Progress Report of the IAEA Nuclear Data Section, 2000-2001

to the IAEA Technical Meeting
on the Network of Nuclear Reaction Data Centres
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OECD Nuclear Energy Agency
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(Extract taken from report to INDC, May 2002)

1. NUCLEAR DATA SECTION: OVERVIEW

The budget and staffing level of the Nuclear Data Section has been relatively stable during the current reporting period. The authorized staff level for 2001-2002 is 18, consisting of 10 professionals (P-staff) and 8 support staff (G-staff). Of these 18 staff members, 3 (2 P-staff and 1 G-staff) are assigned to the Atomic and Molecular Data Unit.

The previous Section Head (Douglas Muir) retired from his position, effective from 30 June 2001. His successor (Alan Nichols) was unable to take up his duties in the Section until 8 October 2001. The various Unit Heads are:

Robert Clark, Atomic and Molecular Data Unit,

Liam Costello, Systems Development Unit,

Vladimir Pronyaev, Nuclear Data Unit,

Andrej Trkov, Nuclear Data Development Unit (joined NDS on 10 May 2000),

all of whom have contributed to the contents of this report. Pavel Obložinský resigned from his position as Deputy Section Head (effective from 31 March 2000), and has been subsequently replaced by Andrej Trkov. An atomic physicist is being sought as replacement for Jeffrey Stephens, who resigned with effect from 31 December 2001 to accept employment at the University of Colorado in Bolder, USA. The previous Section Secretary (Elisabeth Baumgartner) was promoted to Divisional Secretary (June 2000), and has been replaced by Andrea Scherbaum.

IAEA staff costs after 2000 are shown to rise markedly as a consequence of agreed parity alignments with equivalent workers elsewhere (Table 1). The programme budgets from 2000 to 2003 exhibit some fluctuations, but are almost unchanged bearing in mind the variability of the exchange rates year on year. There has been some shift of emphasis in the programme of the Section, with more resources devoted to workshops and other user training initiatives, and efforts are being made to increase staff involvement in Technical Cooperation projects. Increased communication through the more user-friendly IAEA-NDS Website is a noteworthy feature and continues to aid in reducing other expenditures (e.g., hard-copy printing and manual retrieval). Figures for 2003 are provisional, and subject to significant modifications prior to approval in the autumn of 2002.

Table 1. Budget and staff summary: 2000-2003

	2000	2001	2002	2003
Authorized Staff Level	18	18	18	18
Actual Staff Level	18	18	17	18
Staff Costs Budget US$	1564000	1701465	1760800[+]	1760800[+]
Programme Budget US$	640000	517798	566200	569200
Total Budget US$	**2204000**	**2219263**	**2327000**	**2330000**

[+] Assuming 18 members of staff throughout year.

2. DATA CENTRE ACTIVITIES

The primary objectives of the NDS Nuclear Data Centre in 2000–2001 have been as follows:

- collection, assessment and dissemination of nuclear data for a wide range of applications,
- international exchange of nuclear data,
- co-ordination of the worldwide networks of national and regional nuclear reaction and nuclear structure and decay data centres,
- maintenance of manuals and software for internationally-agreed database formats and exchange procedures,
- improvements to the methods by which the data centre provides Member State users with information.

A new objective has been introduced during this timeframe to accommodate the need to perform database services on different hardware and software platforms:

- co-operate with other centres in the development of platform-independent nuclear databases and services.

2.1 Nuclear Data Compilations

Bibliographic information continues to be compiled on nuclear reaction data for assembly in the computerized formats of CINDA and EXFOR. NDS assumes a supervisory role in this area of NRDC activity.

The general purpose libraries of evaluated nuclear reaction data are prepared under national and regional programmes. After international release, they are placed in the ENDF database by NNDC, Brookhaven. Special purpose nuclear databases, libraries and files are prepared within the framework of IAEA Coordinated Research Projects or national and regional programs, and are documented by the IAEA NDS. Various checks and tests are performed before disseminating the data on request via online access or CD-ROMs.

2.1.1 CINDA

The CINDA exchange format will be revised as an inevitable consequence of the forthcoming unification of CINDA, EXFOR and ENDF to produce a joint nuclear reaction database. These revisions are controlled by NNDC, BNL in cooperation with other data centres. CINDA and Web-retrieval formats will also be substantially extended. The first transition to A4 format for the CINDA book (CINDA 2000) was initiated by the IAEA, while a new layout was approved at the 2001 NRDC meeting and will be implemented in CINDA 2002.

NDS staff scanned over 40 journal titles and about 20 titles from indexing journals. NDS prepared and transmitted 3290 CINDA entries in 2000-2001 either as direct input to the CINDA file (documentation of laboratory work is the responsibility of NDS) or for further processing by other responsible data centres. CINDA 2000 represents the cumulative index for 1988–2000, while CINDA 2002 will be the cumulative index for 1988-2002. NDS has established a duplicate database on the NDS Alpha server for use by CJD (Obninsk), who could not prepare any CINDA input during 2000-2001.

2.1.2 EXFOR

Twenty-five EXFOR entries were compiled during 2000-2001, representing new contributions from Argentina (6), Bulgaria (1), China (13), Hungary (1), Libya (1), Poland (1), Slovakia (1) and Ukraine (1). Seven entries prepared at the China Nuclear Data Centre were checked and processed at NDS, while data received from Ukraine (1) and Argentina (2) in a "raw EXFOR" format were finalized at NDS. Twenty-one charged-particle EXFOR entries compiled at ATOMKI (Hungary) were also checked and finalized at NDS and transmitted separately.

81 TRANS files were checked and included in the EXFOR database, containing 671 neutron entries (184 new, 487 revised), 1295 CPND entries (643 new, 652 revised), and 43 photonuclear entries (33 new, 10 revised). The EXFOR dictionaries were regularly updated and distributed. NDS will become fully responsible for the maintenance of common dictionaries with the development of the joint CINDA/EXFOR/ENDF database.

2.1.3 Evaluated Data Libraries, Files and Programs

Various evaluated data libraries, files and programs have been updated or added to the IAEA NDS database (listed in chronological order):

- IAEA Photonuclear Data Library – available on Web and CD-ROM;
- Charged-Particle Cross Section Database for Medical Radioisotope Production – **available on Web and CD-ROM;**
- FENDL/A in Picture Presentations – available on Web and CD-ROM;
- ENDF/B-VI Library, Release 7 – available on Web and CD-ROM;
- ENDF/B-VI Charged-Particle Sublibraries, Version: April 2000 – available on Web and CD-ROM;
- Nuclear Wallet Cards, Sixth Edition – available on Web and as hardcopy;

- PREPRO2000: 2000 ENDF/B Pre-processing Codes – available on Web and CD-ROM;
- SaBa: Library of Evaluated and Experimental Data on Charged Particles for Fusion Applications, Version for MS Word 97 – available on CD-ROM;
- EXFOR/ACCESS relational database with enhanced search and retrieval capabilities and interactive graphic tools – available on CD-ROM;
- Reference Neutron Activation Library (RNAL) for 255 most important reactions – available on Web and CD-ROM;
- POINT2000: Temperature Dependent ENDF/B-VI, Release 7 Cross Section Library (point-wise data for 8 temperatures between 0 and 2100 K) – available on Web and CD-ROM;
- DROSG-2000: Neutron Source Reactions, Version 2002 – available on Web and CD-ROM;
- Updates to PREPRO2000, updates to graphical pre-processing codes – available on Web or CD-ROM;
- ENDVER – Evaluated Data File Verification Support Package – available on Web and CD-ROM;
- EPDL97 Evaluated Photon and Electron Evaluated Data Libraries in ENDF-6 format – available on Web and CD-ROM;
- EMPIRE-II, System of Codes for Nuclear Reaction Calculations – available on Web and CD-ROM;
- ENDF/B-VI Library, Release 8 – available on Web and CD-ROM.

All these files, libraries and codes are documented either in the IAEA-NDS Report series or in INDC Reports, and are freely distributed.

2.1.4 Future Tasks

Two of the most important tasks to be performed by the NDS data centre within the next two years (2002-2003) are as follows:

- co-operate with other centres to develop the Nuclear Reaction Database (NRD), combining CINDA, EXFOR and ENDF as relational database for multi-platform/multimedia environment, and develop procedures to update and retrieve data;

- assist in the unification of different versions of EXFOR master files in a form acceptable to all network centres.

2.2 Nuclear Data Services

2.2.1 Improvements and Developments

The main activities associated with user services in 2000-2001 have been as follows:

- Layout and design of the NDS Web page has been significantly improved to ease user access;

- Contents of ADLIST (database of user addresses) was substantially updated, along with ease of registration for receipt of NDS publications and data;

- INDC reports are prepared in electronic format, and all of the more recent IAEA-NDS reports and Nuclear Data Newsletters are available on the NDS Web site;

- More than 30 different databases, libraries and computer packages can now be distributed to customers on CD-ROMs, which represents the best media for storing "frozen" versions of the libraries and files; CD-ROMs containing the major databases and interfaces are periodically updated for distribution to customers;

- NDS statistical analysis of Web page usage has been improved to give an accurate and more detailed quantification of user activity;

- EXFOR/ACCESS relational database on CD-ROM with retrieval system and interactive plotting was distributed to users who have no access to the Internet or prefer a localised database;

- Co-operative studies underway with other data centres to develop a platform-independent version of joint Nuclear Reaction Database combining EXFOR, CINDA and ENDF (see Section 2.3).

2.2.2 Statistics

A wide variety of user requests persist, and a range of different media are required to maintain services. These communications include: standard mail for hardcopies of documents, PC diskettes and CD-ROMs, e-mails with attached retrieved data or electronic documents, and on-line transfer of data retrieved by the users through the Web interface. Overall statistical analyses of user services are listed in Table 2 which covers the previous five years.

Table 2. Data Services of IAEA-NDS – Numbers of Serviced Requests and Retrievals per Annum

	1997	1998	1999	2000	2001
Web retrievals from the main NDS nuclear databases	23	4276	9581	9642	12894
Web retrievals of documents and other NDS files	4200	7809	7757	11472	16513
Telnet-based nuclear data retrievals	7350	2700	2180	1387	550
Requests for CD-ROMs	-	205	420	648	883
Off-line retrievals	1900	1995	2290	2557	2231

On-line retrievals from NDS databases are made directly by users through Telnet or Web access to the libraries, files and reports. Each registered retrieval contains at least one homogenous piece of information: one report, or a set of different data retrieved from one library or database, or a computer code or package of codes. On-line retrieval corresponds to a user creating output either on hard disk or in screen mode. CD-ROM distribution is simply the number of CD-ROMs sent to users. Off-line retrievals include dispatch by ordinary mail of hardcopy reports or computer outputs prepared by the NDS staff.

Figure 1 shows various representations of user access to the IAEA-NDS Web server and the mirror system in Brazil, including definition by geographical distribution and topics. The total number of data retrievals has increased by 40% due mainly to customer requirements for data from the general purpose and special applications libraries. Another observation is that the number of queries from developing countries has continued to grow in 2001. More detailed Web statistics are available, including user access from individual countries, monthly access and retrievals from different libraries.

The following trends are noted for the previous two years:

- CD-ROMs with "frozen" or regularly updated libraries and files are a popular medium for data distribution;

- About 32 Gbytes of information were downloaded by Web users in 2001 (doubling of 2000 figure);

- Number of Telnet retrievals is decreasing because of the alternative of user-friendly access to the Web site.

2.3 Development of New Generation of Nuclear Databases

NDS has invested in alternative Relational Database Management Systems, and is looking at various operating systems and hardware platforms. This project will have a major impact on the cost and nature of all nuclear data services, including the formulation of nuclear reaction databases on multisystem/multimedia environments to provide a common solution to the handling of different software and hardware platforms. This approach will create more user-friendly access, and improve the quality of the computerized data services. The new system is being developed in close co-operation with NNDC, based on shared responsibilities. Major nuclear databases will be included (CINDA, EXFOR, ENDF, ENSDF and NSR), and the resulting system will be proposed for the Nuclear Data Centers Network.

Current status:

- co-operative studies are underway with NNDC-USA to develop platform-independent relational nuclear databases and services;

- development of Nuclear Reaction Database (NRDB) is on-going, combining CINDA, EXFOR and ENDF as platform-independent relational database (final results will include procedures for maintenance and retrieval on Web and CD-ROM);

- test version of EXFOR has been developed as a platform-independent database with Web interface;

- EXFOR-relational database was installed on experimental Web sites of NDS and NNDC, and Java-retrieval program for CD-ROM distribution is under development;

- CINDA and ENDF-relational databases are under development.

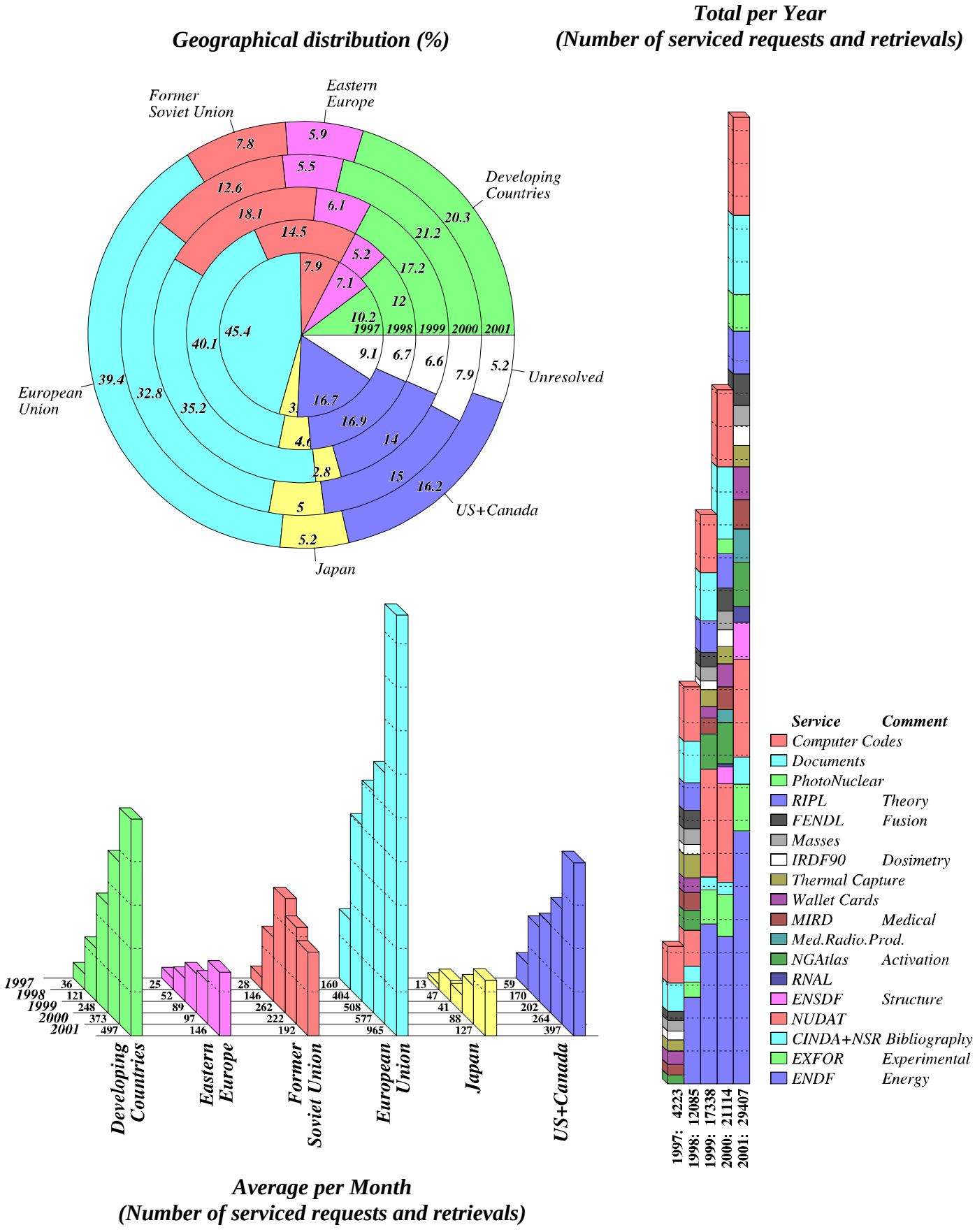

Fig. 1 IAEA Nuclear Data Services: Web Statistics

2.4 Future Tasks

The following tasks will improve user services further, and are proposed for 2003-2005:

- Continue the development of a new generation of nuclear databases (see Section 2.3, above).

- Migration of ADLIST (database for data and reports distribution) to the relational database platform, with addition of distribution options that can be selected by users.

- Creation of data services for special applications (Web pages linked to relevant data on CD-ROMs).

3. NETWORK CO-ORDINATION

3.1 Network of Nuclear Reaction Data Centres

The NDS assists the network of Nuclear Reaction Data Centres by organising the annual coordination meetings. This network includes four core data centres and nine national and specialised data centres. Biennial meetings of the data centre heads are designed to generate general recommendations on nuclear reaction data exchange and the development of shared databases and services. Technical matters associated with data exchange are also considered, although biennial technical meetings every other year are primarily devoted to this topic. Bilateral visits and consultancies are also used to solve difficulties in data exchange and database development.

3.1.1 NRDC Network Meetings

IAEA Advisory Group Meeting on Network of Nuclear Reaction Data Centres, Obninsk, Russia, 15-19 May 2000 (INDC(NDS)-418): conclusions and actions focused on the further development of the nuclear databases and services in a multiplatform/multimedia environment.

IAEA Consultants' Meeting on the Co-ordination of Nuclear Reaction Data Centres, Vienna, 28-30 May 2001 (INDC(NDS)-427): agreed actions focused on the coding rules, dictionaries and software development for nuclear relational databases.

3.1.2 Bilateral visits

- V. Zerkin (NDS) to NNDC, Brookhaven, 11–29 September 2000: participation in Workshop on “Relational Databases for Nuclear Data” and common software development of nuclear databases and services.
- O. Schwerer (NDS) to the Japan Charged-Particle Nuclear Reaction Data Group at Hokkaido University, 29 September – 30 October 2000 (no cost to the IAEA): assist in conversion of compiled nuclear reaction cross sections from NRDF to EXFOR format.
- Y. Ohbayasi, (JCPNRDG, Hokkaido University) to NDS, 13–22 February 2001 (no cost to the IAEA): unification of NRDF and EXFOR databases.

- V. Zerkin (NDS) to NNDC, Brookhaven, 5–16 March 2001: design, development and testing of CINDA/EXFOR/ENDF components of NRDB.
- V. McLane (NNDC, Brookhaven) to NDS, 21–27 May 2001: development of shared nuclear databases and services.
- V. Zerkin (NDS) to NNDC, Brookhaven, 7–21 November 2001: training and cooperation related to the introduction of new RDBM system and programming languages, and common nuclear database development.
- S. Takacs (Nuclear Data Group, Debrecen) to NDS, 3–14 December 2001: conversion of the medical isotope production experimental data files from internal to initial EXFOR format.
- L. Chervonna (UkrNDC, Kiev) to NDS, 18–21 December 2001: training and compilation of latest experimental data produced by Ukraine in EXFOR format; electronic publication of nuclear reactor dosimetry guide.

Detailed information about the NRDC network and latest activities can be found in INDC(NDS)-401 (Rev. 3), "The Nuclear Data Centres Network", ed. by V.G. Pronyaev (Rev. July 2000).

3.1.3 Future Tasks

Completion of the following tasks would improve the co-ordination of the NRDC network:

- Compilation of experimental data by the network data centres, e.g. by organizing workshops for compilers, and using consultants to help bridge gaps in the database.

- Organize workshops, consultancies and bilateral visits that assist in the development of shared databases and related software - requires some changes in NDS tasks as well as wider consideration of such topics at the network coordination meetings.

3.2. Network of Nuclear Structure and Decay Data Evaluators

The international network of nuclear structure and decay data (NSDD) evaluators is sponsored by the IAEA, and consists of evaluation groups and data service centres in several countries. A primary aim of this network is to provide up-to-date nuclear structure and decay data for all known nuclides by evaluating existing experimental data. The network includes more than 20 centres and groups.

Resulting recommended data are included in the Evaluated Nuclear Structure Data File (ENSDF) and published in Nuclear Physics A and Nuclear Data Sheets. Recommended values are made available to users through various media such as online computer services, PC diskettes and compact disks, wall charts of nuclides, handbooks and nuclear wallet cards. The ENSDF master database is maintained by the US National Nuclear Data Centre at the Brookhaven National Laboratory. Data from the latest version of ENSDF are also available from other distribution centres including the IAEA-NDS server.

Biennial meetings of the network assist in the co-ordination of the work by all centres and groups participating in the compilation, evaluation and dissemination of NSDD, and maintaining and improving the standards and rules governing NSDD evaluation. Consideration is also given to the development and use of the computerized systems and databases maintained specifically for this activity. The work of ENSDF evaluators and programmers is coordinated by the NNDC, Brookhaven, including centres that undertake "horizontal" evaluations (specific quantities for a well-defined set of nuclei) and dissemination. Some of the NDS Coordinated Research Projects contribute to the provisions of "horizontal" evaluations.

4. CONCLUDING REMARKS

Other work programmes are undertaken by the NDS (eg. Coordinated Research Projects, Data Development Projects, Workshops Training and Technology Transfer, and Hardware Development). Their features are not mentioned in the report, which focuses exclusively on direct Data Centre activities and associated networks.