

~~IND SWG-189~~

INDC(ENE)*015

CCDN-NW/5

NEWSLETTER

N° 5

APRIL 1967

000196

NEUTRON DATA COMPILATION CENTRE

EUROPEAN NUCLEAR ENERGY AGENCY

TABLE OF CONTENTS

| | | |
|------|--|------|
| | Preface | iii |
| I. | Introduction | v |
| II. | Evaluated Files held at the ENEA Neutron Data Compilation Centre | vii |
| III. | Structure of the List | viii |
| IV. | References to the Text | xi |
| V. | List of Evaluations of Neutron Cross Sections Available at April 1967 | 1 |
| VI. | References to the List | 50 |
| VII. | Fold-out Sheet: Explanatory Notes to the List | 57 |

PREFACE

The Statute and Tasks of the ENEA Neutron Data Compilation Centre envisaged that the CCDN would undertake as one of its routine activities co-operation with existing evaluation groups to establish a central depository for compilations of evaluated data. It was hoped that evaluation groups would be persuaded to send copies of their completed work to the Centre where the material could be copied, stored and distributed on request to reactor design groups and other users. This activity was referred to briefly on page 32 of the CCDN's 1st Newsletter⁽¹⁾.

The coordination of evaluation work has been discussed at both national and international level on various committees and at conferences. In particular a very free and outspoken discussion took place at the Seminar on the Evaluation of Neutron Cross Section Data, held at Brookhaven National Laboratory in May 1965⁽²⁾. Here free vent was given to the general disquiet amongst evaluators on the then haphazard status of activities on evaluation. Such matters were also discussed at the Washington Conference, March 1966⁽³⁾, and the Paris Conference, October 1966⁽⁴⁾. Information on activities and requests for new evaluations have been collected and various recommendations made within the framework of the European-American Nuclear Data Committee and the European-American Committee on Reactor Physics, as well as in the EANDC-EACRP Joint Sub-committee on Nuclear Data Evaluation and the Committee of the ENEA Centre.

In the United States, the outcome has been a large coordinated and fast moving programme to apportion different evaluation requirements to competent laboratories and to collect the results in a uniform format at the Brookhaven Cross-Section Evaluation Centre in an evaluated nuclear data file (ENDF)⁽⁵⁾⁽⁶⁾. In Europe, the contribution which the CCDN could make to coordinate the evaluation effort was discussed at a meeting of the Committee of the Centre in July 1965. The Committee was of the opinion that progress could be made in a manner similar to that for data compilation; the references should first be properly collected and as the files of evaluated data became available, these should be collected in the Centre which would be required to supply copies on demand to the user.

In preparation for this kind of activity, an extensive overall improvement was made to the evaluation reference entries in CINDA⁽⁷⁾. The Committee had also recommended that K. Parker's compilation of extended references in evaluation work⁽⁸⁾⁽⁹⁾ also be taken over by the Centre and the first step in this collaboration resulted in a joint paper presented at the Paris Conference (CN-23/28)⁽¹⁰⁾. As a final step the Centre has taken over complete responsibility for this work and the present Newsletter contains an up-to-date compilation of evaluations, in the sense elaborated in the Introduction.

At a meeting in October 1966, the Committee of the Centre discussed again the question of the format of evaluated files. It was felt that unlike the American activities it was perhaps premature for many reasons to attempt to impose a common format in Europe for the evaluation files held on computer tape. The Centre Committee recommended that the Centre continue to collect evaluated files in the form supplied by the European evaluators and continue, under the co-operative arrangement between ENEA and the USAEC, to exchange European files with the US and to make available in Europe copies of the American files. Page vii lists the files presently held by the CCDN.

The Centre's present aims in this evaluation field are to maintain an up-to-date reference list of the type contained in the present Newsletter, to attempt to obtain as many evaluated files as are freely obtainable and to make these readily available to the users in its member countries.

Both the United States and the European Centres would be greatly aided in this work of coordination and compilation if evaluators write to their respective Centres pointing out errors and omissions in the present listing. At the same time evaluators should send completed files to the Centres in any suitable form. These will be distributed on request but detailed queries on the contents will be passed on to the originator of the file.

I. INTRODUCTION

Nuclear Data result from experiments and theory on the determination of quantities pertinent to nuclear structure and to the interaction between nuclei and particles. Within this very wide definition nuclear data appear in a large variety of forms comprising classes such as well-defined discrete parameters, discrete parameters determined within a given interval of confidence, a pointwise determination of a continuous quantity, the details of structure being more or less undisturbed by experimental resolution or by details of theoretical approach, etc.

Along with the growing quantity of information in the field, there has naturally developed a need for systematic collection and comparative critical studies of the existing material as a basis for continued fundamental research as well as for the different sectors of nuclear applications. A notable project on an international scale was the establishment and operation of the CINDA reference index(7), in which the field of interest is restricted to neutron data relevant to development of nuclear energy, that is to data relevant to neutron-induced processes in the energy range extending up to some 20 MeV. This basic effort was followed up by development of computerized systems for storage and retrieval of neutron data, presently providing rapidly expanding data libraries through the international co-operation of different compilation centres, notably those at Brookhaven, Obninsk, Saclay and Vienna.

In principle reference indices and data libraries form the basis for the activity referred to as nuclear data evaluation. This implies the establishment of a consistent and complete set of "best" values derived from critical studies of experimental results and systematic utilization of nuclear theory to interpret, condense and extrapolate experimental information. Accordingly, an evaluated file, by definition, gives all information concerning a specific nuclide needed as input to processing programmes for neutronics calculations. The consistency refers to quantities which are interrelated in some way, either directly or by their appearance in integral experiments. The completeness is viewed relative to the application, and thus the requirements vary with nuclide (material) and also with utilization of the file. Thus the work on fast reactors has brought about a large demand for the extension of the files on fast neutron data.

Obviously the term "critical comparison" involves a subjective factor and the evaluation process is not bound to yield a unique result determined by the physics information at hand. Since it is a well-known phenomenon that measurements on a given quantity often differ significantly (as a result of the great difficulty in eliminating all sources of systematic error), it may be difficult to state from the published data what weight to attach to a given series of data points. Further, the continuous production of new data resulting from refined methods (experimental and theoretical) calls for re-evaluation or at least updating of part of a file.

This continuous effort and the amount of work and experience needed for the process has necessitated the creation of programmes on national and international levels for rational co-operation as described in the Preface. The status and progress of evaluation work have been discussed at a number of conferences. As for coordination of effort, information on activities and requests for new evaluations have been collected and recommendations made within the framework of EANDC and EACRP. The release of the UKAEA Nuclear Data Library (latest version January 1967), the Kedak files from Karlsruhe and the ENDF/A library from BNL are examples of the development to make available the results of large evaluation programmes. The ENDF/B project, which now begins to yield results, some of which have already been released, is the latest example of a global effort to produce an up-to-date universal library incorporating all available information.

II. EVALUATED FILES HELD AT THE ENEA NEUTRON DATA COMPILATION CENTRE

The CCDN is building up a library of evaluated files for distribution to its member countries. From many aspects a library of this kind is very convenient for the user. For instance, the revision of a file may be automatically transmitted to all users by the exchange of the old tape for a new copy. Also the users of evaluated files can be kept informed of new completed files and of files in progress. The Centre already supplies from its data library all new experimental material arriving at Saclay to evaluators working on new files or on revisions.

Evaluated files available on request from the CCDN in computer media are listed below:

- I. The UKAEA Nuclear Data Library, new version released January 1967, (UK format)⁽¹¹⁾⁽¹²⁾;
 - II. ENDF/A from Brookhaven, (ENDF format)⁽¹³⁾;
 - III. Cu (V. Benzi), (UK format)⁽¹⁴⁾;
 - IV. Capture cross sections for fission product isotopes (V. Benzi), (UK format)⁽¹⁵⁾;
 - V. U^{238} (J. Ravier, only part of the energy range listed), (UK format)⁽¹⁴⁾;
 - VI. Cu (H. Haggblom), (UK format)⁽¹⁶⁾
 - VII. KEDAK library (J.J. Schmidt, will be released by the end of April 1967), (KEDAK format)⁽¹⁷⁾;
-
- VIII. 26-group cross section set (L.P. Abagyan et al.)⁽¹⁸⁾.

Further details on these evaluations are given in the computer listing presented in this Newsletter.

III. STRUCTURE OF THE LIST

The present list is a continuation of the work carried out by K. Parker, AWRE. The first two reports⁽⁸⁾⁽⁹⁾ included discussion of critical aspects and comparison of material available at September 1963 and November 1964 respectively. In the third report, published in co-operation with D. Goldman, NBS, and L. Wallin, CCDN⁽¹⁰⁾, detailed discussion was replaced by brief comments and the critical aspects were excluded (material regarded as obsolete or not of sufficiently general interest was not included). A new format, permitting rapid survey of the contents of an evaluation and of the general status for a given nuclide, was devised.

The present publication is a modified and updated version of the previous paper. The criteria for inclusion in the list are that the material should be generally available, that it should give a complete set of data for input to neutronics calculations, and that full documentation should be provided in support of the evaluation. These criteria can of course only be taken as a general policy and a certain arbitrariness necessarily obtains in the selection. (A much wider sense of "evaluation" has been applied in the CINDA index, where the notion of "file" is not considered. Consequently a study on the existing information for a specific quantity and nuclide is entered as an evaluation if conclusions are presented in the form of a "best value".) Suggestions from the users of the present list on the question of policy of entries will be of great importance in order to improve the value of forthcoming editions.

Details of the structure of the list are explained briefly on the fold-out sheet at the end of the Newsletter in order to facilitate the use of the list. Some further remarks may however be clarifying.

1. Nuclide (Material): Besides the isotope symbols and chemical symbols, there appear the abbreviations FPROD = fission products and GRPHT = graphite.
2. Energy Range: CINDA convention followed, i.e. a fixed point format with a two-digit number between 0.0 and 9.9 followed by an exponent, the dimension being eV.
 Thus for ab c read $a.b \cdot 10^c$ eV
 and for ab-c read $a.b \cdot 10^{-c}$ eV

The energy range as a rule gives the widest limits considered for the set of quantities listed, so that for any specific reaction type the interval of evaluation may only be a fraction of the interval stated.

3. Date of Evaluation: Gives a limit up to which the available literature is within reason thoroughly considered in the evaluation. This limit is as a rule several months before the date of publication

of the report. In cases where an available evaluated file has been updated or revised, the date of release is indicated in brackets below the date of evaluation.

4. Laboratories: CINDA abbreviations are used.
5. Reference: CINDA conventions are used. As a rule for institution reports the symbols are identical to the report codes. The date is the date of publication of the report or journal article. In cases where the reference is stated as "unpublished" the date of release of the file is given.
6. Data Media: This column indicates the form in which data are available. In particular, computer media (C) are the most convenient for transferring large blocks of data between laboratories. In most such cases the data are available on request from one or more of the international neutron data centres.
7. Data Bank: Indicates the data centres which can furnish copies of the evaluated file on request. If there is no data bank entry requests for data should go to the originating laboratory.
8. Reactions Considered: The system of Particular Classification Numbers devised for the UK Nuclear Data Library has been adopted. This scheme enables a brief description of the contents of an evaluation to be given in a small space. The information is reinforced by the column Data Type and by the Comments.
9. Data Type: A symbol giving a general quantitative classification of the evaluation. Together with the reactions listed and the comments, this indicates the completeness of the file in relation to a specific application.
10. Comments: The comment part is intended to give supplementary information not included in the fixed columns. This might concern specific types of representation of data (e.g. Legendre expansions of angular distributions) or the existence of some type of processed data (e.g. multi-group cross sections). In addition there are comments on the origins of the files, relation to other evaluations, status of the material presented, etc.

ACKNOWLEDGEMENTS

The ENEA Neutron Data Compilation Centre gratefully acknowledges the co-operation offered by many workers in the evaluation field. In particular, valuable contributions have been made by Drs. V. Benzi, D.T. Goldman, K. Parker, S. Pearlstein, J. Ravier, J.J. Schmidt and J.S. Story, both to the evaluation library of the Centre and to the information on evaluation activities.

REFERENCES

- (1) ENEA Neutron Data Compilation Centre, Newsletter no. 1 (CCDN-NW/1), May 1966;
- (2) Proceedings of the AEC-ENEA Seminar on the Evaluation of Neutron Cross Section Data, Brookhaven, May 1965;
- (3) Proceedings of the Conference on Neutron Cross Section Technology, Washington, D.C., March 1966;
- (4) Proceedings of the IAEA Conference on Nuclear Data - Microscopic Cross-Sections and Other Data Basic for Reactors, Paris, October 1966;
- (5) Honeck, H.C., "The Evaluation and Processing of Nuclear Data for Use in Reactor Calculations", American Nuclear Society Meeting, Pittsburgh, October 1966;
- (6) Pearlstein, S., private communication;
- (7) CINDA: An Index to the Literature on Microscopic Neutron Data (published periodically by the ENEA Neutron Data Compilation Centre, Saclay, and the USAEC Division of Technical Information Extension, Oak Ridge); latest issue - Supplement 2 to CINDA '66, EANDC 70"U", CCDN-CI/15, available shortly;
- (8) Parker, K., "A Review of Evaluations of Neutron Cross Sections Available at September 1963", EANDC(UK) 26 "U", September 1963;
- (9) Parker, K., "A Review of Evaluations of Neutron Cross Sections Available at November 1964", AWRE O-13/65, March 1965;
- (10) Parker, K., Goldman, D.T. and Wallin, L., "Neutron Cross Section Evaluations - Past, Present and Future", Paris Conference [see ref. (4)], paper CN-23/28;
- (11) Story, J.S., et al., "Evaluation, Storage and Processing of Nuclear Data for Reactor Calculations", Third United Nations International Conference on the Peaceful Uses of Atomic Energy, A/CONF.28/P/168, May 1964;
- (12) James, M.F. and Parker, K., "Neutron Cross-Section Data Evaluation by the United Kingdom Atomic Energy Authority", Brookhaven Seminar [see ref. (2)], Activity Report United Kingdom - 2;
- (13) Honeck, H.C., "Evaluated Nuclear Data File - Description and Specifications", BNL 8381, June 1964;
- (14) Unpublished;
- (15) Benzi, V. and Bortolani, M.V., "An Evaluation of Fission Product Neutron Capture Cross Sections in the Energy Range 1 keV - 10 MeV", Paris Conference [see ref. (4)], paper CN-23/115;

- (16) Häggblom, H., "Copper Cross Sections for Fast Reactors", AE-RFR-597, March 1967;
- (17) Schmidt, J.J., "Neutron Cross Sections for Fast Reactor Materials Part I: Evaluation", KFK 120, EANDC-E-35"U", February 1966;
- (18) Abagyan, L.P., et al., "Group Constants for Designing Nuclear Reactors", Consultants Bureau, N.Y., 1965 [also KFK-tr-144 (German translation) and EDF-tr-1287 (French translation)].