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**Interaction Between the National Neutron Cross Section Center,
the Cross Section Evaluation Working Group, and the User Community**

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The primary base of evaluated nuclear data in use in the United States is produced by the cooperative efforts of two groups: The Cross Section Evaluation Working Group (CSEWG) and the National Neutron Cross Section Center (NNCSC), which administrates the former.

The coordination of tasks and activities by these two groups has resulted in considerable savings of time and effort at laboratories throughout the U.S. due to elimination of duplications and the standardization of reference files and formats. The most outstanding product of the interaction between these two groups, however, is the Evaluated Nuclear Data File-B[1] (ENDF/B), the third version of which has been distributed in February 1972, and which, at present, contains some 238 different sets of data.[2] The file has been generated entirely in agreement with basic cross section measurements, available at the time of the evaluation. Although results from carefully performed integral benchmark calculations were used in some cases to influence the selection of one experimental set over another, the file is intended to serve as a "user's" file and not merely as a starting point to be thrown away after an "adjusted" set has been created.

The CSEWG-NNCSC interaction with each other, the user community, and the funding agencies, as well as the procedures followed in the generation of the ENDF/B files, will be examined in this paper.

1. OBJECTIVES OF CSEWG

CSEWG was organized in 1966, by the Division of Reaction Development and Technology of the USAEC, for the purpose of assessing data evaluation

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needs and capabilities among its contractors and similar organizations. Since that time, CSEWG has provided a forum where nuclear data problems can be discussed, solutions proposed, and evaluation and testing activities coordinated.

A prominent achievement of CSEWG has been the significant cooperation that it was able to bring about among the members of the three groups most directly concerned with nuclear data: the experimentalists, the evaluators, and the users.

At present the objectives of CSEWG are:

- a) To formulate the scope and contents of the reference library (ENDF/B).
- b) To establish formats and procedures for the use of the library.
- c) To perform differential and integral testing of the data for consideration in ENDF/B.
- d) To provide recommendations on new experiments, evaluations, or codes that are needed.

2. COMPOSITION AND FUNCTIONS OF CSEWG

CSEWG consists of a group of working level representatives from national laboratories, industrial organizations, and academic institutions that are formally committed towards the achievement of CSEWG objectives. Participation is by laboratory rather than on an individual basis, in order to insure the continuity of activities.

Formal laboratory participation can be established by direct communication from the funding agency or laboratory management to the chairman of CSEWG. (A list of current participating laboratories is shown in Table I.) To this group of evaluation and data testing experts, the NNCSC, by request of the USAEC, acts as a secretariat; providing a chairman, meeting facilities, personnel, preparation and distribution of material, preliminary data, and other services as required. CSEWG, in return, provides the NNCSC with guidelines for the preparation of ENDF/B; and the funding agencies with recommendations for new evaluations, measurements, or codes.

The NNCSC provides the interface to the user community by distributing the finalized and approved data files and their documentation. User requests for new or additional evaluations are received by the NNCSC and channeled to CSEWG through the chairman.

3. ADMINISTRATION OF CSEWG

Decisions regarding CSEWG objectives are reached at the CSEWG executive meetings. These meetings are held twice a year at the Brookhaven National Laboratory. Although wide participation in the overall CSEWG effort is encouraged, attendance at the executive meetings is limited to one or two representatives from each institution in order to assure the representation of each laboratory without sacrificing the advantages of effective face to face discussion offered by a small group.

Much of the ground work necessary in order to reach decisions on CSEWG objectives, is done either by permanent specialized subcommittees or

temporary "ad-hoc" committees in between executive meetings. These "ad-hoc" committees are appointed as needed and generally have a wider participation. Experts from outside of CSEWG may be invited. In general, no attempt is made to include all experts on a matter, but only as many as is necessary to reasonably deal with the problem at hand.

At present, CSEWG consists of the following subcommittees:

1) Data Testing	6) Fission Products
2) Codes and Formats	7) Error Quantities
3) Normalization and Standards	8) Nuclear Model Codes
4) Shielding	9) Non Neutron Data.
5) Resonance Region	

In carrying out their assigned tasks and responsibilities, the subcommittees must closely interact with one another. From this point of view, the two most central committees are the Data Testing and Codes and Formats Subcommittees. Decisions regarding the balance between the physics and user needs in the areas of fast, thermal, shielding, and fusion applications are made in these two central committees.

4. THE DATA TESTING SUBCOMMITTEE

The primary purpose of the Data Testing Subcommittee is to provide CSEWG with a formal mechanism for the testing of nuclear data. Evaluated data sets being considered for inclusion in ENDF/B must undergo a series of tests. The first level of testing is done at the NNCSC in a more or less mechanical manner. Data sets submitted to the NNCSC are tested for correctness of structure and formats[3] to insure their processability by further codes. Next, increasingly rigorous physics consistency checks are conducted.[4,5] Obvious errors, when present, are reported to the original evaluator and corrected. Finally the data set is put into a standard form and a package containing the results of all checking codes, as well as a set of detailed plots is produced and submitted to the Data Testing Subcommittee. Data sets reaching this stage are assigned, by the Subcommittee, to one or more reviewers for a detailed "microscopic" review. The purpose of this review (referred to as Phase I review) is to determine the adequacy of the evaluation with respect to the most current experimental evidence. The Data Testing Subcommittee is responsible for the coordination of all Phase I reviews, as well as the recommendation for the acceptance, modification, or rejection of the preliminary sets. Data sets approved by the Subcommittee become officially part of the ENDF/B Library as category I data.

A further responsibility of the Data Testing Subcommittee is to determine the validity of the ENDF/B data in certain specific areas of application important to the overall national nuclear effort.

This objective is achieved by coordinating the Phase II integral and differential testing of the data in certain well defined "benchmark" situations. This phase of the testing is carried out in close cooperation with other subcommittees specifically responsible for a particular area of application. The major areas of Phase II testing are the following:

- a) Fast neutron data
- b) Thermal neutron data

- c) Dosimetry
- d) Shielding
- e) Fission products.

The results of the Phase II testing are evaluated and published by the Data Testing Subcommittee in a timely manner, and are used in making recommendations for further data measurements, evaluations, or integral experiments when the need for these has been established.

5. THE CODES AND FORMATS SUBCOMMITTEE

The second objective of CSEWG, the establishment of formats and procedures for the use of the ENDF/B Library, is the responsibility of the Codes and Formats Subcommittee.

This responsibility includes the consideration of all proposed format additions and modifications and consequently it involves close cooperation with other subcommittees. Although any member of CSEWG may propose a format modification, in general, these proposals are made by the subcommittee most directly involved with the type of data that would be affected by the format modification (i.e., proposals affecting the formats and use of the gamma ray production are made by the Shielding Subcommittee).

After considering a proposal, the Codes and Formats Subcommittee may approve it, reject it, or return it to the originator with a request for further documentation or testing. Often suggestions for an alternate approach are made.

An approved format modification generally results in the following CSEWG tasks:

- 1) Updating of the Formats and Procedures Manual[1] by the NNCSC.
- 2) Updating of all affected computer programs to recognize the new formats by their responsible programmers.
- 3) Translation of the old library into the new format by the NNCSC.
- 4) Requesting of evaluators to conform to the new formats.

Because of the magnitude of the above tasks, proposals most likely to be accepted are those which do not involve extensive modifications in existing computer programs, or the translation of large amounts of data sets.

In addition to the ENDF/B formats and procedures, the Codes and Formats Subcommittee has responsibility for:

- a) Improving and maintaining the integrity of codes which directly use the ENDF/B data.
- b) Making recommendations for the development of additional processing or data manipulation codes.

The "Tedium Isotopes Test"[7] constitutes a good example of some of the effort going into the maintenance and improvement of existing codes. The "Tedium Isotopes" are a set of fictitious materials created in the ENDF/B format for the purpose of testing processing codes. In general, these isotopes contain a single salient and potentially troublesome

characteristic (e.g., single narrow p-wave resonance, a large resonance located at a group boundary, etc.). The intercomparison of results from different codes processing the Tedium materials has resulted in the discovery and correction of numerous theoretical inaccuracies in algorithms or simple coding errors.

In the area of recommendations for new processing codes, the Subcommittee is presently cooperating in the specification of a group library preparation code capable of producing a single, ENDF/B based, library of group constants that could be used for thermal reactor and shielding applications as well as for fast reactors. The production of such a library is planned for the near future.

6. OTHER SUBCOMMITTEES

In close cooperation with the first two subcommittees are a number of more specialized groups. These are:

6.1. The Normalization and Standards Subcommittee

A number of ENDF/B Cross sections are defined as standards. These include the thermal cross sections of all primary fissile nuclei as well as all cross sections classed as measurement standards by the U.S. Nuclear Data Committee.

The Normalization and Standards Subcommittee has the responsibility for continual review of these cross sections. Any modification of their ENDF/B files must have the concurrence of the Subcommittee. In addition, the Subcommittee makes recommendations on the values and shapes of thermal cross sections and resonance integrals of all ENDF/B materials and is in the process of developing a file of neutron dosimetry cross sections. The Phase I review and Phase II testing of the dosimetry file is being done under the direction of the Data Testing Subcommittee.

6.2. The Shielding Subcommittee

Checking the validity of the shielding data files in ENDF/B, determining their deficiencies, improving and correcting them is the primary responsibility of the Shielding Subcommittee. This is done through Phase I review and Phase II testing in cooperation with and under the direction of, the Data Testing Subcommittee.

The interaction with the Codes and Formats Subcommittee consists of:

- 1) Suggesting formats and procedures for the shielding data files.
- 2) Reviewing the adequacy of codes used in processing of data for shielding calculations, including determination of needs or deficiencies through data testing and "Tedium" like code testing programs, recommending corrective actions.

Because of the nature of the data involved, the Shielding Subcommittee must interact strongly with other data centers in addition to the NNCSC (e.g., the Radiation Shielding Information Center at Oak Ridge National Laboratory, and the Photonuclear Data Center at the National Bureau of Standards) and with the shielding community in general.

6.3. Resonance Region Subcommittee

The committee is primarily concerned with problems relating to the different formalisms in use in the resonance region; their interpretation, formats, and procedures.

6.4. Fission Product Subcommittee

The evaluation, review, and testing of materials produced in fission is the primary responsibility of this Subcommittee, in cooperation with the Data Testing and Normalization and Standards Subcommittees.

6.5. Nuclear Model Codes Subcommittee

Nuclear model codes are used to supplement experimental evidence in producing the ENDF/B files. The use of these highly complex codes may often result in discrepancies due to numerical or physical errors. The scope of the Nuclear Model Codes Subcommittee is to keep the CSEWG members aware of codes reflecting those discrepancies as well as of new areas of code development.

6.6. New Subcommittees

The final two subcommittees are indicative of the trends presently being considered for the future versions of ENDF/B. The purpose of the Error Quantities Subcommittee is to study and make recommendations on the means and procedures for including errors or confidence limits in the ENDF/B files to be used in sensitivity calculations; while the Non Neutron Data Subcommittee is responsible for recommending means of including charged particle cross sections of interest to shielding and fusion calculations.

7. CONCLUSION

The cooperative NNCSC-CSEWG effort can be viewed as a successful example for the generation of a data base designed to satisfy the needs of a wide user community. The success of this effort can be seen in the widespread use of the ENDF/B Library as a reference file. The generation of a evaluated file, based entirely on the best experimental information available, yet accurate in the calculation of integral experiments, could only be made possible through the close cooperation of evaluators with experimenters and users through the CSEWG organization.

This effort is expected to continue in the future in order to achieve the following goals:

7.1. Improve the accuracy of the existing files

In particular, ^{235}U capture and fission, ^{239}Pu capture, the standard cross sections, and the number of neutrons emitted in fission will be reviewed in the light of recent experimental evidence. The existing files are known to give reasonably good agreement with integral experiments for the case of fast assemblies. The next version of ENDF/B is expected to give improved agreement with thermal assemblies.

7.2. Expand the number and type of evaluations in the library

The next version of the library should contain evaluations for additional materials and reaction types. Shielding data files will be provided for additional materials.

7.3. Expand the usefulness of the library in new areas of application

This can be done by providing error files, charged particle interaction data, and reactions of interest to controlled thermonuclear fusion work.

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TABLE I

Institutions Participating in CSEWG Activities

CSEWG - Laboratory

Aerojet Nuclear Co. (ANC)
Argonne National Laboratory (ANL)
Atomic Power Development Assoc. (APDA)
Atomics International (AI)
Bettis Atomic Power Laboratory (BAPL)
Babcock & Wilcox (B&W)
Battelle Northwest (BNW)
Combustion Engineering (CE)
Defense Nuclear Agency (DNA)
General Electric Co. (GE)
Gulf Radiation Technology (GRT)
Hanford Engineering Development La. (HEDL)
Knolls Atomic Power Lab. (KAPL)
Lawrence Livermore Lab. (LLL)
Los Alamos Scientific Lab. (LASL)
National Bureau of Standards (NBS)
Nuclear Fuel Systems (NFS)
Oak Ridge National Lab. (ORNL)
Rensselaer Polytechnic Inst. (RPI)
Savannah River Lab. (SRL)
U. S. Atomic Energy Comm. (USAEC)
Westinghouse Electric Corp. (W)

Other

Atomic Energy of Canada Ltd. (AECL)
Columbia University
Mathematical Application Group, Inc. (MAGI)
Radiation Shielding Information Center (RSIC)
Stanford University

Fig. 1 - Relationship between NNCSC-CSEWG, the funding agencies and the user community.

Fig. 2 - Checking procedures for ENDF/B evaluations.