

NUCLEAR REACTION DATA CENTERS

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Abstract: The cooperating Nuclear Reaction Data Centers are involved in the compilation and exchange of nuclear reaction data for incident neutrons, charged particles and photons. Individual centers may also have services in other areas, e.g., evaluated data, nuclear structure and decay data, reactor physics, nuclear safety; some of this information may also be exchanged between interested centers.

(data centers, nuclear data, neutrons, photons, charged particles)

Introduction

Eight Nuclear Reaction Data Centers (see Table 1) are involved in international agreements for the compilation and exchange of nuclear reaction data for incident neutrons, charged particles and photons. Individual centers may also have services in other areas, e.g., evaluated data, nuclear structure and decay data, reactor physics, nuclear safety; some of this information may also be exchanged between interested centers.

Each of the centers provides various services to its customers. These include retrievals from several files which are available at some or all centers. The data are available in various forms, including magnetic tapes, plots and publications issued either by individual centers or jointly by several centers. Some of the centers now provide on-line computer access to authorized customers.

International exchange

EXFOR

EXFOR^{1,2} is the exchange format designed to facilitate transmission of nuclear data between the data compilation centers. It was originally conceived for the exchange of neutron data through discussions held between personnel from a number of laboratories (i.e., Saclay, Vienna, Livermore and Brookhaven) and was accepted as a result of a meeting which was held in Moscow in November 1969 and which included participants from the neutron data centers at Saclay, Vienna, Brookhaven and Obninsk.

Subsequently, the format was further developed

and adapted to cover all types of nuclear reaction data as a result of two meetings held in Vienna in 1975/1976 on Charged Particle Nuclear Data Compilation, attended by representatives from an increased number of data centers.

The format is continually being modified to handle new types of data. Annual meetings, sponsored by the IAEA, are held to work out format agreements and the technical details of the exchange.

EXFOR is designed to meet the diverse needs of the nuclear data compilation centers, and has been designed for flexibility rather than optimization of data processing. Experimental nuclear reaction data for incident neutrons, charged particles, and photons are compiled at the data centers (see Table 1) and exchanged in the EXFOR format. Files containing the data are maintained at the centers.

Retrieval formats^{2,3} have been developed independently at each center to meet the needs of the users within each center's own sphere of responsibility. Efforts are being made to standardize these output formats in the future. Thus, codes written to use input data in the format of one of the centers would be able to use as input data retrieved by the other data centers.

Evaluated data

Evaluated data for neutrons is exchanged in the ENDF/B format, e.g., ENDF/B and BROND. ENDF/B-VI is being implemented to allow the inclusion of additional data types, such as double differential data and charged-particle induced reactions, as well as expanded covariance matrices.

CINDA

The Computer Index to Neutron Data (CINDA), contains bibliographic references to measurements, reviews, calculations, evaluations, and compilations of microscopic neutron data. All types of neutron reaction data as well as resonance parameters, level densities, spontaneous fission, photoneutron and photofission data are included.

The file is compiled as a joint effort of the four neutron data centers (NNDC, NEADB, NDS, CJD), and published on behalf of the centers by the IAEA⁴. Retrievals from the computerized data library are available on request.

Data Centers

National Nuclear Data Center (NNDC)

The NNDC is designated by the U.S. Department of Energy (DOE) to provide nuclear physics information services to users in the U.S. and Canada. The Center coordinates the Cross Section Evaluation Working Group (CSEWG) and the U.S. Nuclear Data Network, and edits and produces the *Nuclear Data Sheets* and *Recent References* for the International Nuclear Data Network.

ENDF/B (evaluated neutron data file) is maintained by NNDC. ENDF/B-V contains complete evaluations for ~100 elements. In addition there are some 900 partial evaluations of fission-product and dosimetry data. Many materials contain information about radioactive decay. Some multigroup data libraries, generally derived from ENDF/B, are available at the center.

NNDC also maintains the ENSDF (evaluated nuclear structure and decay data) file. ENSDF includes adopted level properties and decay schemes for ~2100 isotopes. The *Nuclear Wallet Cards* are produced directly from ENSDF. The Nuclear Structure Reference File (NSR) is also maintained at NNDC.

NNDC publishes an atlas of neutron data^{5,6,7} which features a volume of resonance parameters and a book of curves. They also publish an integral charged particle reaction data bibliography⁸ which is updated annually.

The NNDC has recently made its data bases available for on-line retrieval services⁹.

In addition to the *NNDC Newsletter*, published quarterly, the NNDC also issues the *Fast Neutron Cross Section Newsletter* annually. See *NNDC Products and Services*, available from NNDC on request, for more information.

Nuclear Energy Agency Data Bank (NEADB)

The NEA Data Bank operates as a special agency of the Organization for Economic Cooperation and Development (OECD) to provide a service to scientific users in the areas of nuclear data, reactor physics, nuclear safety, waste management, and computer codes related to nuclear reactor technology. The Data Bank serves fifteen Member countries in Europe, and Japan.

The Joint Evaluated File project (JEF), a combined effort by national laboratories in member countries, is coordinated by the Data Bank. The project aims to provide a complete file, fully valid for thermal and fast reactors, while the associated European Fusion File project (coordinated by ECN Petten) extends the range of applications to include fusion. The JEF-1 version contains approximately 100 complete evaluations, and 1300 partial evaluations. Following very extensive testing of JEF-1, a revised JEF-2 version is in preparation for 1989. The *Neutron Nuclear Data Evaluation Newsletter*¹⁰, issued by NEADB, covers evaluation projects worldwide.

The Computer Program service, maintained in association with U.S. software centres (National Energy Software Centre, Argonne and Radiation Shielding Information Center, Oak Ridge) and the IAEA, covers the full range of nuclear energy applications.

The scope of data compilations has recently been extended to include chemical thermodynamic data for waste management applications, and a computerised power reactor Incident Reporting System.

NEADB publishes a regularly updated cumulation of *Nuclear Programs Abstracts*¹¹, and two or more annual issues of *News from NEA Data Bank*, with occasional Newsletters on special technical topics. An on-line service¹² allows authorised users to scan the different data bases and request dispatch of information by post or computer network.

Nuclear Data Section (NDS)

NDS was established by the International Atomic Energy Agency (IAEA) to promote and coordinate the exchange of nuclear data among its member states. It also functions as the Secretariat to the International Nuclear Data Committee (INDC), and supplies to developing countries assistance needed for nuclear data measurements.

NDS services those countries outside the region of the OECD and the U.S.S.R., thus, its service area includes, in addition to Eastern Europe and Australia, all developing countries. Therefore, it is essential that NDS provide to users, not only the nuclear data files, but also the training to use these files. This purpose is served by the following projects:

- updating of the ENDF processing codes, not only for use on mainframe computers¹³, but also for use on personal IBM-compatible computers¹⁴.
- organization training courses on reactor physics and related computer codes, partly in cooperation with the International Center for Theoretical Physics in Trieste, Italy.
- sponsorship of coordinated research projects in developing countries.

As well as coordinating the work of the Nuclear Reaction Data Centers, the NDS coordinates the International Nuclear Structure and Decay Data Network and the compilation of WRENDATA, the world request list for nuclear data measurements.

Emphasis is given to standard reference data, their assessment and publication^{15,16}.

Full information on the services of the center can be found in the *IAEA Nuclear Data Newsletter*, issued once or twice a year. An index to the available data libraries is also available¹⁷. NDS also publishes, annually, *Progress in Fission Product Nuclear Data*¹⁸.

Nuclear Data Center (CJD)

The Nuclear Data Center (CJD) at Obninsk was established as an organ of the Nuclear Data Commission under the State Committee for the Utilization of Atomic Energy of the U.S.S.R. with the ultimate objective of providing an evaluated set of neutron data recommended for reactor calculations.

CJD is responsible for maintaining the evaluated neutron data library BROND¹⁹.

They publish the report series *Yadernye Konstanty* (Nuclear Constants) and *Yadernofizicheskie Issledovaniya v SSSR* (Nuclear Physics Studies in the USSR).

Other Participating Centers

The Center for Atomic and Nuclear Data (CAJaD) of the USSR State Committee for the Utilization of Atomic Energy in the U.S.S.R. was established in 1972 to collect, evaluate and disseminate non-neutron nuclear data.

The Center for Photonuclear Experimental Data (CDFE) was organized by the Institute of Physics at Moscow State University for the compilation, evaluation and dissemination of photonuclear data. They publish the bulletin *Fotoyadernye Dannye*

Table 1. List of Cooperating Nuclear Reaction Data Centers

Code	Address	Type of Data Compiled
CJD	Center for Nuclear Data Fiziko Energeticheskiy Institut Obninsk, Kaluga Region, USSR	Neutron
NDS	IAEA Nuclear Data Section P.O.B. 100 A-1400 Vienna, Austria DATEX-P 2322 Host ID 6221047 TYMNET 2329 Host ID 11507701 EARN/BITNET RNS@IAEA1	Neutron, Other
NEADB	NEA Data Bank Bâtiment 445 F-91191 Gif-Sur-Yvette CEDEX, France EARN/BITNET : "DBMAIL@FRNEAB51" TRANSPAC (PSN): (0)208 - (0)or(1)91040946 (Username: NEADB) PHYSNET/HEPNET: Decnet node address 32.9	Neutron
NNDC	National Nuclear Data Center Brookhaven National Laboratory Upton, N. Y., U.S.A. 11973 BITNET "NNDC@BNLDAG"	Neutron, Charged Particle
CAJaD	Center for Nuclear Structure and Reaction Data of the USSR State Committee on the Utilization of Atomic Energy I.V. Kurchatov Institute of Atomic Energy Moscow, USSR	Charged Particle
CDFE	Center for Photonuclear Experimental Data Nauchno-Iss. Inst. Yad. Fiz. Moskovskiy Gos. Universitet Leninskiye Gory Moscow, USSR	Photon
RIKEN	Nuclear Data Group RIKEN Institute of Physics and Chemistry Research Wako-Shi, Saitama, Japan 351-01	Charged Particle
IAE-CP	Charged-Particle Nuclear Data Group Institute of Atomic Energy P.O.Box 275 Beijing, People's Republic of China	Charged Particle

The following center has contributed in the past, but is no longer compiling data.

KaChaPaG	Karlsruhe Charged Particle Group Federal Republic of Germany	Charged Particle
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(Photonuclear Data).

RIKEN Nuclear Data Group in Japan is responsible for the compilation and evaluation of charged particle reaction data used in radioisotope production for medical uses.

The Chinese Nuclear Data Center (CNDC) was founded in 1975 by the Ministry of Nuclear Industry, and is the newest participating member in the Nuclear Reaction Data Center Network. They function as the national center for nuclear data information, and coordinate nuclear data on a national scale. CNDC is responsible for maintaining and developing the Chinese Evaluated Nuclear Data Library (CENDL).

KaChaPaG has published the multivolume *Karlsruhe Charged Particle Reaction Data Compilation*²⁰.

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