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INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

11th IAEA Consultants' Meeting of the NUCLEAR REACTION DATA CENTERS

Obninsk, 7-11 October 1991

SUMMARY REPORT

Edited by

H.D. Lemmel
March 1992

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

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Abstract: This report summarizes the 1991 co-ordination meeting in Obninsk, Russia, of the national and regional nuclear reaction data centers, convened by the IAEA at regular intervals. The main topics are

- the international exchange of nuclear reaction data by means of the "EXFOR" system, and the further development of this system,
- the "CINDA" system as an international index and bibliography to neutron reaction data,
- the sharing of the workload for speedy and reliable nuclear data compilation,
- the exchange and documentation of evaluted data libraries in ENDF format,

with the goal of rendering data center services to data users in IAEA Member States by means of computer retrievals, online services and printed materials.

from left to right

Aleksander Korotaev, FEI, foreign relations
Marina Ulaeva, CJD, programming engineer
K.I. Zolotarev, CJD
Liang Qichang, CNDC
Olga A. Pakhomova, CJD
Larisa Botjanovskaja, CJD, technical secretary
Claes Nordborg, NEA-DB
S.M. Nasyrova, CJD
V.E. Makarenko, CAJaD (behind Nasyrova)
S.A. Maev, CJD
V.V. Varlamov, CDFE
Cai Dunjiu, CNDC
Vladimir G. Pronjaev, CJD
Vicky McLane, NNDC
Joe J. Schmidt, NDS
V.N. Manokhin, CJD
S.Ju. Babykina, CAJaD
M. Chiba, SG
Y. Tendow, RIKEN
Hans D. Lemmel, NDS
Sol Pearlstein, NNDC
Anatoli I. Blokhin, CJD
V.A. Vukolov, CAJaD

Contents

Summary

The eleventh IAEA Consultants' Meeting of the Nuclear Reaction Data Centers (NRDC Meeting) took place in Obninsk in the week 7-11 October 1991. It was hosted by the Centr po Jadernym Dannym (Nuclear Data Center) at the FEI. Dr. V. Manokhin and his staff must be congratulated for an excellent organization of the meeting and splendid hospitality.

The meeting included the 22nd "Four-Centers Meeting" of the Neutron Data Centres and the 12th Meeting on Charged Particle Nuclear Data Compilation.

The meeting was attended by 19 participants from 4 Russian data centers, and 9 participants from 6 foreign centers. For the list of participants see Annex 1.

The agenda is given in Annex 2.

The Conclusions and Actions resulting from the meeting are given in Annex 3.

Progress reports of the centers are given in Annex 4.

Dr. V. Manokhin opened the meeting and welcomed the participants. He emphasized the important functions of the network of the Nuclear Reaction Data Centres to satisfy the worldwide nuclear data needs through the center-to-center data exchange in the internationally agreed formats, and in particular to stimulate nuclear data measurements, data compilation and data evaluation in those fields of nuclear sciences where new data requirements are encountered. These are primarily new data requirements

- in thermonuclear fusion
- in new fission reactor types, specifically for burning of plutonium
- in medical applications
- in space technology
- in the field of intermediate energy nuclear data

and others.

Dr. J.J. Schmidt thanked the hosts on behalf of the participants. He welcomed the representatives of the data centers and, in particular, the strong delegations from four Russian centers.

J.J. Schmidt was elected as chairman for the General Session of the agenda and H.D. Lemmel for the Technical Sessions.

The Agenda was approved as given in Annex 2. Work on the agenda was scheduled for Monday, Tuesday and Friday. Visits to the Russian data centers took place on Wednesday morning (CJD), Thursday morning (CDFE) and Thursday afternoon (CAJaD). On Wednesday afternoon a seminar on the measurements, evaluation and application of intermediate energy nuclear data was held, see Annex 5.

The main problem with which the centers are presently confronted is the lack of adequate funding and staffing. A summary of the relevant discussions is given in the following pages. This problem has led to the creation of an INDC Subcommittee on Data Center Support of which the Minutes of the 1990 Meeting are reproduced in Annex 6.

Some working papers on the EXFOR data exchange are given in Annex 7.

Finally, Annex 8 contains a Glossary of Abbreviations.

For all the other items of the agenda see the "Conclusions and Actions" given in Annex 3.

At the end of the meeting the participants honored several most meritful center heads who were about to retire or had recently retired:

- B.S. Ishkhanov, CDFE
- J.J. Schmidt, NDS
- Cai Dunjiu, CNDC
- A. Hashizume, RIKEN
- Y. Popov, former head of CJD
- S. Pearlstein, NNDC

The retirement of the latter two became known only soon after the meeting. The participants wish to thank all of them most cordially for all they had done for the network of the Nuclear Reaction Data Centers. The loss of so many experienced experts will be difficult to compensate at the centers.

The Network of Nuclear Reaction Data Centers and Manpower Situation at the Centers

The network of Nuclear Data Centers

National and regional nuclear reaction data centers, co-ordinated by the International Atomic Energy Agency, co-operate in the compilation, exchange and dissemination of nuclear reaction data, in order to meet the requirements of nuclear data users in all countries. A brief summary of the data centers network is given below.

The nuclear reaction data centers:

NNDC	-	US National Nuclear Data Center, Brookhaven, USA
NEA-DB	-	OECD/NEA Nuclear Data Bank, Saclay, France
NDS	-	IAEA Nuclear Data Section
CJD	-	USSR Centr po Jadernym Dannym (= Nuclear Data Centre), Obninsk, Russia
CAJaD	-	USSR Centr po Dannym o Stroenii Atomnogo Jadra i Jadernykh Reakcikh (= Nuclear Structure and Nuclear Reaction Data Centre), Moscow, Russia
CDFE	-	Centr Dannykh Fotojad. Eksp. (= Centre for Experimental Photonuclear Data), Moscow, Russia
RIKEN	-	Nuclear Data Group, RIKEN Institute of Physical and Chemical Research, Wako-Shi, Japan
SGIP	-	Study Group for Information Processing, Sapporo, Japan
CNDC	-	Chinese Nuclear Data Centre, Beijing, P.R. of China
JAERI	-	Nuclear Data Center of the Japan Atomic Energy Research Institute, Tokai-Mura, Japan

1. Neutron Nuclear Data

1.a Bibliography and Data Index CINDA:
Input prepared by NNDC, NEA-DB, NDS, CJD, CNDC
Handbooks published by IAEA
Online services by NNDC, NEA-DB (and NDS from 1992)

1.b Experimental data exchanged in EXFOR format:
Input prepared by NNDC, NEA-DB, NDS, CJD
Online services by NNDC, NEA-DB (and NDS from 1992)

1.c Data Handbooks based on EXFOR published by NNDC

1.d Evaluated data exchanged in ENDF format:
NNDC, NEA-DB, NDS, CJD, CNDC, JAERI and others. Main data libraries:

BROND-2 (USSR)
CENDL-2 (China)
ENDF/B-6 (USA)
IRDF-90 (IAEA)
JEF-2 (NEA)
JENDL-3 (Japan)

Online services for BROND, ENDF/B-6, JEF, JENDL-3 by NNDC, NEA-DB (and NDS from 1992)

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

1.f WRENDA: compilation of requested data that are known with insufficient accuracy.
Compiled by NNDC, NEA-DB, NDS, CJD, published by IAEA

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

2.a Bibliography published by NNDC *)

2.b Numerical data exchanged in EXFOR format:
Input prepared by CAJaD, RIKEN, CNDC, NDS, NNDC, SGIP

2.c Data Handbooks based on EXFOR published by NDS, CAJaD

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

3. Photonuclear Data

3.a Numerical data exchanged in EXFOR format:
Input prepared by CDFE, occasional contributions from NNDC, NDS

3.b Bibiliography published by CDFE

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

*) Discontinued in 1990; partly incorporated in the bibliographic system "NSR" for nuclear structure and decay data.

Manpower Situation at the Centers

During the recent years

- the manpower situation at some of the centers has deteriorated such that the completeness of neutron reaction data in the CINDA and EXFOR databases is no longer granted;

- at other centers the manpower situation continued to be insufficient to reach the important aim to create a reliable charged particle reaction database for monitor reactions and for radioisotope production.

An essential part of the meeting was therefore devoted to the discussion of the inadequate financial support of the nuclear data centers.

Concl.

Data Needs

The continuing needs for improvements in nuclear data accuracy were summarized as expressed at the last INDC-Meeting in 1990 and at the Jülich Nuclear Data Conference 1991. These needs exist primarily in the following fields:

- actinide burning ("minor" actinide data)
- advanced reactor design (e.g. epithermal tight lattice reactors)
- fusion
- environmental protection
- reactor decommissioning (activation and decay data)
- basic reference data such as half-lives and branching ratios

It was pointed out that these defined data needs can only partly be met by data evaluation. In many cases new measurements will be required for which only few facilities are still available.

In addition to contributing to satisfy above new data needs, it is the continuing important task of the data centers

- to compile currently all experimental data;
- to make sure that the authors supply adequate information on the uncertainty analysis;
- to examine whether new data satisfy a WRENDA request; and
- to verify whether new experimental data agree or disagree with the established evaluated data files.

It is most essential to keep the existing data files complete, correct and uptodate. Once the completeness of a data file has deteriorated, it requires additional manpower to bring the file uptodate again.

Concl.

Data Center Network

The data centers are convinced that their present scheme of cooperation and worksharing by well-defined criteria is successful and efficient. An optimum between exaggerated centralization and exaggerated decentralization (both have obvious disadvantages) has been reached.

Arguments that reductions in data production justify further reductions in data center staff must be rejected, because staff has been reduced already more than can be justified by this argument.

Inefficiencies are known to exist for the following reasons which are out of the control of the centers

- Different computer configuration at the centers permitted only a limited exchange of data file management software. This situation will improve by the changeover of NDS to a VAX computer. But not all of the centers have the possibilities of transferring their operations to a VAX computer.
- Staff discontinuities (primarily at the international centers NEA-DB and NDS) absorb additional manpower for training and are responsible for occasional poor quality compilation, which, in turn, absorb additional manpower at all centers for the correction of compilation mistakes.
- If a single post devoted to charged-particle data compilation would be added to one of the existing Centers, this could be more effective than a separate charged-particle data group elsewhere with a staff of 3.
- Additional competent groups experienced in measurement, compilation and evaluation of various types of charged-particle nuclear data would be most welcome to join the network.

Available Manpower

Concl. The staff situation at the centers is now such that the data needs and the expectations of data center customers cannot be fulfilled to a satisfactory degree. In particular, the EXFOR and CINDA files are no longer complete and show disturbing gaps for recent data. Staff reductions at the centers were such that none of the centers is still in the position to compile new data fast and to perform the necessary completeness checks. The value of the data files is seriously affected by this lack of completeness. The INDC is most alarmed about this development and has formed a Subcommittee on Data Center Support. The Minutes of this Subcommittee taken from the INDC Meeting Minutes are attached as Annex 6.
Since the time of the INDC Meeting, the situation has become even worse due to staff reduction at NNDC and due to staff discontinuity and temporary post vacancies at NEA-DB and NDS.
NDS actions to approach national authorities for additional support of data center activities, had no success so far.

Statement from NNDC on the effectiveness of the regional responsibility model for exchange of neutron data

Prior to 1965, the NNDC compiled experimental neutron data worldwide. Since then a sharing of the load with other centers has reduced the NNDC regional responsibility to the U.S. and Canada with no loss of information because of the data exchange among the regional centers. This has resulted in great cost savings to the U.S. especially during the information explosion due to new and powerful accelerator sources, efficient detectors and increased computerization.

The use of NNDC permanent staff has been an important aid to the compilation of U.S. and Canadian data. For over 25 years, these measurers have developed confidence in the NNDC handling of their data because they have been dealing with the same physicist (V. McLane) who helped set up the storage and retrieval system and fully understands the subtleties in the physics of data that can arise. It is believed that U.S. measurers will strongly insist the NNDC itself continue to provide this same service and will protest the delegation of this service to any other person or center.

The continuation of regional responsibility is the best interest of U.S. and Canadian scientists.

The NEA Data Bank's role in the NRDC network

The NEA Data Bank has, within the NRDC network, been involved in the compilation of neutron data and references into the EXFOR and CINDA systems covering Japan and the Western European countries. The division, within the network, of the work in geographical areas has been felt to be very efficient due to, among others, the following reasons:

(1) Closeness to the scientists producing and using the data compiled.

(2) Diminishing of language problems within each area (translation and understanding of articles and laboratory reports published in the area concerned).

(3) Keeping the network and the working tools (dictionaries etc.) alive by active discussions and exchange of information between centers working on the same subjects.

At present, the exchange of nuclear data is considered to be of highest priority in the 1992 programme of work of the NEA Data Bank. The Data Bank's future involvement in the NRDC network will be reviewed by the newly established NEA Science Committee. This review will be one of the first tasks of this Committee.

Annex 1

List of Participants

CJD Obninsk, Russia	V.N. Manokhin A.V. Ignatjuk V.G. Pronjaev A.I. Blokhin S.A. Maev O.A. Pakhomova S.M. Nasyrova K.I. Zolotarev V.V. Vozjakov
CAJaD Moscow, Russia	F.E. Chukreev S.Yu. Babykina V.A. Vukolov V.E. Makarenko
CDFE Moscow, Russia	V.V. Varlamov B.S. Ishkhanov V.V. Sapunenko N.G. Efimkin
RI Sankt Petersburg, Russia	A.A. Rimskij-Korsakov A.V. Daniel
NNDC Brookhaven, USA	S. Pearlstein V. McLane
NEA Data Bank, Saclay, France	C. Nordborg
CNDC Beijing, China	Cai Dunjiu Liang Qichang
RIKEN Nuclear Data Group, Saitama, Japan	Y. Tendow
Study Group, Japan	M. Chiba
IAEA Nuclear Data Section	J.J. Schmidt H.D. Lemmel (Sci. Sec.)

Annex 2

11th IAEA Consultants' Meeting of
THE NUCLEAR REACTION DATA CENTRES

7 to 11 October 1991

hosted by the
Centr po Jadernym Dannym
FEI, Obninsk

AGENDA

1. General Session

1.1 Opening, election of chairman
1.2 Adoption of agenda
1.3 Status reports by participants
1.4 Conclusions and actions from last NRDC meeting:
CP-D/210 p. 1+2
1.5 The Jülich Nuclear Data Conference: conclusions relevant to the Data Centers
1.6 Other past meetings: conclusions relevant to the Data Centers
1.7 The network of the Nuclear Reaction Data Centers: communication, commitments, scope, manpower, priorities
1.8 Nuclear data evaluation: co-operation, documentation, discrepancies
- neutron data
- CPND (compare conclusions from last meetings: CP-D/200 p. 8, CP-D/210 p. 10+11)
- photonuclear data

1.9 Medium-energy nuclear data (INDC(NDS)-245)
1.10 WRENDA 92 (letter by J.J. Schmidt)
1.11 Future meetings on nuclear data
- (see NDS meeting calendar)
- other centers

1.12 Computer matters
- CJD computer
- transition of NDS to VAX
- other centers
- networks

1.13 Customer services
1.14 Dates of the 1992 Technical NRDC Meeting and the 12th full NRDC Meeting in 1993 in Paris
1.15 Miscellaneous, conclusions

2. Technical Session: EXFOR, general

2.1 Review of actions from previous meeting (CP-D/200 p. 4-6, CP-D/210 p. 5-7)
2.2 The EXFOR System: rules, manual, dictionaries, proposals, etc.
- EXFOR porposals for photonuclear data
  CP-D/211 (App. CP-M/13)
  CP-C/198 with reply CP-D/215
  CP-C/200 with reply CP-D/219
- particle designaor in Dict. 36: CP-C/201
- restructuring of EXFOR Dictionaries: CP-D/220, CP-C/203

2.3 Fission-product yield data
- review of conclusions and actions: CP-D/200 p. 10+11, CP-D/210 p. 8+9
- status of EXFOR compilation; NDS meeting 2-4 Oct. 1991

2.4 Experiences with EXFOR TRANS tapes
- pending retransmissions (paper by O. Schwerer, see Annex 7)
- disturbing mistakes (paper by O. Schwerer, see Annex 7)

2.5 Miscellaneous, conclusions

3. Technical Session: CPND and Photonuclear Data

3.1 Review of CPND conclusions and actions from previous meeting:
CP-D/200 p. 8, CP-D/210 p. 10
3.2 Compilation and exchange of CPND
- comments on TRANS E009 and R006

3.3 Evaluated CPND, ENDF format (compare action 146 in CP-D/210 p. 13)
3.4 Photonuclear data
- review of conclusions and actions: CP-D/200 p. 7, CP-D/210 p. 12

3.5 Publications
3.6 Miscellaneous, conclusions

4. Technical Session: Neutron Nuclear Data

4.1 CINDA
- review of conclusions and actions: CP-D/200 p. 2+3, CP-D/210 p. 3+4
- compilation, completeness, etc.

4.2 EXFOR completeness
4.3 Important neutron data not covered in EXFOR
4.4 WRENDA, technical matters
4.5 Evaluated data files
4.6 ENDF
- review of conclusions and actions: CP-D/210 p. 13
- computer codes
- NLIB codes

4.7 Fission product yield data
4.8 Nuclear model parameters (NDS meeting)
4.9 Miscellaneous, conclusions

IAEA Consultants' Meeting of
Representatives of the Nuclear Reaction Data Centres
Obninsk, 7-11 October 1991

CONCLUSIONS and ACTIONS

Data Center Network

Concl. A paper describing the Data Center Network in more general terms and without details would be helpful.

Act. NDS to prepare a paper describing the Data Center Network, and to circulate it to the other centers for review.

Act. All to circulate papers on and by Nuclear Data Committees in their countries (block diagrams).

Data Center Co-operation

Concl. NEA-DB will invite to data evaluation working group meetings observers from NDS and (max. 2) from non-OECD countries. The next working group on FP data will be in Mito, 28-29 May 1992.

Act. NEA-DB to inform NDS timely about such meetings.

Act. NDS to try to obtain funding for the attendance of such observers and to carefully select suitable experts.

Concl. the 5-months visit of Dr. Varlamov (CDFE) at NNDC has laid the ground for a fruitful co-operation between CDFE and NNDC+LLNL in the field of photonuclear data. The resulting EXFOR TRANS tapes, which were brought to the meeting, were highly appreciated.

Act. NDS to write a letter of the Agency's encouragement for the work of CDFE and to investigate possibilities of further support, e.g. by a research contract.

Act. NDS to investigate possibilities of support for a CAJaD-RIKEN co-operation in the field of charged-particle nuclear data for monitor reaction and radinuclide production.

Concl. NDS staff (O. Schwerer and R. Arcilla) had visited NEA-DB and NNDC for preparing the transfer of software to the new NDS VAX computer. NDS gratefully acknowledges the assistance of the two centers in this matter. In addition to the successful worksharing in data compilation, the centers will now organize a worksharing in software development for data file management on a VAX computer.

Act. NDS to communicate fast to NEA-DB and NNDC the final choice for software transfer and to prepare the visits of NEA-DB and NNDC staff at NDS after the installation of the VAX computer (i.e. the visits will not be before 1 Jan. 1992).

Concl. To intensify the software exchange among the centers it would be most beneficial if CJD, CAJaD and CNDC could find means to upgrade their VAX computer facilities. Also CDFE needs improved computer facilities (PC and VAX) for efficient participation in the data centers network.

Concl. The change of NDS to a VAX computer will cause difficulties for the two Japanese CPND centers who will continue to work on IBM compatible (VAX incompatible) Japanese computers. These difficulties will have to be studied and solved.

Concl. Difficulties in e-mail connections seem to come, at least partly, from Bitnet, whereas Internet seems to function well. DB will link to Internet in Nov. 1991. NDS is likely to get an Internet connection after the VAX computer has been installed.

Concl. CJD will continue to compile data from, and to render data center services to all countries of the previous USSR, except for the case that one of these countries explicitly requests to change over to NDS.

Concl. Data center services for the former GDR are being shifted from NDS to NEA-DB.

WRENDA

Concl. The preparations for WRENDA 92 proceed as outlined in the circular letters by J.J. Schmidt of 24 July 1991 and 6 August 1991. It was emphasized that requests should be reviewed carefully and that old requests (before 1980) should be removed unless they are replaced by a new request.

Act. NEA-DB It was confirmed that NEA-DB will send their entries in computerized form.

Act. CJD (Nikolaev) Dr. Manokhin announced that CJD is not only reviewing USSR requests but that they have also comments on requests originating from other countries. Dr. Nikolaev was asked to send these comments before the end of November 1991, so that NDS can still submit them to the national reviewers.

Act. NDS NNDC to define how NDS could temporarily assist NNDC in the US CINDA coverage.

CINDA

Act. CJD to continue to cover for CINDA and EXFOR the baltic countries for the time being, unless these countries request a change.

Concl. The CINDA work of CJD, which was reorganized in the past years, was appreciated as functioning smoothly. CJD can now receive small files of CINDA entries (up to 100 records) by electronic mail. Larger files should be sent on floppy diskettes.

Reco The use of floppy diskettes for the transmission of CINDA entries is encouraged. Note that CJD can use only 1.2 MB 5¼ inch diskettes, not 1.4 MB 3½ inch diskettes.

Act. CNDC CNDC is asked to cover Chinese literature for CINDA and to send the entries to NDS.

EXFOR

Act. NDS to update the EXFOR Manual, because this will not be possible to be done at NNDC.

Act. NDS to verify regularly that the other centers receive all TRANS tapes.

Act. NNDC to verify whether the conversion of the temporary EXFOR files 6, 7, 8 has been finished; if not, remind the centers what must still be done.

Act. All to develop procedures for automatic renormalization of EXFOR data, in particular to use renormalized EXFOR data for graphical comparisons between evaluated and experimental data.

Concl. Attention is drawn to the list of disturbing mistakes in EXFOR TRANS tapes (see Annex 7).

Act. All Additional items that should be remembered are:

- it is essential that in case of several bibliographic references in an EXFOR entry, the primary reference is given first; it is this reference which is used by computer codes (plotting) to identify the data set;

- corrections done to an EXFOR entry must be described briefly under HISTORY; to know what has been changed is most essential to receiving data centers and customers.

Urgent action on All to make sure that the entries contained in the list of "Pending Exfor retransmission" (see Annex 7) are corrected and retransmitted as pointed out in the relevant CP-memos. Centers should realize, that these entries could not be added to the EXFOR master libraries of the other centers. Compilations are made for the waste paper basket if such requests for corrections and retransmissions are not followed promptly.

Action McLane to remind the other centers of retransmissions that she had requested earlier during her work for the barn-book.

Act. NDS to monitor regularly that requests for retransmissions are fulfilled.

Act. NDS Following Action 61 of CP-D/210 of the 1990 NRDC Meeting, F. Chukreev submitted a sample EXFOR entry of gamma data from "short-living isomers", using "-S" as an isomer extension. NDS will review this formalism and submit comments in a CP-Memo.

Concl. Memo CP-C/201 about shortening Dict. 36 with respect to Particle Designators is adopted, but implemented only after centers have updated their codes (particularly the Exfor Check programs) accordingly.

Concl. Memo CP-C/203 about the NNDC Dictionary System was studied and found useful. Additional work will be needed to include all the information required by the NNDC System in the overall Dictionary System.

Act. NDS NNDC This should be done jointly by NNDC and NDS when NDS changes over to the VAX computer. NNDC is requested to transmit their dictionary file to the other centers for information. A new Dictionary transmission format will have to be designed by NDS.

Concl. Act. NDS Memo CP-D/220 about structuring of information in certain dictionaries is adopted with the modification that dashes should be omitted from the first field (col. 1-11).

Reco to CJD and CAJaD CJD and CAJaD are asked to update their EXFOR programs such that retransmissions can be done at subentry level (instead of retransmitting entire entries). V. McLane gave to Olga Pakhomova Fortran codes for this purpose which could be forwarded also to CAJaD.

Manual update needed Act. All In the EXFOR record identification field blanks are accepted instead of leading zeros. In cols 72 to 78 zero and blank is equivalent. Where necessary, centers should update programs accordingly.

Concl. F. Chukreev has produced a PC code for the checking of EXFOR entries supplementing the ANDEX code for EXFOR compilation by V. Osorio. So far the code is in Russian only.

Fission-product Yield Data

V. McLane gave a summary of the IAEA CRP-meeting 2-4 Oct. 1991. Within the work of this CRP the Rider data are machine converted to raw Exfor data (not checked), and these data are checked and corrected by specialized physicists and converted to final Exfor entries. Specialized physicists for this work are

Act. Rider for area 1
M. James for area 2
Wang Dao and M. Lammer for area 3
Goverdovskij for area 4

They should also receive author proofs of these Exfor entries.

Concl. The FY entries in EXFOR must be complete. If certain data are found to be wrong or deficient, such information should be entered under the keyword CRITIQUE, but the entry must be kept in the file.

Concl. A new Status code "NCHCKD" is introduced in EXFOR for labelling the uncheched raw Exfor data.

Act. Lammer to send the area 4 FY entries to CJD on tape; so far they have them on a listing only.

Act. NEA-DB NDS CJD

1. to transmit immediately the new unchecked FY data with the Status code NCHCKD added;
2. thereafter to continue to review and correct these entries.

Reco FY compilers should ask the experimenters for precursor data and include such information under DECAY-DATA.

Act. Lammer The requests resulting from the FY-CRP-Meeting should be included in WRENDA. M. Lammer should take care that these are routed through the proper channels.

Act. NNDC NDS The FY-CRP-Meeting requested that EXFOR retrievals by FP nuclides be possible. While the NDS EXFOR index provides this possibility, it is not yet possible in the VAX EXFOR retrieval system, which should be updated accordingly.

Act. Nordborg to advertise and demonstrate the EXFOR system at the Tokai FP data meeting; it was found out that many FP physicists have insufficient knowledge about EXFOR (format, contents, how to make use of it).

Act. Blokhin Dr. Blokhin received from Dr. Greshin (Moscow Engineering and Physics Institute) an evaluated data file with FPY data. This was converted at CJD to ENDF format. Dr. Blokhin is asked to transmist this file as soon as it has been checked and approved.

Evaluated Neutron Data

Concl. JEF-2 was so far distributed only to labs who did benchmark testing. The final JEF-2 will be released after benchmark testing. This is highly appreciated by the other centers.

Act. NEA-DB to distribute JEF-2 to the other neutron data centers.

Reco DB NEA-DB is encouraged to produce a new report (similar to the report JEF-1) comparing characteristics values (thermal cross-sections, resonance integrals, etc) of the main ENDF formatted libraries.

Act. NNDC As far as not yet done send the ENDF/B-6 point data library to the other neutron data centers.

Act. NDS The release of CENDL-2 was highly appreciated. NDS is presently checking the file and will forward it to the other centers as soon as possible.

Act. CJD Of BROND-2 NDS had received a preliminary file, mainly for consideration in the FENDL project. CJD is asked to transmit the final BROND-2 as soon as possible.

Concl. CENDL-2 and BROND-2 include files partly in ENDF-5, partly in ENDF-6 format. This is not disturbing; the ENDF processing codes can handle both.

Act. All When preparing evaluated data libraries, characteristic values (thermal cross-sections, resonance integrals, etc) should be quoted in the text or in accompanying documents together with their uncertainties; however, these values (and uncertainties) would be better usable if they were in a computer readable file.

Concl. The now established evaluated data files will continue to exist and to be updated for the time being. Even the OECD working groups have decided to continue ENDF/B, JEF and JENDL as separate libraries, for a variety of reasons. However, uncoordinated parallel efforts must be avoided.

Concl. A. Ignatjuk and S. Pearlstein stressed the need for close co-operation for improving the existing evaluated data libraries. In general, all libraries appear to be rather good for existing reactors but show disturbing discrepancies in data-types needed for advanced reactors and some other new applications. Some examples that were mentioned, follow.

- U-238 capture: good agreement between BROND-2 and ENDF/B-6.
- U-235: fairly good agreement between ENDF/B-6, BROND-2 and JENDL-3, but also some unneccessary disagreements which could be solved by a joint effort.
- Np-237: now sufficiently good agreement for fission; the previous big discrepancies in n,2n have nearly been solved.
- Cm-242: in the few-MeV region which is important for incineration there are drastic discrepancies in the order of 50%; for n,2n the discrepancies exceed a factor of 10!
- dosimetry reactions: good agreement in general, but still large differences in the cross-section wings which are important for certain applications.

Act. All Evaluators to intensify bilateral contacts for coordination of data evaluation.

Act. NDS NEA-DB NNDC to try to find means and funding for the participation of CJD and CNDC in the joint efforts to improve the evaluted data files.

Act. All to make use of the NNDEN Newsletter to coordinate evaluation efforts.

Act. NEA-DB to investigate whether NNDEN can be supplemented by a table showing who plans to work on what evaluation.

Concl. Unique international files could be achieved so far only in limited areas such as

- standards: ENDF/B-6
- dosimetry: IRDF-90
- fusion: FENDL, possibly to be coordinated with EFF.

Concl. At present there may be avoidable duplication of efforts in the detection of defaults in data libraries. The situation may be improved by the following action:

Act. All Library Originators to collect lists of known defaults in the evaluated data libraries, communicate these lists to the other data centers, possibly to include such lists in the forthcoming issue of NNDEN.

Act. NDS The ENDF utility codes version 6.6 have been distributed by NNDC. NDS will distribute the new version of the ENDF pre-processing codes by Red Cullen.

CPND

Reco Sapporo Dr. Chiba gave a report on the Japanese NRDF system and his efforts to convert NRDF data to EXFOR and vice versa. He distributed printed reports on NRDF for 1989 and 1990 which are in Japanese but with sufficient portions in English. Dr. Chiba's continuing efforts to convert NRDF data to EXFOR are acknowledged and he is strongly encouraged to continue this work, primarily for differential CPND.

Concl. The CPND agreement reached at earlier meetings for the co-ordination of CPND compilation is confirmed. F. Chukreev continues to act as co-ordinator. CPND compilers should communicate with Dr. Chukreev directly and frequently, (with copy to NDS).

Act. McLane to distribute, after consultation with F. Chukreev, the Exfor converted CPND file of R. White (Livermore) on light-element neutron producing reactions.

Act. NDS to contact CAJaD and Arzamas to obtain the quasi-Exfor file of experimental data underlying the Arzamas evaluation.

Reco Chukreev to compile and evaluate the B11 + p reaction.

Reco CAJaD CNDC RIKEN to continue to work, under mutual consultation, towards compilation and evaluation of monitor reactions and of medical radioisotope production reactions according to the needs defined at earlier meetings.

Act. NDS to try to arrange a CRP on this topic which would be an essential stimulance for finding support for this work at CAJaD, CNDC, RIKEN and perhaps others.

Concl. F. Chukreev points out that no monitor data for deuteron beams exist and that there is a strong need for such data.

Concl. For the time being evaluated CPND should continue to be compiled in EXFOR, because this can easily be done without delays. Conversion of such data to ENDF format can be done in a second step.

Act. NNDC to produce a "Short guide to ENDF" for charged-particle data evaluators and send it to Dr. Chukreev.

Concl. F. Chukreev distributed the memo CP-A/61 containing formulae of conversion factors for thick target yields. This was appreciated. It should be included in Lexfor.

Concl. Act. Tendow Dr. Tendow had recently sent to NDS the EXFOR TRANS tape R006. A few comments by O. Schwerer were given to him and Dr. Tendow was asked to update the entries accordingly.

Concl. F. Chukreev plans to hold a CPND workshop on EXFOR and CPND evaluation procedures. He also plans a new book giving the contents of the non-neutron EXFOR database with a preface in English.

Photonuclear Data

Concl. CDFE has established close contacts with NNDC and LLNL. A large number of EXFOR entries was updated, compiled and transmitted on tape at the time of the meeting. This was much appreciated by the meeting, and CDFE was encouraged to continue this work. A "Photonuclear Data ooperation Project between CDFE and NNDC" was formulated; see Annex 4.3.

Concl. CDFE has insufficient computer facilities. For the time being work is restricted to an IBM compatible PC. Additional software, mainly for using ENSDF and NSR on a PC, will be required. Work will concentrate on EXFOR compilation and data evaluation.

Concl. In the course of the CDFE-NNDC co-operation, various proposals for EXFOR coding of photonuclear data have been formulated and distributed in memos CP-C/200 and CP-D/219. These were adopted.

Intermediate Energy Nuclear Data

A seminar on intermediate energy nuclear data was held, see Annex 5.

Reco NNDC NNDC intends to issue an atlas of available intermediate energy data.

Reco All For this purpose all centers were asked, as fas as manpower permits, to increase their efforts to compile intermediate energy data in EXFOR, including neutron data and CPND.

Code Comparisons

Concl. Act. Ignatjuk Additional participants in the model code intercomparison exercise by NEA-DB can still be accepted.

Customer Services

Concl. Request statistics must be interpreted with caution:

- more institutes are now able to process large data libraries; consequently, a single request for an entire library is now more meaningful than previously many requests for special retrievals;
- on the other hand the new on-line services have again a tendency to a larger number of smaller requests;
- request statistics cannot show multiple usage of a single data request.

Concl. All centers encounter increasing user interest for PC codes and for specialized data files for use on PC's.

Concl. NNDC and NEA-DB encounter significantly increasing statistics for their online services. NNDC also offers services by FAX for good quality prints and graphs.

Act. All to do more public relations work;
to advertise data center services at suitable meetings;
to exchange demonstration materials for use at meetings;
to prepare a package describing the services offered, for distribution to individuals (e.g. students)

Meetings

The 1991 Jülich Nuclear Data Conference had identified continuing nuclear data needs for specific applications, and had given the opportunity to advertise the work of the data centers. NEA-DB has prepared CINDA entries (first by paper-number, now being changed to the final page-numbers of the book of proceedings). A CINDA index will not be included in the proceedings and NDS will be asked to publish this as an INDC report. NDS also considers an INDC report to include those USSR papers which were not accepted for inclusion in the proceedings.

The NDS meeting list for 1991/1992 was distributed (see Annex 4.10) and an outline of NDS meetings in 1993/94 was given.

Dr. Manokhin reported that the future of the Kiev nuclear data conferences is uncertain.

Dr. Cai announced the CODATA Conference in Beijing 19-22 Oct. 1992.

Dr. Nordborg announced the Fission Product Nuclear Data Meeting (NEANDC specialists meeting) to take place in JAERI/Tokai-Mura 25-27 May 1992.

The Brookhaven evaluation meeting will be 28 Sept. to 2 Oct. 1992.

It was discussed whether the 1992 Technical NRDC Meeting should be held in Brookhaven adjacent to the evaluation meeting.

Note added in proof: The 1992 Technical NRDC Meeting is planned to be held at the IAEA, 1-3 Sept. 1992.

The next full NRDC Meeting is supposed to take place in Paris in fall 1993.

Dr. Chukreev announced that the next NSDD network meeting has been scheduled to take place in Tashkent in October 1992.

Note added in proof: It turned out that the meeting could no be held in Tashkent.

Progress Reports of the Centers

4.1 CJD progress report (V. Manokhin)

4.2 Report of CAJaD (F.E. Chukreev)

4.3 CDFE progress report (V.V. Varlamov)
Note: Dr. Varlamov also distributed the report Fotojadernye Dannye/Photonuclear Data No. 13 1989.

4.4 Progress on nuclear data work in China (Cai Dunjiu)

4.5 The activities on CENDL, EXFOR, CINDA and WRENDA in China (Liang Qichang)

4.6 Data activities in the RIKEN Nuclear Data Group (Y. Tendow)

4.7 Status report of SG (M. Chiba)
Note: Dr. Chiba also distributed two documents
- NRDF Annual Report 89
- NRDF Annual Report 90

These are too voluminous to be reproduced here. Although they are in Japanese they give valuable information on the contents of the NRDF database.

4.8 NEA Data Bank progress report (C. Nordborg)

4.9 NNDC Status report (S. Pearlstein)

4.10 IAEA Nuclear Data Section progress report (H.D. Lemmel)

CJD Progress report.

1. CINDA. During 1991 the CJD compiled into CINDA 977 new records and modified 1386 records. Information on Iulich Conference was put into the catalog.

2. EXFOR. Three tapes with TRANS 4081-4083 were prepared with 27 entries (142 Subentries) and 32 corrected entries (518 Subentries).

The ANDEX code for EXFOR compilation from NDS has been put into operation on PC AT.

3. Evaluated Data.

3.1. BROND. A lot of efforts was spent in order to deve - lop new version of BROND-library (BROND-2). The selection of evaluated data for the BROND-2 library, its analysis and handling have been completed mainly in 1990. Some additional checking and correction of files of the library was made this year.

For principal reactor materials the evaluated data developed by soviet specialists have been included into the library. In the case of materials used as neutron standards the data recommended by the IAEA were accepted. For remaining materials, the files which soviet specialists considered as the most relible were taken from existing foreign libraries and used as a basis for thorough revision. As a result of such revision the evaluated data were changed or completed in correspondence with recent experimental data and theoretical calculations (replacement of resonance parameter file, inclusion of the data for the (n,2n) and (n,3n) reactions and proper modification of spectra of neutron inelastic scattering, reexamination of proton production data in neutron reactions and so on). All materials were checked by the ENDF Utility codes.

The description of BROND-2 will be published in Yadernye Konstanty this year. The texts are ready but we need some time to take corrections and format changes.

For further development of BROND-2 it is necessary to expand the data on radionuclide production cross sections and improve a quality of the data on photon production in neutron reactions.

The BROND-2 files together with additional files (as a rule of foreign origin), which are not completely expertized yet, are named as the FUND-library.

3.2. Evaluations for FENDL.

In the framework of FENDL activity the files of natural Cr, Sn and Nb from BROND-library were corrected and partially revised for fusion reactor applications. Other files (D, Be, isotopes of Cr and Fe) from BROND and ENDF libraries were analyzed and intercompared where it was possible. The 175-group cross section library was generated for the most of these files.

Expertise of ECN (Petten) activation library and conver - sion it into 175 group cross section library was done. The conditions of the sphere transmission benchmark tests for Pb provided by IAEA were analyzed and it was shown that the description of the experiment was not adequite to real conditions.

3.3. Dosimetry reactions.

The CJD file of dosimetry reactions is in process of formation. For that the additional analysis of data of 30 reactions was performed and the data were corrected taking into account integral measurements. Covariance matricies are under preparation for several data sets.

3.4. Others compilation and evaluation.

Some practical applications in our institute required to compile the decay data for radionuclides. The ENSDF library was used as a base. Additional data were attracted as well. The final library for 2200 radionuclides was adapted on micro-VAX and PC/AT.

Also having in mind the requirement for practical calcu - lations the CJD prepared a book of curves of experimental photonuclear data and formed on this base the evaluated photonuclear data for 27 elements.

4. Computers and codes.

Besides computer EC 1033 the local network on the base of micro-VAX-II and PC/AT was realized. There are 3 PC/AT-286 and 2 soviet PC(EC-1840, EC-1841) as well.

All the evaluated data libraries and necessary codes for data processing and calculation were put into operation on

micro-VAX. Programs NJOY-87 and ANISN are used to develop data for FENDL. Monte-Carlo code BRAND was adopted also to read the ENDF-6 formated data as input data for neutron transport calculations and was used for description of Be sphere neutron transmission measurements with data from ENDF/B-6 library.

Some progress is in adaptation on PC/AT programs for graphic presentation of evaluated nuclear data (including double differential cross sections) for its comparison.

Now the CJD actively uses e-mail.

REPORT OF CAJaD

F.E. Chukreev

After the Technical Meeting of the Centers in 1990 our main concern was the renovation of the Center equipments. After long hesitation, we decided to connect the computer with VMS operation system. This connection will take some time to finish. When this connection is done, we will transfer all our database into the new system.

1. Data Evaluation

During the last two years the following evaluation of charged particle reactions were done:

C-12(p,pn)C-11	up to 1000 MeV
C-12(He-3,x)C-11	up to 30 MeV
AL-27(He-3,x)Na-22	up to 100 MeV
Cu-65(He-3,2n+p)Zn-65	up to 70 MeV
Cu-65(He-3,2n)Ga-66	up to 50 MeV

These data will be presented in a separate report on this meeting.

2. Preparation of new data for EXFOR library

TRANS A024 has been transmitted in 1991 (05.04.91) and TRANS A025 is ready now. It contains some new publications and corrected old ones. The TRANS have been written on diskettes. The transmission of data is preferably on diskettes rather than on tape, because

a. the price of mailing diskettes is low,
b. our experience has shown that the preservation of information is very good.

I cannot judge the size of neutron data entries and TRANS, but charged-particle nuclear data can be transmitted on floppy diskettes. I believe that after the connection to the new computing system we will have the possibility of correcting old errors in transmitted entries. This is a very complex problem for us today.

3. Checking code for EXFOR

We are using IBM-compatible PC NEIRON (USSR product) for input and checking EXFOR entries to transfer our data into the new system.

The code for checking EXFOR entries has been written. This code is directed to check charged-particle data. A demonstration of data processing can be arranged during your visit to the CAJaD if you would like to see.

The quality of checking with our new code by CAJaD and other Center entries is acceptable, but this code cannot find some errors.

For example, this code does not find errors:

invalid DATA unit PER-CENT
or
EN-MAX < EN-MIN

We are constantly increasing the possibility of finding errors, but I can assure that to create a checking code for EXFOR entries which could find all errors is impossible.

CDFE PROGRESS REPORT - 1991

I.N.Boboshin, V.V.Varlamov, N.G.Efimkin, V.V.Sapunenko, M.E.Stepanov

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This report contains the review of the works caried out by CDFE since the beginnig of 1990 till the middle of 1991.

The main field of CDFE's activity remains the production of photonuclear experimental data files using EXFOR format. The new consecutive exchange magnetic tape (CDFE TRANS M010), which contains the data from 38 articles published in USSR and abroad has been finished.

In the beginning of 1991 during the CDFE head Dr.V.Varlamov's visit to USA BNL NNDC the addition of 100 new EXFOR ENTRIES has been done to the photonuclear data fund. So the total number of CDFE-made M0-ENTRIES have reached about 430 (M0001-M0500 with several blanks).

Besides that the last version of Dr.B.Berman's EXFOR library (L0037-L0059) of photonuclear reaction cross sections obtained using quasimonoenergetic photon beams have been reprocessed in accordance with the new requirements of EXFOR format for photonuclear data.

In addition the new magnetic tape was found in the USA National Institute of Standards and Technology, which contains a lot of photonuclear data have been diggitized previously in USA National Bureau of Standards (photonuclear group of Dr.E.Fuller). Now these data are in preparation for including in CDFE photonuclear data EXFOR fund.

During Dr.V.Varlamov's visit the Draft Proposals of Photonuclear Data Cooperation Project between MSU INP CDFE and USA BNL NNDC (with participation of scientists of Lawrence Livermore Laboratory) have been produced. The main aim of the Project (see Annex) is the progress in compilation and evaluation of photonuclear data. In connection with this aim a number of new additions to EXFOR DICTIONARIES and LEXFOR have been made by CDFE together with NNDC (Memos CP-C/199,200).

For progress in the field of photonuclear data evaluation the solving of the well known problem of systematic discrepancies between the results of experiments fulfilled using bremsstrahlung and quasimonoenergetic photon beams is very important. Sticking the photonuclear data evaluation programm CDFE has published in 1989 the Preprint /1/, in which the possible reasons of the discrepancies in shapes and amplitudes of the photonuclear reaction cross sections obtained with bremsstrahlung gamma-rays and quasimonoenergetic photons from annihilation in flight of fast positrons have been investigated. The influence of the quasiminoenergetic photon spectrum parameters upon the structure of cross sections was studied. It was shown that the difference of the spectrum's shape from the delta-function assumed in traditional scheme of the quasimonoenergetical photons experiment makes inconsistent the result interpretation as a reaction cross section namelly. It was shown that this result is really only the reaction yield. The energy resolution overestimation follows this difference. The method of reduction, independent on nuclear models, a priori information, and any regularization /2/ was used to improve the energy resolution. It was shown that the data analysis taking into account the shape of the quasimonoenergetic photon spectrum results in better agreement with the structures of bremsstrahlung data.

Sticking the program of photonuclear data information publication the CDFE work on publishing of the annual Information Bulletins and Indexes "Photonuclear Data", containing the systematized information about the experimental works on photo- and electronuclear reactions and inverse reactions of radiative capture has been continued. The bulletin N 13 "Photonuclear Data-1989" /3/ has been published in 1990. The CDFE has prepared "Photonuclear Data Index 1986-1990" /4/ included the corrected and added information for 1986-1989 period and new information for 1990. The Index will be published in this year.

In addition to EXFOR-activity CDFE has continued the activity in the field of using other international computer files such as ENSDF and NSR for processing of requests of soviet scientists at first from universities and institutes.

Within the reviewed period CDFE have received and processed about 200 requests concerning bibliographical information (EXFOR, NSR) and about 300 requests concerning numerical photonuclear and charge-particle data (EXFOR, ENSDF).

There are a serious problems with computer in CDFE now. The main CDFE computer "ES-1022" is more then 10 years old and doesn't operate well now. Because of hard economic situation in CDFE, Institute of Nuclear Physics, and Moscow State University at all there are no possibilities for receiving of new sufficiently powerful computer. The new CDFE IBM PC computer does not solve all problems of CDFE and of new CDFE-NNDC cooperation in the field of photonuclear data processing and evaluation. So CDFE need IAEA help.

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ANNEX

DRAFT PROPOSAL

Photonuclear Data Cooperation Project between CDFE - Moscow State University and NNDC - Brookhaven National Laboratory

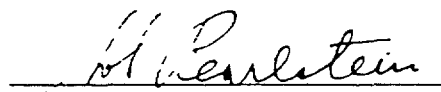
Project subject:	Production of experimental and evaluated photonuclear data files.
Participating organizations:	USA BNL NNDC USA LLNL USSR MSU CDFE.
Personnel:	Dr. V. McLane, NNDC (USA) Dr. V. Varlamov, CDFE (USSR) Dr. S. Warshaw, LLNL (USA).
Project duration:	First phase, 3 years (June, 1991 – June, 1994).

CDFE RESPONSIBILITY

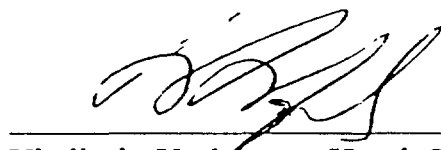
1. give NNDC all CDFE-compiled photonuclear data prepared up to June, 1991 (ENTRIES M0001 - M0500).
2. send NNDC all compiled photonuclear data in EXFOR format which CDFE will prepare in the future.
3. prepare and give NNDC all photonuclear information from the CDFE Information Bulletins (NN 1 - 14 and subsequent) in computer-readable form for merging them in the CINDA system.
4. organize EXFOR compilation of the experimental data contained on the tape obtained from the USA NIST.
5. give NNDC all new materials (Bulletins,Indexes Reviews etc.) to be published by CDFE in the future.
6. give NNDC the description of CDFE's photonuclear data evaluation software and the software itself.
7. organize the EXFOR-compilation of experimental papers and the digitizing of the data as agreed by Dr. S. Warshaw and Dr. V. Varlamov.
8. organize the creation of the evaluated photonuclear data in ENDF format as agreed by Dr. S. Warshaw and Dr. V. Varlamov.
9. organize the permanent contacts with LLNL by means of e-Mail.
10. promote visits of USA scientists to CDFE .

NNDC RESPONSIBILITY

1. give CDFE the latest version of Berman's compilation in EXFOR format (L0001-L0059).
2. give CDFE Fuller's photonuclear digital data obtained from USA NIST.
3. give CDFE the various software for VAX and IBM/PC processing of the NSR- EXFOR-, ENDF/B- and ENSDF data.
4. merge the photonuclear data from the CDFE Information Bulletins with the data into CINDA system if staff available.
5. give CDFE the CINDA system software (for VAX) and the CINDA photonuclear data.
6. study the possibilities of joint (with CDFE) publication of materials (atlases, catalogues etc.) with photonuclear data.
7. give CDFE various nuclear data (maps, schemes, booklets, notebooks etc.) published by NNDC.
8. give CDFE all photonuclear materials (published and computer) which NNDC will receive from other (non-CDFE) sources.
9. organize the permanent contacts with LLNL in accordance with the CDFE-LLNL agreement.
10. promote visits of USSR scientists to NNDC.



Sol Pearlstein, Head NNDC



Vladimir Varlamov, Head CDFE

7 June 1991

Date

The CDFE and LLNL Photonuclear Data Processing Activities.

REQUIREMENTS:

- Photon energy range: Threshold to about 40 mev.

- Photon source types:
  1. Mono — radioactive nuclei, radiative capture reactions (X,G), Compton-scattering; kinematic selections; threshold technique;
  2. Quasimono — (B+) -annihilation, tagging;
  3. Bremsstrahlung — "whole", "hardened", "difference".

- Experimental categories:
  1. Photoneutron production
     (for medicine, electronics, shielding)
     - quantities: Y, SIG
     - reactions: (G,N), (G,2N), (G,3N), ..., (G,XN), (G,N+P), (G,2N+P),...
  2. Specific isotope production
     (for activation, radiation damage)
     - quantities: SIG, DA, DE, DA/DE
     - reactions: (G,N), (G,N+P), (G,P), (G,A)
  3. Total photoabsorption
     (for shielding, atomic data benchmarks)
     - quantities: SIG
  4. Photofission
     - quantities: Y, SIG
  5. Nuclear (non-atomic) scattering
     - quantities: SIG

- Scope of isotopes:

(with evaluation
priorities)

1. Lightest nuclei
   H, He, Li, Be, B
   ---
2. Industrial and shielding materials
   Al, Fe, Cu, Ni, W, Pd
   ---
3. Electronic materials
   Si, Ge,
4. Biological materials
   C, N, O
   ---
5. Nuclear fuels
   Th, U, Pu, Am

PROGRESS ON NUCLEAR DATA WORK IN CHINA

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Abstract : Recent years we have made great efforts to prepare CENDL–2 and to improve the evaluation further. Therefore, advanced evaluation and theoretical calculation methods and programs have been or are being developed.

1 Nuclear Data Evaluation[1~3,19~21]

1.1 Neutron Data for General Purpose

1.1.1 Evaluations for CENDL–2

Based on the first version of the Chinese Evaluated Nuclear Data Library (CENDL–1)[3], the CENDL–2 has been prepared. The CENDL–2 includes files 1–5 for about 50 nuclides (or elements), which were evaluated by ourselves. The neutron incident energy range is from 10^{-5} eV to 20 MeV. The nuclides include H, D, T, ^{3,4}He, ^{6,7}Li, ^{9}Be, ^{10,11}B, ^{14}N, ^{16}O, F, Na, Mg, Al, Si, P, S, Cl, ^{40}Ar, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Zr, Nb, Mo, ^{107,109,N}Ag, Cd, In, Sn, Sb, ^{138}Ba,Hf,Ta,W,Au,Pb, ^{232}Th, ^{235,238}U, ^{237}Np, ^{239,240}Pu, ^{241}Am,^{249}Bk,^{249}Cf. Among them O, F (cooperated with LANL and ORNL) ^{241}Am (with covariance), ^{249}Bk, ^{249}Cf were evaluated also for ENDF / B–6, ^{107,109,N}Ag (including γ–production data, in cooperation with JAERI / NDC) for JENDL–3. Most of the evaluations have been complemented with model theory calculations by using the codes (the main ones are MUP2, FUP1 etc.) developed by ourselves. Most of the evaluations have been reviewed by assigned reviewer respectively at first. And secondly, reviewed and approved by the Working Group of Neutron Nuclear Data Evaluation. Finally, checked through by the codes of CHECKER, PHYCHE, FIZCON, and then accepted by CENDL–2.

Generally, most recently measured data in the smooth energy region have been taken into account in the evaluations. The evaluations have been compared with the newly available evaluations, and for some evaluations every effort has been made to update them significantly. The evaluated resonance

parameters including those for the negaetive level(s) have been checked and adjusted if necessary via comparing the calculated cross sections with resolved parameters with Doppler–broadened to the available point–wise data measured at thermal and resonance energy region. To ensure the "continually connection" of the group–averaged cross sections with the unresolved energy region physically, at the boundaries, the parameters of the resonances located above the boundary of the "resolved energy region" are added if possible. Or more often, the "background cross sections" are given properly to the corresponding interval at the boundary, similarly to other boundaries.

The unresolved resonance parameters are estimated based on the resolved parameters then checked and adjusted to fit the newly measured point–wise data (if any) in the unresolved resonance energy region.

So CENDL–2 is much more improved comparing the CENDL–1. And it seems that most of the evaluations included in CENDL–2 are comparable to the corresponding files of the available newest versions of other evaluated nuclear data libraries.

Compared with newest evaluated data ENDF / B–6 and JENDL–3, the nuclides and files of CENDL–2 are much less than ENDF / B–6 and JENDL–3. Comparings show that the data for most nuclides, which are included in all CENDL–2, ENDF / B–6 and / or JENDL–3, agree with each other within experimental error, and some are considerably different. For example, the double differential cross sections of D(n,2n) neutrons are given systematically in CENDL–2, which were calculated with Faddeev equation and the results are consistent with experimental data quite well (Fig. 1). Compared to ENDF / B–6, the cross section of inelastic scattering to 4.63 MeV level for ^{7}Li is considerably lower, this is based on newly measured data, in which the correction to D–D break–up neutron was made. For structural materials, some examples are the cross section of Ni(n,α), Cr(n,2n) and (n,α), Ta(n,2n) and (n,3n), Nb(n,α) reactions, they are shown in Fig. 2～6. For fission nuclides, the comparison with ENDF / B–6 of ^{239}Pu fission cross section is shown in Fig. 7, they are consistent with each other within 4%. The examples of the differences are the cross sections of ^{238}U(n,n′), and ^{239}Pu(n,2n) (Fig. 8, 9).

1.1.2 Preparations for further improvement of CENDL

Only files 1～5 have been included in CENDL–2. So in recent years much effort has also been paid to the preparations for further improvement of CENDL–2, mainly to include the files of γ–production data, double differential cross section (DDX), and covariance file, etc.. Correspondingly, a code UNF which is able to calculate the DDX of neutron and charged particles emission as well as recoil nuclei, to calculate the data of γ–production concerned, etc. based

on a more perfect model theory framework; and a code system for combining the correlated data sets to obtain combined (evaluated) values and their covariances correctly and reasonably have been developed. these codes have been used to do some calculations and evaluations successfully. Furthermore, for improving the evaluations of averaged resonance parameters, especially the average level spacing and the level density, a method based on Bayesian approach for correcting the energy level missing related to not only the Porter–Thomas distribution but also the Wigner distribution has been advanced and a code correspondingly have been developed.

In the meantime, we have taken part in the international cooperation of FENDL improvement and the related activities. Undoubtedly, these activities will be very helpful to the further improvement of CENDL.

1.2 Nuclear Data for Special Purposes

a) Nuclear Structure and Decay Data (NSDD)

All useful ENSDF codes have been transplanted on MICRO–VAX–II computer of CNDC. The data for A = 51–55, 195–198, 170,172 (total of 12 mass chains) have been evaluated and renew of some mass chains started in 1990.

b) Fission Product Yield Data (FPYD)

The Chinese Evaluated Fission–Product Yield Library has been established. The 1987 version of this library contains data in ENDF / B–5 format for 10 fissioning systems, they are U235T, U235F, U235HE, U238F, U238HE, Pu239T, Pu239F, Pu241T, U233T, Th232F. (T–thermal neutron, F–fast (fission) neutron, HE–14 MeV neutron). The data library on magnetic tape is available from the IAEA / NDS.

At present, the efforts is being paid to obtain an improved and more complete data base of experimental data in EXFOR format and study the methods to derive a best recommended set of fission yield data, which aim at update the 1987 version data.

Besides, the "decay heat production" research has been developed in recent years.

c) Charged Particle Nuclear Data (CPND)

. The twenty sets of data measured in China have been compiled in EXFOR format and sent to IAEA. The 220 sets of measured data (50–1000 MeV) for the reactions induced by proton or heavy charged particles were compiled in EXFOR format cooperated with BNL / NNDC. Some activation cross sections induced by charged particles are being evaluated.

. Nuclear data of proton induced reaction at the energy region of 4～ 50

MeV, including 1～4 particle emission have been calculated for p+^{89}Y by using CMUP2 with the code APCOM.

d) Neutron Activation and Dosimetry Reaction Data

Combined with measurements (77 reaction channels), the cross sections of (n,γ), (n,n′), (n,2n), (n,3n), (n,p), (n,t), (n,α) for 55 reaction channels have been evaluated. 《 Compilation of Evaluation for Activation Cross Section》 –CNDC–89014, INDC (CPR)–16 has been published.

The following reactions have been evaluated in an IAEA contract subject (5516 / RI / RB): ^{23}Na, ^{45}Sc, ^{58}Fe, ^{59}Co, ^{109}Ag(n,γ); ^{46,47}Ti(n,p), ^{N}Ti(n,x); ^{54}Fe, ^{59}Co(n,α); ^{55}Mn, ^{59}Co, ^{115}In, ^{127}I, ^{181}Ta(n,2n) and ^{115}In(n,n′). The complete evaluated dosimetry file including a pointwise cross section and covariance file in ENDF / B–6 format with the minidisk as well as evaluated reports have been sent to IAEA.

e) Photo–Nuclear Reaction Data

The $\sigma_{\gamma,n}$ for D, Be, ^{75}As, ^{95}Zr and ^{127}I have been reevaluated. Together with the EXFOR entries, they have been sent to IAEA.

f) Atomic and Molecular (A+M) Data

The sputtering data for collisions of C, Al, Fe atoms and their ions with H, D, He atoms are being compiled and evaluated. The excitation cross sections of collision for He, Ne, Ar atoms with their ions, the electron impact ionization cross sections for the atoms and ions with high Z and the cross section for K–shell ionization by electron impact are also being compiled.

g) Medium Energy Nuclear Data

Several studies on medium energy nuclear data calculation and evaluation have been done recently. The subjects are : 1. Calculation of 5～ 50 MeV neutron induced reaction data of ^{56}Fe; 2. The study of neutron emissions in 585 MeV proton on ^{56}Fe with Quantum Molecular Dynamics; 3. Neutron relativistic phenomenological and microscopic optical potential; 4. Systematics of intermediate energy proton nonelastic and neutron total cross section.

2 Evaluation Method Research[1,2,4～14,19～25]

The three aspects evaluation methods were usually used to generate the evaluated data :

. combine and fit available measured data by using least squares method;

. predict cross section by systematics;

. carry out a consistent theory calculation;

The related codes have been or are being developed.

2.1 Data Processing Method[4,5,19～21,25]

— **Correlated Data Combination and Covariance Evaluation**

a) Covariance matrix construction for experimental data using the information about errors in experiments given by authors.

b) Curve fitting The least squares codes based on polynomials, orthogonal polynomials, Legendre polynomial and B–spline, have been developed previously for curve fitting and used to combine the data of multi–measurements to obtain the evaluated excitation functions. A spline fitting program for multi–sets of data has been developed. With which the knots can be optimized, spline order number can be chosen, the correlative data can be fitted and the covariance matrix of the fit values can be calculated. Also a universal code is developed. The functions include single parameter combination, curve fitting by using orthogonal Polynomial and Legendre Polynomial as base.

c) Simultaneous evaluation Based on spline fitting for multi–curves and Bayes method, several relative reaction cross sections and their ratios for different nuclides, or all reaction cross sections of a nuclide are fitted simultaneously. As a result, they are made consistent with each other, and the correlation between different reactions and nuclides can be calculated.

d) PPP in correlated data combination and the ways to solve it

When the least squares method are used to combine the correlated data, sometimes the combined values are outside all of the measured values. Obviously it is unresonable and unacceptable. This phenomenon is proposed by R. W. Peelle as "Peelle's Pertinent Puzzle (PPP)". The description in detail of ppp and a way to solve it as well as the methods to deal with it approximately in practise are included in some reports[25] to be published.

The approximate methods have been adopted in the codes GAFC. TPFC, and MPFC for correlated data combination.

e) A code of transforming neutron and charged particle emission data from ENDF / B–4,5,6 format into DDX or EDX and plotting have been written.

2.2 Systematics Studies

Systematics studies on the excitation functions of the (n,γ), (n,2n), (n,3n) as well as (n,x) (x = p,d,t and ^{3,4}He) reactions have been performed. The parameterized formulae and all the parameters concerned have been obtained on the basis of the evaporation model with the preequilibrium mechanism and the collected data for A = 25–200 in the neutron energy range from threshold to 25 MeV.

With the formulae and parameters, the excitation functions could be pre-

dicted simply for the energy regions or nuclides not measured heretofore and the formulae have been used for curve fitting in case the measured data are scarce.

2.3 Nuclear Data Calculation and Nuclear Theory Research[1,2,6~14,19~24]

In recent years, our theoretical research on the nuclear reaction theory,calculation method and parameter and computer codes has been advanced greatly which are as follows :

a. Semi–classical theory of multi–step nuclear reaction processes[22]

The semi–classical model of multi–step direct and compound reactions has been developed. In this model, the pre–equilibrium reaction processes can be described by a unified approach with the angular momentum and the parity conservation without any ansatz. The exciton transition rate in J–Pai dependent and the mean lifetime of the exciton state dependent on the angular momentum by solving the J–Pai dependent master equation exactly were obtained. In this theory, the Pauli exclusion effect is considered in the exciton state density. For composite particle emissions, the pick–up mechanism has been adopted and the formation factors of the heavier composite particles have been derived. With the leading particle model, DDX of all kinds of emitted particles can be calculated.

Based on this model the code UNF has been set up.

b. Non–relativistic and relativistic phenomenological and microscopic optical potentials for neutron induced reactions at low and medium energies[23]

Non–relativistic and relativistic phenomenological and microscpic optical potentials are studied and compared for neutron induced reactions at low and medium energies. The calculated results show that the microscopic optical potential based on generalized and modified Skyrme force (GS2 and Ska), which has an analytical formalism without any free parameters, is useful in nuclear data calcualtion and evaluation. The global neutron relativistic phenomenological optical potential based on the available experimental data for various nuclei ranging from C to U with incident energies 20~ 1000 MeV has been obtained through automatic search of the best parameters. The nucleon relativistic microscopic optical potential is studied by utilizing effective Lagrangian based on Popular Walecka model, through extensive comparisons we can understand the neutron optical potential in large range of energy quite well.

c. Dispersion optical potential[8]

A review of optical model analyses in A = 40–60 mass region is given and the variation of the total cross section, the elastic scattering angular distribution and the absorption cross section with the optical potential parameters is

studied. The comparative analyses of different parameterizations of the spherical optical potential have shown that a deep minimum in the total cross section at low energies cannot be reproduced by any existing parameterizations. These optical potentials which fit the higher energy data, very accurately tend to give total cross sections at low energies that are clearly greater than the mean of the fluctuating experimental values. We show that a consistent analyses using the dispersion relations remove this "anomaly" of the total cross sections at low energy.

d. Nuclear level density[8]

Although the Gilbert–Cameron (GC) formula is rather universal in the application of the statistical theory, its constant temperature formula at low energy range is from an empirical approach without theoretical guidance, and the spin cut–off factor for the constant temperature formula is not well–defined and disagree with the experimental data either. Compared to GC formula, the problem mentioned above does not exist in the back–shifted Fermi gas model (BS formula), but its parameter form is not as universal as GC formula. The reasonable parts have been extracted from both formulas and combined them together. First of all, the level density parameters a and V values of BS formula for 318 nuclei have been obtained by fitting the evaluated experimental data. The spin cut–off factor at low energy region for BS formula has been improved. The systematics study of the parameters a has been carried out. The systematics results of S(Z) and S(N) have been obtained.

e. Radiative neutron capture[20]

Three nonstatistical effects, the capture in shape elastic, compound elastic and compound inelastic channels, have been studied[11]. The research shows that the contributions of some nonstatistical effects must be taken into account carefully even if the incident neutron energy is smaller than 3 MeV. Nonstatistical effects lead to an improvement of the gamma emission spectrum in high energy region.

The theory research for light nuclides

By using phase shift analysis, the calculations of n–H, n–D and n–T scattering cross sections have been carried out. The results are in agreement with experimental data.

The double differential cross sections for n+D have been calculated with solving Faddeev equation[12]. A set of low rank separable nucleon–nucleon potentials has been constructed, which includes different partial waves and tensor force. The calculated results are in good agreement with experimental data. The results also show that the contribution from off–shell effect is more significant than those from three body force and relativistic correlation.

On the basis of theory research mentioned above, some codes for the nuclear data calculations have been developed. Some of them have been sent to NEA Data Bank. Main ones[21] are :

. MUP2 MUP2[9,10] is the second version of a unified program for theoretical calculation of fast neutron data for medium–heavy nuclei by using the optical model, Hauser–Feshbach theory with width fluctuation correction (WHF) and pre–equilibrium (PE) statistical theory based on the exciton model and evaporation model. With AUJP, an associated code of MUP2 used for automatically searching of optimal optical potential parameters. MUP2 has been used in the evaluations for CENDL–2, and compared with international nuclear model programs.

. CMPU2 Based on MUP2, for calculation of charged particle as well as neutron induced reactions at the energy region of 4～ 50 MeV, including 1～4 particle emission. With the codes APCOM and APNOM used to search the optimal optical potential parameters, CMUP2 has been used to calcuate the data sets of p+^{89}Y and n+^{56}Fe reactions, the incident energy from 4 to 50 MeV.

. MUP3 MUP3[11] code is developed recently which is an extend code of MUP2 to calculate the double differential cross section for secondary particles and to deal with composite particle emission.

. FUP1 FUP1 is an extended code of MUP2 for fission nuclides calculation. With ASOP and ASFP, the associated codes of FUP1 used to automatically search for optimal fission and optical potential parameters respectively.

. CCOM A code of coupling channel optical model for deformed nucleus to calculate the direct reaction components of the inelastic scattering for 3 isolated levels of the residual nucleus. These direct components are added to the calculated compound nucleus cross section and angular distribution.

. UNF Developed recently for structural material calcualtion with the unified treatment of the pre–equilibrium and equilibrium reaction processes with angular momentum and parity conservations. The pick–up mechanism of complex particle (d, t, ^{3}He, ^{4}He) emission and the discrete level effects are taken into account for improving the calculations of reaction cross sections concerned. It is able to calculate DDX of particles emission as well as recoil nuclei, and γ–production data. With other codes for optimal optical parameters and direct components complement, UNF has been used to calculate the data sets of n+^{56}Fe, n+^{209}Bi reactions

Some codes have been developed for light nuclides :

. TSD TSD is based on solving the Faddeev equation for n+D reaction.

. ROP is a unified code of optical model and R matrix theory;

. CROP is able to fit simultaneously the experimental data of both a reac-

tion and the corresponding inverse reaction in a system;

. DRM is a unified code[13] for calculating direct inelastic scattering cross section for 1P shell nuclei with optical model and DWBA.

These codes have been used to improve the evaluations for ^{6,7}Li.

. RAC A comprehensive R–matrix analysis code based on multichannel and multilevel R–matrix theory. It has been used to analyse the ^{7}Li and ^{17}O systems to evaluate the data of n+^{6}Li (E_n < 1.72 MeV) and n+^{16}O (E_n < 6.2 MeV) reactions respectively.

. In the study of the three–body breaking up reactions, the code for the quasi–free particle scattering was developed to calculate the integral cross sections, DDX and normalization factor at any angular momentum.

Recently, CNDC is engaged in the compilation, evaluation and theoretical calculation for intermediate energy nuclear data (IEND)[14,23]. Based on our investigation, the nuclear reaction theories which can be easily and realistically used to calculate IEND are as follows : relativistic optical model; relativistic collective deformed DWBA approach; intranuclear cascade model and hybrid–type preequilibrium model. Some microscopic theories for IEND calculation have also been researched. Both the phenomenological and microscopic nucleon relativistic optical potentials are presented. The global neutron relativistic phenomenological optical potential (RPOP) based on the available experimental data for various nuclei ranging from C to U with incident energies E_n = 20–1000 MeV has been obtained through automatically searching for the optimal parameters. The nucleon relativistic microscopic optical potential (RMOP) is studied by using effective lagrangian based on popular Walecka model. Through comparison between the theoretical results and experimental data, some insight into both the RMOP and RPOP have been obtained. It is shown that the calculated results of the microscopic relativistic optical potential at the nucleon energy range 20~ 1000 MeV over a wide nucleus region are in reasonable agreement with experimental data without any adjustable parameters.

The evaluation of ^{56}Fe(p,n) experimental cross sections (E_p = threshold –1000 MeV) have been finished.

3 Multigroup Constant Generating and Benchmark Testing[1,2,15–17]

To meet the urgent needs in nuclear engineering, since 1986 large amount of the nuclear data for nuclear power, nuclear safety analysis and nuclear engineering design have been processed. Through international exchange, some valuable codes have been obtained from ORNL / RSIC, ANL / NESC and NEA

Data Bank, and based on them, a few of program systems used for data processing and reactor calcuations have been established. Now we can provide the codes and data for the nuclear science and engineering.

1) Three program systems of group constant generating have been implemented on computer CYBER–825 at CIAE. These codes are AMPX–II, NJOY and MINX which are used in data processing for nuclear science and technology.

2) PASC–1[16] was made based on AMPX–II in cooperation with ECN (Holland). It is composed of AMPX / SCALE group constant module, several transport calculation codes Sn and 1–3 dimension diffusion code CITATION. PASC–1, has been sent to NEADB. This code can be used in the design of reactors. A library including 45 and 52 group constants of 37 nuclides has been processed by PASC–1 for the fast reactor calculations. A multigroup Monte–Carlo code KENO–IV from RSIC has been linked to the code system PASC–1. Going through large amount of benchmark calculations, it has been proved that the AMPX–KENO–IV is reliable to use it in critical safety analysis. Therefore it has been applied to the critical safety calculations of the high–density spent–fuel storage racks at the Qinshan nuclear power station.

3) Based on BINX and CINX, the CCCCPS code system[15], which is automatized, has been made for processing the interface file of CCCC format library. By using the CCCCPS code system, the 50 group constants of 49 nuclides from LIB–IV CCCC library were processed into 46 group ABBN library in the Bondarenko format for the input of the code 1DX for the fast reactor design.

4) The FRBT code system is composed of three codes EXDL, BRKP and NDP, and an integral experiment data library included 19 fast benchmark assemblies. The material compositions, geometric conditions and the other controlled variables about 19 assemblies recommended by American CSEWG have been included in the library. The EXDL is a code to retrieve an interface file for calculating a reactor by NDP. The BRKP is able to retrieve an interface file of the multigroup constants in the Bondarenko format from the ABBN library. NDP is an one–dimension diffusion code used in critical calculations of reactors. The user's input of the FRBT is very simple and inputing one of the numbers to be arranged in order of assemblies is only required. Using the FRBT code system with the ABBN library of 46 groups, the calculations about 14 fast critical benchmark assemblies have been finished. The results are consistent with those given by CSEWG.

5) The theoretical analysis for Be sphere shell neutron multiplication factor is also carried out. This is a cooperation project with U.S.A. and Japan.

In cooperation with ECN (Holland), the ECNJEF–1 Library[17] was set up by using NJOY–87.0, CRECTJ5, MILER, NPTXS and XLACS–2. The ECNJEF–1 Library is a 219 neutron group Library from JEF–1 in the AMPX master format. 16 files are included in this Library with 434 elements. Some problems in JEF–1 and related processing codes were met. Most of the them were solved. MILER–ECN version was sent to NEA Data Bank by ECN.

Now we can make the benchmark testing for the nuclear data and provide various multi–group constants for the calculations in thermal reactor, fast reactor and fission–fusion reactor and for shielding calculations.

4 Construction of Nuclear Data Library and Related Program Library, Management, and Service[1~3,18~21]

A group in CNDC is responsible for the nuclear data library and the associated program library. At present, the group has the following main tasks :

. to prepare and maintain the Chinese Evaluated Nuclear Data Library (CENDL).

. to get experimental and evaluated nuclear data and computer programs from abroad through exchange.

. to improve or develop the library management, data processing and evaluation program systems.

. to compile the data measured in China in EXFOR format.

. to collect, compile and evaluate atomic and molecular data and establish such a data library in cooperation with the atomic and molecular data working group.

. to provide nuclear data and program services to Chinese users and exchange them with IAEA / NDS and other centers.

. to operate, maintain and manage the computer.

Now, the PDP 11 / 70 and MICRO–VAX–II computers are operated and used in data evaluations, data calculations and library construction successfully; The ENDF / B–6 and EXFOR code systems (including the ENDF utility programs, version 6.6) have been transplanted onto MICRO–VAX–II, so neutron data in EXFOR and data files in ENDF / B4–6 format can be processed; We have set up a complete program systems for nuclear data evaluation and library management.

Development of the code library. Following codes have been stored and / or checked or assessed : 30 codes made by ourselves, ~ 60 codes, used in nuclear engineering, obtained from RSIC (U.S.A.), ~ 100 codes obtained from NEADB (OECD). So far more than 100 codes have been used by the home users.

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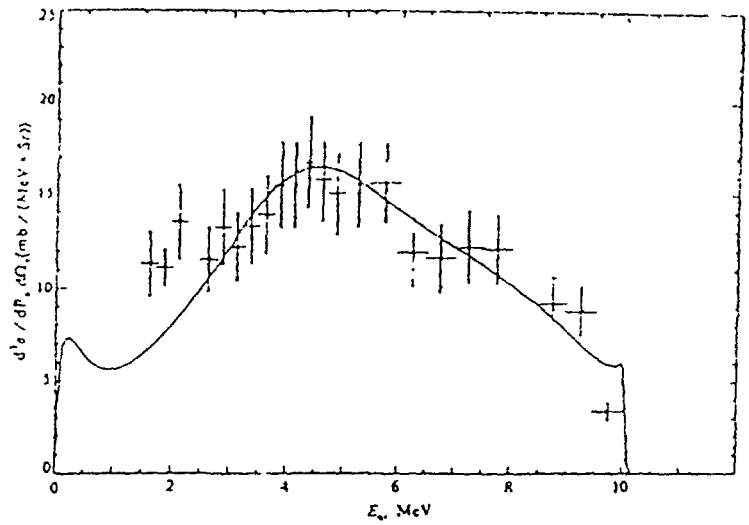

Fig. 1 D(n,2n) Double Differential Cross Section at $\theta = 25°$, $E_n = 13.6$ MeV
—— Present work,
+ Experimental data (China)

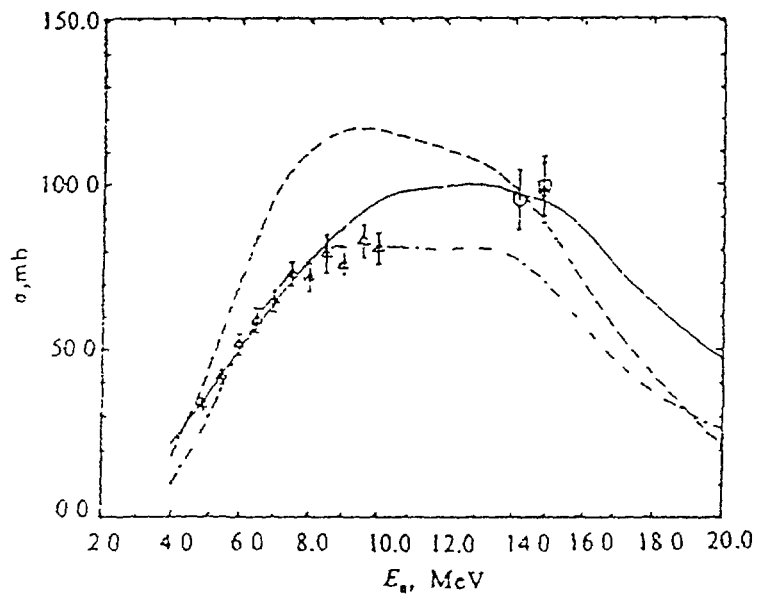

Fig. 2 Ni(n,α) Cross Section
—— Present work
— — ENDF / B-VI
— · — JENDL-3
⊙ GEL Wattecamps (83)
△ GEL Paulsen (81)
⊡ Al Kneff (86)
◇ LRL Grimes (79)

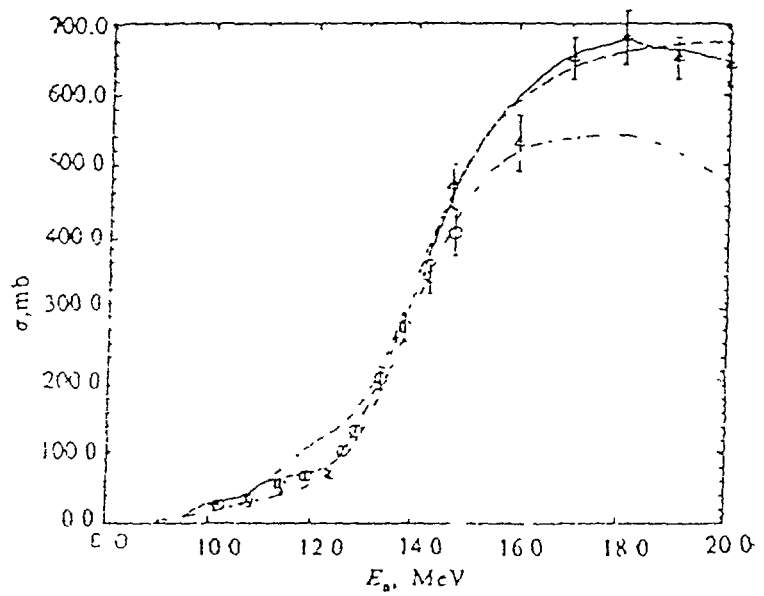

Fig. 3 Cr(n,2n) Cross Section
—— Present work
— — ENDF / B-VI
— · — JENDL-3
⊙ BRC Frehuat (80)
△ LAS Auchamp (77)

The Activities on CENDL, EXFOR, CINDA and WRENDA in China

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The main nuclear data activities in China have been reported by Dr. Cai Dunjiu, Director of Chinese Nuclear Data Center, in this Meeting[1]. In this article, we merely give some supplement on several aspects, i.e. CENDL-2, EXFOR, CINDA, and WRENDA.

1. CENDL-2 and relative programs system

The Chinese Nuclear Data Center and Nuclear Data Committee of China started evaluation and compilation work for CENDL-2 in the beginning of 1986. The main purpose for making CENDL-2 is to develop and improve the CENDL-1[2,3], such as to extend the incident neutron energy to thermal energy region, supplement the data type of evaluations, improve and update the earlier evaluations, and add some new evaluations to the library. CENDL-2 was finally completed in July 1991; it contains data for main engineering, construction and fuel materials in nuclear reactors, radiation shielding materials and so on.

The CENDL-2 was based on the CENDL-1. 54 nuclides in all are included in this version, as shown in Table 1. Of these, 36 nuclides are from CENDL-1, but have been re-evaluated or extensively revised around the years 1989/1990. The rest (⅓) were newly evaluated. All evaluations were performed by Chinese evaluators of CNDC and Chinese Nuclear Data Coordination Network (CNDCN) except that a few ones were completed by Chinese evaluators at home or abroad for foreign libraries via international cooperation and these evaluations are also included in CENDL-2. Some evaluations are based on existing foreign libraries, such as ENDF/B-6, JENDL-3 and BROND, with partial updates and revisions performed by Chinese evaluators.

Table 1. Nuclides Contained in CENDL-2

^{1}H, ^{2}H, ^{3}H, ^{3}He, ^{4}He, ^{6}Li, ^{7}Li, ^{9}Be, ^{10}B, ^{11}B, ^{14}N, ^{16}O, ^{19}F, ^{23}Na, Mg, ^{27}Al, Si, ^{31}P, S, K, Ca, Zn, Ti, ^{51}V, Cr, ^{55}Mn, Fe, ^{59}Co, Ni, Cu, Zr, ^{93}Nb, Mo, Ag, ^{107}Ag, ^{109}Ag, Cd, In, Sn, Sb, Hf, Ta, W, ^{197}Au, Pb, ^{232}Th, ^{235}U, ^{238}U, ^{237}Np, ^{239}Pu, ^{248}Pu, ^{241}Am, ^{249}Bk, ^{249}Cf.

The library contains full sets of neutron data, i.e. resonance parameters in the resonance region and cross sections of all reactions, energy and angular distribution of secondary neutrons, and for some evaluations also double differential cross sections or γ-production

data, in the energy range from 10^{-5} eV to 20 MeV. Most of the evaluations are presented in the ENDF-5 format, some in ENDF-6 which contains double-differential cross section or Reich-Moore resonance parameters in resolved resonance region, which are not permitted in ENDF-5 format.

All the evaluations were carefully checked and reviewed by Chinese specialists. The Chinese Nuclear Data Center also organized a collective examination carried out by specialists from various institutes and universities. Finally, all the evaluations were checked through by CHECKR, PSYCHE, FIZCON and then accepted by CENDL-2.

More detailed descriptions of CENDL-2 and the evaluations contained in CENDL-2 are given in elsewhere[4,5].

In order to manage the library, the ENDF data base system, i.e. the storage and retrieval system, developed at NNDC, U.S.A. has been installed in Micro-VAX-II computer at CNDC.

The ENDF Utility codes, version 6.6 from NNDC have also been transplanted on Micro-VAX-II computer and used for checking and processing evaluated neutron data for CENDL-2.

A code CRECTJ5 developed at JAERI/NDC has been transplanted to Micro-VAX-II computer, this code has functions of reading evaluated nuclear data and making a complete file of them. In addition to such fundamental functions, it has also useful functions of arithmetic operation of cross-section data, averaging of cross sections, correction of data, construction of natural element data from its isotope data and so on. This code has been used for evaluation and compilation work of CENDL-2.

Now the CENDL-2, ENDF/B-6, JENDL-2 and BROND libraries have been loaded in disk of VAX-II and serves the users in China.

2. EXFOR

According to the research contract to IAEA, in recent years, many efforts have been made to develop the EXFOR software system for nuclear data compilation and to compile the EXFOR nuclear data measured in China. Now the EXFOR software system, which includes three parts, i.e. Edition, Check, and Retrieval, has been completed basically and used in the EXFOR data compilation.

Another "PC software assisting the nuclear data compilation in EXFOR" dēveloped by Dr. V. Osorio has also been transplanted to our 386 PC.

The EXFOR processing program system and Storage and Retrieval system developed by NNDC have also been installed in Micro-VAX-II computer under the assistance of IAEA expert Dr. C. Dunford.

So now the conditions for EXFOR nuclear data compilation and management in CNDC is quite good.

The main purpose of EXFOR work in CNDC is the data compilation itself, and it will be a long-term task, because IAEA/NDS no longer compile in EXFOR Chinese data since 1988. Up to now, we have compiled 10 EXFOR entries and sent them to IAEA/NDS in 1989, 1990 respectively, another 5 EXFOR entries will be compiled and sent to IAEA/NDS by the end of 1991, and we plan to compile at least 20 EXFOR entries in the coming year.

In order to coordinate the activity on EXFOR nuclear data compilation in China, the Network for EXFOR data compilation has been established last year. The Network consists of several institutes and universities in China. Unfortunately, the scientists of the network are not familiar with EXFOR field, so they have spent much time to be familiar with this matter in the past two years, and the EXFOR data compilation work was a little delayed.

In the EXFOR data service, we hope that the entire EXFOR data library will be supplied by IAEA/NDS and loaded in our Micro-VAX-II computer when the new hard disk provided by IAEA is installed.

3. CINDA

Up to now, the CINDA work has not been carried out systematically in CNDC, although we have compiled some CINDA entries in the past several years. We hope that this work will be continued hereafter.

Besides, IAEA/NDS has sent us the entire CINDA library and related codes system, we also hope we could build and maintain the CINDA library in Micro-VAX-II computer in future.

4. WRENDA

The WRENDA work was started in CNDC in 1987. We have collected some nuclear data requests in China and compiled the requests list for inclusion in WRENDA 87/88 at that time. According to the requirement of IAEA/NDS, we are now starting the preparatory work for WRENDA 91/92, the main tasks are as follows:

(1) To ask previous requestors to review, update and make necessary changes on their previous nuclear data requests, or to delete the previous requests if they are satisfied by recent work or no longer needed.

(2) To collect new requests, check and review them, fill in request form and then submit to IAEA/NDS.

5. Proposal for ENDF format modification

(1) The theoretical and evaluation scientists feel that the highest order Legendre polynomial NL $\leq$ 20 is not enough to describe the angular distribution of secondary neutron for medium-heavy nuclides in the higher energy region. It is appropriate to increase the NL up to $\leq$30.

(2) The requirement for giving the angular and energy distribution of secondary neutrons from the first, second, third and fourth-chance fission (i.e. MF=4,5 MT=19,20,21,38) are not necessary even when their cross sections have been given in MF=3, because their average number of neutrons released by these chance are not given in MF=1 correspondingly. So we would like to propose that:

- no longer require to give the MF=4,5 MT=19,20,21,38 in evaluation even when their cross section are given in MF=3; or

- to give the average number of neutrons released by these chance fission in corresponding section (MT) in MF=1, when the MF=3,4,5 MT=19,20,21,38 are given in the evaluations.

References

[1] Cai Dunjiu, Progress of Nuclear Data Work in China (1991).

[2] Liang Qichang et al., Chinese Evaluated Nuclear Data Library (CENDL), IAEA-NDS-61 (1985).

[3] Chinese Evaluated Nuclear Data Library, Version 1 (CENDL-1), Edited by CNDC, 1986 (in Chinese).

[4] Liang Qichang et al., Chinese Evaluated Nuclear Data Library, Version 2, (CENDL-2), 1991.

[5] Communication of Nuclear Data Progress No. 6, special issue for CENDL-2, Edited by CNDC (to be published).

DATA ACTIVITIES IN RIKEN NUCLEAR DATA GROUP

Status Report

to the

Eleventh Meeting of the Nuclear Reaction Data Centers

Obninsk, October 7 - 11, 1991

Y. Tendow

1) Staff

There were some changes in the staff of RIKEN Nuclear Data Group this year. A.Hashizume retired from RIKEN and moved to another organization. He still renains in the group as a part-time member and is supposed to continue the nuclear data compilation works. Y.Tendow has succeeded him as the person in charge. In addition to EXFOR, we also are in charge of compilation of ENSDF and Nuclear Structure Reference file (NSR) for secondary sources originated in Japan. So, any decrease in the proper staff would lead to a constant shortage of manpower. From long-term pointof view, it is an important matter to obtain new members in the group.

1	Permanent,	EXFOR, ENSDF, NSR.
1	Concurrent,	EXFOR.
1	Concurrent,	Computer.
2	Part-time,	EXFOR, ENSDF.
1	Assistant,	EXFOR, ENSDF, NSR.

2) Computers

Nuclear Data Group belongs to the Radiation Laboratory in the Main Research Building. The central mainframe computer FACOM M780 (which will soon be upgraded to FACOM M1800 256 MB memories, 120 GB disks, 400 GB MT library) is running under double operating systems, MSP (IBM compatible) and UTS (UNIX). We are using the mainframe for the compilation works, and also several PC's linked to the mainframe and other networks. PC's mainly used are as follows:

FUJITSU FM-R70, terminal of the mainframe. 40 MB HD.

IBM PS/5530 (equivalent to PS/2). 40 MB HD, math.co-processor.

NEC PC-9801. 120 MB HD, math.co-processor.

Macintoshes and other NEC PC's.

In the RIKEN Acceleraror Facility area, another computer network (FACOM M380, VAX6510, VAX8350, μVAXII's etc.) is running under DECnet / TCP/IP protocol. It is also connected to the Main Building network with optical cables. Although we can access and remote login to these computers, we are not yet using them for data compilation works at the moment. We can exchange E-mail through the BITNET, and can remote login to overseas computers through the Internet or HEPNET etc.

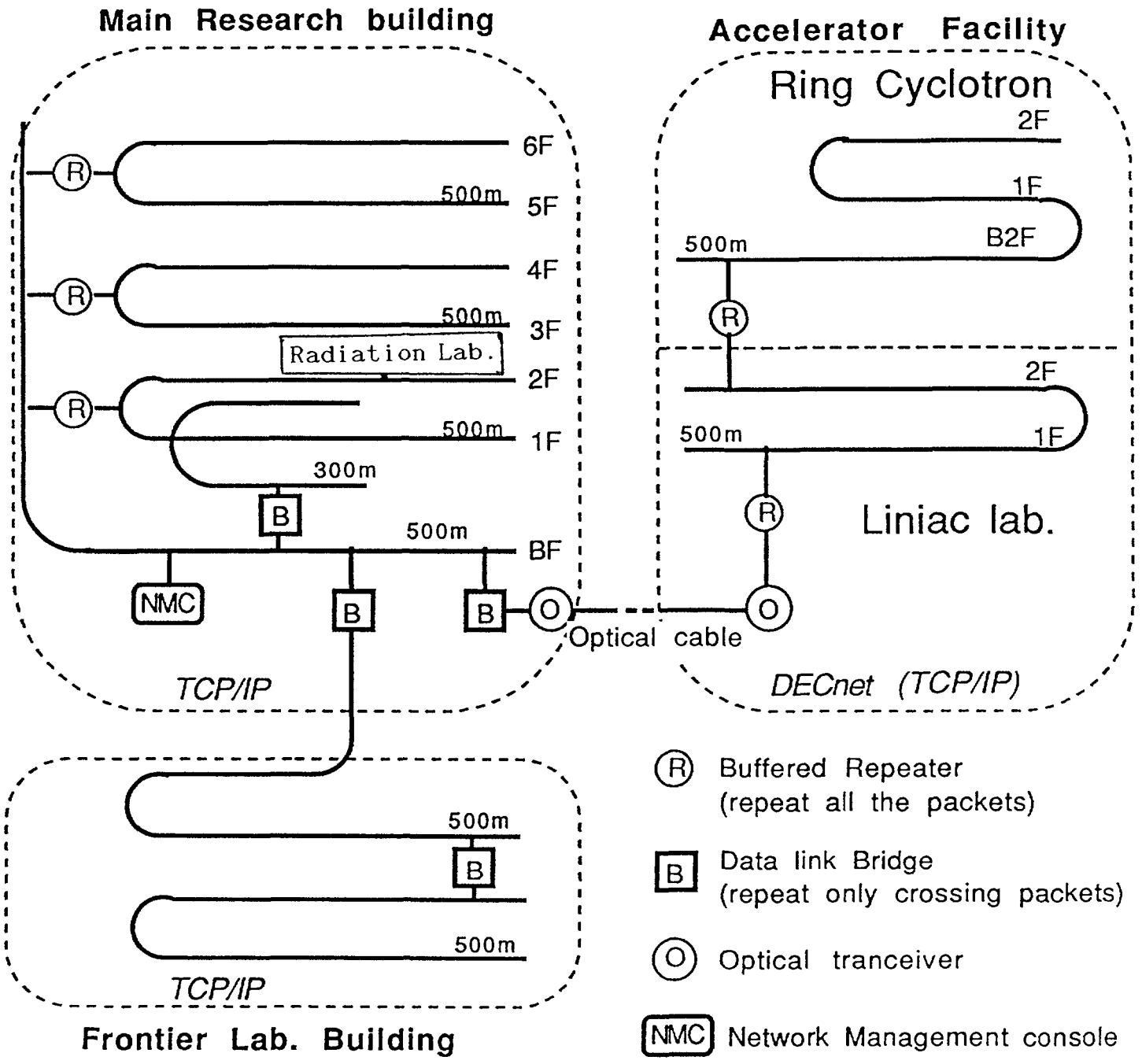
3) EXFOR

We have been continuing to collect cross section data restricting to 20 isotopes of medical use. Most of them are already incorporated into EXFOR file but not a small number of important works are left untouched. To cover these missing works as well as recent ones is essential for the completeness of EXFOR file. We have just sent the trans tape R006 to NDS which contains 4 entries with a total of 41 subentries of excitation functions.

4) ENSDF, NSR

The mass-chain evaluation and compilation for A = 177 is in progress suffering a considerable delay. Another mass-chain evaluation for A = 129 has just started. NSR file compilation for 1988 and 1989 secondary sources of Japanese origin has completed with some delay. The file is just to be sent to NNDC. We have started on the compilation for 1990 secondary sources.

Ethernet cable routing at RIKEN



Status Report of SG to the 1991 NRDC Meeting

Japan Charged-Particle Nuclear Reaction Data Groupe

M. Chiba
Sapporo Gakuin University
Bunkyodai-11, Ebetsu, Hokkaido, 069, Japan

CPND compiling with NRDF

CPND compiling with NRDF format has been continuing since 1980. 46 and 59 entries have been added in 1989 and 1990, respectively. By March 1991, the total amount of compiled data have reached 52 MB, 1100 entries. The newly compiled entries in 1989 and 1990 are the ones that were almost all produced in Japan.

Into EXFOR translation

In 1990 we submitted to NDS two TRANS tapes: E007 and E008. But TRANS E007 is a revised retransmission of entries in TRANS E005 and E006 to eliminate mistakes found. E008 contains 8 entries which are selected from the NRDF data compiled in 1989.

In 1991, TRANS E009 was submitted to NDS. This TRANS contains 19 entries. These are converted from the entries compiled in 1990.

NRDF ANNUAL REPORT

Our activities has been reported since 1987 by "NRDF ANNUAL REPORT" which is written in Japanese. This report is distributed among reserchers in the related fields in Japan.

Main topic of "NRDF ANNUAL REPORT 89" is on the result of questionaire

survey to the potential users about NRDF activities. This survey positively showed that many authors of data would cooperate with NRDF in direct data acquisition from the author or author proof. So we are now under deliberation of inventing some means to get authors' cooperation of data.

In "NRDF ANUAL REPORT 90", index lists of the NRDF entries and translated EXFOR entries appeared. Titles and author's names of the entries compiled in 1990 are also listed.

Computer Facility

We utilize the Hokkaido University Computing Center for the storage and retrieval of NRDF and EXFOR information. The Hokkaido University Computing Center installs Hitachi M-682H and S-820/80 computers. These computers are connected to the National Academic Information Network. So Researchers of the universities or colleges in Japan can access our NRDF or EXFOR information through the Network.

For NRDF data compiling and graph data reading, we also utilize several PC's with a digitizer.

収集している物理量

約１５０種類

Contents of NRDF

ANGL-DSTRN	66.9 %
DSIGMA/DOMEGA	60.5
ANALPW	27.5
ENGY-SPEC	24.0
XSECTN	22.3
OPT-POL-PARA	18.0
EXC-FUNCT	17.6
SPIN	17.1
PTY	16.5
EXC-ENGY	16.4

NEA DATA BANK Progress Report

to the NRDC Meeting in Obninsk/Moscow, October 1991

INTRODUCTION

The demand on the Data Bank services has recently been very high. Computer program requests have increased 20 percent when compared with the last few years and the nuclear data requests by about 50 percent. The last value could be explained by the fact that new versions of the three major evaluated libraries were released in 1990. The work on the Thermochemical Data base (TDB) continued as planned and the report on the uranium elements was sent out for final review with the aim to be published at the end of 1991.

The cooperative arrangement between US DOE and the NEA concerning nuclear data and computer program exchange was provisionally prolonged until September 1991. The nine months prolongation was requested from US DOE to finalize the arrangement covering a longer period of time.

COMPUTER PROGRAM SERVICES

Testing and Masterfiling

In all 110 new computer code packages were master-filed in 1990. Ninety percent were fully tested while the others were only screened for completeness and correct syntax. The large turnover of staff together with vacancies during the year have further increased the backlog of programs available but not yet tested at the Data Bank

An increasing amount of software designed to be operated on personal computers is acquired every year. The programs running on personal computers amount to about 150 (about 10% of the total) This software is checked as to whether it contains one of the known viruses. For the purpose standard software has been acquired. Internal procedures have been set up to ensure a full protection from virus infection. Also software sent out on diskettes is checked against virus infection before it is sent off to the user

Program Distribution.

The request for computer codes has increased by about twenty percent during 1990 as compared to the previous few years. In fact 1720 computer program packages (plus 130 additional reports) were sent out to requesters 400 of these were sent to non-OECD establishments. This increase can be explained as follows computer programs are increasingly used in a dual mode, small problems are solved locally on a personal computer while larger problems are executed remotely on a large mainframe. Data communication is realized via a local or remote network connection. An increasing number of programs exist now in both a PC and mainframe version. In 1990 about 350 PC versions of programs were distributed (20%). This percentage has steadily increased over the last several years. Twelve percent of the computer codes sent out in 1990 were not tested

Computer program abstracts were looked up by users in about 200 sessions and 25 requests were deposited in the on-line program request mail box. In general an increasing number of requests is placed via electronic mail

NUCLEAR DATA SERVICES

CINDA and EXFOR Activities

These activities are facing a temporary standstill following the departure of Simon Webster in August 1991. At programme to educate one of our supporting staff members in the tape-handling and loading of CINDA and EXFOR data have been started. It is envisaged that a new physicist will be employed in the near future

Concerning the CINDA activity, there is not much to report. The coverage of area 2 entries has continued as usual

Three tapes of EXFOR data were produced and sent to other data centers in 1990. The tapes contained 30 new compilations and an additional 38 re-transmissions. There is no backlog for the EXFOR compilation, but only some articles waiting to be compiled, as the numerical data has not yet been sent to the Data Bank by the author.

NUMBER OF EXFOR ENTRIES COMPILED IN RECENT YEARS
BY THE FOUR NEUTRON DATA CENTERS
WITH RESPECT TO THE YEAR OF REFERENCE
4-AUG.-1991

	Subworks					*Works*				
Year	*1*	*2*	*3*	*4*	*Sum*	*1*	*2*	*3*	*4*	*Sum*
75	*700*	*421*	*172*	*491*	*1784*	*98*	*70*	*23*	*48*	*239*
76	*470*	*486*	*261*	*203*	*1420*	*84*	*82*	*35*	*47*	*248*
77	*487*	*506*	*253*	*430*	*1676*	*82*	*60*	*39*	*63*	*244*
78	*564*	*1072*	*245*	*257*	*2138*	*86*	*93*	*37*	*16*	*232*
79	*453*	*583*	*227*	*293*	*1556*	*70*	*68*	*39*	*26*	*203*
80	*209*	*748*	*200*	*629*	*1786*	*49*	*66*	*37*	*39*	*191*
81	*282*	*447*	*207*	*454*	*1390*	*60*	*65*	*32*	*14*	*171*
82	*404*	*818*	*239*	*316*	*1777*	*69*	*57*	*37*	*17*	*180*
83	*253*	*482*	*166*	*550*	*1451*	*47*	*36*	*31*	*69*	*183*
84	*207*	*551*	*117*	*280*	*1155*	*54*	*51*	*24*	*25*	*154*
85	*232*	*703*	*319*	*272*	*1526*	*47*	*43*	*34*	*38*	*162*
86	*200*	*731*	*255*	*164*	*1350*	*41*	*31*	*30*	*38*	*140*
87	*166*	*672*	*81*	*528*	*1447*	*36*	*20*	*17*	*47*	*120*
88	*114*	*470*	*60*	*238*	*882*	*26*	*40*	*14*	*20*	*100*
89	*148*	*268*	*157*	*66*	*639*	*28*	*36*	*25*	*8*	*97*
90	*63*	*333*	*15*	*14*	*425*	*15*	*33*	*4*	*4*	*56*
91	*1*	*1*	*2*	*0*	*4*	*1*	*1*	*1*	*0*	*3*

Customer Service

254 requests for data and documents from 86 different requesters were "manually" answered in 1990. This is a significant increase compared to the figure of 151 requests for 1989, but could be explained by the fact that new versions of the three major evaluated data libraries (ENDF, JEF and JENDL) were released in 1990. The main items asked for were: JEF data (35%), other evaluated data (26%) and EXFOR data (20%). Almost 30 percent of these requests came to the Data Bank via computer network.

A continued increase in the use of computer networks could be seen in the on-line customer service. More than 1100 accesses to the data bases containing nuclear data were registered. The trends for the different services are given in the table below showing the statistics since the introduction of the on-line service in 1989.

NEADB ON-LINE STATISTICS

	1989	*1990*	*1991 (JAN.-SEPT.)*
EXFOR	*98*	*132*	*64*
CINDA	*14*	*29*	*30*
EVALUATED DATA	*64*	*155*	*128*
ENSDF	*309*	*314*	*114*
NSR	*358*	*424*	*240*
NUDAT	*66*	*79*	*77*

Joint Evaluated File (JEF)

At the JEF Scientific Coordination Group Meeting on 1st June 1990, it was decided to abolish the restriction on the distribution of the JEF-1 evaluated library. The files were then released to users outside the NEA Data Bank community. The decision affected also the group cross section libraries derived from JEF-1. At the subsequent meeting in June 1991 it was decided to continue the present policy for the distribution of the JEF-2 library, e.g. the JEF-2 library would be released world-wide after the library had been properly benchmark tested. The benchmark testing programme was estimated to run until about the end of 1992. The preliminary versions of the JEF-2 files would continue to be released within the framework of the OECD International Evaluation Project.

A preliminary version of the JEF-2 general purpose files (JEF-2.0) had, at the end of February 1990, been sent out to laboratories involved in the benchmark testing of the library. Foreseen revisions to some of the major isotopes was performed in the spring of 1990 and the revised data (JEF-2.1) were issued in October 1990. Following feedback from the first use and benchmark testing of the JEF-2.1 data, a number of corrections to the existing files were discussed at the JEF meetings in December 1990 and June 1991 and it was decided to release an updated version called JEF-2.2 in September 1991.

The first versions of the JEF-2 Radioactive Decay Data and the Fission Yield Data were distributed for testing in the middle of June 1990. A final version of the Fission Yield data were compiled at the end of 1990, whereas the work on the about 2300 isotopes present in the Radioactive Decay Data library will not be terminated until the end of 1991.

The benchmark testing of the first version of the JEF-2 library has been started at several laboratories directly involved in the JEF project.

Considering the amount of feedback from and the number of laboratories using the NJOY code, it was felt of utmost importance to organise this feedback and the experience in the use of the code. It was decided to create a "NJOY User Group" with E. Sartori as coordinator. One person from each major laboratory involved in the processing of the JEF data were nominated to participate. The Group would meet at regular intervals (4 to 6 months interval) and report back to the JEF Working Groups and the JEF Scientific Coordination Group. The NJOY User Group would discuss experience in the use of the code, suggest solutions to encountered problems, be the focal point for feedback, and be the central

body for discussions with the authors of the NJOY code.

The first meeting of the NJOY User Group was held at the NEA Data Bank on 20th September 1991. One of the objectives at the first meeting would be to assist in the organisation of a NJOY workshop, to be held at the NEA Data Bank, tentatively on 7th and 8th May 1992.

The present cooperation between the JEF and EFF (European Fusion File) projects has been discussed during 1990 and it has been agreed to ultimately merge the two libraries to a common library to be used both for fission and fusion purposes. A starter file of this common library, for which the acronym J/EFF is proposed, will be prepared in 1992 from an agreed choice of isotopes from both libraries The two projects would still keep their identities and work in parallel and close cooperation on the improvement of the data

NUCLEAR SCIENCE ACTIVITIES

The NEA Steering Committee had in 1990 asked for a simplification of the present structure of the NEA Science programme K. Uematsu, the Director General of NEA, consulted widely within the nuclear science community and presented a first proposal to the Steering Committee meeting in April 1991. It was suggested to merge the present NEA science committees, NEANDC and NEACRP, and the NEA Data Bank Committee into one Committee, called the NEA Nuclear Science Committee. The Data Bank scientific services would be overlooked by an executive group within the Nuclear Science Committee. The Steering Committee generally supported the proposal to set up a Nuclear Science Committee, and instructed the NEA Secretariat to draw up the required Terms of Reference. The NEACRP, NEANDC and the Data Bank Committee were consulted when drafting the new Terms of Reference. At the Steering Committee meeting on 1st and 2nd October 1991 it was decided to establish a Nuclear Science Committee to replace to old committees (NEANDC, NEACRP and the Data Bank Committee) and the first meeting of the new committee was proposed for the 18th and 19th December 1991.

The International Evaluation Cooperation

The 3rd Working Group Meeting of the OECD wide International Evaluation Cooperation (IEC) was held at ECN, Petten, Holland, in May 1991. The meeting reviewed progress in the work of the different subgroups. Following a discussion on subject areas of interest to the evaluation projects, it was decided to create four new subgroups:

- Subgroup 8: Minor Actinide Data (Monitor: M. Sowerby)
- Subgroup 9: High Priority Request List for Data Needs in Future/Advanced Reactors. (Monitor and Coordinator: M. Salvatores)
- Subgroup 10: Fission Product Inelastic Scattering. (Monitor H. Gruppelaar)
- Subgroup 11. Inter-Comparison of the Resonance Region of ^{52}Cr, ^{56}Fe, and ^{58}Ni (Monitor: D Larson)

Unofficial requests for the participation of non-OECD experts at Working Group meetings had been received Following a discussion, it was decided to allow for observers to be present at Working Group meetings. The following procedure was decided: A maximum of three observers (at least one from the IAEA) would be allowed, nominated through the IAEA Nuclear Data Section, and subject to approval by the Working Group chairman. Nomination for observers should be sent to the Working Group chairman with a copy to the NEA Secretariat well in advance of a meeting.

Validation of Computer Codes and Data

An international nuclear mode code comparison concerning the Hauser-Feshbach theory was completed in 1990 Ten participants submitted results and of the 22 sets of results, 12 were sufficiently consistent with each other to be accepted as benchmark values. The results were presented at the International Conference on Nuclear Data and Technology in Jülich, Germany. A parallel comparison study of Weisskopf-Ewing calculations gave such discrepant results that no benchmark values could be identified

A blind intercomparison of codes used in decay heat calculations, was performed at the Data Bank in 1989 and 1990. The result of the exercise confirmed the hypothesis that the differences observed in decay heat calculations are due to the input data used and not to the calculational methods used in the different computer codes. The conclusions were also presented at the Julich Conference.

A blind intercomparison of nuclear model cross section calculations of the Co-60 (n,p) reaction was started in 1990. The first contributions from the participants were received at the end of 1990 and the analysis of the results will continue in 1991.

IN-HOUSE COMPUTER INSTALLATION

The in-house computer installation has not recently been modified. The VAX computers performed in general well with one exception: the VAX-11/780 suffered from some hardware problems and above all slow performance mainly due to the increased load from on-line users. A proposal for a update of the installation has been discussed and it is foreseen to replace the present installation with a VAX 6510 computer and increase the number of Workstations (presently two VAXstation 3100).

NATIONAL NUCLEAR DATA CENTER

Status Report
to the
Eleventh Consultants' Meeting
of the Nuclear Reaction Data Centers
7 - 11 October 1991

General

Since the last meeting of the Nuclear Reaction Data Centers in October 1989, our staff has been decreased by one scientific and three support positions (there are currently 11 scientific/professional and 6 support staff). In addition, we have had two visiting scientists. Vladimir Varlamov (CDFE) was at NNDC for five months doing photonuclear data compilation, and working on future cooperation between the U.S.A. and the U.S.S.R. for the evaluation of photonuclear data. Wolfgang Rothenstein (from Haifa, Israel) is at the Center on sabbatical, working on data and methods testing for thermal reactor applications.

Computer Facilities

In the past two years the following hardware has been added. All are networked into the VAX cluster.

A Sun SPARCstation work station 1+ with 8mm tape, and two disk drives.

X-window terminals: 4 Dec-1200, 1 Dec-1000.

Four IBM-compatible PC's.

A diagram of the system as of September, 1991, is attached.

Bibliographies

The NSR activity has continued. 6 supplements of ***Recent References*** have been published. The last edition of ***Charged Particle Nuclear Data Bibliography*** was published covering the literature from November, 1988 through November, 1989.

As of sping 1990, the CINDA compilation activity has been severly cut back to those references associated with the experimental data compiled at the Center.

Data Libraries

In the period from October 1989 through September 1991, 11 neutron data transmission tapes (TRANS 1235-1245) and 1 photonuclear tape (TRANS L004) were sent containing new and corrected entries.

Compilation of the data from the Rider Fission Product Yield data file has been completed and most of the data has been entered into the EXFOR system.

Evaluated Nuclear Reaction Data

NNDC continues to coordinate the work of the Cross Section Evaluation Working Group. The ENDF/B-VI library was released in 1990 with unrestricted distribution, and contains complete evaluations for neutrons incident on approximately 100 materials, and partial evaluations of fission-product cross sections and dosimetry reactions. The ENDF/B Library also contains neutron and proton reaction data for ^{56}Fe at energies up to 1000 MeV. A library of charged-particle data for proton with energies up to 100 MeV on two materials and for 5 reactions important for fusion applications, as well as fission product yields and decay data were released in 1991. Corrections to the initial releases, ENDF/B-VI Revision 1, were also released in 1991.

Plans are underway for the Symposium on Nuclear Evaluation Methodology which will be held at Brookhaven in September 1992.

Nuclear Structure Data

NNDC continues to publish the *Nuclear Data Sheets*. As of September, 1991, issues through Volume 64, #1 have been sent to Academic Press.

Customer Services

Since October 1, 1989, use of the online data service has steadily increased. There are nearly 300 customer accounts which may have more than one user, and 111 single user accounts. There have been around 1000 retrievals per month this year with several months in which the number exceeded 2000.

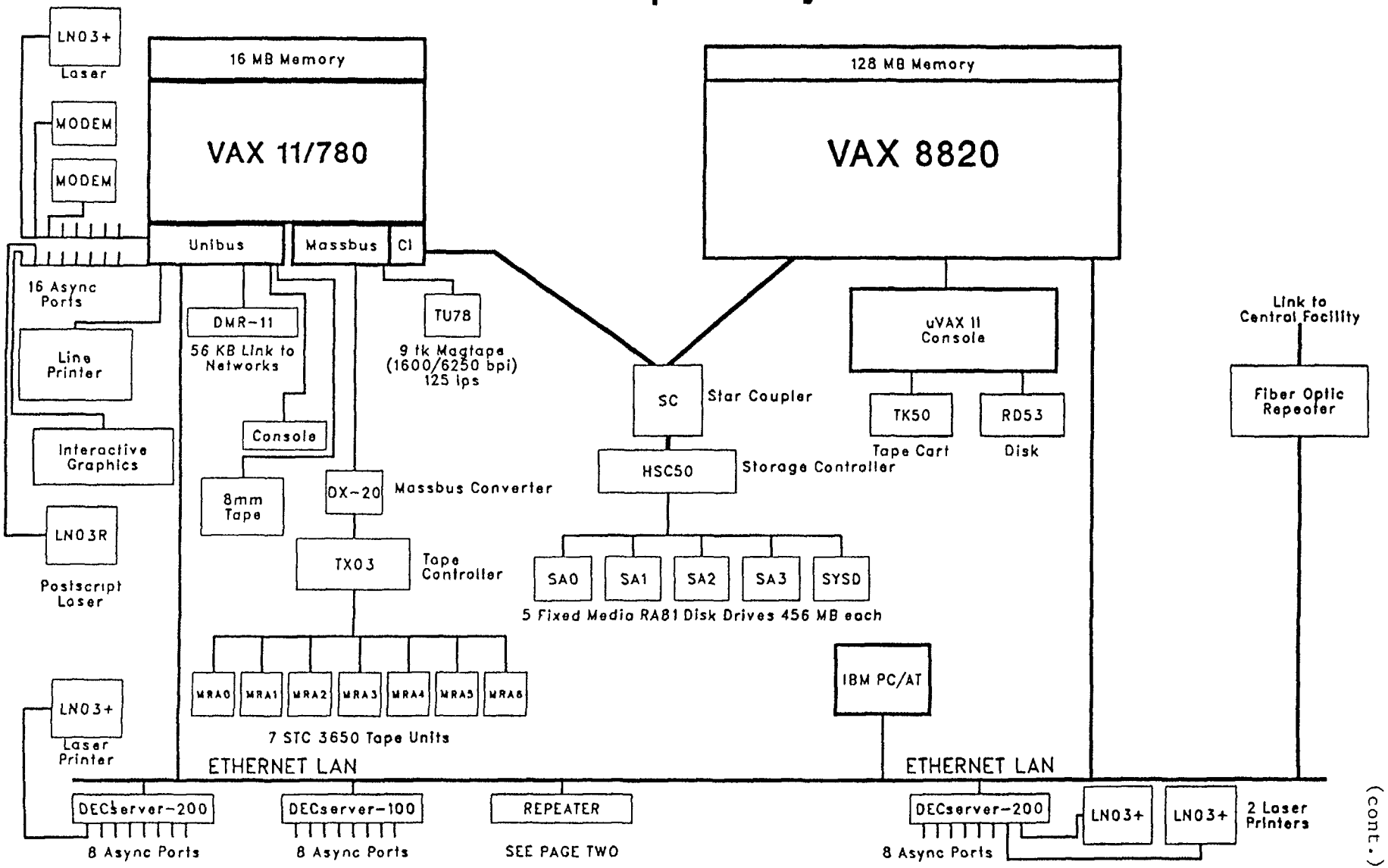
Publications

Fast Neutron Cross Section Newsletter, Issue #14 was published; issue #15 is in preparation.

A new edition of Nuclear Wallet Cards was issued in July, 1990.

The DOE compilation of requests for nuclear data will be done at Oak Ridge and published by NNDC.

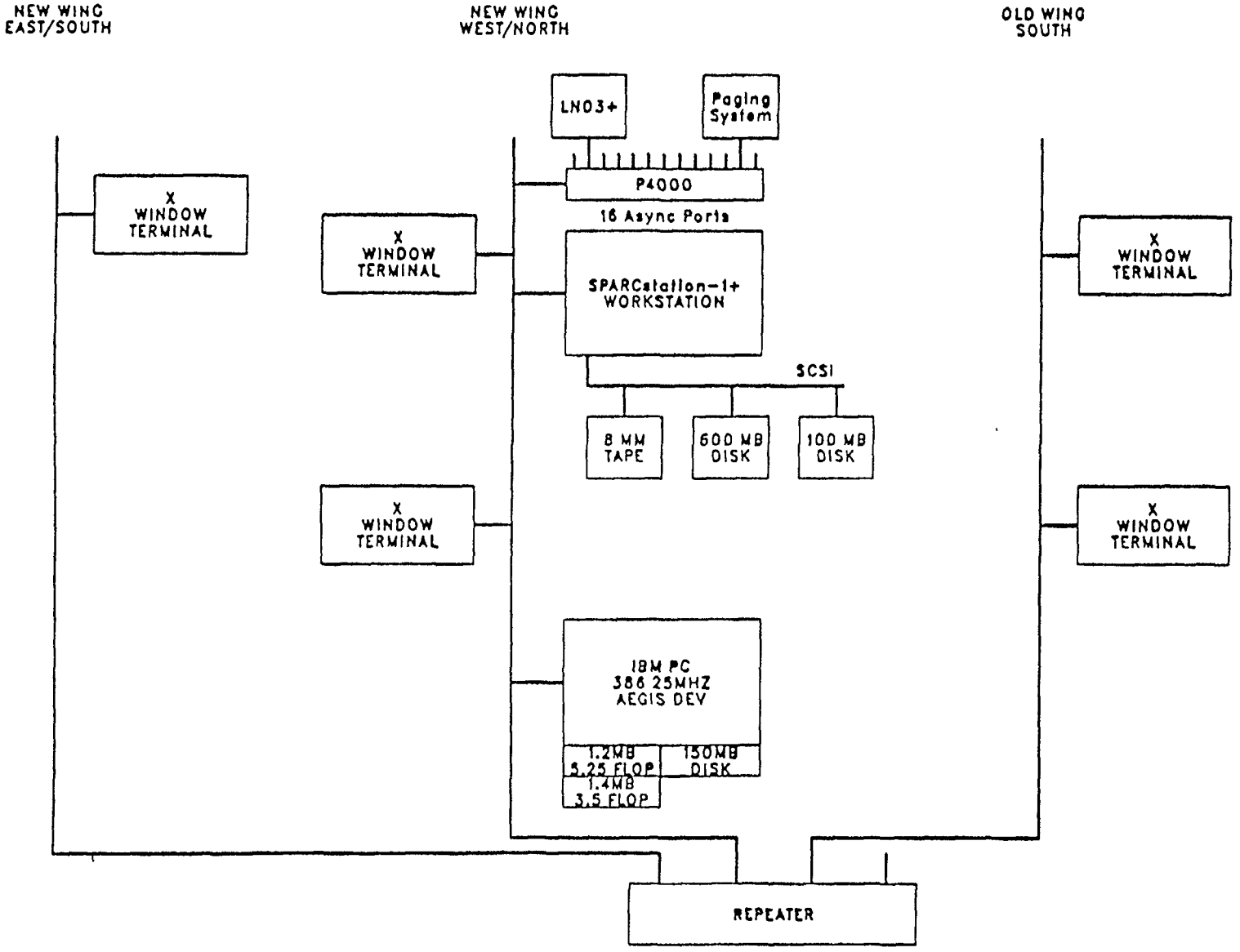
National Nuclear Data Center
Computer System



Annex 4.9
(cont.)

Brookhaven National Laboratory
Upton, N.Y. 11973
September, 1990

National Nuclear Data Center
Computer System



Brookhaven National Laboratory
Upton, N.Y. 11973
September, 1990

On-line Access Statistics												
Year	Runs	Retrievals*	NSR	ENSDF	NUDAT	CINDA	CSISRS	ENDF	MIRD	PLOT	PHYSCO	XRAY
1986	648	1621	814	142	536	129						
1987	1275	4263	2521	863	815	60						
1988	2264	8748	5022	1303	1492	285	459	187				
1989	3374	8406	3253	850	1841	522	1649	150	121	11	9	
1990	5436	12067	5613	1256	2204	187	1623	1019	53	39	65	8
991@	4575	8708	4079	809	2245	201	489	612	10	38	113	112

@ January to June 24

The number of pieces of information in each retrieval depends on the complexity of the retrieval

Annex 4.9
(cont.)

IAEA Nuclear Data Section

Progress Report

Staff

NDS lost long-term experienced staff: Alex Lorenz, who was the Deputy Head of the Section and was responsible for nuclear structure data; Monica Seits, who was the author of many computer codes for Cinda, Exfor and other systems; and Koichi Okamoto, author of the NDS handbook on Nuclear Activation Data and scientific secretary of many meetings in a variety of topics.

New staff recruited instead are Doug Muir from USA, as Deputy Head of the Section and head of the computer unit; S. Ganesan from India as a nuclear data expert for reactor calculations; and Ramon Arcilla from the Philippines as a programmer.

The EXFOR compiler Vicente Osorio changed to the Physics Section. After some vacancy of this post he will be replaced by Harm Wienke, who will join the Section in November 1991.

A professional post which had been vacant for some time, was finally lost.

There is significant staff shortage now, primarily for programming, but also in some other areas. There were delays in the answering of requests, in the processing of incoming data libraries or codes, and in the preparation of reports and documents.

CINDA

After the publication of the big Archival Issue of CINDA, the photo-typesetting machine was removed. The book production programmes had to be revised for a new laser printer. Due to temporary vacancy of the programmers post, this re-programming could be done only such that the 1991 issue of CINDA got published with a delay of half a year. The book is now in print and will be distributed in November 1991.

EXFOR

The EXFOR coverage for area 3 was quite complete until early 1991, and a good amount of backlog could be compiled. Due to the vacancy of the EXFOR compiler's post, nothing has been compiled in the past six months, and no TRANS tapes were sent out in this period.

V. Osorio produced a PC code for EXFOR compilation called ANDEX, which will now be used in the Section. It is documented in IAEA-NDS-101.

The EXFOR system remained fairly stable. Changes and additions to Manual and Dictionaries were mainly required for Photonuclear Data.

We have a backlog in EXFOR programming. In particular, the EXFOR check program was not updated with the conclusions reached at the past NRDC Meetings. Consequently, the check program now produces a lot of wrong error messages. We were not able to send an updated check program to the other centers who had requested that.

Evaluated Data

The reporting period was characterized by a particularly large amount of new evaluated data files. Significant efforts were required to make these files available to customers. Several documents in the IAEA-NDS-series were produced, including IAEA-NDS-107 giving a joint index to these libraries.

It is still an important task for the customers services to work out the differences and possible discrepancies between these libraries, and to advise customers which data may be best for a given application.

NDS produced the following libraries:

- "IRDF-90" (dosimetry) documented in IAEA-NDS-141;
- a tape with selected data for geophysics applications "INGDB-90" documented in IAEA-NDS-127;
- FENDL (fusion applications); this is still being worked on;
- activation libraries, mainly also for fusion applications:
  "ACTV-FUS/ECN" (from Petten) documented in IAEA-NDS-126;
  "ACTV-FUS/INT" documented in IAEA-NDS-148

Publications

The routine publications continued including

- INDC reports
- Nuclear Data Newsletter
- IAEA-NDS-documents
- CINDA

Special publications were

- Nuclear Data for Safeguards (preliminary issue, being distributed in October 1991)
- various meeting proceedings
- translations of Russian reports

Computer

The main event will be the transition from the IBM mainframe to a VAX computer. The consequences will be discussed during this meeting.

Request statistics

The request statistics for 1989-1991 is attached. Whereas the total number of requests decreased slightly, there was a strong increase in the requests for evaluated data. In 1991 424 diskettes and 446 tapes were sent out.

Meetings

The NDS meeting calendar for 1991 to 1994 is attached, partly tentative.

NDS Request Statistics

1989

Area Frequency	Biblio Data	Codes	Doc's	E	Eval Data	Expt Data	Total
U	0	0	0	0	0	0	0
1	1	4	65	0	4	0	74
2	2	11	159	0	17	9	198
3	6	42	330	0	62	18	458
4	1	5	15	0	17	5	43
Total	10	62	569	0	100	32	773

1990

Area Frequency	Biblio Data	Codes	Doc's	E	Eval Data	Expt Data	Total
U	0	0	1	0	0	0	1
1	0	0	36	0	7	0	43
2	1	0	96	0	22	7	126
3	5	25	359	1	149	24	563
4	0	3	19	1	15	1	39
Total	6	28	511	2	193	32	772

1991

Area Frequency	Biblio Data	Codes	Doc's	E	Eval Data	Expt Data	Total
B	0	0	0	0	0	0	0
U	0	0	0	0	1	0	1
1	0	1	29	0	12	0	42
2	0	0	83	0	34	3	120
3	0	15	270	0	166	19	470
4	0	0	25	0	26	4	55
Total	0	16	407	0	239	26	688

NUCLEAR AND ATOMIC DATA MEETINGS FOR 1991

PROJECT	TASK	TYPE	DATE	LOCATION	TITLE	NDS STAFF	CODE	COST
G104	1	RCM	8 Jan-11 Jan, 1991	Brussels, Belgium	Nuclear Data Needed for Neutron Therapy (3rd RCM)	Kocherov	F4-RC-365.3	20800
G104	2	RCM	14 Jan-17 Jan, 1991	Brussels, Belgium	Atomic and Molecular Data for Radiotherapy (2nd RCM)	Kocherov	F4-RC-405.2	31900
G103	11	RCM	15 May-17 May, 1991	Vienna, Austria	A+M Data for Plasma-Interaction-Induced Erosion of Fusion Reactor Materials (1st RCM)	Janev	F4-RC-470	22400
G103	16	CM	3 Jun-5 Jun, 1991	Vienna, Austria	He-beam Data Base for Alpha Particle Diagnostics of Fusion Plasmas	Janev		7000
G101	18	ITC	3 Jun-22 Jun, 1991	Leningrad, USSR	Interregional Training Course on Targets and Samples for Nuclear Applications	Kocherov / Wang		0
G103	10	CM	10 Jun-12 Jun, 1991	Vienna, Austria	Atomic Data Base for Be and B	Janev		7000
G102	4	RCM	17 Jun-19 Jun, 1991	Vienna, Austria	Compilation and Evaluation of Fission Yield Nuclear Data (1st RCM)	Lammer	F4-RC-475	15000
G101	13	AGM	23 Sep-24 Sep, 1991	Vienna, Austria	10th Meeting of the A+M Data Centres and ALADDIN Network	Janev / Smith	F4-AG-781	12000
G104	10	CM	23 Sep-25 Sep, 1991	Vienna, Austria	Nuclear Data Needs for Tight-lattice Fission Reactors	Ganesan		7000
G103	12	AGM	25 Sep-27 Sep, 1991	Vienna, Austria	A+M Data for Fusion Plasma Impurities	Janev	F4-AG-717.2	12000
G101	11	CM	7 Oct-11 Oct, 1991	Moscow/Obninsk USSR	11th Nuclear Reaction Data Centers Meeting	Lemmel		7000
G103	5	RCM	11 Nov-12 Nov, 1991	Vienna, Austria	Activation Cross Sections for the Generation of Long-lived Radionuclides (1st RCM)	Wang	F4-RC-469	10900
G103	4	CM	13 Nov-15 Nov, 1991	Vienna, Austria	Methods of Calculation of Fast Neutron Nuclear Data for Structural Materials (replacing 4th RCM)	Muir		7000
G103	2	AGM	18 Nov-22 Nov, 1991	Vienna, Austria	FENDL-2 and Associated Benchmark Calculations	Muir / Pashchenko	F4-AG-758	12000
G102	9	AGM	2 Dec-6 Dec, 1991	Vienna, Austria	Nuclear Data Requirements for Fission Reactor Decommissioning	Kocherov	F4-AG-782	12000
G101	20	RW	to be decided	Algeria (or Sudan or Morocco)	African Regional Workshop of XRF Laboratory Network	Wang		

Annex 4.10 (cont.)

PROJECT	TASK	TYPE	DATE	LOCATION	TITLE	NDS STAFF	CODE	COST
			1992					
G101	14	NDW	10 Feb-13 Mar, 1992	ICTP Trieste, Italy	Workshop on Computation and Analysis of Nuclear Data Relevant to Nuclear Energy and Safety	Schmidt / Muir	-	0
G103	6	RCM	31 Mar-2 Apr, 1992	Chiang Mai, Thailand	Measurement and Analysis of 14 MeV Neutron-Induced Double-Differential Neutron Emission Cross Sections Needed for Fission and Fusion Reactor Technology (3rd RCM)	Wang	F4-RC-376.3	12750
G102	8	RCM	May 1992	Vienna, Austria	*) A+M Data for Plasma-Interaction-Induced Erosion of Fusion Reactor Materials (2nd RCM)	Janev	F4-RC-470.2	25400
G101	13	AGM	15 Jun-16 Jun, 1992	Vienna, Austria	11th Meeting of the A+M Data Centers and ALADDIN Network	Janev	F4-AG-757.2	20000
G101	17	IIC	15 Jun-10 July, 1992	Obninsk, CIS	Interregional Training Course on Nuclear Data and Measurement Techniques in Nuclear Reactor and Personal Neutron Dosimetry	Pashchenko	-	0
G102	8	RCM	17 Jun-19 Jun, 1992	Vienna, Austria	Atomic and Molecular Data for Plasma Edge Studies (2nd RCM)	Janev	F4-RC-443.2	24000
G101	11	CM	1 Sep-3 Sep, 1992	Vienna, Austria	Technical Aspects of the Nuclear Reaction Data Centre Co-operation	Lemmel		10000
G102	9	AGM	7 Sep-11 Sep, 1992	Vienna, Austria	Nuclear Data Requirements for Fission Reactor Decommissioning	Kocherov	F4-AG-782	20000
G101	12	AGM	21 Sep-25 Sep, 1992	Tashkent, CIS	Meeting of the NSDD Evaluators' Network	Lemmel	F4-AG-791	20000
				or Geel, Belgium				0
G103	3	CM	7 Oct-9 Oct, 1992	Brookhaven, USA	Charged Particle and Photonuclear Cross Section Data for Fusion	Pashchenko	-	0
G103	13	TCM	12 Oct-16 Oct, 1992	Cadarache, France	A+M and PMI Data for Fusion Reactor Technology	Janev	F4-TC-799	15000
G101	16	TCM	16 Oct-17 Oct, 1992	Cadarache, France	7th Meeting of the IFRC Sub-committee on A+M Data for Fusion	Janev	F4-TC-436.44	0
G101	15	TCM	October/November 1992	Vienna, Austria	19th Meeting of the International Nuclear Data Committee	Schmidt successor	F4-TC-440.38	15000
G103	2	CM	November 1992 (3 days)	Vienna, Austria	*) Integral Benchmark Testing of FENDL-1	Pashchenko / Ganesan	-	10000
G103	15	RCM	November 1992 (3 days)	Debrecen, Hungary	*) Improvement of Neutron-induced He Production Cross Sections (1st RCM)	Pashchenko	F4-RC-498	27050
G103	-	CM	to be decided	Vienna, Austria	Material Property Data or He Removal from Divertors	Janev	-	10000

NUCLEAR AND ATOMIC DATA MEETINGS FOR 1993

Project	Task	Type	Date	Location	Title	NDS staff	Code	$ Cost
G.1.04	2	RCM	Jan./Feb. 1993	Vienna, Austria	Atomic and Molecular Data for Radiotherapy (3rd RCM)	Kocherov	F4-RC-405.3	44 950
G.1.03	4	RCM	Spring 1993 (2 days)	San Diego, USA (in conjunction with US Fusion Nuclear Data Meeting)	Activation cross sections for the generation of long-lived radio-nuclides (2nd RCM)	Pashchenko/ Wang	F4.10.08	20 000
G.1.02	4	RCM	Spring 1993	Vienna, Austria	Compilation and evaluation of fission yield nuclear data (2nd RCM)	Lammer	F4.20.03	17 500
G.1.03	12	SM	Jun 1993	Vienna, Austria	Plasma surface interaction processes for tritium inventory computation	Janev	-	-
G.1.01	7	CM	Fall 1993	Vienna, Austria (adjacent to 20th INDC Meeting)	Standard input data sets for nuclear model computations of nuclear data	Muir's successor	-	10 000
G.1.02	1	AGM	Before 20th INDC Meeting	Vienna, Austria	Nuclear data requirements for advanced thermal and fast reactors	Schmidt's successor	-	20 000
G.1.01	18	TCM	Fall 1993	To be decided by INDC at 19th INDC Meeting	20th Meeting of the International Nuclear Data Committee	Schmidt's successor		15 000
G.1.04	6	SM	Sep. 1993	JAERI, Japan	Comparison of activation cross section measurements and experimental techniques	Pashchenko	-	-

Annex 4.10 (cont.)

Nuclear and Atomic Data Meetings for 1993 - continued

Project	Task	Type	Date	Location	Title	NDS staff	Code	$ Cost
G.1.03	1	AGM	Sep. 1993	JAERI, Japan	Review of uncertainty files and improved multigroup cross section files for FENDL-2	Ganesan/ Pashchenko	-	20 000
G.1.01	16	AGM	Sep. 1993		12th meeting of the A+M data centres and ALADDIN network	Janev		20 000
G.1.01	14	AGM	Oct. 1993	Brookhaven, USA	13th nuclear reaction data centre meeting	Lemmel		20 000
G.1.04	2	RCM	To be co-ordinated with Incineration AGM	To be co-ordinated with Incineration AGM	Neutron fission and capture cross sections of minor actinide isotopes (1st RCM)	Ganesan	-	18 000
G.1.04	3	RCM	To be co-ordinated with Incineration AGM	To be co-ordinated with Incineration AGM	Nuclear data for neutron emission in actinide fission (1st RCM)	Ganesan	-	18 000
G.1.04	1	AGM	to be co-ordinated with NENF & NENP	to be co-ordinated with NENF & NENP	Nuclear data for design, operation and safety aspects of nuclear waste incineration facilities	Ganesan	-	20 000
G.1.03	9	RCM			Atomic data for medium- and high-Z impurities in fusion plasmas (3rd RCM)	Janev	F4.30.05	20 000
G.1.03	7	RCM			Plasma-interaction induced erosion of fusion reactor materials (3rd RCM)	Janev	F4.30.04	20 000

NUCLEAR AND ATOMIC DATA MEETINGS FOR 1994

Project	Task	Type	Date	Location	Title	NDS staff	Code	$ Cost
G.1.01	17	NDW	Feb./Mar. 1994	ICTP Trieste, Italy	Workshop on nuclear data processing and reactor physics calculations for applications in nuclear technology	Schmidt's successor/ Ganesan	-	-
G.1.02	3	CM	Mar. 1994	Vienna, Austria	Nuclear data for the estimation of potential radiation hazards connected with reactor decommissioning	Kocherov	-	10 000
G.1.03	6	RCM	May 1994	Bratislava, CSFR	Measurement, calculation and evaluation of photon production cross sections	Kocherov	-	14 000
G.1.02	4	RCM	Fall 1994	Vienna, Austria	Compilation and evaluation of fission yield nuclear data (3rd RCM)	Lammer	F4.20.03	17 500
G.1.01	15	AGM	Fall 1994		Meeting of the NSDD evaluator's network	Lemmel	-	20 000
G.1.03	5	RCM	Sep. 1994 (3 days)	Vienna, Austria	Improvement of neutron-induced He production cross sections (2nd RCM)	Pashchenko	F4.10.10	24 000
G.1.03	2	AGM	Sep. 1994 (5 days)	Vienna, Austria	Benchmark and sensitivity studies for FENDL-2	Pashchenko/ Ganesan	-	20 000
G.1.03	3	CM	Sep. 1994 (2 days)	Arzamas, CIS or Livermore, USA	International library of charged particle fusion reaction cross sections	Pashchenko	-	10 000

Annex 4.10 (cont.)

Nuclear and Atomic Data Meetings for 1994 - continued

Project	Task	Type	Date	Location	Title	NDS staff	Code	$ Cost
G.1.04	6	RCM	Sep. 1994 (3 days)	Arzamas, CIS or Livermore, USA	International reference data library of nuclear activation cross sections (1st RCM)	Pashchenko	-	16 000
G.1.01	19	TCM	Sep. 1994	Vienna, Austria	8th Meeting of the IFRC Sub-committee on A+M Data for Fusion	Janev	-	-
G.1.01	16	AGM	Sep. 1994	Vienna, Austria	13th Meeting of the A+M data centres and ALADDIN network	Janev	-	20 000
G.1.01	14	CM	Oct. 1994	Vienna, Austria	Technical aspects of nuclear reaction data processing and exchange	Lemmel	-	10 000
G.1.01	21	ITC	Nov. 1994	Dresden, Germany	Interregional Training Course on nuclear data measurements and applied neutron physics research with neutron generators and associated radiation protection aspects	Kocherov	-	-
G.1.04	2	RCM		Vienna, Austria	Neutron fission and capture cross sections of minor actinide isotopes (2nd RCM)	Ganesan	-	18 000
G.1.04	3	RCM		Vienna, Austria	Nuclear data for neutron emission in actinide fission (2nd RCM)	Ganesan	-	18 000
G.1.02	7	CM		Vienna, Austria	Representation and processing of neutron cross sections in the unresolved resonance region	Ganesan	-	10 000
G.1.03	15	RCM			Radiative cooling rates of fusion plasma impurities (1st RCM)	Janev	-	14 000

Nuclear and Atomic Data Meetings for 1994 - continued

Project	Task	Type	Date	Location	Title	NDS staff	Code	$ Cost
G.1.03	8	RCM			Reference data for thermal response of fusion-plasma facing materials exposed to high heat and particle fluxes (3rd RCM)	Janev	-	18 000
G.1.04	5	CM			Standard reference data library of radioactive decay half lives	Lemmel	-	10 000

Annex 4.10
(cont.)

Annex 5

Seminar on Intermediate Energy Nuclear Data

held during the 11th IAEA Consultants' Meeting
of the Nuclear Reaction Data Centers
Obninsk, 9 October 1991

1. Shubin, FEI Obninsk
   Summary of theory and calculations in the field of Intermediate Energy data at the FEI Obninsk.

2. A.V. Daniel, RI St. Petersburg
   Intermediate Energy Nuclear Data at the Radium Institute. See Annex 5.1.

3. S. Pearlstein, NNDC, Brookhaven
   Activities at the NNDC in the field of Intermediate Energy Nuclear Data.

4. V. Pronjaev, CJD Obninsk
   Nuclear structure effects by different reaction mechanisms in the cross-section and spectra in the intermediate energy range.

5. V.A. Vokolov, CAJaD Moscow
   Some problems of the cross-section evaluation for charged-particle monitor reactions.

INTERMEDIATE ENERGY NUCLEAR DATA AT THE RADIUM INSTITUTE

A. V. Daniel, V. Yu. Perov, V. A. Rubchenya
A. A. Rimski-Korsakov

V. G. Khlopin Radium Institute
St. Petersburg, USSR

(ABSTRACT)

The importance of intermediate energy nuclear data for contemporary technical applications is now widely accepted. The key issue in this field (from our point of view) is the correct Monte-Carlo calculation of space- and energy distributions of various particles in the target construction, irradiated by the primary beam. The "inclusive" and "exclusive" approaches are usually considered.

It has been shown [1] that in the "exclusive" approach using the nuclear models such as [2] and its modifications tends to underestimate the high-energy neutron yields. This situation will probably lead to revision of the models - but in this field we at the KRI do not plan at present any serious effort, since traditionaly we are using the "inclusive" method.

Different approaches to approximation problem

The "inclusive" approach is based on solving a system of integral equations for radiation transport, where the integral operater A can be presented as a superposition of transport operator T and interaction operator K. The kernel of the latter includes a function describing double-differential spectra of secondary particles in the particle-nucleus interaction. This function (for practical purposes) can be an approximation of the existing experimental or calculated data. The whole success of the "inclusive" method depends on the accuracy of the approximation used.

We have analysed a number of known approximation systems - such as Hassgen's [3], Sychov's [4], Pearlstein's [5,6] and Nakahara's [7] - to find that (naturally) they are not universally applicable and in some cases even contradict one another. For instance, Fig. 1 shows that the mean kinetic energy carried by outcoming protons in the wide primary energy range (from 50 to 1000 MeV) coincides nicely in Hassgen's [3] and Sychov's [4] approximation. The same quantity for neutrons in their approximations differs significantly (see Fig. 2). The mean kinetic energies, carried by secondary protons and neutrons (and their multiplicities), calculated by Pearlstein's methods [5,6] exceed systematically the values, calculated by methods [3] and [4]. More than that, in our evaluation by the [5,6] method the total kinetic energy of secondary particles for lead target nucleus may exceed the energy of the primary proton. This can be caused by independent way of approximating the proton and neutron spectra. On the other hand, Pearlstein's approximation gives the best aggreement with neutron spectra [1] for thin lead target bombarded by 590 MeV protons (see Fig. 3), which should not be surprising, since this approximation was probably based on this experiment. The Tsukada-Nakahara's approximation [7] overestimates the neutron yields compared to experiment [1], while Hassgen's [3] and

Sychov's [4] methods underestimate the same , especially for large angle values.

This comparison of approximation methods [3,4,5,6,7] has lead us to conclusion, that the existing systems for approximate description of double-differential particle spectra should be revised, and probably some better new approximation system should be developed. In this case, such future approximation systems must comply to a certain set of principles :

- first, the complete information on experimental and calculational data to build such system is needed ;
- second, the system must permit a relatively simple parameter correction procedure, and should permit further fitting of some independent parameters to correct the curves when new, more accurate data become avaliable ;
- third, the system must not contain internal contradictions, that is it must comply to some definite integral rules.

The first two principles are valid in Pearlstein's [5,6] and Tsukada-Nakahara [7] systems. The last principle holds best in the Sychov's [4] case, which unfortunately practically does not comply to the second principle. This second principle will be (probably) suited best in case of a system using a wide choice of parameters fitted to separate nuclei and incident particles, and also using one group of parameters for limited incident energy intervals. To build such approximation system one will need extensive data on double-differential particle spectra, and that means accumulation, evaluation and exchange of a large volume of data.

Another systematics is being developed at KRI for fission product yields for fission, induced by various means. The fractional independent yield after the emission of prompt fission neutrons is approximated by :

$$Y_j(A,Z) = \sum_n Y_i(A+n) * P_i(A+n,Z) * W(n,A+n,Z)$$

where : $Y_i(A+n)$ is the mass distribution before prompt neutrons,
$P_i(A+n,Z)$ is the isobaric chain distribution before prompt neutron emission,
$W(n,A+n,Z)$ is probability of emission of n neutrons from fragment (A,Z).

The primary mass distribution Y (A+n) was approximated by seven Gaussians, related to shell structure influence. The parameters of charge distribution P (A,Z) and multiplicity distribution W(n,A+n,Z) dependence on E,A,Z of compound nucleus and on A and Z of target nucleus is taken into account. The parameters of Y (A+N) distribution were found from experimental data for spontaneous fission and thermal neutron induced fission.

Medium energy library - plans and status

The structure of medium energy data bank, that we hope to compile and use, has been planned. It involves four data levels which differ in data character and also in the software support.

The first level relates to thin target experimental data and perhaps calculations based on various nuclear models. The international exchange on such experimental data is done in EXFOR format. Special re-formatting software will be necessary to con-

vert this data to database form for evaluations.

The second level will store evaluated nuclear data in the ENDF/B-VI format.

The third level is for systematics parameters, fitted to the evaluated data of the second level.

The fourth level is for benchmark experimental data from measurements with large target assemblies, that will be necessary for verification of integral modelling of medium energy radiation transport, and for correction of the whole process.

At present we have partly implemented the structure and software support of this project, namely :

- with the help of IAEA NDS we started to use the EXFOR coding of experimental data - and the ANDEX package for PC, that was brought here by V.Osorio is now used extensively.
- we developed a supporting package to extract the EXFOR-coded data into our mainframe EC-1045 computer in database format.
- the 1989 ENDF Pre-processing Codes IAEA-NDS-39 [9] are now used on our mainframe for ENDF library data work, and our internal neutron data library HECSF [10] has been composed for some calculations.
- as a main instrument for parameter evaluation we implemented the CERN package MINUIT [11], and now have started work on the particle spectra with integral restricting rules.
- the analysis of large target experiments is done by our "inclusive" model package SITHA [12,13], which takes into cosideration protons, neutrons and charged pions in the energy range from 20 MeV to 10 GeV, and only neutrons below 20 Mev. In the latter case we use an original multigroup cross-section library named GR175-V1 [13].

We hope to continue this project with the help of the established Nuclear Data Centers both in the USSR and abroad, and we are grateful for their constant support and understanding.

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12. A.V.Daniel Preprint RI-181, M., 1984
13. A.V.Daniel Preprint JINR P3-91-320, Dubna, 1991

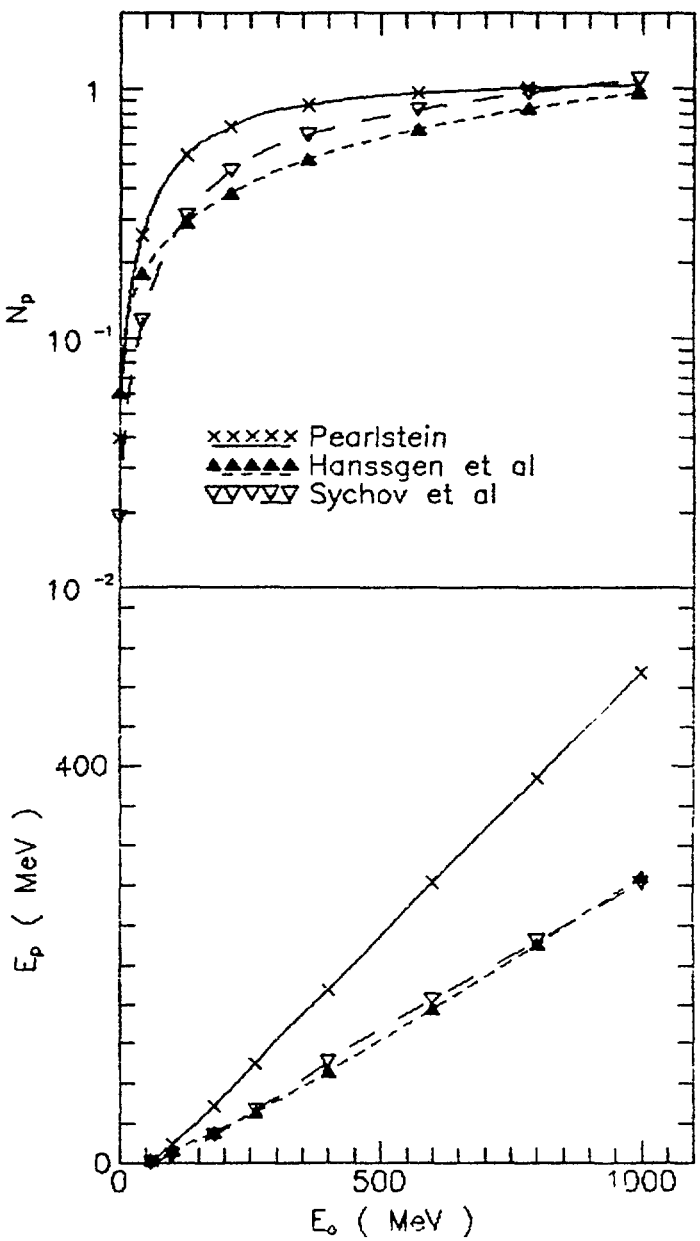

Fig.1 Numbers of emitted protons and mean kinetic energies taken away by protons in reaction Pb(p,p)X when E_p>50 MeV.

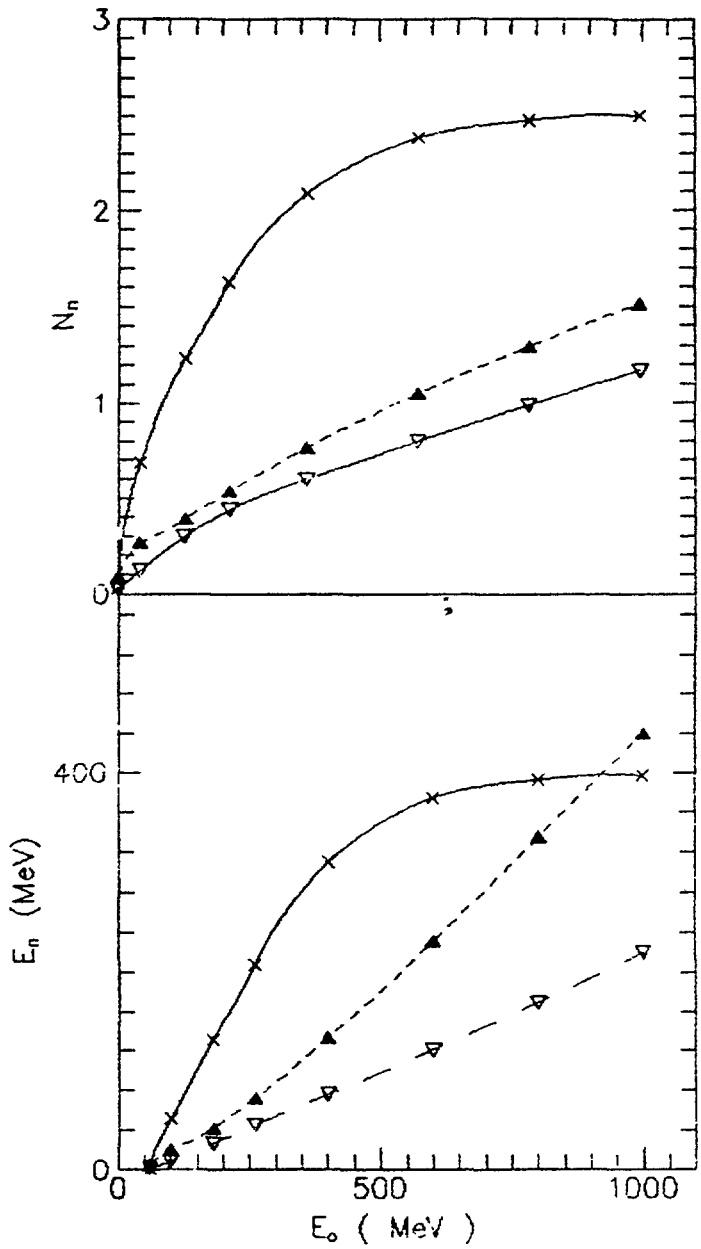

Fig.2 Numbers of emitted neutrons and mean kinetic energies taken away by neutrons in reaction Pb(p,n)X when E_n > 50 MeV. Designations are the same as in Fig.1.

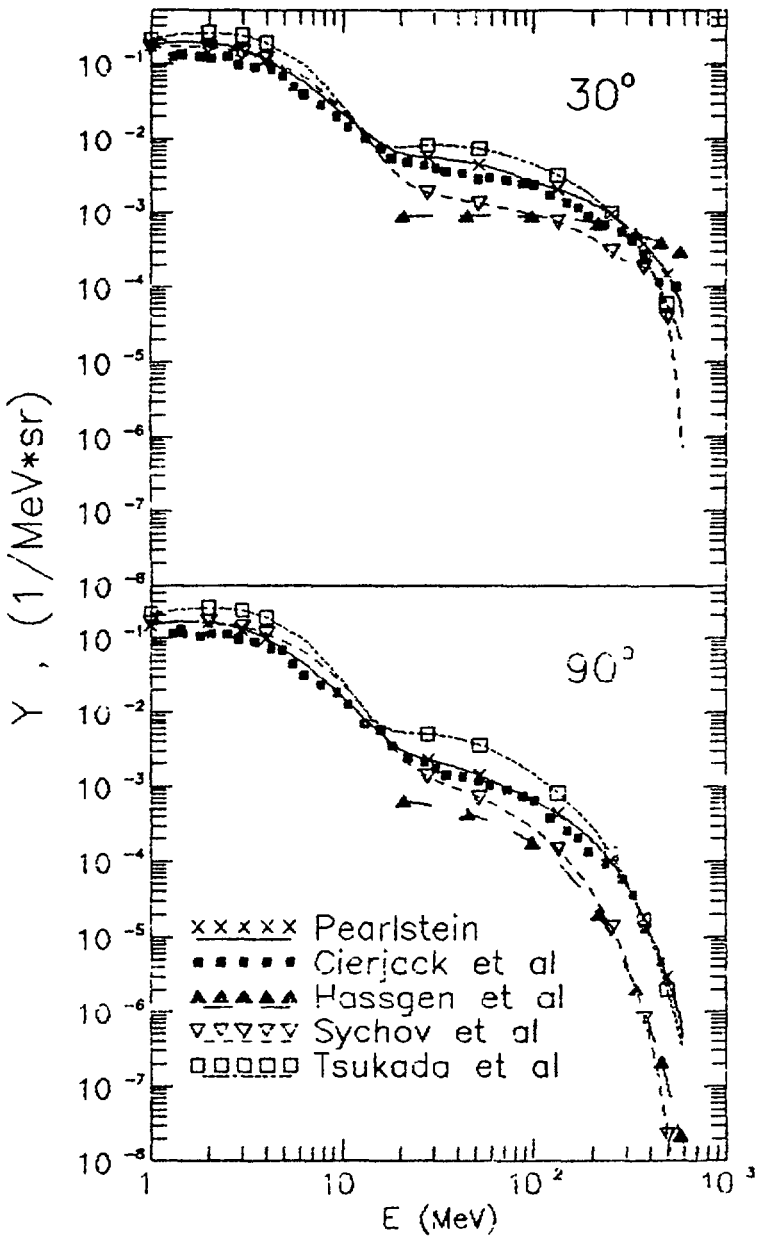

Fig.3 Double differential spectra of neutron emitted through reaction Pb(p,n)X, E_p=600 MeV.

Annex 6

Minutes of the INDC Subcommittee on Data Center Support
Reproduction from Appendix 12 of the INDC Meeting Minutes 1990

Members:	O. Bersillon	France	B.D. Kuzminov	USSR
	M.V. Blinov	USSR	H.D. Lemmel	IAEA/NDS
	M.S. Coates	UK	Liu Tingjin	PR China
	F. Fröhner	Germany (Chairman)	Y. Nakajima	Japan
	R.C. Haight	USA	R.W. Peelle	USA
	S.S. Kapoor	India	J.J. Schmidt	IAEA/NDS

Immediate Goals

The SC was convened ad hoc to address the problem described by Lemmel in INDC/P(90)-26 as follows: "Due to continuing budget reductions the staff situation at the co-operating nuclear data centers has now reached a stage that the international data bases CINDA/EXFOR, CPND-EXFOR, NSR/ENSDF, are gradually deteriorating. In future, data users will no longer receive complete and updated information out of these data bases".

It was discussed what actions could be taken to

- avoid further reduction of manpower in nuclear data centers;
- resume recently interrupted data center activities (Germany, US, UK, others);
- to start additional data activities in important areas (CPND, medium-E data, A chain evaluation).

and to address, in particular, the immediate main problems,

- lack of staff at NNDC for CINDA and EXFOR;
- CPND compilation and evaluation;
- need for additional A chain evaluators.

The SC expressed great concern, in view of the implications of a deficient nuclear data base for nuclear activities of world-wide and growing urgency, viz.

- reactor safety,
- nuclear waste management,
- reactor decommissioning,
- fusion research and development (NET, ITER).

The outcome of the discussion was that appeals via "diplomatic" and IAEA channels are not likely to be enough.

The actions agreed upon are listed in Appendix 3, Actions 55 to 60.

Appendix 3

ACTIONS ARISING FROM 18TH INDC MEETING

No	Session	Respondents	Action
55.	DC SC	NDS	Prepare by the end of October 1990 a concise "awareness document", with a clear warning what cannot be expected by nuclear data users any more if nothing is done, directed at decision makers who are not necessarily physicists, with a few pertinent charts and figures. This should be mailed to INDC members.
56.	DC SC	INDC members	Use of the "awareness document" in home countries to enhance awareness among affected groups (in universities, national labs, industry, others) and especially among policy makers.
57.	DC SC	INDC members	Explore potential useful addresses of letters to be written by IAEA (both DDG and NDS level), provide NDS with the addresses by end of 1990.
58.	DC SC	Head, NDS	See to it that these letters are sent out to the addressees proposed by the members.
59.	DC SC	INDC Chairman	Send letter to NEANDC and NEACRP chairmen to inform them and ask them to participate in a concerted effort.
60.	DC SC	NDS	Make sure that the data center emergency is brought to the attention of the participants of the 1991 Julich conference, e.g. in the papers on the data centers and on ENSDF.

ANNEX 7

Working papers on Exfor Trans tapes

Disturbing mistakes in Exfor TRANS tapes

O.Schwerer

This is a summary of more important mistakes in Exfor transmission tapes as found by NDS.

- Isomeric ratios should be given as implicit ratios -M/G, -M/T, etc., not as explicit cross section ratios
- Use of heading DATA-ERR where more specific headings are available (ERR-T, ERR-S etc.)
- E-format data not right-adjusted within field
- Incorrect use of PAR in REACTION SF 5 (e.g. with SPC in SF 6 or EL in SF 3)
- Confusion of units PER-CENT, NO-DIM and ARB-UNITS
- SPA missing in SF 8 for reactor spectrum
- redundant particle considered
- missing or inconsistent HISTORY entries
- REACTION code and units not consistent
- use of FLAG for distinguishing different reactions (instead of using different REACTION codes)
- missing incident particle energy
- particle codes in SF 3 must be given in increasing ZA order (except when SEQ is given in SF 5)

Pending EXFOR retransmissions

O.Schwerer

Please find attached a reminder as for which EXFOR entries are still pending for retransmission as requested by NNDC and NDS from NNDC, NEA-DB, NDS, CJD and CAJaD.

When mistakes are found in TRANS tapes, retransmission is requested for those cases where the correction to be done is not obvious. According to our records, requests for retransmission remained without response for the EXFOR entries listed. May we ask each center to review this list, update the listed entries and retransmit them.

TRANS	ACCESSION #	RE-TRANSMITTED
A017	A0229004	
A017	A0317004	
A017	A0329002	
A018	A0320002	
A019	A0178001	
A019	A0198001	
A019	A0202002	
A019	A0202003	
A019	A0202004	
A019	A0345003	
A019	A0345010	
A020	A0319023	
A020	A0319030	
A020	A0322005	
A020	A0347004	
A020	A0352004	
A020	A0363001	
A020	A0364001	
A020	A0365001	

TRANS	ACCESSION #	RE-TRANSMITTED
A021	A0366001	
A021	A0371001	
A021	A0387007	
A021	A0388001	
A021	A0393002	
A021	A0393004	
A022	A0399001	
A024	A0294001	A025
A024	A0431002	A025
A024	A0431003	A025
A024	A0434002	A025
A024	A0434003	A025
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Annex 8

GLOSSARY OF ABBREVIATIONS

BNL	Brookhaven National Laboratory, Upton, N.Y., USA
BROND-2	Russian evaluated neutron reaction data library
CAJaD	Center for Nuclear Structure and Reaction Data, Kurchatov Institute, Moscow, Russia
CDFE	Centr Dannykh Fotojad. Eksp., Moscow State University, Russia
CENDL-2	Chinese evaluated neutron reaction data library
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, Russia
CNDC	Chinese Nuclear Data Center, Beijing, P.R. China
CP...	Numbering code for memos exchanged among the NRDC
CPND	Charged-particle nuclear reaction data
CRP	Coordinated Research Programme of the IAEA Nuclear Data Section
CSEWG	US Cross-Section Evaluation Working Group
CSISRS	Cross-Section Information Storage and Retrieval System, the EXFOR-compatible internal system of NNDC
EFF	European evaluated nuclear data file for fusion applications
ENDF-6	International format for evaluated data exchange, version 6
ENDF/B-6	US Evaluated Nuclear Data File, version 6
ENSDF	Evaluated Nuclear Structure Data File
EXFOR	Format for the international exchange of nuclear reaction data
FEI	Fiziko-Energeticheskij Institut, Obninsk, Russia
FENDL	Evaluated nuclear data file for fusion applications, developed by IAEA-NDS
IAEA	International Atomic Energy Agency
IFRC	Intenational Fusion Research Council
INDC	International Nuclear Data Committee
INIS	International Nuclear Information System, a bibliographic system
IRDF	The International Reactor Dosimetry File, maintained by the IAEA-NDS
ITER	International Thermonuclear Experimental Reactor
JAERI	Japan Atomic Energy Research Institute
JEF	The Joint Evaluated File of neutron data, a collaboration of European NEA member countries and Japan

LEXFOR	Part of the EXFOR manual containing physics information for compilers
NDS	IAEA Nuclear Data Section, Vienna, Austria
NEA	Nuclear Energy Agency of the OECD, Paris, France
NEA-DB	NEA Data Bank, Saclay, France
NND	Neutron Nuclear Data
NNDC	National Nuclear Data Center, Brookhaven National Laboratory, USA
NNDEN	Neutron Nuclear Data Evaluation Newsletter
NRDC	the Nuclear Reaction Data Centers
NSDD	Nuclear structure and decay data
NSR	Nuclear structure references, a bibliographic system
OECD	Organization for Economic Cooperation and Development, Paris, France
PC	Personal Computer
PhND	Photonuclear data
RI	Radievyj Institut, Sankt Peterburg, Russia
RIKEN	Nuclear Data Group, RIKEN Inst. of Phys. and Chem. Res., Wako-Shi, Saitama, Japan
SG,SGIP	Study Group for Information Processing, Sapporo, Japan
TRANS	Name of transmission tapes for data exchange in the EXFOR system
WRENDA	World Request List for Nuclear Data
4C...	Numbering code of memos exchanged among the four Neutron Data Centers