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ADS-2.0

A Test Library for Accelerator Driven Systems and New Reactor Designs

Prepared by

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Abstract

Research groups exploring the utilization of Accelerator Driven Systems (ADS) for power generation and the transmutation of actinide and fission product waste require well-defined cross-section libraries suitable for their transport calculations. Thus, a test library has been developed further and re-assembled to meet this request, and assist benchmarking studies linked to ADS experiments and design concepts. The ADS-2.0 library has been prepared from the ENDF/B-VII.0 library and the JENDL/AC actinoid and IAEA-NDS tungsten files, and processed in suitable forms for Monte-Carlo and deterministic transport codes used in the analysis of ADS. This resulting data package can also be applied to criticality calculations for new reactor designs, particularly for high-temperature systems (core materials up to 1800K). ADS-2.0 is freely available from the IAEA Nuclear Data Section, and is readily accessible on the web site: http://www-nds.iaea.org/ads/

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1. Introduction

Important projects on the utilization of Accelerator Driven Systems (ADS) are being undertaken by several research institutes in different countries as well as by the International Atomic Energy Agency (IAEA). The groups involved in ADS analysis have expressed their nuclear data requirements in conferences and topical meetings. These needs include additional nuclear data measurements, theoretical data based on nuclear models, and cross-section libraries suitable for transport calculations.

More specifically, the generation of a test library for a number of code systems used in the analysis of ADS was discussed during an IAEA Technical Meeting entitled "Application Libraries for ADS and Transmutation", held in Vienna on 15-17 December 2004 [1]. Participants recommended the generation of a *test* library of limited scope for Monte-Carlo as well as deterministic transport codes used in the analysis of ADS. This library should also be applicable to criticality calculations of new reactor designs.

The preparation of the ADS nuclear data library was undertaken in 2005 by the IAEA Nuclear Data Section (NDS) in the form of ADS-1.0 [2]. This test library has now been fully updated in 2008 as ADS-2.0, and the data files are available to users at http://www-nds.iaea.org/ads/ and also on CD-ROM on request. Sources of the evaluated nuclear data files were the ENDF/B-VII.0 library [3], the JENDL/AC actinoid files [4] and the IAEA-NDS project for W isotopes [5]. Processing was carried out using NJOY-99.259 [6] with local updates at IAEA-NDS. The resulting files are available in ACE format for MCNP [7] and in MATXS format and GENDF format for multi-group transport calculations. This work to generate the ADS-2.0 test library is briefly described below. The sources of evaluated nuclear data are presented, and the main processing methods and verification tools are summarized. All relevant information is tabulated in Annexes A, B and C, while a description of the procedure to be adopted when using the ADS library is provided as Annex D.

2. Sources of evaluated nuclear data files

Sources of the evaluated nuclear data files were as follows:

- JENDL/AC actinoid files for U-232, Np-237, Np-239, Cm-242 and Cm-247;
- IAEA-NDS project for W-180, W-182, W-183, W-184 and W-186;
- ENDF/B-VII.0 library for the rest of the materials.

The new library was restricted to those materials needed for benchmarking efforts linked to short and mid-term experimental ADS results and reactor design concepts. This library could be extended to as many materials as requested by ADS at a later stage, to address waste transmutation problems and further new reactor designs. 156 materials were selected, and are listed in Table 1 – this number of files represents a significant increase over the 30 materials considered for the earlier release as ADS-1.0 [2].

Table 1: ADS-2.0 – selected evaluated nuclear data files.

No.	Element	Isotopes							
2	H	H-1	H-2						
2	He	He-3	He-4						
2	Li	Li-6	Li-7						
1	Be	Be-9							
2	B	B-10	B-11						
1	C	C-nat							
2	N	N-14	N-15						
1	O	O-16							
1	F	F-19							
1	Na	Na-23							
3	Mg	Mg-24	Mg-25	Mg-26					
1	Al	Al-27							
4	Si	Si-28	Si-29	Si-30					
2	P	P-31							
3	S	S-32	S-33	S-34	S-36				
6	Cl	Cl-35	Cl-37						
3	K	K-39	K-40	K-41					
6	Ca	Ca-40	Ca-42	Ca-43	Ca-44	Ca-46	Ca-48		
5	Ti	Ti-46	Ti-47	Ti-48	Ti-49	Ti-50			
1	V	V-nat							
4	Cr	Cr-50	Cr-52	Cr-53	Cr-54				
1	Mn	Mn-55							
4	Fe	Fe-54	Fe-56	Fe-57	Fe-58				
1	Co	Co-59							
5	Ni	Ni-58	Ni-60	Ni-61	Ni-62	Ni-64			
2	Cu	Cu-63	Cu-65						
1	Zn	Zn-nat							
5	Zr	Zr-90	Zr-91	Zr-92	Zr-94	Zr-96			
1	Nb	Nb-93							
7	Mo	Mo-92	Mo-94	Mo-95	Mo-96	Mo-97	Mo-98	Mo-100	
2	Ag	Ag-107	Ag-109						
8	Cd	Cd-106	Cd-108	Cd-110	Cd-111	Cd-112	Cd-113	Cd-114	Cd-116
2	In	In-113	In-115						
2	Eu	Eu-151	Eu-153						
7	Gd	Gd-152	Gd-154	Gd-155	Gd-156	Gd-157	Gd-158	Gd-160	
6	Er	Er-162	Er-164	Er-166	Er-167	Er-168	Er-170		
2	Lu	Lu-175	Lu-176						
6	Hf	Hf-174	Hf-176	Hf-177	Hf-178	Hf-179	Hf-180		
1	Ta	Ta-181							
5	W	W-180[a]	W-182[a]	W-183[a]	W-184[a]	W-186[a]			
1	Au	Au-197							
7	Hg	Hg-196	Hg-198	Hg-199	Hg-200	Hg-201	Hg-202	Hg-204	
4	Pb	Pb-204	Pb-206	Pb-207	Pb-208				
1	Bi	Bi-209							
1	Th	Th-232							
2	Pa	Pa-231	Pa-233						

Table 1 (cont.)

No.	Element	Isotopes						
7	U	U-232[b]	U-233	U-234	U-235	U-236	U-237	U-238
2	Np	Np-237[b]	Np-239[b]					
5	Pu	Pu-238	Pu-239	Pu-240	Pu-241	Pu-242		
4	Am	Am-241	Am-242	Am-242m	Am-243			
6	Cm	Cm-242[b]	Cm-243	Cm-244	Cm-245	Cm-246	Cm-247[b]	
156								

[a] Evaluated nuclear data from the IAEA-NDS Project for W isotopes.
[b] Evaluated nuclear data from the JENDL/AC library.

3. Processing evaluated nuclear data to generate ACE and MATXS formats

Selected evaluated nuclear data files were processed using the NJOY-99.259 modular code system with local updates undertaken at IAEA-NDS - the processing sequence is shown in Figure 1. The ACE-formatted library is suitable for use by the MCNP family of Monte-Carlo codes and other codes that can read the same library format, while the MATXS-formatted library is a multi-group library intended for use in deterministic transport codes such as DORT and TORT [8]. This processing sequence can be divided into three NJOY calculations for each material:

first calculation is commonly called the "PENDF run" in which the NJOY modules RECONR, BROADR, HEATR, GASPR, PURR and THERMR are used to produce point-wise data in ENDF format [9];

second calculation is the "ACER run" in which the ACER module generates the ACE-formatted file that can be directly used in MCNP calculations - error checking and consistency checks are also invoked during the "ACER run";

third calculation is the "GROUPR/MATXS run", performed to produce the multi-group data library in MATXS format at different temperatures and Bondarenko σ_o values.

A complete set of input is available on the IAEA-NDS web site or through CD-ROM distribution. A summary of the main processing options is presented below for completeness:

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

2. BROADR
   - Thinning tolerance: 0.1%
   - Integral criterion tolerance: 0.3%
   - Maximum energy: Doppler broadening was forced to the upper energy limit of the resolved resonance range, but never above 2 MeV
   - Temperature ranges (Table 2)

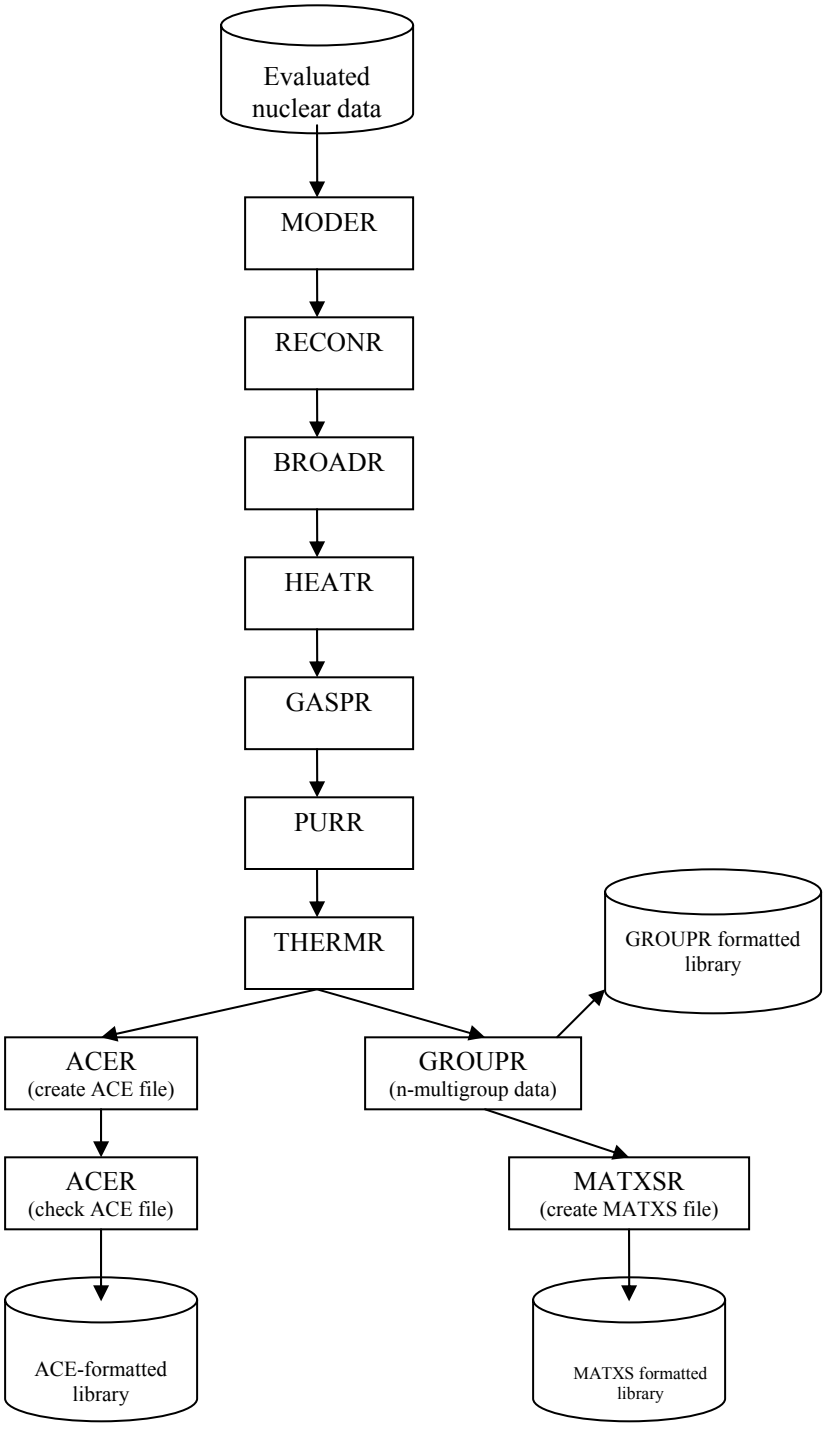

Figure 1: NJOY processing sequence.

Table 2: Temperature ranges.

Set	Temperature (K)	Materials
1	293.6, 350, 400, 450, 500, 550, 600, 650	H-1 (H_2O), H-2 (D_2O)
2	296, 400, 500, 600, 700, 800, 1000, 1200, 1600, 2000	C-nat (graphite)
3	293.6, 600, 900, 1200, 1500, 1800	actinides, Si, O
4	293.6, 600, 900, 1200	rest of materials

- BOOTSTRAP = 0
- RESTART = 0
- Al-27 and Fe-56 are two important structural materials with high-resolution point-wise data above the resonance range; two BROADR calculations were performed: (1) RESTART = 0, from 0.0 to 293.6K with Doppler broadening active to the end of the resonance range, (2) from 293.6K to all higher temperatures with RESTART = 1 and Doppler broadening up to 2 MeV

3. HEATR
   - MT = 444 and MT = 443 were requested; no partial heating was processed, and therefore there was no self-shielded unresolved resonance heating in PURR (should not be a serious problem for ADS or new reactor designs)

4. PURR
   - Number of probability bins: 20
   - Number of resonance ladders: 100
   - Temperature ranges: see BROADR
   - Bondarenko σ_o values (Table 3)

Table 3: Bondarenko σ_o values.

Set	Bondarenko σ_o values	Materials
1	1.E10	$Z < 4$
2	1.E10, 1.E4, 1000, 100, 10, 1	$4 < Z < 61$
3	1.E10, 1.E4, 3000, 1000, 300, 100, 60, 30, 10, 1	actinides and materials with $Z > 61$

5. THERMR
   - Number of angles bins: 12
   - Tolerance: 0.1%
   - Maximum energy: 4 eV
   - Scattering laws:
     H-1: S(α,β) for hydrogen bound in water
     H-2: S(α,β) for deuterium bound in heavy water
     C: S(α,β) for carbon in graphite
     free gas model for all materials

6. ACER
   - Type of ACE file: 1
   - ZAID suffix .70, .71, .72, … (as a function of temperature)
   - New cumulative angle distribution
   - Detailed photon calculation
   - No thinning
   - Fast data temperature (see temperature ranges)

7. GROUPR
   - Neutron groups: 421 in ORNL 421-group energy structure (Annex E)
   - Gamma groups: 0
   - Neutron weight function: adopted neutron spectrum is the standard PWR spectrum included in the GROUPR module of NJOY, modified in such a way as to follow the 1/E shape from 4.0 eV to 9.811 keV and from 10 to 20 MeV (Figure 2)
   - Legendre order P-6 for transport correction to P-5
   - Reactions:
     all MT in file 3, MT = 443, MT = 444, MT = 251, MT = 252, MT = 253 and
     MT = 259 and MTs for thermal scattering law (if applicable)
     for actinides: MT = 452 and MT = 455
   - for H-1: MT = 222
   - Self-shielding:
     for actinides: NJOY flux calculator for homogenous mixtures
     narrow resonance approximation for the rest of the materials
   - Temperature range: as BROADR
   - Bondarenko σ_o values: as PURR

8. MATXSR
   - Type of particles: neutrons (n)
   - Data types: 2 (nscat, ntherm)
   - Number of neutron groups: 421

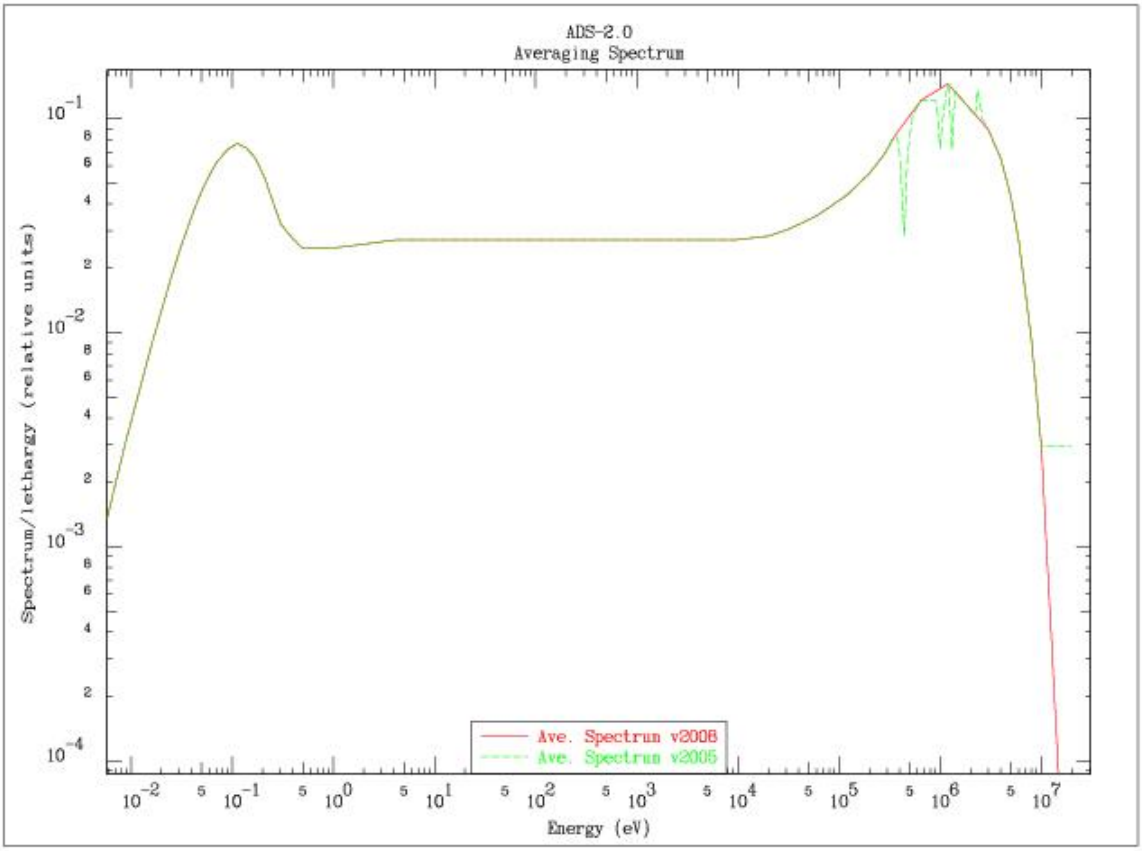

Figure 2: Averaging neutron spectrum used in GROUPR.

4. Continuous-energy data library in ACE format

ACE-formatted files contain point-wise cross-section data for use in the MCNP Monte-Carlo code. Two files were created for each material: one containing cross-section data with extension ".ace", and the second containing XSDIR information (extension ".XSD") to run the MCNP code. Details are given in Annex A. Cross-section files are defined at different temperatures, but they are not equivalent to the previous version of the ADS library (ADS-1.0). Doppler broadening to different temperatures can be performed with the ACEDOP package, except in the unresolved resonance region described by the resonance parameters in the original evaluation and probability tables (ptable) in the ACE-formatted files. The materials affected can be easily recognized by the ptable indicator in the XSDIR file (*.XSD). Thermal scattering law data are also available at different temperatures for hydrogen bound in water, deuterium bound in heavy water, and carbon bound in graphite.

5. Multi-group cross-section data in MATXS format

The ADS multi-group library contains neutron multi-group data in MATXS format. One file is supplied with the extension ".mxs" for each material. These files can be processed by the TRANSX 2 code [10] for further use in deterministic transport codes.

The ORNL-421-group energy structure was selected, which includes 421 energy groups between 0.00001 eV and 20.0 MeV. Cross-section data are given at different temperatures and Bodarenko σ_o values. Additionally, thermal scattering cross-section data were generated for hydrogen bound in water, deuterium bound in heavy water, and carbon bound in graphite. Annex B gives general information on the ADS multi-group data library.

6. Multi-group cross-section data in GENDF format

A multi-group library containing cross-section data in GENDF format is provided. This library is equivalent to the MATXS-formatted library, and can be used for further processing or reformatting. Details are supplied in Annex C.

7. Verification of cross-section library

The first verification procedure was to check the NJOY output file for each material. All the NJOY messages were understood and most of them are related to the evaluations themselves. Corrective actions performed in the second ACER run were considered appropriate and plot files were generated for visual inspections.

A second verification procedure was used for all ACE-formatted files. Processed data were converted back to ENDF-6 format using ACELST [11]. Then the original evaluation was processed using the PREPRO-2007 code system (LINEAR + RECENT + SIGMA1) [12]. Finally, the two resulting files were compared by means of either COMPLOT or COMHARD.

No significant deviations in the cross-section data were found. After running these basic verification procedures, the processed data were released as a test library for integral benchmarking.

8. ADS-2.0 test library

The ADS-2.0 test library is freely available from the IAEA Nuclear Data Section upon request, and is also readily accessible at web site http://www-nds.iaea.org/ads/

ADS-2.0 includes:

- evaluated nuclear data files in ENDF-6 format
- ACE-formatted continuous energy data files for MCNP calculations
- MATXS-formatted files for multi-group transport calculations
- GENDF-formatted files for multi-group transport calculations
- NJOY inputs for all materials
- auxiliary FORTRAN programs and MS-DOS/WINDOWS batch procedures for the generation and verification of the processed libraries
- ACEDOP code package for Doppler broadening of ACE-formatted files
- documentation: IAEA-NDS reports

9. Final remarks and recommendations

A test library for ADS has been assembled and made available for the ADS community. This library is designed to assist benchmarking efforts linked to short- and intermediate-term experimental ADS results and design concepts. At a later stage, the library could be extended to as many materials as requested by the ADS community to address waste transmutation problems. The ADS-2.0 library is readily available from the IAEA Nuclear Data Section on request through services@iaeand.iaea.org or can be obtained directly from web page http://www-nds.iaea.org/ads/

References

[1] Stanculescu, A., Trkov, A., "Application Libraries for ADS and Transmutation", 15-17 December 2004, IAEA Headquarters, Vienna, Austria, INDC(NDS)-469, IAEA, Vienna (2004).

[2] Lopez Aldama, D., Trkov, A., "ADS-v1: A Test Application Library for ADS Systems", INDC(NDS)-474, IAEA, Vienna (2005).

[3] Chadwick, M.B., *et al.*, "ENDF/B-VII.0: Next Generation Evaluated Nuclear Data Library for Nuclear Science and Technology", Nucl. Data Sheets, 107 (2006) 2931 – 3060;
ENDF/B-VII: http://www.nndc.bnl.gov/exfor/endf00.htm

[4] Iwamoto, O., Nakagawa, T., Otsuka, N., Chiba, S., Okamura, K., Chiba, G., "Development of JENDL Actinoid File", paper presented at Int. Conf. on Reactor Physics, Nuclear Power: a Sustainable Resource, PHYSOR 2008, 14 – 19 September 2008, Interlaken, Switzerland;
JENDL/AC: http://wwwndc.jaea.go.jp/ftpnd/jendl/jendl-ac-2008.html

[5] Trkov, A., Capote, R., Kodeli, I., Leal, L., "Evaluation of Tungsten Nuclear Reaction Data with Covariances", Nucl. Data Sheets, 109 (2008) 2905 – 2909;
IAEA-NDS W isotopes: http://www-nds.iaea.org/wolfram/wolfram.htmlx

[6] MacFarlane, R.E., Muir, D.M., "NJOY-99.0: Code System for Producing Pointwise and Multigroup Neutron and Photon Cross Sections from ENDF/B Data", PSR-480, Los Alamos National Laboratory, 2000.

[7] Briesmeister, J.F., "MCNP – A General Monte Carlo N-Particle Transport Code, Version 4C", LA-13709-M, Los Alamos National Laboratory, 2000.

[8] Rhoades, W.A., *et al.*, "DOORS 3.2, One-, Two-, Three-Dimensional Discrete Ordinates Neutron/Photon Transport Code System", CCC-650, RSICC, Oak Ridge National Laboratory, 1998.

[9] McLane, V. (editor), "ENDF-6 Formats Manuals", IAEA-NDS-76 Rev. 6, IAEA, Vienna, April 2001.

[10] MacFarlane, R.E., "TRANSX 2: A Code for Interfacing MATXS Cross Section Libraries to Nuclear Transport Codes", LA-12312-MS, Los Alamos National Laboratory, 1992.

[11] Trkov, A., ACELST code, private communication, IAEA, Vienna, December 2002.

[12] Cullen, D.E., PREPRO 2007: ENDF/B Pre-processing Codes, IAEA-NDS; available online at http://www-nds.iaea.org/ndspub/endf/prepro/

MATERIAL: Isotope or element

ZAID: Material identification number in the ADS library.
ZAID = (Z*1000+A).XXY where
Z: atomic number
A: mass number
XX: identification suffix.
7N is used:7 for ENDF/B-VII.0 and
N = 0,1,2,…… according to the number of temperatures
Y: c for continuous fast cross-section data
t for thermal scattering law

AT. RATIO: Atomic weight ratio

FILE NAME: Cross-section file name
T: Temperature in Kelvin
T[MeV] = K·T[K] where K = $8.617385 \cdot 10^{-11}$ MeV/K

PTABLE: Probability table index

EMAX: Maximum energy in MeV

MAT: ENDF material number

A-1: Cross-section data

MATERIAL	ZAID	AT. RATIO	FILE NAME	T [K]	PTABLE	EMAX[MeV]	MAT
H-1	1001.70c	0.999167	H_001.ACE	293.6		20.0	125
	1001.71c			350			
	1001.72c			400			
	1001.73c			450			
	1001.74c			500			
	1001.75c			550			
	1001.76c			600			
	1001.77c			650			
H-2	1002.70c	1.996800	H_002.ACE	293.6		150.0	128
	1002.71c			350			
	1002.72c			400			
	1002.73c			450			
	1002.74c			500			
	1002.75c			550			
	1002.76c			600			
	1002.77c			650			
He-3	2003.70c	2.989032	He003.ACE	293.6		20.0	225
	2003.71c			600			
	2003.72c			900			
	2003.73c			1200			
He-4	2004.70c	3.968219	He004.ACE	293.6		20.0	228
	2004.71c			600			
	2004.72c			900			
	2004.73c			1200			
Li-6	3006.70c	5.963400	Li006.ACE	293.6		20.0	325
	3006.71c			600			
	3006.72c			900			
	3006.73c			1200			
Li-7	3007.70c	6.955732	Li007.ACE	293.6		20.0	328
	3007.71c			600			
	3007.72c			900			
	3007.73c			1200			
Be-9	4009.70c	8.934780	Be009.ACE	293.6		20.0	425
	4009.71c			600			
	4009.72c			900			
	4009.73c			1200			
B-10	5010.70c	9.926921	B_010.ACE	293.6		20.0	525
	5010.71c			600			
	5010.72c			900			
	5010.73c			1200			
B-11	5011.70c	10.914700	B_011.ACE	293.6		20.0	528
	5011.71c			600			
	5011.72c			900			
	5011.73c			1200			

MATERIAL	ZAID	AT. RATIO	FILE NAME	T [K]	PTABLE	EMAX[MeV]	MAT
C-nat	6000.70c	11.898000	C_nat.ACE	296		150.0	600
	6000.71c			400			
	6000.72c			500			
	6000.73c			600			
	6000.74c			700			
	6000.75c			800			
	6000.76c			1000			
	6000.77c			1200			
	6000.78c			1600			
	6000.79c			2000			
N-14	7014.70c	13.882780	N_014.ACE	293.6		150.0	725
	7014.71c			600			
	7014.72c			900			
	7014.73c			1200			
N-15	7015.70c	14.871000	N_015.ACE	293.6		20.0	728
	7015.71c			600			
	7015.72c			900			
	7015.73c			1200			
O-16	8016.70c	15.857510	O_016.ACE	293.6		150.0	825
	8016.71c			600			
	8016.72c			900			
	8016.73c			1200			
	8016.74c			1500			
	8016.75c			1800			
F-19	9019.70c	18.835000	F_019.ACE	293.6		20.0	925
	9019.71c			600			
	9019.72c			900			
	9019.73c			1200			
Na-23	11023.70c	22.792000	Na023.ACE	293.6		20.0	1125
	11023.71c			600			
	11023.72c			900			
	11023.73c			1200			
Mg-24	12024.70c	23.779000	Mg024.ACE	293.6		20.0	1225
	12024.71c			600			
	12024.72c			900			
	12024.73c			1200			
Mg-25	12025.70c	24.771200	Mg025.ACE	293.6		20.0	1228
	12025.71c			600			
	12025.72c			900			
	12025.73c			1200			
Mg-26	12026.70c	25.759400	Mg026.ACE	293.6		20.0	1231
	12026.71c			600			
	12026.72c			900			
	12026.73c			1200			
Al-27	13027.70c	26.749750	Al027.ACE	293.6		150.0	1325
	13027.71c			600			
	13027.72c			900			
	13027.73c			1200			
Si-28	14028.70c	27.737000	Si028.ACE	293.6		150.0	1425
	14028.71c			600			
	14028.72c			900			
	14028.73c			1200			
	14028.74c			1500			
	14028.75c			1800			

MATERIAL	ZAID	AT. RATIO	FILE NAME	T [K]	PTABLE	EMAX[MeV]	MAT
Si-29	14029.70c	28.728000	Si029.ACE	293.6		150.0	1428
	14029.71c			600			
	14029.72c			900			
	14029.73c			1200			
	14029.74c			1500			
	14029.75c			1800			
Si-30	14030.70c	29.716000	Si030.ACE	293.6		150.0	1431
	14030.71c			600			
	14030.72c			900			
	14030.73c			1200			
	14030.74c			1500			
	14030.75c			1800			
P-31	15031.70c	30.708000	P_031.ACE	293.6		150.0	1525
	15031.71c			600			
	15031.72c			900			
	15031.73c			1200			
S-32	16032.70c	31.697300	S_032.ACE	293.6		20.0	1625
	16032.71c			600			
	16032.72c			900			
	16032.73c			1200			
S-33	16033.70c	32.687800	S_033.ACE	293.6		20.0	1628
	16033.71c			600			
	16033.72c			900			
	16033.73c			1200			
S-34	16034.70c	33.676200	S_034.ACE	293.6		20.0	1631
	16034.71c			600			
	16034.72c			900			
	16034.73c			1200			
S-36	16036.70c	35.658000	S_036.ACE	293.6		20.0	1637
	16036.71c			600			
	16036.72c			900			
	16036.73c			1200			
Cl-35	17035.70c	34.668450	Cl035.ACE	293.6		20.0	1725
	17035.71c			600			
	17035.72c			900			
	17035.73c			1200			
Cl-37	17037.70c	36.648300	Cl037.ACE	293.6		20.0	1731
	17037.71c			600			
	17037.72c			900			
	17037.73c			1200			
K-39	19039.70c	38.629300	K_039.ACE	293.6		20.0	1925
	19039.71c			600			
	19039.72c			900			
	19039.73c			1200			
K-40	19040.70c	39.620700	K_040.ACE	293.6		20.0	1928
	19040.71c			600			
	19040.72c			900			
	19040.73c			1200			
K-41	19041.70c	40.610100	K_041.ACE	293.6		20.0	1931
	19041.71c			600			
	19041.72c			900			
	19041.73c			1200			

MATERIAL	ZAID	AT. RATIO	FILE NAME	T [K]	PTABLE	EMAX[MeV]	MAT
Ca-40	20040.70c	39.619300	Ca040.ACE	293.6		200.0	2025
	20040.71c			600			
	20040.72c			900			
	20040.73c			1200			
Ca-42	20042.70c	41.598180	Ca042.ACE	293.6		200.0	2031
	20042.71c			600			
	20042.72c			900			
	20042.73c			1200			
Ca-43	20043.70c	42.589730	Ca043.ACE	293.6		200.0	2034
	20043.71c			600			
	20043.72c			900			
	20043.73c			1200			
Ca-44	20044.70c	43.577880	Ca044.ACE	293.6		200.0	2037
	20044.71c			600			
	20044.72c			900			
	20044.73c			1200			
Ca-46	20046.70c	45.558930	Ca046.ACE	293.6		200.0	2043
	20046.71c			600			
	20046.72c			900			
	20046.73c			1200			
Ca-48	20048.70c	47.540600	Ca048.ACE	293.6		200.0	2049
	20048.71c			600			
	20048.72c			900			
	20048.73c			1200			
Ti-46	22046.70c	45.557900	Ti046.ACE	293.6		20.0	2225
	22046.71c			600			
	22046.72c			900			
	22046.73c			1200			
Ti-47	22047.70c	46.548400	Ti047.ACE	293.6		20.0	2228
	22047.71c			600			
	22047.72c			900			
	22047.73c			1200			
Ti-48	22048.70c	47.556000	Ti048.ACE	293.6		20.0	2231
	22048.71c			600			
	22048.72c			900			
	22048.73c			1200			
Ti-49	22049.70c	48.527400	Ti049.ACE	293.6		20.0	2234
	22049.71c			600			
	22049.72c			900			
	22049.73c			1200			
Ti-50	22050.70c	49.515700	Ti050.ACE	293.6		20.0	2237
	22050.71c			600			
	22050.72c			900			
	22050.73c			1200			
V-nat	23000.70c	50.504000	V_nat.ACE	293.6		20.0	2300
	23000.71c			600			
	23000.72c			900			
	23000.73c			1200			
Cr-50	24050.70c	49.517000	Cr050.ACE	293.6		150.0	2425
	24050.71c			600			
	24050.72c			900			
	24050.73c			1200			

MATERIAL	ZAID	AT. RATIO	FILE NAME	T [K]	PTABLE	EMAX[MeV]	MAT
Cr-52	24052.70c	51.494000	Cr052.ACE	293.6		150.0	2431
	24052.71c			600			
	24052.72c			900			
	24052.73c			1200			
Cr-53	24053.70c	52.486000	Cr053.ACE	293.6		150.0	2434
	24053.71c			600			
	24053.72c			900			
	24053.73c			1200			
Cr-54	24054.70c	53.476000	Cr054.ACE	293.6		150.0	2437
	24054.71c			600			
	24054.72c			900			
	24054.73c			1200			
Mn-55	25055.70c	54.466100	Mn055.ACE	293.6		20.0	2525
	25055.71c			600			
	25055.72c			900			
	25055.73c			1200			
Fe-54	26054.70c	53.476000	Fe054.ACE	293.6		150.0	2625
	26054.71c			600			
	26054.72c			900			
	26054.73c			1200			
Fe-56	26056.70c	55.454000	Fe056.ACE	293.6		150.0	2631
	26056.71c			600			
	26056.72c			900			
	26056.73c			1200			
Fe-57	26057.70c	56.446000	Fe057.ACE	293.6		150.0	2634
	26057.71c			600			
	26057.72c			900			
	26057.73c			1200			
Fe-58	26058.70c	57.436000	Fe058.ACE	293.6		20.0	2637
	26058.71c			600			
	26058.72c			900			
	26058.73c			1200			
Co-59	27059.70c	58.426900	Co059.ACE	293.6		20.0	2725
	27059.71c			600			
	27059.72c			900			
	27059.73c			1200			
Ni-58	28058.70c	57.438000	Ni058.ACE	293.6		150.0	2825
	28058.71c			600			
	28058.72c			900			
	28058.73c			1200			
Ni-60	28060.70c	59.416000	Ni060.ACE	293.6		150.0	2831
	28060.71c			600			
	28060.72c			900			
	28060.73c			1200			
Ni-61	28061.70c	60.408000	Ni061.ACE	293.6		150.0	2834
	28061.71c			600			
	28061.72c			900			
	28061.73c			1200			
Ni-62	28062.70c	61.396000	Ni062.ACE	293.6		150.0	2837
	28062.71c			600			
	28062.72c			900			
	28062.73c			1200			

MATERIAL	ZAID	AT. RATIO	FILE NAME	T [K]	PTABLE	EMAX[MeV]	MAT
Ni-64	28064.70c	63.379000	Ni064.ACE	293.6		150.0	2843
	28064.71c			600			
	28064.72c			900			
	28064.73c			1200			
Cu-63	29063.70c	62.389000	Cu063.ACE	293.6		150.0	2925
	29063.71c			600			
	29063.72c			900			
	29063.73c			1200			
Cu-65	29065.70c	64.370000	Cu065.ACE	293.6		150.0	2931
	29065.71c			600			
	29065.72c			900			
	29065.73c			1200			
Zn-nat	30000.70c	64.834000	Znnat.ACE	293.6		20.0	3000
	30000.71c			600			
	30000.72c			900			
	30000.73c			1200			
Zr-90	40090.70c	89.132400	Zr090.ACE	293.6	X	20.0	4025
	40090.71c			600	X		
	40090.72c			900	X		
	40090.73c			1200	X		
Zr-91	40091.70c	90.124700	Zr091.ACE	293.6	X	20.0	4028
	40091.71c			600	X		
	40091.72c			900	X		
	40091.73c			1200	X		
Zr-92	40092.70c	91.115500	Zr092.ACE	293.6	X	20.0	4031
	40092.71c			600	X		
	40092.72c			900	X		
	40092.73c			1200	X		
Zr-94	40094.70c	93.099600	Zr094.ACE	293.6	X	20.0	4037
	40094.71c			600	X		
	40094.72c			900	X		
	40094.73c			1200	X		
Zr-96	40096.70c	95.084400	Zr096.ACE	293.6		20.0	4043
	40096.71c			600			
	40096.72c			900			
	40096.73c			1200			
Nb-93	41093.70c	92.105100	Nb093.ACE	293.6		150.0	4125
	41093.71c			600			
	41093.72c			900			
	41093.73c			1200			
Mo-92	42092.70c	91.117300	Mo092.ACE	293.6	X	20.0	4225
	42092.71c			600	X		
	42092.72c			900	X		
	42092.73c			1200	X		
Mo-94	42094.70c	93.098400	Mo094.ACE	293.6	X	20.0	4231
	42094.71c			600	X		
	42094.72c			900	X		
	42094.73c			1200	X		
Mo-95	42095.70c	94.090600	Mo095.ACE	293.6	X	20.0	4234
	42095.71c			600	X		
	42095.72c			900	X		
	42095.73c			1200	X		

MATERIAL	ZAID	AT. RATIO	FILE NAME	T [K]	PTABLE	EMAX[MeV]	MAT
Mo-96	42096.70c	95.080800	Mo096.ACE	293.6	X	20.0	4237
	42096.71c			600	X		
	42096.72c			900	X		
	42096.73c			1200	X		
Mo-97	42097.70c	96.073500	Mo097.ACE	293.6	X	20.0	4240
	42097.71c			600	X		
	42097.72c			900	X		
	42097.73c			1200	X		
Mo-98	42098.70c	97.064300	Mo098.ACE	293.6	X	20.0	4243
	42098.71c			600	X		
	42098.72c			900	X		
	42098.73c			1200	X		
Mo-100	42100.70c	99.049000	Mo100.ACE	293.6	X	20.0	4249
	42100.71c			600	X		
	42100.72c			900	X		
	42100.73c			1200	X		
Ag-107	47107.70c	105.987000	Ag107.ACE	293.6	X	20.0	4725
	47107.71c			600	X		
	47107.72c			900	X		
	47107.73c			1200	X		
Ag-109	47109.70c	107.969000	Ag109.ACE	293.6	X	20.0	4731
	47109.71c			600	X		
	47109.72c			900	X		
	47109.73c			1200	X		
Cd-106	48106.70c	104.996000	Cd106.ACE	293.6	X	20.0	4825
	48106.71c			600	X		
	48106.72c			900	X		
	48106.73c			1200	X		
Cd-108	48108.70c	106.977000	Cd108.ACE	293.6	X	20.0	4831
	48108.71c			600	X		
	48108.72c			900	X		
	48108.73c			1200	X		
Cd-110	48110.70c	108.959000	Cd110.ACE	293.6	X	20.0	4837
	48110.71c			600	X		
	48110.72c			900	X		
	48110.73c			1200	X		
Cd-111	48111.70c	109.951000	Cd111.ACE	293.6	X	20.0	4840
	48111.71c			600	X		
	48111.72c			900	X		
	48111.73c			1200	X		
Cd-112	48112.70c	110.942000	Cd112.ACE	293.6	X	20.0	4843
	48112.71c			600	X		
	48112.72c			900	X		
	48112.73c			1200	X		
Cd-113	48113.70c	111.930000	Cd113.ACE	293.6	X	20.0	4846
	48113.71c			600	X		
	48113.72c			900	X		
	48113.73c			1200	X		
Cd-114	48114.70c	112.925000	Cd114.ACE	293.6	X	20.0	4849
	48114.71c			600	X		
	48114.72c			900	X		
	48114.73c			1200	X		

MATERIAL	ZAID	AT. RATIO	FILE NAME	T [K]	PTABLE	EMAX[MeV]	MAT
Cd-116	48116.70c	114.909000	Cd116.ACE	293.6	X	20.0	4855
	48116.71c			600	X		
	48116.72c			900	X		
	48116.73c			1200	X		
In-113	49113.70c	111.934000	In113.ACE	293.6	X	20.0	4925
	49113.71c			600	X		
	49113.72c			900	X		
	49113.73c			1200	X		
In-115	49115.70c	113.917000	In115.ACE	293.6	X	20.0	4931
	49115.71c			600	X		
	49115.72c			900	X		
	49115.73c			1200	X		
Eu-151	63151.70c	149.620000	Eu151.ACE	293.6	X	20.0	6325
	63151.71c			600	X		
	63151.72c			900	X		
	63151.73c			1200	X		
Eu-153	63153.70c	151.608000	Eu153.ACE	293.6	X	20.0	6331
	63153.71c			600	X		
	63153.72c			900	X		
	63153.73c			1200	X		
Gd-152	64152.70c	150.615000	Gd152.ACE	293.6	X	20.0	6425
	64152.71c			600	X		
	64152.72c			900	X		
	64152.73c			1200	X		
Gd-154	64154.70c	152.599000	Gd154.ACE	293.6	X	20.0	6431
	64154.71c			600	X		
	64154.72c			900	X		
	64154.73c			1200	X		
Gd-155	64155.70c	153.592000	Gd155.ACE	293.6	X	20.0	6434
	64155.71c			600	X		
	64155.72c			900	X		
	64155.73c			1200	X		
Gd-156	64156.70c	154.583000	Gd156.ACE	293.6	X	20.0	6437
	64156.71c			600	X		
	64156.72c			900	X		
	64156.73c			1200	X		
Gd-157	64157.70c	155.576000	Gd157.ACE	293.6	X	20.0	6440
	64157.71c			600	X		
	64157.72c			900	X		
	64157.73c			1200	X		
Gd-158	64158.70c	156.567000	Gd158.ACE	293.6	X	20.0	6443
	64158.71c			600	X		
	64158.72c			900	X		
	64158.73c			1200	X		
Gd-160	64160.70c	158.553000	Gd160.ACE	293.6	X	20.0	6449
	64160.71c			600	X		
	64160.72c			900	X		
	64160.73c			1200	X		
Er-162	68162.70c	160.538000	Er162.ACE	293.6		20.0	6825
	68162.71c			600			
	68162.72c			900			
	68162.73c			1200			

MATERIAL	ZAID	AT. RATIO	FILE NAME	T [K]	PTABLE	EMAX[MeV]	MAT
Er-164	68164.70c	162.521000	Er164.ACE	293.6		20.0	6831
	68164.71c			600			
	68164.72c			900			
	68164.73c			1200			
Er-166	68166.70c	164.505000	Er166.ACE	293.6		20.0	6837
	68166.71c			600			
	68166.72c			900			
	68166.73c			1200			
Er-167	68167.70c	165.498000	Er167.ACE	293.6	X	20.0	6840
	68167.71c			600	X		
	68167.72c			900	X		
	68167.73c			1200	X		
Er-168	68168.70c	166.487000	Er168.ACE	293.6		20.0	6843
	68168.71c			600			
	68168.72c			900			
	68168.73c			1200			
Er-170	68170.70c	168.476000	Er170.ACE	293.6	X	20.0	6849
	68170.71c			600	X		
	68170.72c			900	X		
	68170.73c			1200	X		
Lu-175	71175.70c	173.438000	Lu175.ACE	293.6	X	20.0	7125
	71175.71c			600	X		
	71175.72c			900	X		
	71175.73c			1200	X		
Lu-176	71176.70c	174.430000	Lu176.ACE	293.6	X	20.0	7128
	71176.71c			600	X		
	71176.72c			900	X		
	71176.73c			1200	X		
Hf-174	72174.70c	172.446000	Hf174.ACE	293.6	X	20.0	7225
	72174.71c			600	X		
	72174.72c			900	X		
	72174.73c			1200	X		
Hf-176	72176.70c	174.430000	Hf176.ACE	293.6	X	20.0	7231
	72176.71c			600	X		
	72176.72c			900	X		
	72176.73c			1200	X		
Hf-177	72177.70c	175.423000	Hf177.ACE	293.6	X	20.0	7234
	72177.71c			600	X		
	72177.72c			900	X		
	72177.73c			1200	X		
Hf-178	72178.70c	176.415000	Hf178.ACE	293.6	X	20.0	7237
	72178.71c			600	X		
	72178.72c			900	X		
	72178.73c			1200	X		
Hf-179	72179.70c	177.409000	Hf179.ACE	293.6	X	20.0	7240
	72179.71c			600	X		
	72179.72c			900	X		
	72179.73c			1200	X		
Hf-180	72180.70c	178.401000	Hf180.ACE	293.6	X	20.0	7243
	72180.71c			600	X		
	72180.72c			900	X		
	72180.73c			1200	X		

MATERIAL	ZAID	AT. RATIO	FILE NAME	T [K]	PTABLE	EMAX[MeV]	MAT
Ta-181	73181.70c	179.400000	Ta181.ACE	293.6	X	20.0	7328
	73181.71c			600	X		
	73181.72c			900	X		
	73181.73c			1200	X		
W-180	74180.70c	178.401000	W_180.ACE	293.6		150.0	7425
	74180.71c			600			
	74180.72c			900			
	74180.73c			1200			
W-182	74182.70c	180.385000	W_182.ACE	293.6	X	150.0	7431
	74182.71c			600	X		
	74182.72c			900	X		
	74182.73c			1200	X		
W-183	74183.70c	181.379000	W_183.ACE	293.6	X	150.0	7434
	74183.71c			600	X		
	74183.72c			900	X		
	74183.73c			1200	X		
W-184	74184.70c	182.371000	W_184.ACE	293.6	X	150.0	7437
	74184.71c			600	X		
	74184.72c			900	X		
	74184.73c			1200	X		
W-186	74186.70c	184.357000	W_186.ACE	293.6	X	150.0	7443
	74186.71c			600	X		
	74186.72c			900	X		
	74186.73c			1200	X		
Au-197	79197.70c	195.274000	Au197.ACE	293.6		30.0	7925
	79197.71c			600			
	79197.72c			900			
	79197.73c			1200			
Hg-196	80196.70c	194.282000	Hg196.ACE	293.6		150.0	8025
	80196.71c			600			
	80196.72c			900			
	80196.73c			1200			
Hg-198	80198.70c	196.266000	Hg198.ACE	293.6		150.0	8031
	80198.71c			600			
	80198.72c			900			
	80198.73c			1200			
Hg-199	80199.70c	197.259000	Hg199.ACE	293.6		150.0	8034
	80199.71c			600			
	80199.72c			900			
	80199.73c			1200			
Hg-200	80200.70c	198.250000	Hg200.ACE	293.6		150.0	8037
	80200.71c			600			
	80200.72c			900			
	80200.73c			1200			
Hg-201	80201.70c	199.244000	Hg201.ACE	293.6		150.0	8040
	80201.71c			600			
	80201.72c			900			
	80201.73c			1200			
Hg-202	80202.70c	200.236000	Hg202.ACE	293.6		150.0	8043
	80202.71c			600			
	80202.72c			900			
	80202.73c			1200			

MATERIAL	ZAID	AT. RATIO	FILE NAME	T [K]	PTABLE	EMAX[MeV]	MAT
Hg-204	80204.70c	202.221000	Hg204.ACE	293.6		150.0	8049
	80204.71c			600			
	80204.72c			900			
	80204.73c			1200			
Pb-204	82204.70c	202.220800	Pb204.ACE	293.6		200.0	8225
	82204.71c			600			
	82204.72c			900			
	82204.73c			1200			
Pb-206	82206.70c	204.205000	Pb206.ACE	293.6		200.0	8231
	82206.71c			600			
	82206.72c			900			
	82206.73c			1200			
Pb-207	82207.70c	205.197900	Pb207.ACE	293.6		200.0	8234
	82207.71c			600			
	82207.72c			900			
	82207.73c			1200			
Pb-208	82208.70c	206.190000	Pb208.ACE	293.6		150.0	8237
	82208.71c			600			
	82208.72c			900			
	82208.73c			1200			
Bi-209	83209.70c	207.185000	Bi209.ACE	293.6		150.0	8325
	83209.71c			600			
	83209.72c			900			
	83209.73c			1200			
Th-232	90232.70c	230.045000	Th232.ACE	293.6	X	60.0	9040
	90232.71c			600	X		
	90232.72c			900	X		
	90232.73c			1200	X		
	90232.74c			1500	X		
	90232.75c			1800	X		
Pa-231	91231.70c	229.051000	Pa231.ACE	293.6	X	60.0	9131
	91231.71c			600	X		
	91231.72c			900	X		
	91231.73c			1200	X		
	91231.74c			1500	X		
	91231.75c			1800	X		
Pa-233	91233.70c	231.038000	Pa233.ACE	293.6	X	60.0	9137
	91233.71c			600	X		
	91233.72c			900	X		
	91233.73c			1200	X		
	91233.74c			1500	X		
	91233.75c			1800	X		
U-232	92232.70c	230.044000	U_232.ACE	293.6	X	20.0	9219
	92232.71c			600	X		
	92232.72c			900	X		
	92232.73c			1200	X		
	92232.74c			1500	X		
	92232.75c			1800	X		
U-233	92233.70c	231.037700	U_233.ACE	293.6	X	30.0	9222
	92233.71c			600	X		
	92233.72c			900	X		
	92233.73c			1200	X		
	92233.74c			1500	X		
	92233.75c			1800	X		

MATERIAL	ZAID	AT. RATIO	FILE NAME	T [K]	PTABLE	EMAX[MeV]	MAT
U-234	92234.70c	232.030400	U_234.ACE	293.6	X	30.0	9225
	92234.71c			600	X		
	92234.72c			900	X		
	92234.73c			1200	X		
	92234.74c			1500	X		
	92234.75c			1800	X		
U-235	92235.70c	233.024800	U_235.ACE	293.6	X	20.0	9228
	92235.71c			600	X		
	92235.72c			900	X		
	92235.73c			1200	X		
	92235.74c			1500	X		
	92235.75c			1800	X		
U-236	92236.70c	234.017800	U_236.ACE	293.6	X	30.0	9231
	92236.71c			600	X		
	92236.72c			900	X		
	92236.73c			1200	X		
	92236.74c			1500	X		
	92236.75c			1800	X		
U-237	92237.70c	235.012400	U_237.ACE	293.6	X	30.0	9234
	92237.71c			600	X		
	92237.72c			900	X		
	92237.73c			1200	X		
	92237.74c			1500	X		
	92237.75c			1800	X		
U-238	92238.70c	236.005800	U_238.ACE	293.6	X	30.0	9237
	92238.71c			600	X		
	92238.72c			900	X		
	92238.73c			1200	X		
	92238.74c			1500	X		
	92238.75c			1800	X		
Np-237	93237.70c	235.012000	Np237.ACE	293.6	X	20.0	9346
	93237.71c			600	X		
	93237.72c			900	X		
	93237.73c			1200	X		
	93237.74c			1500	X		
	93237.75c			1800	X		
Np-239	93239.70c	236.999000	Np239.ACE	293.6		20.0	9352
	93239.71c			600			
	93239.72c			900			
	93239.73c			1200			
	93239.74c			1500			
	93239.75c			1800			
Pu-238	94238.70c	236.004500	Pu238.ACE	293.6	X	20.0	9434
	94238.71c			600	X		
	94238.72c			900	X		
	94238.73c			1200	X		
	94238.74c			1500	X		
	94238.75c			1800	X		
Pu-239	94239.70c	236.998600	Pu239.ACE	293.6	X	20.0	9437
	94239.71c			600	X		
	94239.72c			900	X		
	94239.73c			1200	X		
	94239.74c			1500	X		
	94239.75c			1800	X		

MATERIAL	ZAID	AT. RATIO	FILE NAME	T [K]	PTABLE	EMAX[MeV]	MAT
Pu-240	94240.70c	237.992000	Pu240.ACE	293.6	X	20.0	9440
	94240.71c			600	X		
	94240.72c			900	X		
	94240.73c			1200	X		
	94240.74c			1500	X		
	94240.75c			1800	X		
Pu-241	94241.70c	238.978000	Pu241.ACE	293.6	X	20.0	9443
	94241.71c			600	X		
	94241.72c			900	X		
	94241.73c			1200	X		
	94241.74c			1500	X		
	94241.75c			1800	X		
Pu-242	94242.70c	239.979000	Pu242.ACE	293.6	X	20.0	9446
	94242.71c			600	X		
	94242.72c			900	X		
	94242.73c			1200	X		
	94242.74c			1500	X		
	94242.75c			1800	X		
Am-241	95241.70c	238.986000	Am241.ACE	293.6	X	30.0	9543
	95241.71c			600	X		
	95241.72c			900	X		
	95241.73c			1200	X		
	95241.74c			1500	X		
	95241.75c			1800	X		
Am-242	95242.90c	239.980100	Am242.ACE	293.6	X	20.0	9546
	95242.91c			600	X		
	95242.92c			900	X		
	95242.93c			1200	X		
	95242.94c			1500	X		
	95242.95c			1800	X		
Am-242m	95242.70c	239.980100	Am42m.ACE	293.6	X	20.0	9547
	95242.71c			600	X		
	95242.72c			900	X		
	95242.73c			1200	X		
	95242.74c			1500	X		
	95242.75c			1800	X		
Am-243	95243.70c	240.973400	Am243.ACE	293.6	X	30.0	9549
	95243.71c			600	X		
	95243.72c			900	X		
	95243.73c			1200	X		
	95243.74c			1500	X		
	95243.75c			1800	X		
Cm-242	96242.70c	239.979000	Cm242.ACE	293.6	X	20.0	9631
	96242.71c			600	X		
	96242.72c			900	X		
	96242.73c			1200	X		
	96242.74c			1500	X		
	96242.75c			1800	X		
Cm-243	96243.70c	240.973000	Cm243.ACE	293.6	X	20.0	9634
	96243.71c			600	X		
	96243.72c			900	X		
	96243.73c			1200	X		
	96243.74c			1500	X		
	96243.75c			1800	X		

MATERIAL	ZAID	AT. RATIO	FILE NAME	T [K]	PTABLE	EMAX[MeV]	MAT
Cm-244	96244.70c	241.966000	Cm244.ACE	293.6	X	20.0	9637
	96244.71c			600	X		
	96244.72c			900	X		
	96244.73c			1200	X		
	96244.74c			1500	X		
	96244.75c			1800	X		
Cm-245	96245.70c	242.960000	Cm245.ACE	293.6	X	20.0	9640
	96245.71c			600	X		
	96245.72c			900	X		
	96245.73c			1200	X		
	96245.74c			1500	X		
	96245.75c			1800	X		
Cm-246	96246.70c	243.953000	Cm246.ACE	293.6	X	20.0	9643
	96246.71c			600	X		
	96246.72c			900	X		
	96246.73c			1200	X		
	96246.74c			1500	X		
	96246.75c			1800	X		
Cm-247	96247.70c	244.948000	Cm247.ACE	293.6	X	20.0	9646
	96247.71c			600	X		
	96247.72c			900	X		
	96247.73c			1200	X		
	96247.74c			1500	X		
	96247.75c			1800	X		

A-2: Thermal scattering law data

MATERIAL	ZAID	AT. RATIO	FILE NAME	T [K]	PTABLE	EMAX[MeV]	MAT
lwtr	lwtr.70t	0.999167	LWTR.ACE	293.6		$4 \cdot 10^{-6}$	125
	lwtr.71t			350			
	lwtr.72t			400			
	lwtr.73t			450			
	lwtr.74t			500			
	lwtr.75t			550			
	lwtr.76t			600			
	lwtr.77t			650			
hwtr	hwtr.70t	1.996800	HWTR.ACE	293.6		$4 \cdot 10^{-6}$	128
	hwtr.71t			350			
	hwtr.72t			400			
	hwtr.73t			450			
	hwtr.74t			500			
	hwtr.75t			550			
	hwtr.76t			600			
	hwtr.77t			650			
grph	grph.70t	11.898000	GRPH.ACE	296		$4 \cdot 10^{-6}$	600
	grph.71t			400			
	grph.72t			500			
	grph.73t			600			
	grph.74t			700			
	grph.75t			800			
	grph.76t			1000			
	grph.77t			1200			
	grph.78t			1600			
	grph.79t			2000			

MATERIAL: Isotope or element

ID: Material identification number in the ADS library

FILE NAME: Cross-section file name

T: Temperature in Kelvin

σ_0: Bondarenko cross section in barns

MAT: ENDF material number

B-1: Cross-section data

MATERIAL	ID	FILE NAME	T [K]	σ_0	MAT
H-1	H1	H_001.MXS	293.6 - 650	(1)	125
H-2	H2	H_002.MXS	293.6 - 650	(1)	128
He-3	He3	He003.MXS	293.6 - 1200	(1)	225
He-4	He4	He004.MXS	293.6 - 1200	(1)	228
Li-6	Li6	Li006.MXS	293.6 - 1200	(1)	325
Li-7	Li7	Li007.MXS	293.6 - 1200	(1)	328
Be-9	Be9	Be009.MXS	293.6 - 1200	(2)	425
B-10	B10	B_010.MXS	293.6 - 1200	(2)	525
B-11	B11	B_011.MXS	293.6 - 1200	(2)	528
C-nat	Cnat	C_nat.MXS	296.0 - 2000	(2)	600
N-14	N14	N_014.MXS	293.6 - 1200	(2)	725
N-15	N15	N_015.MXS	293.6 - 1200	(2)	728
O-16	O16	O_016.MXS	293.6 - 1800	(2)	825
F-19	F19	F_019.MXS	293.6 - 1200	(2)	925
Na-23	Na23	Na023.MXS	293.6 - 1200	(2)	1125
Mg-24	Mg24	Mg024.MXS	293.6 - 1200	(2)	1225
Mg-25	Mg25	Mg025.MXS	293.6 - 1200	(2)	1228
Mg-26	Mg26	Mg026.MXS	293.6 - 1200	(2)	1231
Al-27	Al27	Al027.MXS	293.6 - 1200	(2)	1325
Si-28	Si28	Si028.MXS	293.6 - 1800	(2)	1425
Si-29	Si29	Si029.MXS	293.6 - 1800	(2)	1428
Si-30	Si30	Si030.MXS	293.6 - 1800	(2)	1431
P-31	P31	P_031.MXS	293.6 - 1200	(2)	1525
S-32	S32	S_032.MXS	293.6 - 1200	(2)	1625
S-33	S33	S_033.MXS	293.6 - 1200	(2)	1628
S-34	S34	S_034.MXS	293.6 - 1200	(2)	1631
S-36	S36	S_036.MXS	293.6 - 1200	(2)	1637
Cl-35	Cl35	Cl035.MXS	293.6 - 1200	(2)	1725
Cl-37	Cl37	Cl037.MXS	293.6 - 1200	(2)	1731
K-39	K39	K_039.MXS	293.6 - 1200	(2)	1925
K-40	K40	K_040.MXS	293.6 - 1200	(2)	1928
K-41	K41	K_041.MXS	293.6 - 1200	(2)	1931
Ca-40	Ca40	Ca040.MXS	293.6 - 1200	(2)	2025
Ca-42	Ca42	Ca042.MXS	293.6 - 1200	(2)	2031
Ca-43	Ca43	Ca043.MXS	293.6 - 1200	(2)	2034
Ca-44	Ca44	Ca044.MXS	293.6 - 1200	(2)	2037
Ca-46	Ca46	Ca046.MXS	293.6 - 1200	(2)	2043

MATERIAL	ID	FILE NAME	T [K]	σ_0	MAT
Ca-48	Ca48	Ca048.MXS	293.6 - 1200	(2)	2049
Ti-46	Ti46	Ti046.MXS	293.6 - 1200	(2)	2225
Ti-47	Ti47	Ti047.MXS	293.6 - 1200	(2)	2228
Ti-48	Ti48	Ti048.MXS	293.6 - 1200	(2)	2231
Ti-49	Ti49	Ti049.MXS	293.6 - 1200	(2)	2234
Ti-50	Ti50	Ti050.MXS	293.6 - 1200	(2)	2237
V-nat	Vnat	V_nat.MXS	293.6 - 1200	(2)	2300
Cr-50	Cr50	Cr050.MXS	293.6 - 1200	(2)	2425
Cr-52	Cr52	Cr052.MXS	293.6 - 1200	(2)	2431
Cr-53	Cr53	Cr053.MXS	293.6 - 1200	(2)	2434
Cr-54	Cr54	Cr054.MXS	293.6 - 1200	(2)	2437
Mn-55	Mn55	Mn055.MXS	293.6 - 1200	(2)	2525
Fe-54	Fe54	Fe054.MXS	293.6 - 1200	(2)	2625
Fe-56	Fe56	Fe056.MXS	293.6 - 1200	(2)	2631
Fe-57	Fe57	Fe057.MXS	293.6 - 1200	(2)	2634
Fe-58	Fe58	Fe058.MXS	293.6 - 1200	(2)	2637
Co-59	Co59	Co059.MXS	293.6 - 1200	(2)	2725
Ni-58	Ni58	Ni058.MXS	293.6 - 1200	(2)	2825
Ni-60	Ni60	Ni060.MXS	293.6 - 1200	(2)	2831
Ni-61	Ni61	Ni061.MXS	293.6 - 1200	(2)	2834
Ni-62	Ni62	Ni062.MXS	293.6 - 1200	(2)	2837
Ni-64	Ni64	Ni064.MXS	293.6 - 1200	(2)	2843
Cu-63	Cu63	Cu063.MXS	293.6 - 1200	(2)	2925
Cu-65	Cu65	Cu065.MXS	293.6 - 1200	(2)	2931
Zn-nat	Znnat	Znnat.MXS	293.6 - 1200	(2)	3000
Zr-90	Zr90	Zr090.MXS	293.6 - 1200	(2)	4025
Zr-91	Zr91	Zr091.MXS	293.6 - 1200	(2)	4028
Zr-92	Zr92	Zr092.MXS	293.6 - 1200	(2)	4031
Zr-94	Zr94	Zr094.MXS	293.6 - 1200	(2)	4037
Zr-96	Zr96	Zr096.MXS	293.6 - 1200	(2)	4043
Nb-93	Nb93	Nb093.MXS	293.6 - 1200	(2)	4125
Mo-92	Mo92	Mo092.MXS	293.6 - 1200	(2)	4225
Mo-94	Mo94	Mo094.MXS	293.6 - 1200	(2)	4231
Mo-95	Mo95	Mo095.MXS	293.6 - 1200	(2)	4234
Mo-96	Mo96	Mo096.MXS	293.6 - 1200	(2)	4237
Mo-97	Mo97	Mo097.MXS	293.6 - 1200	(2)	4240
Mo-98	Mo98	Mo098.MXS	293.6 - 1200	(2)	4243
Mo-100	Mo100	Mo100.MXS	293.6 - 1200	(2)	4249
Ag-107	Ag107	Ag107.MXS	293.6 - 1200	(2)	4725
Ag-109	Ag109	Ag109.MXS	293.6 - 1200	(2)	4731
Cd-106	Cd106	Cd106.MXS	293.6 - 1200	(2)	4825
Cd-108	Cd108	Cd108.MXS	293.6 - 1200	(2)	4831
Cd-110	Cd110	Cd110.MXS	293.6 - 1200	(2)	4837
Cd-111	Cd111	Cd111.MXS	293.6 - 1200	(2)	4840
Cd-112	Cd112	Cd112.MXS	293.6 - 1200	(2)	4843
Cd-113	Cd113	Cd113.MXS	293.6 - 1200	(2)	4846
Cd-114	Cd114	Cd114.MXS	293.6 - 1200	(2)	4849
Cd-116	Cd116	Cd116.MXS	293.6 - 1200	(2)	4855
In-113	In113	In113.MXS	293.6 - 1200	(2)	4925
In-115	In115	In115.MXS	293.6 - 1200	(2)	4931
Eu-151	Eu151	Eu151.MXS	293.6 - 1200	(3)	6325
Eu-153	Eu153	Eu153.MXS	293.6 - 1200	(3)	6331
Gd-152	Gd152	Gd152.MXS	293.6 - 1200	(3)	6425
Gd-154	Gd154	Gd154.MXS	293.6 - 1200	(3)	6431
Gd-155	Gd155	Gd155.MXS	293.6 - 1200	(3)	6434
Gd-156	Gd156	Gd156.MXS	293.6 - 1200	(3)	6437

MATERIAL	ID	FILE NAME	T [K]	σ_0	MAT
Gd-157	Gd157	Gd157.MXS	293.6 - 1200	(3)	6440
Gd-158	Gd158	Gd158.MXS	293.6 - 1200	(3)	6443
Gd-160	Gd160	Gd160.MXS	293.6 - 1200	(3)	6449
Er-162	Gd162	Er162.MXS	293.6 - 1200	(3)	6825
Er-164	Gd164	Er164.MXS	293.6 - 1200	(3)	6831
Er-166	Er166	Er166.MXS	293.6 - 1200	(3)	6837
Er-167	Er167	Er167.MXS	293.6 - 1200	(3)	6840
Er-168	Er168	Er168.MXS	293.6 - 1200	(3)	6843
Er-170	Er170	Er170.MXS	293.6 - 1200	(3)	6849
Lu-175	Er175	Lu175.MXS	293.6 - 1200	(3)	7125
Lu-176	Er176	Lu176.MXS	293.6 - 1200	(3)	7128
Hf-174	Hf174	Hf174.MXS	293.6 - 1200	(3)	7225
Hf-176	Hf176	Hf176.MXS	293.6 - 1200	(3)	7231
Hf-177	Hf177	Hf177.MXS	293.6 - 1200	(3)	7234
Hf-178	Hf178	Hf178.MXS	293.6 - 1200	(3)	7237
Hf-179	Hf179	Hf179.MXS	293.6 - 1200	(3)	7240
Hf-180	Hf180	Hf180.MXS	293.6 - 1200	(3)	7243
Ta-181	Ta181	Ta181.MXS	293.6 - 1200	(3)	7328
W-180	W180	W_180.MXS	293.6 - 1200	(3)	7425
W-182	W182	W_182.MXS	293.6 - 1200	(3)	7431
W-183	W183	W_183.MXS	293.6 - 1200	(3)	7434
W-184	W184	W_184.MXS	293.6 - 1200	(3)	7437
W-186	W186	W_186.MXS	293.6 - 1200	(3)	7443
Au-197	Au197	Au197.MXS	293.6 - 1200	(3)	7925
Hg-196	Hg196	Hg196.MXS	293.6 - 1200	(3)	8025
Hg-198	Hg198	Hg198.MXS	293.6 - 1200	(3)	8031
Hg-199	Hg199	Hg199.MXS	293.6 - 1200	(3)	8034
Hg-200	Hg200	Hg200.MXS	293.6 - 1200	(3)	8037
Hg-201	Hg201	Hg201.MXS	293.6 - 1200	(3)	8040
Hg-202	Hg202	Hg202.MXS	293.6 - 1200	(3)	8043
Hg-204	Hg204	Hg204.MXS	293.6 - 1200	(3)	8049
Pb-204	Pb204	Pb204.MXS	293.6 - 1200	(3)	8225
Pb-206	Pb206	Pb206.MXS	293.6 - 1200	(3)	8231
Pb-207	Pb207	Pb207.MXS	293.6 - 1200	(3)	8234
Pb-208	Pb208	Pb208.MXS	293.6 - 1200	(3)	8237
Bi-209	Bi209	Bi209.MXS	293.6 - 1200	(3)	8325
Th-232	Th232	Th232.MXS	293.6 - 1800	(3)	9040
Pa-231	Pa231	Pa231.MXS	293.6 - 1800	(3)	9131
Pa-233	Pa233	Pa233.MXS	293.6 - 1800	(3)	9137
U-232	U232	U_232.MXS	293.6 - 1800	(3)	9219
U-233	U233	U_233.MXS	293.6 - 1800	(3)	9222
U-234	U234	U_234.MXS	293.6 - 1800	(3)	9225
U-235	U235	U_235.MXS	293.6 - 1800	(3)	9228
U-236	U236	U_236.MXS	293.6 - 1800	(3)	9231
U-237	U237	U_237.MXS	293.6 - 1800	(3)	9234
U-238	U238	U_238.MXS	293.6 - 1800	(3)	9237
Np-237	Np237	Np237.MXS	293.6 - 1800	(3)	9346
Np-239	Np239	Np239.MXS	293.6 - 1800	(3)	9352
Pu-238	Pu238	Pu238.MXS	293.6 - 1800	(3)	9434
Pu-239	Pu239	Pu239.MXS	293.6 - 1800	(3)	9437
Pu-240	Pu240	Pu240.MXS	293.6 - 1800	(3)	9440
Pu-241	Pu241	Pu241.MXS	293.6 - 1800	(3)	9443
Pu-242	Pu242	Pu242.MXS	293.6 - 1800	(3)	9446
Am-241	Am241	Am241.MXS	293.6 - 1800	(3)	9543
Am-242	Am242	Am242.MXS	293.6 - 1800	(3)	9546
Am-242m	Am242m	Am42m.MXS	293.6 - 1800	(3)	9547

MATERIAL	ID	FILE NAME	T [K]	σ_0	MAT
Am-243	Am243	Am243.MXS	293.6 - 1800	(3)	9549
Cm-242	Cm242	Cm242.MXS	293.6 - 1800	(3)	9631
Cm-243	Cm243	Cm243.MXS	293.6 - 1800	(3)	9634
Cm-244	Cm244	Cm244.MXS	293.6 - 1800	(3)	9637
Cm-245	Cm245	Cm245.MXS	293.6 - 1800	(3)	9640
Cm-246	Cm246	Cm246.MXS	293.6 - 1800	(3)	9643
Cm-247	Cm247	Cm247.MXS	293.6 - 1800	(3)	9646

293.6 - 650 ➔ 293.6, 400, 450, 500, 550, 600, 650K
296 – 2000 ➔ 296, 400, 500, 600, 700, 800, 1000, 1200, 1600, 2000K
293.6 – 1200 ➔ 293.6, 600, 900, 1200K
293.6 – 1800 ➔ 293.6, 600, 900, 1200, 1500, 1800K
(1) ➔ 1E10 barn
(2) ➔ 1.E10, 1.E4, 1000, 100, 10, 1
(3) ➔ 1.E10, 1.E4, 3000, 1000, 300, 100, 60, 30, 10, 1

MATERIAL: Isotope or element library

FILE NAME: Cross-section file name

T: Temperature in Kelvin

σ_0: Bondarenko cross section in barns

MAT: ENDF material number

MATERIAL	FILE NAME	T [K]	SIGMA0	MAT
H-1	H_001.GXS	293.6 - 650	(1)	125
H-2	H_002.GXS	293.6 - 650	(1)	128
He-3	He003.GXS	293.6 - 1200	(1)	225
He-4	He004.GXS	293.6 - 1200	(1)	228
Li-6	Li006.GXS	293.6 - 1200	(1)	325
Li-7	Li007.GXS	293.6 - 1200	(1)	328
Be-9	Be009.GXS	293.6 - 1200	(2)	425
B-10	B_010.GXS	293.6 - 1200	(2)	525
B-11	B_011.GXS	293.6 - 1200	(2)	528
C-nat	C_nat.GXS	296.0 - 2000	(2)	600
N-14	N_014.GXS	293.6 - 1200	(2)	725
N-15	N_015.GXS	293.6 - 1200	(2)	728
O-16	O_016.GXS	293.6 - 1800	(2)	825
F-19	F_019.GXS	293.6 - 1200	(2)	925
Na-23	Na023.GXS	293.6 - 1200	(2)	1125
Mg-24	Mg024.GXS	293.6 - 1200	(2)	1225
Mg-25	Mg025.GXS	293.6 - 1200	(2)	1228
Mg-26	Mg026.GXS	293.6 - 1200	(2)	1231
Al-27	Al027.GXS	293.6 - 1200	(2)	1325
Si-28	Si028.GXS	293.6 - 1800	(2)	1425
Si-29	Si029.GXS	293.6 - 1800	(2)	1428
Si-30	Si030.GXS	293.6 - 1800	(2)	1431
P-31	P_031.GXS	293.6 - 1200	(2)	1525
S-32	S_032.GXS	293.6 - 1200	(2)	1625
S-33	S_033.GXS	293.6 - 1200	(2)	1628
S-34	S_034.GXS	293.6 - 1200	(2)	1631
S-36	S_036.GXS	293.6 - 1200	(2)	1637
Cl-35	Cl035.GXS	293.6 - 1200	(2)	1725
Cl-37	Cl037.GXS	293.6 - 1200	(2)	1731
K-39	K_039.GXS	293.6 - 1200	(2)	1925
K-40	K_040.GXS	293.6 - 1200	(2)	1928
K-41	K_041.GXS	293.6 - 1200	(2)	1931
Ca-40	Ca040.GXS	293.6 - 1200	(2)	2025
Ca-42	Ca042.GXS	293.6 - 1200	(2)	2031
Ca-43	Ca043.GXS	293.6 - 1200	(2)	2034
Ca-44	Ca044.GXS	293.6 - 1200	(2)	2037
Ca-46	Ca046.GXS	293.6 - 1200	(2)	2043
Ca-48	Ca048.GXS	293.6 - 1200	(2)	2049
Ti-46	Ti046.GXS	293.6 - 1200	(2)	2225
Ti-47	Ti047.GXS	293.6 - 1200	(2)	2228
Ti-48	Ti048.GXS	293.6 - 1200	(2)	2231

MATERIAL	FILE NAME	T [K]	SIGMA0	MAT
Ti-49	Ti049.GXS	293.6 - 1200	(2)	2234
Ti-50	Ti050.GXS	293.6 - 1200	(2)	2237
V-nat	V_nat.GXS	293.6 - 1200	(2)	2300
Cr-50	Cr050.GXS	293.6 - 1200	(2)	2425
Cr-52	Cr052.GXS	293.6 - 1200	(2)	2431
Cr-53	Cr053.GXS	293.6 - 1200	(2)	2434
Cr-54	Cr054.GXS	293.6 - 1200	(2)	2437
Mn-55	Mn055.GXS	293.6 - 1200	(2)	2525
Fe-54	Fe054.GXS	293.6 - 1200	(2)	2625
Fe-56	Fe056.GXS	293.6 - 1200	(2)	2631
Fe-57	Fe057.GXS	293.6 - 1200	(2)	2634
Fe-58	Fe058.GXS	293.6 - 1200	(2)	2637
Co-59	Co059.GXS	293.6 - 1200	(2)	2725
Ni-58	Ni058.GXS	293.6 - 1200	(2)	2825
Ni-60	Ni060.GXS	293.6 - 1200	(2)	2831
Ni-61	Ni061.GXS	293.6 - 1200	(2)	2834
Ni-62	Ni062.GXS	293.6 - 1200	(2)	2837
Ni-64	Ni064.GXS	293.6 - 1200	(2)	2843
Cu-63	Cu063.GXS	293.6 - 1200	(2)	2925
Cu-65	Cu065.GXS	293.6 - 1200	(2)	2931
Zn-nat	Znnat.GXS	293.6 - 1200	(2)	3000
Zr-90	Zr090.GXS	293.6 - 1200	(2)	4025
Zr-91	Zr091.GXS	293.6 - 1200	(2)	4028
Zr-92	Zr092.GXS	293.6 - 1200	(2)	4031
Zr-94	Zr094.GXS	293.6 - 1200	(2)	4037
Zr-96	Zr096.GXS	293.6 - 1200	(2)	4043
Nb-93	Nb093.GXS	293.6 - 1200	(2)	4125
Mo-92	Mo092.GXS	293.6 - 1200	(2)	4225
Mo-94	Mo094.GXS	293.6 - 1200	(2)	4231
Mo-95	Mo095.GXS	293.6 - 1200	(2)	4234
Mo-96	Mo096.GXS	293.6 - 1200	(2)	4237
Mo-97	Mo097.GXS	293.6 - 1200	(2)	4240
Mo-98	Mo098.GXS	293.6 - 1200	(2)	4243
Mo-100	Mo100.GXS	293.6 - 1200	(2)	4249
Ag-107	Ag107.GXS	293.6 - 1200	(2)	4725
Ag-109	Ag109.GXS	293.6 - 1200	(2)	4731
Cd-106	Cd106.GXS	293.6 - 1200	(2)	4825
Cd-108	Cd108.GXS	293.6 - 1200	(2)	4831
Cd-110	Cd110.GXS	293.6 - 1200	(2)	4837
Cd-111	Cd111.GXS	293.6 - 1200	(2)	4840
Cd-112	Cd112.GXS	293.6 - 1200	(2)	4843
Cd-113	Cd113.GXS	293.6 - 1200	(2)	4846
Cd-114	Cd114.GXS	293.6 - 1200	(2)	4849
Cd-116	Cd116.GXS	293.6 - 1200	(2)	4855
In-113	In113.GXS	293.6 - 1200	(2)	4925
In-115	In115.GXS	293.6 - 1200	(2)	4931
Eu-151	Eu151.GXS	293.6 - 1200	(3)	6325
Eu-153	Eu153.GXS	293.6 - 1200	(3)	6331
Gd-152	Gd152.GXS	293.6 - 1200	(3)	6425
Gd-154	Gd154.GXS	293.6 - 1200	(3)	6431
Gd-155	Gd155.GXS	293.6 - 1200	(3)	6434
Gd-156	Gd156.GXS	293.6 - 1200	(3)	6437
Gd-157	Gd157.GXS	293.6 - 1200	(3)	6440
Gd-158	Gd158.GXS	293.6 - 1200	(3)	6443
Gd-160	Gd160.GXS	293.6 - 1200	(3)	6449
Er-162	Er162.GXS	293.6 - 1200	(3)	6825

MATERIAL	FILE NAME	T [K]	SIGMA0	MAT
Er-164	Er164.GXS	293.6 - 1200	(3)	6831
Er-166	Er166.GXS	293.6 - 1200	(3)	6837
Er-167	Er167.GXS	293.6 - 1200	(3)	6840
Er-168	Er168.GXS	293.6 - 1200	(3)	6843
Er-170	Er170.GXS	293.6 - 1200	(3)	6849
Lu-175	Lu175.GXS	293.6 - 1200	(3)	7125
Lu-176	Lu176.GXS	293.6 - 1200	(3)	7128
Hf-174	Hf174.GXS	293.6 - 1200	(3)	7225
Hf-176	Hf176.GXS	293.6 - 1200	(3)	7231
Hf-177	Hf177.GXS	293.6 - 1200	(3)	7234
Hf-178	Hf178.GXS	293.6 - 1200	(3)	7237
Hf-179	Hf179.GXS	293.6 - 1200	(3)	7240
Hf-180	Hf180.GXS	293.6 - 1200	(3)	7243
Ta-181	Ta181.GXS	293.6 - 1200	(3)	7328
W-180	W_180.GXS	293.6 - 1200	(3)	7425
W-182	W_182.GXS	293.6 - 1200	(3)	7431
W-183	W_183.GXS	293.6 - 1200	(3)	7434
W-184	W_184.GXS	293.6 - 1200	(3)	7437
W-186	W_186.GXS	293.6 - 1200	(3)	7443
Au-197	Au197.GXS	293.6 - 1200	(3)	7925
Hg-196	Hg196.GXS	293.6 - 1200	(3)	8025
Hg-198	Hg198.GXS	293.6 - 1200	(3)	8031
Hg-199	Hg199.GXS	293.6 - 1200	(3)	8034
Hg-200	Hg200.GXS	293.6 - 1200	(3)	8037
Hg-201	Hg201.GXS	293.6 - 1200	(3)	8040
Hg-202	Hg202.GXS	293.6 - 1200	(3)	8043
Hg-204	Hg204.GXS	293.6 - 1200	(3)	8049
Pb-204	Pb204.GXS	293.6 - 1200	(3)	8225
Pb-206	Pb206.GXS	293.6 - 1200	(3)	8231
Pb-207	Pb207.GXS	293.6 - 1200	(3)	8234
Pb-208	Pb208.GXS	293.6 - 1200	(3)	8237
Bi-209	Bi209.GXS	293.6 - 1200	(3)	8325
Th-232	Th232.GXS	293.6 - 1800	(3)	9040
Pa-231	Pa231.GXS	293.6 - 1800	(3)	9131
Pa-233	Pa233.GXS	293.6 - 1800	(3)	9137
U-232	U_232.GXS	293.6 - 1800	(3)	9219
U-233	U_233.GXS	293.6 - 1800	(3)	9222
U-234	U_234.GXS	293.6 - 1800	(3)	9225
U-235	U_235.GXS	293.6 - 1800	(3)	9228
U-236	U_236.GXS	293.6 - 1800	(3)	9231
U-237	U_237.GXS	293.6 - 1800	(3)	9234
U-238	U_238.GXS	293.6 - 1800	(3)	9237
Np-237	Np237.GXS	293.6 - 1800	(3)	9346
Np-239	Np239.GXS	293.6 - 1800	(3)	9352
Pu-238	Pu238.GXS	293.6 - 1800	(3)	9434
Pu-239	Pu239.GXS	293.6 - 1800	(3)	9437
Pu-240	Pu240.GXS	293.6 - 1800	(3)	9440
Pu-241	Pu241.GXS	293.6 - 1800	(3)	9443
Pu-242	Pu242.GXS	293.6 - 1800	(3)	9446
Am-241	Am241.GXS	293.6 - 1800	(3)	9543
Am-242	Am242.GXS	293.6 - 1800	(3)	9546
Am-242m	Am42m.GXS	293.6 - 1800	(3)	9547
Am-243	Am243.GXS	293.6 - 1800	(3)	9549
Cm-242	Cm242.GXS	293.6 - 1800	(3)	9631
Cm-243	Cm243.GXS	293.6 - 1800	(3)	9634
Cm-244	Cm244.GXS	293.6 - 1800	(3)	9637

MATERIAL	FILE NAME	T [K]	SIGMA0	MAT
Cm-245	Cm245.GXS	293.6 - 1800	(3)	9640
Cm-246	Cm246.GXS	293.6 - 1800	(3)	9643
Cm-247	Cm247.GXS	293.6 - 1800	(3)	9646

293.6 - 650 → 293.6, 400, 450, 500, 550, 600, 650K
296 – 2000 → 296, 400, 500, 600, 700, 800, 1000, 1200, 1600, 2000K
293.6 – 1200 → 293.6, 600, 900, 1200K
293.6 – 1800 → 293.6, 600, 900, 1200, 1500, 1800K
(1) → 1E10 barn
(2) → 1.E10, 1.E4, 1000, 100, 10, 1
(3) →1.E10, 1.E4, 3000, 1000, 300, 100, 60, 30, 10, 1

ANNEX D
Use of the ADS cross-section library

D-1: Continuous-energy cross-section library in ACE format

A continuous-energy cross-section library has been prepared in ACE format for MCNP calculations [7] and a brief description of this library is given below for completeness.

The MCNP code identifies the data tables for each ZAID based on information contained in a system-dependent XSDIR directory file This directory file is a sequential formatted ASCII file with 80-character records (lines) containing free-field entries delimited by blanks. The complete XSDIR master file has three sections:

first section

first line is an optional entry of the form
DATAPATH = *datapath*
where DATAPATH (optionally capitalized) must start in column 1. The equals sign (=) is optional, and the directory where the data libraries are stored is the '*datapath*' string.

The search hierarchy to find the data libraries is the following:
- xsdir = *datapath* on the MCNP execution line,
- DATAPATH = *datapath* in INP file message block,
- current directory,
- DATAPATH entry on the first line of XSDIR file,
- Unix environmental variable DATAPATH (setenv DATAPATH *datapath*),
- individual data table line in XSDIR file (see below under "access route"),
- directory specified at MCNP compile time in BLOCK DATA subroutine.

second section

atomic weight ratios

Starts with the words "ATOMIC WEIGHT RATIOS" (capitalization is optional) beginning in column 1. The lines following are free-format pairs of ZAID AWR, where ZAID is an integer of the form ZZAAA, and AWR is the atomic weight ratio. These atomic weight ratios are used to convert from weight fractions to atom fractions, and for selecting the average Z in order to compute electron stopping powers.

third section

listing of available data tables.

Starts with the word "DIRECTORY" (capitalization is optional) beginning in column 1. The lines following consist of the seven- to eleven-entry description of each cross section table; material identifier ZAID of each cross-section table must be the first entry. There are seven to eleven entries in each row for every table:

1. ZAID identifier of the cross-section table;,
2. atomic weight ratio,
3. file name,
4. access route (zero, if the file is accessible in one of the default path options),
5. file type (one for ASCII-formatted files),
6. starting address (consecutive record number in the file),

7. cross-section table length for the material (words),
8. record length (not applicable for type-1 files),
9. number of entries per record (not applicable for type-1 files),
10. temperature in MeV,
11. probability table index (‘ptable’ string).

Cross-section tables are given in a separate file, defined by the filename and the access route (items 3 and 4 of the third section, above) in the XSDIR master file.

The ADS library contains two files for each material and temperature. Files with extension “*.XSD” give only the third section of the XSDIR file after the DIRECTORY word (example is given below of Mn055.XSD):

```
25055.70c  54.466099 Mn055.ACE 0 1       1  318857 0 0 2.530E-08
25055.71c  54.466099 Mn055.ACE 0 1   79728  312362 0 0 5.170E-08
25055.72c  54.466099 Mn055.ACE 0 1  157831  308922 0 0 7.756E-08
25055.73c  54.466099 Mn055.ACE 0 1  235074  306442 0 0 1.034E-07
```

This file has to be pasted into the third section of the full XSDIR file that is used in the calculations. Files with extension “*.ACE” contain the cross-section tables.

You should do the following in order to set-up the ADS library for MCNP calculations:

- Download from the IAEA-NDS Web page or obtain on CD-ROM the ACE-formatted data files (*.ACE) and associated XSDIR files (*.XSD) - they are usually supplied in a zipped file.
- Copy the cross-section files on to the MCNP cross-section directory as described earlier.
- Update your local XSDIR file with the *.XSD files.
- Run MCNP with the new library data - ZAID and general information for the material are given in Annex A.

The library is supplied as a type 1 (ASCII-formatted) file. Users can convert the cross-section files into a binary file using the corresponding MCNP package utilities, and the *.XSD file should be consistently changed.

D-2: Multi-group cross section library in MATXS format

The MATXS format is defined in Refs. [6, 10]. These files can be processed by the TRANSX code [10] for further use in deterministic transport codes such as DORT, TORT and ANISN. The material IDs are listed in Annex B, and this key parameter is needed to specify the material composition of each mixture in the transport problem.

Data usage requires the following actions:

- Download from the IAEA-NDS Web page or obtain on CD-ROM the MATXS-formatted data files (*.MXS) - they are usually supplied in a zipped file with some general information.

- Convert ASCII file to binary files by means of the corresponding TRANSX utility program.
- Copy the binary files to the TRANSX cross-section directory.
- Prepare TRANSX input data, particularly CARD 7 in the input stream – ADS library has 421 energy groups including 97 below 4 eV.
- Run TRANSX to prepare the cross-section data for the transport problem.
- Run the transport code.

D-3: Multi-group cross section library in GENDF format

The (*.GXS) files are mainly supplied for further processing with NJOY if necessary. General information is presented in Annex C. They can be used as input tapes for the formatting modules of NJOY, and are also useful to perform sensitivity studies.

ORNL 421-group energy structure for NJOY input

```
1.000000-5 1.000000-4 5.000000-4 7.500000-4 1.000000-3 1.200000-3
1.500000-3 2.000000-3 2.500000-3 3.000000-3 4.000000-3 5.000000-3
7.500000-3 1.000000-2 2.530000-2 3.000000-2 4.000000-2 5.000000-2
6.000000-2 7.000000-2 8.000000-2 9.000000-2 1.000000-1 1.250000-1
1.500000-1 1.750000-1 2.000000-1 2.250000-1 2.500000-1 2.750000-1
3.000000-1 3.250000-1 3.500000-1 3.750000-1 4.000000-1 4.500000-1
5.000000-1 5.500000-1 6.000000-1 6.250000-1 6.500000-1 7.000000-1
7.500000-1 8.000000-1 8.500000-1 9.000000-1 9.250000-1 9.500000-1
9.750000-1 1.000000+0 1.009990+0 1.020000+0 1.030000+0 1.040000+0
1.049990+0 1.059990+0 1.070000+0 1.080000+0 1.089990+0 1.099990+0
1.110000+0 1.120000+0 1.129990+0 1.139990+0 1.150000+0 1.174990+0
1.200000+0 1.224990+0 1.250000+0 1.299990+0 1.349990+0 1.400000+0
1.450000+0 1.500000+0 1.589990+0 1.679990+0 1.770000+0 1.860000+0
1.940000+0 2.000000+0 2.120000+0 2.209990+0 2.299990+0 2.379990+0
2.469990+0 2.570000+0 2.669990+0 2.770000+0 2.870000+0 2.969990+0
3.000000+0 3.049990+0 3.150000+0 3.500000+0 3.730000+0 4.000000+0
4.750000+0 5.000000+0 5.400000+0 6.000000+0 6.250000+0 6.500000+0
6.750000+0 7.000000+0 7.150000+0 8.099990+0 9.099990+0 1.000000+1
1.150000+1 1.190000+1 1.290000+1 1.375000+1 1.440000+1 1.509990+1
1.600000+1 1.700000+1 1.850000+1 1.900000+1 2.000000+1 2.100000+1
2.250000+1 2.500000+1 2.750000+1 3.000000+1 3.125000+1 3.175000+1
3.325000+1 3.375000+1 3.460000+1 3.550000+1 3.700000+1 3.800000+1
3.910000+1 3.960000+1 4.100000+1 4.240000+1 4.400000+1 4.520000+1
4.700000+1 4.830000+1 4.920000+1 5.060000+1 5.200000+1 5.340000+1
5.900000+1 6.100000+1 6.500000+1 6.750000+1 7.200000+1 7.600000+1
8.000000+1 8.200000+1 9.000000+1 1.000000+2 1.080000+2 1.150000+2
1.190000+2 1.220000+2 1.860000+2 1.925000+2 2.075000+2 2.100000+2
2.400000+2 2.850000+2 3.050000+2 5.500000+2 6.700000+2 6.830000+2
9.500000+2 1.000000+3 1.047129+3 1.096478+3 1.150000+3 1.202264+3
1.258925+3 1.318257+3 1.380384+3 1.445440+3 1.500000+3 1.513561+3
1.550000+3 1.584893+3 1.659587+3 1.737801+3 1.800000+3 1.819701+3
1.905461+3 1.995262+3 2.089296+3 2.187762+3 2.200000+3 2.290000+3
2.398833+3 2.511886+3 2.580000+3 2.630268+3 2.754229+3 2.884032+3
3.000000+3 3.162278+3 3.311311+3 3.467369+3 3.630781+3 3.740000+3
3.801894+3 3.900000+3 3.981072+3 4.168694+3 4.365158+3 4.570882+3
4.786301+3 5.011872+3 5.248075+3 5.495409+3 5.754399+3 6.000000+3
6.309573+3 6.606934+3 6.918310+3 7.244360+3 7.585776+3 7.800000+3
8.030000+3 8.317638+3 8.709636+3 9.120108+3 9.500000+3 9.750000+3
1.000000+4 1.047129+4 1.096478+4 1.148154+4 1.202264+4 1.258925+4
1.300000+4 1.318257+4 1.380384+4 1.445440+4 1.513561+4 1.584893+4
1.659587+4 1.700000+4 1.760000+4 1.819701+4 1.905461+4 1.995262+4
2.089296+4 2.187762+4 2.290868+4 2.398833+4 2.500000+4 2.630268+4
2.754229+4 2.884032+4 3.000000+4 3.162278+4 3.311311+4 3.467369+4
3.630781+4 3.801894+4 3.981072+4 4.168694+4 4.365158+4 4.500000+4
4.570882+4 4.786301+4 5.000000+4 5.011872+4 5.200000+4 5.300000+4
5.495409+4 5.754399+4 6.000000+4 6.309573+4 6.606934+4 6.918310+4
7.244360+4 7.300000+4 7.500000+4 7.650000+4 7.943282+4 8.200000+4
8.317638+4 8.500000+4 8.709636+4 9.120108+4 9.549926+4 1.000000+5
1.047129+5 1.096478+5 1.148154+5 1.202264+5 1.258925+5 1.283000+5
1.318257+5 1.380384+5 1.445440+5 1.500000+5 1.513561+5 1.584893+5
1.659587+5 1.737801+5 1.819701+5 1.905461+5 2.000000+5 2.089296+5
2.187762+5 2.290868+5 2.398833+5 2.511886+5 2.630268+5 2.700000+5
```

2.754229+5 2.884032+5 3.019952+5 3.162278+5 3.300000+5 3.467369+5
3.630781+5 3.801894+5 3.981072+5 4.000000+5 4.168694+5 4.200000+5
4.365158+5 4.400000+5 4.570882+5 4.700000+5 4.786301+5 4.995200+5
5.011872+5 5.248075+5 5.495409+5 5.500000+5 5.730000+5 5.754399+5
6.000000+5 6.025596+5 6.309573+5 6.606934+5 6.700000+5 6.790000+5
6.918310+5 7.244360+5 7.500000+5 7.943282+5 8.200000+5 8.317638+5
8.611000+5 8.709636+5 8.750000+5 9.000000+5 9.120108+5 9.200000+5
9.549926+5 1.000000+6 1.010000+6 1.047129+6 1.096478+6 1.100000+6
1.200000+6 1.250000+6 1.317000+6 1.356000+6 1.380384+6 1.400000+6
1.445440+6 1.500000+6 1.513561+6 1.584893+6 1.659587+6 1.737801+6
1.819701+6 1.850000+6 1.905461+6 1.995262+6 2.089296+6 2.187762+6
2.290868+6 2.354000+6 2.398833+6 2.479000+6 2.511886+6 2.630268+6
2.754229+6 2.884032+6 3.000000+6 3.162278+6 3.311311+6 3.467369+6
3.630781+6 3.801894+6 3.981072+6 4.168694+6 4.304000+6 4.365158+6
4.570882+6 4.800000+6 5.011872+6 5.248075+6 5.495409+6 5.754399+6
6.025596+6 6.309573+6 6.434000+6 6.606934+6 6.918310+6 7.244360+6
7.585776+6 7.943282+6 8.187300+6 8.317638+6 8.709636+6 9.120108+6
9.549926+6 1.000000+7 1.284000+7 1.384000+7 1.455000+7 1.568300+7
1.733300+7 2.000000+7

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