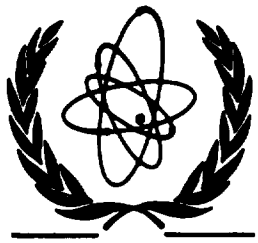

International Atomic Energy Agency

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INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

Report on the SIXTH IAEA CONSULTANTS' MEETING OF NUCLEAR REACTION DATA CENTERS

Vienna International Centre,

3 - 7 May 1982

Including

the 17th FOUR-CENTERS MEETING

of THE NEUTRON DATA CENTERS

and

the 7th MEETING ON CHARGED PARTICLE NUCLEAR DATA COMPILATION

December 1982

IAEA NUCLEAR DATA SECTION, WAGRAMERSTRASSE 5, A-1400 VIENNA

Reproduced by the IAEA in Austria
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Abstract

This report summarizes the 1982 coordination meeting of the national and regional nuclear reaction data centers, convened by the IAEA at an interval of about 1 1/2 years. The main topics are

- the international exchange of nuclear reaction data by means of the "EXFOR" system,
- the further development of this system,
- the sharing of the workload for speedy and reliable data compilation,
- the exchange of specialized and evaluated data libraries,
- the role of ENDF/B as an international format for the exchange of evaluated data

with the goal of rendering data center services to data users, by means of computer retrievals and printed materials.

Edited by

M. Lammer
O. Schwerer

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GLOSSARY OF ABBREVIATIONS

BNL	Brookhaven National Laboratory, Upton, N.Y., USA
CAJaD	Center for Nuclear Structure and Reaction Data, Kurchatov Institute, Moscow, USSR
CDFE	Centr Dannykh Fotojad. Eksp., Moscow State University, USSR
CINDA	A specialized bibliography and data index on neutron nuclear data operated jointly by NNDC, NEA-DB, NDS and CJD
CJD	USSR Nuclear Data Center at F.E.I., Obninsk, USSR
CPND	Charged-particle nuclear reaction data
CRP	Coordinated Research Programme of the IAEA Nuclear Data Section
CSISRS	Cross-Section Information Storage and Retrieval System, the EXFOR-compatible internal system of NNDC
DOE	US Department of Energy
DOE-NDC	Nuclear Data Committee of DOE
ENDF	US Evaluated Nuclear Data File
ENSDF	Evaluated Nuclear Structure Data File
EXFOR	Format for the international exchange of nuclear reaction data
FIZ	Information Center of the Fed. Rep. of Germany for energy, physics, mathematics, Karlsruhe, Fed. Rep. of Germany
IAEA	International Atomic Energy Agency
INDC	International Nuclear Data Committee
INDL	The IAEA Nuclear Data Library for evaluated neutron reaction data
INIS	International Nuclear Information System
IRDF	The International Reactor Dosimetry File, maintained by the IAEA/NDS
JEF	The Joint Evaluated File of neutron data, a collaboration of European NEA member countries and Japan
KACHAPAG	Charged particle nuclear data group, Karlsruhe, Fed. Rep. of Germany

LANL	Los Alamos National Laboratory, Los Alamos, N.M., USA
LEXFOR	Part of the EXFOR manual containing physics information for compilers
LMFBR	Liquid-Metal Fast Breeder Reactor
NDS	IAEA Nuclear Data Section, Vienna, Austria
NEA	Nuclear Energy Agency of the OECD, Paris, France
NEACRP	Nuclear Energy Agency Committee on Reactor Physics
NEA-DB	NEA Data Bank, Saclay, France
NEANDC	Nuclear Data Committee of the OECD Nuclear Energy Agency
NEUDADA	Neutron Data Direct Access. Earlier data file of NEA, now included in EXFOR.
NND	Neutron Nuclear Data
NNDC	National Nuclear Data Center, Brookhaven National Laboratory, USA
NRDC	the Nuclear Reaction Data Centers
NSDD	Nuclear structure and decay data
OECD	Organization for Economic Cooperation and Development, Paris, France
ORNL	Oak Ridge National Laboratory, Oak Ridge, Tenn., USA
PhDC	Photonuclear Data Center, Washington, USA
SGIP	Study Group for Information Processing, Sapporo, Japan
SOKRATOR	USSR evaluated neutron data library (and format), now included in INDL
SR	Status report of centers to this meeting
TP	Topical paper presented at this meeting
TRANS	Name of transmission tapes for data exchange in the EXFOR system
WP	Working paper presented at this meeting
WRENDA	World Request List for Nuclear Data

The Nuclear Reaction Data Centers

The following data centres participate in the international data exchange by means of the EXFOR system developed and maintained under the coordination of the IAEA Nuclear Data Section:

NDS	- IAEA Nuclear Data Section
NNDC	- US National Nuclear Data Center, Brookhaven, USA
NEA-DB	- OECD/NEA Nuclear Data Bank, Saclay, France
CJD	- USSR Centr po Jadernym Dannym (= Nuclear Data Center), Obninsk, USSR
KACHAPAG	- Karlsruhe Charged Particle Group, Karlsruhe, FRG*)
CAJaD	- USSR Centr po Dannym o Stroenii Atomnogo Jadra i Jadernykh Reakcikh (= Nuclear Structure and Nuclear Reaction Data Center), Moscow, USSR
CDFE	- Centr Dannykh Fotojad. Eksp. (= Center for Experimental Photonuclear Data), Moscow, USSR
PhDC	- Photonuclear Data Center, Washington, USA
FIZ	- Fachinformationszentrum Karlsruhe, FRG
SGIP	- Study Group for Information Processing, Sapporo, Japan (expected to join)

These data centers cooperate on the following projects:

1. Neutron Nuclear Data

1.a Bibliography and Data Index "CINDA":
Input prepared by NEA-DB, NNDC, NDS, CJD
Handbooks published by IAEA

1.b Experimental data exchanged in EXFOR format:
Input prepared by NNDC, NEA-DB, NDS, CJD

1.c Data Handbooks based on EXFOR published by NNDC

1.d Evaluated data exchanged in ENDF/B format:
NNDC, NEA-DB, NDS, CJD and others

1.e Computer retrieval services upon request of customers:
NNDC, NEA-DB, NDS, CJD

2. Charged Particle Nuclear Data (including heavy-ion reaction data)

2.a Bibliography and Data Index published by NNDC*)

2.b Numerical data exchanged in EXFOR format:
Input prepared by KACHAPAG*), CAJaD, NDS, NNDC; SGIP

2.c Data Handbooks based on EXFOR published by FIZ/KACHAPAG**)

2.d Computer retrieval services upon request of customers:***)
NNDC, NEA-DB, NDS, CAJaD

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*) Discontinued by the end of 1981
**) To be discontinued in 1982
***) Retrievals will be more and more incomplete due to lack of compilation of newly measured data

3. Photonuclear Data

3.a Numerical data exchanged in EXFOR format:
Input prepared by CDFE, NNDC(PhDC), NDS

3.b Bibliography published by CDFE

3.c Computer retrieval services upon request of customers:
NNDC, NEA-DB, NDS, CDFE

LIST OF PARTICIPANTS

NNDC	V. McLane
	S. Pearlstein (centre head)
NEA-DB	C. Nordborg
	N. Tubbs (centre head)
NDS	D. Cullen (part-time, chairman for topical session)
	M. Lammer (meeting secretary)
	H. D. Lemmel (chairman for technical sessions)
	P. K. McLaughlin (part-time)
	K. Okamoto
	M. Okumu (part-time)
	V. Pronyaev (part-time)
	J. J. Schmidt (centre head, chairman for general sessions)
	O. Schwerer (meeting secretary)
	M. Seits (part-time)
CJD	V. N. Manokhin (centre head)
CAJaD	F. E. Chukreev (centre head)
	G. M. Zhuravleva
FIZ	H. Behrens (Wednesday)

A G E N D A

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MINUTES

Note: Only selected papers submitted to this meeting are included in this document and referred to by the appendix in which they appear. All papers submitted are identified in the minutes by an abbreviation under which they can be found in the list given in Appendix 1.

The Conclusions, Recommendations and Actions are given in separate sections following the minutes.

INTRODUCTION

Agenda Item 1. Introduction of Meeting Participants, Election of Chairmen

J.J. Schmidt introduced the meeting participants to Prof. Frolov, Director of the Division of Research and Laboratories.

The following session chairmen were elected by the meeting participants:

J.J. Schmidt for the general sessions

H.D. Lemmel for the technical sessions

D.E. Cullen for the topical discussion on ENDF/B

Agenda Item 2. Opening of the Meeting

The meeting was opened by Prof. M. Zifferero, Deputy Director General of the IAEA's Department of Research and Isotopes. He congratulated the participants for the successful data exchange system developed since the beginning of the IAEA Nuclear Data Section in 1964, being an excellent example of international cooperation. He mentioned the stronger participation of developing Member States in the Agency's nuclear data programme and the enhanced transfer of nuclear data information to those States as a consequence of changing priorities and requirements as defined by the International Nuclear Data Committee. Nuclear data needs as well as data determination activities by experiment, theory and evaluation continue at rather constant level in developed countries, but at increasing level in developing countries.

Prof. Zifferero pointed out that the Agency's nuclear data programme emphasizes the development of reference evaluated nuclear data files for specific applications, and consequently an important part of this meeting will be devoted to the development of international evaluated nuclear data files in ENDF/B format. Prof. Zifferero expressed his wishes for a succesful meeting and an enjoyable stay in Vienna.

Agenda Item 3. Adoption of Agenda

The tentative agenda was discussed and adopted (see page 7). However, it was decided to combine agenda items 16, 17, 21 and 23 into a session on CPND and photonuclear data at the time when H. Behrens is present. At the same time the heads of data centres meet for "policy" discussions. Agenda items 27. and 28. were deferred to the final session.

Agenda Item 4. Status reports of the Centres

S. Pearlstein presented the status report of NNDC (see Appendix 2). Regarding the discontinuation of the bibliography of integral charged particle nuclear data he pointed out that the "Reaction List" of Recent References could be used or enhanced in some way as a continuation. The planning for ENDF/B-VI is continuing, but release cannot be expected before 1985. The work on the "charged particle barn-book" is continuing, details have still to be fixed.

N. Tubbs presented the status report of NEA Data Bank (see Appendix 3). The main new activity of NEA-DB is the development of the new Joint Evaluated File (JEF) of neutron data.

V.N. Manokhin presented the status report of CJD (see Appendix 5). Since July 1980 TRANS tapes 4040-4043 were transmitted to other centres. However, TRANS tapes 4042 and 4043 had not yet arrived at NDS by the time of the meeting. Retransmission was requested (see Actions 1,2*)).

F.E. Chukreev presented the status report of CAJaD (see Appendix 6). Since August 1980 tapes A005 and A007 were transmitted. Emphasis was given to the compilation of (p,n) reactions in accordance with action 14 (33) of the fifth NRDC meeting. F. E. Chukreev asked whether CPND from US compiled by CAJaD could be disseminated.

S. Pearlstein replied that there is no restriction for CPND.

F.E. Chukreev presented also the report of the CDFE centre (see Appendix 7). The TRANS tape M002 was sent to NDS but not received. Retransmission was requested (see Action 4).*)

J.J. Schmidt and H.D. Lemmel presented the status report of NDS (see Appendix 4). The main new activity of NDS as data centre is the processing of ENDF/B formatted data and the development of the IAEA Evaluated Neutron Data Library (INDL), with subfiles for Actinides (INDL/A) and for dosimetry (IRDF-82). Emphasis is also given to the fast increasing number of requests and the increasing contacts to the People's Republic of China.

Besides the data centre activities, the main activity is the "Interregional Project for the Training of Nuclear Scientists in Developing Countries, Using the Expertise Available in the Nuclear Data Field".

D.E. Cullen reported on evaluated data compilation and processing at NDS. He pointed out that during the comparisons mistakes were found in many processing codes.

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*) TRANS-4042 and 4043 arrived at NDS in June, TRANS-M002 in August 1982.

N. Tubbs remarked that codes should only be distributed to requestors by NEA-DB to ensure that they receive the last, checked version.

Agenda Item 5. Review of actions from previous NRDC meeting

The actions of the last NRDC meeting were reviewed. No important actions were found pending.

TECHNICAL DISCUSSIONS

Agenda Item 11. CINDA

H.D. Lemmel reported on the cost and price development of CINDA and its possible implications for the publication schedule.

This topic was discussed by the meeting. Several actions were formulated to find out alternatives to the present publication schedule (Actions 6-9).

A working paper on the CINDA book production and the coding of conferences was presented by M. Lammer (WP2) and discussed by the meeting (Actions 10, 11, Conclusions 2,3).

Agenda Item 12. WRENDA

Until a successor for N. DayDay will join NDS, M. Lammer will proceed in the initiation of WRENDA 83/84 (Conclusion 1): in July 1982 country retrievals will be produced and sent out (see Appendix 4 for schedule of WRENDA update cycle).

J.J. Schmidt pointed out that NDS is not authorized to do any selection on WRENDA request entries submitted.

The meeting expressed continuous concern of the data centres about the contents and usefulness of WRENDA and the actual review of WRENDA requests by the requestors and national bodies. Efforts should be made towards improved verification of requests.

Agenda Item 13. EXFOR matters relevant to all nuclear reaction data

Starting from a working paper presented by O. Schwerer (WP13) the meeting surveyed mistakes that occur in EXFOR TRANS tapes and their implications on EXFOR rules (Conclusions 4-14, Action 12).

The meeting accepted the introduction of Kerma factors by NDS (Memo CP-D/106 p.2) for use in the EXFOR-V series (Conclusion 15).

Following the suggestion in memo CP-D/105, the proposal of memo CP-A/29 to change the minimum unit for retransmissions to whole entries was discussed at the meeting. It was decided that this should not be a general rule for EXFOR. However, NDS offered to temporarily supply CJD and CAJaD with updated complete entries until these centres can accept retransmissions of altered subentries.

The meeting agreed that transmissions in ISO-QUANT formalism will be terminated by the end of 1982 (Action 14). However, conversion of the master files is left to the centres and bilateral arrangements.

It was emphasized that changes in EXFOR entries should always be documented under HISTORY or STATUS when retransmitted.

It was requested that NDS changes the date on the TRANS record of corrected tapes from CJD and CAJaD (Action 15).

The proposed LEXFOR entry on the code "INT" (Memo CP-D/104) was discussed and adopted with one addition (Conclusion 16).

The meeting emphasized that redundant codes in the REACTION string should be avoided (Conclusion 17).

Agenda Item 14. EXFOR matters relevant to neutron data only, and
Agenda Item 15. Use of EXFOR by Data Evaluators; Error Analysis, Covariances

K. Okamoto presented a paper on a completeness check of EXFOR and CINDA for some important dosimetry reactions (Memo 4C-3/255). Some inconsistencies between CINDA data flags and EXFOR were observed when compiling an evaluation of these reactions in the EXFOR-V series. In order to facilitate the necessary corrections, the meeting asked NEA-DB to retrieve from CINDA all cases where such inconsistencies occur (Actions 19,20).

The meeting agreed that the conversion of the 80000 series should be started by identifying duplications with Area 4 entries which can immediately be deleted (Actions 16, 17).

H.D. Lemmel presented a letter by Dr. L. Adamski (Swierk, Poland, WP11 see Appendix 12) and asked all centres to correct the mistakes in EXFOR entries mentioned in this letter (Action 18).

The proposals of NNDC regarding the repetition of the data-heading keywork MASS (Memo CP-C/92) and new headings for energy resolution (Memo CP-C/91) were adopted (Conclusions 18, 19).

The meeting adopted (Conclusion 20) NNDC's proposal on Polarization (Memo CP-C/93) and asked NDS to reword the relevant codes in Dict. 36 (Action 21). In case of questions about the dictionary update or the LEXFOR entry NDS should contact V. McLane. If entries containing the code POL,,ASY (which is to be deleted) are found by NDS retransmission will be requested *).

NNDC suggested a cleanup of the Dictionaries 3 and 7. In Dictionary 3 (Institutes) a uniform style of the expansions and English translations of institute names is aimed at (Conclusions 21, 22, Action 22). For Dictionary 7 (conferences and books) an additional short expansion not exceeding one line is introduced (Conclusion 23).

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*) Editor's note: EXFOR entries 10163, 20989 and 21312 contain the code POL,,ASY. Retransmission is requested.

H.D. Lemmel presented a paper on "Statistics of EXFOR" (WP3, see Appendix 10) showing the development of EXFOR compilation. He noted that certainly no overall decrease in nuclear data activities can be observed.

The completeness of EXFOR compilation is saticfactory up to 1977; however, from experimental year 1978 onwards, transmissions of Area 4 data have decreased drastically. The meeting considered it important that CJD catches up with compilation of these experimental years.

The meeting discussed NNDC's proposal on error specifications (Memo CP-C/81). It was decided that the keyword COVARIANCE is introduced (Conclusion 24) but information should be given in free text only. The proposal was adopted with some modifications (see Conclusion 26 and page 23).

The meeting agreed that the restriction to 18 columns for DATA and COMMON sections remains in effect (Conclusion 25).

CPND AND PHOTONUCLEAR DATA

Agenda Item 16. Charged-Particle Nuclear Data,
Agenda Item 17. Photonuclear Data
Agenda Item 21. Brief Status Report by H. Behrens, Karlsruhe, and
Agenda Item 23. How to Continue the Work of KACHAPAG (partially)

H. Behrens introduced the status report of FIZ Karlsruhe (see Appendix 9) explaining the reasons for the discontinuation of CPND compilation at KACHAPAG (see Appendix 8). However, three more volumes of the series "Physics Data" No. 15 and one index will still be published.

K. Okamoto introduced working papers on the importance of selected CPND and photonuclear data (WP 10, see Appendix 11) and on the results of questionnaires concerning the nuclear data needs for medical applications (WP 14 + 17). In summary (WP 14): out of a total of 44 answers, 17 stated that they were not satisfied with the currently available data for medical radionuclide productions. Out of these 17, 11 are in need of excitation functions, 6 of yield data. 22 of the 44 answers had no comment on this, and only 5 stated that they were satisfied with the available data. He concluded that the need for compilation of CPND for medical applications is shown.

F.E. Chukreev commented on stopping power data, pointing out discrepancies in particular in experimental data.

Concerning the question whether CAJaD could take over part of KACHAPAG's compilation, he explained that the scope of CAJaD's compilation depends on requests from USSR and that no increase in manpower is expected. Perhaps another Soviet group could be found. CAJaD will look into the possibility of maintaining the CPND master file.

H.D. Lemmel offered that for the time being NDS would take over the maintenance of the master file and checking of CAJaD TRANS tapes. NDS will also try to find other groups to contribute to the compilation effort.

The meeting agreed on a Statement on charged-particle nuclear data summarizing the discussions which was added to the Center Heads' Statement on CPND (see page 18).

Concerning photonuclear data, F.E. Chukreev informed the meeting that the Moscow University Centre (CDFE) compiles primarily data from USSR institutes. The future scope will depend on available manpower and the requests from USSR. Apart from its compilation activity, CDFE is also one of the main producers of photonuclear data.

H.D. Lemmel appreciated that CDFE has taken over the EXFOR format.

V. McLane reported that, in spite of repeated requests, the Berman Library of photonuclear data could not be obtained. Whatever will be obtained in the future will be forwarded to CAJaD. At this time only the 1978 version is available (to all centres).

It was agreed that NDS will try to obtain the most recent version of the Berman library (Action 23).

"POLICY" DISCUSSIONS

The heads of the data centers met in a separate session to discuss policy matters (Agenda Items 22. - 25.). Part of the conclusions is summerized elsewhere in the minutes under the appropriate items. Re charged particle data compilation: see the Statement on page 18.

Agenda Item 26. Customer Services

Working papers on the status of the NDS EXFOR Computation format, a new CSISRS Users Manual and NNDC products and services were presented to the meeting (WP 16, 19, 20; see Appendices 13, 14, 15; Action 26).

Topical Session: ENDF/B AS INTERNATIONAL FORMAT

Agenda Item 31. Presentation of Topical Papers
Agenda Item 32. Discussion on Future Cooperation

The meeting decided to draft the conclusions on ENDF/B as international format after the discussions. They are, therefore, generally not referred to individually in the following summary.

S. Pearlstein gave an introduction to the role of NNDC in ENDF (TP3, Appendix 16). He announced Revision 2 of ENDF/B-V for June 1982, including a re-evaluation of Li-7 and several elemental evaluations based on evaluations performed for their isotopes. For ENDF/B-VI, changes in format will probably concentrate on the planned inclusion of CPND, while no major changes in the format for neutron data are anticipated.

The need for new reaction types (MT numbers) will probably arise for fission spectra - where LANL plans to introduce a new parametrization - and for the energy range above 20 MeV. Requests for such extensions should be directed to S. Pearlstein.

NDS will review the coding in ENDF/B of reactions leading to metastable states and send comments to NNDC (Action 27).

In reply to questions from N. Tubbs and H.D. Lemmel, S. Pearlstein gave the following information:

- Evaluated CPND might first be stored in EXFOR format and later be translated automatically into the new format.
- NNDC has no conversion program from ENDF/B-V to ENDF/B-IV format since the two formats are largely compatible.
- ENDF/A is a collection of various files in different formats. New files received are advertised in NNDC's newsletter, but there are only few requests for those data.

S. Pearlstein asked NDS to continue to involve participants from US in the Actinides CRP (INDL/A file) and similar projects. In order to ascertain the completeness of the INDL/A file as far as user requirements are concerned, Bob Schenter should be asked to identify the data types needed for actinides evaluations to be used in burn-up calculations.

V. Manokhin asked what should be done when deficiencies of an evaluation were found, in particular, if theoretical models used are inappropriate. He himself suggested that in order to find the reason of discrepancies, also the optical-model codes used for the evaluations should be compared.

D.E. Cullen mentioned the review procedure by another evaluator foreseen in ENDF/B, which could also be applied to other evaluated files.

S. Pearlstein mentioned the international exercise for comparing codes organized by NEA-DB.

V. Manokhin said that sufficient information on models and parameters used should be given to allow judgement of the evaluation and possible reasons for discrepancies.

N. Tubbs summarized the experience of NEA-DB with the comparison of codes. He said that in a rather simple level density exercise, only two codes out of eight did what the authors thought they do. The existing exercise should be extended and no parallel program should be started.

V.Manokhin said that if INDL/A is intended to develop from a collection of evaluations to a recommended file, a working group similar to CSEWG would be needed which would also have to agree on common evaluation methods.

N. Tubbs and C. Nordberg presented a paper on the compilation of the Joint Evaluated File (JEF) (TP4, Appendix 17). So far 27 nuclides have been compiled in ENDF/B-V format. All data are given in point-wise form without the use of resonance parameters, but in a later stage a second file giving resonance parameters might be created.

Version 1 of the library (JEF-1) will be released at the end of 1982, JEF-2 is foreseen for the end of 1985. The file will be available to member countries of the NEA-DB.

V. Manokhin gave a summary of the programmes used in CJD in connection with the ENDF/B format (see attachment to CJD progress report, Appendix 5). He further presented problems in the use of the ENDF/B format for evaluations covering the resolved and unresolved resonance region, e.g. the different energy limits for s- and p-wave resonances.

These and other problem areas were further discussed by the meeting and some solutions suggested. However, the meeting agreed that changes for the ENDF/B-V format should be kept to a minimum.

D.E. Cullen presented the NDS project on verification of nuclear cross section processing codes (TP1). He explained that in view of the discrepancies found in the processing accuracy of codes when processing the same input data, NDS has started a step-by-step verification procedure with the participation of a number of laboratories in the US and Europe. Another project, involving a selected group of users, has the goal of creating a new version of the ENDF/B Pre-processing codes that is compatible with use on the widest variety of computers possible.

V. Pronyaev reported on USSR evaluations in ENDF/B-V format and conversions of the SOKRATOR library to this format done at NDS. In particular he mentioned problems in the format conversion caused by the limitation of the number of competitive widths in the unresolved resonance region to 1 in ENDF/B, e.g. in the (n, f)-process.

O. Schwerer reported on problems encountered in the conversion of some Austrian evaluations related to spectra of secondary charged particles and some special partial reactions (TP2).

K. Okamoto reported on evaluations compiled at NDS in EXFOR format (EXFOR-V). Above 20 MeV, the large variety of reactions created problems. It was suggested to ask the users of such data what kind of presentation and degree of detail was needed. Also the ENDF/C format could be useful for such data. He showed an example of high energy neutron cross sections: the large variety of reactions with thresholds around 20 MeV and above makes it impossible to compile these data in ENDF/B (TP5, Appendix 18).

He also discussed the importance of (n,t) reactions in the energy range near 20 MeV where evaluated data files are deficient (see the graph of Al-27(n,t) reaction in WP16, Appendix 13).

V. Pronyaev summarized problems with the covariance files in IRDF. He explained problems with the cross section interpolation in evaluations where the points of the excitation function actually represent average cross sections for energy groups of varying widths.

D.E. Cullen said that different versions of the same computer codes related to ENDF/B are being used in different laboratories. Some ways for a common development of codes should be found.

S. Pearlstein suggested that information about such codes should be exchanged through a newsletter (see Conclusion 35).

As a result of the discussion, conclusions 27 through 35 on ENDF/B as international format as well as Actions 28 and 29 were formulated.

FINAL SESSION

Agenda Item 42. Actions, Conclusions and Recommendations

The list of conclusions, recommendations and actions resulting from the meeting were reviewed and corrected by the participants.

Agenda Item 41. Remaining Items from the Agenda

J.J. Schmidt briefly informed the meeting about the centre heads discussions.

V. McLane added that a reduction of EXFOR compilation to priority data may be possible in case of further budget restrictions.

Agenda Item 28. Date and Place of next NRDC Meeting

The next NRDC Meeting was announced to be held in Moscow, adjacent to the Kiev Conference (September 1983) with an excursion to Obninsk.

Agenda Item 27. Meetings

J.J. Schmidt summarized the planned meetings. NDS will send a list to the other centres (Action 32).

J.J. Schmidt closed the meeting.

6th IAEA Consultants' Meeting of the
Nuclear Reaction Data Centers*)
IAEA, Vienna, 3-7 May 1982

Statement on charged-particle nuclear data

The Heads of the Nuclear Reaction Data Centers noted that the discontinuance, forced by reduction in budgets, of the Index to the Bibliography of Integral Charged Particle Data at the National Nuclear Data Center (NNDC) at Brookhaven National Laboratory and of the compilation of integral charged particle data by the Karlsruhe Charged Particle Group (KACHAPAG) at the Kernforschungszentrum Karlsruhe created setbacks in charged-particle nuclear data compilations and exchange. These activities have provided valued services to a large body of scientists in basic and applied science. The loss of this information from centralized sources will cause great redundancy of individual users' efforts. It is hoped that ways will be found to preserve this expertise and for the NNDC and KACHAPAG to resume the discontinued compilations and services.

The meeting identified classes of charged-particle nuclear reaction data important for application in various technologies (including neutron sources, nuclear activation techniques, radioisotope production, charged-particle data supporting nuclear model calculations for important neutron data, nuclear fusion, cancer therapy and others). The need is recognized for having an international coordination and cooperation for the systematic measurement, compilation, evaluation and publication of such data. The existing nuclear reaction data centres have the tools and expertise but insufficient manpower to perform this task, and therefore the participation of additional groups in the existing data center cooperation would be necessary. Such a co-operation should use the existing formats and exchange procedures of the internationally agreed EXFOR System.

*) See page 4 for a list of the co-operating Nuclear Reaction Data Centers, taken from the document IAEA-NDS-1 Rev.1, "Short Guide to EXFOR", September 1981.

List of Conclusions and Recommendations

Conclusion on WRENDA

1) The preparations for the next issue, WRENDA 83/84, will proceed as the last issue.

Conclusions of the working session on CINDA on conference codes

2) New conference codes in EXFOR (Dictionary 7) are restricted to 8 characters (2 digits + 6 alphabetic characters).

3) Conference codes in the style of 80BNL-2 continue to be acceptable.

Conclusions on Exfor

4) The restricted character set is retained. Centres are asked to implement checks on invalid characters.

5) The rule, that no opening parenthesis in col. 12 is permitted for keywords without coded information, remains strict.

6) (Change!) The use of the heading MISC in the COMMON section is permitted from now on (although not recommended).

7) The coding rules for DECAY-DATA remain strict. Because of the fairly complicated structure of these rules it is recommended to improve the check programs in this respect.

8) (Change!) For DECAY-DATA, the use of the -G extension to identify the ground-state of a nuclide which has one or more metastable states, is no longer compulsory. This does however not change the coding rules for the reaction product field (SF4) of REACTION, where -G indicates that a partial cross section is given.

9) (Change!) Coded information is no longer obligatory for DECAY-DATA.

10) The * in col. 80 of the NOSUBENT record of deleted subentries must not be omitted, since it is needed in some of the EXFOR programs (e.g. the NDS indexing program).

11) The following coding rules for REACTION remain strict: -G for the ground-state may only be used when metastable state(s) exist; -M may only be used for metastable states (not for shortliving excited levels).

12) Receiving centres should accept blanks instead of zeroes in EXFOR subaccession numbers and line numbers.

13) The centres are encouraged to improve checking codes to detect coding errors in the numerical data tables.

14) The rules for the use of the keyword EN-SEC (in particular when the reaction proceeds through a shortliving intermediate state) should be observed.

15) (Addition) The compilation of KERMA-factors is accepted for the EXFOR-V and charged particle series (together with the required dictionary additions), but is not accepted for regular neutron EXFOR.

16) The LEXFOR entry on the code "INT" as proposed in Memo CP-D/104 is adopted with the following addition:

"If such data are coded it should be clearly mentioned who integrated them. Generally only data provided by the experimentor are included.
If the differential data are compiled, a reference to the integrated data under ADD-RES may be sufficient."

17) Redundant codes in the REACTION string (examples: 'particle considered' where no ambiguity exists, 'IND' when only one reaction channel is possible) should be avoided since they may create problems e.g. for retrieval programs.

18) (Change!) The proposal of Memo CP-C/92 (add the data-heading keyword MASS to the list of keywords which may be repeated within a subentry) is adopted.

19) (Addition) The proposal of CP-C/91 on Energy Resolution is adopted (new headings EN-RSL-FW and EN-RSL-HW). A graphical example should be added to the proposed LEXFOR entry for clarification.

20) NNDC's proposal on polarization is adopted.

21) New principles for the style of expansions in Dict. 3 (Institutes) are accepted:

1. The expansion has the purpose to enable the user to identify the institute. Instructions for compilers (like old names) follow the expansions in the free text.
2. No country code in the expansion.
3. Do not repeat the city name if already given in the institute's name.
4. City name should always be present, and should be in the original language, if appropriate.
5. Where necessary, original language name and English translation should both be given, separated by an equal sign, with the original language name first.
6. Use commonly known abbreviations where necessary.
7. Expansions are limited to 2 lines.

22) If NNDC makes a thorough clean-up of Dict. 3, they will send suggested changes to the responsible centre for approval.

23) For Dict. 7 (Books and Conferences) a short expansion will be introduced in addition. It is limited to 1 line and enclosed in parentheses. In the following line(s) a longer expansion may be given in the usual style, also enclosed in parentheses.

24) The keyword COVARIANCE is introduced in the BIB section. Covariance information will be given where possible in structured form in free text.

25) The restriction to 18 columns both for DATA and COMMON sections remains in effect.

26) Memo CP-C/81 about Error Specifications is adopted with some modifications (see page 23).

Conclusions on ENDF/B as international format

27) The ENDF/B format should be a good basis for international cooperation as NNDC states that no changes are to be expected for at least the next 3-4 years.

28) Changes in the ENDF/B dictionaries and conventions (such as extension of dictionaries, clarifications, improvement of the manual) should be directed to NNDC, Dr. Sol Pearlstein.

29) Problem areas relating to (28) above as identified at the meeting are:

- neutron induced reactions leading to metastable states;
- different borderlines between resolved and unresolved resonance regions for s- and p-wave resonances;
- the use of Reich-Moore parameters;
- charged particle spectra in neutron induced reactions;
- limitation of the number of competitive widths to 1 in the unresolved resonance region (e.g. the $(n,\gamma f)$ process).

30) If the coding of an evaluation in ENDF results in a loss of the information provided by the evaluator, and if it is desired to keep all information, an alternate format, e.g. EXFOR should be used in addition, for storing the evaluator's original data.

31) Evaluators submitting their evaluations for inclusion in an ENDF/B format file should give a summary documentation of the methods and major sources used in the 1451 section. Data centres should request authors to provide also detailed documentation.

32) For the selection of appropriate evaluation methods, the "Workshop on Evaluation Methods and Procedures" held at BNL, 22-25 Sept. 1980, forms a suitable basis.

33) If errors or deficiencies in particular evaluations are found, the authors and the data centres should be notified.

34) The comparison and testing of nuclear model codes on an international scale conducted by the NEA-DB is very much appreciated. It is recommended that this effort be continued by NEA-DB and extended to other types of benchmarks. Data centres are asked to verify the relevance of the current exercises to their interests and to suggest other problems if necessary.

35) A newsletter on nuclear model and processing codes related to ENDF/B is suggested that contains information on formats and different versions of the same codes at different laboratories. NEA-DB volunteers to consider an extension of contents and distribution of its Newsletter NNDEN.

Recommendations on EXFOR

1) Centres should study whether neutron data and charged particle data require different checks in the EXFOR checking programs.

2) After collecting experience with the presentation of covariances the centres should propose a method for coding covariance data in a retrievable format.

3) On the basis of the increasing volume and variety of services requested from the data centres, the meeting strongly recommends that the completeness of the EXFOR neutron data compilation, including fission yields, be continued in the future.

Agreed Rules for the Inclusion of Detailed Error Information in the International Data Exchange Files (EXFOR)

Formulated at the Fifth Nuclear Reaction Data Centers Meeting
Brookhaven National Laboratory, September 1980,
modified at the Sixth Nuclear Reaction Data Centers Meeting
Vienna, May 1982

General Comments

1. First priority should be given to the compilation of detailed information on statistical and systematic errors for experimental data on neutron cross sections of standards and dosimetry reactions, in new entries and for retransmitted data sets.

2. When the required information is not given in the puclication, every effort should be made to obtain the information from the authors.

3. They keyword COVARIANCE is introduced. All correlation factors and covariances, if given by the authors, are given in free text, where possible in structured form. If this becomes too bulky for inclusion in EXFOR, a reference where details can be found is sufficient.

4. Errors should be broken down into statistical and systematic errors.

5. Errors will be given as one standard deviation or the equivalent for systematic errors.

6. Systematic errors should be broken down into individual independent components and these components should be given as a function of energy. They should not be combined into a final variance-covariance matrix (V-C matrix) as this represents a significant loss of information.

7. The breakdown of systematic errors into major components by source should be "fine" enough so that the correlations between sub-components at different energies within a given major component may be reasonably set equal to a constant lying between +1.0 and -1.0.

8. In the case of systematic errors where the preceding is not satisfied, e.g., background determination in a time-of-flight experiment with black filters, the quantitative information on the energy dependence of the correlations should be given in "comments" which include the appropriate algebraic expressions.

Note: *Errors referred to here are an expression of the uncertainty of the measured data and are not mistakes or blunders.

9. The preceding two proposals avoid the problem of having to give a gigantic V-C matrix in the files and allow the evaluator construct the V-C matrix of the data from the information given. They also allow for the inclusion of new information on any major error component obtained at a later date.

10. Measured ratios should <u>always</u> be given when they are available.

11. Data measured in different experimental runs with changes in experimental parameters, e.g., sample, flux monitor, etc., should be given as separate sets.

<u>Specific Proposal</u>

1. Error fields will be identified as statistical or systematic (or total, if that is all that is given). The definition of the different systematic errors will be given in free text comments.

2. Only errors which are one standard deviation or the equivalent will be entered using this format. If authors give 2- or 3-sigma-errors, EXFOR compilers will convert them to 1-sigma-errors. Other types of error information will usually be given in free text only.

3. Constant errors, such as in sample thickness, etc., will be entered in the COMMON data section or in free text under ERR-ANALYS, others will be given as a function of energy.

4. The data will be tabulated as follows:

ERR-1	ERR-2						
$\varepsilon 1$	$\varepsilon 2$						
ENERGY	EN-ERR	EN-RSL	DATA	ERR-S	ERR-3	ERR-4	. . .
E_1	ΔE_1	$E_R(E_1)$	$B(E_1)$	$\Delta_{stat}(E_1)$	$\varepsilon_3(E_1)$	$\varepsilon_4(E_1)$	. . .
E_2	ΔE_2	$E_R(E_2)$	$B(E_2)$	$\Delta_{stat}(E_2)$	$\varepsilon_3(E_2)$	$\varepsilon_4(E_2)$	. . .
.	.	.	.	.	.	.	. . .
.	.	.	.	.	.	.	. . .
E_i	εE_i	$E_R(E_i)$	$B(E_i)$	$\Delta_{stat}(E_i)$	$\varepsilon_3(E_i)$	$\varepsilon_4(E_i)$	. . .
.	.	.	.	.	.	.	. . .
.	.	.	.	.	.	.	. . .
E_n	ΔE_n	$E_R(E_n)$	$B(E_n)$	$\Delta_{stat}(E_n)$	$\varepsilon_3(E_n)$	$\varepsilon_4(E_n)$	. . .

where ENERGY = Lab energy of incident particle
EN-ERR = energy uncertainty
EN-RSL = resolution
(a Gaussion distribution is assumed; (EN-RSL) defines the variance of the distribution.)

DATA = the measured data (B)
ERR-S = statistical error (Δ_{stat})
ERR-1 = constant 1st major component of systematic error (ε_1)
ERR-2 = constant 2nd major component of systematic error (ε_2)
ERR-3 = 3rd major component of systematic error (ε_3)
ERR-4 = 4th major component of systematic error (ε_4) etc.

The following are assumed:

$$\langle \Delta_{stat}(E_i) \; \Delta_{stat}(E_j) \rangle \equiv 0 \quad \text{if } i \neq j$$

$$\langle \Delta_{stat}(E_i) \; \varepsilon_\ell(E_j) \rangle \equiv 0$$

$$\langle \varepsilon_\ell(E_i) \; \varepsilon_m(E_j) \rangle \equiv 0 \quad \text{if } \ell \neq m.$$

$$\langle \varepsilon_\ell(E_i) \; \varepsilon_\ell(E_j) \rangle \equiv \varepsilon_\ell(E_i) \; \varepsilon_\ell(E_j) \; \rho_{ij}$$

where ρ_{ij} is a constant between -1.0 and +1.0

See General Comment 8, when ρ_{ij} is energy dependent.

List of Actions

No.	on	
1	CJD	Inform receiving centres when EXFOR TRANS tapes 4042, 4043 were sent; retransmit 4042 and 4043 to NDS.
1a	V. Mclane	Check, if (and if yes, when) tape 4042 was received at NNDC.
2	all	When sending tapes to other centres, send telex giving date of dispatch, contents and tape number.
3	CAJaD	Transmit n-source CPND to other centres.
4	CAJaD	Retransmit TRANS-M002 to NDS.
5	all	Address tapes clearly to NDS, not only to IAEA.
6	NDS	Investigate how the CINDA price would be affected if the bulk orders would decrease.
7	NDS	Submit until August 1982 different publication scenarios of CINDA with cost estimates.
8	NEA-DB	Provide statistics of CINDA file, on which cost estimate can be based.
9	all except NDS	Comment on NDS' CINDA publication proposals (ref. Action 7) until October 82.
10	all	Check the list of "selected literature scanned" in the CINDA book and delete publications with low CINDA-relevance.
11	all	Comment on the new CINDA layout.
12	NDS	Change the EXFOR checking programme so that blanks in sub-accession numbers and line numbers can either be accepted as such or automatically replaced by zeroes without causing error messages.
13	NDS	Update files after receipt of corrections from NNDC and NEA-DB in subentry units and send complete files to CJD and CAJaD until these centres have adapted their programmes to accept subentries as the units of retransmission.
14	neutron data Centres	By the end of 1982 the transmission of keywords ISO-QUANT and STANDARD will be terminated.

No.	on	
15	NDS	When NDS corrects tapes from CJD and CAJaD to be sent on to the other centres, the date on the TRANS record should be changed so that the corrected version can be distinguished from the original version.
16	NNDC	Retransmit the 80000 series to CJD.
17	CJD	Inform the other centres which entries of the 80000 series can immediately be deleted.
18	all	Correct the mistakes found by Dr. Adamski in his letter (WP11, see Appendix 12).
19	NEA-DB	Check whether they can retrieve from the CINDA file and send to responsible centres: - data flagged entries on experiments which do not have an EXFOR index line; - a list of EXFOR index lines in CINDA.
20	all	Make necessary corrections arising from action 19.
21	NDS	Reword in Dict. 36 existing entries on POL as listed in the new LEXFOR entry page Polarization-5 as well as POL - POL/DA - POL/DA,,ASY; remove POL,,ASY from Dict. 36.
22	all	Each centre should review Dict. 3 from its area, but it is not expected that much manpower is invested.
23	NDS	Try to obtain most recent version of Berman's file and send it to CAJaD for the Moscow Photonuclear Centre.
24	NDS	To improve the wording in the EXFOR Manual about the use of REACTION-SF7 (particle considered) and to introduce examples for clarification.
25	NDS	Send comments on CJD CINDA EXFOR index lines.
26	NDS	Send completed parts of EXFOR computational format to CJD.
27	NDS	Review the coding in ENDF/B of reactions leading to metastable states and send comments to NNDC for clarification.
28	NDS	Investigate quantitatively the effect of the $(n,\gamma f)$ process on the self-shielding, in order to be able to judge whether this process requires improved treatment in ENDF/B.

No.	on	
29	NDS	Test the effect of particular interpolations chosen for cross sections between the nuclear and the Coulomb threshold on calculated spectrum average cross sections.
30	NNDC and NDS	Update EXFOR Manual and Dictionaries according to the EXFOR Conclusions of this meeting.
31	neutron data Centres	Circulate to evaluators and selected experimentors the proposal for inclusion of detailed uncertainty information in EXFOR.
32	all	Send lists of planned meetings until 1985 to the other centres.
33	NDS	Circulate list of actions and conclusions to all before draft minutes.

Continuing actions from last meeting

34(7)	all	When Center staff attend specialists meetings, collect and distribute papers relevant to the other Centers' interests.
35(19)	NDS	Inspect data sets 30319.002, 30328.011 and 30395.002 to see if limiting the number of EXFOR data fields to 18 is reasonable.
36(20)	all	Review references for charged particle reactions that have equivalent neutron fission reactions, such as (d,pf) and (t,df), and decide whether or not to compile them in EXFOR. The retroactive cutt-off data is 1965.
37(21)	all	Implement checking programs to verify that compilers observe the LEXFOR rule concerning particles in reaction subfield 7 (SF7).
38(41)	Neutron Data Centers	Compile fission spectrum data in EXFOR with priority.

Appendix 1

List of papers presented at the meeting

Status Reports		Reference
SR1	NNDC Status Report	Appendix 2
SR2	NEA-DB Committee Progress Report	Appendix 3
SR3	NDS Status Report	Appendix 4
SR4	CJD Progress Report	Appendix 5
SR5	CAJaD Status Report	Appendix 6
SR6	The Activities of CDFE	Appendix 7
SR7	KACHAPAG Status Report (Memo CP-B/33)	Appendix 8
SR8	FIZ Status Report	Appendix 9

Working Papers		
WP1	Actions from the last meeting	Report INDC(NDS)-125
WP2	CINDA matters (M. Lammer)	Memo 4C-3/257
WP3	EXFOR statistics (H.D. Lemmel, O. Schwerer)	Appendix 10
WP4	Pending retransmissions of EXFOR entries (O. Schwerer)	Memo 4C-3/256
WP5	INDL/V Summary Documentation (V. Pronyeav, D.E. Cullen, H.D.Lemmel, O. Schwerer)	Document IAEA-NDS-31, Rev. 2
WP6	IRDF-82 Summary Documentation (D.E. Cullen, N. Kocherov, P.M. McLaughlin)	Document IAEA-NDS-41
WP7	INDL/A Summary Documentation (H.D. Lemmel)	Document IAEA-NDS-12, Rev. 6
WP8	Sample pages from CINDA (M. Lammer)	CINDA 82
WP9	NDS Meetings 1981/82 (H.D. Lemmel)	Report INDC(NDS)-124
WP10	Importance for compilation of selected CPND and Photonuclear Data (K. Okamoto)	Appendix 11
WP11	Letter to NDS by L. Adamski	Appendix 12
WP12	Collection of items for technical discussions (H.D. Lemmel)	
WP13	NDS checking of incoming TRANS tapes (O. Schwerer)	
WP14	Results of a questionnaire concerning nuclear data needs for medical radionuclide production (K. Okamoto)	

WP15	Evaluation of the $^{27}Al(n,\alpha)$, $^{56}Fe(n,p)$, $^{63}Cu(n,2n)$, $^{65}Cu(n,2n)$, $^{197}Au(n,2n)$, $^{93}NB(n,2n)$, $^{32}S(n,p)$ and $^{1}H(n,n)$ cross sections: completeness check of EXFOR and CINDA (K. Okamoto)	Memo 4C-3/255
WP16	EXFOR Computation Format Status Report (D.E. Cullen, O. Schwerer)	Appendix 13
WP17	Results of questionnaire concerning nuclear data needs for medical applications in Japan (K. Okamoto)	JAERI-memo 57-041
WP18	see Topical Paper 4	
WP19	CSISRS Users Manual (NNDC)	Appendix 14
WP20	NNDC Products and Services (NNDC)	Appendix 15
WP21	Contents of BOSPOR-80 (V. Pronyaev)	Document IAEA-NDS-31, Rev. 2

Topical Papers

TP1	Verification of Nuclear Cross Section Processing Codes (D.E. Cullen, W.L. Zijp, R.E. McFarlane)	Report INDC(NDS)-134
TP2	Conversion to ENDF/B format of some Austrian evaluations: quantities having no representation in ENDF/B (O. Schwerer)	
TP3	NNDC role in ENDF (S. Pearlstein)	Appendix 16
TP4	Compilation of the Joint Evaluated File (NEA-DB)	Appendix 17
TP5	Example of high-energy neutron cross sections	Appendix 18

Appendix 2

National Nuclear Data Center

Status Report
to the
Sixth Nuclear Reaction Data Centers Meeting

3-7 May 1982

I. General

Since our last report to the Nuclear Reaction Data Centers Network, the NNDC staff has been reduced by 4 1/2 people due to budget cuts. For this reason we have terminated charged particle bibliographic and data compilation. The forthcoming "Bibliography of Integral Charged Particle Nuclear Data" will be the final issue.

In the past year we have acquired a Vector Automation grahics system and installed one additional 180-megabyte disc drive.

II. WRENDA

The biennial review and updating of the U.S. Nuclear Data Request List is in progress. Requests have been sent to originators for review.

III. Bibliographies

The normal CINDA and NSR activity has continued. Special indicis have been prepared for the 1981 and 1982 DOE-NDC Status Reports.

NNDC has now produced a total of two cumulative issues and two supplement issues of Recent References.

IV. Data Libraries

In the period from October 1980 through April 1981, 21 neutron data transmission tapes (TRANS 1114-1134) were sent containing 101 new entries and numerous corrected data sets.

An effort is being made to convert all data in the ISO-QUANT format to REACTION format.

A comparison has been made between the SCISRS-1 60000 and 70000 series conversion data and the data transmitted from area 2 and 3. Data which were not identified as having been transmitted were converted to the REACTION format and sent to the appropriate data center.

V. Evaluated Nuclear Rection Data

Revision 2 to ENDF/B-V will be released this spring. The planning for ENDF/B-VI continues. The ENDF/B formats should be fixed in spring 1982 and the "standards" evaluations completed in the spring of 1983.

VI. Nuclear Structure Data

The transfer of responsibility for the publication of the Nuclear Data Sheets from the Nuclear Data Project at ORNL to NNDC has been completed. NNDC is now responsible for publishing the Nuclear Data Sheets, beginning with the June 1981 issue (NDS 33, No. 2).

NNDC has been providing data and bibliographic retrievals and monthly bibliographic updates to the evaluators of Nuclear Data Sheets and other requestors. Several request for non-standard retrievals from ENSDF were also satisfied.

A new edition of the Nuclear Wallet Cards is planned during latter half of 1982. A microfiche of the computerized chart of nuclides called Computope Chart was distributed in March 1982. Both of these represent data extracted from the computerized ENSDF and are therefore consistent and current with Nuclear Data Sheets.

VII. Customer Services

The request statistics for July 1, 1980 to March 31, 1982 are attached.

Work on a CSISRS Users Manual is in progress. It should be issued this year.

VIII. Publications

The forth edition "Neutron Cross Sections," (formerly known as BNL-325) Vol. I, Part A, Resonance Parameters for Z=1-60 was published by Academic Press, Inc. It is expected that Part B will be published by the end of 1982.

Work will begin in the fall on the planning for the publication of the "book of curves."

The Nuclear Physics section of the Physics Vade Mecum published on the 50th anniversary of the American Institute of Physics was contributed by NNDC.

IX. Future Meetings

Thermal Reactor Benchmark Calculations, BNL, Upton, NY., May 17-18, 1982.

STATISTICS

TABLE I

1 JULY 1980 TO 31 DECEMBER 1981

AREA 1

NUMBER OF REQUESTS FOR DATA AND OTHER INFORMATION*

Requestor	Experimental Neutron and Charge Particle Data	Evaluated Neutron and Charge Particle Data	Bibliographic Neutron and Charge Particle Information	All Programs	All Documents	TOTAL
USA-Government Agencies	71	59	20	11	127	288
USA-Educational Institutions	23	32	4	10	138	207
USA-Industry	34	62	4	17	126	243
Canada	1	5	0	6	14	26
Foreign (except Canada)	---	---	---	10	265	275
TOTAL	129	158	28	54	670	1039

* This page does not include regular distributions, see Table II.

STATISTICS

TABLE II

1 JULY 1980 TO 31 DECEMBER 1981

AREA 1

REGULAR DISTRIBUTION OF DATA AND INFORMATION

A. Experimental Neutron Data: 26 Tapes-TRANS 1109 to 1134

B. Evaluated Neutron Data: 7 Tapes -

ENDF/B-V TAPE 541	FISSION PRODUCT FILES
ENDF/B-V TAPE 542	
ENDF/B-V TAPE 543	
ENDF/B-V TAPE 544	
ENDF/B-V TAPE 545	
ENDF/B-V TAPE 546	
ENDF/B-V TAPE 531 (V.1)	DOSIMETRY FILES

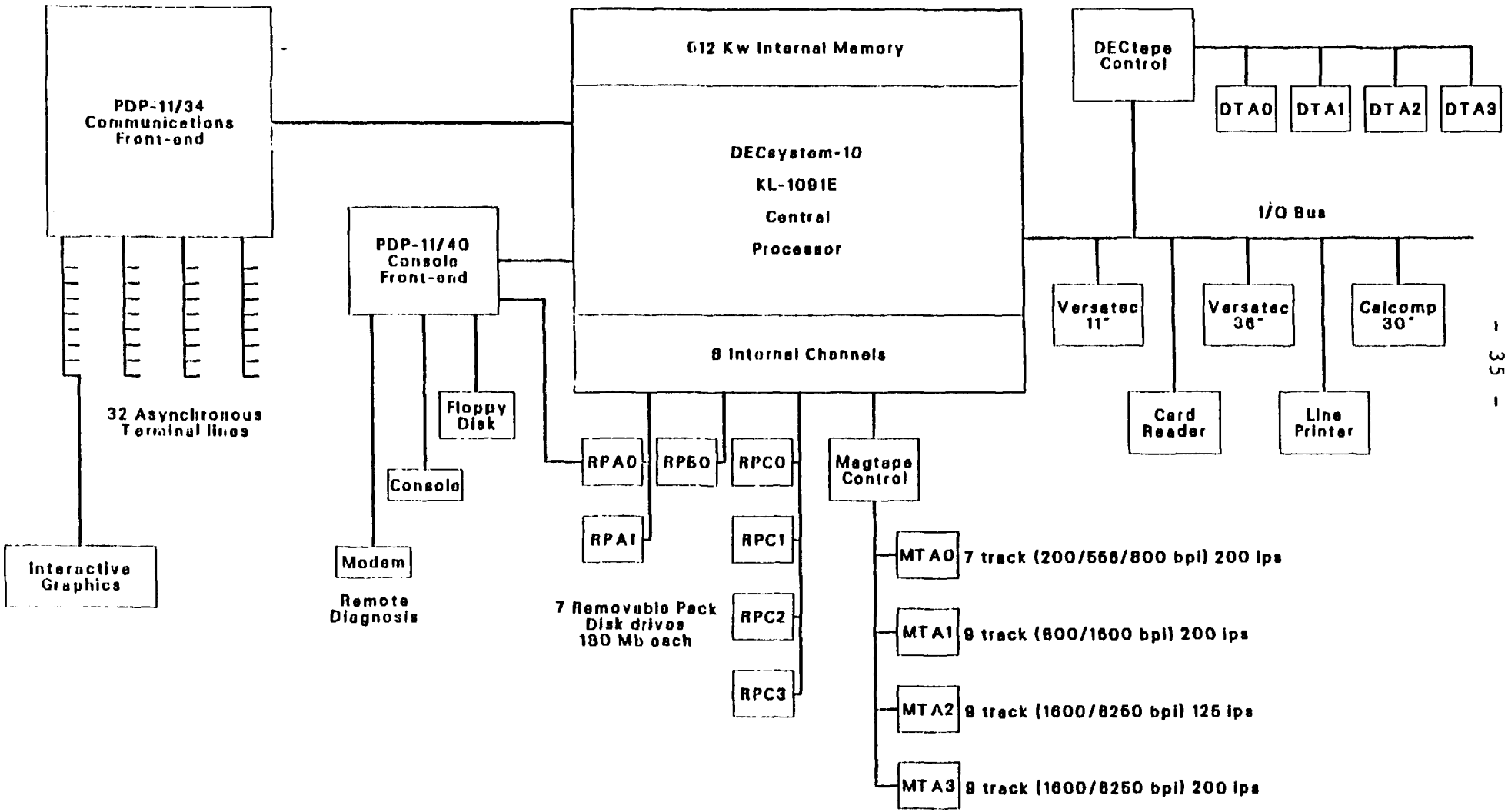
C. Bibliographic Neutron Information: 14 Tapes - CINDA COVERAGE

D. Experimental Charge Particle Data: 1 Tape - Version 2/80

E. Bibliographic Charge Particle Information: 3 Tapes - Versions 1/80, 1/81, 2/81

FMS:jb

National Nuclear Data Center
Computer System



Brookhaven National Laboratory
Upton, N.Y. 11973

March, 1982

Appendix 3

For Nuclear Reaction Data Centres meeting May 1982

NEA DATA BANK COMMITTEE

Progress Report - May 1981 to April 1982

I. INTRODUCTION

The past twelve-month period was marked by successive gaps in the permanent scientific staff, only some of which could be planned for. In this context, it may be considered as a successful test of the working procedures built up during the conversion period that the programme of work for 1981 was in fact adequately carried out. Since the beginning of 1982, the scientific staff has been back at full strength, and good progress has been made not only in the regular work of program testing, data compilation and customer service, but also in the assembly of a "starter file" for the Neutron Joint Evaluated Data File project and in the standardisation of computer program testing procedures.

II. NUCLEAR DATA SERVICES

Following the recompilation during the previous 12-month period of all NEUDADA information from the NEA-DB service area not previously included in EXFOR exchanges, and the absorption of the backlog of new data available but not yet compiled, data compilation work fell back to a more normal level, comparable with the input received from NNDC, Brookhaven.

Development on the nuclear data side was concentrated on the provision of graphical output from the files of numerical, experimental and evaluated neutron data, and on the first half of Phase 1 in the Joint Neutron Data Evaluation project.

1. Neutron data Compilation

During 1981, six EXFOR tapes were sent out to the other three centres in the neutron data network : a total of 57 new compilations, and 177 retransmissions of corrected data sets. This represented the data newly available during the year, although at the beginning of April some 150 data sets in all had been requested but not yet received. This figure should not be considered as a backlog, since many of these measurements were still at an early stage, or had not yet been fully analysed, and had been added to the list, and the authors contacted, on the basis of interim progress reports.

2. Customer Services for Neutron Data

Service work fell into two parts : traditional customer service, more recently augmented in 1982 by a certain number of data plots, and the preparatory data plotting work carried out in cooperation with CEN Bruyères-le-Châtel for the NEANDC meeting on Fast Neutron Scattering on Actinide Nuclei.

A total of 163 requests for experimental and evaluated neutron data were handled in 1981, and about 55 in the first three months of 1982. If the peak in 1978-9 is removed, corresponding to requests for different sections of ENDF/B V as they were released, the level of requests appears as roughly constant at about 200/year over the last seven years. Data plots have been included only when specifically requested, generally by evaluators.

In preparation for the meeting on Fast Neutron Scattering on Actinide Nuclei,some 400 complex plots were prepared for consideration by the two working groups, comparing experimental data and the different evaluations. Revised versions of the more important of these plots will be published with the proceedings.

3. Nuclear Structure and Decay Data

The Data Bank provides a limited service to users of the Evaluated Nuclear Structure Data File (ENSDF), who may either request data in the usual way, or reach both the data and the corresponding search and output formatting programs directly on the CISI computers, by requesting access to a specified Data Bank disc. It is planned to provide similar access to the Nuclear Structure Reference file; this file has been loaded on the PDP 11/70, and simple retrievals carried out.

The complex structure of these files, and their sophisticated output formats in print, require a reasonable investment in program development and maintenance if an adequate customer service is to be maintained. It is intended during 1982 to bring the output presentation and retrieval facilities offered by the Data Bank or directly on CISI computers up to a simple but fully adequate level. Dr. Coddens will be reporting on this work at the first meeting of NSDD groups.

III. THE JOINT NEUTRON DATA EVALUATION PROJECT (JEF)

The final meeting of the NEACRP ad-hoc working group, held at Winfrith in September 1981, reviewed recommendations for a number of evaluations for individual isotopes to be included in the file, and nominated reviewers for further materials. The work of translating and assembling these files in ENDF/B V format has been carried out by the Data Bank, and by 1st April 1982 a total of 27 materials had been prepared, in addition to those already available in ENDF/B V format and the natural iron file prepared at AEE Winfrith.

Meanwhile, and following the acceptance by the Steering Committee for Nuclear Energy of the Data Bank Committee's proposal for a first phase of this project (the constitution of a "starter" file in ENDF/B V format), a Scientific Coordination Group has been established in consultation with members of the Data Bank Committee. This group met on 30th March, 1982, to review progress on the "starter" file and to make recommendations for the continuing work on Phase 1 of the project, and for a possible second phase.

A proposal for a three-year second phase, covering extensive benchmark testing of the JEF-1 starter file and preparation of the next version JEF-2 will be presented to the Data Bank Committee this month.

IV. COMPUTER PROGRAM SERVICES

1. Computer program testing and special projects

A total of 98 new programs were tested, packaged and master filed in 1981.

In addition to this constant effort in response to user requests, the Data Bank was involved in two special projects:

a) Safety programs to be presented at the ANS San Francisco meeting in June 1982. The NORCOOL code has been fully implemented at Saclay, and work continues on SSYST. We have received formal confirmation that DRUFAN will very shortly be released to the Data Bank.

b) The shielding version of TRIPOLI. In collaboration with the French CEA, who have undertaken to extend this code to cover coupled neutron-gamma production, and with the help of an expert consultant from Oak Ridge National Laboratory and representing the Radiation Shielding Information Centre, the Data Bank is undertaking extended testing of the code, including calculation of a standard problem based on the IRT large-scale integral experiment with a concrete and steel shield.

The CRAY-1 computer has been used rather regularly and successfully for testing CDC programs. Although none of the programs tested were written with parallel processing in mind, the price/performance ratio is similar to the CDC-7600, with a slight gain for programs where this proportion of computation to input/output is higher, and an important gain in facility due to the much larger memory of the CRAY, which obviates the overlaying work necessary before larger programs can be tested on the CDC-7600.

Work on documentation and standarisation of the information to be included by Data Bank programmers in the packages they prepare, has continued in parallel with our efforts to obtain FORTRAN language verifiers corresponding to the 1968 and 1977 standards. It is hoped to have this software in the near future.

2. Computer Program Abstracts and the Integrated Data Base

During this 12-month period, the information on European and Japanese programs in the integrated Data Base was completed and corrected in preparation for the publication in July 1981 of the "NEA/IAEA Abstracts".

Information entered on all aspects of the testing and packaging process, as well as on programs themselves, becomes immediately available to everyone authorised to access the Data Base of computer program information, thus in particular eliminating most of the clerical delays in handling requests for programs already tested and available on the master files. Thus for the 200-odd program packages sent out so far in the early part of 1982, 90 per cent of all packages were dispatched within 10 days of the receipt of the request. This figure may be compared with 60 per cent in 1980.

3. Requests for computer programs

A total of 1187 program packages were sent out in 1981, corresponding to 564 distinct programs. 967 of these packages went to OECD countries, and 220 to countries serviced on behalf of IAEA. The subject categories of the programs requested are as follows :

REQUEST DISTRIBUTION BY CATEGORY

Category		Distribution by percentage
1.	General mathematical and computing system routines	17
2.	Radiological safety, hazard and accident analysis	11
3.	Spectrum calculations, generation of group constants, lattice and cell problems	9
4.	Static design studies	9
5.	Heat transfer and fluid flow	8
6.	Cross section and resonance integral calculations	7
7.	Gamma heating and shield design	7
8.	Data management	7
9.	Depletion, fuel management, cost analysis, and power plant economics	5
10.	All other	20
		100

Another interesting distribution refers to the "age" of programs requested. If we examine the years in which the codes requested in 1981 were received at the Data Bank (or by its predecessor, NEA/CPL Ispra) we see that although the maximum of this curve lies in 1980 with 28 per cent of the programs requested, the curve then tails off smoothly backwards beyond 1971, excepting only a sharp dip in 1978 caused by the reduced number of programs collected during the year in which Computer Program services were transferred from Ispra to Paris.

Copies of programs tested are distributed about six times during approximately ten years of useful life. If programs of U.S. origin are included, the figure becomes about ten copies distributed.

V. SERVICE ON EXPERIENCE IN CODE UTILISATION (SECU) AND BENCHMARKS

1. SECU Using the newly stored information on the computer program information Data Base concerning the destination of program packages sent to users, four programs of European origin frequently requested by European users have been selected, and questionnaires sent out to these users. This exercise will be extended in the light of the replies received.

2. Nuclear theory benchmarks The NEA/IAEA exercise on Nuclear model code comparisons has raised genuine interest in countries outside the NEA community : although delays in sending answers from non-OECD countries have somewhat slowed the exercise, its value is surely enhanced. Work has been completed on both the coupled channel and spherical optical model/statistical model components of the exercise, and reports are in preparation.

Following a workshop on the calculation of Average Resonance Parameters, held at the Data Bank in October 1981, several codes were promised for deposit on the code collection, and it was agreed that a "blind" rerun of this calculation exercise should be carried out at the Data Bank by two physicists with no previous experience of the question, as a means of testing the revised versions of the codes as implemented at Saclay and above all of identifying the remaining subjective aspects of the interactive selection of neutron width thresholds for separating s- and p- wave resonances. The codes received by April 1982 have been tested and a draft report on this work prepared for discussion with the program authors. It is intended to issue a full report of the study as a NEANDC "u" document.

VI. PUBLICATIONS

1. CINDA : The tapes for the 1981 CINDA supplement, and the full CINDA 82 cumulative volume (covering the period 1977 to 1982), were prepared and sent to IAEA for publication.

2. Computer Program Abstracts. The full edition of the Abstracts for European and Japanese programs was sent for printing in July 1981. The abstracts are made available in book and microfiche form, and tape copies of these plus the U.S. abstracts have been sent to three major centres for possible use in providing a local information service to their users.

3. Serial Publications. Two issues of the Neutron Nuclear Data Evaluation Newsletter (NNDEN) Nos. 30 and 31, and five of News from NEA Data Bank, were published during the twelve-month period.

4. Proceedings of the 1981 Seminar at NESC Argonne. These proceedings reproduce the presentations at NESC of four European and Japanese core computation codes, and the extensive discussions which followed. The programs presented were the WIMS family of codes, LAMP-B, SYNTH and FEM-BABEL.

5. NEANDC Monographs The Data Bank has been helping in the preparation of Dr. Cierjack's monograph on Neutron Sources. Both this and Dr. Chrien's book on Neutron Capture are in the final stages of typing, and should go for printing within the next two months.

VII. WORK IN COOPERATION WITH NEA SECRETARIAT

1. Work on behalf of the Nuclear Science Division

Under the arrangement with the main NEA Secretariat by which NEACRP and NEANDC are serviced from the Data Bank, staff members took part in the organisation of NEANDC specialist meetings on Fast Neutron Scattering on Actinide Nuclei (at OECD and CEN Bruyères-le-Chatel) and Fast Neutron Capture Cross-Sections of Important Isotopes at Argonne National Laboratory. A computer program comparison workshop was held to review the results of a calculation exercise on Average Values of Resonance Parameters (at NEA Data Bank). NEANDC meetings are spaced at 18-month intervals, and none was held during this period.

The annual NEACRP meeting was held at AEE Winfrith in September 1982, and was accompanied by a final meeting of their ad hoc Working Group on Neutron Data Evaluation. With the adoption by the Steering Committee for Nuclear Energy of the Joint Evaluated Data File project, this group was replaced by a Scientific Coordination Group, which met in March 1982 to review progress in the constitution of a first-stage Joint Evaluated File. The Third Specialist Meeting on Reactor Noise (SMORN III) was held in Tokyo in October 1981, and the proceedings will be published this month by Pergamon Press.

2. Data Files maintained in Cooperation with NEA Secretariat

This cooperation has over the last three years been distinguished by the examination of several information projects. Two have been rejected, or postponed until interest proves greater: the IAEA Uranium Resources Data Base, and the U.S. LOCA (Loss of Coolant Accident) Data Base. Two projects are being actively pursued and are expected to be maintained; the highly sophisticated ISIRS International Sorption Information and Retrieval System, presented in a separate document DATA/DOC(82)3 and due for installation on the Data Bank's in-house computer in 1982-83, and the newly-proposed Compendium of Research Activities on Radio-nuclide Migration, which is very much at an early stage in terms of the number of entries, and will initially aim for neat presentation and layout of a printed brochure to be developed later for computer searches as the size of the file increases. Two other projects have been brought to the Data Bank for initial planning work: an Incident Reporting System for the Nuclear Safety Division, and a data file on the Mechanical Properties of Structural Steels.

The work invested in these projects is still very small, but is expected to increase somewhat with the size of these files maintained on disc, and as a common pattern of requirements emerges to justify more extensive programming work.

VIII USE OF THE PDP 11/70 COMPUTER

Availability of the PDP-11/70 has continued to be good, and the further development of Digital Equipment Corporation maintainance services by the addition of remote on-line diagnostic equipment has minimised the time lost through hardware faults. Very little further software development has been undertaken during the past twelve months, and existing systems, including the two Data Bases (nuclear data and computer program information) have worked well under increasingly heavy use.

Appendix 4

NDS Status Report to the 1982 NRDC Meeting

H.D. Lemmel, April 1982

1. Staff, budget, programme

The organization of the Section as of April 1982 is shown on the next page. During the past 18 months the staffing was fairly stable. End of 1981, Mrs. H. Hendrickson who took care of the request logs, left the Section and was replaced by Ms. M. Okumu. At the beginning of 1982 N. DayDay, who was mainly responsible for request services, left the Section. A successor was not yet nominated. In the Atomic and Molecular Data Unit R. Langley left. His functions as Unit Head were taken over by A. Lorenz, so that R. Langley's replacement will fill part A. Lorenz's work, in particular the field of nuclear structure and decay data. K. Sheikh was hired as a data processing clerk.

The difficult budget situation of the Agency continued. It seems however, that the NDS program is recognized as important for the technology transfer to developing countries, so that the program is continuing at its present level, though some shifts in the program may occur. One professional post which had to be kept vacant for a longer period, was finally lost. On the other hand, a "general service" post was raised to the professional level.

As a general trend within the IAEA and its Member States, there will be a continuing shift of emphasis towards developing countries with respect to data center services, research contracts, staffing within NDS, and the so-called "Interregional Project for the Training of Nuclear Scientists in Developing Countries Using the Expertise available in the Nuclear Data Field".

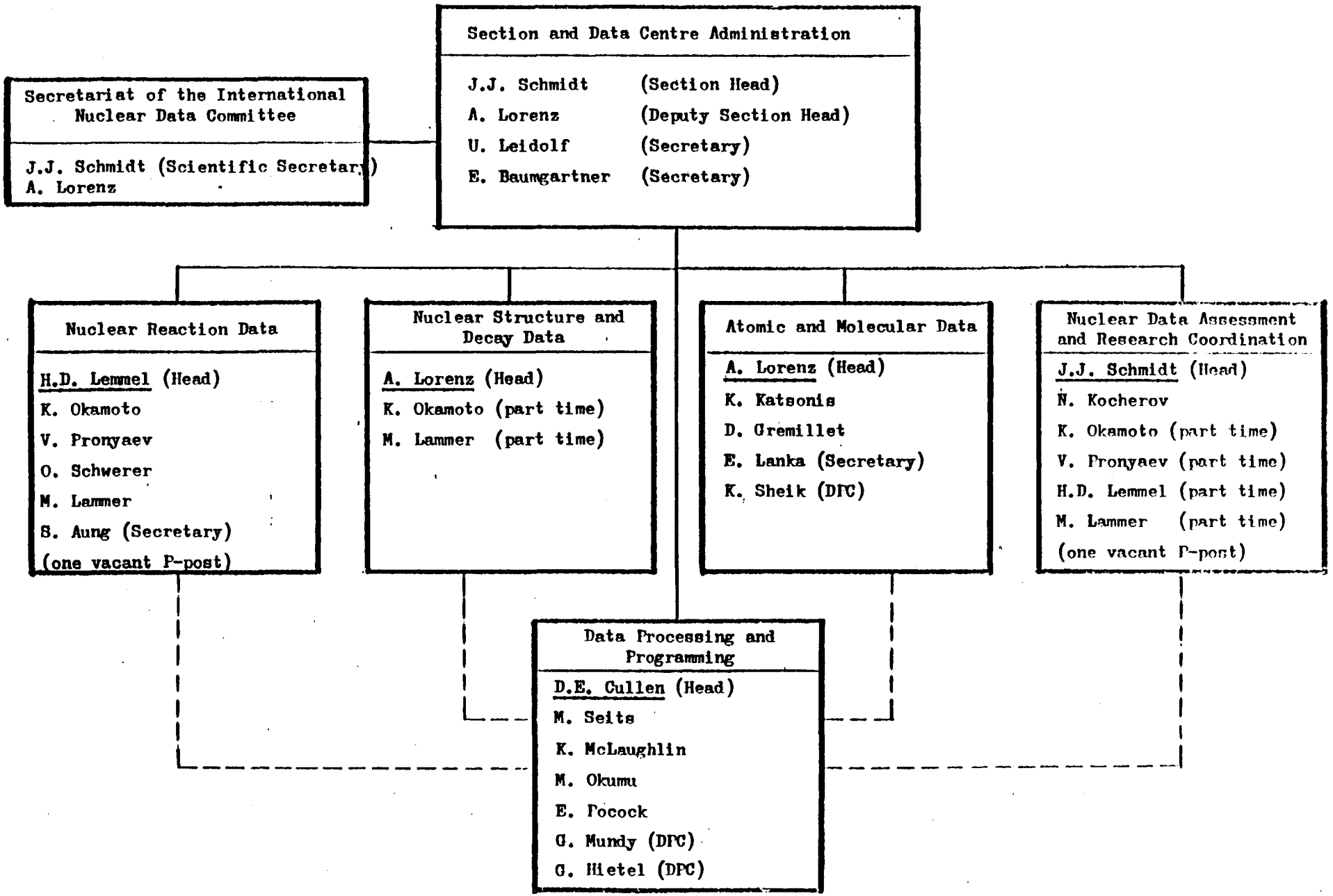
2. CINDA work at NDS

The backlog in the coverage of journals due to move of the IAEA to the new building (V.I.C.) and due to a reorganization of the V.I.C. library was almost completely overcome by now. Unfortunately a few journal series are still not available to NDS at the V.I.C. library. Hopefully, this will be solved in the near future.

The installation of the report library at the V.I.C. was completed only in 1981 and the scanning of reports received up to that date is rather time consuming and still not finished. However, the coverage of current issues of the most important report series is fairly complete.

The production of the CINDA-book file for photocomposition went more smoothly this time, thanks to a special effort at NEA-DB (G. Coddens): all missing author flags were added and erroneous coding of authors (delimeters) corrected (5131 lines!); all underscores were removed; all compounds were coded correctly. Also, cutoff-dates of literature coverage and expansions of new codes were received in time and (almost) complete.

ORGANIZATION CHART OF THE NUCLEAR DATA SECTION AS OF MARCH 1982



In the CINDA81 book, for the first time the tables 3 (REF-codes) and 4 (LAB-codes) were produced by the photocomposition process and reduced to contain only those codes that appear in the CINDA entries of the current issue. The latest issue, CINDA82, which is presently being produced, has several new features:

- The introductory part and the Annex are almost entirely computerized and produced by the photocomposition process, thus speeding up the updates to be made for each issue.

- The introduction carries the page numbers I.1 through I.28, the Annex page numbers A.1 through A.45 (including the tables). All page numbers now appear in the outer corners of the pages.

- The sequence of items in the introduction is rearranged, i.e. the foreword is followed by "A brief introduction to CINDA", "Quick reference list of the 'quantities'", "Computer retrievals available from the CINDA file", "Computer libraries of cross-section data", "Selected literature scanned for the present edition" and "Neutron data handbooks".

- The neutron data handbooks' section on "Neutron-induced reactions" is subdivided into 6 parts with subtitles:

  1.1 Comprehensive handbooks and data libraries

  1.2 Neutron-capture gamma rays

  1.3 Fission product data

  1.4 Activation data and neutron metrology

  1.5 Thermonuclear reaction and fusion data

  1.6 Various special purpose handbooks and data libraries

- The compund headings and, accordingly, Table 1 have been revised to: Z - element symbol - expansion of compund code.

  Comments to these slight changes in the layout will be most welcome.

The number of CINDA entries for each book sent to NEA Data Bank, including revisions and CJD entries, is given in the following table:

Summer 1976	2523	entries
Winter 1976/77	2030	
Summer 1977	2166	
Winter 1977/78	3586	
Summer 1978	7077	preparation for the thoroughly completed
Winter 1978/79	8867	and revised archival issue "CINDA-A"
Summer 1979	4176	
Winter 1979/80	1809	move to VIC, interruption of library
Summer 1980	1394	
Winter 1980/81	1486	
Summer 1981	2096	
Winter 1981/82	2508	

3. EXFOR Compilation (KO)

1) EXFOR 3-Series: Experimental Neutron Data

During the period August 1980 and April 1982, we compiled 81 new EXFOR entries originating from the following countries:

	EXFOR-Entries
China (People's Republic)	20
India	14
Hungary	8
Czechoslovakia	7
German Democratic Repubic	7
Pakistan	5
Poland	5
Egypt	3
Argentina	3
Australia	2
South Africa	2
Bulgaria	1
Taiwan	1
Romania	1
Bangladesh	1
Vietnam	1
	81

In addition to the EXFOR Compilation of new data more than the double was retransmitted, due to additional publications or authors' comments received after the first compilation.

For the period of this report we are confident that our compilation work was speedy and complete. The only backlogs known are:

- several new fission-product yield data are on the waiting list to be compiled;
- for some older data, in particular from India, the authors could no longer be reached. (This example demonstrates the importance of speed in the data compilation work! Once one is fallen behind, it is difficult to catch up.);
- the next TRANS tape from NDS will be significantly delayed due to a temporary vacancy at NDS.

2) EXFOR V-Series: Evaluated Neutron Nuclear Data

Not systematically, NDS continues to compile selected important evaluated neutron data in the EXFOR V-series, in particular when these data are not suitable for compilation in ENDF/B format.

Important data recently compiled in EXFOR-V are:

- Neutron Reaction Cross Sections of C,O,N and others calculated by Dimbylow cover the energy range from 20 to 60 MeV, normalized at 20 MeV to the corresponding ENDF/B-4 data.
- Kerma Factors derived from above mentioned data.
- Evaluated 14.7 MeV cross-sections on important reactions with covariances.

EXFOR-V series data transmitted in the period of August 1980 and April 1982 are summarized in the following:

V0023 "P-wave Neutron Strength Functions"
S.K. Rathi and H.M. Agrawal; J.Phys.G: Nucl.Phys. 7 (1981)53

V0025 "Evaluation of Resonance Parameters for Cr, Fe and Ni Isotopes"
These data supplement the KEDAK data of the same nuclides.
F. Froehner; Specialists' Meeting on Neutron data of Structural Materials for Fast Reactors, CBNM, Geel, December 1977, page 138.

V0026 "Total Neutron Cross-Sections of Benzene (from 0.002 to 2 eV Neutron Energy) - Calculation"
J. Abbate, J.V. Lolich, H.S. Wio; Priv. Comm. Abbate (1981)

V0027 "Neutron Cross-Sections for Elements of Biomedical Importance from 20 to 50 MeV"
P.J. Dimbylow; Phys.Med.Biol. 25 (1980) 637

V0028 "Total Kerma Values for Elements of Biomedical Importance from 20 to 60 MeV"
P.J. Dimbylow; 4th Symp. on Neutron Dosimetry, Munich-Neuherberg, June 1981

V0029 "A Simultaneous Evaluation of Some Important Cross-Sections at 14.70 MeV, - $^{27}Al(n,\alpha)$, $^{56}Fe(n,p)$, $^{63}Cu(n,2n)$, $^{65}Cu(n,2n)$, $^{197}Au(n,2n)$, $^{93}Nb(n,2n)$, $^{32}S(n,p)$ and $^{1}H(n,n)$"
H.G. Hayes and T.B. Ryves; Ann. of Nucl. Energy 8 (1981) 469

The EXFOR-V file is documented in IAEA-NDS-34 and indexed in CINDA.

3) EXFOR D-series: Charged-Particle Nuclear Reaction Data (CPND)

NDS does the best to compile the CPND specially for biomedial applications and for neutron production. However, the lack of manpower prevents systematic coverage of these items.

The following entries have been made since last Four Centres Meeting:

D0021 "Measurement of the Absolute Total Cross Section for the Reaction $^{7}Li(d,p)^{8}Li$ at Low Energies"
D.W. Mingay; S.Afr.J.Phys. 2 (1979) 107

D0025 "Excitation Function for O-15 Production via $^{14}N(d,n)^{15}O$ Reactions"
H. Vera Ruiz, A.P. Wolf; Radiochimica Acta 24 (1977) 65

D0026 "Activation Analysis with Deuteron - The Total Cross-Sections of $^{10}B(d,n)^{11}C$, $^{14}N(d,n)^{15}O$ and $^{16}O(d,n)^{17}F$ Reactions up to 3.2 MeV"
K. Wohlleben, E. Schuster; Radiochimica Acta 12 (1969)75

D0028 "Cross Sections for Reactions with 593 MeV and 540 MeV - Protons in Aluminium, Arsenic, Bromine, Rubidium and Yttrium. Part I Al(Beam Monitor Reaction)"
A. Grutter; Preprint to Int.J.Appl.Radiat.Isot. (1982)

D0029 "Cross Sections for Reactions with 593 MeV and 540 MeV - Protons in Aluminium, Arsenic Bromine, Rubidium and Yttrium. Part II As, Br, Rb and Y"
Ibid.

4) EXFOR G-Series: Photonuclear data

A first entry of photonuclear data was compiled by NDS in the new EXFOR G-Series. The data are Isomeric Ratios for (γ,n) reactions in Mo-92, Zr-90, Sr-86 and Se-74 by Fam Zui-Hien et al. (National Institute for Nuclear Research, Vietnam). The experiment consisted of a simultaneous study of the (n,2n) and (γ,n) reactions on above mentioned nuclei. We therefore decided to compile the (n,2n) data as usual as 3-Series, however, with a cross-reference to entry G0001, with which we opened a new EXFOR "G-Series" of photonuclear data. We have neither intention nor manpower for a systematic compilation of photonuclear data but may eventually compile such photon reaction data that have direct relevance to neutron reactions as in above example.

4. The EXFOR System

During the past period of 2 1/2 years, the EXFOR System remained stable. Only few memos concerning the EXFOR System, were exchanged. This demonstrates, that the EXFOR revision done in the 1979/80 period has proven to be successful.

A few items where mistakes in the EXFOR transmission tapes continue to occur and where improvements in the checking programs would be desirable, will be discussed in the technical session of this NRDC Meeting.

There is another alarming fact, however, which requires discussion at the present meeting. Whereas in the previous years there was a clear tendency that additional centers or groups would join the EXFOR cooperation, this tendency has stopped, due to lack of financial support. This is regrettable for two reasons:

Firstly: Nuclear data measurements continue and are needed to continue due to increasing accuracy requirements for various applications. These measurements can serve their purpose only, if the results reach the data evaluators and data users speedily through the international EXFOR data exchange.

Secondly: Until recently, the EXFOR file was in a very good shape with respect to completeness and reliability of the data, as we found out in several checks. To maintain this high quality and to keep the EXFOR file up-to-date, can be done with rather little manpower. But even this minimum of manpower apparently is no longer guaranteed.

EXFOR Statistics

See the paper WP3 on EXFOR statistics. An EXFOR retrieval was made by "year of experiment" (= normally the "year of the primary reference"). Although the figures for the most recent years are not yet final, one can demonstrate, that data production continues at constant rate in the OECD countries, but at even increasing rate in the USSR and the developing countries.

EXFOR TRANS tapes received (OS)

All incoming EXFOR TRANS tapes are run through the NDS check program. A list of errors found is sent to the originating centre. Where possible, errors are corrected at NDS. When important errors cannot be corrected retransmission is requested from the originating centre. We appreciate that in particular NEA-DB has retransmitted all entries requested by NDS. A list of pending retransmissions from Areas 1, 2 and 4 is given in Memo 4C-3/256 of 20 April 1982 superseding Memo 4C-3/239 of 23 April 1980. Please note that this does not include pending requests by other centres for area 3 retransmissions which, admittedly, are sometimes slow depending on availability of manpower.

Updates of Dictionaries 27 (nuclides) and 36 (quantities, REACTION SF5-8) are most frequently based on apparent "errors" found by the check program. For entirely new codes, in particular for institutes and references, we would however appreciate receiving them ahead of time, i.e. before the TRANS tape where they are used.

5. ENDF/B Compilation at NDS

The most important project of the past 18 months was the start of the IAEA Nuclear Data Library (INDL) in ENDF/B format. First versions have been transmitted to the other centers. New increased files are presently prepared for transmission. This library consists presently of the following parts:

INDL/V: The main part, INDL/V, consists of various evaluations from varying origin. The data included were compiled by NDS or converted from other formats into ENDF/B-5 format and thoroughly checked by the Checker code and by graphical plotting. The data included are documented in IAEA-NDS-31. Most of the data are still partial evaluations for a given reaction or in a limited energy range. Some are "complete" evaluations for all the energy range up to 15 or 20 MeV. It is hoped that we can find means, through coordinated reasearch programmes, to increase the number of "complete" evaluations as to be useful for reactor calculations and other projects.

IRDF-82: Some reactions from INDL/V were included, together with the ENDF/B-5 dosimetry file, in the International Reactor Dosimetry File IRDF-82, which is documented in IAEA-NDS-41.

INDL/A: The file INDL/A is the working file of the coordinated research program on the intercomparison of evaluations of actinide neutron nuclear data. The present contents is documented in IAEA-NDS-12 Rev.6. It contains partial and complete actinide evaluations in the formats of ENDF/B-4, ENDF/B-5, UKNDL and KEDAK. At the end of 1982 this library should be finalized in ENDF/B-5 format.

INDL/R: INDL/V data containing resonance parameters will be collected in the form of 300K RECENT output in INDL/R.

INDL/V4: As a service to data requestors, INDL/V data should be available also in ENDF/B-4 format.

INDL/X: This is an archival collection of superseded INDL/V data.

6. WRENDA (ML)

The responsibility for WRENDA was taken over by N. DayDay in December 1980. He coordinated the update of the WRENDA master file and the publication of WRENDA 81/82. N. DayDay has left the NDS in February 1982. Until his replacement arrives, M. Lammer has taken over the activities temporarily.

The "WRENDA Input Guide", issued by D.W. Muir before his departure in June 1980, was revised by N. DayDay and printed in August 1981 as IAEA-NDS-35.

WRENDA 81/82 which was issued in August 1981 as INDC(SEC)-78, reflects a number of changes since the publication of the previous edition: 437 requests were withdrawn, 331 were modified and 271 new requests added. The total number of requests related to fission reactor technology is 1352, very nearly unchanged, while the number related to nuclear fusion has increased from 449 to 594.

The issue of WRENDA 83/84 is planned for the summer of 1983. The data centres should therefore be receiving "country retrievals" in August 1982 to begin the next WRENDA update cycle. The deadline for the receipt of updated requests at NDS will be 1 February 1983.

7. Fission Product Nuclear Data (FPND) (ML)

The report series "Progress in Fission Product Nuclear Data" is published annually, starting with issue no. 1 in November 1975. Up to December 1979 the information about activities in the field, measurements and compilations/evaluations of FPND, contained in this series, was collected by G. Lammer. The activity is continued by M. Lammer since January 1980.

Issue no. 7 was published as INDC(NDS)-116 in June 1981. The 8th issue, to be published as INDC(NDS)-130 in June 1982, is under preparation. Invitation circulars for contributions were sent out at the beginning of April and a number of new potential contributors were contacted. The first replies and contributions are arriving presently. The still increasing interest in this report series can be illustrated by a few numbers given below:

issue 5, 1979, INDC(NDS)-102: contributions: 81 pages, total: 91 pages

issue 6, 1980, INDC(NDS)-113: contributions: 119 pages, total: 134 pages

issue 7, 1981, INDC(NDS)-116: contributions: 153 pages, total: 166 pages

Also, the number of copies on P-distribution has increased from 303 in 1980 to 347 at present.

8. Interregional Project TC/INT/1/018 for Nuclear Data Techniques and Instrumentation which is designed for transfer of nuclear data technology to developing countries (NK).

The project was approved by the Technical Cooperation Subcommittee of the IAEA Board of Governors in December 1980 and was incorporated into the regular programme of the IAEA Technical Cooperation so far for the years 1981 and 1982. 21 developing countries have applied and requested IAEA support (fellowships, expert missions, targets and samples, auxiliary equipment) for participation in this interregional project. 5 developed countries are also participating in the project. The level of the laboratories in developing countries varies greatly from those who are just installing neutron generators and are complete beginners to very well known neutron laboratories from Warsaw, Krakow, Zagreb, Debrecen, Budapest etc.

The main purposes of the project are to help the beginning laboratories and to transfer the existing expertise in the nuclear data field to the staff of these laboratories and to help the somewhat more advanced laboratories to make further improvements and the necessary upgrading of their equipment.

The scope of work which is going on and will be continued in the near future is to measure neutron nuclear data specified in the World Request List for Nuclear Data (WRENDA), mainly reaction cross-sections, angular and energy distributions of the secondary particles. The project is now only at the initial stage and it is not possible to give yet a list of detailed data which will be measured in the framework of the project. Evaluations of nuclear data are also foreseen as part of the project work.

9. Meetings

Summaries of NDS Meetings held in the past 18 months are included in a separate paper. This includes also a list of meetings planned in 1982/83.

10. INDC reports

Please refer to the document INDC(SEC)-76 giving an index to all INDC reports. They continue to include progress reports from various countries, reports of NDS meetings, translations into English from selected USSR publications, and scientific papers from the NDS service area.

Some recent reports of special interest to the Nuclear Reaction Data Centers are:

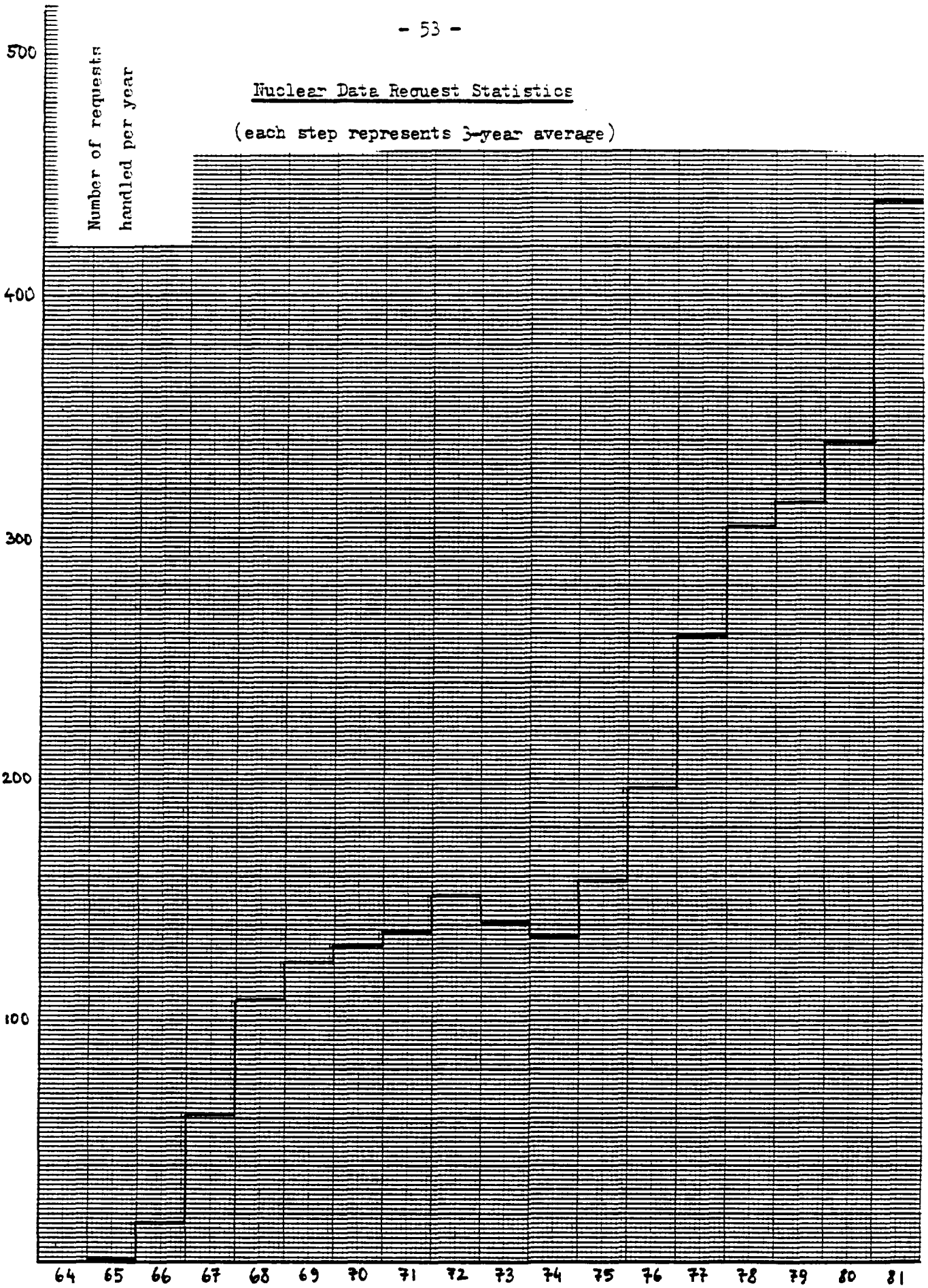
INDC(NDS)-129: Proceedings of the IAEA Consultants Meeting on U and Pu Isotope Resonance Parameters, Vienna 28 Sept - 2 Oct 1981

INDC(IND)-30: Proceedings of the Workshop on Nuclear Data Evaluation, Processing and Testing, Kalpakkam, 4 - 5 Aug. 1981

Several reports on actinide neutron data evaluations and recommended actinide half-lives.

Nuclear Data Request Statistics

(each step represents 3-year average)

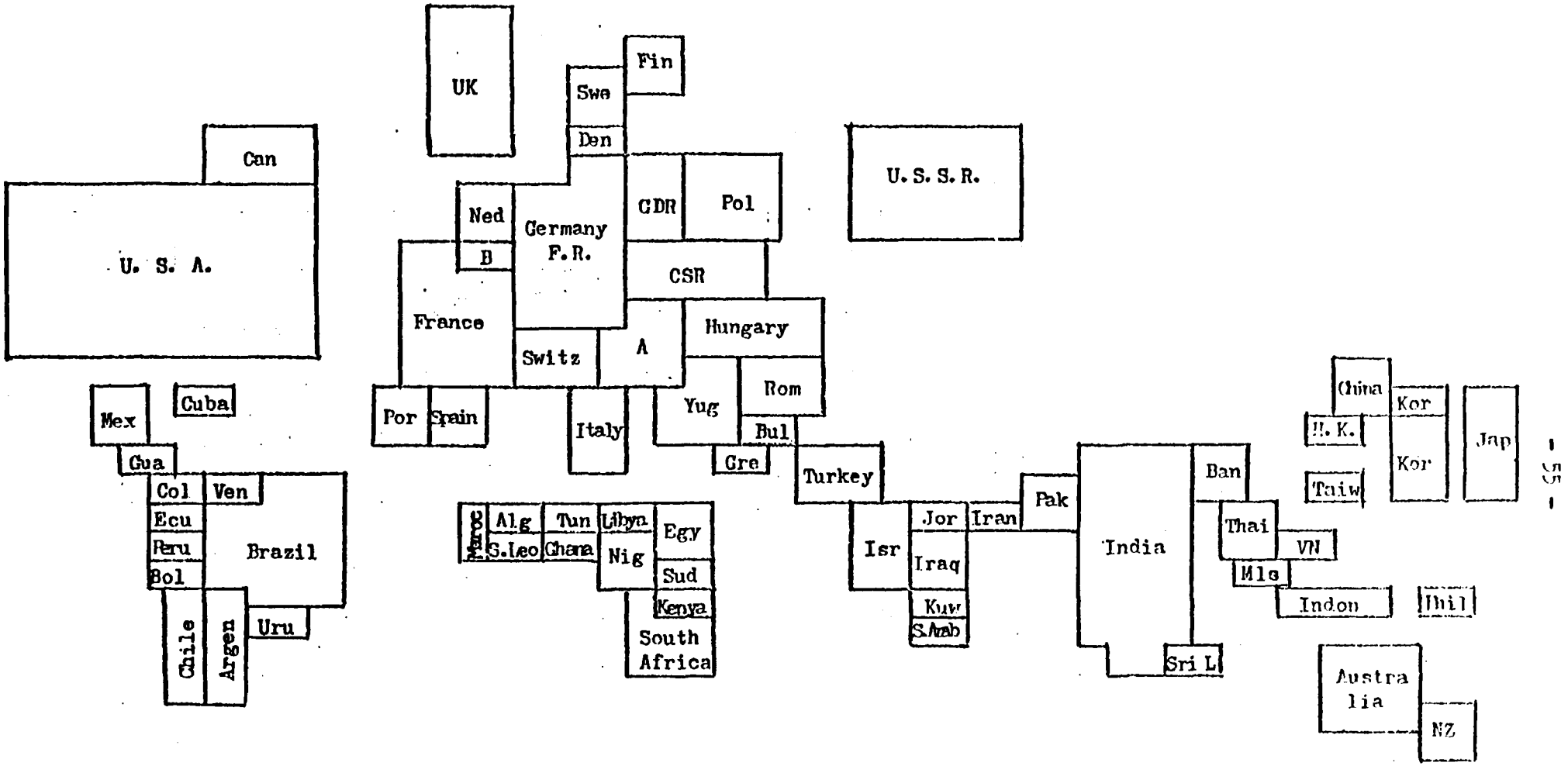


Data Request and Distribution Statistics 1965 - 1981

Year	Request Statistics (Number of Requests)								Combined Experimental and Evaluated Data Distribution	
	Experimental Data	Evaluated Data	Experimental and Evaluated Data		Documents	Other*)	Totals per year	Totals (Averaged over three years)	Totals Cumulative	Data Sets per Year	Data Sets Cumulative
1965	3	-	3		-	-	3	1	3	73	73
1966	40	-	40		-	5	45	16	48	138	211
1967	118	-	148		9	8	135	61	183	474	685
1968	119	-	119		16	9	144	108	327	560	1 245
1969	48	15	63		25	5	93	124	420	403	1 648
1970	95	20	115		34	8	157	131	577	857	2 505
1971	76	33	109		43	8	160	137	737	2 308	4 813
1972	48	23	71		60	8	139	152	876	7 274	12 087
1973	43	22	65		54	6	125	141	1 001	8 081	20 168
1974	49	24	73		61	6	140	135	1 141	5 427	25 595
1975	43	49	92		114	3	209	158	1 350	8 472	34 067
1976	34	43	77		153	9	239	196	1 589	14 533	48 600
1977	45	49	94	+)	232	3	329	259	1 918	15 100	63 700
1978	62	71	133	10	193	17	343	304	2 261	23 691	87 391
1979	63	93	156	21	95	18	269	314	2 530	36 807	124 198
1980	42	85	127	26	237	41	405	339	2 935	37 568	161 766
1981	61	185	246	28	366	31	643	439	3 578	34 865	196 631
1982 /1-4	27	69	96		178	48	322				

*) Since 1978 this category contains exclusively computer programmes, all others, including bibliographies, are included under documents.

+) This column: thereof multigroup libraries.



IAEA Nuclear Data Services World Map (not for publication!)

The size of the fields corresponds to the number of institutes that received nuclear data from, or sent nuclear data to the IAEA Nuclear Data Section. Period: 1979-1981

Note: USA, USSR and OECD countries including Japan have their own data centers so that IAEA services to these countries cover only a small fraction of their nuclear data activities.

11. Customer Services

The fourth issue of the Nuclear Data Newsletter has been issued with a distribution of 1800, thereof close to 600 upon explicit individual requests from within the NDS service area, where an increasing number of developing countries (30 at present) shows active interest in nuclear data. Correspondingly, there was a drastic increase in the number of data requests received and fulfilled per year, as shown in the attached figures.

The data-user oriented documentation of nuclear data libraries continued within the IAEA-NDS-documentation series.

The EXFOR computation format, which was longtime delayed at NDS is under development, and graphical plots of experimental data together with evaluated data have been produced.

Graphical plotting from ENDF/B-format data has been done for many files.

12. Programming and Systems Development (DEC + MS)

General

During this period an extensive system of programmes were implemented in order to improve the reliability of the evaluated data distributed by NDS; this included format and physics checking, graphic output, etc. Work is now underway on an index system for all of our evaluated data, in order to simplify information inquiries and to automate data retrieval. Work on the computation format for experimental data has continued. The production programmes for EXFOR, CINDA and WRENDA may be considered to be complete and require only minor maintenance and improvements.

Photocomposition directly from the computer was extended to the text pages of the CINDA book (introduction and explanatory appendices). An extensive system to locate an up-to-date record of the location and maintain the status of all reports, data bases, etc. is now under development; this is the Internal Report Indexing System (IRIS). Each of these topics will be discussed in detail below.

Card based data entry was completely phased out as of January 1981 and has been replaced by an IBM-5280 remote data entry system. The NDS now has six video display units plus two remote data entry screens and a remote printer for output. Using this combination of resources, all programme development, data entry, data requests, on-line input and correction of data are performed remotely at NDS in a time sharing environment.

EXFOR Programming

The current EXFOR production programmes may be considered up-to-date and only require a minimum of maintenance. The implementation of the computation format for experimental data has been progressing; the first examples of experimental data in the Nuclear Data Section's computation format are now available.

Request and Dissemination Log System

The request log is designed to monitor the arrival of requests at NDS as well as the processing of requests through NDS, in order to insure that each request is answered on a timely basis. The dissemination log is designed to monitor the flow of information out of NDS. Together, the request and dissemination logs allow us to determine what types of information are required by our users, and to quantify the output from our centre.

During this period the entire request and dissemination log was re-designed in order to improve and expand the information stored in the system as well as to improve the types of statistics which may be obtained from the system; in particular usage patterns by isotope, country, type of data (e.g. experimental vs. evaluated), etc.

Further enhancements to the new system are envisaged and their implementation partly underway. These enhancements are automatization of the data collection in order to reduce the manual processes to an absolute minimum.

WRENDA

The WRENDA programme system is essentially complete; minor maintenance and improvements were performed during this period, in particular in order to improve retrieval criteria and output sort orders.

The Data Index System

Instead of searching the large data files at NDS, many requests can be more economically satisfied by searching relatively small data index files in order to determine which data satisfy a given request. A Data Index System which indexes all of NDS's data files has been implemented. At present entries into the Data Index System are performed automatically for all EXFOR data when a TRANS tape is merged into our EXFOR master file.

For EXFOR data it is possible to retrieve data by reaction (by each individual subfield), author, institute, energy range, etc. For the evaluated data, at present, retrieval is only possible for whole evaluations.

The index system is currently being extended to automate the handling of evaluated data and to allow retrieval of evaluated data by reaction.

The Index System Data Base currently contains 55,680 records.

Profile System

NDS maintains a PROFILE system, consisting of a computerized file of the names, addresses and the areas of interest for each of the centre's correspondents. Areas of interest are described by the use of one or more distribution/interest codes. This file is used routinely to produce reports, to selectively retrieve lists, or print address labels for the mailing of publications and correspondence.

There are currently more than 4900 names and addresses stored in the PROFILE system master file; last year approximately 600 names were added, and about 200 corrections and/or changes per month were made.

During this period the newly revised system has remained stable and only minor improvements were incorporated.

CINDA Programming

The system of CINDA programmes that are operational at NDS are used to check new or revised entries, retrieve from the master library and produce the CINDA book. The CINDA check and retrieval programmes have remained rather stable over the years and only minor improvements have been performed.

The procedure and programs to produce transmission tapes have been completely revised - all aspects now being under program control.

Also, the production of the CINDA book has been extensively revised. While in the past only the main body of the CINDA book was produced by photocomposition program, additional photocomposition programs have been written and all relevant tables and text have been stored on-line, so that now almost the entire book is produced automatically via photocomposition programs, greatly facilitating, of course, the modifications to the text which are necessary from issue to issue. In the course of this revision, the format of the book itself was modified somewhat in order to improve legibility.

Evaluated Data Processing

The growing number of evaluated data libraries (e.g. UKNDL, KEDAK, ENDF/B etc.) requires that a growing number of programmes be maintained and operated at NDS in order to allow for file maintenance, retrieval and correction of evaluated data. In addition, in order to allow the evaluated data to be used by our customers, the data handling programmes are distributed with the data.

In order to avoid duplication of effort, programmes developed at other data centres are adopted for use at the NDS whenever possible. At present NDS maintains and distributes to customers only elementary file handling programmes. All requests for more complex programmes, such as multigroup processors, are referred to the IAEA liaison officer at the Computer Progress Library of the NEA Data Bank.

During this period a number of computer programmes were implemented at NDS. This has allowed us to start introducing procedures to improve the reliability of the evaluated data which is disseminated by NDS.

After these procedures have been fully implemented we shall be able to check all new evaluated data both for format and physical content, and to produce graphical output of cross sections, energy and angular distributions. When minor problems are encountered the format or data can be corrected on-line and the action taken reported to the originating evaluator.

IRIS (Internal Report Indexing System)

This new system has been conceived and parts thereof implemented during this period. The purpose of this system is to index all the various documents, reports, books, microfiches, data libraries, processing programs, etc. kept at NDS. The system is designed, not only to provide information as to the availability and location of all these documents held at NDS (a series of keywords providing information as to the contents or topic of the documents), but also to provide a cross-reference between the various documents, data libraries and computer processing codes. The IRIS data base will be used by other NDS Systems: Request and Dissemination Systems and the various retrieval systems to automate the data retrievals and the collection of statistics. As of April 1982, this data base contains over 1,700 entries.

Appendix 5

CJD Progress Report

1. Since July 1980 CJD has transmitted TRANS 4040-4043 with 58 new entries and 6 corrected entries to other centers. The total number of entries transmitted up to now is 532. About 60 works are in the process of compiling.

2. In February 1981 a new computer EC 1033 was put into operation at CJD. In this connection a lot of work has been done by the CJD's specialists in order to study hardware and software of the new computer, and to put data libraries and data processing programmes into operation.

The EXFOR library programmes, a number of codes of nuclear cross section calculations using theoretical models of nuclear reactions and a few programmes associated with evaluated data libraries have been put into operation at the new computer.

Further implementation of various programmes is in progress. At the present time the following programmes are being put into operation: the EXFOR checking programme (taken from NDS), the programme of data conversion from EXFOR format into computational format, servicing programmes of the ENDF/B-V library, programmes of producing group constants from libraries in ENDF/B format.

The study of Data Management Systems available in the USSR has begun with a view towards implementation of a suitable system for data processing at CJD's computer.

3. CJD continues the work on the development of nuclear data evaluation methods using theoretical models of nuclear reactions. Great attention is paid to the investigation of direct process contributions to the reactions (n,n'),(n,p),(n,γ).

Now the file for chromium is revised and capture cross sections of a number of fission products and transactinide nuclides are analysed at CJD.

The evaluation of (n,t) - reaction cross sections is under way. CJD organises an activity on the analysis of available evaluated data files suitable for inclusion in its recommended data library.

CJD received the new versions of the full files for ^{239}Pu, ^{240}Pu from Minsk.

In 1981 the collections VANT, series "Nuclear Constants", NN 40-44 were issued. The number of requests on nuclear data is about 120 - 130 annualy.

At CJD the following programmes assosciated with ENDF/B-V format have been implemented: CHECKER, CRECT, FIZKON, PSYCHE, RESEND, INTEND, INTER, SUMRIZ. Programmes for retrieving data from libraries in ENDF/B format have been developed. The system of programmes RECENT, NJOY (partly), GRUKON (developed in FEI) has been adapted at the EC-1033 computer producing group constants.

Appendix 6

Translated from Russian

The Activities of the Atomic Nuclear Structure and Nuclear Reaction Data Centre (CaJaD) (Operated by the State Committee on the Utilization of Atomic Energy) on the Collection and Dissemination of Charged Particle Nuclear Reaction Data

G.M. Zhuravleva, N.V. Timofeeva, F.E. Chukreev

This report covers the period from August 1980 through April 1982.

1. During this period the Centre has prepared and transmitted to the network of Centres magnetic tapes A005, A006 and A007 containing numerical data from 27 publications.

2. Carrying out Action 14(33) (cf. Ref. [1]), i.e. to give the highest priority to the compilation of those data which satisfy the requests expressed at specialists meetings, the Centre has compiled data from a number of works by Soviet researchers who have studied (p,n) reactions. We could also transmit our compilations of some American papers on this subject, since we have the relevant experimental data in our internal format. The (p,n) reaction is not the only example. In the course of satisfying the requests of Soviet scientists we select and compile data from world literature, but we transmit to the network of Centres only the result of Soviet research. Thus, for example, we have compiled a number of reactions with lithium ions. The results of Soviet research have been transmitted by us to colleagues throughout the network of Centres, while the American results are available in the internal format of our Centre.

The transmission of foreign data is restricted by the well-known rule (cf. item B3 of the "Protocol") which states that regular transmission of EXFOR data from any one Centre shall include data only from its own service area.

It seems that we should all be considering how Rule B3 can be so amended as to avoid duplication of compilation work by different Centres on the same publications.

3. We note with regret that so far there has been no significant progress in describing excited states of nuclei and the associated lack of logic of certain items in EXFOR Dictionary 27. In particular this dictionary lacks indications of the existence of isomeric states in the case of nuclei having normal millisecond isomers. On the other hand, in the case of a number of nuclei (e.g. the nuclides of americium) an indication is given of the existence of spontaneous fission isomers with very short half-lives.

4. During the period covered by the report our Centre prepared replies to approximately one hundred requests for data on nuclear reactions.

Ref. [1] INDC(NDS)-125, Vienna, June 1981.

Appendix 7

THE ACTIVITIES OF THE MSU INP CDFE.

V.V.Varlamov, B.S.Ishkhanov, A.N.Panov, A.P.Chernyaev.
V.V. Surgutanov

The present communication surveys the CDFE activity since the middle of 1980 till the end of 1981.

Within the CDFE program work was done along the following main lines:

1. Bibliographic activity.

We continued to collect, systematize and disseminate the bibliographic information about the experimental photonuclear works published in the USSR and abroad in the periodical literature. The MSU Publishers have turned out and sent to organizations and persons concerned, the CDFE Information Bulletin N 4 "Photonuclear Data - 1980" covering works devoted to the study of nuclear reactions induced by photons, electrons and the processes of radiation capture in the nuclear excitation energy region between the nucleon and meson thresholds. The Bulletin contains information about the works themselves, features of experimental procedures, main results obtained, bibliography and abstracts, and also the author's index.

The bibliographic Index "Photonuclear Data 1976 - 1980" has been completed and is ready for publication.

In the CDFE a computer-aided bibliography of experimental photonuclear works so far published in the scientific literature has been compiled. The bibliography makes use of the BIB format specially designed in the CDFE. Information about the works is given out in the form close to that of the table of CDFE Information bulletins.

2. Compilation of data in the EXFOR format.

We have prepared and sent to the IAEA the exchange magnetic tape M002 (total number of works 26, subworks 181, recording points 12248) with photonuclear data taken from works of soviet authors. Work on the tape M003 containing data from 25 studies has been finished.

Along with the current compilation of data from newly published works, the CDFE is concerned with setting up thematic computer libraries of data on definite branches of photonuclear reaction physics.

3. Development of specialized software.

Sets of special programs permitting the work with computer files and various libraries (including international) are being developed and realized using Unified Series Computers.

At the present time, the CDFE is capable of effectively handling the data in the formats EXFOR, ENSDF and BIB (CDFE's internal format). All data are unified within the CDFE Information search system.

To ensure work on the compilation of data published in the fraphi-

cal form, which could not for various reasons be promptly prepared by the authors directly in the digital form, the CDFE Information search system is supplemented with an automated system for digitizing the graphical information, which is based on the use of an on-line complex consisting of a coordinate-surveying table and a mini-computer.

3. Organizing activity.

The CDFE coordinates scientific research and renders help to the interested organizations in the practical utilization of data of photonuclear experiments. In the order to increase the efficiency of this activity, an All-Union Conference on the problems of use of photonuclear data was held in 1981. Annual holding of such conferences is planned.

Appendix 8

KARLSRUHE CHARGED PARTICLE GROUP

KERNFORSCHUNGSZENTRUM · D-7500 KARLSRUHE · POSTFACH 3640 · TELEX 7826-484

Information

12.2.1982/Ki

Memo CP-B/33

Subject: Trans B011

This memo will be the last Kachapag-memo, since as you all know, Kachapag had to finish its activities by the end of 1981.

Under separate cover the last transtape B011 is distributed to the cooperating centers. It contains

- 6 CAJaD-entries with alterations as agreed with CAJaD
- 5 corrected Kachapag-entries B 81, 113,114, 115, 118
- 35 new Kachapag-entries B 146 to B 180.

The whole file as well as the data in our computational format (KARDIF) will be transmitted to and stored by IAEA/NDS. Furthermore some programs to produce and maintain this computational format will be transferred to NDS, too. The file KARDIF contains also integral data from the CPX-file according to the permission given by Dr. McGowan. In addition we want to inform that all data contained in the files will be printed in the Physics Data 15 series. Volume 5 will contain the last Kachapag entries and in addition a short-handed version of the CPX-data implemented in the file. The updated index-volume presents most of the excitation functions contained in Physics Data in graphical form condensed in 400 figures.
We hope that all volumes will be available in summer 1982.

Finally, we want to thank all colleagues from the other centers for the good, fruitful, and friendly cooperation during the past years. We hope that whoever of you will be in the region of Karlsruhe will spent at least a few hours for a visit in our group, which will concentrate now in surface analysis

activities within the institute of radiochemistry. Nevertheless, the production of the Chart of Nuclides will be continued in our group as announced formerly.

Mit herzlichen Grüßen

Appendix 9

30.4.82

FACHINFORMATIONSZENTRUM ENERGIE PHYSIK MATHEMATIK
Karlsruhe, Federal Republic of Germany
H. Behrens

Status Report

Within the network of the Nuclear Reaction Data Centers the centers of the Federal Republic of Germany contributing to the charged particle nuclear data compilation were

for compilation and evaluation:
- the "Institut für Radiochemie, Kernforschungszentrum Karlsruhe" and the "Technische Hochschule Darmstadt" (the latter supported financially by the Fachinformationszentrum)

and for the production of the printed version:
- Fachinformationszentrum Energie Physik Mathematik GmbH-(FIZ),

the main manpower, of course, going into the compilation and evaluation work. The result was the "Kachapag" File and the "Kachapag" printed data compilation which contained integral cross sections of charged particle nuclear reaction data.

Because of financial restrictions, the Nuclear Research Centre Karlsruhe was not able to supply the manpower anymore for these activities. For the same reasons, the Fachinformationszentrum was not able to take over the workload vacated by the withdrawal of the Nuclear Research Centre. Thus, there was no alternative but to conclude the KACHAPAG activities by the end of 1981. The last-up-to-date tape was distributed around that date. As far as the printed products are concerned, three more volumes of the series "Physics Data" No.15 and one index are still to come. They are arranged as follows:

1. An edition with all entries compiled so far in the volumes 15-3 up to 15-5.
2. Volume 15-5, containing in addition entries of the CPX file
3. An index, containing in addition a number of graphics describing the behaviour of cross sections.

These volumes are in print and will be published within the next three months.

This will be the end of the contributions of the Federal Republic of Germany. We regret this very much. The Fachinformationszentrum, however, still makes efforts to find ways to restart these activities. Unfortunately no definitive statement can be made yet as to the outcome.

Appendix 10

H.D. Lemmel + O. Schwerer: Exfor statistics 26 January 1982

Statistics of the

Experimental neutron data file EXFOR

The following tables show Exfor statistics by year of experiment and geographical area, for experimental neutron data.

Warning. The statistics should be treated with caution. A bomb-shot experiment yielding hundred thousand data points at once cannot be compared with precision measurement of a single data point of basic importance as standard reference value.

Some conclusions:

1. In all areas there was a peak of experiments ("data sets") in the period 1966-1970, however a peak of "data points" in the period 1971-1975. This corresponds to a significant increase in the size of an Exfor entry, i.e. the average number of "data points" per "data set".

2. There seems to be some decrease in the experimental neutron data activities for the period 1976-1980. However, one must stress, that for the last years the figures are not yet final because the compilation is not yet complete. Many more data for the 1976-80 period are, particularly, expected from USSR, but probably also from the other areas.

3. If there is a noticeable trend to decreasing Exfor statistics for the last five years (subject to completion of compilation), one must realize on the other hand that there is a significant change in the experimental goal: there is a trend from measuring "many data" (around 1970) towards "higher precision data" at present. It seems therefore, that the experimental efforts are likely to remain constant, even if the Exfor statistics decrease.

4. A decrease in Exfor statistics seems to be most evident in USA but certainly not in the developing countries.

5. The data contributed by different countries give different results, depending whether the file is analyzed by "data sets", "data index entries", or "data points". Explanation: In a "data set" two nuclear reactions may have been measured simultaneously (= 2 "data index entries") at 100 different energies or angles (= 100 "data points").

6. The developing countries contribute 12 to 14% of the experimental data sets. Counting the number of data points, the developed countries are dominating due to some large facilities producing ten thousands of data points in a highly automated manner.

Experimental neutron data file EXFOR

Period 1971 - 1980

Contributions from

	USA	West Europe +Japan	USSR	other countries	Total
data sets	4.243 = 33%	4.903 = 38%	1.950 = 15%	1.856 = 14%	12.952 = 100%
data index entries	6.950 = 30%	10.023 = 43%	3.529 = 15%	2.747 = 12%	23.249 = 100%
data points	756.000 = 53%	552.000 = 38%	82.000 = 6%	40.000 = 3%	1.430.000 = 100%

Experimental neutron data file EXFOR

Number of "data sets" by geographical area and year of experiment

	USA	West Europe +Japan	USSR	other countries	Total
1936 - 40	45	-	-	-	45
1941 - 45	52	13	-	-	65
1946 - 50	797	75	-	-	872
1951 - 55	1.985	266	110	15	2.376
1956 - 60	2.514	835	589	69	4.007
1961 - 65	2.456	1.427	1.151	591	5.625
1966 - 70	3.005	3.198	1.556	1.264	9.023
1971 - 75	2.930	2.646	1.300	826	7.702
1976 - 80 *	1.313	2.257	650	1.030	5.250
Total	15.097 = 43%	10.717 = 31%	5.356 = 15%	3.795 = 11%	34.965 = 100%

* For the last years, additional data that are being processed, were not yet included in the statistics.

Experimental neutron data file EXFOR

Number of "data index entries" by geographical area and year of experiment

	USA	West Europe +Japan	USSR	other countries	Total
1936 - 40	31	-	-	-	31
1941 - 45	56	14	-	-	70
1946 - 50	869	76	-	-	945
1951 - 55	2.246	313	113	15	2.687
1956 - 60	3.170	984	601	72	4.827
1961 - 65	2.985	1.683	1.222	634	6.524
1966 - 70	3.651	3.859	1.701	1.450	10.661
1971 - 75	3.636	3.650	1.802	1.063	10.151
1976 - 80 *	3.314	6.373	1.727	1.684	13.098
Total	19.958 = 41%	16.952 = 35%	7.166 = 15%	4.918 = 10%	48.994

* For the last years, additional data that are being processed, were not yet included in the statistics.

Experimental neutron data file EXFOR

Number of "data points" by geographical area and year of experiment

	USA	West Europe +Japan	USSR	other countries	Total
1936 - 40	46	7	-	-	53
1941 - 45	237	77	-	-	314
1946 - 50	6.000	294	-	-	6.000
1951 - 55	30.000	4.000	4.000	87	38.000
1956 - 60	65.000	9.000	3.000	183	77.000
1961 - 65	156.000	57.000	15.000	3.000	231.000
1966 - 70	265.000	348.000	32.000	15.000	660.000
1971 - 75	517.000	369.000	29.000	26.000	941.000
1976 - 80 *	239.000	183.000	53.000	14.000	489.000
Total	1.278.000 = 52%	970.000 = 40%	135.000 = 6%	58.000 = 2%	2.44 Mio

* For the last years, additional data that are being processed, were not yet included in the statistics.

Charged-Particle Data File EXFOR

At the end of 1981 the EXFOR subfile for charged-particle and heavy-ion reaction data consisted of

2206	data sets compiled by KACHAPAG
912	data sets compiled by USSR
710	data sets compiled by USA
114	data sets compiled by IAEA
6	data sets compiled by Japan
Total 3948	data sets with nearly 50 000 data points.

KACHAPAG and USSR were mainly concentrating on integral charged-particle nuclear data used for activation techniques and isotope production.

USA and IAEA were mainly, but not only, engaged in compiling charged-particle nuclear data of neutron-source reactions.

Japan is planning to join by compiling differential charged-particle nuclear data of primary interest to theoretical nuclear physics.

Appendix 11

Importance for compilation of selected CPND and Photonuclear Data

K. Okamoto

Items	No. of Reactions	Remarks
RI production for biomed. appl.	~ 50	mostly daughter nuclei as specified in INDC(NDS)-123, and in addition $^{15}N(p,n)^{15}O$ and $^{78}Se(p,n)^{78}Br$
Neutron source	~ 10 $^{2}H(d,n)$, $^{1}H(t,n)$, $^{3}H(p,n)$, $^{3}H(d,n)$, $^{2}H(t,n)$, $^{7}Li(p,n)$, $^{45}Sc(p,n)$, $^{51}V(p,n)$, $^{9}Be(p,n)$ + others + $^{3}H(t,n)$ + spallation n-sources	mainly monoenergetic source
Cancer therapy	~ 20	
	charged particle reactions on tissue (H, C, N, O + others)	reactions for secondary CP (p,d,α,t..) in neutron therapy
	neutron source properties for neutron therapy	for example, the cross-section and the angular and energy distribution of the emitted neutrons for $^{9}Be(\alpha,n)$
Fusion CPND	charged particle reactions for DT, advanced and exotic fuels D-D, p-T, D-T, T-T, D-^{3}He, T-^{3}He, ^{3}He-^{3}He, D-^{4}He, p-^{6}Li, D-^{6}Li, ^{3}He-^{6}Li, ^{6}Li-^{6}Li, p-^{7}Li, D-^{7}Li p-^{9}Be, p-^{10}B, p-^{11}B, ^{4}He-^{11}B, etc.	^{3}He-^{3}He,p-^{6}Li, ^{3}He-^{6}Li,p-^{9}Be and p-^{11}B are so called "clean" fusion plasma reactions with small or neglible neutron emission $\langle V\sigma \rangle$ fusion reaction rate over a Maxwellian distr. of reacting ions as function of ion temp.(KT) (Unit cm^{3}/sec) is to be included. Ref. EXFOR D0016 and others. Memo CP-D/82

Items	No. of Reactions	Remarks
Neutron product.	many (α,n) and others	as general
	(α,n) for fusion reactor fuel cycle, (fuel reprocessing) ^{6}Li, B, ^{13}C, ^{14}N, Nat_O, $^{17,18}O$, ^{19}F, Mg, Si, etc.	up to A ≅ 40 (because high (α,n) threshold)
	(α,n) for safeguards (non destructive analysis) ^{6}Li, ^{9}Be, C, O, ^{19}F, Mg ^{27}Al, Ca, etc.	α energy 100 keV ~ 6.5 MeV
Material analysis	many	activation half-life of products between "day" and "sec"
Astrophysics		mostly e^-, p, low Z particle reactions
Proton scattering	whole A range as target	supplementing neutron data Ref. A.B. Smith
Nuclear physics	all Z, A	for nuclear structure; detailed level scheme
	(d,p), (d,pf) and (p,d) as useful information for the equivalent (n,γ), (n,f) and (n,2n)	entry for CINDA
Inverse react.	a few, such as $^{13}C(\alpha,n)^{16}O$ $^{3}H(p,n)^{3}He$	entry for CINDA
CP fiss. react	~ 20 (d,pf) and other selected reactions	"negative" energy
PIXE, DIXE	many	proton (deuteron) induced X ray emission

Items	No. of Reactions	Remarks
Photo-fission		entry for CINDA $E_\gamma \leq 15$ MeV
RI production for biomed. appl.	a few (γ,n) reactions such as $^{12}C(\gamma,n)^{11}C$ $^{14}N(\gamma,n)^{13}N$ $^{16}O(\gamma,n)^{15}O$ $^{19}F(\gamma,n)^{18}F$	cross-section and yield

Świerk, 13th April, 1982

Appendix 12

Nuclear Data Section
I A E A
Vienna

Re: EXFOR

I am much obliged for your EXFOR retrieval from 19th Feb., concerning ^{28}Si/n,p/ and ^{181}Ta/n,2n/ reactions which I got after our liaison-officer Mrs. K. Stankiewicz request. I find it much useful in our evaluation work concerning mentioned reactions. As my compilation on this topic based on direct literature search is at this moment enough advanced, comparing my notes with the EXFOR files I was able to collect some remarks, questions and corrections:

1. General remark: From the user's point of view I find excellent the content of more recent entries where I feel I need not to look into the original paper to get all details which could have some effect in evaluation procedure. This is not the case for those entries which are "translated from SCISRS".

2. There are some errors /if I am not wrong/:

EXFOR 11645.024 /Prestwood/: In comparison with the original paper there are two lacking energy- and sigma values /at 12.13 and 13.52 MeV/ and an erroneous sigma error at 14.50 MeV: 36 mb instead of 56. I am not able to check whether the first mentioned omissions are not repeated for other reactions studied /other sub-accession numbers/.

EXFOR 11263 /Strain/: There is an obvious error chain in MONITOR: Should be: 118 mb for Al, 250 mb for Si and 550 mb for Cu. Source of error: SCISRS?

EXFOR 30507 /Misra/: "STATUS: Data taken from the abstract" /?!/ But there is a significant difference: in the abstract sigma value for ^{181}Ta/n,2n/ equals 900 mb /same in 30507.004/ while in the

Table 2 it equals 990 mb, and only the authors could clear this up. As in the reprint I got from the authors I see some hand-written corrections and I find some other errors /both in Table 2 and in References/ I would advise to contact the authors to find "the absolute truth".

EXFOR 30554 /Ghose/: Energy value given in the TITLE is 8.4 MeV while in subentry .003 in DATA TABLE: 8.6 MeV. Original report IAEA/TA-1390 is not (accesible, even not) referenced except EXFOR and CINDA-81 - no way to check. Could you help?

EXFOR 21588 /Akiyoshi/: I have gotten two subentries .009 and .012 which differ from each other by sigma value only: 1.79 and 1.80 b. Comparing with the original paper I find that probably the 1.80 value and the whole .012 subentry should be ascribed to /n,n'/ rather than to /n,2n/ reaction.

EXFOR retrieval: I presume the retrievals are automatically taken from the master file. In this context I wonder why I did not get in my retrieval on ^{181}Ta /n,2n/ reaction the entries No.

11097 /Ashby 1958/
11223 /Rosen 1957/
30264 /Araminowicz 1973/

- accession numbers taken from CINDA. Having access to original papers I am interested in alterations only /if any/ - and in the problem itself.

Two next observations concern retrieval of 17th Sept. 1979 /for my former evaluation/ and perhaps the errors do not exist now:

EXFOR 30032 /Csikai/: Throughout the .008 subentry Ag-109 should read Ag-107 and respectively Ag-108 should read 106. This error does not appear in CINDA-A. My information is based on typewritten data table /according to ATOMKI Közl. 8 /66/ 79/ obtained from Prof. Csikai.

EXFOR 61208/If not deleted/: In my opinion this entry should be withdrawn as obsolete, uncomplete /no authors, no details/ and making confusions. It contains a very early version of Mannhart and Vonach results. In EXFOR 20611.012 /after 7 years/ the same numerical data are given in absolute scale, with some corrections.

At least cross-references should be given, if I am right.

3. Now a question: Compilation and evaluation process takes some months. Would I be allowed to ask once more for the EXFOR retrievals at the end of our work /not now!/ - to be sure that the evaluation is really up-to-date?

Re: IRDF

We have received your IRDF-82 report, which contains our reprocessed evaluation of ^{23}Na/n,2n/ reaction cross section /L.Adamski, M.Herman, A.Marcinkowski/. We call the attention of the IRDF authors that they used the data contained in the progress report INR-1809 while the final version with slightly changed numerical data appeared later as INR-1885 report.

Sincerely yours

L. Adamski

Lesław ADAMSKI
Nuclear Data Group
IX-A
Institute of Nuclear Research
05-400 Otwock-Swierk, Poland

Appendix 13

EXFOR Computation Format

Status Report

by
Dermott E. Cullen
and
Otto Schwerer

At the present time the Nuclear Data Section is experimenting with a computer program that translates EXFOR formatted data into the Nuclear Data Section experimental data computation format.

Presently this computer program is capable of translating cross sections, angular distributions and energy distributions to the Nuclear Data Section computation format. This format, which is described in detail in NDS Memo 408, is a fixed field, fixed unit, format which simplifies the use of experimental data in evaluation.

On the following two pages examples are given of data in the EXFOR and Nuclear Data Section computation format. This is a rather simple example of a $^{235}U(n,2n)$ measurement. The original data which is given in the EXFOR format in MeV and Barns is converted for use in the computation format to the standard ENDF/B units of eV and Barns and the EXFOR reaction of (n,2n) cross section is replaced by the ENDF/B convention of MF=3 (cross section) and MT=16((n,2n)).

Next plots are presented of just the EXFOR data and then a plot of the EXFOR data compared to the corresponding ENDF/B-IV data.

Finally two additional examples are given comparing EXFOR subentries to the corresponding ENDF/B-IV evaluated data.

In the near future this computation format can be used for author proofs (to improve the quality of the data in EXFOR) as well as to answer requests from users of experimental data for evaluation.

EXFOR entry 21568 in standard format

```
ENTRY           21568      800612                                          2156800000001
SUBENT       21568001      800612                                          2156800100001
BIB                 14          25                                          2156800100002
REFERENCE    (J,NSE,74,29,8004)                                            2156800100003
             (W,FREHAUT,800609) LETTER OF FREHAUT.                         2156800100004
TITLE        -MEASUREMENT OF THE U-235(N,2N) CROSS SECTION BETWEEN         2156800100005
              TRESHOLD AND 13 MEV.-                                        2156800100006
AUTHOR       (J.FREHAUT,A.BERTIN,R.BOIS)                                   2156800100007
INSTITUTE    (2FR BRC) SERVICE DE PHYSIQUE NEUTRONIQUE ET                  2156800100008
              NUCLEAIRE.                                                   2156800100009
FACILITY     (VDGT,2FR BRC) 14 MEV TANDEM VAN DE GRAAFF,                   2156800100010
              2.5 MHZ, PULSE WIDTH 2 NS.                                   2156800100011
N-SOURCE     (P-T   ) PROTON-TRITIUM REACTION ON GASEOUS TARGET.           2156800100012
DETECTOR     (STANK) LARGE GD-LOADED LIQUID SCINTILLATOR.                  2156800100013
              EFFICIENCY ABOUT 75. PERC.                                   2156800100014
PART-DET     (N     ) NEUTRONS.                                            2156800100015
SAMPLE       .METALLIC ENRICHED SAMPLE. DISK OF 25 MM DIAM.,               2156800100016
              ABOUT 15 GRAMS.                                              2156800100017
CORRECTION   .BACKGROUND, DEAD TIME, EFFICIENCY, MULTIPLE                  2156800100018
              EVENTS, FISSION EVENTS WITH A MULTIPLICITY OF                2156800100019
              2 NEUTRONS.                                                  2156800100020
ERR-ANALYS   .STATISTICAL ERROR ONLY. NO CONTRIBUTION FOR THE              2156800100021
              REFERENCE MONITOR REACTION.                                  2156800100022
ANALYSIS     .DETERMINATION OF THE NEUTRON MULTIPLICITY                    2156800100023
              DISTRIBUTION FOR THE DETECTED EVENTS.                        2156800100024
STATUS       .TEXT, NSE, 74(1980)29.                                       2156800100025
HISTORY      (800609C) G.C.                                                2156800100026
             (800612E)                                                     2156800100027
ENDBIB              25           0                                         2156800100028
NOCOMMON             0           0                                         2156800100029
ENDSUBENT           28           0                                         2156800199999
SUBENT       21568002      800612                                          2156800200001
BIB                  4           8                                         2156800200002
REACTION     (92-U-235(N,2N)92-U-234,,SIG)                                 2156800200003
MONITOR      (92-U-235(N,F),,SIG) TAKEN FROM ENDF-B-5.                     2156800200004
              DETECTOR EFFICIENCY DETERMINED RELATIVE TO THE               2156800200005
              AVERAGE NUMBER OF PROMPT NEUTRONS PER SPONTANEOUS            2156800200006
              FISSION OF CF-252, TAKEN AS 3.732.                           2156800200007
STATUS       .TABLE 1, NSE,74,29.                                          2156800200008
HISTORY      (800609C) G.C.                                                2156800200009
             (800612E)                                                     2156800200010
ENDBIB               8           0                                         2156800200011
NOCOMMON             0           0                                         2156800200012
DATA                 5          16                                         2156800200013
EN          EN-RSL      MONIT       DATA        DATA-ERR                   2156800200014
MEV         MEV         B           B           B                          2156800200015
 5.73       0.090       1.060       0.004       0.024                      2156800200016
 5.98       0.090       1.112       0.126       0.023                      2156800200017
 6.49       0.085       1.364       0.273       0.030                      2156800200018
 7.01       0.080       1.553       0.355       0.032                      2156800200019
 7.52       0.075       1.720       0.463       0.034                      2156800200020
 8.03       0.075       1.782       0.482       0.038                      2156800200021
 8.54       0.070       1.782       0.614       0.052                      2156800200022
 9.04       0.065       1.770       0.642       0.043                      2156800200023
 9.55       0.065       1.760       0.734       0.048                      2156800200024
10.06       0.060       1.748       0.772       0.055                      2156800200025
10.56       0.060       1.737       0.775       0.055                      2156800200026
11.07       0.055       1.732       0.857       0.066                      2156800200027
11.57       0.055       1.734       0.870       0.071                      2156800200028
12.08       0.055       1.751       0.857       0.085                      2156800200029
12.58       0.050       1.840       0.863       0.109                      2156800200030
13.09       0.050       1.930       0.717       0.110                      2156800200031
ENDDATA             18           0                                         2156800200032
ENDSUBENT           31           0                                         2156800299999
```

Numerical data of EXFOR 21568 in computational format

```
21568 2 75FREHAUT
21568 2 75FREHAUT
21568 2 75FREHAUT
21568 2 75FREHAUT
21568 2 75FREHAUT
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21568 2 75FREHAUT

 0.024
 0.023
 0.030
 0.032
 0.034
 0.038
 0.052
 0.043
 0.048
 0.055
 0.055
 0.066
 0.071
 0.085
 0.109
 0.110

 0.004
 0.128
 0.273
 0.355
 0.463
 0.482
 0.614
 0.642
 0.734
 0.772
 0.775
 0.857
 0.870
 0.857
 0.863
 0.717

 90000.0
 90000.0
 85000.0
 80000.0
 75000.0
 75000.0
 70000.0
 65000.0
 65000.0
 60000.0
 60000.0
 55000.0
 55000.0
 55000.0
 50000.0
 50000.0

 5730000.0
 5780000.0
 6490000.0
 7010000.0
 7520000.0
 8030000.0
 8540000.0
 9040000.0
 9550000.0
 10060000.
 10560000.
 11070000.
 11570000.
 12080000.
 12580000.
 13090000.

 3 16 0
 3 16 0
 3 16 0
 3 16 0
 3 16 0
 3 16 0
 3 16 0
 3 16 0
 3 16 0
 3 16 0
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 0
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 0
```
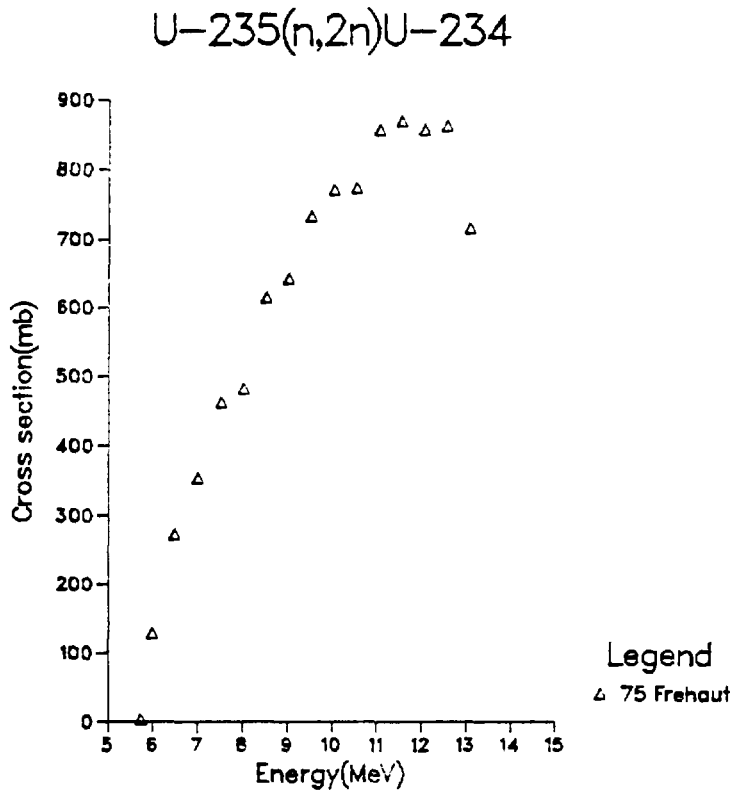
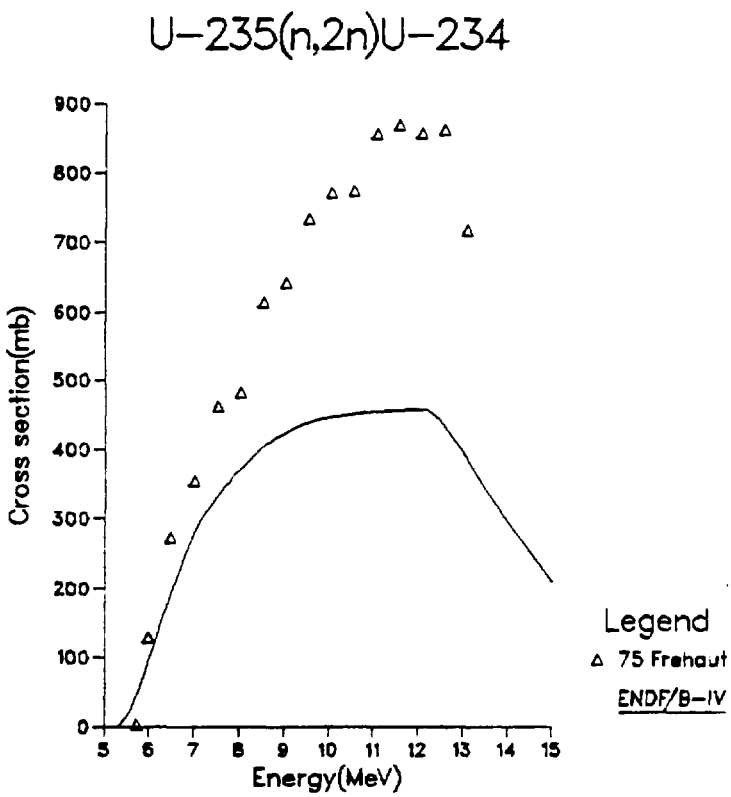
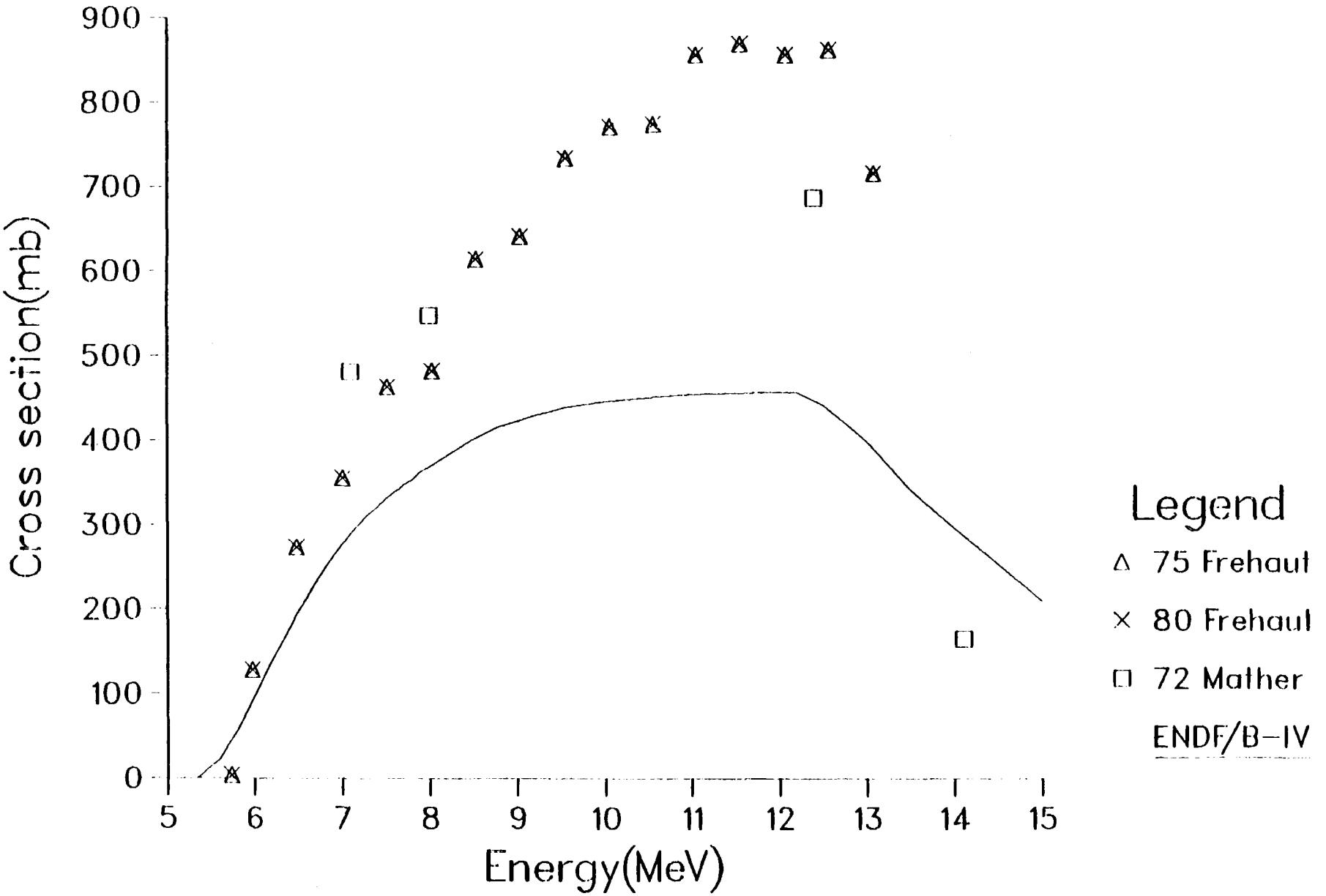
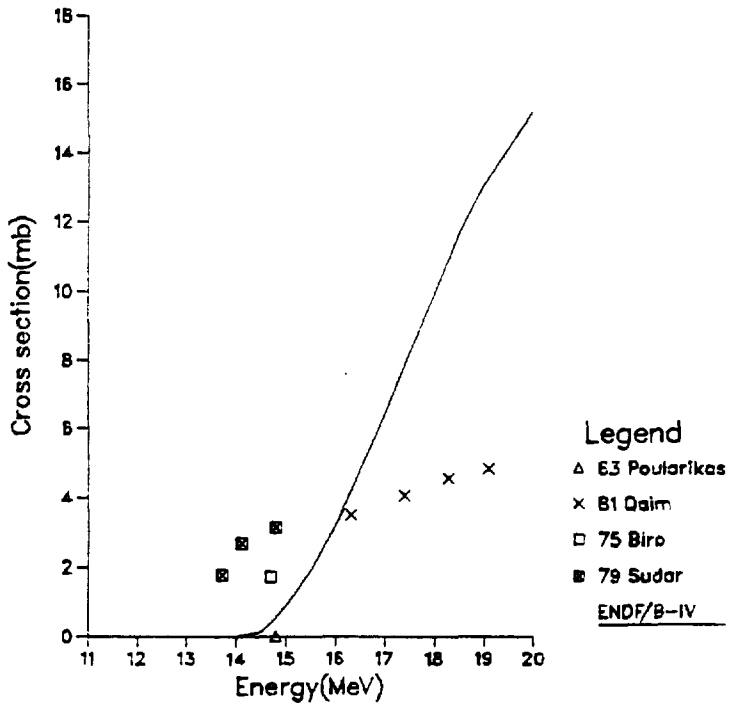


U-235(n,2n)U-234
Cross section(mb)
Energy(MeV)
Legend
75 Frehaut


U-235(n,2n)U-234
Cross section(mb)
Energy(MeV)
Legend
75 Frehaut
ENDF/B-IV

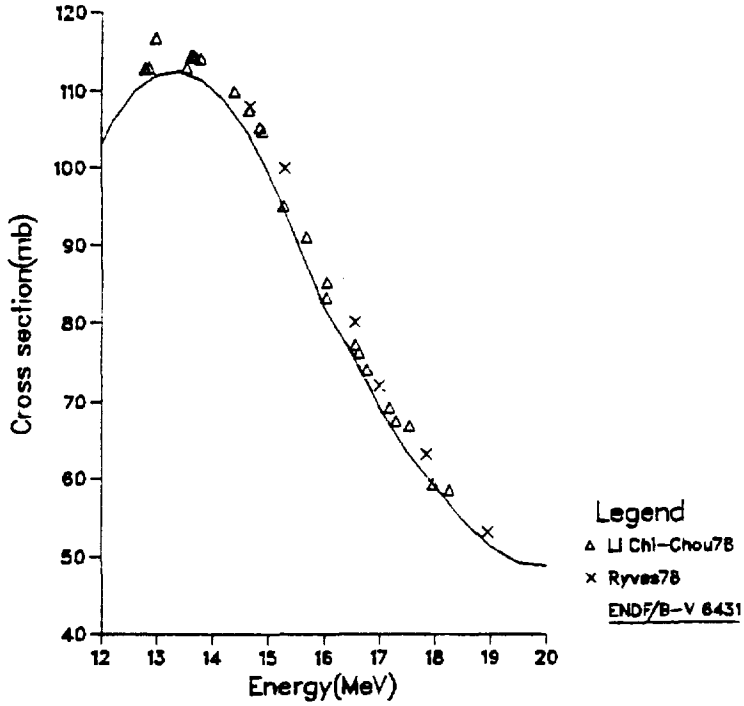
U--235(n,2n)U--234



Al-27(n,t)Mg-25



Fe-56(n,p)Mn-56



Appendix 14 CSISRS Users Manual

Table of Contents

CHAPTER 1

INTRODUCTION

Nuclear Reaction Data System

The Nuclear Reaction Data Storage and Retrieval System at the National Nuclear Data Center (N.N.D.C.) consists of data for, and bibliographic references to, nuclear reaction data induced by neutrons, charged particles and gammas.

The data are obtained through compilation efforts at the N.N.D.C. and through an exchange agreement with the data compilation centers included in the Nuclear Reaction Data Network. A list of participating centers and the areas they service is given in Appendix A.

Retrievals may be made from the system of either bibliographic references to the data or of the data itself. The remainder of this chapter outlines the general retrieval criteria and output formats presently in use. Sample retrieval output is found in Appendix B at the end of this manual.

Summary of available retrieval formats

Bibliographic References:

- Neutron data formats
- Charged particle data formats

Point Data:

- Tape: EXFOR format
  Line Computation Format
  Table Computation Format
- Printout: Any of the above tape formats
  Expanded list format
- Plots: Individual plots by reference
  Plots grouped by reaction

Bibliographic References

Bibliographic retrievals may be made using any combination of the following criteria:

- Target nucleus Z
- Target nucleus A
- Incident projectile
- Process (reaction, outgoing particles) considered
- Parameter (aspect of process) considered
  e.g., cross section, resonance integral, etc.
- Energy range
- Reference cutoff date
- Laboratory
- Work type
  e.g., experimental, evaluated

The output is available as listings or on tape in the formats described in Chapter 3 for neutron data and charged-particle data.

Data Retrievals

Reaction data may be retrieved using any combination of the following criteria:

- Target nucleus Z
- Target nucleus A
- Incident projectile
- Process (reaction, outgoing particles) considered
- Parameter (aspect of process) considered,
  e.g., cross section, resonance integral, etc.
- Reaction Product
- Energy range

The output is available in any of the formats outlined on the following page and will be accompanied by a listing of the index to the data sets retrieved.

Tape Formats

1. EXFOR format (see Chapter 3 for detailed specifications). All data is available in this format.

   - 80-character record length
   - reference oriented
   - flexible format
   - complete set of experimental information

2. Line Computation Format (see Chapter 4 for detailed specifications). Cross-sections, angular distributions, resonance parameters and fission-product yields are available in this format.

   - 132-character record length
   - standard variables and units
   - self-contained lines (i.e., all information for a given datum on the same line)
   - restricted set of experimental information

3. Table Computation Format (see Chapter 4 for detailed specifications). Cross sections and angular distributions are available in this format.

   - 80-character record length
   - standard variables and units
   - data tables of X vs. Y with associated information given in header records.
   - restricted set of experimental information

List Formats

Retrievals may be printed in any of the data formats outlined previously or may be produced in an expanded list format (as detailed in Chapter 5).

Plot Formats: (see Chapter 6 for detailed specifications)

1. Individual plots by data set, i.e., data for each reference and reaction will appear on a separate plot or set of plots.

2. Grouped plots by reaction, i.e., all data for a given reaction will appear on the same plot or group of plots, labeled by reference.

3. More than one reaction on the same plot or group of plots.

CHAPTER 2

BIBLIOGRAPHIC REFERENCES

Neutron Data (CINDA)

CINDA, the Computer Index to Neutron Data, contains references to data for neutron reactions. Also included are other categories of data of interest to reactor physicists: some photon-induced reactions (neutron emission and fission) and spontaneous fission. Integral measurements are not included.

Retrieval output is sorted by target nuclide, quantity and date of the main reference. All references to the same data set will be blocked together in order of date.

Separate listings are given for each target nuclide. The content of a reference line is as follows:

Quantity
Energy range (eV)
Laboratory
Work type
Reference type
Reference
Comment

See the CINDA publication for explanations of quantities, codes and abbreviations.

Example of a CINDA retrieval

NATIONAL NUCLEAR DATA CENTER

** CINDA RETRIEVAL **
20-Jan-82

Element	Z:	C
Mass	A:	13
Quantity	Q:	TOT
Laboratory	L:	
Block Number	B:	
Publication Date	D:	
Energy Range	E:	
Publication Type	P:	
Work Type	W:	

NUCLIDE C 13 20-Jan-82

Total	1.1+5	2.3+7	ORL	Expt	Jour	PR 122	334	8104	Dohni TRANS TO F+ ABOVE 16 MEV
	1.1+4	2.3+7		Expt	Data	EXFOR11330.		7606	. 214 PTS. SIGMA.
Total	1.8-1	5.0+0	BNL	Expt	Proc	WASH-1124 17		6811	Sailor+ IPI RESOL MTG ANALYSIS TEC
Total		2.0+6	KFK	Eval	Proc	EANDC(E)140U		7108	Cierjacks, EFF.RANGE THEORY
Total	1.0+5	2.3+7	PEN	Comp	Jour	NP/A 268	67	7609	Adenbere-Selove.REFS.TOL REE P+RS.
Total	1.0+5	2.3+7	BRC	Revw	Conf	77NBS	93	7704	Lachkar.CS CONTRIBUTION TO NATURAL C
Total	1.0+6	1.4+7	LAS	Expt	Jour	NSE 69	30	7901	Auchampaugh+TRNS.TOF.0RPM.
	1.0+6	1.4+7		Expt	Conf	77BNL	231	7705	Auchampaugh+TRNS.HIGH RESOL.ACC.NDG
	1.5+6	1.4+7		Expt	Conf	76LOWELL	1399	7607	Auchampaugh+TRNS.DFD ENDF CS. NDI
	1.0+6	1.4+7		Expt	Proc	ERDA-NDC-9	106	7704	Auchampaugh/NDG.TOF.CS DATA.ACC
	1.0+6	1.4+7		Expt	Proc	LA-UR-77-521 1		7704	Jurney+IDENTICAL TO ERDA-NDC-9 APR77
	1.2+6	1.4+7		Expt	Data	EXFOR10884.006		7908	. 3185 PTS.TOT CS GUN.
Total	3.0+4	4.8+6	ANL	Expt	Proc	DOE-NDC-15 23		7904	Poenitz.TRNS.CS 0RPM.DFD ENDF B-V.
Total	1.0+6	2.0+7	LRL	Revw	Conf	79KNOX	229	7910	Holmst+CS FOR FUSION.NDG.
Total	1.3+5	5.5+6	OHO	ExTh	Jour	PR/C 23	51983	8105	Lane+ANL LAS DATA NSE 69+30
		5.5+6		Expt	Proc	DOE-NDC-24	142	8104	Lane+R-MATRIX.NDG.TOF PR/C.

Charged Particle Data (CPBib)

CPBib contains references to excitation functions and thick target yields integrated over product angle and energy for reactions for incident projectiles and targets with atomic mass greater than or equal to one (excluding neutrons). The atomic masses of the outgoing particles and residual nuclei must also be greater than or equal to one with the exception of collective processes (e.g., total cross sections) and gamma-ray production reactions. The incident particle energy has a minimum of less than 100 MeV in the laboratory system.

There are some exceptions to these criteria.

1. All data compiled in EXFOR are indexed.

2. If there are data in an article satisfying the above criteria and there are additional data satisfying all the criteria except minimum energy, these additional data are cited.

3. Charged-particle indices prepared by the N.N.D.C. for conference proceedings and other documents are included as long as the criteria for mass are satisfied.

4. Differential neutron-source reaction data are included.

Coverage of the literature began in 1976, but may include earlier references.

The references are grouped and sorted by target nuclide and reaction. The content of a reference line is as follows:

Laboratory
Work Type
Reference Type
Reference
Energy Range (MeV)
Comment

See "The Bibliography of Integral Charged Particle Nuclear Data" for explanations of codes and quantities.

Example of a CPBIB Retrieval

NATIONAL NUCLEAR DATA CENTER

*** CHARGED PARTICLE RETRIEVAL ***

20-Jan-82

TARGET: 6-C-13

INCIDENT: P

OUTGOING: A

C-13(p,alpha)B-10 partial sigma(E)

JUL	Expt	Prog	JUEL-1974	19		74	2.3+1	Rohwer+ CURV, AG GROUP, INTAD.
JUL	Expt	Prog	JUEL-SPEC-7212	Mar	80	4.1+1		Wenst CURV, INTAD(6-PODED), DFD 8.

C-13(p,alpha)B-10 partial relative sigma(E)

JUL	Expt	Prog	JUEL-SPEC-7212	Mar	80	1.1+1	4.1+1	Wenst CURV, INTAD(6-PODED), DFD 8.

C-13(p,alpha)B-10 relative sigma(E)

JCL	Theo	Prog	A-JCL-13	104	Dec	79	+0	+1 Mozzki+ CHART OF ER. C=6-13.

CHAPTER 3

EXFOR FORMAT

Introduction

EXFOR 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 programming personnel from a number of laboratories (i.e., Saclay, Vienna, Livermore and Brookhaven) and accepted as a result of a meeting of representatives from the neutron data centers at Saclay, Vienna, Brookhaven and Obninsk, which was held in Moscow in November 1969.

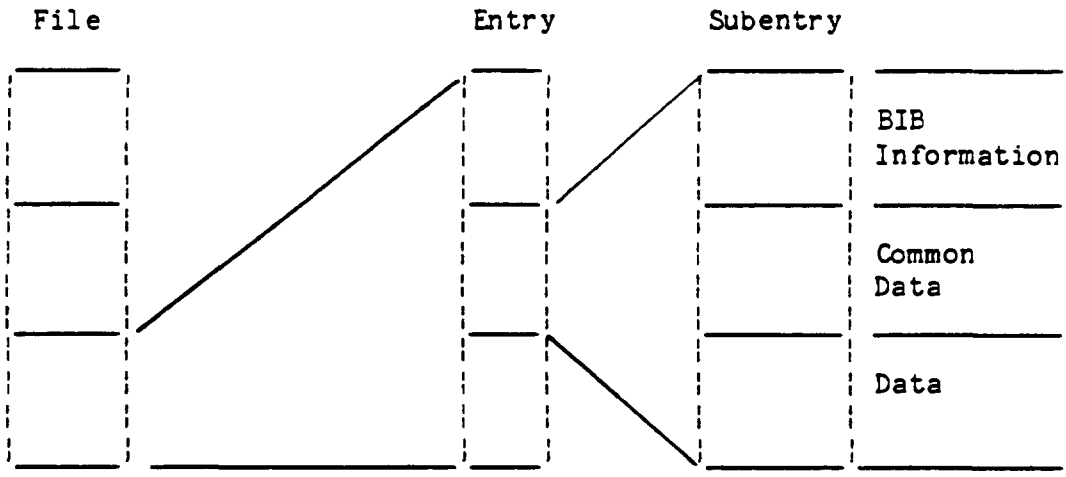
Subsequently, the format was further developed and finally adapted to cover all types of nuclear reaction data. This came about as the result of two meetings held in Vienna in 1975 and 1976 on Charged Particle Nuclear Data Compilation, attended by representatives from an increased number of data centers.

The EXFOR format has been designed for flexibility rather than optimization of data processing. The format as outlined allows a large variety of numerical data tables with explanatory and bibliographic information to be transmitted in an easily-machine-readable format which is easily read by users.

This chapter outlines the general format specifications. For more detail see the EXFOR Systems Manual, LEXFOR and the EXFOR Dictionaries. See Appendix II for an example of a retrieval in the EXFOR Format.

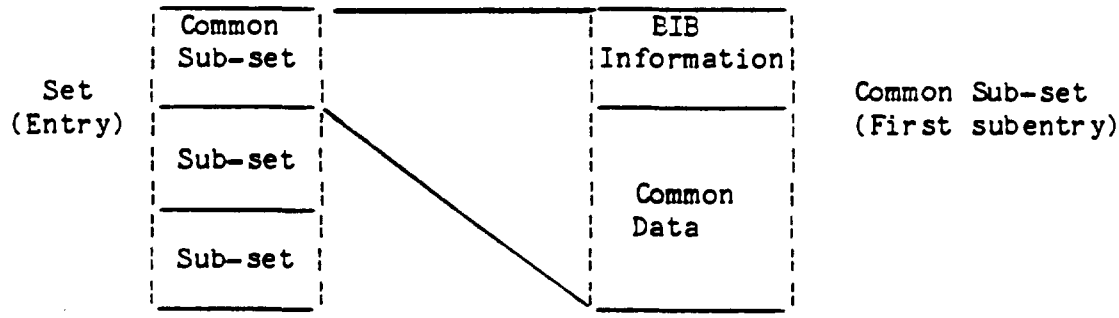
EXFOR-file format

An EXFOR file may contain a number of data sets (entries). Each set may be divided into a number of sub-sets (subentries). The sub-sets may be further subdivided into bibliographic or descriptive information (hereafter called BIB information), common data that applies to all lines of a data table in a sub-set, and a data table. The file may, therefore, be considered to be of the following form;



A number of system identifiers are used to define the beginning and end of each of the above units (see page 3-4).

In order to avoid repetition of information that is common to all sub-sets, information may be associated with an entire set. In order to accomplish this, the first sub-set of each set contains information that applies to all other sub-sets. The common sub-set is subdivided into common BIB information and common data information; it does not contain a data table.



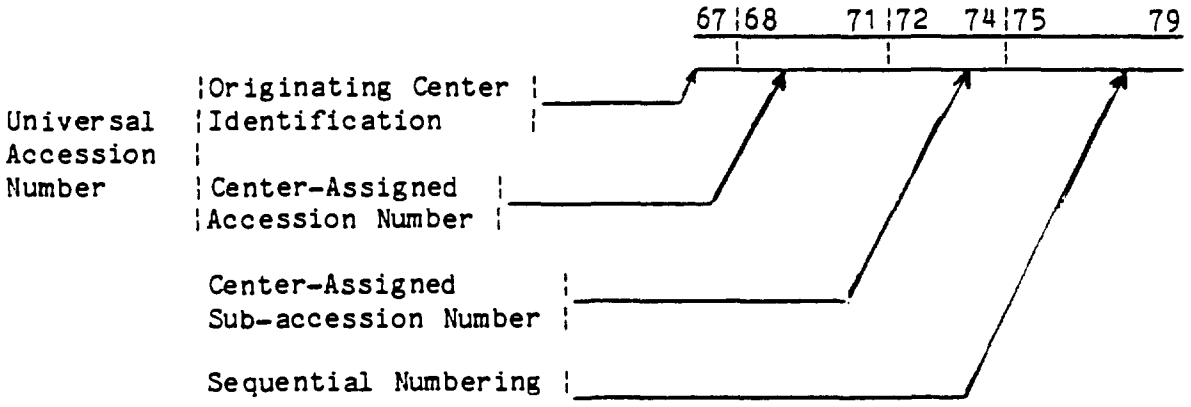
A subentry is defined as a table of data as a function of one or more independent variables, i.e., X, X' vs. Y with associated errors for X, X' and Y (e.g., X = energy; X' = angle; Y = differential cross section) and any associated variables (e.g., standard).

When more than one representation of Y is present, the table may be X vs. Y and Y', with associated errors for X, Y and Y' and a possible flag (e.g., X= energy; Y = absolute cross section, Y' = relative cross section). The criteria for grouping a Y with a Y' is that they both be derived from the same experimental information by the author of the data (see page 3-14, Multiple Reaction Formalism).

For some data, the data table does not have an independent variable X but only the function Y. (Examples: spontaneous nu-bar; resonance energies without resonance parameters; etc.)

Record Identification

Columns 67-79 of each record uniquely identify the record in the EXFOR system. The record identification consists of four fields as follows:



The first field (column 67) is alphanumeric, the next 3 fields (columns 68-79) are strictly numeric.

Accession numbers and sub-accession numbers are not changed, once they are entered in the system. If a subentry is deleted from the system, the same identification is not assigned to another data set.

Records are in ascending order by record identification, i.e., column 67 - 79. Column 80 will be blank on all retrievals.

Permitted character set

The following character set ispermitted for use in the EXFOR format:

- All Roman capitals, A to Z.
- All numbers, 0 to 9.
- The special characters:

+ (plus)	- (minus)	. (decimal point)
) (right parenthesis)	((left parenthesis)	* (asterisk),
/ (slash)	= (equal sign)	' (apostrophe)
, (comma)		

System Identifiers

Each of the basic System-Identifier Keywords refers to one of the hierarchy of units contained in an EXFOR file. The System-Identifier Keywords and corresponding units are:

REQUEST - A request is the unit
ENTRY - An entry (accession number) is the unit
SUBENT - A subentry (sub-accession number) is the unit
BIB - The BIB section of an entry or subentry is the unit
COMMON - The common data section of an entry or subentry is the unit
DATA - The data table section of a subentry is the unit

These basic System-Identifier Keywords are combined with the modifiers NO and END to indicate three conditions:

1. The beginning of a unit (basic System Identifier only)

2. The end of a unit (modifier END preceding the basic System Identifier)

3. A positive indication that a unit is intentionally omitted (modifier NO preceding the basic System Identifier)

However, only those combinations of basic System-Identifier Keywords and modifiers which are defined on the following pages are used.

The general format of a system identifier record is:

```
1                  11|      22|      33|      44|                66|
[System Identifier]  |      N1|      N2|      N3|      Free text  |
```

Columns 34-66 (with the exception of the special use for columns 34-44 of the REQUEST records) may contain free text information.

The following pages describe all permitted System-Identifier records in detail. Where the content of the numeric fields is not given for any System Identifier, the field is not presently in use.

REQUEST. The first record on a request file.

N1 - Request number
N2 - Date file was generated (year, month, day; format - YYMMDD).
N3 - Request type: = 1, EXFOR Format

Record identification: '1' in column 67 and zeros in columns 68-79.

ENDREQUEST. The last record on request file.

N1 - The number of entries (accession numbers) on the file.

Record identification: 'Z' in column 67 and 9's in columns 68-79.

ENTRY. The first record of each entry.

N1 - Five-digit universal accession number
N2 - Date of entry (or date of last change) (year, month, day).

Record identification: universal accession number, sub-accession number zero, sequence number '1'.

ENDENTRY. The last record of each entry.

N1 - The number of subentries (sub-accession numbers) in the entry

Record identification: universal accession number, sub-accession number '999', sequence number '99999'

SUBENT. The first record of each subentry.

N1 - 8-digit universal sub-accession number
N2 - Date of entry (or date of last alter) (year, month, day).

Record identification: universal accession and sub-accession numbers, sequence number '1'.

ENDSUBENT. The last record of each subentry.

N1 - Number of records within the subentry.

Record identification: universal accession and sub-accession numbers, sequence number '99999'.

BIB.* The first record of each BIB section if one is present.

N1 - Number of keywords in the BIB section
N2 - Number of records in the BIB section

ENDBIB.* The last record of each BIB section if one is present.

N1 - Number of records in BIB section

NCBIB.* Positive indication that there is no BIB section associated with subentry.

COMMON.* The first record of each common data section if one is present.

N1 - Number of common data entries.
N2 - Number of records in common data section.

ENDCOMMON.* The last record of each common data section if one is present.

N1 - Number of records in the common data section.

* See note on following page.

NOCOMMON.* Positive indication that there is no common data associated with the subentry.

DATA.* The first record of each data table section if one is present.

N1 - Number of fields (variables) associated with each line of a data table.
N2 - Number of data lines in the table (excluding headings and units). If N1>6, a line will consist of more than one record.

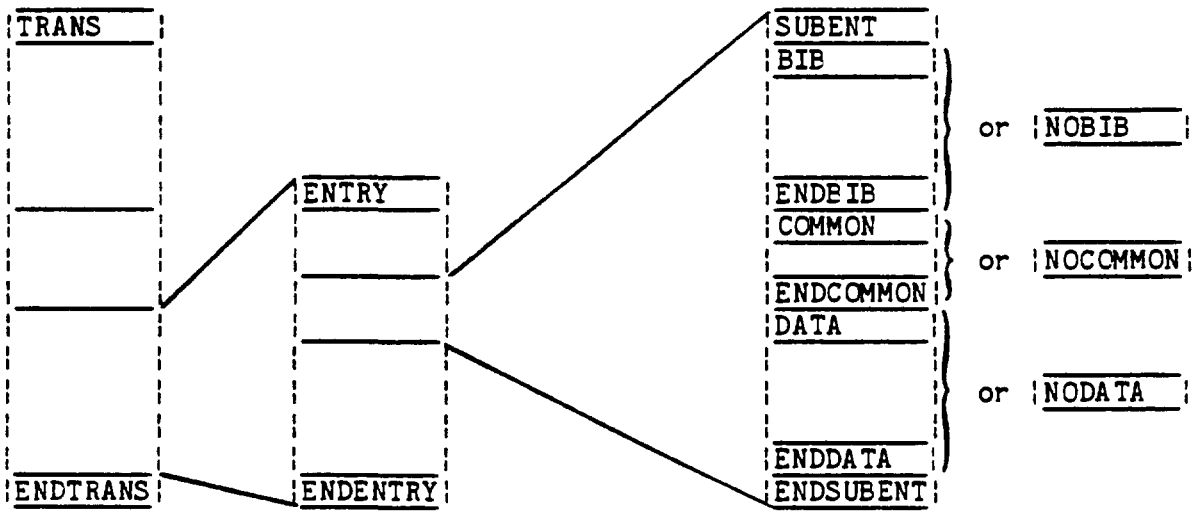
ENDDATA.* The last record of each data table section if one is present.

N1 - Number of records in the data section

NODATA.* Positive indication that there is no data table associated with the subentry.

* Record identification for these System Identifiers: universal accession and subaccession numbers, sequence number assigned sequentially within the subentry.

The EXFOR file then has the following form:



Note: DATA, ENDDATA, and NODATA must not appear in the first (all common) sub-accession number.

BIB SECTION

This section of an EXFOR entry is identified as that information between the system identifiers BIB and ENDBIB. (See page 3-5 for an explanation of the numerical fields on the BIB and ENDBIB records.) In addition to bibliographic information, this section also includes information required to describe an experiment (e.g. method, facility, etc.) and administrative information (e.g. history).

A BIB record consists of up to four parts: keyword, machine retrievable information (codes), free text and identification.

1. Information-Identifier Keyword

The Information-Identifier Keyword defines the significance of the information given in columns 12-66. It is left adjusted to begin in column 1, and does not exceed a length of 10 characters; column 11 is blank or contains a pointer. (See EXFOR Dictionary 2 for a list of all keywords.)

Within any one BIB section an Information-Identifier Keyword is not repeated. For a given keyword, columns 1-10 of continuation records are blank and column 11 is blank or contains a pointer. The pointer is given in the first record of the information to which it refers and is not repeated on continuation records. The pointer refers to all BIB information until either another pointer or a new keyword is encountered. Pointer-independent information for each keyword appears first. (See page 3-14 for use of pointers.)

The keywords, in general, may appear in any order within a BIB section.

2. Machine Retrievable Information

Machine retrievable information is used either to code the actual BIB information, as a link to the COMMON and DATA section, or to code numerical data. The machine retrievable information is enclosed in parentheses and left adjusted so that the opening parenthesis appears in column 12. More than one piece of machine retrievable information may be associated with a keyword. (See 3-16 for formats and coding rules and the EXFOR Dictionaries for codes.

Machine retrievable information may be continued onto successive records. Information on continuation records begins in column 12.

Note that some keywords have no machine retrievable information associated with them and that, for many keywords that may have machine retrievable information associated with them, it is not always present.

3. Information-Identifier Keywords and Codes

Codes for use with a specific keyword are used singly or in conjunction with one or more other codes. Two possibilities exist if more than one code is used:

a.) two or more codes are given within the same parenthesis, separated by a comma, for example:

```
KEYWORD     (CODE1,CODE2) + free text
```

b.) each code is enclosed in its own set of parenthesis, each code entry starting in column 12, for example:

```
KEYWORD     (CODE1) + free text
            (CODE2) + free text
```

Both of these possibilities, or a combination of the two, may occur, in general. However, for some keywords, the coded string (between the parenthesis) may include retrievable information in addition to the code.

4. Free Text

Under each of the keywords in the BIB section free text may be entered in columns 12 - 66, either starting in column 12 or following the closing of the machine retrievable information. The free text may be continued onto any number of records.

An example of several BIB information entries is given below:

```
1        11|12                                                    66
ENTRY      |      00001
SUBENT     |   00001001
BIB        |
AUTHOR     |(J.W.DOW,M.P.JONES) THIS SPACE MAY CONTAIN ANY FREE
           | TEXT. THE BEGINNING OF A NEW BIB ENTRY IS INDICATED
           | BY A NON-BLANK IN THE KEYWORD FIELD COLUMNS 1 - 10.
INSTITUTE  |(3AAABBB) SINCE THE KEYWORD FIELD IS NON-BLANK, THIS
           | IS CONSIDERED A NEW BIB ENTRY.
N-SOURCE   |(ABC,WXYZ) THIS IS AN EXAMPLE OF A BIB ENTRY WITH MORE
           | THAN ONE PIECE OF MACHINE-RETRIEVABLE INFORMATION IN
           | ONE SET OF PARENTHESES. THE ABSENCE OF A POINTER IN
           | COLUMN 11 SHOWS THAT THIS INFORMATION REFERS TO ALL
           | DATA.
COMMENT    | THIS IS AN EXAMPLE OF A BIB ENTRY WITHOUT MACHINE-
           | RETRIEVABLE INFORMATION.
           1|THE POINTER IN COLUMN 11 INDICATES THAT THIS RECORD,
           | AND THE FOLLOWING RECORDS UNTIL A NEW POINTER IS
           | ENCOUNTERED, REFER TO ALL DATA WITH THE SAME POINTER
           | IN ALL FOLLOWING SUBENTRIES.
ENDBIB     |
NOCOMMON   |
ENDSUBENT  |
SUBENT     |   00001002
BIB        |
REACTION   1|(92-U-235(N,EL),,WID) THIS IS AN EXAMPLE OF MULTIPLE
           2|(92-U-235(N,F),,WID) ISO-QUANTS WITH POINTERS
ANALYSIS   1|(CDEFG).   THIS IS AN EXAMPLE OF A BIB ENTRY WITH MORE
           |          THAN ONE PIECE OF MACHINE-RETRIEVABLE
           2|(HIJ).    INFORMATION EACH CODED IN ITS OWN SET OF
           |          PARENTHESES. EACH PART OF THE BIB ENTRY IS
           |          LINKED BY A POINTER IN COLUMN 11 TO OTHER
           |          INFORMATION IN THIS SUBENTRY AND IN SUBENTRY
           |          1 WITH THE SAME POINTER.
           |            THE POINT AFTER THE CLOSING PARENTHESIS
           |          INDICATES THAT THE CONTENTS OF THE PARENTHESES
           |          IS NOT REPEATED IN FREE TEXT, AS WOULD BE
           |          REQUIRED IF THE POINT WERE ABSENT.
ENDBIB     |
NOCOMMON   |
DATA       |
EN         |DATA      1DATA-ERR  1DATA       2
EV         |MILLI-EV   MILLI-EV   MILLI-EV
 ....      | ....        ....       ....
ENDDATA    |
ENDSUBENT  |
ENDENTRY   |
```

COMMON AND DATA SECTIONS - General

The format of the COMMON and DATA sections is identical; however, the significance of the content is different. Each section is a table of data having a data heading and units associated with each field. The COMMON section contains all data that apply to each line of the data table. The data table contains rows of information; each row contains information associated with a data point (e.g., angle, angular error, cross section, cross section error).

Each record contains six information fields, each 11 columns wide; if more than six fields are used, the remaining information is contained on the following records. (See example on page 3-12). The number of fields is unrestricted.

Records are not packed; rather, individual point information is kept on individual records (i.e., if only four fields are associated with a point value, the remaining two fields are left blank, and, for the data point table, the information for the next point begins on the following record. Similarly, if eight fields are used, the remaining four fields on the second record remain blank. These rules apply not only to the data, but also to the headings and units associated with each field. (See example on page 3-12).

The content of the COMMON and DATA sections are as follows:

1. Data headings: identify what the value given in each field represents, left adjusted to the beginning of each field (columns 1, 12, 23, 34, 45, 56). (See EXFOR Dictionary 24 for permissible Data-Heading Keywords.)

   A one-character pointer can be placed in the last (eleventh) column of any data-heading field if the corresponding field is to be linked to some other part of the same subentry or subentry 001. (See page 3-14 for more information on pointers.)

2. Data units: the units in which the values in each field are given, left adjusted to the beginning of each field (Columns 1, 12, 23, 34, 45, 56). (See EXFOR Dictionary 25 for permissible Data-Unit Keywords.)

3. The numerical data which is Fortran readable using an 'E' format.

   That means in detail:

   - A decimal point is always required, even for integers.
   - A decimal number without an exponent can have any position within the 11-character field.
   - No blank is allowed following the sign of the exponent (+ or -).
   - A plus sign can be omitted, except that of an exponent when it is not preceded by an E.
   - In an exponential notation, the exponent is right-adjusted within the 11-character field. The mantissa can have any position.

Repetition of Data Headings

Within the three sections: COMMON section of subentry nnn, not = 001,
DATA section of subentry nnn, not = 001,
COMMON section of subentry 001 of same entry,

no data heading (Data-Heading Keyword plus perhaps a pointer) is repeated except for the following cases.

Any fields with identical data headings are adjacent and appear within only one of the three sections mentioned above.

1. Two or or more unresolved energy levels (given as level energies or Q-values) are entered as follows:

E-LVL	E-LVL	E-LVL
MEV	MEV	MEV
0.077	0.107	0.177

Similarly, the data heading EN-RES is repeated in the case of unresolved resonance energies.

2. An angle given in degrees and minutes is entered in two separate fields with the data heading ANG repeated; as follows:

ANG	ANG
ADEG	AMIN
90.	47.

3. Half-life values in different units, such as SEC, D, YR, are entered as follows:

HL	HL	HL
SEC	D	YR
	15.	
		28.3
4.8		

4. Two or more flags defined under the BIB keyword FLAG which apply to the same line of the data table, are entered as follows:

FLAG	FLAG
NO-DIM	NO-DIM
1.	
2.	3.

5. Errors or resolutions given in different units over an energy range are entered as follow:

EN-RSL	EN-RSL
KEV	PER-CENT
20.	
	10.
20.	

COMMON SECTION

The COMMON section of an EXFOR entry is identified as that information between the system identifiers COMMON and ENDCOMMON. (See page 3-5 for explanation of numerical fields on COMMON and ENDCOMMON records).

In the common data table only one number is entered in a given field.

The data values are never given in the COMMON section.

An example of a common data table is shown below:

1	12	23	34	45	56	66
COMMON						
EN	EN-ERR	EN-RSL	E-LVL	E-LVL	ANG	
ANG-ERR						
MEV	MEV	MEV	MEV	MEV	ADEG	
ADEG						
4.1	0.05	0.1	3.124	3.175	90.	
10.						
ENDCOMMON						

DATA SECTION

The DATA section of an EXFOR entry is identified on the EXFOR file as that information between the system identifiers DATA and ENDDATA. (See page 3-6 for explanation of numerical fields on DATA and ENDDATA records).

In the DATA table all entries of a record are integrally associated with an individual point.

Blanks are permitted in all fields, however, every line in a data table must give data information. Similarly, each independent variable must occur at least once in each line. Supplementary information such as resolution or standard values are not given as a line in a data table if there is no data information for that line.

An example of a point data table is shown below:

1	12	23	34	45	56	66
DATA	4	4				
ANG	ANG-ERR	DATA	DATA-ERR			
ADEG	ADEG	MB/SR	MB/SR			
10.4	0.8	243.	8.7			
22.9	1.2	127.	4.2			
39.1	0.9	83.2	3.7			
59.1	0.7	14.8	2.9			
ENDDATA	6					

Field Sequence in a DATA Table

The preceding example illustrates the simplest type of table representing the dependent variable DATA as a function of the independent variable ANG (one-dimensional table). The rules for multi-dimensional tables require a distinction between the four data categories occuring in data tables, namely

- independent variables (EN, EN-MIN, EN-RES, E, ANG,...);
- dependent variables (DATA, RATIO,...);
- associated quantities (EN-ERR, ANG-RSL, DATA-ERR,...);
- additional information (STAND, MISC, FLAG, HL,...).

DATA tables are arranged as follows:

- All fields with independent variables precede the fields with dependent variables.

- Fields with additional information are preferably placed after the last dependent-variable field but if they refer to a specific field they may be placed next to it.

  Note: Some Data-Heading Keywords may be used either as independent variables or as additional information.

- Fields with associated quantities are placed right after the field to which they refer.

Line sequence of a DATA Table

Independent variables are arranged so that the rate at which the values change within each field increases from left to right. Values in a given independent-variable field must increase or decrease monotonically until the value in the preceding independent-variable field changes or the end of the table is reached.

Example:

```
DATA
EN          EN-ERR      ANGLE       ANGLE-ERR   DATA
MEV         MEV         ADEG        ADEG        MB/SR
1.          .02         35.         10.          -
1.          .02         60.         10.          -
1.          .02         90.         10.          -
2.          .02         30.          5.          -
2.          .02         60.          5.          -
2.          .02         90.          5.          -
3.          .03         30.          5.          -
3.          .03         60.          5.          -
3.          .03         90.          5.          -
ENDDATA
```

Pointers

Different pieces of EXFOR information may be linked together by pointers. A pointer is a numeric or alphabetic character (1,2,...9,A,B,...Z) placed in the eleventh column of the Information-identifier Keyword field in the BIB section (see page 3-7) and in the Data-heading Keyword fields in the COMMON or DATA section (see page 3-10). Pointers may link, for example,

- one of several reactions with its DATA field;
- one of several reactions with a specific piece of information in the BIB section (e.g., ANALYSIS), and/or with a value in the COMMON section and/or with a field in the DATA section;
- a value in the COMMON section with a field in the DATA section.

A pointer used in subentry '1' applies to all subentries and has a unique meaning throughout the entire entry.

Examples of the use of pointers follow.

1. Multiple Reaction Formalism

In certain cases more than one code unit may be given under the Data-Specification Keyword for a subentry, each unit having its own data field(s). Each data field is then linked to the appropriate code string by means of a pointer.

Example:

```
BIB
REACTION  1(92-U-235(N,0),,EN)
          2(92-U-235(N,0),,J)
          3(92-U-235(N,TOT),,WID)
          4(92-U-235(N,F),,WID)
ENDBIB
COMMON
MOMENTUM L DATA-ERR  3DATA-ERR  4
NO-DIM      PER-CENT   PER-CENT
0.          8.         10.
ENDCOMMON
DATA
DATA       1DATA      2DATA      3DATA      4
EV          NO-DIM     MILLI-EV   MILLI-EV
....
....
ENDDATA
```

In the example above, the field headed 'MOMENTUM L' in the COMMON Section does not have a pointer and, therefore, relates to all fields of the DATA Section. The two fields headed 'DATA-ERR' in the COMMON Section are linked, by means of pointers, to fields of the DATA Section and to specific reaction units in the BIB Section.

2. BIB/BIB Links

Pointers may be used to link pieces of BIB information, but must all refer to the same REACTION.

Example:

```
REACTION    (.......)
PART-DET    1(G)
            2(N)
DETECTOR    1(ABCDE)
            2(FGHIJ)
```

3. BIB/DATA Links

Pointers used in the BIB section may also be used to link to information in the COMMON and DATA sections.

Examples:
```
REACTION  1(....)
          2(....)
 PART-DET 1(....)
          2(....)
```

or:
```
REACTION   (....)
COMMENT    1 Free text about first angle
           2 Free text about second angle
ENDBIB
COMMON
ANG        1ANG      2
ADEG        ADEG
 10.         20.
ENDCOMMON
DATA
EN          DATA     1DATA     2
.....       ....      ....
```

4. Alternative results

Different results for the same quantity in the same experiment by, e.g., two different methods of analysis, may be entered in the same subentry, using pointers. In this case, the code unit for the Data Specification Keyword is repeated.

Example:

```
REACTION    1(92-U-235(N,G),,WID)
            2(92-U-235(N,G),,WID)
ANALYSIS    1(AREA)
            2(SHAPE)
```

Dictionaries

Following is a list of the EXFOR Dictionaries, which contain all of the keywords and codes used.

Number	Name	Code length	Expansion provided
1.	System-Identifier Keywords	10	
2.	Information-Identifier Keywords	10	yes
3.	Institutes	5 to 7	yes ext
4.	Reference Type	1	yes
5.	Journals	6	yes
6.	Reports	11	
7.	Conference and Books	10	yes ext
8.	Elements	6	yes
9.	Chemical Compounds	7 to 10	yes
10.	Process/Parameter (Quantity SF1)	3	
11.	Function (Quantity SF2)	3	
12.	Modifier (Quantity SF3)	3	
13.	Particle (PART-DET and Quantity SF4)	3	yes
14.	Quantity (SF1 - 4)	18	yes ext
15.	History	1	yes
16.	Status	5	yes
17.	Rel-Ref (SF1)	1	yes
18.	Facility	5	yes
19.	N-Source	5	yes
20.	Additional Results	5	yes
21.	Method	5	yes
22.	Detectors	5	yes
23.	Analysis	5	yes
24.	Data-Heading Keywords	10	
25.	Data-Units Keywords	10	
27.	Nuclides	10	
28.	Incident Particles (REACTION SF2)	3	yes
29.	Product Particles (REACTION SF3)	3	yes
30.	Process (REACTION SF3)	3	
31.	Branch (REACTION SF5)	5(-)	
32.	Parameter (REACTION SF6)	3	
33.	Particles Considered (REACTION SF7)	3	yes
34.	Modifiers (REACTION SF8)	3	
35.	Data-Type (REACTION SF9)	5	yes
36.	Quantities (REACTION SF5-8)	44	yes ext

(-) Normally limited to 3-character code.
ext Expansion may extend to follow-up records. In all other cases, the expansion is restricted to the length of the explanation field of one record.

Coding for nuclides and compounds

Nuclides appear in the coding of many keywords. The general code format is Z-S-A-X, where:

Z is the mass number; up to 3 digits, no leading zeros
S is the element symbol; 1 or 2 characters
A is the atomic weight; up to 3 digits, no leading zeroes, a single zero denotes natural isotopic composition
X is an isomer code denoting the isomeric state This subfield is omitted if the nucleus does not have a known metastable state of if the data are given for the sum of all isomeric states.

X may have the following values:
G for ground state (of a nucleus which has a metastable state) M if only one metastable state is regarded
M1 for the first metastable state
M2 for the second, etc.
T for sum of all isomers (limited to use within an isomeric ratio in SF4 under REACTION)

Exceptions to this coding are noted on the pages for each keyword.

Compounds may in some cases replace the nuclide code. Compounds are coded using either the specific compound code, taken from Dictionary 9, or the general code for a compound of the form Z-S-CMP. (e.g., 26-FE-CMP).

Information-Identifier Keywords

Following is a list of Information-Identifier Keywords and the structure of the coded information associated with them.

ADD-RES

Gives information about any additional results which were obtained in the experiment, but which are not compiled in the data tables.

Coded information, if given, will be in either of the general forms, see page 3-8, with code(s) from Dictionary 20.

ANALYSIS

Gives information as to how the experimental results have been analysed to obtain the values given under 'DATA' which actually represent the results of the analysis.

Coded information, if given, will be in either of the general forms, see page 3-8, with code(s) from Dictionary 23.

ASSUMED (REACTION formalism)

Gives information about values assumed in the analysis of the data, and COMMON or DATA section fields headed by ASSUM and its derivatives.

The format of the code is: (heading,reaction)

Heading field: contains the heading to be defined.

Reaction field: Coded the same as for the keyword REACTION. (see page 3-26)

In the case of more than one assumed data heading (ASSUM1, ASSUM2, etc.), each must be coded separately, starting in column 12.

AUTHOR

Gives the authors of the work reported.

Authors names are entered in the normal way a name is written, i.e., A.B.NAME, each name separated by a comma. Hyphenated family names, 2-character initials (as in the transliteration of some Cyrillic characters), and any other deviations from the normal name structure are permitted. For a family name modified by 'Junior', JR is entered following the family name and separated from it by a blank.

All names are entered between one set of parenthesis. The authors names may be continued on the next record, but names are not broken, i.e., the last character on the line to be continued will be a comma.

Examples: AUTHOR (A.B.JONES,L.POZA-LOBO,YA.M.IVANOV,NGO-DINH-LONG,
A.MORALES AMADO)
AUTHOR (W.W.HAVENS JR)

COMMENT

Gives pertinent information which cannot logically be entered under another of the keywords available.

No coded information.

CORRECTION

Gives information about corrections applied to the data in order to obtain the values given under the data heading 'DATA'.

No coded information.

DECAY-DATA

Gives the decay data (for any nuclide occurring in the reaction measured) used by the author to obtain the data given.

Decay data relevant to a monitor reaction are coded under the keyword DECAY-MON (see following page).

The coding string consists of five fields which may be preceded by a flag:

((flag)nuclide,half-life,radiation,energy,abundance)

The radiation field, followed by its energy and abundance, may be repeated.

If a code string is broken for continuation onto the next record, the break comes at the end of a field or subfield, i.e., the comma separating the fields is the last character on the line (see example c).

If a field is omitted, the following comma is included; trailing commas are omitted (see examples a and b). If the flag is omitted, its parenthesis is omitted.

If decay data is given for more than one nuclide, then each will be coded separately, starting in column 12.

Flag. Contains an integer (n.) which is linked to the same value appearing in the data section under the data heading DECAY-FLAG (see example c).

Nuclide field: The general format of the code is Z-S-A-X (see page 3-17).

Half-life field: Contains the half-life of the nuclide specified, coded as a number, readable in an E format, followed by a unit of time (see Dictionary 25).

Type-of-radiation: A code from Dictionary 13
Where two or more decay modes are possible and are not distinguished in the measurement, two or more codes may be given, each separated by a slash. (See example b).

Energy: Energy of the radiation in keV, coded as a floating-point number. In the case of two or more unresolved decays, two or more energies or a lower and upper energy limit may be given, each separated by a slash.

Abundance.: Abundance of the observed radiation per decay, coded as a floating-point number.

Examples:

```
a. DECAY-DATA  (40-ZR-89-M)
b. DECAY-DATA  (60-ND-140,3.3D)
                (59-PR-140,,B+/EC,,0.500)
c. DECAY-DATA  ((1.)60-ND-138,5.04HR,DG,328.,0.065)
d. DECAY-DATA  (60-ND-139-G,30.0MIN,B+,,0.257,
                                    DG,405.,0.055)
```

DECAY-MON (REACTION formalism)

Gives the decay data assumed by the author for any nuclide occurring in the monitor reaction used.

The coding rules for DECAY-MON are the same as those for DECAY-DATA, except that the flag field is omitted.

DETECTOR

Gives information about the detector(s) used in the experiments.

Coded information, if given, will be in either of the general forms, see page 3-8, with code(s) from Dictionary 22.

EN-SEC

Gives information about secondary energies, and/or defines secondary-energy fields given in the data table.

The format of the coded information is: (heading, particle)

Heading Field: Contains the Data-Heading Keyword to be defined.

Particle Field: Contains the particle or nuclide to which the Data-Heading Keyword refers. The code is either a particle code from Dictionary 13. or a nuclide coded in the standard format as described on page 3-17.

In the case where more than one secondary-energy Data-Heading Keyword is defined, each is coded separately, starting in column 12.

Example: EN-SEC (E1,G)
(E2,N)
(E-EXC,3-LI-7)

ERR-ANALYS

Explains the sources of errors and the values given in the COMMON or DATA sections under data headings having the modifier -ERR.

The coded information is of the form: (Heading) free text

If only one heading is defined, the coded information may be omitted.

If two or more error fields are given, the data headings are repeated as codes for this keyword, each starting in column 12, followed by free text.

Example: ERR-ANALYS (EN-ERR) followed by explanation of energy error
(DATA-ERR1) followed by explanation of first error
(DATA-ERR2) followed by explanation of second error

EXP-YEAR

Defines the year in which the experiment was performed if it differs significantly from the date of the references given. (Example: Classified data that was published many years after the experiment).

The format of the code is (yy) where yy is the two digits of the year, e.g., (65).

FACILITY

Defines the main apparatus used in the experiment.

Coded information, if given, is in either of the general forms, see page 3-8, with code(s) from Dictionary 18, or the facility code from Dictionary 18 may be followed by an institute code from Dictionary 3, which specifies the location of the facility.

Example: FACILITY (CHOPF,1USACOL)

FLAG

Supplies comments for specific lines in a data table.

The code is a fixed point number (n.) which is linked to the same value appearing in the DATA section under the data heading FLAG. The code is followed by a free text comment.

If two or more codes are given, each begins on a separate line, starting in column 12, followed by a free text explanation of the meaning of the flag.

Example:

```
BIB
..
FLAG        (1.) Data averaged from 2 runs
            (2.) Modified detector used at this energy
..
ENDBIB
..
DATA
EN          DATA        FLAG
KEV         MB          NO-DIM
1.2         123.        1.
2.3         234.
3.4         456.        2.
ENDDATA
```

HALF-LIFE

Gives information about half-life values and defines the half-life fields given in the data table.

The general coding format is: (heading, nuclide)

Heading field: Contains the Data-Heading Keyword to be defined.
Nuclide field: General format of the code is Z-S-A-X, see page 3-17.

If two or more half-lives are given, each is coded separately starting in column 12.

HISTORY

Documents the handling of the date set.

The general format of the code is (yymmddX):

where yymmdd is a date (year,month,day) on which some action was taken on the entry or subentry;
X is a code from Dictionary 15 denoting what action was taken. X may be omitted.

Each piece of coded information begins on a separate line, starting in column 12.

INC-SPECT

Gives information on the characteristics and resolution of the incident-projectile beam.

No coded information.

INSTITUTE

Defines the laboratory, institute or university at which the experiment was performed, or with which the authors are affiliated.

The coded information is given in either of the general forms, see page 3-8, with code(s) from Dictionary 3.

Trailing blanks are omitted, however, embedded blanks are included, as they are considered part of the code.

Examples: INSTITUTE (1USAGA,1USALAS)
INSTITUTE (2FR SAC)

METHOD

Describes the experimental technique(s) employed in the experiment.

If coded information is given it may be in either of the general forms, see page 3-8, with code(s) from Dictionary 21.

MISC-COL

Defines fields in the COMMON or DATA sections headed by the data heading MISC and its derivatives.

If more than one miscellaneous field is given, the data headings are repeated as codes, followed by free text explanation.

Example: (MISC1) Free text
(MISC2) free text

MONITOR

Gives information about the monitor (standard reference data) used in the experiment and defines the information coded in the COMMON and DATA sections under the data heading MONIT, etc.

The coding rules for MONITOR are identical to those for REACTION, with the following exception: subfields 5 to 9 may be omitted when only the reaction is known. (In this case, no monitor information will be given in the COMMON and DATA sections).

In the case of two or more monitors, each monitor is coded separately, starting in column 12. The respective monitor values coded are linked to the monitor codes:

a.) by using pointers (see page 3-16 BIB/DATA links)

b.) using the data headings MONIT1, MONIT2, etc., where MONIT1 refers to the first code entered, MONIT2 the second, etc.

Information about the reference from which the MONITOR information was taken may be entered under the keyword MONIT-REF, see next page.

MONIT-REF (REACTION formalism)

Gives information about the reference from which the monitor (standard) data used in the experiment is taken.

The general format of the code is: (subaccession#,author,reference)

If a field is omitted the following comma is included; trailing commas are omitted.

Subaccession-Number Field: EXFOR subaccession number of monitor data. Cnnnn001 refers to the entire entry Cnnnn. Cnnnn000 refers to a yet unknown subentry within the entry Cnnnn.

Author Field: First author (coded as under AUTHOR), followed by '+' when more than one author exists.

Reference Field: Contains up to 6 subfields, coded as under REFERENCE. (See page 3-30).

In the case of more than one monitor reference, each will be coded separately, started in column 12. Entries under MONIT-REF and MONITOR may be linked:

a.) using pointers (see page 3-15, BIB/BIB links)

b.) by coding the monitor references in the same sequence as the monitors coded (i.e., the first reference coded refers to the first monitor coded, etc.)

Examples: MONIT-REF (B0017005,J.GOSHAL,J.PR,80,939,50)
(,A.G.PANONTIN+,J,JIN,30,2017,68)

N-SOURCE

Gives information on the source of the incident particle beam used in the experiment.

Coded information, if given, is in either of the general forms, see page 3-8, with code(s) from Dictionary 19.

PART-DET

Gives information about the particles detected directly, in the experiment. (See RAD-DET coding of decay particles.) Particles detected in a standard/monitor reaction are not coded under this keyword.

The code is either a code from Dictionary 13 or, for particles heavier than alpha particles, a code of the form Z-S-A-X, see page 3-17.

More than one code may be given in either of the general forms, see page 3-17. Particles detected pertaining to different reaction units within a reaction combination, are coded on separate lines in the same order as the corresponding reaction units. (See page 3-29 for reaction combinations).

RAD-DET

Gives information about the radiations and/or particles and nuclides observed in the reaction measured.

The general format of the code is: ((flag)nuclide,radiation)

Flag Field. The code is a fixed-point number (n.), which is linked to the same value appearing in the data section under the data heading keyword DECAY-FLAG.

If this field is omitted, its parenthesis is also omitted.

Nuclide field. The general format of the code is Z-S-A-X, see page 3-17.

Radiation field consists of one or more codes from Dictionary 33, each separated by a comma.

For two or more nuclides, the coded information for each nuclide is given separately, each code starting in column 12.

Examples:

a.) RAD-DET (96-CM-240,A)

b.) RAD-DET (25-MN-52-M,DG,B+)

c.) RAD-DET (48-CD-115-G,B-)
(49-IN-115-M,DG)

d.) RAD-DET 1(94-PU-237-M1.SF)
2(94-PU-237-M2,SF)

e.) RAD-DET ((1.)48-CD-115-G,B-)
((2.)49-IN-115-M,DG)

REACTION

Specifies the data which is presented in the DATA section under the headings DATA, RATIO and SUM (and their derivatives).

A reaction-unit consists of six major fields:

(reaction,branch,parameter,particle considered,modifier,data type)

If a field is omitted, the following comma is included; trailing commas are omitted.

Reaction field.: Consists of 4 subfields, separated by commas or parentheses.

(SF1(SF2,SF3)SF4,.....)

SF1. Target nucleus: May be a nuclide or compound, coded as given on page 3-17.

SF2. Incident particle: Contains either a particle code from Dictionary 28 or, for particles heavier than alpha, a code in the form Z-S-A (isomer field omitted), see page 3-17.

SF3. Process: Contains one of the following:

a.) a process code from Dictionary 30, e.g., TOT.

b.) a particle code from Dictionary 29 which may be preceded by a multiplicity factor, e.g., A or 4A.

c.) for particles heavier than alpha, a code in the form Z-S-A-X, see 3-17 (atomic weight (A) may not have the value zero). The nuclide code is repeated, if necessary, e.g., 8-0-16+8-0-16.

d.) combinations of a., b. and c., with the codes connected by '+'. Outgoing particles are ordered starting with the 'lightest' in Z, A order, followed by process codes given in the same order as given in Dictionary 30.

The exception to this order is, when SF5 contains the code 'SEQ', the particles and/or processes are ordered in the sequence in which the reaction proceeds.

Examples: HE3+8-0-16
A+XN+YP

If SF5 contains the branch code 'UND' (undefined), the particle codes given in SF3 represent only the sum of emitted nucleons, implying that the product nucleus coded in SF4 has been formed via different reaction channels. The code '(DEF)' in SF5 denotes that it is not evident from the publication whether the reaction channel is undefined or defined.

Where mass and element distributions of product nuclei have been measured and the Z and/or A of the reaction product acts as an independent variable, the sum of outgoing neutrons and protons may be entered as variables into the data table. In this case SF3 of the REACTION keyword contains at least one of the following codes:

XN - variable number of neutrons given in the data table.

YP - variable number of protons given in the data table.

The numerical values of the multiplicity factors X and Y are entered in the data table under the data headings N-OUT and P-OUT, respectively.

SF4. Reaction Product: In general, the heaviest of the products (in Z,A order) is defined as the reaction product.

If SF5 contains the code 'SEQ', indicating that the sequence of several outgoing particles and/or processes coded in SF3 is meaningful, the nuclide to be coded in SF4 is the heaviest of the final products.

Coding: This subfield

either is blank if:

1.) SF3 contains the process code TOT, ABS or NON.

2.) the reaction specifies a resonance parameter (as defined in Dictionary 36 by a point in column 22).

3.) in the case where no specific reaction product is considered. This may occur if:
- SF3 contains the process code F.
- SF3 contains a combination of the process code X with a particle code, e.g., (P,G+X),SEQ.
- the reaction is measured on a target of natural composition.
- a nuclear quantity is given.

In the case where emission cross-sections, production cross sections, product yields, etc., may be given for specified nuclides, particles or gammas, the product considered is defined as the reaction product (even if this is not the heaviest of several reaction products). This may occur if SF3 contains the process codes F, X, XN or YP.

or contains a code in the form Z-S-A-X as described on page 3-18.

In the case of isomeric ratios and sums the isomer code may consist of a combination of codes separated by a slash or a plus sign. The use of these separators will be algebraic, e.g., M1+M2/G. The code T is used to denote the sum over all isomers.

Examples: (92-U-235(N,F)54-XE-124,CUM,FY)
(39-Y-89(P,2N+P)39-Y-87-M/G,,SIG)

or, when SF3 includes the codes F,X,XN or YP, and emission cross sections, and product yields, etc., are given, SF4 of the REACTION keyword may contain one of the following codes:

ELEM - If the Z (Mass number) of the reaction product is given in the DATA table.
MASS - If the A (atomic weight) of the reaction product is given in the DATA table.
ELEM/MASS - If the Z and A of the reaction product are given in to COMMON section or DATA table.

If the data headings ELEMENT and MASS are present, a third field with the Data-Heading Keyword ISOMER is used when isomer states are specified:

0. = ground-state (used only if nuclide also has an isomeric state)
1. = first metastable state
or: the metastable state when only one is considered
2. = second metastable state
etc.

Only certain combinations of codes in the next four fields are meaningful. These are listed in Dictionary 36.

If two or more codes are given, they are separated by a slash.

Branch: Code(s) from Dictionary 31.
Indicates a partial reaction if, for example, only one of several energy levels or particle groups has been considered.

Parameter: Code(s) from Dictionary 32.
Contains information about the reaction parameter given, such as integral or differential cross-section.

Particle considered: Code(s) from Dictionary 33.
Provides particle code(s) indicating to which of several outgoing particles the quantity refers, if there is ambiguity.

Modifier: Code(s) from Dictionary 34.
Contains information on the representation of the data, for example relative data, fitting coefficients, etc.

Data-type field: Code(s) from Dictionary 35.
Indicates whether the data are experimental, theoretical, evaluated, etc. If the field is omitted, the data are experimental.

Reaction Combinations

For data sets referring to complex combinations of reactions and/or materials, the code units for REACTION can be connected into a single machine-retrievable field, with appropriate separators and properly balanced parentheses. Parentheses are used in the same manner as in FORTRAN to define algebraic operations.

The permitted separators are:

+(Plus) : Sum of 2 or more quantities.
-(Minus): Difference between 2 or more quantities
*(Times): Product of 2 or more quantities
/ (Over): Ratio of 2 or more quantities
= (Also): Tautologies
, (And) : Obsolete, but may be found in older NND entries. Used for multiple representations of the same Quantity, which are now coded using pointers.

The complete reaction combination will be enclosed in parenthesis.

The general form of these combinations is: ((------)+(-----))

A code unit is not broken for continuation on the next line. The separator will appear last on any line, with the first parenthesis of the next code unit beginning in column 12 of the next line.

Examples:((92-U-235(N,F),,SIG)/(79-AU-197(N,G)79-AU-198,,SIG))

(((28-NI-58(N,N+P)27-CO-57,,SIG)+(28-NI-58(N,D)27-CO-57,,SIG))/
(13-AL-27(N,A)11-NA-24,,SIG))

Multiple Reaction Formalism

If pointers are used with this keyword, the code fields associated with each pointer may be a reaction unit or a reaction combination. (see page 3-14).

REFERENCE

Used to give information on references which contain information on the work for which the data are coded.

The general coding format consists of 3 main fields.

(reference type, reference, date)

No embedded blanks are allowed

Reference Type: Contains a code from Dictionary 4.

Reference: Contains up to four subfields depending on reference type. If a subfield is omitted, the separating comma is included, except in the case:

a.) of a parenthesised subfield
b.) when the omitted subfield is the page number

See type of reference, following pages, for specific coding rules for each subfield.

Date: Contains a code of the form YYMMDD (year, month, day, each two digits). The month and day may be omitted.

In the case of more than one reference, each reference is coded separately, starting in column 12. The main reference is given first.

In the case of a document which has more than one identification, each may be coded within one set of parenthesis, each code being in parenthesis, and separated from the other codes by an equal sign. The primary code is given first.

e.g., ((R,USNDC-7,143,7306)=(R,EANDC(US)-181,143,7306))

The same rules apply for continuation records as those given for Reaction Combinations, page 3-29.

Type of Reference = B, C or J; Books, Conferences and Journals

Contains up to 4 subfields: code, volume, part or issue #, page (paper number).

General coding form: (B or C,Code,Volume,(Part or issue #), Page(paper number),Date)

Code subfield contains a code from Dictionary 7 for books and conferences, Dictionary 5 for journals.

Volume subfield may have any content, except commas or parentheses.

Part or issue # subfield, if present, is enclosed in parenthesis and may have any content, except commas or parentheses.

Page (paper number) subfield, if present, contains:
- the page number which is numeric
- and/or the paper number, enclosed in parenthesis, which may have any content, except commas or parentheses.

Examples:

(C,67KHARKOV,,(56),6702)	= 1967 Kharkov Conference Proceedings, paper number 56, February 1967.
(J,PR,104,1319,5612)	= Phys.Rev.,Volume 104,page 1319,Dec. 1956
(J,XYZ,5,(2),89,6002)	= Journal XYZ,Volume 5,Issue # 2, page 89,Feb. 1966

Type of Reference = P, R or S; Reports

Contains up to 3 subfields, Code-number, Volume/part, Page.

General coding form: (Type,Code-number,(Volume/part),Page,Date)

Code-number subfield contains:
a.) a code taken from Dictionary 6.
b.) the number, which may have any format, but will not contain a comma, for example: 3058-39, 4648-MS, 66-12-9, 630-1X-A/PR

Volume or part subfield, if present, is enclosed in parenthesis and may have any content, except commas or parentheses.

Page subfield, if present, is numeric. If there are two works on a page, they may be distinguished as described under Books, et al., above.

Examples:

(R,JINR-P-2713,6605)	= Dubna report, series P, number 2713, published in May 1966.
(R,BNL-325,(2ED,SUPPL.2,VOL.2A),6602)	= an extreme but well-known example for the Vol. or Part field.

Type of Reference = T, or W; Thesis or Private Communication

Contains up to 2 subfields: author, page

General coding forms: (W or T,Author,Page,Date)

Author subfield contains the family name of the first author.

Page subfield, if present, will be numeric.

Examples:

(W,BENZI,661104)	= private communication from Benzi received in November 4, 1966.
(T,ANONYMOUS,586802)	= Page 58 of thesis by Anonymous, published in February 1968.

REL-REF

Gives information on references related to, but not directly pertaining to, work coded.

The code contains four main fields: (code,subaccession#,author,reference)

If a field is omitted, the following comma is included; trailing commas are omitted.

Code field: Contains a code from Dictionary 17.

Subaccesion# field: Contains the EXFOR subaccession number for the reference given, if it exists. Cnnnn001 refers to the entire entry Cnnnn. Cnnnn000 refers to a yet unassigned subentry within the entry Cnnnn.

Author field: Contains the first author, coded as under AUTHOR, followed by + when more than one author exists.

Reference field: Contains up to 8 subfields coded as under the keyword REFERENCE. (See page 3-30).

Example:

(C,B9999001,A.B.NAME+,J,XYZ,5,(2),90,7701)=Critical remarks by A.B.Name, et al., in Journal XYZ, Volume 5, issue-number 2, page 90, January 1977.

SAMPLE

Gives information on structure, composition, shape, etc., of the measurement sample.

No coded information.

STATUS

The coded information may be entered in:

a.) either of the general forms, see page 3-8; codes from Dictionary 16.

b.) as coded information with two fields: (code,subaccession #)

Code Field: Contains a code from Dictionary 16

Subaccession Field: Contains a cross-reference to an EXFOR subaccession number. Cnnnn001 refers to the entire entry Cnnnn. Cnnnn000 refers to a yet unassigned subentry within the entry Cnnnn.

This field is used only for the codes SPSDD, DEP, OUTDT, and RNORM.

If more than one status code with a cross-reference is given, they are coded separately, starting in column 12.

Examples: STATUS (DEP,12345002)
(DEP,12345003)

TITLE

Used to enter the title of the work referenced.

No coded information.

Example of a retrieval in the EXFOR format:

CHAPTER 4

COMPUTATION FORMAT

Introduction

The CSISRS computation formats are output formats for the data library which contain specified data given in fixed fields and in standard units.

A trial computation format was developed at N.N.D.C. in 1973. Due to the experience with that format over the past years and the increased flexibility of the data system, a review was made of our retrieval capabilities. The formats described in this report have been developed as a result of that survey.

Two types of computation formats are provided:

1. Self-contained-line format: All information necessary to define a datum is included on one line and each line is, therefore, independent.

   The format has been restricted to a 132-character line to allow for processing and listing at most computer facilities.

   This format has the obvious advantage to the user of simplifying file handling. Re-sorting of the file can be done easily with standard sort routines and the file can be easily split into smaller files. The line format is also very readable from a human standpoint.

2. Data-table format: The data are presented in a two-dimensional table of 'x' versus 'y' with their associated errors and an identification tag. Other associated information necessary to define each datum may be presented as header records to the table.

   The data-table format has the advantage that the record length is restricted to 80 characters for users who are card oriented. More detailed information on a datum is presented through use of header records; the repetition necessary on self-contained lines is eliminated.

Initially, no attempt is being made to convert all data to the computation formats; formats have been developed to handle the needs of most users.

The initial formats have been limited to:

1. Data versus energy, including partial cross sections for a given secondary energy or metastable state
2. Angular distributions including partial cross sections for a given secondary energy or metastable state
3. Resonance parameters

Associated errors are given in the same units as the variables to which they apply.

Blanks are used (instead of zeros) where no value is given.

Evaluated data may be retrieved in the same formats and merged with the experimental data.

Support programs are being developed to handle basic manipulations of the data, e.g., retrieval of a data set, and are available to the user, along with necessary documentation (see Chapter 7).

Cross-Section Formats

Standard variables and their units are as follows:

1. Incident energy in eV.
2. Secondary energy in eV.
3. Angle in degrees.
4. Data which is :

    either cross section in barns
    or angular distribution in barns/steradian
    or fission parameter - no dimensions

Angular distributions are given in the laboratory system.

Secondary energies are given in a representation suitable for the data presented, with a flag specifying which representation is used.

The retrieval output tape consists of three files: an index, a Bib file and a data file. The format of each is determined by the format specified.

The Bib file contains that information associated with a data set which is most useful for machine processing of the data, i.e., INSTITUTE, REFERENCE, AUTHOR, REACTION, STANDARD, DECAY-DATA, HISTORY.

Line Format

1. Index: The format of the index file is

Columns 1-3:	Atomic number (3-digit integer)
4-6:	Atomic weight or compound code (3-digit integer)
7:	Metastable state code
8-11:	Incident projectile (particle code or, for A4, chemical symbol + last 2 digits of atomic weight)
12-14:	Reaction code
15-16:	Reaction modifier
17:	Dimension code
18:	Secondary energy code
21-31:	Lower energy limit
32-42:	Upper energy limit
43-49:	Starting record #
50-56:	# Records

2. BIB file" The format of the Bib file is the same as for the Table format, (see page 4-5).

3. Data file. The data file format is as follows:

1-18:	Same as for index, above
19-20:	Standard code
21-23:	Laboratory code (last 3 characters from CSISRS code)
24-25:	Date (2-digit year)
26-30:	CSISRS accession number (or ENDF MAT)
31-33:	CSISRS subaccession number (or blank for ENDF)
34-132:	Data fields (as shown)

Asymmetric errors are allowed only for the cross section.

Table Format

The data table format was designed to be similar to the EXFOR format so that processing programs can be easily converted to handle retrievals in either format. Since many users have expressed a preference for purely numerical files, the format was set up with this consideration in mind.

A table consists of all data for one quantity (e.g., Li(n,t) angular distributions). Each table is further divided into sets, with each set being defined by the common variables given in a header record.

All files are opened with a file identification record containing:

Columns 1-11: File identification
12-22: Request number
23-33: Retrieval date
34-44: Request type: 2 = Computation format

All records are tagged with a record identification as follows:

Columns 67-71: Table number
72-74: Set number
75-79: Reference number

Record identification is assigned to allow easy re-sorting or merging of the files.

1. Index.

Index file identification record:

9	18	27	36	72	75	80
INDEX	Req. #	Date	Req.Type		0	0

Index data record has the following format:

Columns 1- 9: Target nucleus
10-18: Incident projectile
19-45: Outgoing particles
46-54: Branch
55-63: Parameter
64-72: Modifier
73-75: Table type
76-80: Table number

2. Bib file.

Bib file identification record:

BFILE	Reg #	Date	Req. type	0	0	0

Bib information is given in sections resembling the EXFOR Format, headed by a BIB record with the following format:

Columns 1-11: 'BIB'
12-22: CSISRS Accession/Subaccession number
23-33: Number of records in section

Bib information is given once for each reference number within a data table. The set number is assigned as zero.

3. Data tables.

11	22	33	44	55	66	71	74	79
REQUEST	REQ. #	Date	Req. type			0	0	0
PHYSENT	Table type	E' type	# points	En-min	En-max	Tab.#	0	0
X1	+X1 error	-X1 error	X2	+X2 error	-X2 error	Tab.#	Set	0
X	+X error	-X error	Y	+Y error	-Y error	Tab.#	Set	Ref.#
'	'	'	'	'	'	'	'	'
'	'	'	'	'	'	'	'	'
'	'	'	'	'	'	'	'	'
ENDPHYSENT						Tab.#	999	99999
ENDREQUEST						99999	999	99999

Each table is headed by a record (PHYSENT Record) with the following format:

Columns 1-11: 'PHYSENT'
12-22: Table Type (see following)
23-33: Secondary Energy Type
34-44: # of points in Table
45-66: Energy range (2E11.4)

Each data set is headed by a record (HEADER Record) with the following format:

Columns 1-33: 1st common variable and errors (as defined by table type)
33-66: 2nd common variable and errors (as defined by table type)

4. Table types.

1. Total integrated cross sections

HEADER record: (blank)

DATA record:

E	+E error	-E error	Data	+Data err	-Data err

2. Partial integrated cross sections

HEADER record:

E'	+E' error	-E' error			

DATA record:

E	+E error	-E error	Data	+Data err	-Data err

3. Total differential cross sections

HEADER record:

E	+E error	-E error			

DATA record:

Angle	+Angle err	-Angle err	Data	+Data err	-Data err

4. Partial differential cross sections

HEADER record:

E	+E error	-E error	E'	+E' error	-E' error

DATA record:

Angle	+Angle err	-Angle err	Data	+Data err	-Data err

Resonance Parameter Format

Resonance parameters are taken as a special case since the most useful form of presentation is to have all data for a given resonance on a single line. Therefore, the computation format for resonance parameters is a third and specialized format.

The following format has been developed for single-level resonance parameter formalisms:

Standard variables and their units are as follows:

1. Resonance energy in eV.
2. Parity
3. Spin (J)
4. Angular momentum (l)
5. Total width in eV.
6. 2g * neutron width in eV.
7. Radiation width in eV.
8. Fission width in eV.
9. Peak cross section in barns

Associated variables are given in the same units as the variables to which they apply.

Widths may be given in the laboratory system or center-of-mass system as specified for retrieval.

Blanks are used (instead of zeros) where no value is given.

A companion listing format has been developed which merges recommended and experimental resonances parameters and groups by resonance (see Chapter 5).

Format for Recommended Resonance Parameters

The resonance parameter format consists of 2 records of 132 columns each.

Record 1:	Col.	Contents
	1-7	Isotope (ZZZAAAM)
	8-9	'RP'
	10-18	Energy (±X.XXXX±N)
	19-24	Energy error (X.XX±N)
	25	'R'
	26	Parity (±)
	27-29	Spin (X.X̄)
	30	Spin Flag
	31	Momentum (X)
	32	Momentum flag
	33-112	*5 Quantity Fields of 16 characters each: Quantity (X.XXXX±N) Quantity error (X̄.XXX±N) Quantity flag
	113-115	'BNL'
	116-119	Date (YYMM)
	120-124	'10000'
	125-132	Parameter codes

Record 2:		
	1-7	same as Record 1
	8-9	'R2'
	10-25	same as Record 1
	26-32	blank
	33-96	4 Quantity Fields (see record 1 for format)
	97-112	blank
	113-124	same as record 1
	125-132	Book flags

---

* Quantity fields are:

1. Total width (eV)
2. Radiation width (eV)
3. 2g X Neutron width (eV)
4. Miscellaneous (Fission width for Z≥88)
5. Miscellaneous
6. Not used
7. Not used
8. Not used

CHAPTER 5

LIST FORMAT

(to be written)

CHAPTER 6

PLOTS

(to be written)

CHAPTER 7

USER PROGRAMS

(to be written)

APPENDIX A

COOPERATING NUCLEAR REACTION DATA CENTERS

A list of the cooperating Nuclear Reaction Data Centers and their areas of responsibility follows.

Center	Areas Serviced	Data Types
1. National Nuclear Data Center Brookhaven National Laboratory Upton, NY, USA	USA and Canada	CPD, NND
2. N.E.A. Data Bank Gif-sur-Yvette FRANCE	non-American OECD member countries	NND
3. I.A.E.A. Nuclear Data Section Vienna, AUSTRIA	IAEA member states not included in the service areas of Centers 1, 2 or 4	NND
4. Center for Nuclear Data Obninsk, U.S.S.R.	U.S.S.R.	NND
5. Center for Nuclear Structure and Reaction Data I.V. Kurchatov Institute Moscow, U.S.S.R.	U.S.S.R.	CPD
6. Charged Particle Nuclear Data Group Karlsruhe, Fed. Rep. of Germany		CPD

Appendix 15

NATIONAL NUCLEAR DATA CENTER

Brookhaven National Laboratory
Upton, New York 11973

PRODUCTS and SERVICES

March 1982

I. Background

The National Nuclear Data Center (NNDC) offers services to users in the United States, Canada and, in some cases, other countries, covering the entire field of low energy nuclear physics. In particular, the center can provide information on neutron, charged particle and photonuclear reactions, nuclear structure and decay data. The information available to users of NNDC services is the product of the combined efforts of the NNDC and cooperating data centers and other interested groups, both in the United States and worldwide.

Extensive bibliographic files for neutron and integral charged-particle reaction, nuclear structure, and radioactive decay data publications are available at the center.

Files of experimental neutron, charged-particle and photonuclear reaction data are also available.

Evaluated nuclear data is important for applications and to fundamental research. The center has organized a cooperative national effort to produce neutron reaction data evaluations within an organization known as the Cross Section Evaluation Working Group (CSEWG). The resulting evaluated data file, ENDF/B, has been made available to users since 1967. Evaluated data files originating in other countries are also available from NNDC. The NNDC also coordinates the U.S. nuclear structure evaluation effort and acts as a liaison between the international nuclear structure evaluation centers. Recently, the NNDC assumed responsibility for the distribution of information on nuclear-structure and radioactive-decay data. Evaluated charged particle reaction data are also available for distribution.

The center also has selected preprocessed neutron and photon data in the form of multigroup libraries which can be used to meet the needs of many users.

The center maintains its own computer in order to better serve its users. Specific requests are satisfied with documents or computer retrieval output in the form of listings, plots and or tapes. Magnetic tapes can be formatted to satisfy the needs of most users. More general needs are often satisfied by one of the center's many publications.

II. Bibliography

A. Neutron Data (CINDA) - bibliographic references to measurements, calculations, reviews and evaluations of microscopic neutron data.

Both published and unpublished literature are scanned. All types of neutron reaction data as well as resonance parameters, level densities, spontaneous fission, photoneutron and photofission reactions are included. References are compiled worldwide through an exchange agreement with other neutron data centers.

B. Charged Particle Data (CPBIB) - bibliographic references for integral charged-particle nuclear data and integral and differential neutron-source reaction data for energies up to 100 MeV.

References are compiled at NNDC, and are complete from 1976.

C. Nuclear Structure and Radioactive Decay Data (NSR) - reference-oriented bibliography of the literature pertaining to nuclear structure, nuclear reactions and radioactive decay data.

Many papers on nuclear reactions and radioactive decay and some papers on atomic physics pertinent to nuclear structure are included. The file is complete for published data from 1969 on. The complete file was received from the Nuclear Data Project in 1980 and is currently updated at NNDC.

III. Experimental Data

A. Neutron, Charged-Particle and Photonuclear Reaction Data (CSISRS)

The computerized experimental data library contains the following types of data plus associated descriptive information:

- energy-dependent total and partial cross sections and fission-product yields for incident neutrons and charged particles.
- thick target and product yields for incident charged particles.
- outgoing-particle energy and angular distributions, resonance parameters, and gamma-ray production for neutron-induced reactions.
- photonuclear data translated from the Berman library.

Worldwide coverage is achieved through exchange agreements with other data centers for the collection and dissemination of neutron, charged-particle and photonuclear data in a mutually agreed on exchange format (EXFOR).

B. Nuclear Structure and Radioactive Decay Data

Spontaneous fission data and level density parameters may be found in CSISRS.

A file containing experimental nuclear structure data compiled or received in the ENSDF format is maintained (see Evaluated Data B).

IV Evaluated Data

A. Neutron

ENDF/B contains the complete evaluations for approximately 100 different elements or isotopes. In addition there are some 900 partial evaluations of fission-product cross sections and dosimetry data. Many materials contain information about radioactive decay. ENDF/B is revised periodically.

ENDF/A contains data sets from other data systems and data sets that may be only partially complete or untested, but which are, nevertheless, useful for scientific studies. There are currently more than 30 evaluation sets in ENDF/A, including the ENDL, KEDAK and UK libraries.

NNDC is responsible for the coordination of CSEWG, involving a cooperative agreement of many laboratories within the U.S. and Canada to produce specific reference data sets which are complete in the information needed for application studies.

Worldwide coverage is achieved through cooperative arrangements with other data centers and with laboratories in the U.S. and Canada.

B. Nuclear Structure Data

ENSDF contains nuclear structure information on approximately 1900 isotopes, covering $A \leq 263$. Included are adopted level properties, complete decay schemes and reaction data.

NNDC is responsible for coordinating the U.S. effort and for cooperating in a worldwide effort to evaluate nuclear structure data involving several centers. The results are edited by NNDC and published in Nuclear Data Sheets.

C. Radioactive Decay Data

As noted above both ENDF and ENSDF contain information on radioactive decay.

ENSDF contains approximately 1900 decay schemes for $A \leq 263$.

The present version of ENDF contains Q-value, half-life, and average energies for approximately 800 fission product nuclei; of these, 180 also have spectral information. ENDF also contains decay data for tritium and about 60 actinides.

D. Charged Particle Nuclear Data

A starter library of proton, deuteron and alpha induced reactions based on nuclear systematics in pseudo-ENDF format is available from the NNDC.

A library of fusion related charged-particle reaction data ($\leq$ 20 Mev) has been received from Los Alamos (Hale) and is available in an ENDF-like format.

V. Preprocessed Data

The following preprocessed data is available from NNDC:

1. The SAND-II library for Dosimetry applications in 620 groups and including 64 materials.

2. For epithermal reactor applications DLC-2 100 group library from RSIC at ORNL. This library was generated from ENDF/B-III cross sections and contains 69 materials. This library is appropriate for codes such as ANISN and DOT.

3. The 50 group LIB-IV cross section library from LASL based upon ENDF/B-IV contains 101 materials. This library is issued in the "CCCC" interface format, and is intended for use by the nuclear community for fast reactor design calculations. LIB-IV features cross sections for use in the self-shielding factor method, sometimes called the Bondarenko method. Utility programs are provided with the library.

4. For thermal reactor applications a 460 thermal group library (in the universal supergroup system) generated by Westinghouse Nuclear Energy Systems from the ENDF/B-IV files is available. Cross sections are available for all materials included in the general files.

5. Thermal scattering matrices generated by Savannah River Laboratories from ENDF/B-III special files for 13 materials containing $S(\alpha,\beta)$ information are available. The kernels were generated for various temperatures and are available in 30 and 50 group formats.

6. An interim 84 group cross section library for actinides in the production chain from ^{242}Pu through ^{253}Es was generated by Savannah River Laboratories and is appropriate for input to the HAMMER code. The epithermal range contains 54 groups in the MUFT structure, and the thermal range contains 30 groups typical of the THERMOS code.

VI. Services

Retrievals from Computerized Libraries

CSISRS - Retrievals of specific data sets or retrieval by specific input criteria, such as, target Z and/or A, Energy Range and Reaction. Output is provided in the form of tapes, listings or graphical displays, with a choice of several output formats available. Data may be retrieved in the original format (EXFOR) or in a format more easily usable for machine processing of the data (Computation Format).

ENDF/B - Retrievals for specific materials are available in the form of tapes, listings or plots.

ENDF/A - Retrievals of specified evaluated data sets or specified types of data retrievals will be available in a format more easily usable for machine processing of the data.

ENSDF - Retrievals in ENSDF format for specified nuclides or nuclide ranges or for nuclides with specific properties. Level and/or decay scheme plots and/or listings of level properties and radiations will also be provided upon request.

CINDA and CPBIB - Retrievals are available for specific input criteria (as for CSISRS) in the form of tape or listings.

NSR - Retrievals are available for references to information on nuclear structure and decay properties of a nuclide or for nuclear reactions, reaction targets or reaction properties.

Retrievals may be made interleaving data from:

- CSISRS and ENDF: in the form of plots.
- Recommended and experimental resonance parameters: in the form of listings.

Plans are underway to provide retrievals interleaving data from ENDF, ENSDF, and BNL-325, Vol. I.

VII. Publications

A complete list of recent NNDC publications is available. Examples of NNDC publications are the following:

A. NNDC Newsletter

B. Compilations of microscopic neutron data derived from the center's data files.

Neutron Cross Sections (BNL-325). This represents perhaps the earliest and best-known evaluation of neutron resonance data and cross-sections published by the center.

- Vol. I: resonance parameters: Part A, Z = 1-60. Academic Press, 1981. (Part B is scheduled for publication in 1982.)
- Vol. II: experimental data plotted against eye-guides evaluated curves: 3rd edition, 1976.

BNL-400: Angular Distributions for Neutron-Induced Reactions: 3rd edition, 1970.

C. Bibliography of Integral Charged-Particle Nuclear Data (BNL-NCS-50640).

D. CINDA and Charged-Particle Reaction indices included in conference proceedings and progress reports.

E. Nuclear Data Sheets, including Recent References, Academic Press.

F. Compilation of Requests for Nuclear Data (BNL-NCS-51354) 1981.

G. Reports on the Evaluated Nuclear Data System (ENDF).

BNL-50446: ENDF/B-IV Dosimetry File (ENDF-216)
BNL-50464: ENDF/B-IV Cross Section Measurement Standards (ENDF-225)
BNL-50545: ENDF/B Fission Product Decay Data (ENDF-243)
BNL-NCS-17541: ENDF/B Summary Documentation, 3rd Ed. (ENDF B-V), 1979 (ENDF-201)
BNL-NCS-50300: Description of ENDF/B Processing Codes and Retrieval Subroutines: revised 1971 (ENDF-110)
BNL-NCS-50496: Data Formats and Procedures for the Evaluated Nuclear Data File, ENDF, 2nd Ed., 1979 (ENDF-102)

H. NNDC technical reports on data evaluation.

I. Reports to the DOE Nuclear Data Committee, compiled annually.

Appendix 16

NNDC Role in ENDF

S. Pearlstein

May 1982

1. ENDF/B is produced by the Cross Section Evaluation Working Group (CSEWG) which is coordinated by the NNDC. The NNDC performs all administrative and most technical tasks.

2. CSEWG cosists of 3 main working committees 1) Evaluation, 2) Data Testing and Applications, and 3) Methods and Formats, which are overseen by the Executive Committee. The Executive Committee consists of the CSEWG chairman, representatives of funding agencies, heads of the 3 main working committees, and a few CSEWG members at large.

3. Each main working committee coordinates the work of several subcommittees. Examples are shielding, utility codes, data status and requests, dosimetry, etc.

4. The NNDC has responsibility for developing and maintaining codes to check ENDF data, prepare review kits, perform final corrections, and distribute library and subsequent updates. The NNDC also prepares and distributes ENDF related documentation. The NNDC performs several evaluations for ENDF/B including Cr, Ni, Au and U-235.

5. Some revisions to ENDF/B-V (Revision 2) will be issued in June 1982. ENDF/B-VI measurement standards should be completed in 1983-84. ENDF/B-VI schedule is tentatively 1985-86. For ENDF/B-VI, no major changes in format are anticipated for neutron data. Although a generalized format is possible, revisions to present formats will be preferred to minimize code changes. The expansion of the contents of ENDF/B-VI will depend on the progress of such programs as the d+Li source irradiation facility (FMIT), use of covariance matrices, biomedical applications, radiation damage, etc.

Appendix 17

COMPILATION OF THE JOINT EVALUATED FILE

NEA Data Bank

A. Introduction

Following an initiative by the NEA Committee on Reactor Physics (NEACRP) at their meeting in September 1980 a first meeting of an ad-hoc working group to initiate a collaborative programme of nuclear data evaluation work in Japan and the European member countries of NEA was held in Paris in November 1980. In October 1982 the NEA Steering Committee approved the setting up of a Joint Programme on Neutron Data Evaluations. A Scientific Co-ordinating Group was set up to determine the content of the Joint Evaluated File (JEF) and to coordinate work in national research organisations associated with the periodic revisions to this file.

The NEA Data Bank will act as coordinator of work on the Joint Evaluated File (JEF) and will also assemble and maintain the file. Other tasks assigned to the NEA Data Bank are:

- Secretariat functions of the Joint Programme on Neutron Data Evaluation.
- Assistance in the preparation and publication of summary documentation for the evaluated file.
- Implementation and operation of computer codes for verification and consistency checking in evaluated files.
- Format translation of selected evaluation.

B. Outline of Evaluated Data File

- The ENDF/B-V format was adopted.
- Resonance parameters are not included in the evaluated data file. There is, however, the following rule in the ENDF/B-V format:

  "Every ENDF file must have a File 2 even if no resonance parameters are given in order to specify the effective scattering radius."

  According to this rule, the evaluated data file should contain at least scattering radii for all the material.
- The data are at the moment given at 0°K.
- The material numbers (MAT) are determined as follows:

MAT = 4000 + Z*10 + the last digit of A.

example 4925 = U-235
4633 = Eu-153

The first digit '4' was suggested by BNL. The above-mentioned rule will be violated in some cases. For example, in the case where the data of Mo-100 and Mo-nat exist, we have to make an exception as follows:

4420 = Mo-nat
4421 = Mo-100

- All cross section data are given in the pointwise tabulated form. Therefore the following ENDF/B-V rule is not valid in our evaluated data file:

"Energy mesh size NP $\leq$ 5000"

Some data files contain more than 10,000 energy points.

C. Computer Codes Used in the Compilation Work

The following programs have so far been used in the compilation work at the NEA Data Bank:

- KTOE

translates a KEDAK format file into ENDF/B-IV format. This program was modified:

- To output values in the ENDF/B-V six-digit format.
- To output the inelastic scattering cross section to discrete levels.

The programme will later on be modified so it will be able to translate, in a more general way, the energy distributions (MF=5).

- LINEAR

changes the interpolation law defined in the evaluated file to a 'Linear-Linear Interpolation' and reduces the number of energy points. This program was used to create an input file to the code RECENT. A maximum acceptable error of 0.1% was used in the calculation within the whole energy range.

- RECENT

calculates pointwise cross sections from given resonance parameters and background data. A maximum acceptable error of 1% for both calculations of pointwise cross sections from resonance parameters and File 2 + File 3 calculations was used.

RECENT reduces the number of energy points calculated to a number which is enough to represent the cross section shapes within an error of 1%. This reduction is done for the total, elastic, fission and capture cross sections.

- CRECTJ5

compiles evaluated data in the ENDF/B-IV or ENDF/B-V format. CRECTJ5 has the following functions:

- It combines partially existing evaluated data files to one file.
- It performs all kind of calculations such as addition, subtraction, multiplication and division on an evaluated file.

Example: $\sigma_{tot} = \sigma_{el} + \sigma_{nonel}$

- It modifies cross sections by partially replacing data with other evaluated data.
- It makes a dictionary table in MF = 1, MT = 451.
- It outputs data in the ENDF/B-V six-digit format.

- CHECKER5

tests the ENDF/B-V format.

- INTER5

calculates resonance integrals, Maxwellian average cross sections, thermal values, fission spectrum average cross sections. A PDP-11 version of INTER5, written by A. Hasegawa, was used.

- FIZCON5

checks ENDF/B-5 data for physics consistency and to see that recommended procedures are followed.

All the jobs with KTOE, INTER, RECENT, CRECTJ5 and FIZCON5 were carried out using the IBM 3033 computer at CIS1, Saclay, whereas CHECKER5 and INTER5 were run on the PDP-11 at the NEA Data Bank.

D. Assembling of the Evaluated File

In the compilation work special attention was given to the following points:

- All the important flags in the ENDF/B-V format were carefully checked.

- The consistency of Q-values and threshold energies.

$$E_{th} = \frac{AWR + 1.0}{AWR} * Q$$

In the case when Q-values are not given in recommended data, we used the Q-values calculated by Howerton.

- Summation of partial cross sections.

The following rule for the ENDF/B-V format is also valid for the total inelastic scattering cross section:

"The total cross section is the sum of all partial cross sections and has an energy mesh that includes all energy meshes for partial cross sections."

By assuming that the total cross section and total inelastic scattering cross section have the same shapes as the sum of their corresponding partial cross sections, the following calculations were performed with the code CRECTJ5:

- The total inelastic scattering cross section (MT = 4) = sum of MT = 51, 52, ..., 91.

- The non-elastic scattering cross section (MT = 3) = sum of all partial non-elastic cross sections, e.g. MT = 4, 16, 17, 18, 102 up to MT = 114.

- The total cross section (MT = 1) = the elastic scattering cross section (MT = 2) + the non-elastic scattering cross section (MT = 3).

This total cross section and total inelastic scattering cross section thus calculated with CRECTJ5 will then have the same energy mesh as the corresponding partial cross sections.

- As a result of the above-mentioned procedure, each material file contains the non-elastic scattering cross section.

E. Status of Compilation

Twenty-seven nuclides have so far been compiled in the ENDF/B-V format. The format and the content of the files have been checked with the codes CHECKER5 and FIZCON5. The following problems have been encountered in the translation and compilation work:

- When calculating pointwise cross-sections from resonance parameters with the code RECENT, the output data is given in a nine-digit floating point format, which is more exact than the normal six-digit format. A conversion from nine to six digits will then result in a lot of duplicate energy points with different cross sections. The nine-digit format should therefore be used with a 0°K pointwise cross section data file.

- The resonance region for some evaluated data files are characterised with single level Breit-Wigner formula. This can give rise to negative cross sections when pointwise data are calculated with the code RECENT, because of incorrect background data in file MF = 3. This problem can be avoided, e.g. by using multi-level Breit-Wigner formula instead.

- The computer code KTOE that translates KEDAK format to ENDF/B-IV format does not, in a general way, translate energy distributions (MF = 5). Some corrections will be made to this part of the program in the near future.

- There have been requests from some users of the file that the original resonance parameters should be kept. It was not found to be easy according to the ENDF/B-V format specification to include these parameters in the pointwise cross section file. The suggestion was therefore to create two files, one with pointwise cross sections and one with resonance parameters.

F. Plans for Phase 2 of the Joint Evaluated File

The aim of Phase 1 is to prepare a complete neutron cross-section library for release at the end of 1982. The process of selection and assembly of files is planned to be completed by September 1982 and the consistency checks should be completed at the end of 1982. These consistency checks will include the comparision of 2200 m/s, thermal Maxwellian, resonance integrals and fission spectrum averages with available experimental data.

In the course of the assessment of the files for inclusion in Version 1 of the Library (JEF-1), a number of nuclei have been identified as in need of at least partial re-evaluation. Some of minor improvements will be included in JEF-1, but the major improvements, which also take into account the results of new measurements, will be left for the proposed re-evaluations for Version 2 (JEF-2), which will be developed in Phase 2 of the project. The outline plan is to release JEF-2 at the end of 1985.

Following the release of JEF-1, a programme of benchmark testing will be carried out. This will be in two stages. Stage 1, to be completed at the end of 1983, will be to analyse simple benchmarks (including several of the benchmarks used for ENDF/B-V testing, together with some selected European benchmarks). The distribution of work at this stage will be discussed at the next meeting. It is hoped that the NEA Data Bank will be able to participate in this phase, for example, by preparing group cross-sections and possibly also by calculating simple integral properties using codes available at the Data Bank. In the second stage of benchmark testing, more complex assemblies will be analysed, including assemblies for which the composition data have not been published. In this case the results of the analyses will be communicated to other participants so that the performance of the library for a very wide range of applications can be understood.

In both stages of benchmark testing an important aim will be to try to identify both the items of nuclear data responsible for discrepancies and the preferred choices (when these are different sets of measurements upon which evaluations can be based).

G. Availibility of the Joint Evaluated File (JEF)

The question of availability of the file was discussed at the last meeting of the Scientific Co-ordinating Group and it was stated that the file will be available to member countries of the NEA Data Bank. Reports presented at the meetings of the Scientific Co-ordinating Group are confidential and should not be circulated outside members of this group or members of the NEA Data Bank Committee.

Appendix 18

Example of high energy neutron cross sections

The large variety of reactions with thresholds around 20MeV and above makes it impossible to compile these data in ENDF/B (example taken from data compiled in EXFOR-V0027).

Nitrogen cross-sections

Reaction	Energy in MeV											
	20	22	24	26	28	30	32	36	40	45	50	60.7
Total	1550.0	1543.0	1530.0	1510.0	1485.0	1455.0	1422.0	1351.0	1274.0	1178.0	1085.0	906.0
Elastic	984.0	998.0	1003.0	999.0	989.0	973.0	953.0	903.0	845.0	768.0	691.0	539.0
(n,n')	24.4	20.7	16.9	14.0	13.5	10.1	9.2	6.2	4.2	2.9	2.1	1.2
(n,2n)	20.8	19.6	16.9	14.2	12.3	11.0	9.6	5.9	3.8	2.5	2.2	0.8
(n,np)	115.0	103.2	84.7	67.6	57.9	49.8	45.0	27.1	16.8	11.2	9.4	3.6
(n,nd)	29.4	30.4	28.1	24.6	23.9	20.0	17.8	12.1	7.9	5.2	3.9	1.6
(n,na)	22.3	27.3	27.4	25.1	22.9	21.2	18.9	12.9	8.3	5.3	4.3	1.8
(n,2np)	9.3	13.5	17.2	19.0	23.5	26.3	25.5	25.4	18.7	11.7	13.9	4.5
(n,2na)p2a							2.1	5.0	5.5	5.3	4.9	2.5
(n,npn)	5.7	14.8	26.3	37.6	43.2	49.3	44.9	47.1	36.6	26.7	19.7	7.8
(n,npa)				0.6	2.1	3.9	6.0	11.3	9.8	10.7	9.5	5.7
(n,npa)n2a						0.7	9.0	8.0	6.6	4.4	4.6	1.9
(n,nda)										2.5	5.0	6.8
(n,ndp)								1.2	3.7	7.0	11.4	14.9
(n,nda)2a			0.5	1.5	2.8	4.2	5.3	13.1	19.5	23.4	24.3	21.7
(n,2a)			1.5	3.1	4.1	5.5	4.2	4.0	3.0	1.4	1.2	0.5
(n,2npa)2a					0.2	0.9	1.2	3.7	6.2	8.6	11.9	11.6
(n,npnp)										1.2	3.0	6.2
(n,npna)					0.3	0.9	3.1	5.8	9.7	12.2	17.1	17.4
(n,p)	18.2	15.0	12.9	11.5	10.8	9.4	8.5	5.4	4.5	3.5	2.7	2.7
(n,pn)	176.3	155.3	133.1	111.4	99.2	82.4	76.1	45.4	34.4	23.1	15.2	8.7
(n,pa)							0.6	1.6	2.5	1.7	1.3	0.7

/continued

Reaction	Energy in MeV											
	20	22	24	26	28	30	32	36	40	45	50	60.7
(n,pt)							1.7	2.9	3.9	3.5	2.5	1.5
(n,pα)	5.6	8.3	10.6	11.8	12.0	11.9	12.0	9.5	7.3	4.9	3.4	1.9
(n,pnn)	13.2	31.3	52.5	71.2	82.3	85.2	77.2	79.9	73.9	57.0	37.5	20.4
(n,pnp)								0.5	1.5	3.0	3.4	4.6
(n,pnd)										2.6	3.3	5.5
(n,pnα)			0.1	1.0	3.5	6.1	9.0	17.9	23.2	23.7	21.3	15.8
(n,pnd)n2α						1.1	2.2	6.4	9.4	919	7.8	5.3
(n,pαn)			0.1	0.8	2.1	3.3	4.1	6.4	6.7	7.8	8.6	10.0
(n,pαn)n2α						0.5	0.7	1.9	1.8	3.1	2.7	2.1
(n,pnnp)										2.9	6.5	17.2
(n,pnnα)					0.5	1.4	2.7	8.9	19.8	28.3	37.0	49.6
(n,d)	25.9	21.1	18.1	15.9	14.0	12.6	11.4	9.5	8.0	6.3	5.0	3.1
(n,dn)	35.6	34.5	27.5	19.4	13.5	10.4	9.6	5.8	5.0	3.7	2.7	1.6
(n,dα)		1.7	4.0	4.9	4.6	4.1	3.9	3.3	3.3	2.9	2.2	0.9
(n,dnp)										2.0	3.0	5.0
(n,dnα)2α		0.2	0.7	1.5	2.0	2.4	2.7	4.6	7.6	8.0	7.6	6.2
(n,dαn)2α			0.5	1.3	1.6	1.7	1.6	1.5	1.3	0.8	1.0	1.6
(n,t)	5.9	2.8	2.8	2.4	2.1	2.0	2.0	1.9	1.0	0.7	0.7	0.2
(n,tn)							0.8	1.8	2.4	2.2	2.0	1.0
(n,tp)			0.2	0.9	1.7	2.4	2.5	4.1	4.8	3.9	3.4	1.7
(n,tα)2α	9.7	8.8	12.4	15.7	14.5	13.6	12.7	11.4	10.3	7.5	6.8	1.2
(n,α)	15.5	9.4	6.4	5.4	4.0	3.7	3.1	2.4	1.6	1.0	0.9	0.4

/continued

Reaction												
	20	22	24	26	28	30	32	36	40	45	50	60.7
(n,an)	8.1	9.7	9.8	8.5	6.9	6.3	5.2	4.1	3.3	2.7	1.9	0.9
(n,ap)	1.5	1.9	2.3	2.7	2.8	3.3	2.5	2.0	1.8	1.7	1.2	0.6
(n,ad)		0.5	1.4	1.9	2.2	2.5	2.8	2.6	2.4	1.7	1.3	0.7
(n,2α)	28.6	21.8	15.6	12.8	10.0	8.6	7.4	3.8	3.1	2.3	1.5	0.7
(n,ann)p2α							0.1	0.4	0.6	0.8	0.9	1.1
(n,anp)					0.2	0.3	0.4	0.8	0.8	0.9	0.8	2.3
(n,and)2α					0.2	0.3	0.5	0.8	1.1	1.3	1.3	1.7
(n,anα)			0.2	1.1	1.2	1.5	1.6	1.6	1.7	0.9	0.8	0.5
(n,2pn)							1.3	1.8	2.2	1.9	1.8	4.4
(n,2dn)2α				0.5	0.8	1.1	1.3	1.8	2.3	2.6	2.7	3.5
(n,at)2α	4.5	5.7	5.8	5.4	4.5	4.3	4.2	3.2	2.7	2.4	2.0	1.0
(n,2α)tα	0.3	0.9	1.4	1.6	1.5	1.5	1.9	1.5	1.4	1.0	0.8	0.4

All cross-sections in mb