000 65
        0.57358 60 0.64279 55 0.70711 50 0.76604 45
        0.81915 40 0.86603 35 0.90631 30 0.93969 25
        0.96593 20 0.98481 15 0.98619 10 1.00000 5
si3 h  0 0.6
sp3 d -21 1
sp4 -41 .3 0
si5 h 15.106 15.110
sp5 d 0 1
si10 h 15.095 15.106
sp10 d 0 1
si15 h 15.075 15.095
SP15 d 0 1
si20 h 15.049 15.075
```

```
sp20 d 0 1
si25 h 15.015 15.049
sp25 d 0 1
si30 h 14.974 15.015
sp30 d 0 1
si35 h 14.927 14.974
sp35 d 0 1
si40 h 14.873 14.927
SP40 d 0 1
si45 h 14.814 14.873
sp45 d 0 1
si50 h 14.750 14.814
sp50 d 0 1
si55 h 14.681 14.750
sp55 d 0 1
si60 h 14.608 14.681
sp60 d 0 1
si65 h 14.532 14.608
sp65 d 0 1
si70 h 14.453 14.532
sp70 d 0 1
si75 h 14.372 14.453
sp75 d 0 1
si80 h 14.289 14.372
sp80 d 0 1
si85 h 14.206 14.289
sp85 d 0 1
si90 h 14.123 14.206
sp90 d 0 1
si95 h 14.040 14.123
sp95 d 0 1
si100 h 13.958 14.040
sp100 d 0 1
si105 h 13.878 13.958
sp105 d 0 1
si110 h 13.800 13.878
sp110 d 0 1
si115 h 13.725 13.800
sp115 d 0 1
si120 h 13.654 13.725
sp120 d 0 1
si125 h 13.586 13.654
sp125 d 0 1
si130 h 13.522 13.586
sp130 d 0 1
si135 h 13.464 13.522
sp135 d 0 1
si140 h 13.410 13.464
sp140 d 0 1
si145 h 13.362 13.410
sp145 d 0 1
si150 h 13.320 13.362
sp150 d 0 1
si155 h 13.284 13.320
sp155 d 0 1
si160 h 13.254 13.284
sp160 d 0 1
si165 h 13.230 13.254
sp165 d 0 1
si170 h 13.214 13.230
sp170 d 0 1
si175 h 13.203 13.214
sp175 d 0 1
si180 h 13.200 13.203
sp180 d 0 1
FC5 NE213 DETECTOR RESPONSE FUNCTION, 766CM FLIGHTPATH, 30 DEGREES
f5x:n -663.4 383 0.0
t5   1.37E+01 1.39E+01 1.41E+01 1.43E+01 1.45E+01 1.47E+01
```

```
     1.49E+01 1.51E+01 1.53E+01 1.55E+01 1.57E+01 1.59E+01
     1.61E+01 1.63E+01 1.65E+01 1.67E+01 1.69E+01 1.71E+01
     1.73E+01 1.75E+01 1.77E+01 1.79E+01 1.81E+01 1.83E+01
     1.85E+01 1.87E+01 1.89E+01 1.91E+01 1.93E+01 1.95E+01
     1.97E+01 1.99E+01 2.01E+01 2.03E+01 2.05E+01 2.07E+01
     2.09E+01 2.11E+01 2.13E+01 2.15E+01 2.17E+01 2.19E+01
     2.21E+01 2.23E+01 2.25E+01 2.27E+01 2.29E+01 2.31E+01
     2.33E+01 2.35E+01 2.37E+01 2.39E+01 2.41E+01 2.43E+01
     2.45E+01 2.47E+01 2.49E+01 2.51E+01 2.53E+01 2.55E+01
     2.57E+01 2.59E+01 2.61E+01 2.63E+01 2.65E+01 2.67E+01
     2.69E+01 2.71E+01 2.73E+01 2.75E+01 2.77E+01 2.79E+01
     2.81E+01 2.83E+01 2.85E+01 2.87E+01 2.89E+01 2.91E+01
     2.93E+01 2.95E+01 2.97E+01 2.99E+01 3.01E+01 3.03E+01
     3.05E+01 3.07E+01 3.09E+01 3.11E+01 3.13E+01 3.15E+01
     3.17E+01 3.19E+01 3.21E+01 3.23E+01 3.25E+01 3.27E+01
     3.29E+01 3.31E+01 3.33E+01 3.35E+01 3.37E+01 3.39E+01
     3.41E+01 3.43E+01 3.45E+01 3.47E+01 3.49E+01 3.51E+01
     3.53E+01 3.55E+01 3.57E+01 3.59E+01 3.61E+01 3.63E+01
     3.65E+01 3.67E+01 3.69E+01 3.71E+01 3.73E+01 3.75E+01
     3.77E+01 3.79E+01 3.81E+01 3.83E+01 3.85E+01 3.87E+01
     3.89E+01 3.91E+01 3.93E+01 3.95E+01 3.97E+01 3.99E+01
     4.01E+01 4.03E+01 4.05E+01 4.07E+01 4.09E+01 4.11E+01
     4.13E+01 4.15E+01 4.17E+01
c ne213 low bias response function
de5 lin 1.6 1.8 1.9 2.0 2.1 2.2 2.3 2.4 2.5 2.75
        3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.4 6.6 6.8 7.0
        7.5 8.1 8.5 9.0 10.0 11.0 12.0 12.5 13.0
        13.5 14.0 15.0 16.0
df5 lin 0.00 1.46 1.86 2.26 2.58 3.00 3.29 3.42
        3.63 3.95 4.10 4.25 4.33 4.39 4.40 4.37 4.28
        4.15 4.20 4.18 4.12 3.97 3.80 3.77 3.65 3.44
        3.24 3.06 3.01 2.98 2.98 3.01 3.08 3.25
M1   26054.31c .0562600
     26056.31c .8896840
     26057.31c .0213400
     26058.31c .0027160
      6000.31c .012
     25055.31c .010
     15031.31c .007
     16032.31c .001
M2    7014.31c -.7885
      8016.31c -.2115
CUT:N 39.1 1.6
PRINT
prdmp 2j -1
nps 20000000
```