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FENDL/C-1.0

Charged-Particle Reaction Data Library for Fusion Applicatons
Version 1.0 of November 1991

Data extracted from ENDF/B-6 evaluations
by R.M. White and D.A. Resler, LLNL

Summary documentation by

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Abstract: This document describes the FENDL/C-1.0 charged-particle reaction data library which is a sublibrary of FENDL, the evaluated nuclear data library for fusion applications. This file contains evaluated data in ENDF-6 format for the D(d,n), D(d,p), T(d,n), T(t,2n), He-3(d,p) reactions. The processed information, i.e. Maxwellian-averaged reaction rates, and related quantities, calculated from reaction cross-sections, are also included. The data are available from the Nuclear Data Section online via INTERNET by FTP command, or on magnetic tape upon request.

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> R.M. White, D.A. Resler, "FENDL/C-1.0. Charged-particle reaction data library for fusion applications", report IAEA-NDS-166 (IAEA Jan. 1995). Data library retrieved online (or: received on tape) from the IAEA Nuclear Data Section.

FENDL/C-1.0
Charged-Particle Reaction Data Library for Fusion Applicatons
Version 1.0 of November 1991

Data extracted from ENDF/B-6 evaluations
by R.M. White and D.A. Resler, LLNL

The FENDL/C-1.0 is sublibrary of FENDL, the evaluated nuclear data library for fusion applications. The FENDL/C-1.0 sublibrary consists of two parts: integrated charged-particle cross-section evaluations and processed data as generated at the Lawrence Livermore National Laboratory for the end-users.

Integrated Cross-Sections

Following the recommendation of the IAEA Advisory Group Meeting on 'FENDL-2 and Associated Benchmark Calculations', held in Vienna from 18 to 22 November 1991, report INDC(NDS)-260, this file contains the ENDF/B-6 integrated charged-particle cross section evaluations for the following energy-producing fusion gas reactions:

1-H-2(d,n)2-He-3
1-H-2(d,p)1-H-3
1-H-3(d,n)2-He-4
2-He-3(d,p)2-He-4
1-H-3(t,2n)2-He-4

The data were distributed by the US National Nuclear Data Center on September 6, 1991, on

tape 320: deuteron induced reaction data sublibrary,
tape 340: triton induced reaction data sublibrary,

for description, see document IAEA-NDS-105.

The ENDF/B-6 deuteron and triton sublibraries which contain so far only cross-sections as function of energy (MF=3), were evaluated and compiled by R.M. White and D.A. Resler at the Lawrence Livermore National Laboratory, USA. Included in the commentary sections are compilations of experimental data by various authors. The data are in ENDF-6 format, which is documented in IAEA-NDS-76, Rev.4.

FENDL/C-1.0 data library are available in the NDS open area 'FENDL' under the subdirectory

'[FENDL.FENDLC]'

It contains the following sublibraries and reactions:

Deuteron sublibrary, 435 blocks

1-H-2(d,n)2-He-3	(MF=3, MT=50 or MT=4)
1-H-2(d,p)1-H-3	(MF=3,MT=103)
1-H-3(d,n)2-He-4	(MF=3, MT=50 or MT=4)
2-He-3(d,p)2-He-4	(MF=3,MT=103

Note: In numerical section MT=4 has been used by the (d,n) reaction, although explanatory section gives MT=50.

Triton sublibrary, 74 blocks

1-H-3(t,2n)2-He-4 (MF=3, MT=16)

Processed information

The end-users of these charged-particle reaction evaluations are most often in need of processed information, i.e., Maxwellian-averaged reaction rates, and related quantities, calculated from reaction cross sections.

Following the recommendation of the above mentioned IAEA Advisory Group Meeting on 'FENDL-2 and Associated Benchmark Calculations', the FENDL/C-1.0 data library also contains the Livermore Thermonuclear Data File, TDF, and the utility routines in TDFLIB, library of subprograms to read TDF. The current file TDF containing the five reactions listed above has been created from the reaction cross section information contained in ENDF/B-6 charged-particle file.

Status of evaluations

The status of the important energy-producing charged-particle reactions for fusion applications was discussed at the IAEA Consultants' Meeting hosted in October 1992 by the U.S. Brookhaven National Laboratory, (see INDS(NDS)-268 document) and at the IAEA Specialists' Meeting held by April 1994 at the Smolenice Castle, Slovakia (see INDC(NDS)-306).

It was concluded (Brookhaven) that the three sets of integrated cross-sections evaluated at Arzamas, Russia, and at Los Alamos and Livermore, USA, are, in general, in a good agreement. However, a difference exists in the low-energy cross section for T(d,n)He-4 reaction. This difference is about four percent, which is larger than the uncertainty placed on this cross-section by the evaluators. Both, the Brookhaven and Smolenice meetings recommended that the ENDF/B-6 charged-particle sublibrary be adopted for the FENDL project and that the current low-energy difference of ~4% in the T(d,n)He-4 reaction be investigated by evaluators from Arzamas, Livermore, Los Alamos, and Vienna, so that it can be resolved. The jointly agreed-upon evaluation (Los Alamos-Vienna/Livermore/Arzamas) will be accepted for FENDL to replace previous one.

For any clarifications/suggestions, please contact:

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Attachment

DISTRIBUTION OF THE FENDL LIBRARY

(As recommended at the IAEA Advisory Group Meeting on FENDL, held in Del Mar, California, 5-9 Dec.1995)

The master copy of the FENDL-1 library resides with the Nuclear Data Section of the International Atomic Energy Agency. To facilitate user access to the library the official copy of FENDL-1 was distributed in February 1996 to the major nuclear data centres in Europe (NEA Data Bank, Paris), Japan (JNDC, Tokai-mura), Russia (CJD,Obninsk) and USA (NNDC, Brookhaven and RSIC, Oak Ridge). As agreed between data centers, sharing common FENDL information, the recipients are receiving now the same products from all above centers. The data are available and may be further distributed to the user community according to the customer service options given below. Each FENDL sub-library will be in a single data set, i.e. Activation, Decay, etc. in the 8 mm tape, 6 mm tape, 4 mm tape or standard 9 track magnetic tape (6250 bpi or 1600 bpi) and CD-ROM options. The interested scientists may request FENDL-1 (or parts of it) directly from the IAEA/NDS or from one of these centers.

Table 1. FENDL CUSTOMER SERVICE OPTIONS

MEDIA	FORMAT	By WHOM
Electronic	FTP	IAEA, NEADB, NNDC
4 mm tape	UNIX TAR	CJD, IAEA, NEADB, NNDC, RSIC
	VAX BACKUP	CJD, IAEA, NEADB, NNDC
	ASCII	NEADB
6 mm tape	UNIX TAR	NEADB
	VAX BACKUP	NEADB
	ASCII	NEADB
8 mm tape	UNIX TAR	NEADB, NNDC, RSIC
	VAX BACKUP	NEADB, NNDC
	ASCII	NEADB
9 track	ASCII	CJD, IAEA
	EBCDIC	CJD, IAEA
CD-ROM	UNIX TAR	RSIC
	ASCII	NEADB

Table notes
1) NNDC will distribute FENDL unprocessed data
2) RSIC will distribute FENDL processed data
3) RSIC offers cost free service to ITER customers

FENDL SUMMARY

FENDL is the evaluated nuclear database for fusion applications. Its present version consists of the following sublibraries for which the documentation and the FTP subdirectory for online service are given below. At the ITER neutronics coordination meeting in San Diego, Feb. 1995, the ITER participants agreed to use FENDL in all design calculations.

1. **FENDL/A-1.1** (April 93): neutron activation cross-sections, selected from different available sources, for 636 nuclides, given in four representations:
   - FENDL/A: "point data", i.e. cross-sections as function of energy in ENDF-6 format (see IAEA-NDS-148, Rev. 2, Feb. 1995). FTP subdirectory: ACTIVATION.FENDLA
   - "MCNP": processed into the format for input to the MCNP Monte-Carlo transport code (see IAEA-NDS-168, Rev. 3, Feb. 1996). FTP subdirectory: ACTIVATION.PROCESSED.MCNP
   - "VITJ_E": VITAMIN-J 175 group data, processed for input to the code REAC*2/3 using the VITAMIN-E weighting spectrum (see IAEA-NDS-168, Rev. 3, Feb. 1996). FTP subdirectory: ACTIVATION.PROCESSED.VITJ_E
   - "VITJ-FLAT": VITAMIN-J 175 group data, processed using a flat weighting spectrum (see IAEA-NDS-148, Rev. 2, Feb. 1995). FTP subdirectory: ACTIVATION.PROCESSED.VITJ_FLAT
2. **FENDL/D-1.0** (Jan. 92): nuclear decay data for 2900 nuclides in ENDF-6 format, extracted from ENDF/B-6 and ENSDF (see IAEA-NDS-167, Jan. 1995). FTP subdirectory: DECAY.FENDLD
3. **FENDL/DS-1.0** (Oct. 93): neutron activation data for dosimetry by foil activation. This is identical with file 1 (neutron activation cross-sections) of the International Reactor Dosimetry File IRDF-90 version 2 of Oct. 1993 (see IAEA-NDS-141, Rev. 2, Oct. 1993), given as multigroup data in 640 group extended SAND-2 format, without covariance data. FTP subdirectory: DOSIMETRY.FENDLDS
4. **FENDL/C-1.0** (Nov. 91): data for the fusion reactions D(d,n), D(d,p), T(d,n), T(t,2n), He-3(d,p) extracted from ENDF/B-6 and processed (see IAEA-NDS-166, Jan. 1995). FTP subdirectories: FUSION.FENDLC and FUSION.PROCESSED
5. **FENDL/E-1.1** (Nov. 94): data for coupled neutron-photon transport calculations, including
   - a data library for neutron interaction and photon production for 63 elements or isotopes, selected from ENDF/B-6, JENDL-3, or BROND-2 (see IAEA-NDS-128, Rev. 2, Feb. 1996)
   - a photon-atom interaction data library for 34 elements taken from ENDF/B-6 (see IAEA-NDS-58, Rev. 4, Sept. 1994)

   These are available in three representations:
   - original ENDF-6 format, as above, with resonance-parameters where applicable. FTP subdirectory: TRANSPORT.FENDLE
   - "FENDL/MG" (March 95): VITAMIN-J 175 group data in GENDF and MATXSR format processed by NJOY using the VITAMIN-E weighting spectrum (see IAEA-NDS-129, Rev. 3, Feb. 1996). FTP subdirectory: TRANSPORT.PROCESSED.FENDLMG
   - "FENDL/MC" (March 95): processed into the ACE format needed for input to the Monte Carlo code MCNP4A (see IAEA-NDS-169, Rev. 3, Feb. 1996). FTP subdirectory: TRANSPORT.PROCESSED.FENDLMC

FENDL BENCHMARKS

The FENDL/BENCHMARKS subdirectory contains compiled fusion benchmark descriptions and data, provided by the international community of benchmark specialists, for validation of the above mentioned FENDL libraries.

INTERNET/FTP online access to FENDL files

The FENDL data files can be electronically transferred to users from the IAEA Nuclear Data Section online system through INTERNET. In the NDS open area 'FENDL', a subdirectory was created for each sublibrary. The subdirectory names are given above. The file transfer via INTERNET (unix system) can be performed by 'ftp' command to the address 'iaeand.iaea.or.at' or '161.5.2.2'. The user should logon to the foreign user name 'FENDL'. No password is required. After having logged on, the user can set the definition to any required subdirectory and transfer files as desired. A grand total of 47 (sub)directories with 810 files with total size of nearly 2 million blocks or about 1 Gigabyte (1 block = 512 bytes) of numerical data is currently available on-line.

(96/2/29; app. to 7, 128, 129, 148, 166, 167, 168, 169)