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INTERNATIONAL NUCLEAR DATA COMMITTEE

Report of the IAEA Nuclear Data Section

to the

International Nuclear Data Committee

for the period 1995/1996

Pavel Obložinský

July 1997

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

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**Report of the IAEA Nuclear Data Section
to the
International Nuclear Data Committee
for the period 1995/1996**

Abstract

This progress report describes the activities of the IAEA Nuclear Data Section in the years 1995 and 1996, 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.

Pavel Obložinský

July 1997

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Nuclear Data Section

Organization Chart

(15 July 1997)

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(04914-33-P5)
(21709/21710)

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Nuclear Data Physicist
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INDC Secretariat

Section Head
Deputy Section Head
E. Baumgartner

| <i>Nuclear Data Centre Unit</i> | <i>Nuclear Data Development Unit</i> | <i>Computer Operations Unit</i> | <i>Atomic and Molecular Data Unit</i> |
|---|--|---|---|
| Vacant (Head) Nuclear Data Physicist (04950-33-P4) (21717) | P. Obložinský (Head) Nuclear Data Physicist (04923-33-P5) (21712) | D.W. Muir (Head) Section Head (04914-33-P5) (21709) | R.K. Janev (Head) Atomic Physicist (04932-33-P4) (21731) |
| M. Lammer Asst. Nucl. Data Phys. (05078-33-G7) (21727) | M. Herman Nuclear Physicist (04969-33-P4) (21713) | R. Arcilla Data Service Specialist (05041-33-P2) (21720) | J.A. Stephens Atomic Physicist/ Dev. Programmer (04987-33-P3) (21729) |
| Q. Schwerer Asst. Nucl. Data Phys. (05133-33-G7) (21715) | R. Paviotti de Corcuera Nuclear Data Information Physicist (05023-33-P3) (21708) | M. O'Connell Data Entry Clerk (06499-33-G4) (21722) | K. Sheikh Document Clerk/Typist (05142-33-G4) (21730) |
| H. Wienke Nuclear Physicist (05069-33-P2) (21714) | M. Wirtz Office Clerk (05087-33-G4) (21711) | E. Baumgartner Secretary (05050-33-G4) (21710) | |
| P.K. McLaughlin Programmer Analyst (06619-33-P3) (21723) | | | |
| G. Bush Production Progr. (05106-33-G5) (21725) | | | |
| A. Scherbaum Secretary (05115-33-G4) (21726) | | | |
| Vacant Secretary (05096-33-G4) (21716) | | | |

GLOSSARY OF ABBREVIATIONS

| | |
|----------|--|
| A+M | Atomic and Molecular Data for fusion applications |
| AGM | Advisory Group Meeting of the IAEA |
| AMDIS | Atomic and Molecular Data Information System |
| BNL | Brookhaven National Laboratory, Upton, N.Y., USA |
| BROND-2 | Russian evaluated neutron reaction data library, version 2 |
| 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, version 2 |
| 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 FEI, 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 |
| JEFF-3 | The Joint European Fission and Fusion File (combines the former JEF and EFF) |
| 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" |
| NDIS | Nuclear Data Information System |
| 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 | Radievj 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

As a result of budget cuts in 1995-96, the Section lost 3 positions compared to 1994. The authorized staff level was reduced from 22 (status as of December 1994) to 19 (status as of December 1996). The present authorized staff consists of 10 Professional (P-Staff), 5 Support (G-Staff) and 4 Secretarial (G-Staff). Of these, 2 Professionals (3 Professionals until May 1996) and 1 Secretary are assigned to the Atomic and Molecular Data Unit.

During the period 1995-96, except at the very beginning of 1995, the Section did not operate at its full strength. Fairly large difference between the authorized staff level and the actual staff level is caused by several factors, of which the most important is the Agency fixed-term contract policy for P-staff and related high P-staff turnover coupled with slow hiring procedures.

The post of the Section Head was vacant for 11 months after Charles Dunford left in July 1995. It was filled by Douglas Muir in June 1996. In the interim period Pavel Oblozinsky served as acting Section Head. Nikolai Kocherov retired in April 1995, his position was occupied by Robert Langley of the Atomic and Molecular Data Unit until May 1996. This position has now been returned to the Nuclear Data Development Unit. Gordon Mundy retired in October 1995, and his position was lost. Hans Lemmel retired in November 1996 after 32 years of outstanding service.

The budget for the Nuclear Data Section in 1995-1996 was reduced by about US\$ 250,000 and US\$ 350,000, respectively, compared to 1994. To make the budget comparison in different years meaningful, we follow the current Agency practice. The figures given in the table below consider the constant exchange rate of 12.7 AS for 1.0 US\$ and take into account the price increase. Thus, the budget in 1995 was US\$ 2,312,000, in 1996 it was US\$ 2,271,000 including 3.5% price increase, mainly reflecting increased salaries.

BUDGET AND STAFF SUMMARY 1995 -1998

| | 1995 | 1996 | 1997 | 1998 |
|------------------------|-----------|-----------|-----------|-----------|
| Authorized Staff Level | 20 | 19 | 19 | 19 |
| Actual Staff Level | 18.9 | 18.0 | 17.8* | 18.5* |
| Staff Cost Budget | 1,652,000 | 1,630,000 | 1,600,000 | 1,600,000 |
| Programmatic Budget | 660,000 | 641,000 | 645,000 | 614,000 |
| Total Budget US\$ | 2,312,000 | 2,271,000 | 2,245,000 | 2,214,000 |
| Price increase | - | 3.5% | 0.5% | 0.0% |

* *Estimates*

Staff costs represent approximately 73% of the budget, leaving 27% percent for programmatic activities. In 1995-96, the Nuclear Data activity amounted to approximately 75% of the total budget. The remaining 25% was devoted to Atomic and Molecular Data activities.

The actual expenses are at the moment available for 1995 only. They, on the first look, differ substantially from the original budget. This is largely due to changes in exchange rates. Thus, the 1995 adjusted budget was US\$ 2,819,700 (exchange rate, 10.03 AS for 1.0 US\$), and the actual expenditures were US\$ 2,749,937. As indicated by the actual staff level, the Section underspent planned staff-cost money. On the other hand, the Section overspent planned equipment money (purchase of DEC Alpha computer), and it overspent research contract money (individual Research Contracts).

In the period 1997-1998, we anticipate unusually high (half of all professional positions) staff turnover. In February 1997, Michal Herman filled in the post vacated by Nikolai Kocherov/Robert Langley. Anatoly Pashchenko left in March 1997, his position was filled by Racquel Paviotti Corcuera in July 1997. The important position of the Data Center Unit Head should be filled by late summer 1997. The critical post of the DEC Alpha computer manager, held by Ramon Arcilla, will be vacated in February 1998. Harm Wienke's contract will expire in October 1998.

The 1997-1998 budget was submitted on the level equal to that of 1996. The approved budget is somewhat below the 1996 budget. This is caused by the fact that there was an overall cut across the Agency of non-staff travel and staff travel money (10%), of printing money and general expenses. The assumed small price increase of 0.5% in 1997 is explained by the fact that staff salaries will be not inflation-adjusted. No price increase for 1998 is foreseen at the moment.

II. DATA CENTER OPERATION

A. Data Compilation

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 1995/1996 seven EXFOR tapes were transmitted to the other centers containing

| | |
|------|----------------------------|
| 73 | new entries |
| 263 | data tables (= subentries) |
| 4489 | data lines |

coming from Bangladesh (1 entry), Brazil (2), China (31), Czechia (1), Finland (1), Germany (14), Hungary (19), Slovakia (1), Thailand (1), USA (1), and Vietnam (1).

In addition, these EXFOR tapes included revisions of 14 earlier entries.

The handbook CINDA95 was published as cumulative issue (1988 - 1995), CINDA96 was published as supplement to CINDA95. Some delays were experienced, due to the reprogramming necessary for the introduction of the new Archive EXFOR-CINDA dictionaries.

The acquisition and documentation of evaluated data files continued as publicized in

Nuclear Data Newsletter No. 21, July 1995
Nuclear Data Newsletter No. 22, November 1996.

Important NDS products in this 2-year period were

- the Neutron Metrology File NMF-90, which presents the updated International Reactor Dosimetry File IRDF integrated with PC codes; see IAEA-NDS-171;
- and the official release of Version 1 of the Fusion Evaluated Nuclear Data Library, FENDL-1.

Summaries of available nuclear data libraries are contained in the updated reports

| | |
|------------------------|---|
| IAEA-NDS-7 Rev. 96/11 | (available libraries), and |
| IAEA-NDS-107 Rev. 11 | (joint index to BROND, CENDL, ENDF/B, JEF, JENDL), IRDF, EFF and FENDL). |
| IAEA-NDS-150 Rev. 96/8 | "Online Nuclear Data Service", User manual", by C.L. Dunford and T.W. Burrows |

**Table 1: EXFOR neutron reaction data of area 3 by country
(by 31 December 1996)**

| Country | Data lines | Subentries | Entries |
|------------------|------------|------------|---------|
| Algeria | 3 | 2 | 1 |
| Argentina | 3053 | 103 | 30 |
| Australia | 7327 | 475 | 75 |
| Bangladesh | 1620 | 102 | 20 |
| Bolivia | 1 | 1 | 1 |
| Bulgaria | 40 | 30 | 13 |
| Brazil | 4332 | 101 | 21 |
| Chile | 145 | 29 | 10 |
| China *) | 7570 | 737 | 206 |
| Colombia | 1 | 1 | 1 |
| Croatia | 15 | 15 | 1 |
| Czechoslovakia | 862 | 100 | 29 |
| Czech Republic | 151 | 6 | 3 |
| Egypt | 3678 | 132 | 24 |
| German Dem. Rep. | 23144 | 410 | 47 |
| Hungary | 2737 | 649 | 110 |
| India | 2583 | 988 | 177 |
| Iran | 2 | 2 | 2 |
| Iraq | 1672 | 31 | 11 |
| Israel | 266 | 59 | 24 |
| Korea, Rep. | 12 | 9 | 3 |
| Malaysia | 4 | 2 | 1 |
| Mexico | 143 | 21 | 4 |
| Morocco | 401 | 114 | 12 |
| Myanmar (Burma) | 2 | 2 | 1 |
| New Zealand | 25 | 6 | 2 |
| Pakistan | 1816 | 103 | 21 |
| Poland | 5127 | 559 | 95 |
| Romania | 1751 | 156 | 38 |
| South Africa | 7181 | 187 | 21 |
| Saudi Arabia | 22 | 18 | 2 |
| Slovakia | 65 | 6 | 2 |
| Sudan | 3 | 3 | 1 |
| Thailand | 909 | 47 | 3 |
| Vietnam | 24 | 22 | 5 |
| Yugoslavia | 3108 | 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" (tables).

*) Including 14 entries from Taiwan, China containing 46 Subentries with 621 data lines

B. Data Services

1. Services by mail

The request statistic for mail shipment requests is given in Tables 2 and 3 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, for example, for both experimental and evaluated data, it is counted as 2 requests. In the past 5 years, requestors from 95 countries have been served by mail shipment.

While the number of requests per year was fluctuating around 700 - 800 until 1995, a decrease by about 40% can be seen for 1996. Probably the main reason for this is the delay in publishing the Nuclear Data Newsletter in 1996 which reached the users only in December. In past years always a large fraction of the requests received came in direct response to the Newsletter, while the requests stimulated by the 1996 Newsletter started coming in only in January 1997. Efforts will be made to publish 2 issues of the Newsletter per year. Target publication dates are March and September of each year, starting in 1997.

Table 2: Data Request Statistics 1986 - 1996 for services by mail

| | Biblio-graphic information | Documents | Expt. Data | Eval. Data | Data pro-cessing 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 | 426/1324 | 31/41 | 260/435 | 25/44 | 742/1844 |
| 1992 | 0/0 | 507/1422 | 27/32 | 237/303 | 142/161 | 913/1918 |
| 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 |
| 1995 | 0/0 | 452/1155 | 8/16 | 228/357 | 18/28 | 706/1556 |
| 1996 | 0/0 | 242/554 | 12/14 | 147/205 | 11/13 | 412/786 |

Note: The notation, e.g. 86/173 under Eval.Data, means that on 86 incoming requests 173 evaluated data libraries have been sent out

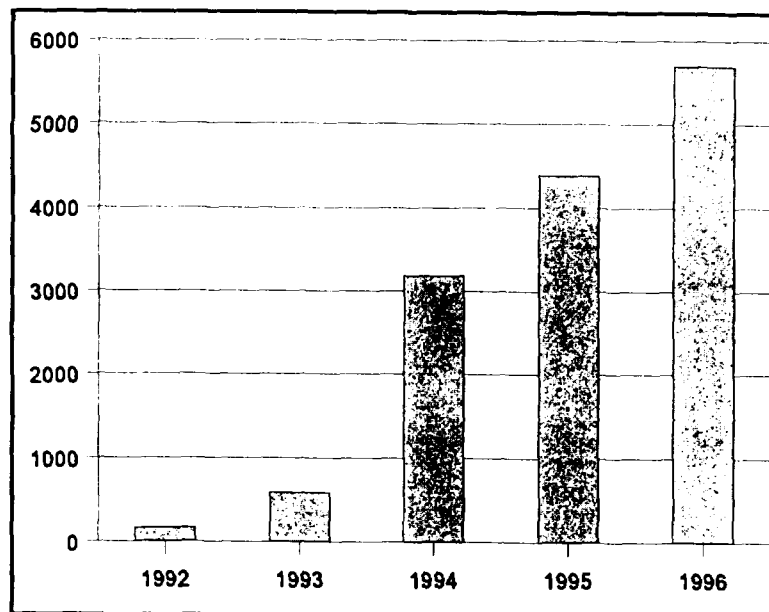
Table 3: Shipment of Tapes and Diskettes by Year

| Year | Magnetic tapes (including DAT types) | PC diskettes | Sum |
|------|--|--------------|-----|
| 1990 | 214 | (no records) | - |
| 1991 | 457 | (no records) | - |
| 1992 | 143 | (no records) | - |
| 1993 | 125 | 367 | 492 |
| 1994 | 168 | 486 | 654 |
| 1995 | 140 | 463 | 603 |
| 1996 | 68 | 621 | 689 |

2. Online nuclear data services

The usage of the Telnet-based online nuclear data service NDIS has again increased by about 25% from 1995 to 1996 as can be seen from Table 4. In 1996, 5700 retrievals were made. By January 1997, there are registered users from 46 countries (see Table 5); the breakdown of retrievals by geographical region, in comparison with the mail services, is given in Table 6.

Table 4: Retrieval statistics for the Nuclear Data Information System (NDIS)



Development of the retrieval statistics of the nuclear data Online (Telnet) Services, which are presently used by 42 Member States

Table 5: Registered Users of NDIS by Country (January 1997)

| Country | Users ("Names") | Country | Users ("Names") |
|----------------|-----------------|----------------|-------------------------|
| Algeria | 1 | Japan | 3 |
| Argentina | 11 | Korea, Rep. | 7 |
| Australia | 16 | Latvia | 1 |
| Austria | 22 | Mexico | 4 |
| Belgium | 4 | Netherlands | 4 |
| Brazil | 12 | New Zealand | 1 |
| Bulgaria | 5 | Norway | 1 |
| Canada | 6 | Poland | 17 |
| Chile | 1 | Romania | 6 |
| Colombia | 1 | Russia | 32 |
| Croatia | 4 | Slovakia | 7 |
| Cuba | 1 | Slovenia | 2 |
| Czech Republic | 19 | South Africa | 7 |
| Denmark | 1 | Spain | 9 |
| Finland | 6 | Sweden | 1 |
| France | 7 | Switzerland | 3 |
| Germany | 23 | Thailand | 3 |
| Hungary | 26 | Turkey | 1 |
| India | 6 | United Kingdom | 12 |
| Ireland | 1 | U.S.A. | 47 |
| Israel | 10 | Venezuela | 2 |
| Italy | 15 | Yugoslavia | 1 |
| Jamaica | 1 | | |
| | | 45 countries | 359 users ^{*)} |

Table 6: Nuclear Data Services in 1992 - 1996 by Geographical Region

| Region | Services by Mail | | Online Services (NDIS) | |
|---------------------------------|------------------|------------------------|------------------------|--------------------------|
| | # of countries | percentage of requests | # of countries | percentage of retrievals |
| OECD countries (incl. Japan) | 20 | 29 | 17 | 35 |
| former USSR | 6 | 9 | 2 | 25 |
| East Europe | 12 | 16 | 9 | 33.3 |
| Asia, Australia | 16 | 25 | 6 | 0.3 |
| Africa and Near East | 27 | 11 | 2 | 3.1 |
| Latin America | 14 | 10 | 6 | 3.3 |
| | 95 | 100% | 42 | 100% |

*) This total includes 1 user from Taiwan, China

In November 1996, a dedicated Nuclear Data Webserver started its operation on the NDS DEC Alphaserwer computer. The new WWW pages offer

- direct WWW access to a number of databases, documents and nuclear data utility programs;
- a Web version of the catalog of nuclear data libraries available from NDS (IAEA-NDS-7 called on the Web the "IAEA Nuclear Data Guide"), with many internal and external hypertext links;
- a Web version of the latest Nuclear Data Newsletter;
- general information on the NDS services and programs, and a direct link to the Telnet-based service NDIS.

The URL address of the Webserver is: <http://www-nds.iaea.or.at/>

Many of these new features were developed in cooperation with NNDC. For the future, the introduction of more WWW interfaces is planned, gradually replacing part of the Telnet-based retrieval possibilities. Considering the poor networking and computing infrastructure in many developing countries, it is not expected that the conventional services can be eliminated any time soon. Even users in developed countries have experienced periods of unsatisfactory overall network transmission speed. The transmission speed has fluctuated dramatically, and the underlying reasons for this are a topic of active investigation by NDS and Computer Centre staff.

A first attempt at extracting usage statistics for the NDS Web Server is given in Figs. 1 and 2.

Monthly Web Statistics

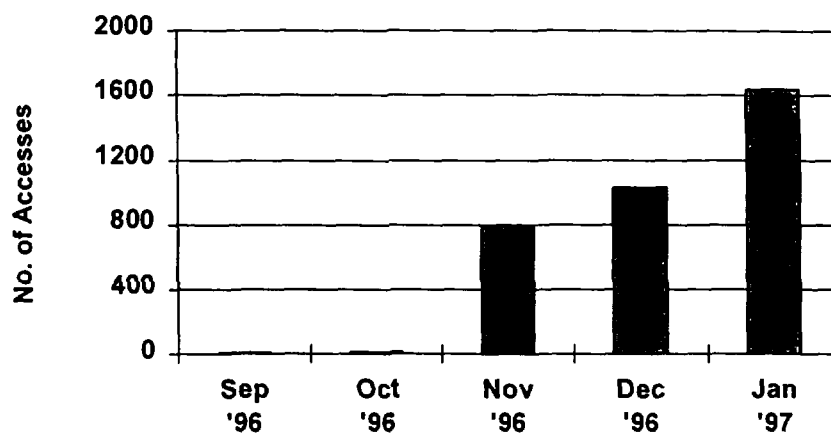


Fig. 1 shows the Web access statistics from the start of the NDS dedicated Webserver. By January 1997, the number of access had grown to 1641.

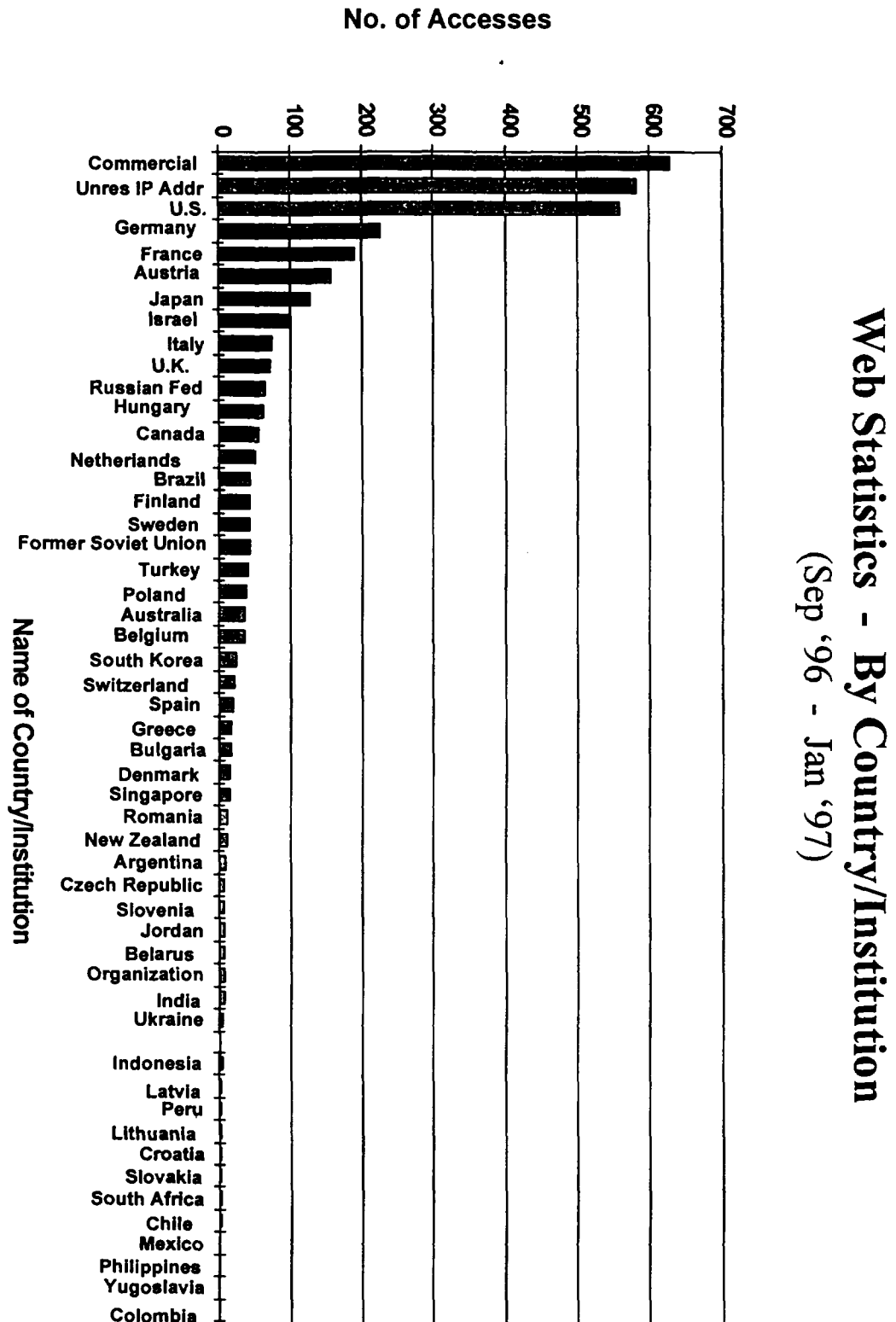


Fig. 2 shows the Web access up to January 1997 by country. Because of the Internet addressing system (unresolved numerical addresses and addresses ending with 'COM' or 'ORG'), not all accesses can be traced back to a particular country

Several files, databases, documents and programs are available (as an alternative to direct WWW access) by FTP (Internet File Transfer Protocol), as is the FENDL library. A statistics program to keep track of the number of retrievals made this way is still being developed.

III. COMPUTER OPERATIONS

In October 1995, the Section retired its pioneering VAX-4000/200 and VAXstation 3100 computers, and installed a single-processor 275-MHz AlphaServer 2100 computer system with 256 MB of main memory on the NDS Ethernet local area network (LAN). The whole package, i.e., hardware, software and installation services, was obtained at a cost of US\$ 130,000. The AlphaServer provides 10 times the processing power of the previous VAXcluster. In 1996, the LAN was upgraded at a cost of an additional US\$ 95,000.

A. Hardware and Software Migration

The following hardware-related tasks were completed in 1995:

- A 275-MHz AlphaServer computer with 256 Megabytes of main memory was installed and tested.
- The following old peripheral devices were migrated from the VAX/VMS to the AlphaServer/Open VMS environment: nine Gigabytes of external DSSI disk drives, seven X-Window terminals, one IBM PS/2 PC, 13 VT-420 terminals, one 9-track magnetic tape drive, one DAT drive, three CD-ROM drives, one DEClaser printer and two HP LaserJet 4M printers.

In addition, the following software-related tasks were carried out:

- OpenVMS operating system and almost two dozen software products were installed on the AlphaServer .
- ONLINE SERVICES system was migrated immediately thereafter by C.L. Dunford (NNDC Brookhaven, USA) from the VAX to the Alpha environment.

B. Hardware and Software Improvements

The Section's Ethernet LAN has continually undergone upgrades since it became operational in October 1995 to keep its functionalities in tune with the changing computing needs. The following hardware upgrades were undertaken:

- a) Two DEC Multia workstations were installed, to be used for: 1) building, testing and maintaining the Section's Web pages, 2) network administration, and 3) developing client/server applications.
- b) The Section's computing resources (except for secretarial PCs) were relocated outside the Agency's FireWall security system to prevent inconveniences to remote users of the Section's electronic data services.

- c) The following peripheral devices were added to the LAN in 1996:
- a DEC Digital Linear Tape drive for large-capacity, unattended backup;
 - a fast HP LaserJet 5SiMX to handle large-volume print jobs (2000 sheet capacity);
 - the AlphaServer's main random-access memory was doubled to 512 Megabytes and an additional 12 Gigabytes of disk storage capacity was installed.

Figure 1 shows the current Ethernet LAN configuration. The AlphaServer computer and most of its peripheral devices are now located on the Section's office floor (A23). The retired VAX-4000/200 had been housed in the IAEA's central computing facility, which has naturally tightly-controlled physical access for non-computer-centre staff members.

Furthermore, the following software products were installed on the AlphaServer over the last year or so to enhance its overall functionality and usefulness to the end-users:

- a) Web browsers (Netscape and Mosaic), a Web server and document viewers to allow the Section to build and maintain its own Web site as well as access other Web sites.
- b) A MIME-capable messaging system and a powerful document conversion utility to handle the exchange and distribution of data, programs and documents through electronic mail.
- c) DOS/Windows Emulator to allow X-Window terminal users who do not have a PC on their desktops to handle applications and documents which specifically require the DOS/Windows environment.

C. Inter-Centre Cooperation

The Section continued to benefit from having similar computing facilities to that of NNDC, Brookhaven, USA. In September 1996, T. Burrows installed on the AlphaServer Web-related applications software developed at the NNDC, particularly ENSDF and the Wallet Cards. Since then, retrieval of data through the Web site has demonstrated steady growth.

1. Planned Computing Facilities Upgrade

The Section will continue to upgrade its computer facilities when needed to match growth in the demand for service. For the period 1997 to 1998, the following activities are foreseen:

Nuclear Data Section Floor, A23

Central Computer Services Floor, F06

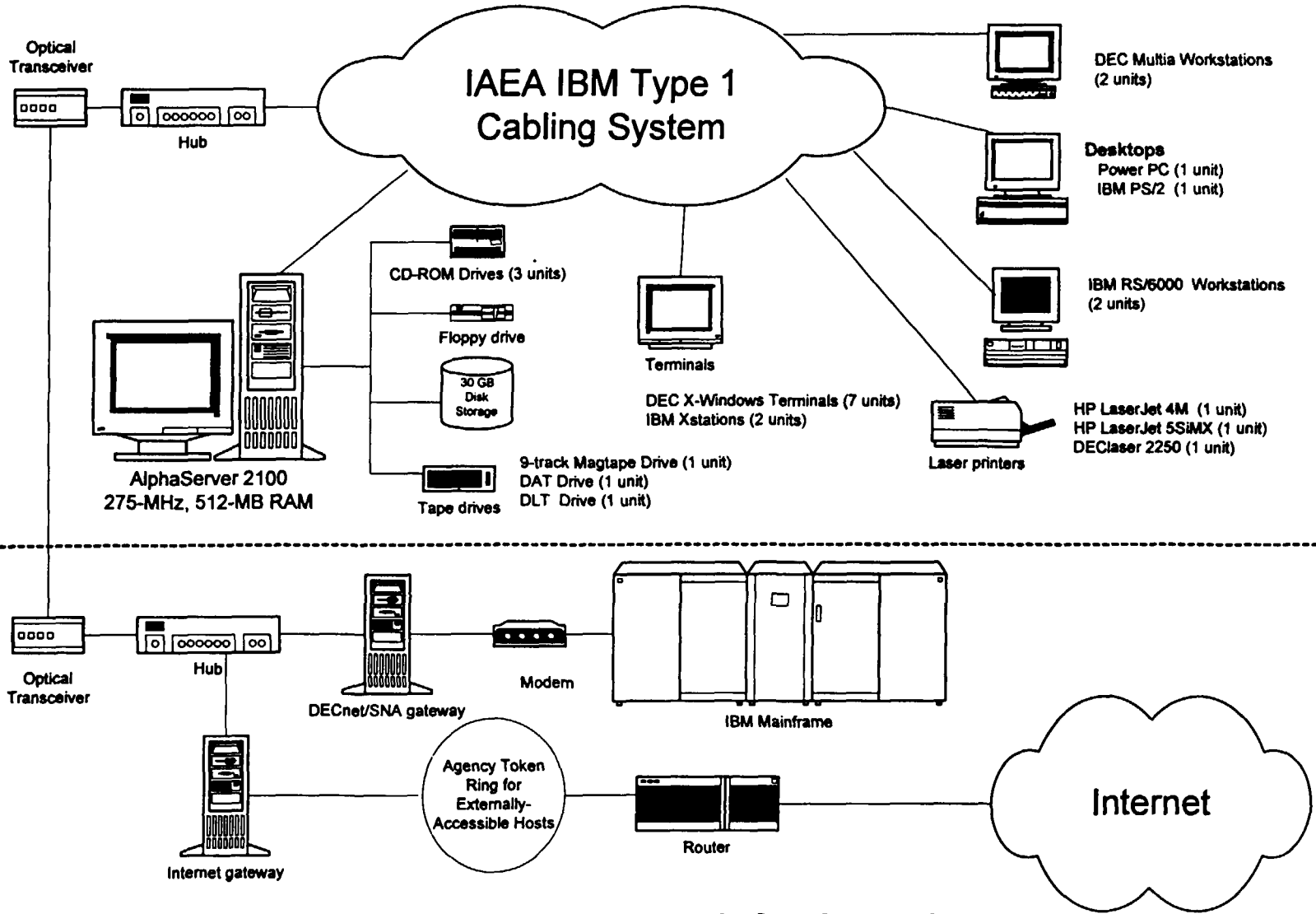


Fig. 1: The IAEA/NDS Ethernet LAN Configuration

- Another Alpha-based workstation will be purchased for the incoming head of the data centre unit to give him the flexibility to run Windows NT, Digital UNIX or OpenVMS.
- Client/server applications will be developed to replace the outmoded “legacy” systems running on the IBM mainframe. The clients will be X-Windows-based desktops and the database server will be the AlphaServer.
- A Compact Disc writer has been purchased and installed in a PC. It will be used in distributing data libraries and processing codes on CD-ROM.
- An IBM E30 UNIX Server was purchased in July 1997 for the Atomic and Molecular Data Unit. This workstation will be the central server for accessing the atomic and molecular databases and has approximately three times the processing speed of the previous server.

IV. NETWORK COORDINATION

The network of eleven Nuclear Reaction Data Centers (see Table 7) continued its smooth cooperation, with four main elements:

- compilation of experimental data in EXFOR and CINDA;
- exchange of evaluated nuclear data files;
- exchange and joint operation of related software; and
- the work-sharing in the Data Center Services to customers worldwide.

In all of these elements there is lack of manpower, leading to delays in data transmission as well as in developing improved processing and checking codes. However, despite the reduced manpower available, significant amounts of valuable new data have been exchanged.

Table 7: Network of 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 Reakcih (= 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 1995 - 1996

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

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

Type: Consultants' Meeting

Objective:

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

Product/result:

1. Report INDC(NDS)-343 containing updated coding rules and actions for the next two years.
2. Regular data exchange by tape or FTP in agreed procedures.

2. Co-ordination of the Nuclear Reaction Data Centres Network, Brookhaven, USA, 3 - 7 June 1996

Type: Advisory Group Meeting

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)-360 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.

3. Co-ordination of the Nuclear Structure and Decay Data Evaluators Network, Budapest, Hungary, 14 - 18 October 1996

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 nuclear programs in energy and non-energy nuclear technologies in the Member States.

Product/result:

Report INDC(NDS)-363 (in preparation) will contain specific recommendations on methods to reduce the estimated 25 evaluator-year backlog of experimental structure data waiting to be put into ENSDF, to increase co-ordination with the nuclear reaction community, and to move toward increased usefulness of ENSDF in multiple fields of application.

B. 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. The timeliness of the transmissions has improved, as can be seen in Table 8.

Table 8: CINDA/EXFOR data transmission (20 January 1997)

| | Last CINDA entries received ^{*)} | Last EXFOR entries received ^{*)} |
|-----------|--|---|
| from NNDC | September 96 | December 96 |
| from NEA | August 96 | December 96 |
| from NDS | July 96 (believed to be up-to-date and complete except for China) | January 97 |
| from CJD | January 97 | January 97 |

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

Though the regularity of transmissions between the four neutron centers has improved compared to the 1993/94 period, the delay from publication date to the center-to-center transmission was still between ½ year and 3 to 4 years, which is far from satisfactory (see Table 9).

**Table 9: New EXFOR entries (neutron data) transmitted
January 1995 - January 1997**

| | <u>Publication Year</u> | | | | | | | |
|-------------|-------------------------|----|----|----|----|----|----|--------------|
| | 96 | 95 | 94 | 93 | 92 | 91 | 90 | pre-90 |
| from NNDC | 11 | 6 | 10 | 5 | 1 | 1 | - | - |
| from NEA-DB | 0 | 3 | 12 | 5 | 17 | 10 | - | 1 |
| from NDS | 2 | 6 | 13 | 1 | 4 | - | - | 15 (Chinese) |
| from CJD | 0 | 11 | 19 | 7 | 5 | 7 | 4 | 10 |

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

2. Evaluated Data

In 1995 - 1996, the following major evaluated data files have been released to the network:

- ENDF/B-VI updates and ENDF utility codes by NNDC
- CENDL-2.1 by CNDC
- EFF-2.4 by NEA-DB
- the neutron activation library ADL-3 and the intermediate energy data library MENDL-2 by CJD
- new version of PREPRO96 codes by R. Cullen

3. Charged-particle Reaction Data and Photonuclear Data

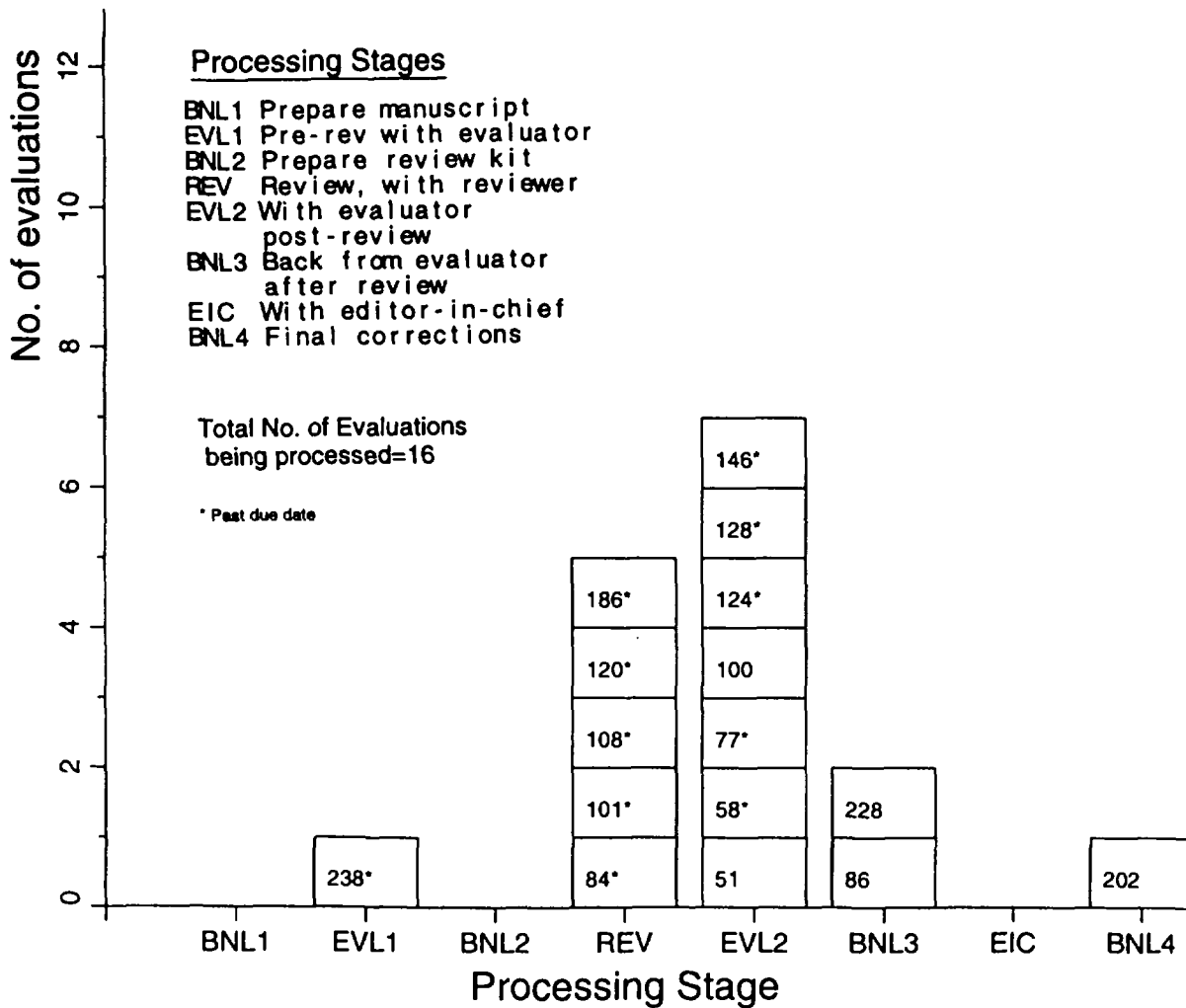
The charged-particle reaction data file in EXFOR has grown considerably. Between January 1995 and January 1997, 8 transmissions were received from CAJaD (Kurchatov Institute, Moscow), 3 of which contain compilations made in the Sarov center (Arzamas). Through NEA, 3 transmissions containing intermediate energy CPND, compiled at CAJaD under contract with NEA, were received. After an interruption of several years, NNDC transmitted 6 CPND EXFOR tapes in 1996. The first two CPND transmission tapes compiled at ATOMKI/Debrecen (finalized in cooperation with NDS) were also distributed. Contributions were received also from the two Japanese CPND centers and from the Chinese center.

In photonuclear data, the main compilation activity was a major revision of the EXFOR entries originating from the US "Berman file" by V. Varlamov (CDFE, Moscow State University) including not only corrections but many additional data tables, and one transmission of new compilations by CDFE.

4. Nuclear Structure and Decay Data

The current (February 1997) status of the preparation of ENSDF evaluations is shown in Table 10, supplied by J. Tuli, NNDC.

Table 10: Status of ENSDF Evaluation Processing



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V. NUCLEAR DATA IMPROVEMENT PROJECTS

The objective of these projects is to assess current nuclear data needs and to improve and/or develop data files for the most critical energy and non-energy applications and to maintain standards and reference nuclear data. The activity in 1995-96 was focused on the final release of the first version of the Fusion Evaluated Nuclear Data Library (FENDL-1), preparations for assembling a much improved version, FENDL-2, on 8 Research Coordinated Programmes, and 6 other projects. The achievements are discussed in more detail below. Added is a summary of plans for 1997-98.

A. Fusion Evaluated Nuclear Data Library, FENDL

The first version of the comprehensive evaluated nuclear data library for fusion applications, FENDL-1, was tested, benchmarked and validated. The library, containing about 1 GBytes of numerical data, was officially released in February 1996, with the master copy residing at the IAEA Nuclear Data Section. In the process of FENDL-1 validation, needs for improvements were identified. In 1996, selection of improved activation and basic evaluations was performed, processed sublibraries were produced, and the improved version of the library, FENDL-2, was largely completed. An Advisory Group Meeting to finalize FENDL-2 is scheduled for March 1997.

In 1995-96, the project was supported by 3 small Consultants' Meetings devoted to specific technical problems and by 1 major Advisory Group Meeting for an overall review of FENDL:

- Consultants' Meeting on "Selection of Evaluations for the FENDL/A-2 Activation Cross Section Library" was held in St. Petersburg, Russia, 25-27 June 1995. Selection of activation data for the improved sublibrary, FENDL/A-2, was performed.
- Consultants' Meeting on "Benchmark Validation of FENDL-1" was held in Karlsruhe, Germany, 17-19 October 1995. A comprehensive benchmark validation of FENDL-1 was reviewed.
- Advisory Group Meeting on "Completion of FENDL-1 and start of FENDL-2" was held in Del Mar, USA, 5-9 December 1995. Status of FENDL-1 was reviewed and its official release was approved. Procedures for preparing FENDL-2 were agreed.
- Consultants' Meeting on "Selection of Basic Evaluations for the FENDL-2 Library" was held in Karlsruhe, Germany, 24-28 June 1996. Selection of basic evaluations for the FENDL/E-2 sublibrary was performed. Out of 63 materials in FENDL/E-1, better evaluations for 11 materials were selected for FENDL/E-2 and 13 materials were added.

References:

- INDC(NDS)-341, February 1996 (CM Summary Report)
 INDC(NDS)-351, January 1996 (CM Summary Report)
 INDC(NDS)-352, March 1996 (AGM Summary Report)
 INDC(NDS)-356, September 1996 (CM Summary Report)

B. Coordinated Research Programmes

Altogether, 8 Coordinated Research Programmes (CRP) were active during the period 1995-96. For each CRP at least one Research Coordination Meeting (RCM) was held. Two CRPs were completed, 1 is nearing completion and 2 new were initiated. As the final result of the CRP completed in 1994, the extensive IAEA-TECDOC-799 "Atomic and Molecular Data for Radiotherapy and Radiation Research" was published (May 1995, editor N. Kocherov).

| Short Title | Duration | Participants (Contracts) | Officer | Remark |
|--------------------------|----------|-----------------------------|------------|---------------|
| Long-lived Radionuclides | 1989-96 | 11 (0) | Pashchenko | Completed |
| Fission Yields | 1991-97 | 7 (1) | Lammer | Last RCM held |
| He Production | 1992-96 | 9 (3) | Pashchenko | Completed |
| Activation Library | 1993-97 | 8 (5) | Pashchenko | |
| Input Parameters | 1994-97 | 9 (3) | Oblozinsky | |
| Photon Production | 1994-98 | 9 (3) | Oblozinsky | |
| Medical Radioisotopes | 1995-99 | 7 (3) | Oblozinsky | New |
| Photonuclear Data | 1996-00 | 6 (3) | Oblozinsky | New |

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

- The goal of the CRP was to obtain reliable information (experimental and evaluated) for 16 long-lived activation reactions of special importance to fusion reactor technology.
- The last (3rd) RCM was held in St. Petersburg, Russia, 19-23 June 1995. Evaluation of most of reactions was completed and CRP was completed. Final Report for the CRP is under completion.

Summary of final results achieved:

- New evaluations for 12 neutron-induced reactions were completed in the incident energy range from threshold up to 20 MeV. Uncertainties for 8 of them are considered to be satisfactory.

| Reaction | Evaluation | Uncertainties |
|--------------------------|------------|---------------|
| 27-Al(n,2n)Al-26 | new | |
| 63-Cu(n,p)Ni-63 | new | |
| 94-Mo(n,p)Nb-94 | new | satisfactory |
| 109-Ag(n,2n)Ag-108m | new | satisfactory |
| 151-Eu(n,2n)Eu-150g | new | satisfactory |
| 153-Eu(n,2n)Eu-152g+m2 | new | satisfactory |
| 158-Dy(n,p)Tb-158 | new | |
| 159-Tb(n,2n)Tb-158 | new | satisfactory |
| 179-Hf(n,2n)Hf-178m2 | new | satisfactory |
| 182-W(n,n'alpha)Hf-178m2 | new | |
| 187-Re(n,2n)Re-186m | new | satisfactory |
| 193-Ir(n,2n)Ir-192m2 | new | satisfactory |

- no new evaluations were made for the remaining 4 reactions, all of them (n,gamma). Use of other evaluations was recommended, though uncertainties are considered to be too high.

| Reaction | Evaluation |
|-----------------------------|------------|
| 62-Ni(n,gamma)Ni-63 | Other |
| 98-Mo(n,gamma)Mo-99 → Tc-99 | Other |
| 165-Ho(n,gamma)Ho-166m | Other |
| 191-Ir(n,gamma)Ir-192m2 | Other |

- Evaluated cross sections for all 16 reactions were accepted for inclusion in the FENDL activation sublibrary, FENDL/A-2.

References:

INDC(NDS)-340, November 1995 (RCM Summary Report)
 INDC(NDS)-342, February 1996 (RCM Papers)
 INDC(NDS)-344, in print (CRP Final Report)

2. CRP on "Compilation and Evaluation of Fission Yield Nuclear Data"

- The goal of the CRP was to improve existing evaluations and evaluation methodology up to 20 MeV to arrive at complete, consistent and reliable evaluated fission yield sets including covariances and energy dependence.

- The CRP was extended for additional 2 years, 1995-96. Last (4th) RCM was held in Vienna, 14-18 October 1996. CRP is nearing completion, and the final report is in preparation as an IAEA-TECDOC.

Summary of final results achieved:

- Measurement methods for various fission yields types were reviewed and summarized: auxiliary data for analysis, corrections, typical systematic and minimum errors, to be considered in the evaluation process.
- The computer program ZOTT using covariance information was adapted for fission yield evaluation and applied:
 - * for studies of the energy dependence of experimental fission yields
 - * to produce U-235 reference fission yields (thermal neutron and energy dependent yields).
- Models for mass and charge distribution of isomeric ratios were further developed and tested. Reliable parameters were derived allowing prediction of yields for practically all fissioning nuclei with varying accuracy. Related uncertainties were also derived for use in evaluations.
- A new model for deriving isomeric yield ratios from spin distributions was developed and tested. For reliable systematics further measurements are required.
- Theoretical investigations to develop a model for the energy dependence of fission yields and to study systematic trends were completed. Their practical applicability was found insufficient. Work on semiempirical systematics was done, but further measurements are required.

References:

IAEA TECDOC, in preparation (CRP Final Report)

3. CRP on "Improvement of Measurements, Theoretical Computations and Evaluations of Neutron Induced Helium Production Cross Sections"
 - The goal of the CRP was to improve knowledge of neutron induced helium production cross sections up to 20 MeV and to provide reliable data for the important structural materials, especially for Cr, Fe and Ni.
 - The last (3rd) RCM was held in Sendai, Japan, 25-29 September 1995. CRP was completed and a CRP Status Report was prepared, but some follow-up activity is still needed.

Summary of final results achieved:

- Evaluation of helium production on 56-Fe was completed. Results were included into EFF-3.0 and selected for inclusion in FENDL/E-2.
- Double-differential measurements of helium production on 58,60-Ni were completed. Experimental database seems to be adequate for total helium emission cross sections for nat-Ni and its main isotopes. Evaluation is expected to be completed in 1997.
- No measurements were performed for the main isotope of chromium, 52-Cr, due to lack of suitable targets. Evaluation is pending.
- New activation data of helium production for a number of isotopes were measured.
- Progress in theoretical computations of He-production was achieved. Particularly, detailed analysis of related level density parametrization was performed.

References:

INDC(NDS)-353, September 1996 (RCM Summary Report)
INDC(NDS)-358, December 1996 (CRP Status Report)

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

- Goal of the CRP is to provide a universal reference database of most important neutron activation cross sections up to 20 MeV and related decay data for a broad range of applications.
- The 2nd RCM was held in Madrid, Spain, 13-16 May 1996. Master list of 257 reactions was prepared and agreed. The following applications were considered: magnetic and inertial confinement fusion, fission reactors, geophysics and borehole logging, dosimetry, and astrophysics. Selection of reactions largely agrees with that for the core of activation reactions selected for FENDL/A-2. In addition, selection of 41 reactions was made. A starter file of the library, IRDL, was assembled at NDS.

References:

INDC(NDS)-361, in print (RCM Summary Report)

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

- The goal of the CRP is to develop a complete starter file of the input model parameter library for model calculations of nuclear reactions induced by neutrons, gammas and light charged particles with incident energies up to about 100 MeV.
- The 2nd RCM was held in Vienna, Austria, 30 October-3 November 1995. Assembly of 2 sublibraries was completed, assembly of 4 remaining sublibraries is near completion. Selection of recommended input parameters is under way. Staircase plots of cumulative numbers of discrete levels for level density calculations were produced. Handbook on the Starter File is in preparation.

References:

INDC(NDS)-350, March 1996 (RCM Summary Report)
INDC(NDS)-367, May 1997 (Staircase Plots)

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

- The goal of the CRP is to work out procedures and methods to be recommended for future evaluations of photon production data, and improve selected photon production cross sections in general purpose nuclear data libraries.
- The 2nd RCM was held in Vienna, Austria, 21-24 May 1996. Atlas of Neutron Capture Cross Sections was completed and submitted for print. Improved evaluations of photon production for C and O were performed for JENDL-3.2. A file of gamma ray strength functions was nearly completed. Assessment of status of photon production data is under way (capture, 14 MeV, higher energies). Outline of the Final Report of the CRP was prepared.

Reference:

INDC(NDS)-357, December 1996 (RCM Summary Report)
INDC(NDS)-362, April 1997 (Atlas of Neutron Capture)

7. CRP on "Development of Reference Charged-Particle Cross Section Database for Medical Radioisotope Production"

- The goal of the CRP is to develop a reference database of cross sections for production of radioisotopes most commonly used in medicine with beams of light charged particles up to about 30 MeV with a possible later extension up to about 100 MeV. The CRP will cover beam monitor reactions, and reactions for production of gamma and positron emitters.

- The CRP was prepared, approved and initiated in 1995. The 1st RCM was held in Vienna, Austria, 15-17 November 1995. Collection of experimental data is underway for cross sections of 7 proton-induced beam monitor reactions, and for 6 proton-induced gamma emitter reactions for production of ^{111}In , ^{201}Tl and ^{123}I .

References:

INDC(NDS)-349, March 1996 (RCM Summary Report)

8. CRP on "Compilation and Evaluation of Photonuclear Data for Applications"

- The goal of the CRP is to produce a Handbook on Photonuclear Data and to develop internationally available Photonuclear Library. The Library will focus on data for medical applications (shielding and biology materials) for photons up to 25 MeV.
- The CRP was prepared, approved and initiated in 1996. The 1st RCM was held in Obninsk, Russia, 3-6 December 1996. Outline of Handbook on Photonuclear Data was prepared, priority list of materials and procedures for preparing the IAEA Photonuclear Library were agreed.

References:

INDC(NDS)-364, April 1997 (RCM Summary Report)

C. Other Projects

1. Handbook on Nuclear Data for Safeguards

A PC version of the Handbook was created, using the 1991 database published in INDC(NDS)-248. A user can receive the Handbook on diskette with the option to view it on the screen or to print a hard copy.

An updated database, revision of INDC(NDS)-248, is in preparation; publication is planned in spring 1997.

2. Nuclear Data Standards

A Consultants' Meeting was held (Vienna, 2-6 December 1996) on update of INDC database "Nuclear Data Standards for Nuclear Measurements". Reviewed were standards for $\text{H}(n,n)$, $^{10}\text{B}(n,\alpha)$, $^{209}\text{Bi}(n,\text{fission})$ and $^{235,238}\text{U}(n,\text{fission})$. Work on the Handbook was initiated.

3. Fission Product Newsletter

Work continued on the report series "Progress in Fission Product Nuclear Data". The 15th issue of this series is under preparation and it will be published in spring 1997.

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

Envisaged for 1995-96 were voluntary contributions to updates of "Decay Data for Actinides", IAEA TECDOC-261 (1986), and also "X- and Gamma-Ray Standards for Detector Calibration", IAEA TECDOC-619 (1991). Due to lack of funds, no essential activity was performed.

5. Data Needs for Medical Applications

A Consultants' Meeting was held (Vienna, 9-11 December 1996) to review the status of nuclear data needed for radiation therapy and existing data development activities. It was recommended that the IAEA focus on data for accelerator-based neutron capture therapy, heavy-ion radiation therapy, production of therapeutic radionuclides and activation cross sections of tissue and shielding elements by particle therapy beams. Distribution of information in the forthcoming ICRU Report on "Nuclear Data for Neutron and Proton Radiation Therapy" by the IAEA was recommended.

6. Individual Research Contracts

Current IAEA policy limits the granting of individual research contracts, which are research contracts not related to a CRP. Despite that, thanks to the availability of funds, it was possible to award 29 individual research contracts in 1995 (mostly at the very end of the year) with an average financial support between 4 000 and 5 000 US\$ per contract per year. In 1996, the number of individual research contracts was reduced to about one half. By comparison, at the end of 1994 only 8 individual research contracts were active.

D. Summary of Activities Planned for 1997-98

In 1997-98, four ongoing Co-ordinated Research Programmes will be completed: Fission Yields, Reference Activation Library, Photon Data, and Input Parameter Library (Starter file). Three new CRPs will be initiated.

An emphasize will be on development of databases for theoretical evaluations of nuclear reaction data. CRP on Input parameter library (Phase I: Starter File) will be followed by Nuclear model parameter testing (Phase II).

The near-term emphasise will be placed on development of databases for medical applications. Two CRPs will continue (Medical Radioisotopes and Photonuclear Data).

Transmutation of nuclear waste will be addressed by initiating a new CRP on fission yields for neutrons above 20 MeV with a focus on minor actinides.

Fusion related activity will be decreased. FENDL-2 will be completed and officially released as early as possible in 1997. A limited follow-up activity is foreseen. A new CRP will be initiated on activation data for fusion technology.

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VI. Technical Cooperation and Technology Transfer

A. Technical Cooperation Projects

The following Technical Cooperation (TC) projects were active in 1995-96.

1. Project UKR/0/003, Institute for Nuclear Research of the Ukrainian Academy of Sciences, Kiev, Ukraine, "Organization of Ukrainian Nuclear Data Center"

The objective of the project is to provide a VAX computer and advice on the establishment of a nuclear data centre.

This is the so-called "Footnote A" project, meaning that funding must be provided by a donor country. In the present case the funds were provided by the USA for fellowships, and under discussion is the purchase of a DEC Alpha computer.

In 1996, Victor Zerkin was trained for 3 months in the NNDC, Brookhaven National Laboratory, USA, in use of the DEC Alpha computer. Nina Kalach was trained for 3 months in the ORNL, Oak Ridge, USA in nuclear data processing.

2. Project ETH/1/005, Department of Physics Addis Ababa University, Ethiopia, "Teaching Applied Nuclear Physics"

Two expert missions were organized during the period 1995-1996. The neutron detector, G-M counter, scintillation detector, HPGe detector were checked and put into operation. Lectures on neutron activation analysis were delivered, the local staff had received the basic training. Some spare parts for the liquid nitrogen plant were provided. At present the Nuclear Laboratory of the Physical Department of the University is used normally for teaching and performing some routine measurements. A fellowship for one of the University staff members to the IAEA Seibersdorf Laboratory is in preparation.

3. Project NIR/2/005, Department of Physics, Ile-Ife University, Nigeria "Neutron Activation Analysis"

An expert mission was organized in 1996 to repair the neutron generator. At present the generator is in operation.

The project was closed.

4. Project SIL/0/005, Physics Department, University of Sierra Leone, Freetown, Sierra Leone, "Nuclear Science Laboratory"

An expert mission is in preparation to put into operation the XRF spectrometer provided by the IAEA. The software for data treatment and analysis will also be installed.

B. Workshop on Nuclear Data, ICTP Trieste, 15 April - 17 May 1996

The Workshop on "Nuclear Reaction Data and Nuclear Reactors – Physics, Design and Safety", held at the International Centre for Theoretical Physics in Trieste from 15 April to 17 May 1996, was organized in collaboration with the Italian Comitato Nazionale dell' Energia Nucleare ed Energia Alternative (ENEA, Italy) and the Nuclear Data Section.

The 5-week Workshop was followed by 1 week in-depth training for two selected groups at ENEA laboratories, nuclear data at ENEA Bologna and reactor calculations at ENEA Rome. The Workshop was attended by 50 participants, 47 of whom were from 24 developing countries.

The Workshop was directed by A. Gandini (ENEA Rome), J. Kupitz (IAEA, Nuclear Power Technology Development Section), P. Oblozinsky (IAEA, Nuclear Data Section), M. Ravnik (Institute Josef Stefan, Ljubljana, Slovenia) and G. Reffo (ENEA Bologna) with the assistance of H.R. Dalafi and L. Fonda (both ICTP Trieste).

The Workshop provided 2 weeks of training on nuclear reaction data evaluation, followed by 1 week of nuclear data processing, followed by 2 weeks of reactor calculations. NDS staff presented, among others, 2 lectures on "Nuclear Data Libraries" and "Online Services". The Proceedings of the Workshop will be published by World Scientific, Singapore, later this year.

C. Training Courses

No training course on Nuclear Data was given support by the IAEA Department of Technical Cooperation for 1995-96. This is true also for 1997-98. The Section proposed "Methodology of Nuclear Data Evaluation for Use in Industrial Application" in Beijing, October 1996. It further proposed "Applications of Nuclear Data and Measurement Techniques in Nuclear Reactor Dosimetry" in Obninsk, June 1997. None of them was approved; the last TC-supported training course related to nuclear data was held in 1992.

VII. ATOMIC AND MOLECULAR DATA ACTIVITIES

The atomic and molecular (A+M) data activity of the Nuclear Data Section is conducted by the Section's Atomic and Molecular Data Unit, which during the reporting period (until May, 1996) consisted of 3 (now 2) professionals and one clerical staff. The activity in this period was focussed on (1) establishment of new, comprehensive numerical databases for fusion, (2) conducting several CRPs and other data generation and assessment actions, (3) co-ordination of the activity of the A+M Data Centre Network, (4) development of the on-line accessibility of the A+M Data Information System (AMDIS), (5) organization of 5 experts meetings per year, and (6) publication (with editing) of regular (periodic) and other data related Agency publications. The main achievements along the above activity lines of the NDS A+M Data Unit in the reporting period are briefly described below.

A. Establishment of new numerical databases

Databases completed or in progress:

1. "Recommended cross sections for Li atoms interacting with electrons, protons, multiply charged ions and hydrogen molecules"
Completed in 1995. ALADDIN formatted and introduced into AMDIS (in 1996). Hard-copy version in press in ADNDT (to appear in February 1997).
2. He database upgrade
The electron-impact excitation cross section for He were upgraded by newly generated and evaluated results for all $n\ell-n'\ell'$ transitions with $2 \leq n, n' \leq 4$ ($\ell \leq n-1$). A Consultants' Meeting was held to review data evaluation work in this field in November 1995.
3. Be, B database upgrading
 - A group of about 20 experts has carried out sophisticated theoretical calculations on excitation, ionization and electron capture processes of Be^{q+} and B^{q+} ions colliding with H, H_2 and He. The results of this effort are published as a Topical issue of Physica Scripta, **T62**, 1996.
 - A consultancy meeting was held in September 1996 devoted to the upgrading (new data and assessment) of electron-impact excitation and ionization cross sections for Be^{q+} and B^{q+} ions.
4. Handbook on erosion rates of Be, C-based and W fusion materials
 - More than 800 data files for the physical sputtering, chemical erosion and radiation enhanced sublimation for Be, C-based, and W plasma facing fusion materials were prepared (data collected, critically assessed, ALADDIN formatted) for inclusion in the erosion rate

Handbook. A data assessment/ Handbook editing specialists' meeting was held in December 1996. The publication of the Handbook is scheduled for 1997.

B. Co-ordinated Research Programmes

The following active CRPs were run or initiated in 1995-1996:

1. Plasma-interaction induced erosion of fusion reactor materials.
(10 participants; terminated at the end of 1995)
2. Tritium retention and release from fusion reactor plasma facing components.
(6 participants; 1st RCM held in October 1995)
3. Atomic and plasma-wall interaction data for fusion reactor divertor modeling.
(12 participants, 1st RCM held in November 1995)
4. Collection and evaluation of reference data for thermomechanical properties of fusion reactor plasma facing components.
(6 participants; 2nd RCM held in March 1996)
5. Radiative cooling rates of fusion plasma impurities.
(9 participants; 1st RCM held in October 1996)

C. Co-ordination of A+M Data Centre Network Activity

A+M Data Centre Network (DCN) presently includes about 15 national data centres, with activities covering spectroscopic and collisional atomic and molecular data, particle-surface interaction data, and thermophysical and thermomechanical material properties data. The financial and manpower situation in the A+M DCN continues to be stable. The DCN activity is focussed on data areas of both immediate and long-term interests of the international fusion programme. The 13th A+M DCN meeting was held in July 1995.

D. Development of AMDIS

The online electronic access to the Atomic and Molecular Data Information System (AMDIS) became fully operational during 1995 via Internet. AMDIS contains both the bibliographic and numerical IAEA A+M databases related to fusion. The associated AMDIS documentation (Users Manual, etc.) is still in a draft form and awaits endorsement by the A+M DCN (at its next meeting in 1997). A C-language version of ALADDIN was also created in 1995. The preparation of a WWW home page for AMDIS is currently underway.

E. Expert meetings in 1995-1996

1995

1. 3rd RCM: "Plasma-Interaction Induced Erosion of Fusion Reactor Materials"
(October 1995; 9 participants)
2. AGM: "13th A+M Data Centre Network Meeting (AGM)"
(July, 1995; 14 participants)
3. 1st RCM: "Tritium Retention in Fusion Reactor PFCs"
(October 1995; 5 participants)
4. 1st RCM: "Atomic and Plasma-Wall Interaction Data for Divertor Modeling"
(November 1995; 10 participants)
5. CM: "Electron-Impact Excitation Cross Section Data for He⁺"
(November 1995; 4 participants)

1996

1. 2nd RCM: "Collection and Evaluation of Reference Data for Thermo-mechanical Properties of Fusion Reactor PFM's"
(March 25-27, 1996; 6 participants)
2. TCM: "9th IFRC A+M Subcommittee Meeting"
(July 1-2, 1996; 8 participants)
3. CM: "Electron Impact Collision Processes of Be and B Ions"
(September 2-3, 1996; 3 participants)
4. 2nd RCM: "Radiative Cooling Rates of Fusion Plasma Impurities"
(October 14-15, 1996; 9 participants)
5. CM: "Preparation of the Handbook on Erosion Data for Fusion"

(December 9-11, 1996; 4 participants)

F. Publications

1. Regular

- a) "International Bulletin on Atomic and Molecular Data for Fusion"
(vol. 49 (1995); vols. 50-51 (1996))

- b) "Atomic and Plasma-Material Interaction Data for Fusion"
(vol. 6 (1995); vol. 7 (1996; in preparation)

2. Others

- a) "Atomic and Molecular Processes in Fusion Edge Plasmas" (book)
Ed.: R.K. Janev (Plenum Press, New York, 1996)
- b) "Collision Processes of Be and B Ions and Atoms"
Physica Scripta Topical Issue T62 (1996). Guest Editor: R.K. Janev
- c) "Collision processes of Li atoms with electrons, protons, multiply
charged ions and hydrogen molecules" (D. Wute, R.K. Janev et al)
At. Data Nucl. Data Tables, 65 xxx (1997) (in print)
- d) More than ten data related INDC(NDS) reports.

Appendix

Meetings 1995 and 1996

Altogether 19 meetings were conducted in the period 1995-96. They are listed below as follows: 1 Technical Committee Meeting, 3 Data Centre Co-ordination Meetings, 1 Scientific Advisory Group Meeting, 8 Research Co-ordination Meetings and 6 Consultants' Meetings.

A. Technical Committee Meeting

A.1. 20th Meeting of the "International Nuclear Data Committee"

- Venue & date: Vienna, Austria, 3 - 7 April 1995
- Report: INDC/P(96)-1; September 1996
- Responsible officer: C.L. Dunford

B. Data Centre Co-ordination Meetings

B.1. Consultants' Meeting on "Co-ordination of Nuclear Reaction Data Centers"

- Venue & Date: Vienna, Austria, 2 - 4 May 1995
- Report: INDC(NDS)-343; October 1995
- Responsible officer: H.D. Lemmel and O. Schwerer

B.2. Advisory Group Meeting on "Co-ordination of the Nuclear Reaction Data Centers"

- Venue & date: Brookhaven, USA, 3 - 7 June 1996
- Report: INDC(NDS)-360; November 1996
- Responsible officers: H.D.Lemmel and O. Schwerer

B.3. Advisory Group Meeting "Co-ordination of the International Network of Nuclear Structure and Decay Data Evaluators"

- Venue & Date: Budapest, Hungary, 14 - 18 October 1996
- Report: INDC(NDS)-363; in preparation
- Responsible officer: D.W. Muir

C. Scientific Advisory Group Meeting

C.1. Advisory Group Meeting on "Completion of FENDL-1 and Start of FENDL-2"

- Venue & date: Del Mar, USA, 5 - 9 December 1995
- Report: INDC(NDS)-352; March 1996
- Responsible officer: A.B. Pashchenko

D. Research Co-ordination Meetings

D.1. Research Co-ordination Meeting on “Measurements and Calculations of Activation Cross Sections for the Generation of Long-Lived Radionuclides of Importance in Fusion Reactor Technology”

- Venue & date: St. Petersburg, Russia, 19 - 23 June 1995
- Reports: INDC(NDS)-340 and INDC(NDS)-342; November 1995 and February 1996, respectively
- Responsible officer: A.B. Pashchenko

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

- Venue & date: Sendai, Japan, 25 - 29 September 1995
- Reports: INDC(NDS)-353 and INDC(NDS)-358; September 1996 and December 1996, respectively
- Responsible officer: A.B. Pashchenko

D.3. Research Co-ordination Meeting on “Development of Reference Input Parameter Library (RIPL) for Nuclear Model Calculations of Nuclear Data (Phase I: Starter File)”

- Venue & date: Vienna, Austria, 30 October - 3 November 1995
- Report: INDC(NDS)-350; March 1996
- Responsible officer: P. Obložinský

D.4. Research Co-ordination Meeting on “Development of Reference Charged-Particle Cross Section Database of Medical Radioisotope Production”

- Venue & date: Vienna, Austria, 15 - 17 November 1995
- Report: INDC(NDS)-349; March 1996
- Responsible officer: P. Obložinský

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

- Venue & date: Madrid, Spain, 13 - 16 May 1996
- Report: INDC(NDS)-361; in print
- Responsible officer: A.B. Pashchenko

D.6. Research Co-ordination Meeting on “Measurement, Calculation and Evaluation of Photon Production Data”

- Venue & date: Vienna, Austria, 21 - 24 May 1996
- Report: INDC(NDS)-357; December 1996
- Responsible officer: P. Obložinský

D.7. Research Co-ordination Meeting on "Compilation and Evaluation of Fission Yield Nuclear Data"

- Venue & date: Vienna, Austria, 14 - 18 October 1996
- Report: to be prepared
- Responsible officer: M. Lammer

D.8. Research Co-ordination Meeting on "Compilation and Evaluation of Photonuclear Data"

- Venue & date: Obninsk, Russia, 3 - 6 December 1996
- Report: INDC(NDS)-364; April 1997
- Responsible officer: P. Obložinský

E. Consultants' Meetings

E.1. Consultants' Meeting on "Selection of Evaluations for the FENDL/A-2 Activation Cross Section Library"

- Venue & date: St. Petersburg, Russia, 25-27 June 1995
- Report: INDC(NDS)-341; February 1996
- Responsible officer: A.B. Pashchenko

E.2. Consultants' Meeting on "Benchmark Validation of FENDL-1"

- Venue & date: Karlsruhe, Germany, 17 - 19 October 1995
- Report: INDC(NDS)-351; January 1996
- Responsible officer: A.B. Pashchenko

E.3. Consultants' Meeting on "Compilation and Evaluation of Photonuclear Data"

- Venue & date: Vienna, Austria, 23 - 24 November 1995
- Report: Consultants' report; unpublished
- Responsible officer: P. Obložinský

E.4. Consultant's Meeting on "Selection of Basic Evaluations for the FENDL-2 Library"

- Venue & date: Karlsruhe, Germany, 24 - 28 June 1996
- Report: INDC(NDS)-356; September 1996
- Responsible officer: A.B. Pashchenko

E.5. Consultants' Meeting on update of INDC database "Nuclear Data Standards for Nuclear Measurements"

- Venue & date: Vienna, Austria, 2 - 6 December 1996
- Report: INDC(NDS)-368; May 1997
- Responsible officer: H. Wienke

E.6. Consultants' Meeting on "Status of Nuclear Data Needed for Radiation Therapy and Existing Data Development Activities in Member States"

- Venue & date: Vienna, Austria, 9 - 11 December 1996
- Report: INDC(NDS)-365; January 1997
- Responsible officer: N. Kocherov

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username: FENDL for FTP file transfer of FENDL files
For users with web-browsers: <http://www-nds.iaea.or.at>
