

NNDC Support For Fusion Nuclear Data Needs *

BNL-NCS--40836

DE88 007029

by
Charles L. Dunford
National Nuclear Data Center
Brookhaven National Laboratory
Upton, NY 11973

MASTER

for presentation at the
U.S.-Japan Workshop on Fusion Neutronics
University of California at Los Angeles
27-29 January 1988

SUMMARY

The National Nuclear Data Center (NNDC) located at Brookhaven National Laboratory is an outgrowth of the Sigma Center founded by D. J. Hughes to compile low energy neutron reaction data in the 1950's. The center has played a lead role in the production of evaluated nuclear data (ENDF/B) for the United States nuclear power program. This data file, now in its sixth version, is produced as a cooperative effort of many DOE funded organizations via the Cross Section Evaluation Working Group (CSEWG). The NNDC's role, in addition to providing the structure and leadership for CSEWG, is to supply compiled bibliographic and experimental data and provide file processing, checking, distribution and documentation services. In the past, the NNDC has also produced nuclear data evaluations.

*This work was performed under the auspices of the U.S. Department of Energy.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

2A

The National Nuclear Data Center is supported by the U. S. Department of Energy as the United States information center for low and intermediate energy nuclear physics data. The functions of NNDC include coordinating the U. S. nuclear data evaluation activities through the Cross Section Evaluation Working Group and serving as the primary focal point of international data exchange activity.

I. ENDF/B

At the present time, CSEWG is concentrating on the production of the sixth version of the ENDF/B evaluated nuclear data library, ENDF/B-VI. This version of the library will place more emphasis on data of interest for fusion reactor design. This emphasis is reflected in the production of neutron data evaluations for light and structural materials which carefully treat the secondary energy-angle distributions from neutron-induced reactions while extending the maximum energy of the evaluations to 50 or more MeV where possible. Other papers presented at this meeting will describe these new evaluations in more detail. Current plans call for the release of ENDF/B-VI early in 1989 after review and data testing of the new evaluations is completed. It is anticipated that this data file will be released without restrictions on its distribution. International cooperation would be welcomed in the review of the new evaluations.

One major new undertaking for ENDF/B-VI has been the simultaneous evaluation of the neutron standard reactions. It has taken a multi-year effort by evaluators at Argonne National Laboratory, Los Alamos National Laboratory, the National Bureau of Standards and Oak Ridge National Laboratory to produce the final results. Special care has been taken of the interrelationships (covariances) between the different experimental measurements which are included in the fit. Because of these experimental relationships, some heavy element fission and capture cross sections could also be evaluated.

Representation of these improved data evaluations in ENDF has been made possible by revisions to the ENDF file format, in particular the new format for secondary energy-angle distributions in File 6. Format revisions allowing the storage of charged particle reaction data have also been adopted. It is hoped that some evaluated charged particle reaction data will be available in ENDF/B-VI. Formats for covariance information for Files 4 and 5 have been adopted. The National Nuclear Data Center is responsible for the maintenance and production of the ENDF Formats and Procedures Manual for CSEWG. The contents of this manual contain the contributions of many CSEWG members focused on their areas of special expertise. For the first time, proposals for format changes submitted by researchers from other countries have been considered for ENDF-6. Draft sections of the format manual containing all of the important revisions to the ENDF formats, except for the covariance chapters, have been distributed world-wide.

The NNDC's role in the production of ENDF/B-VI includes the processing of new data evaluations, the preparation of review packages for the evaluations and ensuring the accuracy of the evaluations prior to their release. As an aid to fulfilling these responsibilities, NNDC has developed and maintained a package of computer codes designed to format, check, list and plot nuclear data evaluations in the ENDF format. These computer programs have been upgraded to conform to the changes adopted for ENDF-6 and have been distributed to the other international nuclear data centers. Scientists in Japan can request these codes from the Nuclear Energy Agency Data Bank at Saclay, France.

With the full approval of the U. S. DOE's Office of Fusion Research, CSEWG is cooperating with the attempt of the IAEA's Nuclear Data Section to provide an evaluated nuclear data file for the ITER project. NNDC has prepared a tape for transmission to the IAEA containing several older evaluations converted to the ENDF-6 format. Many of the new evaluations which are being presented to this meeting will be submitted for inclusion in this data file.

II. Bibliography

Two bibliographic data bases are maintained at NNDC which are relevant to meeting fusion data requirements. The one of most direct relevance is the CINDA data base. This data base contains a reaction data oriented bibliography of all publications on neutron reactions that have appeared since the discovery of the neutron. NNDC provides entries for publications produced in the United States and Canada as part of an international cooperative effort. Three other data centers cover the remaining literature. All centers exchange their compilations to insure complete world-wide coverage. CINDA also is used as an index to the compiled experimental neutron reaction data described below. New CINDA entries are published by the IAEA at six-month intervals. Each data center provides specialized CINDA retrievals for researchers in their respective service areas.

A second bibliographic data base, Nuclear Structure References, is also maintained at NNDC. This data base contains indexed references to publications reporting low and intermediate energy nuclear physics research. New entries are published at four month intervals in the NUCLEAR DATA SHEETS journal. Most of the literature scanning and abstracting is done at NNDC with some support from other countries for Russian, Japanese, Chinese and French language publications. NNDC and several other organizations around the world offer retrieval services from this data base. NNDC also publishes a specialized integral charged particle bibliography once a year which is derived from this data base.

III. Experimental Data Compilation

Experimental nuclear reaction data is compiled as part of an international cooperative effort using the EXFOR format. The four neutron data centers have made extensive efforts to include all measured neutron reaction data in this exchange. About 12 years ago, charged particle data compilation was added to

the international exchange and new data centers included in the compilation network. While a considerable amount of charged particle reaction data has been included in this exchange, only a small fraction of the available data has been compiled.

Previously, NNDC has published extensive neutron reaction data atlases, presenting the measured cross sections for all neutron induced reactions. Recent editions have used ENDF/B data evaluations where available as the "eyeguides" for the experimental data. The latest publication in this series has been completed and recently delivered to the publisher, Academic Press. This new edition has attempted to review and present ground state and isomer production cross sections in addition to what has traditionally been covered. The publication will contain about 850 pages of graphs and bibliography in both paperback and hardcover editions.

IV. Nuclear Structure and Decay Data

Since the late 1970's, NNDC has played a leading role in the production of evaluated experimental nuclear structure and decay data. This type of data can be important for assessing material activation in fusion systems. This information is evaluated as part of another international cooperative effort wherein scientists around the world evaluate this kind of data on a mass chain basis, that is, all nuclides of a given mass are evaluated simultaneously. In addition to producing some of the data evaluations, NNDC is responsible for the processing, review and publication of these mass chain evaluations in the NUCLEAR DATA SHEETS journal. These data are included in the ENSDF data base which is available from most international nuclear data centers.

These evaluations provide the starting point for the nuclear decay data evaluations which are included in ENDF/B. However since mass chain evaluators only consider experimental data when evaluations are performed, and some evaluations may be as much as ten years out of date, further efforts to update and complete it with theoretical calculations must be made before inclusion in the ENDF/B data file. Most of this work is being done at Idaho National Engineering Laboratory with some assistance from Hanford Engineering Development Laboratory.

V. Nuclear Data Request List

Periodically, the NNDC publishes a nuclear data request list on behalf of the U. S. DOE's Nuclear Data Committee. Requests for measurements of nuclear data are submitted to NNDC and reviewed by CSEWG before acceptance for inclusion. This publication contains a large number of requests for data measurements for the fusion reactor design program which are collected and reviewed by Ed Cheng of GA Technologies.

VI. Online Data Services

For the past two years, NNDC has been developing capabilities on its VAX 11/780 computer to enable our various data bases to be queried directly by researchers. Currently, we are offering access to all of our nuclear data bases in this system except for the experimental reaction data base, which should be available in a few months. In addition to access to the data bases, the online service offers an electronic mail facility, a current "news" feature, file transfer capability and an extensive address file of researchers in the nuclear data field. At present this service is available cost free in the United States. Access is possible via HEPNET, MFENET and telephone.