International Atomic Energy Agency

INDC(NDS)-336
Distr.: L

INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

Report of the IAEA Nuclear Data Section

to the

International Nuclear Data Committee

for the period 1993/1994

Charles L. Dunford

July 1995

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

INDC(NDS)-336
Distr.: L

Report of the IAEA Nuclear Data Section

to the

International Nuclear Data Committee

for the period 1993/1994

Abstract: This progress report describes the activities of the IAEA Nuclear Data Section in the years 1993 and 1994, including staff and budget, the operation of the Nuclear Data Center, the computer operations, the coordination activities of the Nuclear Data Center Networks, the nuclear data improvements projects, Technical Cooperation and technology transfer, atomic and molecular data activities, and the meetings held in the reporting period.

Charles L. Dunford

July 1995

CONTENTS

GLOSSARY OF ABBREVIATIONS

A+M	Atomic and Molecular Data for fusion applications
AGM	Advisory Group Meeting of the IAEA
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 ("Computer Index on Neutron DAta")
CJD	USSR Nuclear Data Center at F.E.I., Obninsk, Russia
CM	Consultants' Meeting of the IAEA
CNDC	Chinese Nuclear Data Center, Beijing, China
CP...	Numbering code for memos exchanged among the NRDC
CPND	Charged-particle Nuclear Reaction Data
CRP	Coordinated Research Program of the IAEA (compare RCM)
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	Formats and procedures for the international exchange of nuclear reaction data ("EXchange FORmat")
FEI	Fiziko-Energeticheskij Institut, Obninsk, Russia
FENDL	Evaluated Nuclear Database for Fusion applications, developed by IAEA-NDS
FPND	Fission-product Nuclear Data
IAEA	International Atomic Energy Agency
ICTP	International Center for Theoretical Physics, Trieste, Italy
IFRC	International 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
JCPRG	Japan Charged-Particle Nuclear Reaction Data Group, Sapporo, Japan
JEF-2	The Joint Evaluated File of neutron data, a collaboration of European NEA member countries and Japan
JENDL-3	Japanese Evaluated Neutron Reaction Data Library
LEXFOR	Part of the EXFOR manual containing physics information for compilers
NDS	IAEA Nuclear Data Section, Vienna, Austria
NDS	Journal "Nuclear Data Sheets"
NEA	Nuclear Energy Agency of the OECD, Paris, France
NEA-DB	NEA Data Bank, Saclay, France
NEANDC	NEA Nuclear Data Committee, discontinued, see NSC
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
NSC	Nuclear Science Committee of NEA
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
RCM	Research Co-ordination Meeting (compare CRP)
RI	IAEA Department of Research and Isotopes
RI	Radievyj Institut, Sankt Petersburg, Russia
RIKEN	Nuclear Data Group, RIKEN Inst. of Phys. and Chem. Res., Wako-Shi, Saitama, Japan
RIPC	IAEA Division of Physical and Chemical Sciences, Dept. of Research and Isotopes
SG, SGIP	Study Group for Information Processing, Sapporo, Japan. Changed to JCPRG
SPM	Specialists' Meeting of the IAEA
TC	Technical Cooperation; also Training Course
TRANS	Name of transmission tapes for data exchange in the EXFOR system
WRENDA	World Request List for Nuclear Data Measurements
4C...	Numbering code of memos exchanged among the four Neutron Data Centers

I. NUCLEAR DATA SECTION STAFF AND BUDGET

The budget for the Nuclear Data Section for 1993 and 1994 was 2,344,000 and 2,487,000 dollars US respectively. Staff costs represent approximately 70% of this amount leaving 30% for programmatic activities.

The Atomic and Molecular Data activity amounts to approximately 25% of the total budget. The remaining 75% is devoted to Nuclear Data activities. At full strength, the the staff consists of 12.0 Professional (P-Staff), 5.5 Support (G-Staff) and 4.5 Secretarial (G-Staff). Of these, 3 Professionals and 1 Secretary are assigned to the Atomic and Molecular Data Unit.

From July 1993 until December 1994 the Section was operating at full strength with 22 staff members. The vacant Section Head position formerly held by J. J. Schmidt was filled by C. L. Dunford who arrived in July 1993.

The Deputy Section Head, P. Obložinský arrived in May 1993 replacing D. Muir. The post vacated by Wang Dahai was placed in the Atomic and Molecular Data Unit and filled by R. Langley. In December 1994, S. Ganesan left the section at the completion of 5 years.

The budget for 1995-1996 was reduced by 250,000 and 350,000 US dollars respectively before inflation. This has resulted in a permanent staff reduction of 3, 2 Professional and 1 Support, by the end of 1996, resulting in an authorized staff level of 19. The reduction also required the elimination or postponement of some tasks. The staff reduction will be accomplished by eliminating the posts vacated by the departure of S. Ganesan and the retirements of N. Kocherov and G. Mundy.

BUDGET AND STAFF SUMMARY 1993 -1996

	1993	**1994**	**1995**	**1996**
Authorized Staff Level	22	22	19.9	19
Actual Staff Level	20.7	21.9	*18.9**	*18.1**
Staff Expenses	1,658,000	1,712,000	1,652,000	1,638,000
Programmatic Expenses	686,000	775,000	660,000	662,000
Total Budget US$ *Constant real dollars*	**2,344,000** *2,344,000*	**2,487,000** *2,487,000*	**2,312,000** *2,623,785*	**2,300,000** *2,736,608*

* *Estimates*

In the 1995-1996 period, we anticipate considerable staff turnover in addition to the loss of posts caused by the budget reductions. The Section Head position will be vacated in 1995. In addition, one other staff member will leave the Agency in 1995. In 1996, H. Lemmel will retire. Also in 1996, three contracts will expire which are unlikely to be renewed. Thus we can expect as many as 4 unfilled positions for some period of time in 1996-1997.

One position from the A+M Unit will be transferred to the nuclear data activity to complete the staff and budget reduction for the 1995-1996 period.

II. DATA CENTER OPERATION

A. Data Compilation

Data compilation and services to customers continued. The number of requests received by mail has remained constant at approximately 800 requests per year. However, there has been a steep increase in the online access to the NDS databases.

Data compilation in CINDA and EXFOR continued on schedule. See the Table 1 for a list of countries versus neutron reaction data in EXFOR.

In the years 1993/1994 eleven EXFOR tapes were transmitted to the other centers containing

54	new entries
297	data tables (= subentries)
2688	data lines,

coming from China (31 entries), Poland (6), India (4), Argentina (3), Bulgaria (3), Hungary (3), Czechia (2), Brazil (1), Pakistan (1).

In addition, these EXFOR tapes included revisions of 178 earlier entries. Such revisions of entries result from additional publications on data that have already been compiled. They may also result from comments by the authors upon receipt of the EXFOR proof copy.

The handbooks CINDA93 and CINDA94 were published, though with some delays due to the required reprogramming for the migration from the IBM to the VAX Computer.

The acquisition and documentation of evaluated data files had two peaks in summer 1993 and in summer 1994, as can be seen in the two newsletters

Nuclear Data Newsletter No. 18, Nov. 1993
Nuclear Data Newsletter No. 19, Sept. 1994.

The total catalogue of available nuclear data libraries by H.D. Lemmel is contained in the document

IAEA-NDS-7 Rev. 94/11 (available libraries), and
IAEA-NDS-107 Rev. 9 (joint index to BROND, CENDL, ENDF/B, JEF, JENDL).

The online nuclear data service is now in full operation. A Users' Manual by C.L. Dunford and T.W. Burrows is available as

IAEA-NDS-150 Rev. 94/9

Table 1. EXFOR neutron reaction data of area 3 by country

Country	Data lines	Index lines	Subentries	Entries
Algeria	3	3	2	1
Argentina	3053	179	103	30
Australia	7327	1021	475	75
Bangla Desh	1573	93	90	19
Bolivia	1	1	1	1
Bulgaria	40	41	30	13
Brazil	4313	82	82	19
Chile	145	29	29	10
China, P.R.	6406	866	618	166
Colombia	1	2	1	1
Croatia	15	15	15	1
Czechoslovakia	862	121	100	29
Czech Republic	151	7	6	3
Egypt	3678	148	132	24
German Dem. Rep.	23144	418	410	47
Hungary	2687	922	643	109
India	2583	1506	988	177
Iran	2	3	2	2
Iraq	1672	31	31	11
Israel	266	216	59	24
Korea, Rep.	12	15	9	3
Malaysia	4	2	2	1
Mexico	143	22	21	4
Morocco	401	141	114	12
Myanmar (Burma)	2	2	2	1
New Zealand	25	6	6	2
Pakistan	1816	106	103	21
Poland	5127	655	559	95
Romania	1751	175	156	38
South Africa	7181	202	187	21
Saudi Arabia	22	18	18	2
Slovakia	51	4	4	1
Sudan	3	3	3	1
Taiwan	621	66	46	14
Thailand	45	33	33	2
Vietnam	20	20	20	4
Yugoslavia	3108	431	419	66

Note: If a publication contains cross-section measurements for 3 target nuclides, the data would be compiled in 1 "Entry" with 3 "Subentries". The measurement of partial cross-sections leading to ground and metastable state would be compiled in one "Subentry" with two "Index lines".

B. Requests Statistics

1. Shipment by mail

Table 2 gives the request statistics for the past decade, for the categories

bibliographic information
documents
experimental data
evaluated data
data processing codes.

For the purpose of the present statistics, any query for one of these categories defines a request. If an incoming letter asks e.g. for both experimental and evaluated data, it is counted as 2 requests. For example, the 831 requests received in 1994 correspond to 702 "incoming letters". On each request, one or more items may be sent out. For example, in Table 2 the notation 86/173 under Eval Data means that 173 evaluated data libraries have been sent out in response to 86 requests.

In the past decade the annual number fluctuated around

~ 700 incoming letters
with ~ 800 requests
resulting in ~ 1700 items sent out.

For the shipment of data files and codes several hundreds of magnetic tapes and PC diskettes are copied and sent each year, see Table 3.

In addition, about 80 tapes are shipped each year for the center-to-center data exchange.

The fluctuations in the statistics depend strongly on the release of new data libraries (e.g. ENDF/B-6 and JENDL-3 in 1990/1991) and on the distribution dates of the Nuclear Data Newsletter which announces the newly available data files and printed materials. The distribution of data files on PC diskettes becomes more and more popular because of the availability of new PC's with large hard disks.

Requestors from more than 80 countries have been served during the past 3 years. The list of countries is not much different from that given in the report 2 years ago, see INDC(NDS)-280 p. 28.

Whereas the conventional request statistics discussed so far is about constant, there was a strong increase in the online services during the past 3 years. It seems that this increased online service has not yet resulted in a significant decrease in the manpower-intensive shipment of magnetic tapes and diskettes.

Table 2. Data Request Statistics 1986 - 1994

	Biblio-graphic info	Docu-ments	Expt Data	Eval Data	Data processing codes	Total
1986	11/25	405/1430	46/56	86/173	40/91	588/1775
1987	21/48	725/2166	27/28	87/147	167/214	1027/2603
1988	5/19	681/1590	34/47	110/191	77/109	907/1956
1989	10/17	564/1418	32/38	96/222	61/94	763/1789
1990	2/3	424/1916	20/32	188/360	26/32	660/2343
1991	0/0	426/?	31/?	260/?	25/?	742/?
1992	0/0	507/?	27/?	237/?	142/?	913/?
1993	0/0	299/801	18/20	190/294	73/100	580/1215
1994	0/0	524/1567	17/23	226/293	64/92	831/1975

The notation, e.g. 86/173 under Eval Data, means that on 86 incoming requests 173 evaluated data libraries have been sent out. A question mark indicates that the detailed records have been corrupted.

Table 3. Shipment of Tapes and Diskettes by Year

Year	Magnetic tapes	PC diskettes
1990	214	(no records)
1991	457	(no records)
1992	143	(no records)
1993	125	367
1994	168	486

2. On-line nuclear data service NDIS

The usage of the online nuclear data service has increased strongly since it was started in 1992. At present, 176 active accounts are registered with 193 users from 38 countries. The number of retrievals made by the customers was

167	in 1992,
590	in 1993, and
3190	in 1994.

The list of countries is given in Table 4.

It should be noted that among the major users there are not only "neighbours" like Austria, Hungary, Czech Republic and Poland, but also remote countries like Australia, Korea, Brazil and USA.

It should also be noted that the increasing usage of the online services is in addition to the continuing services by conventional mail shipment.

NDIS, the online "Nuclear Data Information System" which is the topic of above statistics, offers interactive retrievals from the major systems such as CINDA, EXFOR, NUDAT and the ENDF formatted data libraries BROND, CENDL, ENDF/B, JEF and JENDL.

In addition, the "FTP Service" has been started during the past 2 years. This service does not permit selective retrievals but rather electronic transmission of entire data libraries or codes through INTERNET FTP ("file transfer protocol"). For this new service, which has been used heavily for the shipment of FENDL data files to the participants of the FENDL cooperation, a statistical control system has not yet been developed.

Table 4. Online Service Users by Country

Country	Active Accounts	Users ("Names")
Argentina	1	3
Australia	13	15
Austria	17	22
Brazil	8	9
Bulgaria	1	1
Canada	2	2
Chile	1	1
Croatia	4	4
Czech Republic	12	12
Finland	1	1
France	4	5
Germany	6	6
Hungary	18	19
India	1	1
Ireland	1	1
Israel	6	8
Italy	6	6
Korea, Rep.	7	7
Latvia	1	1
Mexico	1	1
Netherlands	3	3
New Zealand	1	1
Norway	1	1
Poland	16	17
Romania	3	4
Russia	9	9
Slovakia	4	4
Slovenia	1	1
South Africa	2	2
Spain	3	3
Sweden	1	1
Switzerland	2	2
Taiwan	1	1
Thailand	1	1
Turkey	1	1
United Kingdom	4	4
U.S.A.	17	18
Venezuela	2	2
38 countries	**176 active accounts**	**193 users**

III. COMPUTER OPERATIONS

In December 1991, a Digital Equipment Corporation VAX cluster was installed with the Nuclear Data Section envisioned as the primary user. The central computer in that cluster is a VAX 4000-200. In the spring of 1992, application software developed by the U.S. National Nuclear Data Center located at Brookhaven National Laboratory was installed for use by NDS staff. The intention was to move all NDS computer usage from the IAEA's central computer, an IBM mainframe, as quickly as possible. However due to lack of staff, essential hardware and software, and training in the use of the NNDC provided application software, little progress was made toward that goal by the time of the last INDC Meeting in March 1993.

In July 1993, a decision was taken to complete the migration of the Section's computing activity from the IBM mainframe to the VAX by the end of 1994. In particular, the maintenance of the CINDA, EXFOR and evaluated data files has been completely performed on VAX since the Fall of 1994. Electronic access to all data bases over the INTERNET is fully operational.

Request services including tape generation have also been transferred. On the whole the migration objective has been successfully met with only a few tasks remaining to be completed before July 1995.

A. Hardware and System Software Tasks

The following hardware and system software related actions have been completed:

- All Staff have been supplied with terminals in their offices which connect directly to the VAX 4000 computer. Seven staff members whose work is most computer intensive have X-window terminals.

- The memory installed on the VAX 4000 has been doubled to the maximum possible, 64 Megabytes.

- The DEC D5100 front end (Unix Operating system) whose only purpose was to provide a gateway to external electronic networks was removed. Errors in the gateway software prevented it from completely fulfilling its function. MULTINET networking software was purchased for the VAX 4000 thereby providing full INTERNET access for NDS staff and for users of our online data service.

- Approximately 15 hours of training was supplied to all staff members who would be working on the VAX computer.

- A 4-mm digital-audio tape drive was installed to provide disk backup capability and for exchange of large amounts of data between data centres and in some cases with customers.

- Three CD-ROM drives were installed in order to provide access to VAX online documentation for users having X-window terminals.

- Two HP Laser Jet IV laser printers with 600 dpi resolution were added to provide high quality printed and graphic output.

- Recently, the DEC supplied system and layered-product upgrades have been installed removing a three year backlog.

- From January of this year, the a faster link between the IAEA and the global INTERNET electronic network has been in operation so that transfer of large amounts of data in this manner is practical.

B. Application Software Improvements

The following work has been completed or is nearly complete relative to improvement of the application software required to maintain, improve and distribute nuclear information.

- Software to produce the CINDA publication from the VAX data base has been completed and tested except for two tables in the book's appendix.

- A convenient video interface has been developed for updating the CINDA data base.

- The BNL325 computer program used by NNDC to produce the last "Barn Book" has been made operational using a readily available graphics software package. Improvements were incorporated at the same time.

- The NNDC address list and document distribution data base system has been implemented with numerous improvements to meet NDS requirements. Included is a comprehensive update program with a video interface.

- EXFOR dictionary system improvements agreed at the 1994 Data Centre Meeting were made with the help of a consultant from NNDC.

- Development of a VAX-based replacement for the Information Request Logging system written specifically for the IBM has been completed. It is now being tested prior to migrating that activity to the VAX.

- The online data service software is continuously being improved in cooperation with NNDC.

C. *Inter-centre Cooperation*

The major impetus for having similar computing facilities at each of the four core data centres was to be able to share software and expertise. In 1994 the CJD Nuclear Data centre at IPPE Obninsk purchased a DEC ALPHA computer. Now all four centres have DEC computers. Hopefully in the near future all centres will have DEC ALPHA computers. At the present time NDS and NNDC are jointly maintaining most of the application software with corrections and improvements rapidly exchanged via electronic network links. The software commonly used by NDS and NNDC was installed on the new computer at the CJD data centre in November 1994 by staff from both NDS and NNDC.

D. *Planned Computer Upgrade*

It became clear in the fall of 1994 that the NDS VAX 4000 computer usage had saturated. This was indicated by degraded interactive user response and reduced input-output performance. Such a situation was not unanticipated since the computer is relatively slow and outmoded by current computing standards. However, it had been anticipated that the computer would only replaced in 1996 or 1997. After a system analysis by DEC, improvements in operating procedures and reconfiguration of the computer system parameters resulting in an increased capacity of only about 5 percent were recommended. We have managed to put together sufficient funds from the 1995 Budget and the Deferred 1994 Budget to purchase a DEC ALPHA SERVER 2100 4/275 which will satisfy the NDS computing requirements for the next 5 years. We will replace only the central processor and the disk system, preserving our investment in other periferal hardware. The computer will have the memory, speed and input-output capacity to handle the data base maintenance, external online service and system software advances anticipated during that period. We plan installation in June 1995. The migration of NDS usage to the new computer will present little difficulty for our staff who are already familiar with the VMS operating system and for those responsible for migration of application software because of the successful migration already done at NNDC and the recent installation in Obninsk of the software used by NDS.

IV. NETWORK COORDINATION ACTIVITIES

The network of eleven nuclear reaction data centers (see Table 5) continued its smooth cooperation. There was a significant exchange of evaluated nuclear data files. The compilation and exchange of experimental data (EXFOR) and bibliographic data (CINDA) suffers significantly from lack of compilation manpower, and also lack of programming manpower needed for the updating of EXFOR processing and checking codes. The four core centres now use much the same software on VAX computers.

The network of nuclear structure and decay data evaluators continues, after serious discussions of its program and products, more or less unchanged, though with decreasing manpower devoted to the traditional "A-chain" evaluation.

Table 5. 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	-	Centr Jadernykh Dannykh (= Russia Nuclear Data Centre), Obninsk, Russia
CAJaD	-	Centr po Dannym o Stroenii Atomnogo Jadra i Jadernykh Reakcikh (= Russia Nuclear Structure and Nuclear Reaction Data Centre), Moscow, Russia
CDFE	-	Centr Dannykh Fotojadernykh Eksperimentov (= Centre for Experimental Photonuclear Data), Moscow, Russia
CNDC	-	China Nuclear Data Centre, Beijing, P.R. of China
ATOMKI	-	Nuclear Data Group of the ATOMKI Institute, Debrecen, Hungary
RIKEN	-	Nuclear Data Group, RIKEN Institute of Physical and Chemical Research, Wako-Shi, Japan
JCPRG	-	Japan Charged-Particle Nuclear Reaction Data Group, Sapporo, Japan
JAERI	-	Nuclear Data Center of the Japan Atomic Energy Research Institute, Tokai-Mura, Japan
(KACHAPAG)	-	(Karlsruhe Charged Particle Group, Karlsruhe, Germany. Discontinued in 1982, its responsibilities were taken over by CAJaD)

A. Meetings 1993-1994

The following meetings have been held in the past 2 years.

1. Co-ordination of the Nuclear Reaction Data Centres Network. Paris, France, 25-27 April 1994.

   Type: Advisory Group Meeting

   Note: AGM scheduled for 1993 was deferred to 1994. The CS scheduled for 1994 was postponed to 1995.

   Objective:
   To coordinate the network of data centers which provides nuclear reaction data files needed for applications in nuclear science and technology (energy and non-energy) in Member States.

   Product/result:
   Report INDC(NDS)-308 containing actions and procedures for the center-to-center data exchange among the 11 participating centers during the next two years. Main databases: EXFOR, CINDA and ENDF to be updated by regular data exchange procedures. Continuing.

2. Co-ordination of the Nuclear Structure and Decay Data Evaluators Network, Berkeley, USA, 16-20 May 1994.

   Type: Advisory Group Meeting

   Objective:
   To coordinate the network of data evaluators which provide the Agency with nuclear structure and decay data information for use in Member States' nuclear programs (energy and non-energy).

   Product/result:
   1. Report INDC(NDS)-307 containing actions and procedures for data evaluation during the next two years in the 16 participating centers from ten countries. Continuing.

   2. Nuclear Data Newsletter No. 20 advertising the products of the Nuclear Structure and Decay Data Network and giving instructions how to access the online service.

3. Ad-hoc meeting of the heads of the main nuclear data centers, Vienna, 31 Oct - 1 Nov. 1994.

   Type: Consultants' Meeting

   Objective:
   To draft a document describing the nuclear data centers network coordinated by the IAEA Nuclear Data Section.

   Product/result:
   Report INDC(NDS)-324 listing the addresses and contact persons of eleven participating centers, and summarizing the responsibilities of each center within the network.

B. Meetings 1995

4. Technical matters of the Nuclear Reaction Data Centers Network, Vienna, 2-4 May 1995.

   Type: Consultants' Meeting

   Objective:
   Technical seminar on revised procedures in the EXFOR and CINDA systems, compilation and coding rules, and checking of entries.

   Product/result:
   1. INDC-report containing updated coding rules and actions for the next two years.

   2. Regular data exchange by tape or FTP in agreed procedures.

C. Status of data compilation

1. Neutron reaction data. The four centers, i.e. NNDC, NEA Data Bank, NDS, and CJD continue the compilation of new data in EXFOR and CINDA, however with serious delays due to lack of staff. This is illustrated in Tables 6 and 7.

Table 6. CINDA/EXFOR data transmission
(9 February 1995)

	Last CINDA entries received	**Last EXFOR entries received**
from NNDC	June 94	June 94
from NEA	May 93	March 94
from NDS	December 94	January 95
	(believed to be up-to-date and complete except for China)	
from CJD	January 94	November 94

The date given is that of the center-to-center data transmission

Considering that the delay from publication date to the center-to-center transmission of compiled entries may range from ½ year up to 3 years, the CINDA and EXFOR compilation from 1992 to present is far from satisfactory. This is also illustrated in the following table which shows the contents of the CINDA file by year, where the figures from 1992-1995 show a significant incompleteness of the CINDA file, even though a continuing decrease of neutron data activities must be assumed. The incompleteness of CINDA makes a complete data compilation in EXFOR presently impossible.

The present situation is particularly disturbing for neutron data evaluators who are, obviously, primarily interested in the most recent data sets.

In addition to the lack of staff for data compilation, there is a serious lack of staff for programming, specifically for the programming of new features in Exfor.

On the other hand, the four centers have now reached the goal of using much the same software on VAX computers, so that all centers will benefit from updates made to this software which is programmed by C.L. Dunford and V. McLane.

Table 7. Contents of CINDA by year
(13 February 1995)

	"Blocks" for experimental data in CINDA				
Year	**1. U.S., Canada**	**2. NEA**	**3. NDS**	**4. former USSR**	**Total**
1980	344	526	167	336	1373
1981	360	433	206	227	1226
1982	332	601	369	160	1462
1983	209	300	153	372	1034
1984	279	429	126	128	962
1985	309	514	206	229	1258
1986	221	447	171	110	949
1987	238	341	91	380	1050
1988	161	495	100	184	940
1989	190	380	136	228	934
1990	118	329	78	224	749
1991	141	283	168	185	777
1992	85	160	70	171	486
1993	91	7	52	41	191
1994	15	0	11	0	26
1995	0	0	0	0	0

(retrieved 95/2/13)

Note: Different references pertaining to the same experiment form a "block". Above figures show the number of "blocks" versus the year of publication of the main reference. The table includes CINDA entries for experimental data, omitting entries for theory and evaluation. In the case of a Russian measurement published in "Nuclear Physics", the CINDA entry would be made by NEA but counted, in above table, in col. 4, former USSR. The table shows that CINDA entries for the years 1992 to 1994 are drastically incomplete.

2. Evaluated Data

CINDA, EXFOR, and the five ENDF formatted evaluated data libraries, i.e. BROND-2, CENDL-2, ENDF/B-6.2, JEF-2.2, JENDL-3.2 are available in the on-line system which is now in operation at the four centers. An updated version of the ENDF utility codes has been received from NNDC.

A new version of JENDL, i.e. JENDL-3.2, was released in June 1994. It was a major update so that JENDL appears, at present, to be the most comprehensive and most recent evaluated data library for neutron reaction data. However, each of the other four libraries continues to have its merits and specialities, too.

3. Charged-particle reaction data and photonuclear data

For charged-particle reaction data and photonuclear data the EXFOR files have grown. Compilation is done for selected data without aiming at an overall completeness. Contributions were received from the two Japanese centers and the Chinese center. The last regular tape from CAJaD (Kurchatov Institute, Moscow) was received in Dec. 1993. However, in the meantime, F.E. Chukreev worked, on contract with IAEA, on the files compiled many years ago in Karlsruhe, and, on contract with NEA, on intermediate energy data which will be transmitted soon.

Significant amounts of photonuclear data have been compiled by V. Varlamov (Moscow University).

4. Nuclear structure and decay data

After serious discussions in the U.S. about the funding and continuation of the ENSDF project and the publication in the journal Nuclear Data Sheets, the evaluation work for ENSDF continues by cooperation of 16 groups in ten countries. In general, the update of the mass-chain evaluations is in reasonable intervals but available manpower is decreasing. Several new initiatives were started, e.g. on work coordination and priorities, on high-spin data, on improvements in file contents and data entry checking, etc.

V. NUCLEAR DATA IMPROVEMENT PROJECTS

The objective of the subprogramme is to asses current nuclear data needs and to improve and/or develop data files for the most critical energy and non-energy applications and to maintain nuclear data standards and reference nuclear data. The activity in 1993-94 focused on the long-term project Fusion Evaluated Nuclear Data Library, on 7 Co-ordinated Research Programmes, and 8 other projects. The achievements are discussed in more detail below. Added is a summary of plans for 1995-96.

A. Fusion Evaluated Nuclear Data Library, FENDL

Summary:
The first version of an internationally available Fusion Evaluated Nuclear Data Library (FENDL-1) was created. The library was selected to serve as a comprehensive source of processed and tested nuclear data tailored to the requirements of the Engineering Design Activity (EDA) of the International Thermonuclear Experimental Reactor (ITER) Project and other fusion-related development projects. At the recent (February 1995) ITER neutronics co-ordination meeting in San Diego the FENDL was highlighted by the ITER participants as the library to be used in all design calculations.

The activity in 1993-94 was marked by 2 Advisory Group Meetings. FENDL files were made available electronically on-line on the IAEA VAX computer. In support of FENDL, 2 Consultants' and Specialists' Meetings were organized, and 2 Co-ordinated Research Programmes were conducted.

Status and Availability of FENDL-1:

FENDL-1 is composed of several libraries describing the transport of both the plasma-source neutrons and secondary neutrons and gamma rays through fusion reactor components, as well as the resulting radiation effects, such as nuclear heating, tritium breeding, activation and material damage. Also included are cross sections for fusion and other important charged-particle nuclear reactions of the plasma constituents, as well as data for fusion-relevant neutron dosimetry. The FENDL-1 libraries are as follows:

FENDL/E for General Purpose Evaluated Library
FENDL/A for Activation Library
FENDL/DS for Dosimetry Library
FENDL/D for Decay Data Library
FENDL/C for Incident Charged-Particle Library
FENDL/MC for Processed Monte Carlo Library
FENDL/MG for Processed Multigroup Library
FENDL/BENCHMARKS for Compiled Information on Fusion Neutronics Benchmarks

The FENDL project has made significant progress in the reporting period. The working nuclear data libraries of basic evaluations in processed form for use by the ITER team in the early phase of ITER EDA have been derived from FENDL-1 by processing FENDL/E-1.0 using the NJOY code system. The processed libraries of basic evaluations are now available for use online at the IAEA Nuclear Data Section. Furthermore, the processing of the activation library was completed and the processed library of the activation data was prepared for use by the ITER design team. The validation of FENDL-1 is considered to be a high priority to task for the coming months.

In the last few months of report period, effort concentrated on making FENDL-1 available for use by the ITER team. Presently, the libraries FENDL/E, FENDL/A, FENDL/DS, FENDL/D, FENDL/C, FENDL/MC, FENDL/MG and FENDL/BENCHMARKS are complete and ready for full data testing activities except for minor problems. The documentation for all the FENDL libraries have been prepared, the references are as follows:

FENDL/E-1.0	IAEA-NDS-128, Rev. 1, February 1995
FENDL/A-1.1	IAEA-NDS-148, Rev. 2, February 1995
Processed FENDL/A-1.1	IAEA-NDS-168, Rev. 2, February 1995
FENDL/DS-1.0	IAEA-NDS-141, Rev. 2, October 1993
FENDL/D-1.0	IAEA-NDS-167, January 1995
FENDL/C-1.0	IAEA-NDS-166, January 1995
FENDL/MG-1.0	IAEA-NDS-129, Rev. 3, February 1995
FENDL/MC-1.0	IAEA-NDS-169, Rev. 2, March 1995
FENDL/BENCHMARKS	IAEA-NDS-???, under preparation

Since 1994, the FENDL-1 data can be retrieved by users from the Agency Nuclear Data Section online system over the international computer network, INTERNET. A grand total of 47 directories with 810 files with total size of slightly more than 1 Gigabyte of data is currently on-line.

Future Plans:
Improved, well tested and validated nuclear data libraries (FENDL-2) are expected to be ready by mid 1996 for use by the ITER team in the final phase of ITER EDA after extensive benchmarking and integral validation studies in the 1995-96 period. The Agency has plans to organize an Advisory Group Meeting on "Development of Improved Nuclear Data Library for Fusion (FENDL-2)" in Del Mar, U.S.A. from 5 to 9 December 1995. The final Advisory Group Meeting on "Processing and Testing of the FENDL-2 Library" has been planned for 1996 in Vienna. Based upon identified needs, one or two consultants' meetings may be organized by the Agency to address specific problem areas in FENDL.

Meetings:

1. Advisory Group Meeting on "Review of Uncertainty Files and Improved Multigroup Cross Section Files for FENDL"

   - Venue & date: JAERI, Japan, 8-12 November 1993

   - Objectives of the Meeting:
     Review current status of production and accelerate integral testing of improved multigroup cross section libraries for ITER applications.

   - Results achieved:
     Recommendations to the Agency were given on the following topics:
     - experimental and calculational benchmarks,
     - preparation of processed libraries of FENDL for ITER,
     - specifying procedures for improving FENDL
     - improvement of activation data library

2. Advisory Group Meeting on "Improved Evaluations and Integral Data Testing for FENDL"

   - Venue & date: Garching, Germany, 12-16 September 1994

   - Objectives of the Meeting:
     - review the current status of production and integral testing of functional working libraries derived from version 1 of Fusion Evaluated Nuclear Data Library (FENDL-1) for ITER applications against existing experimental and calculational benchmarks, and
     - assign priorities and finalize plans of activities for the generation of FENDL-2 which would be an improvement over FENDL-1.

   - Results achieved:
     Conclusions and Recommendations were prepared on the following topics:
     - basic evaluations towards FENDL/E-2.0 for ITER Design,
     - experimental and calculational Benchmarks on Fusion neutronics for FENDL validation,
     - production and interfacing of FENDL libraries to ITER design, and
     - activation

3. Consultants' Meeting on "Preparation of Fusion Benchmarks in Electronic Format for Nuclear Data Validation Studies"

   - Venue & date: Vienna, 13-16 December 1993

   - Objectives of the meeting:
     - review the current status of preparation of fusion benchmarks in electronic format for nuclear data validation studies

- help to accelerate integral testing of working nuclear data libraries for ITER applications.

- Results:
  Agreed that the data validation by experimental benchmarks should be a continuous process. The participants felt that the IAEA Nuclear Data Section is the suitable body for the co-ordination and encouragement of FENDL validation by experimental benchmarks in view of the use of FENDL in the ITER project.

4. Specialists' Meeting on "Evaluation of Charged Particle and Photonuclear Data for the IAEA FENDL Project"

- Venue & date: Smolenice, Slovakia, 18-21 April 1994

- Objectives of the meeting:
  - review the status and availability of evaluated charged-particle and photonuclear data files for incorporation into the IAEA FENDL library
  - review the theoretical models and their parametrization for the computation of nuclear data
  - review the remaining gaps in the required data
  - identify further measurements and calculations needed to fill the gaps.

- Results:
  Conclusions and recommendation for the Agency were given on the following topics:
  - Thermonuclear and associated charged-particle reactions,
  - Charged-particle activation and medical-isotope production reactions,
  - Photonuclear reaction cross section data

- Recommendation:
  Meeting recommended to organize a co-ordinated research programme with the purpose of development of the evaluated photonuclear data library for applications.

References: INDC(NDS)-297, March 1994
INDC(NDS)-312, December 1994
INDC(NDS)-298, March 1994
INDC(NDS)-306, November 1994

B. Co-ordinated Research Programmes

Altogether, 7 Co-ordinated Research Programmes (CRP) were active during the period 1993-94. For each CRP at least one Research Co-ordination Meeting (RCM) was organized. One CRP was finished and 3 new were initiated. Two CRPs directly supported the FENDL activities.

Short Title	Duration	Participants (Contracts)	RCM	Officer	Remark
Data for Radiotherapy	1988-94	13 (3)	1993	Kocherov	TECDOC in print
Long-Lived Radionuclides	1989-95	11 (0)	1993	Pashchenko	In support of FENDL
Fission Yields	1991-96	7 (1)	1993 1994	Lammer	Extended for 1995-96
Helium Production	1992-95	9 (3)	1993	Pashchenko	In support of FENDL
Activation Library	1993-96	8 (5)	1994	Pashchenko	New
Model Parameters	1994-97	9 (3)	1994	Obložinský	New
Photon Production	1994-97	9 (3)	1994	Obložinský	New

1. CRP on "Atomic and Molecular Data for Radiotherapy"

- Goal of the CRP:
  To survey the current status of atomic and molecular data needed for radiotherapy, to identify the outstanding problems suitable for studying in the near future and to create a comprehensive handbook for data users and data producers.

- Activity in 1993-94:
  3-rd RCM was held (Vienna, 15-18 June 1993) with the objective to review the status of preparation of the Handbook on Atomic and Molecular Data for Radiotherapy.

- Results achieved:
  The contents of 9 chapters of the book were discussed and necessary changes for the final version were formulated. The schedule for the submission of the manuscripts of the chapters was worked out.
  The manuscript is currently in press at the IAEA to appear as the IAEA TECDOC report.

- References: INDC(NDS), under preparation

2. "Activation Cross Sections for the Generation of Long-lived Radionuclides of Importance in Fusion Reactor Technology"

- Goal of the CRP:
  To obtain reliable information (experimental and evaluated) for 16 long-lived activation reactions of special importance to fusion reactor technology. The reactions are

27-Al(n,2n)Al-26,	63-Cu(n,p)Ni-63,
94-Mo(n,p)Nb-94,	109-Ag(n,2n)Ag-108m,
179-Hf(n,2n)Hf-178m2,	182-W(n,n'α)Hf-178m2,
151-Eu(n,2n)Eu-150g,	153-Eu(n,2n)Eu-152g+m2,
159-Tb(n,2n)Tb-158,	158-Dy(n,p)Tb-158,
193-Ir(n,2n)Ir-192m2,	187-Re(n,2n)Re-186m,
62-Ni(n,γ)Ni-63,	98-Mo(n,γ)Mo-99(b-)Tc-99,
165-Ho(n,γ)Ho-166m,	191-Ir(n,γ)Ir-192m2.

- Activities in 1993-94:
  2nd RCM was held (Del Mar, California, U.S.A., 29-30 April 1993). The Meeting was convened in conjunction with the First International Workshop on Nuclear Data for Fusion Reactor Technology, 3 - 6 May 1993. An informal meeting was held in Gatlinburg in May 1994 among these attending the conference.

  Objectives of the Research Co-ordination Meeting:
  - report, discuss and evaluate the results of the research carried out by participants since the first CRP meeting
  - review the status and remaining gaps in the required cross sections for those well-defined activation reactions leading to long-lived radionuclides supposed to be of most importance for radioactive waste disposal and material recycling for fusion reactor materials
  - identify further measurements and calculations needed to fill these gaps.

- Results achieved in 1993-94:
  The CRP has produced extensive new data, significantly improving the nuclear data base for fusion energy applications. The quality of available data is now acceptable for 8 reactions. However, there are unacceptable uncertainties for the 8 remaining reactions. Poor knowledge of the decay half lives remains a concern for several of these reactions. The status of each reaction is given in the paper reported at the Gatlinburg Conference on Nuclear Data, May 1994.
- References: INDC(NDS)-288, November 1993
  INDC(NDS)-319, January 1995

3. CRP on Compilation and Evaluation of Fission Yield Nuclear Data

- Goal of the CRP:
  The overall goal is to improve existing evaluations as well as the evaluation process itself to arrive at complete, consistent and reliable evaluated fission

yield data, to include in particular correlations and covariances and the energy dependence of evaluated yields.

- Meetings:
  2nd RCM was held in Vienna, Austria, 21-23 April 1993,
  3rd RCM was held in Vienna, Austria, 17-19 October 1994.

- Results achieved:
  Apart from the co-operation in an extensive checking and cleanup of the experimental and evaluated yield files,
  - a computer program using correlations and covariance information has been adapted and applied to produce a first set of U-235 reference fission yields and for studies of the energy dependence of experimental yields;
  - models for mass and charge distribution and isomeric yield ratios have been further developed and tested, and reliable parameters have been derived for fission reactions where many experimental data exist; systematic studies including other fission reactions have been started;
  - theoretical investigations to develop a model for the energy dependence of fission yields and to study systematic trends have been completed.

- Future plans:
  An extension of the CRP for 2 more years has been approved during which the inital goals should be reached. The following tasks have to be completed:
  - production of complete sets of reference fission yields;
  - the systematic studies of model parameters;
  - based on the theoretical investigations, to develop a description of the energy dependence of fission yields suitable for use in evalutions;

- References:
  CRP Mid-term Progress Report (March 1994, distributed to INDC members);
  Summary Report of 3rd RCM, INDC(NDS)-332, under preparation.

4. CRP on "Improvement of Measurements, Theoretical Computations and Evaluations of Neutron Induced Helium Production Cross Sections"

- Goal of the CRP:
  To improve knowledge of neutron induced helium production cross sections in general and to provide reliable data (experimental and evaluated) for the important structural materials, especially for Cr, Fe and Ni, where better data are needed for fusion reactor technology.

- Activities in 1993-94:
  2-nd RCM held (Beijing, China, 1-4 November 1994)
  Objectives of the meeting:
  - report, discuss and evaluate the results of the research carried out by each participating laboratory since the first CRP meeting
  - review the status of helium production cross sections data
  - identify the current tasks and further actions of participants and agree on the further co-ordination of work under this CRP

- Results achieved:
  The progress as summarized at the meeting shows a significant achievement in the understanding of the experimental and computational problems faced by evaluators of (n,alpha) reactions. The part of original goal has already been reached by new experiments of alpha-emission cross sections (56-Fe, nat-Fe, 58-Ni, nat-Ni) between threshold and 14 MeV, activation measurements many nuclei around 14 MeV, new calculations and evaluations for important materials. At the same time the meeting expressed the opinion that the original goals of the CRP are still valid and due to the well-established structure of this programme can be met.

- References: INDC(NDS)-323, January 1995

5. CRP on "Establishment of an International Reference Data Library of Nuclear Activation Cross Sections"

- Goal of the CRP:
  To provide universal database of neutron and charged particle activation cross sections and related decay data for nuclear and fusion technology, for environmental protection and for estimating the potential radiation hazards connected with any kind of nuclear installation and technique.

- Activities in 1993-94:
  A proposal for the CRP was developed and approved by the Agency. The CRP was initiated in 1993.
  1-st RCM held (Debrecen, Hungary, 4-7 October 1994)
  Objectives of the meeting:
  - discuss the scope and goals of the CRP,
  - report and evaluate results of the research carried out by participants
  - review the current tasks,
  - identify further actions of participants and agree on the co-ordination of work

- Results achieved:
  - range of applications that should be covered by the reference library was agreed,
  - procedure for the production of the starter file of a neutron induced reactions was adopted,
  - procedure for the production of the starter file of a charged particle induced reactions was agreed,
  - procedure for validation and testing of the starter file was discussed and agreed
  - related actions of CRP members are listed in the Summary Report

- References: INDC(NDS)-320, January 1995

6. CRP on "Development of Reference Input Parameter Library for Nuclear Model Calculations of Nuclear Data (Phase I: Starter File)"

- Goal of the CRP:
  Develop a complete starter file of the input model parameter library. The library should be composed of 6 segments: (1) atomic masses, shell corrections and deformations, (2) discrete level schemes, (3) average neutron resonance parameters, (4) optical model parameters, (5) level densities (total, partial, fission), and (6) gamma-ray strength functions. The library should be arranged in a processing-oriented format and equipped with a retrieval/processing code.

- Activities in 1993-94:
  Consultants' Meeting on "Standard Input Data Sets for Nuclear Model Computations of Nuclear Data" was held (Sirolo/Ancona, Italy, 21-25 June 1993) with the objective to provide technical advice on the plan to assemble a reference library of numerical data for input to nuclear reaction theory computer programs. Using the results of this meeting, the proposal for the CRP was prepared. It was approved by the Agency and the CRP was initiated.

  The 1-st RCM was held (Cervia, Italy, 19-23 September 1994) with the objective to review current status of work in developing the Reference Input Parameter Library and work out detailed programme of the CRP.

- Results achieved:
  CRP members were selected. Work on assembling the Starter file of the Reference Input Parameter Library was started. The Library will consist of 7 segments. A co-ordinator was selected for each segment. 37 technical tasks were identified, respective actions and deadlines specified, and a mechanism of file exchange through the NDS VAX computer agreed. The working files are being assembled electronically and made available on-line for the participants of the CRP on the IAEA VAX computer.

- References: INDC(NDS)-282, September 1993
  INDC(NDS)-321, December 1994

7. CRP on "Measurement, Calculation and Evaluation of Photon Production Data"

- Goal of the CRP:
  To work out procedures and methods to be recommended for future evaluation procedures of photon production data, and to improve selected photon production cross sections in internationally recognized general purpose nuclear data libraries. Expected output is a document of recommended procedures and methods for evaluation of photon production data, and improved files of photon production cross sections for structural and shielding materials.

- Activities in 1993-94:
  The proposal for the CRP was worked out. It was approved by the Agency and the CRP was initiated. The 1-st RCM was held (Bologna, Italy, 14 - 17 November 1994) with the objective to review current status of work in measurement, calculation and evaluation of photon production data and work out detailed programme of the CRP.

- Results achieved:
  CRP members were selected and the CRP initiated. Status of work was reviewed. Problem areas were identified. A detailed working programme of the CRP was developed, specific technical tasks identified, respective actions and deadlines agreed.

- Reference: INDC(NDS)-330, under preparation

C. Other Projects

1. International Reactor Dosimetry File (IRDF-90 Version 2)

The new version of the IRDF Library was distributed for testing to a limited number of specialists in the beginning of 1993. The testing was finished in summer 1993 and after insertion of the necessary corrections the library was released for use by the customers. The library contains data for 39 neutron dosimetry cross sections from the ENDFB/6, 14 evaluations by Prof. H. Vonach and coauthors and 5 evaluations by the specialist from the Chinese Nuclear Data Center in Beijing, prepared specially for this file under contract with the IAEA.

- Reference: IAEA-NDS-141, Rev. 2, October 1993

2. Processing and WIMS-D Library Update Project

Nuclear data processing, an interfacing of basic nuclear data to application calculations of thermal, fast and fusion research and power reactors, was a concern of the Nuclear Data Section for several years. In 1993-94 the work concentrated on continuing testing of the processing code NJOY and on coordination of update of the WIMS-D library for reactor applications.

- Milestones:
  The WIMS-D Library Update Project (WLUP) has been running for three years. Numerous contributions were received from various laboratories throughout the world. The milestones in the project are the following:
  - Current capabilities of the original WIMS-D library were assessed by modelling benchmark experiments with the WIMS-D/4 lattice code.
  - Various data processing codes were assessed and the WIMSR module of NJOY was upgraded by removing errors and implementing the necessary extensions.
  - A numerical benchmark based on ENDF/B-IV data was defined for testing the group constants definitions data processing procedures.

- A detailed parametric study on the sensitivity of the calculated integral parameters on various data processing input options was completed.
- Some important reactor materials were processed from a number of recently released evaluated data files and tested against previously defined benchmarks. This preliminary analysis confirms, that a significantly improved WIMS-D library can be generated from first principles, using codes and methods established in this project.

- Further Requirements:
  The partially-updated library is not yet suitable for practical calculations because the new data are limited to only a few materials and because the old fission product data are inconsistent with the newly entered data. Further work is required on the following items:
  1. Continue with extending the data base of benchmark experiments.
  2. Update the structural material data in the library.
  3. Add materials specifically required by the research reactor users.
  4. Replace systematically the fission product data in the WIMS-D library.

- Meeting:
  Consultants' Meeting on "Preparation of Processed Nuclear Data Libraries for Thermal, Fast and Fusion Research and Power Reactor Applications" was held in Vienna, 8-10 December 1993

- Objectives of the meeting:
  - review the current status of work in the subject of interfacing nuclear data banks to application calculations of thermal, fast and fusion research and power reactors
  - assist the Agency in identifying appropriate IAEA activities to nuclear data processing.

- Results of the meeting:
  - current status of work on the subject of interfacing nuclear data banks to application calculations of thermal, fast and fusion research and power 1 reactors was reviewed,
  - recommendations to the Agency in identifying an appropriate IAEA activities related to nuclear data processing were prepared.

- Informal Specialists' Meeting on the WLUP project was conducted during the ICTP Workshop on "Nuclear Reactor-Physics, Design and Safety", Trieste, 11 April to 13 May 1994. The minutes and recommendations can be found in attachment to the travel report of the IAEA/NDS director of the Workshop.

- Conclusion:
  Good progress has been made on the project and the results available so far confirm that a significantly improved WIMS-D library can be assembled by completing the project. Unfortunately, due to staff reductions the work has been discontinued.

- Reference: INDC(NDS)-299, March 1994

3. International Exercise on Calculation of Radioactive Inventories in Fission Reactors for Decommissioning Purposes

According to recommendations of the IAEA AGM on Nuclear Data for Fission Reactor Decommissioning this International Exercise was organized by the Nuclear Data Section. Started January 1994, still in progress.

- Objective:
  To intercompare the results of inventory calculations made in different laboratories and recommend the most reliable procedures for making such calculations.

- Results:
  The first round of calculations has shown serious disagreements between the experimentally measured activity and the calculated values in the concrete bioshield. The second round is now under way with another input data set in an attempt to find the reasons for this discrepancy.

4. The Second International Activation Calculation Benchmark Comparison Study

An activation comparison study was completed in the reporting period. Selected for comparison were 11 regionally or internationally available computer codes developed principally for fusion reactor technology applications. A set of cross section and decay data libraries was established for all participating codes to use. Two calculations were performed for the Cr-50 and natural iron targets, at a specified neutron spectrum at the first wall of a fusion reactor. The continuous irradiation time was selected as one year for both cases.

The activation calculation codes included worldwide in the comparison study were:

FISPACT (UKAEA/Culham, U.K.).
REAC (Westinghouse/Hanford, U.S.A.)
ACT4 (JAERI, Japan).
RACC (ANL, U.S.A.)
ACAB (Institute of Nuclear Fusion, University of Madrid, Spain).
DKR (University of Wisconsin, Madison, U.S.A.).
FDKR (Southwestern Institute of Physics, China).
ACTIVA (Baikov Institute of Metallurgy, Russia).
SAM (Institute of Power Engineering, Moscow, Russia).
FRINDA (Kurchatov Institute of Atomic Energy, Moscow, Russia).
ANITA (Department of Energy Engineering, University of Genova, Italy).

Four basic criteria can be stated for suitability of an inventory code for fusion applications:

- Ability of the code to read standard libraries
- Accurate ($\approx$ 5%) prediction of amounts of nuclides in multi-step pathways

- Ability to calculate light nuclide (H & He isotopes) production
- Ability to treat isomeric states present in the libraries.

It was found that the codes ACAB and FISPACT are suitable and satisfactory, with ANITA, DKR, RACC and REAC performing less well on at least one criterion. The remaining codes appear, at least on the results of the present study, to be inadequate for detailed fusion calculations.

Other criteria not tested in the current work may need to be considered for the current generation of libraries. These include the ability of the code to use uncertainty data (available only in the EAF-3 library) and produce uncertainty estimates on radiological responses, e.g. on total activity (currrently only FISPACT), and the ability of the code to treat actinide data so that the importance of actinide impurities can be assessed. The importance of sequential charged particle reactions is under investigation and it will become necessary for inventory codes to also use such data libraries.

- References: Report INDC(NDS)-300, February 1994

5. International Databases for High-Priority Nuclear Cross-Sections and Decay Data

- Specialists' Meeting: Vienna, 24-28 October 1994

- Objective:
  To define a mechanism how a database of internationally recommended values and uncertainties can be obtained for the more important nuclear constants.

- Results achieved:
  Procedures were agreed to obtain a new international database of thermal neutron cross-sections (including resonance-integrals et.al.) and decay data (including half-lives of ground and metastable states and gamma-emission probabilities) starting with a few selected nuclides.

- References: INDC(NDS)-328, Summary Report
  INDC(NDS)-329, Papers

- Note:
  The aim of the Specialists' Meeting was to provide a forum in which to discuss and recommend methods to achieve the formation of an internationally-accepted database of high priority decay data and thermal cross-sections. Experts in data evaluation and in the preparation of databases attended the 5-day meeting; notable exceptions were China, Japan and Germany from whom written statements of support were received. There were 29 participants from 9 countries and 2 international organizations. Two Working Groups were formed to discuss and provide recommendations on (a) Decay data, (b) Thermal cneutron cross-sections and resonance-integrals.

It should be noted that the creation of a comprehensive and carefully evaluated database to an agreed international standard is not achievable on a realistic timescale due to limited resources. Therefore, it was decided to establish a database to be described as a subset (in terms of the extent of the data included and the number of radionuclides evaluated in depth). The proposed database will start from small sets of data that have already received international approval by the International Nuclear Data Committee (INDC) or have been generated by IAEA sponsored Co-ordinated Research Programmes (CRP). Additional data can then be added to this database as more comprehensive evaluations are made, reviewed and approved.

As a result of the meeting, new evaluations will be circulated to an international review group. If approved, data will be included in the international database which will receive a well defined circulation to authors of nuclear wall-charts or handbooks and to national standards institutions.

The work will have to be done by correspondence and voluntary contributions. As a first step it is envisaged to obtain updates for the two CRP's:
- Decay Data of Actinides, IAEA Technical Report 261, 1986
- X- and Gamma-Ray Standards for detector calibration, IAEA-TECDOC-619, 1991.

After a few years, the work achieved should be reviewed in a meeting, which may find the necessity for a new CRP.

6. Activation Measurements for Fusion Reactor Technology

- Purpose of the project:
  The experimental groups at JAERI (Tokai, Japan), KRI (St. Petersburg, Russia), IEP (Debrecen, Hungary), ANL (Argonne, U.S.A.) and IPPE (Obninsk, Russia) joined in a collaborative program co-ordinated by the IAEA Nuclear Data Section on comparing their experimental techniques and measurement of cross sections data where discrepancies between their previous measurements exist. The focus is on the comparison in the experimental technique in terms of neutron field characteristics, data processing, methods for various corrections aiming at the mutual consistency and validation of the experimental data.

- Specialists' Meeting on "Comparison of Activation Cross Sections Measurements and Experimental Techniques for Fusion Reactor Technology" was held at JAERI, Japan, 15-17 November 1993

- Objectives of the meeting:
  Discuss the project in details: tasks, goals, time schedule, information exchange, facility visits and working meetings.

- Results of the meeting:

  - action steps have been worked out

- 'Updated Most Important Activation Reaction List' was created and reactions for which the data situation is unsatisfactory were identified
- number of reactions were identified for which the cross sections cannot be measured by activation because of the extremely long half-lives of the reaction products, but probably can be measured by other methods such as accelerator mass spectrometry
- two types of measurements were identified as especially urgent (threshold reactions in the MeV energy range and capture reactions in the keV energy range)

- Second Specialists' Meeting on "Comparison of Activation Cross Sections Measurements and Experimental Techniques for Fusion Reactor Technology" was held in St. Petersburg, Russia, 7-9 September 1994

- Objectives of the second meeting:
  - discuss and evaluate the preliminary results of the researches carried out in the framework of the International programme on "Comparison of Activation Cross Sections Measurements and Experimental Techniques for Fusion Reactor Technology"
  - identify further measurements and actions of participating laboratories.

- Results of the second meeting:
  Detailed plan of the co-ordinated work was agreed and related actions were assigned to the programme members.

- Recommendation of the second meeting:
  To consider the results of the collaborative activity at the next meeting to be organized as the IAEA Consultants' Meeting and to be held in Debrecen, Hungary, in 1996.

- References: INDC(NDS)-301, May 1994
  INDC(NDS)-319, February 1995

7. Individual Research Contracts

According to the IAEA nomenclature, these are non-CRP research contracts. Altogether 18 individual research contracts were supported during the period 1993-94. Financial support amounted between 2000 and 5000 US$ per contract per year. As a rule, contracts dealt with specific tasks useful for one of the projects described above. Due to the IAEA policy that discourages granting of individual contracts, their number was reduced to 8 at the end of 1994.

8. Fission Product Newsletter

Work continues on the biennially published report series "Progress in Fission Product Nuclear Data". The 14th issue of this series was published as INDC(NDS)-304 in June 1994. The 15th issue is envisaged to be published in 1996/97.

D. Activities Planned for 1995-96

Altogether 15 tasks are foreseen for the period 1995-96. Most of them represent a continuation of activities from the previous period. Thus, the FENDL project should continue as a phase 2, 6 Co-ordinated Research Programmes should also continue, we plan to implement 2 new CRPs, and perform several other tasks. Given below is the full list of tasks, accompanied with a short comment.

1. Conduct CRP on "Development of Reference Input Parameter Library for Nuclear Model Calculations of Nuclear Data".
   - Comment: Continued, initiated in 1994, second Research Co-ordinated Meeting (RCM-2) planned for 1995.

2. Conduct CRP on "Compilation and Evaluation of Fission Yield Nuclear Data".
   - Comment: Continued, extended for 1995-96, RCM-4 planned for 1996.

3. Develop improved Fusion Evaluated Nuclear Data Library, FENDL-2.
   - Comment: Continued, Advisory Group Meeting planned for 1995.

4. Process and test FENDL-2.
   - Comment: Continued, AGM planned for 1996 in Vienna.

5. Conduct CRP on "Establishment of International Reference Data Library for Nuclear Activation Cross Sections".
   - Comment: Continued, started in 1993, RCM-2 planned for 1996.

6. Conduct CRP on "Improvement of Measurements, Theoretical Computations and Evaluations of Neutron Induced Helium Production Cross Sections".
   - Comment: Continued, RCM-3 planned for 1995, completion in 1996.

7. Conduct CRP on "Measurement, Calculation and Evaluation of Photon Production Data".
   - Comment: Continued, started in 1994, RCM-2 planned for 1996.

8. Conduct CRP on "Activation Cross Sections for Generation of Long-Lived Radionuclides of Importance for Fusion Reactor Technology".
   - Comment: Continued, RCM-3 planned for 1995, completion in 1996.

9. Asses the impact of NEA sponsored International Evaluation Co-operation Project on the IAEA evaluated data bases.
   - Comment: Continued, consultancy of 2 experts through participation at the NEA Working Party Meetings planned for 1995 and 1996.

10. Prepare INDC report on progress in fission product nuclear data.
    - Comment: Continued, done on a regular biennial basis.

11. Prepare handbook on nuclear data for estimation of potential hazards connected with reactor decommissioning.
    - Comment: Document under preparation.

12. Prepare technical document on the development of International Chart of Nuclides.
    - Comment: Follow-up of Specialists' Meeting held in 1994.

13. Update INDC Nuclear Standards Data File
    - Comment: Consultants' Meeting planned for 1996.

14. Conduct CRP on "Development of Reference Charged Particle Cross Section Data Base for Medical Radioisotope Production".
    - Comment: New CRP, can be initiated in 1995, RCM-1 can be hold in 1995.

15. Conduct CRP on charged particle fusion reactions.
    - Comment: Planned to start in 1995, RCM-1 planned for 1996. Objectives of the CRP seem of decreasing importance, expected main participants changed their interests.

VI. TECHNICAL COOPERATION AND TECHNOLOGY TRANSFER

The following three Technical Cooperation (TC) projects were continued in 1993-94.

A. **Project in Ethiopia ETH/1/002**. Teaching of Applied Nuclear Physics in Addis Ababa University.

Goal: To create a program of Nuclear Physics Course including lectures and practical exercises for the students. A fellowship for the University lecturer (Dr. Heilu) was organized in 1994. A fellow worked in Debrecen with Prof. Csikai for 6 months. For the exercises the following equipment was supplied by the Agency:

Am-Be Neutron source with the shielding tank
BF3 and NaI detectors with electronics
HP Ge detector for activation measurements with the data analysis system
Calibration samples

The equipment has arrived in February 1995. In March an expert mission was organized for 3 weeks to assemble and test the equipment. In the future the University wants also to perform XRF analysis, a possibility of getting a used XRF spectrometer is pursued.

B. **Project in Nigeria NIR/2/005**. Neutron Activation Analysis in Neutron Generator Laboratory of the Department of Physics, Obafemu Awolowo University, Ile-Ife.

Goal: To put into operation the neutron generator which stopped working because of a number of small failures. An expert mission was organized to study the situation and plan the necessary actions in 1993.

During 1994 the liquid nitrogen plant was repaired and put into operation again. A number of spare parts and T-Ti targets were supplied. Another expert mission was organized for 2 weeks to repair the generator. It was put into operational condition and it will be possible to start operation after SF6 and FREON gases will be supplied.

One more mission for 2 weeks is needed and then the project can be closed (probably still this year).

C. **Project in Tanzania URT/1/005**. Nuclear Physics (Phase 2) Department of Physics, University of Dar-es-Salaam.

Goal: To expand the number of nuclear techniques used at the Department of Physics for teaching and applied purposes. In 1994 and 1995 the following equipment was supplied:

Spare parts for liquid nitrogen plant
XRF spectrometer
Moessbauer spectrometer

2 expert missions were organized, the nitrogen plant repaired.
Equipment was installed and put into operation.
The project was closed.

D. **ICTP Trieste Course, 11April - 13 May 1994**

The Workshop on "Nuclear Reactors - Physics, Design and Safety" held at the International Centre for Theoretical Physics in Trieste from 11 April to 13 May 1994 was organized in collaboration with the Italian Comitatio Nazionale dell'Energia Nucleare ed Energie Alternative (E.N.E.A.), Rome, Italy and the Nuclear Data Section. The fifth week of the workshop, from 9 to 13 May 1994, was held at E.N.E.A., Bologna, Italy for a few selected participants. The Workshop was attended by 56 participants from 25 countries.

The workshop was directed by Profs. A. Gandini (ENEA, Rome), S. Ganesan (IAEA/NDS, Vienna), J.J. Schmidt (Vienna) and D.E. Cullen (Lawrence Livermore National Laboratory, U.S.A.) with the assistance of Profs. H.R. Dalafi (ICTP) and L. Fonda (ICTP and the University of Trieste, Italy).

This workshop was designed to meet the needs of participants from developing countries who are currently involved in or are planning a nuclear programme involving research and/or power fission reactors.

The proceedings of the Course will be published by World Scientific and Co., Singapore, later this year.

E. **International Conference on Nuclear Data for Science and Technology, Gatlinburg, Tennessee, USA, 9-13 May 1994**

Participation of specialists of 10 developing countries was financially supported by the IAEA: Bangladesh, Belarus, Bulgaria, China, Hungary, India, Poland, Romania, Thailand and Ukraine.

VII. ATOMIC AND MOLECULAR DATA ACTIVITIES

A. *Introductory Remarks*

The IAEA NDS Atomic and Molecular (A+M) data activity is mainly oriented to satisfy the needs of fusion energy research for such data. Besides the A+M data, this activity includes also data on plasma-material interaction (PMI) processes and data on thermo-mechanical properties (TMP) of plasma facing materials. A small portion of this activity is devoted to A+M data required in radio-biological research.

The NDS A+M data activity is conducted by the A+M Data Unit, consisting of three professionals and one documentation clerk/typist. The A+M Data Unit activity consists of three main components:

(1) Establishment and development of recommended A+M, PMI and TMP numerical databases for fusion energy (and other applied physics) research;

(2) Co-ordination of data generation, compilation and evaluation effort worldwide, including the activity of an A+M/PMI data centre network (15 national data centres), and

(3) Full operation of an autonomous A+M/PMI data centre, which occupies the central place for maintenance, development and dissemination of the internationally recommended A+M, PMI and TMP data for fusion.

The fusion related part of the NDS A+M data activity is supervised and regularly (biennially) reviewed by the Subcommittee on Atomic and Molecular Data for Fusion of the International Fusion Research Council (IFRC). A detailed account of the A+M data activity in the period 1993-1994 can be found in the Summary Report of the 8th Meeting of the IFRC A+M Subcommittee held in September 1994 (see IAEA report INDC(NDS)-325).

B. *Database Establishment Programmes*

In the reporting period 1993-1994, the A+M Data Unit has completed five databases and started the work on another four databases. The completed databases include: a comprehensive collisional database on all processes of hydrogen atoms with electrons, protons and multiply charged ions, a collisional database for Li-beam interaction with fusion plasmas, databases for particle-interchange reactions of plasma impurity ions with H_2, D_2 and H_2, for the radiative losses and electron cooling rates of He, C, and O plasma impurities and for particle-impact induced electron ejection from surfaces of fusion reactor materials. The data information has been included in the Agency's ALADDIN A+M data system and was also published in a hard copy form. Work has started on establishing recommended

databases for the all collision processes ofHe-atoms (colliding with all major plasma constituents and impurities), chemical erosion of carbon-based fusion reactor materials, and thermo-mechanical properties of Be and some other (medium- and high-Z) plasma facing reactor materials.

C. *Co-ordinating Activity in Data Generation, Compilation and Evaluation*

1. Co-ordinated Research Programmes

The work of five Co-ordinated Research Programmes (CRPs) was managed by the A+M Data Unit during the 1993-1994 period, two of which were established in 1994. Three of these CRPs are related to the A+M data area (A+M data for plasma edge studies, for the medium- and high-Z plasma impurities, and for radiative cooling rates of plasma impurities), and two of them are related to PMI and TMP data (plasma-interaction induced erosion and thermo-mechanical properties of plasma facing fusion reactor materials). On average, about 10 laboratories participate in each of these CRPs. Four Research Co-ordination Meetings were organized in the 1993-1994 period, related to these CRPs.

2. A+M/PMI Data Centre Network

The A+M/PMI Data Centre Network (A+M/PMI DCN) consists of 15 national data centres, with a total manpower of about 50 professionals. Many of the national data centres increase their activity by consultancy services. The activity of the A+M/PMI DCN is co-ordinated by the IAEA A+M Data Unit through both direct interactions and biennial meetings. The last A+M/PMI DCN meeting was held in September 1993.

3. IAEA A+M Data Centre Operations

- AMDIS and ALADDIN

  In 1993 the A+M Data Unit established the Atomic and Molecular Data Information System (AMDIS), which includes both ALADDIN (the IAEA A+M/PMI numerical databases) and the IAEA A+M bibliographic database. The content of AMDIS is on-line accessible via INTERNET. The ALADDIN data storage and exchange system is now undergoing a major structural and functional extension, and a new, C-version of the system should be completed by mid-1995. AMDIS resides on an IBM RS 6000 AIX computer system.

- International Bulletin on A+M Data for Fusion and CIAMDA-3

  The bibliographic Bulletin on A+M data for fusion continued to be published semi-annually. Its current distribution includes about 900

recipients. The A+M/PMI bibliographic database is now included in AMDIS and is on-line accessible to external users. The cumulative bibliographic information (since 1987) is now being prepared for a separate publication (CIAMDA-3), scheduled to appear in 1995.

- Data Dissemination and Services

  All databases and other data information produced by the CRPs, the A+M/PMI Data Center Network (DCN) and the IAEA A+M Data Unit data activities are stored in ALADDIN (AMDIS) and, at the same time, they are published in hard-copy versions. These publications are widely distributed to fusion laboratories and other interested users. The new databases are regularly publicized in the bibliographic Bulletin.

  The IAEA A+M Data Unit sporadically (once per week, on average) receives requests for specific data services (such as data retrieval, questions on data availability, more general question on the role of specific processes in fusion plasmas, etc).

4. *Other Activities*

Besides the meetings related to the work of CRPs and A+M/PMI Data Center Network, the A+M Data Unit has organized in the 1993-1994 six other experts' meetings in support of the ongoing programmes or for initiations of new programmes. Two volumes of the IAEA series on "Atomic and Plasma-Material Interaction Data for Fusion" have been prepared, edited and published, and a similar work has been done for two other book-format publications (one published in 1993 by Elsevier, and another prepared for Plenum, to be published in 1995).

Part of the IAEA Data activity is strongly related to ITER EDA needs, and there is an active (formalized) working-level interaction between the A+M Data Unit and the ITER central teams in the area of ITER divertor design. The Head of the A+M Data Unit is member of the Expert Team for the ITER Divertor Physics Design.

APPENDIX

Meetings 1993 and 1994

Altogether 22 meetings were conducted in the period 1993-94. They are listed below as follows: 1 Technical Committee Meeting, 3 Data Centre Co-ordination Meetings, 2 Scientific Advisory Group Meetings, 8 Research Co-ordination Meetings and 8 Consultants' and Specialists' Meetings.

A. Technical Committee Meeting

A.1. 19th Meeting of the "International Nuclear Data Committee".

- Venue & date: Vienna, Austria, 8-12 March 1993
- Report: INDC/P(94)-1
- Responsible officers: H.D. Lemmel, N. Kocherov

B. Data Centre Co-ordination Meetings

B.1. Advisory Group Meeting on the "Co-ordination of the Nuclear Reaction Data Centres Network".

- Venue & date: Paris, France, 25-27 April 1994
- Report: INDC(NDS)-308, July 1994
- Responsible officers: O. Schwerer, Ch.L. Dunford, H.D. Lemmel
- Details: See section IV.A.1.

B.2. Advisory Group Meeting on the "Co-ordination of the Nuclear Structure and Decay Data Evaluators Network".

- Venue & date: Berkeley, U.S.A., 16-20 May 1994
- Report: INDC(NDS)-307, August 1994
- Responsible officers: Ch.L. Dunford, H.D. Lemmel
- Details: See section IV.A.2.

B.3. Consultants' Meeting: Ad-hoc Meeting of the Heads of the Main Nuclear Data Centres.

- Venue & date: Vienna, 31 October - 1 November 1994
- Report: INDC(NDS)-324, Draft March 1995
- Responsible officers: Ch.L. Dunford, H.D. Lemmel
- Details: See section IV.A.3.

C. Scientific Advisory Group Meetings

C.1. Advisory Group Meeting on "Review of Uncertainty Files and Improved Multigroup Cross Section Files for FENDL"

- Venue & date: JAERI, Japan, 8-12 November 1993
- Report: INDC(NDS)-297, March 1994
- Responsible officer: S. Ganesan
- Details: See section V.A.1.

C.2. Advisory Group Meeting on "Improved Evaluations and Integral Data Testing for FENDL"

- Venue & date: Garching, Germany, 12-16 September 1994
- Report INDC(NDS)-312, December 1994
- Responsible officer: S. Ganesan
- Details: See section V.A.2.

D. Research Co-ordination Meetings

D.1. 2nd Research Co-ordination Meeting on "Compilation and Evaluation of Fission Yield Nuclear Data"

- Venue & date: Vienna, Austria, 21-23 April 1993
- Report: none
- Responsible officer: M. Lammer
- Details: See section V.B.3.

D.2. 2nd Research Co-ordination Meeting on "Activation Cross Sections for the Generation of Long-lived Radionuclides of Importance in Fusion Reactor Technology"

- Venue & date: Del Mar, California, U.S.A., 29-30 April 1993
- Report: INDC(NDS)-288, November 1993
- Responsible officer: A.B. Pashchenko
- Details: See section V.B.2.

D.3. 3rd Research Co-ordination Meeting on "Atomic and Molecular Data for Radiotherapy"

- Venue & date: Vienna, 15-18 June, 1993
- Report: IAEA TECDOC, submitted for print
- Responsible officer: N.P. Kocherov
- Details: See section V.B.1.

D.4. 1st Research Co-ordination Meeting on "Development of Reference Input Parameter Library for Nuclear Model Calculations of Nuclear Data"

- Venue & date: Cervia, Italy, 19-23 September 1994

- Report: INDC(NDS)-321, December 1994
- Responsible officer: P. Obložinský
- Details: See section V.B.6.

D.5. 1st Research Co-ordination Meeting on "Establishment of an International Reference Data Library of Nuclear Activation Cross Sections"

- Venue & date: Debrecen, Hungary, 4-7 October 1994
- Report: INDC(NDS)-320, January 1995
- Responsible officer: A.B. Pashchenko
- Details: See section V.B.5.

D.6. 3rd Research Co-ordination Meeting on "Compilation and Evaluation of Fission Yield Nuclear Data"

- Venue & date: Vienna, Austria, 17-19 October 1994
- Report: INDC(NDS)-332, under preparation
- Responsible officer: M. Lammer
- Details: See section V.B.3.

D.7. 2nd Research Co-ordination Meeting on "Improvement of Measurements, Theoretical Computations and Evaluations of Neutron Induced Helium Production Cross Sections"

- Venue & date: Beijing, China, 1-4 November 1994
- Report: INDC(NDS)-323, January 1995
- Responsible officer: A.B. Pashchenko
- Details: See section V.B.4.

D.8. 1st Research Co-ordination Meeting on "Measurement, Calculation and Evaluation of Photon Production Data"

- Venue and date: Bologna, Italy, 14 - 17 November 1994
- Report: INDC(NDS)-330, under preparation
- Responsible officer: P. Obložinský
- Details: See section V.B.7.

E. Consultants' and Specialists' Meetings

E.1. Consultants' Meeting on "Standard Input Data Sets for Nuclear Model Computations of Nuclear Data"

- Venue & date: Sirolo/Ancona, Italy, 21-25 June 1993
- Report: INDC(NDS)-282, September 1993
- Responsible officer: A.B. Pashchenko
- Details: See section V.B.6.

E.2. Specialists' Meeting on "Comparison of Activation Cross Sections Measurements and Experimental Techniques for Fusion Reactor Technology"

- Venue & date: JAERI, Japan, 15-17 November 1993
- Report: INDC(NDS)-301, May 1994
- Responsible officer: A.B. Pashchenko
- Details: See section V.C.6.

E.3. Consultants' Meeting on "Preparation of Processed Nuclear Data Libraries for Thermal, Fast and Fusion Research and Power Reactor Applications"

- Venue & date: Vienna, 8-10 December 1993
- Report: INDC(NDS)-299, March 1994
- Responsible officer: S. Ganesan
- Details: See section V.C.2.

E.4. Consultants' Meeting on "Preparation of Fusion Benchmarks in Electronic Format for Nuclear Data Validation Studies"

- Venue & date: Vienna, 13-16 December 1993
- Report: INDC(NDS)-298, March 1994
- Responsible officer: S. Ganesan
- Details: See section V.A.3.

E.5. Specialists' Meeting on "Evaluation of Charged Particle and Photonuclear Data for the IAEA FENDL Project"

- Venue & date: Smolenice, Slovakia, 18-21 April 1994
- Report: INDC(NDS)-306, November 1994
- Responsible officer: A.B. Pashchenko
- Details: See section V.A.3.

E.6. Second Specialists' Meeting on "Comparison of Activation Cross Sections Measurements and Experimental Techniques for Fusion Reactor Technology"

- Venue & date: St.Petersburg, Russia, 7-9 September 1994
- Report: INDC(NDS)-319, January 1995
- Responsible officer: A.B. Pashchenko
- Details: See section V.C.6.

E.7. Consultants' Meeting on "Nuclear Data for Fission Reactor Decommissioning"

- Venue & date: Vienna, 5-7 December 1994
- Report: INDC(NDS), under preparation
- Responsible officer: N.P. Kocherov
- Details: See section V.C.3.

E.8. Specialists' Meeting on "the Development of an International Nuclear Decay Data and Cross-section Database".

- Venue & date: Vienna, 14-18 October 1994

- Reports: INDC(NDS)-328, Summary
  INDC(NDS)-329, Papers
- Responsible: H.D. Lemmel
- Details: See section V.C.5.