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Report of the IAEA Nuclear Data Section to the International Nuclear Data Committee for the Period January 2000 – December 2001

Edited by

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May 2002

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Abstract

This report contains descriptions of the major activities of the IAEA Nuclear Data Section in 2000 and 2001 for review by the International Nuclear Data Committee (INDC). Information is provided on the staff and budget, atomic, molecular and nuclear data activities of the Nuclear Data Center, coordination of the Nuclear Data Center Networks, nuclear data development projects, technology transfer, and computer support. This information is complemented by descriptions of other relevant activities in the reporting period, including meetings and publications. The atomic and molecular data programmes are presented to the INDC for information only, since those specific activities are reviewed in depth by the A+M Subcommittee of the International Fusion Research Council.

May 2002

Table of Contents

Glossary of Abbreviations

A+M	Atomic and Molecular
ADLIST	Address List database
AGM	Advisory Group Meeting (of the IAEA)
ALADDIN	A Labelled Atomic Data Interface
APID	Atomic and Plasma-Material Interaction Data for Fusion
BNL	Brookhaven National Laboratory
CD-ROM	Compact disk with read-only memory
CINDA	Computer Index on Neutron DAta
CJD	Center of Nuclear Data, Obninsk, Russia
CM	Consultants' Meeting of the IAEA
CRP	Coordinated Research Project of the IAEA (compare RCM)
DBMS	Database Management System
DCN	Data Centre Network
DMZ	De-Militarized Zone
ECN	Netherlands Energy Research Foundation
ENDF	Evaluated Nuclear Data File
ENSDF	Evaluated Nuclear Structure Data File
EXFOR	Computer-based system for the compilation and international exchange of experimental nuclear reaction data (EXchange FORmat)
FENDL	Fusion Evaluated Nuclear Data Library
IAEA	International Atomic Energy Agency, Vienna, Austria
ICTP	International Center for Theoretical Physics, Trieste, Italy
IFRC	International Fusion Research Council
INDC	International Nuclear Data Committee
IP	Internet Protocol
IPEN	Instituto de Pesquisas Energeticas e Nucleares
IT	Information Technology
ITC	Information Technology Coordinator
JPO	Junior Professional Officer
NAPC	Division of Physical and Chemical Sciences (of the IAEA)
NDS	IAEA Nuclear Data Section, Vienna, Austria
NDS	IAEA Nuclear Data Service
NEA	Nuclear Energy Agency of the OECD, Paris, France
NNDC	National Nuclear Data Center, Brookhaven National Laboratory, USA
NRDC	Nuclear Reaction Data Centers
NRDF	Nuclear Reaction Data File
NSDD	Nuclear Structure and Decay Data
NSR	Nuclear Science References, a bibliographic file related to ENSDF
OECD	Organization for Economic Cooperation and Development, Paris, France
PGAA	Prompt Gamma Activation Analysis
PPAS	Programme Performance Assessment
RCM	Research Coordination Meeting (compare CRP)
RIPL	Reference Input Parameter Library
RSIC	Radiation Shielding Information Computational Center
TC	Technical Cooperation
TCM	Technical Committee Meeting
TECDOC	Technical document published by the IAEA
VMS	Operating systems of the Compaq Alpha Server
WS	Workshop

Preface

The IAEA Nuclear Data Section is one of four Sections of the Division of Physical and Chemical Sciences which in turn is one of five Divisions of the Department of Nuclear Sciences and Applications. The general mission of the Department is to provide scientific services, including the provision to Member States of good quality nuclear and atomic data. The Sections aims to provide such data in the areas of both energy- and non-energy-related applications.

Efforts continue within the Agency in general to ensure sound external reviews of all programmes. The role of the INDC and the International Fusion Research Council (IFRC) should continue in this vein to provide advice on the nuclear and atomic data programmes, respectively. The INDC and the IFRC are the only two standing committees that advise the Department of Nuclear Sciences and Applications at the level of individual Sections. These bodies will continue to provide their extremely useful services to the Agency. The terms of reference of all standing committees must contain mechanisms for regular rotation of membership, and this desire has been implemented within a re-drafted statement (Terms of Reference, January 2001).

The Section is internally arranged into four Units as shown in the organization chart; the Systems Development Unit was established in 2000 as a consequence of the on-going changes in data services. All contributions to the various sections of this progress report have been prepared by the senior staff in their roles as Unit Heads. Progress reports for all of the IAEA Nuclear Data Programmes are combined within this document, along with related activities during 2000 and 2001. The report focuses on the nuclear data aspect of these activities, constituting about 75% of both the staff efforts and budget of the Section. A summary of atomic and molecular data activities is also given, as reviewed regularly by a subcommittee of the IFRC.

The main text of the report is complemented by Appendices that provide additional information on the activities of the Section in 2000 and 2001. Appendix 1 gives a list of meetings and workshops organized by the Section, and Appendix 2 summarizes publications.

Alan L. Nichols
IAEA Vienna, Austria
May 2002

Nuclear Data Section

Organization Chart
(May 2002)

Section Office (and INDC Secretariat)

Section Head: **A.L. Nichols ***
Nuclear Data Physicist
(21709/21710)

Deputy Section Head: **A. Trkov** #
Nuclear Data Physicist
(21712/21711)

Section Secretary: **A. Scherbaum**
(21710)

Nuclear Data Centre Unit	Nuclear Data Development Unit	Systems Development Unit	Atomic & Molecular Data Unit
V.G. Pronyaev (Head) Nuclear Data Physicist (21717)	**A. Trkov** (Head) Nuclear Data Physicist (21712)	**W. Costello** (Head) Systems Analyst (21724)	**R. Clark** (Head) Atomic Physicist (21731)
P.K. McLaughlin Programmer Analyst (21723)	**M. Herman** Nuclear Physicist (21713)	**M. O'Connell** Applications Programmer (21722)	**vacancy** Atomic Physicist/ Programmer
V. Zerkin Nuclear Physicist/ Programmer (21714)	**R. Paviotti de Corcuera** Nuclear Data Information Physicist (21708)	A. Scherbaum Secretarial support	**K. Sheikh** Database Clerk (21730)
M. Lammer Asst. Nucl. Data Phys. (21727)	**R. Bojdo** + Secretary (21711)		
O. Schwerer Asst. Nucl. Data Phys. (21715)			
G. Bush Production Programmer (21725)			
M. Wirtz Secretary (21716)			

* Alan Nichols commenced his duties in the Nuclear Data Section on 8 October 2001.
\# Andrej Trkov commenced his duties in the Nuclear Data Section on 10 May 2000.
\+ Rozanna Bojdo commenced her duties in the Nuclear Data Section on 1 December 2000.

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.

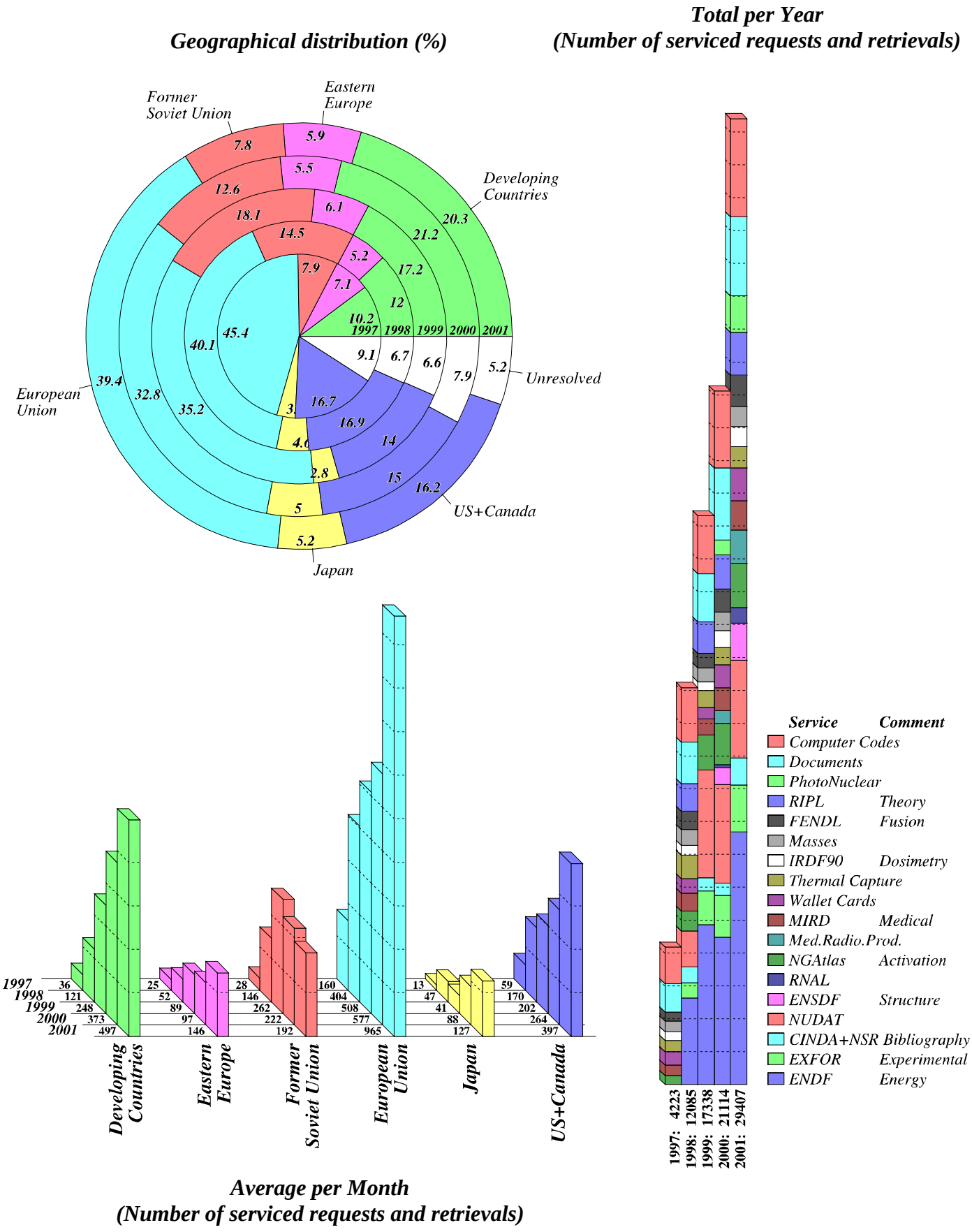

Fig. 1 IAEA Nuclear Data Services: Web Statistics

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 (see CRP list, Section 5.1).

3.2.1 NSDD Network Meeting

Co-ordination of International Network of Nuclear Structure and Decay Data Evaluators, Summary of an IAEA Advisory Group Meeting, Vienna, 4-7 December 2000 (INDC(NDS)-422): conclusions and actions focused on the assignment of mass-chain and nuclide evaluation responsibilities, and the need to extend the network.

3.2.2 Bilateral visits

- T.W. Burrows (NNDC, Brookhaven) to NDS, 8–13 December 2000: installation of Web access to the NSR database and updating of ENSDF and ENDF utility codes.
- D. Winchell (NNDC, Brookhaven) to NDS, 5-9 February 2001: platform independence for network-shared nuclear structure databases and services.
- J. Tuli (NNDC, Brookhaven) to NDS, 3–7 December 2001: preparation of IAEA Workshop on NSDD and evaluation methodologies.
- I. Boboshin (CDFE, Moscow State University) to NDS, 18–21 December 2001: coordination of relational nuclear databases development work.

Detailed information about NRDC network activities can be found in INDC(NDS)-421, "Nuclear Structure and Decay Data (NSDD) Network", compiled by V.G. Pronyaev (February 2001).

3.2.3 Future Tasks

Completion of the following task would improve the performance and assist in ensuring the future continuation of the NSDD network:

- Create a workshop system for the regular training of nuclear structure and decay data evaluators through biennial ICTP-IAEA courses, with a lengthy introduction to nuclear structure theory and the methodology of evaluation that would alternate with IAEA-NDS workshops for ENSDF evaluators.

4. ATOMIC AND MOLECULAR DATA

The mission of the Atomic and Molecular (A+M) Data Unit is to establish and maintain databases in support of magnetic fusion energy (MFE) and other nuclear energy applications. This encompasses a very large number of processes in atomic, molecular, and plasma-material interaction physics. Data for these processes are supplied by research centres around

the world participating in activities such as the Data Centre Network, CRPs, and various other technical meetings. The resulting data are incorporated into the data libraries maintained at the A+M Data Unit, which develops and maintains interfaces to these databases. All such databases are accessible to all Member States through the Internet.

4.1 Data Centre Network

The Data Centre Network (DCN) reviews progress in A+M data-related activities in the twelve established Data Centres. Priorities are set among the data needs of the different members, the methods and procedures applied in the data processing and exchange are reviewed, and work plans are co-ordinated among the Data Centres. The DCN meets biennially (previous meeting held on 10-11 September 2001). Progress reports were presented by each of the Data Centres, including the generation, compilation, and dissemination of data in printed and electronic form, as well as status of the Data Centre programmes and plans for future work. Data Centres are effectively following the recommendations from the previous meeting, and that there is good co-operation.

A lengthy review has been undertaken of the priorities in data generation and compilation. Each item on the previous request list was discussed and evaluated in terms of their urgency and how well the needs have been filled. The result was a revised and comprehensive list of priorities for the generation, evaluation and compilation of data in support of fusion energy research (see summary report INDC(NDS)-430).

An additional and extremely valuable activity of the DCN is the provision of bibliographic data for the A+M Unit publication, the biannual *International Bulletin on Atomic and Molecular Data for Fusion*. Several Data Centres supply bibliographic data to the A+M Data Unit, which combines the data into the finished publication for distribution to Member States.

4.2 Atomic and Molecular Data Subcommittee of the International Fusion Research Council

The A+M Subcommittee of the International Fusion Research Council (IFRC) gives advice and recommendations to the A+M Data Unit. This Subcommittee consists of eleven members, and meets biennially (last meeting was in May 2000). They review past activities of the Unit and recommend future directions. Three new CRPs were strongly recommended in 2000, along with other specific meetings to assess the current status of several types of data relevant to fusion reactors. The review of the activities of the A+M Data Unit indicated that the Unit is doing an excellent job in meeting data needs.

4.3 Programme Performance Assessment

A formal review of fusion activities was undertaken in a Programme Performance Assessment System (PPAS) during 2000. This review process made a detailed assessment of fusion-related activities within the IAEA. An independent outside panel was convened during the period 13-17 November 2000, and the A+M Data Unit was included in this

assessment exercise. Large amounts of background material were provided to the panel and oral presentations were made. The panel concluded that fusion is close to becoming a realistic alternative to other methods of power generation, and should have broader support and increased IAEA resources. Staff working on fusion topics was judged to be doing an excellent job within the available resources.

4.4 Co-ordinated Research Projects

CRPs represent the main method of generating the new data required by the fusion energy research community. Data from these projects are reviewed and published in the journal *Atomic and Plasma-Material Interaction Data for Fusion* (APID series). Three CRPs completed their formal activities within 2000-01, while two new ones were initiated.

The CRP on "Atomic and Plasma-Wall Interaction Data for Fusion Reactor Divertor Modeling" gave rise to a wealth of data on interactions relevant to the divertor region of fusion machines. A very comprehensive compilation of critically-assessed data is now available as volume 9 of the APID series. Much of the new data has been carefully evaluated and entered into the A+M online databases when judged to be of sufficiently high quality.

The CRP on "Plasma-interaction Data for Mixed Materials" resulted in the accumulation of a large amount of information on the effect that the mixing of materials has on interactions of those materials with components of the plasma. As an example, carbon used in the blanket tiles will be eroded by the plasma, and will deposit on metals used in other parts of the machine. The resulting mixed material interacts with the plasma in a significantly different manner than either pure material. These studies will be published as a new volume of the APID series, and plans are also being made to review the data and add to the online databases.

The CRP on "Charge Exchange Cross Section Data for Fusion Plasma Studies" held a final RCM in September 2000. Participants produced large amounts of experimental and theoretical results on the cross sections for the charge exchange processes involving atomic and molecular targets. Those data are extremely useful in analyzing spectra obtained from neutral beam injection in plasmas where electrons from the neutral species are captured by ions in the plasma. Good data on the cross sections allow an analysis of the resulting emitted radiation. Manuscripts from the participants are in the final editorial phase for publication in the APID series.

A new CRP was initiated in 2001 on "Data for Molecular Processes in Edge Plasmas", with the first RCM held on 18-19 October 2001. The IFRC Subcommittee recommended this CRP in May 2000. Edge regions of fusion plasmas operate at sufficiently low temperatures for the formation of molecules to take place. One major concern is the formation of hydrocarbon molecules containing tritium, which could result in the buildup of tritium in the fusion machine. This CRP brings together a large number of experts in molecular physics with the purpose of increasing the amount of data available for processes related to the formation and destruction of such molecules in conditions relevant to fusion reactors. An effective work plan was developed and adopted at the first RCM.

A CRP on "Atomic and Molecular Data for Fusion Plasma Diagnostics" was initiated on 12-13 November 2001, as recommended by the IFRC Subcommittee. The focus of this CRP is to gather and generate more data relevant to the diagnostics of fusion plasmas. There are a number of areas in diagnostics work that require more data, mainly cross sections for excitation, charge exchange, and other processes that can be used to analyze spectra produced in a plasma. A comprehensive list of needs was drawn up at the RCM, and participants indicated areas where they could achieve significant progress.

4.5 Database Management

The size of the electronic database has grown by over a factor of two over the period 2000-2001. Large amounts of new data have been assessed and added to the databases. A user survey taken in connection with the PPAS process revealed that the assessment of the data is a very high priority requirement. Much of the assessment work is carried out in the course of the CRPs and through the use of consultants.

A number of other databases have also become available through Internet interfaces. At several conferences the possibility of linking databases has been discussed, and the A+M Unit has facilitated collaborative work to allow a user to pass one request to a number of completely independent databases and to gather the results of those requests. This interface was installed on the web server of the A+M Unit in December 2001 after development by Y. Ralchenko (Weizmann Institute, Israel) and D. Humbert (GAPHYOR, France).

The bibliographic database maintained by the A+M Unit has only been accessible through a Telnet interface (no longer a viable method to access a public database). During the past year, preliminary work has been undertaken to prepare the database for use with a more modern interface, similar to the database management system used for numerical data. These efforts have prepared the way for a new web-based interface to be developed in the near future.

The extra-budgetary project on "International Database on Irradiated Nuclear Graphite Properties" has continued. The Steering Committee met in September 2000 at Oak Ridge National Laboratory (USA), and in September 2001 at IAEA Headquarters in Vienna. Each year, an updated version of the database has been compiled and distributed to all members. At each Steering Committee meeting, priorities have been set and the activities reviewed of the previous year. The Unit has carried out several consulting agreements to fulfill the needs in developing this database.

5. NUCLEAR DATA DEVELOPMENT

The primary aims of the NDS nuclear data development activities are to improve services to the Member States, particularly with respect to the nuclear databases, their reliability, convenience of retrieval and downloading, specific data search functions and visualisation. These activities are most frequently conducted through:

- co-ordinated research projects,
- individual research contracts, contractual and special service agreements with experts in specific fields,

- specialised technical meetings,
- staff work.

Outputs of data development include the following:

- new contributions or improvements to existing databases to be made available to users in Member States,
- documents related to the database description, verification and validation,
- software tools for data retrieval from the Web, CD-ROM or other media in a user-friendly manner,
- software tools for data manipulation including visualisation and verification,
- technical documents on the developed software and Users' manuals.

The following performance indicators are monitored:

- number of on-line and off-line requests for a particular data product,
- number of publications referring to a particular data development activity.

5.1 Co-ordinated Research Projects (CRP)

Four co-ordinated research projects were active during the years 2000 and 2001, and are still on-going. One planned CRP was cancelled (as recommended by expert consultants). Two CRPs have been approved recently, and preparations for another two are under way. The status of the CRPs are summarised in Table 3.

Table 3. Status of Co-ordinated Research Projects

No	Short title	Duration	Participants (Contracts)	Project Officer	Status	Section
1	Fission yield data < 150 MeV	1997-2002	10 (3)	Lammer	Extended 1 year	5.1.1
2	Update of X- and Gamma-ray standards	1998-2002	8 (3)	Herman	On-going, possible extension	5.1.2
3	Reference Input Parameter library (RIPL-II)	1998-2002	8 (3)	Herman	On-going	5.1.3
4	Prompt-gamma activation analysis (PGAA)	1999-2003	5 (2)	Paviotti	On-going	5.1.4
5	Photoelectron transport for radiotherapy	-	-	-	Cancelled	5.1.5
6	Light element cross-section standards	2002-06		Pronyaev	Approved	5.1.6
7	Nuclear data for Th-U fuel cycle	2002-06		Trkov	Approved	5.1.7
8	Nuclear data evaluation for emerging technologies (RIPL-III)	2002-06		Herman	Planned	5.1.8
9	Nuclear data for production of therapeutic radionuclides	2003-07		Paviotti	Planned	5.1.9

5.1.1 Fission Product Yield Data Required for Transmutation of Minor Actinide Nuclear Waste up to 150 MeV (extended)

Objectives:

- Develop fission yield systematics and nuclear models as a tool for an evaluation of energy-dependent fission yields for incident neutrons with energies up to 150 MeV.
- Produce a computer code to calculate fission yields for any given actinide at any desired neutron energy, with varying accuracy. The final goal is to provide users with the desired evaluated fission yields.

Activities:

- Third research co-ordination meeting was held at IAEA, Vienna, 29 October to 2 November 2001.
- Request for an extension of the CRP by one year has been prepared, as recommended by the participants. The extension would enable implementation of important improvements which have emerged from the CRP studies.

Reference:

Progress report and request for extension: IOM to D.D. Sood, F4.10.16, 29 January 2002.

5.1.2 Update of X- and Gamma-ray Standards for Detector Calibration (on-going)

Objectives:

- Update the existing IAEA database (TECDOC-619, 1991) of X- and gamma-ray standards for the calibration of detectors and spectrometers. The updated database will include precise emission probabilities for 62 radioisotopes that emit X- and gamma-rays with energies up to 3 MeV.
- Publish TECDOC (Update of X- and Gamma-ray Standards for Detector Calibration), and produce an updated data file available on-line and CD-ROM.

Activity:

- Second research co-ordination meeting was held at Physikalisch Technische Bundesanstalt, Braunschweig, Germany, 10-12 May 2000.

Reference:

M. Herman and A. Nichols (Eds.): Update of X- and Gamma-ray Decay Data Standards for Detector Calibration and Other Applications, IAEA Nuclear Data Section, INDC(NDS)-415, September 2000.

5.1.3 Nuclear Model Parameter Testing for Nuclear Data Evaluation, Reference Input Parameter Library: RIPL-Phase II (on-going)

Objectives:

- Test and improve nuclear model parameters for theoretical calculations of nuclear reaction cross sections.

- Produce well-tested Reference Input Parameter Library for calculations of nuclear reactions using nuclear model codes.
- Develop user-oriented retrieval tools for the Reference Input Parameter Library, and establish interfaces to well-established codes for nuclear reaction calculations.
- Publish a TECDOC, and ensure that the library and tools are available on-line and as CD-ROM.

Activities:

- Second research co-ordination meeting was held in Varenna, Italy, 12-16 June 2000.
- Third research co-ordination meeting was held at IAEA, Vienna, 3-7 December 2001.

References:

M. Herman (Ed.): Nuclear Model Parameter Testing for Nuclear Data Evaluation (Reference Input Parameter Library: Phase II), Summary Report of the Second Research Co-ordination Meeting, IAEA Nuclear Data Section, INDC(NDS)-416, September 2000.

M. Herman (Ed.): Nuclear Model Parameter Testing for Nuclear Data Evaluation (Reference Input Parameter Library: Phase II), Summary Report of the Third Research Co-ordination Meeting, IAEA Nuclear Data Section, INDC(NDS)-431, April 2002.

5.1.4 Development of Database for Prompt Gamma-ray Neutron Activation Analysis (on-going)

Objectives:

- Improve the accuracy and completeness of the data needed in prompt gamma activation analysis (PGAA). This powerful analytical technique is of growing importance in many fields such as material science, chemistry, geology, mining, archaeology, environment, food analysis and medicine.
- Develop an international database of neutron capture data to be used in PGAA.
- Produce a database for PGAA in electronic form, and a corresponding printed document as TECDOC publication.

Activities:

- First research co-ordination meeting was held at IAEA, Vienna, 2-4 November 1999.
- Second research co-ordination meeting was held at IAEA, Vienna, 14-17 May 2001.

References:

R. Paviotti-Corcuera and R.M. Lindstrom (Eds.): Development of a Database for Prompt γ-ray Neutron Activation Analysis, Summary Report of the First Research Co-ordination Meeting, IAEA Nuclear Data Section, INDC(NDS)-411, February 2000.

M.A. Lone, S.F. Mughabghab and R. Paviotti-Corcuera (Eds.): Development of a Database for Prompt γ–ray Neutron Activation Analysis, Summary Report of the Second Research Co-ordination Meeting, IAEA Nuclear Data Section, IAEA(NDS)-424, June 2001.

5.1.5 Simulation of Photon/Electron Transport for Radiotherapy (cancelled)

Joint project with the Dosimetry and Medical Radiation Physics Section of the Department of Nuclear Applications in Human Health.

Objective:

- Improve nuclear data for absorbed dose rate determination in radiotherapy using photon and electron beams produced by medical electron accelerators.

Activity:

- Consultants' meeting was held at IAEA, Vienna, 25-29 September 2000.

Outcome:

The present generation of calculational tools employing the Monte Carlo technique generates reaction cross sections from relatively simple models and calculates them "on the fly". More accurate models can be used to generate cross sections, and data formats for containing such data have been defined recently. Unfortunately, the codes have not been upgraded yet for reliable application, and further experience needs to be gained with such data. The project has been postponed until this expertise has developed. Setting-up a co-ordinated research project was judged to be premature by the consultants, and a further meeting should be planned in 2003 to re-address the issues.

Reference:

A. Trkov and P. Andreo: Report on the Joint Consultants' Meeting on Monte Carlo Transport in Radiotherapy – Nuclear Data Needs and Current Status and Prospects, IAEA Headquarters, 25-29 September 2000 (00CT07692 and 00CT07670, 25 October 2000).

5.1.6 Improvement of the Standard Cross Sections for Light Elements (new)

The most recent evaluations of light element standards were completed in 1987, and there are plans to prepare new versions of the national evaluated data libraries in the USA, Russia, China, Japan and Europe. This work should begin with a re-evaluation of the international reaction cross section standards. The NEA/OECD Nuclear Data Standards Sub-Group of the Working Party on International Evaluation Cooperation as well as the Cross Section Evaluation Working Group in the USA have expressed strong interest in the IAEA contributing to the re-evaluation of the light element cross section standards through this CRP mechanism. This project was highly recommended at 23rd INDC Meeting in May 2000 (INDC/P(00)-15, CRP proposal #2).

Objectives:

- Improve the methodology for the evaluation of the covariance matrix of uncertainty in the R-matrix model fits.
- Produce R-matrix evaluations of important light element standards.

Activities:

- Consultants' meeting was held at IAEA, Austria, 2-4 April 2001.
- Preparatory work to initiate the CRP has been completed.
- CRP was approved on 10 October 2001.

Reference:

A.D. Carlson, D.W. Muir and V.G. Pronyaev (Eds.): Full Summary Report of the Consultants' Meeting on Improvement of the Standard Cross Sections for Light Elements, IAEA, Vienna, Austria, 2-4 April 2001, INDC(NDS)-425 (2001).

5.1.7 Evaluated Nuclear Data for the Thorium-Uranium Fuel Cycle (new)

A number of programmes of the IAEA Nuclear Energy Department are aimed at investigating the operational parameters of systems based on Th-U fuel cycle. A Consultants' Meeting held in 1999 concluded that a significant fraction of the uncertainties in the prediction of such parameters is related to uncertainties in the nuclear data. Project was endorsed at 22nd INDC Meeting in May 1999 (INDC/P(99)-25), but was postponed due to external delays in some important experimental activities.

Objectives:

- Update the nuclear data relevant to systems utilizing the Th-U fuel cycle.
- Identify in more detail the variances in nuclear data that are responsible for the discrepancies observed in the calculated parameters of Th-U fuel cycle systems.

Activities:

- Preparatory work to initiate the CRP has been completed.
- CRP was approved on 4 March 2002.

Reference:

V.G. Pronyaev (Ed.): Summary Report of the Consultants' Meeting on Assessment of Nuclear Data Needs for Thorium and Other Advanced Cycles, IAEA, 26-28 April 1999, INDC(NDS)-408, August 1999.

5.1.8 Input Parameters for Evaluation of Nuclear Data for Emerging Technologies (RIPL-III) (new)

Proposed at 23rd INDC Meeting (INDC/P(00)-15, CRP proposal #3) in May 2000, and reformulated to avoid duplication and to satisfy the requirements and priorities of users in Member States.

Objectives:

- Extend RIPL-II database to provide input parameters for nuclear model calculations needed for emerging applications such as ADS, innovative reactors, medical radioisotope production, and astrophysics.
- Develop routines for calculation of certain input parameters in order to facilitate users access to the RIPL library and prevent misuse of the parameters.
- Improve quality of the data by using new experimental results (NTOF and HINDAS projects, heavy ion experiments) and using microscopic approaches for deriving parameters.

The CRP will be carried out in close co-operation with WPEC Subgroup-A.

Activity:

- Scope of the CRP discussed during the third research co-ordination meeting on RIPL-II.

Reference:

M. Herman (Ed.): Nuclear Model Parameter Testing for Nuclear Data Evaluation (Reference Input Parameter Library: Phase II), Summary Report of the Third Research Co-ordination Meeting, IAEA Nuclear Data Section, INDC(NDS)-431, April 2002.

5.1.9 Nuclear Data for Production of Therapeutic Radionuclides (new)

Highly recommended at 23rd INDC Meeting in May 2000 (INDC/P(00)-15, CRP proposal #1).

Objectives:

Reactor-produced radioisotopes:
- Compile and evaluate the cross section as a function of energy in the range 0-20 MeV.
- Deduce spectrum-averaged data in the conventional way for thermal epithermal and fast neutrons and compare with measurements.

Accelerator-produced radioisotopes:
- Compile and evaluate cross sections as a function of energy in the energy range up to 40 MeV (or 100 MeV, where necessary).
- Deduce from the microscopic cross sections the integral yield data as a function of incident energy and compare with the experimental thick target yields available in the literature.

All cases:
- Carry out new measurements when required.
- Prepare missing entries of experimental data for inclusion in the EXFOR database.
- Format the new evaluated data library in the ENDF-6 format.

Activity:

- Consultants' meeting was held at the IAEA, Vienna, 25-27 February 2002, where the detailed scope of the CRP and the outputs were defined.

5.2 Data Development Projects

Data development projects are conducted through individual research contracts, contractual and special service agreements, technical meetings and staff work.

5.2.1 Fusion Evaluated Nuclear Data Library FENDL-2 (on-going)

Maintenance of FENDL-2 library is an on-going activity. "ACE Format Applications Package Project" was recommended at 23rd INDC Meeting in May 2000 (INDC/P(00)-15, CRP proposal #4), and was implemented within this data development project due to shortage of funds.

Objectives:

- Maintain the FENDL-2 library by undertaking corrections and updates as necessary, based on user feedback.
- Distribute the library through the Web and CD-ROM.

Activities:

- Consultant visited IAEA, Vienna, from 13-17 November 2000 to implement corrections to the files.
- Individual research contract was awarded, which included verification and partial validation of the data in FENDL-2 and software package to allow Doppler broadening of cross sections in the ACE files (RC: 11566/R0, started in March 2001). Progress report has been submitted, together with request for an extension (good quality of submitted work justifies this extension).

5.2.2 International Reactor Dosimetry File: IRDF-2002 (new)

The last tested version of the International Reactor Dosimetry File IRDF-90 V2 was released in 1993. Updating of the file was highly recommended at 23rd INDC Meeting in May 2000. Budget constraints had necessitated re-classification as a Data Development Project (INDC/P(00)-15, CRP proposal #1).

Objective:

- Prepare and distribute standardised, updated and benchmarked neutron dosimetry reaction cross section library with uncertainty information (IRDF-2002).

Activities:

- Two individual research contracts have been awarded.
- Web page has been set up for project participants to access up-to-date information on the project status.
- Two informal consultants' meetings were held at IAEA, Vienna, Austria, on 12 July and 7 August 2001.
- Technical Meeting is scheduled for 27-29 August 2002 at IAEA, Vienna, Austria.

5.2.3 Validation of Cross Section Library for Cyclotron Production of Medical Radioisotopes (follow-up)

Co-ordinated research project on "Development of Reference Charged Particle Cross Section Database for Radioisotope Production" was completed in 1999, and the associated document was published in 2001. Maintenance of the database requires follow-up actions.

Objectives:

- Maintain the cross section library for cyclotron production of medical radioisotopes.

Activities:

- TECDOC describing the database was published in May 2001.
- Consultant visited IAEA, Vienna, from 3-14 December 2001 to prepare newly-available experimental data for inclusion in the EXFOR database.

Reference:

IAEA: Charged Particle Cross-section Database for Medical Radioisotope Production: Diagnostic Radioisotopes and Monitor Reactions, Final Report of a Co-ordinated Research Project, TECDOC-1211, May 2001.

5.2.4 Validation of Photonuclear Library (follow-up)

Co-ordinated research project on "Compilation and Evaluation of Photonuclear Data for Applications" was completed in 1999, and the associated document was published in 2000. Maintenance of the database requires follow-up actions.

Objective:

- Maintain the photonuclear cross section library.

Activities:

- Consultants' meeting on Validation of Photonuclear Data Library was held in Abingdon, United Kingdom, on 16-18 February 2000 (Scientific Secretary: P. Obložinský).
- TECDOC describing the library was published in October 2000.
- Based on feedback from the users, a number of corrections were made to the library through staff work.

Reference:

IAEA: Handbook on Photonuclear Data for Applications – Cross-sections and Spectra, Final Report of a Co-ordinated Research Project, TECDOC-1178, October 2000.

5.2.5 **GANDR project** (new)

Much effort has been invested in the development of covariance data. Despite their great potential, these data are not adequately utilised. Therefore, a project has been proposed to develop pilot software for analysing the impact of new measurements on integral results.

Objective:

- Application of sensitivity and uncertainty analyses to the planning of nuclear data research and development.

Actions:

- Contractual Service Agreement was signed with a consultant to deliver prototype software.
- Dell Precision 530 MT Intel Zeon 1.5 GHz PC with 90 GB of fixed disk was purchased to host the software.
- Additional software was ordered from the Radiation Shielding Information Computational Center (RSICC) at Oak Ridge, USA:

  NJOY99 (Package PSR-480, installed),
  MCNPX-2.1.5 (Package DLC-200, installed),
  DANTSYS-3.0 (Package CCC-547, received).

6. TECHNOLOGY TRANSFER

Technology transfer to developing countries is one of the most important IAEA objectives. This transfer is generally done under the Agency's Technical Co-operation Programme (TC), which is managed by the Department of Technical Co-operation. The various technical departments provide technical guidance and expertise through their staff serving as technical officers.

Involvement of the Nuclear Data Section in TC activities has been fairly limited, but other methods of technology transfer exist: nuclear data workshops and data services that include dissemination of data via the world-wide-web, other electronic media and hardcopy documents as well as software for the retrieval of the data from the databases, verification and visualisation. These service activities are described in Section 2.2.

6.1 Technical Co-operation Projects

No new TC projects have been undertaken since the installation of the IAEA Nuclear Data mirror site in Brazil and a knowledge-enhancement project on the utilisation of the Ghana Research Reactor – Phase II.

6.1.1 **Regional Centre for IAEA Nuclear Data Services** (completed)

Objectives:

- Provide reliable, fast and easy access to nuclear data by equipping a centre in the region to provide this service on behalf of the Agency.
- Educate a team on retrieval, management, processing and application of nuclear data, who will operate the site and serve as consultants to users within the region.

Action:

- Workshop "Primer Taller Regional de Capacitacion sobre Acceso en Linea a Datos Nucleares" was held at IPEN, Sao Paulo, Brazil, 20-24 March 2000.

Outcomes:

Project was completed in October 2000, with the Brazilian mirror site operating without problems. Traffic on the server is increasing, although access from neighbouring countries is lower than anticipated due to delays in building faster links between countries (beyond the Agency's control).

Reference:

M.P. Zamudio Igami and R. Paviotti-Corcuera (Eds.): Primer Taller Regional de Capacitacion sobre Acceso en Linea a Datos Nucleares", Summary report from the workshop held at IPEN, Sao Paulo, Brasil, 20-24 March 2000, IAEA, Nuclear Data Section, INDC(NDS)-417, June 2000.

6.1.2 **Utilisation of Ghana Research Reactor – Phase II** (completed)

Set up to enhance utilisation of the research reactor in different technical areas, such as neutron activation analysis and radiotracers applications, by improving the infrastructure related to on-line nuclear data services.

Objectives:

- Provide reliable, fast and easy access to nuclear data by equipping the centre with a local network PC-based nuclear data server.
- Build up expertise on retrieval, management, processing and application of nuclear data; this team will operate the site and serve as consultants to the productive sectors in the region.

Action:

- Counterparts were contacted to obtain feedback on the operation of the centre.

Outcome:

Completed in July 2001; no operational problems have been reported.

6.2 Workshops

6.2.1 Nuclear Reaction Data and Nuclear Reactors: Physics, Design and Safety, ICTP Trieste, Italy, 13 March - 14 April 2000

IAEA Workshop Directors: M. Herman (IAEA-NDS, NAPC) and J. Kupitz (NENP)

Five-week workshop is part of the regular series that started in 1978 on a biennial basis. Covers nuclear reaction model codes, data evaluation, processing and reactor design, with emphasis on thermal research and power reactors. Organized by the IAEA in collaboration with the ICTP Trieste: A. Gandini (ENEA, Rome, Italy), M. Herman (IAEA, Nuclear Data Section), A. Koning (ECN, Petten, Netherlands), J. Kupitz (IAEA, Nuclear Power Technology Development Section), and A. Trkov (Institute of Jozef Stefan, Ljubljana, Slovenia), with the assistance of N. Paver (University of Trieste, Trieste, Italy) as local organizer.

Objectives:

- Train scientists and engineers from developing and developed countries to understand modern methods related to the study of nuclear reaction data and nuclear reactors, with particular emphasis on reactor physics, design and safety.
- Familiarise participants with the important steps in production, storage and use of nuclear data and modern reactor computer codes relevant to these topics, including processing of nuclear data and on-line access to nuclear data.

Actions:

- Workshop material was presented as lectures (mornings) and exercises (afternoons) on personal computers running LINUX and Windows operating systems.
- Workshop covered nuclear data (2 weeks), followed by nuclear data processing (1 week) and nuclear reactor calculations (2 weeks).
- 65 lectures and 29 exercises (each of 1.5 h).
- Computer codes used during the workshop exercises were:
  - SAMMY (code system for multilevel R-matrix fits to neutron data using Bayes' equations;
  - ECIS (optical model calculation code);
  - EMPIRE (statistical model code);
  - NJOY (nuclear data processing);
  - TRIGLAV (research reactor and neutron diffusion calculations);
  - ARS and CARD (reactor simulation packages).

Outcomes:

- 54 participants from 29 countries received training from 7 directors and 26 lecturers.
- Twelve participants from developed countries.
- Audience genuinely interested, and actively participated in lectures and exercises.
- Workshop resulted in a large number of requests for the data and codes.

6.2.2 Nuclear Data for Science and Technology: Accelerator Driven Waste Incineration, ICTP Trieste, Italy, 10-21 September 2001

IAEA Workshop Director: M. Herman (IAEA-NDS)

Two-week workshop was organized by the IAEA in collaboration with the ICTP, Trieste: A. Mengoni (ENEA, Bologna, Italy) and M. Herman (IAEA, Nuclear Data Section), with the assistance of N. Paver (University of Trieste, Trieste, Italy) as local organizer.

Workshop was thematically linked to the "Workshop on Hybrid Nuclear Systems for Energy Production, Utilisation of Actinides and Transmutation on Long-Lived Radioactive Waste", which took place one week earlier.

Objectives:

- Familiarize students with the status of the research and development activities regarding accelerator driven systems.
- Stimulate nuclear data activities by training young scientists in the understanding, production and use of relevant nuclear data.

Actions:

- Workshop material was presented as lectures (mornings) and exercises (afternoons) on personal computers running LINUX and Windows operating systems.
- Computer exercises included three programmes (EMPIRE-II, FLUKA and MCNPX) and on-line nuclear data retrieval from IAEA-NDS Web site. About 20 PCs with LINUX operating system were used. One afternoon session was dedicated to participants' presentations (8 contributions).

Outcomes:

- 36 participants from 26 countries received training from 3 directors and 11 lecturers.
- Audience interested and actively participated in lectures and exercises.
- Workshop also attracted seven cost-free participants from developed countries (out of 36).
- Proceedings of the Workshop are to be published in the series 'Lecture Notes' edited by the ICTP.

7. COMPUTER SUPPORT

At the end of May 2000 the NDS Computer Operations Unit was reorganized into a new Systems Development Unit. This unit consists of two staff members who were previously managed directly by the Section Head: a Unit Head and one staff member.

Major highlights in computer services since the 2000 INDC meeting:

- commissioning of a new Compaq Alpha DS20,
- NDS Ethernet moved inside the Agency Firewall,
- Workshop on Relational Databases for Nuclear Data held at the NNDC in September 2000, and impact of this workshop on NDS,
- Agency-wide move to Windows 2000 and Ethernet.

These and other activities are described in greater detail below.

7.1 Data Servers

A new Compaq Alpha Server model DS20 was commissioned and brought online in June 2000. This system is now the primary nuclear data server, and mirrors user-ready data services from the older AS2100 which has reverted to a development role.

The specification of the DS20 is as follows:

1	Alpha DS20 model 6/500 with 256 MB RAM
6	9.1 GB Disks
1	4mm DAT tape drive
1	CD ROM drive
1	10/100Mbps dual Ethernet Card/Ultra SCSI Controller
1	3 Channel RAID Controller with 8MB Cache
1	Operator's Console with 17" color monitor
1	Uninterruptable Power supply
8	VMS User Licenses
8	Oracle CODASYL concurrent device licenses
1	Oracle Bronze maintenance renewed annually

The DS 20 is totally dedicated to providing Internet-based nuclear data services, and operates at 100Mbps on the Ethernet Local Area Network with a fibre optic backbone link to the central computer services of the Agency and thence to the Internet service provider. Updates to Web data and non-Codasyl databases are mirrored from the AS2100 nightly. Codasyl database updates are mirrored weekly.

NDS now maintains three Compaq Alpha servers: an AS2100 and a DS20 at headquarters, and an AS800 at IPEN, Brazil. The DS 20 and the AS800 mirror the user-ready services from the AS2100 development server. This arrangement is shown in Figure 2. The Alpha server at IPEN continues to function efficiently with negligible down-time. Collaboration between the Systems Development Unit and counterparts at IPEN are excellent, and all tasks are performed quickly and well.

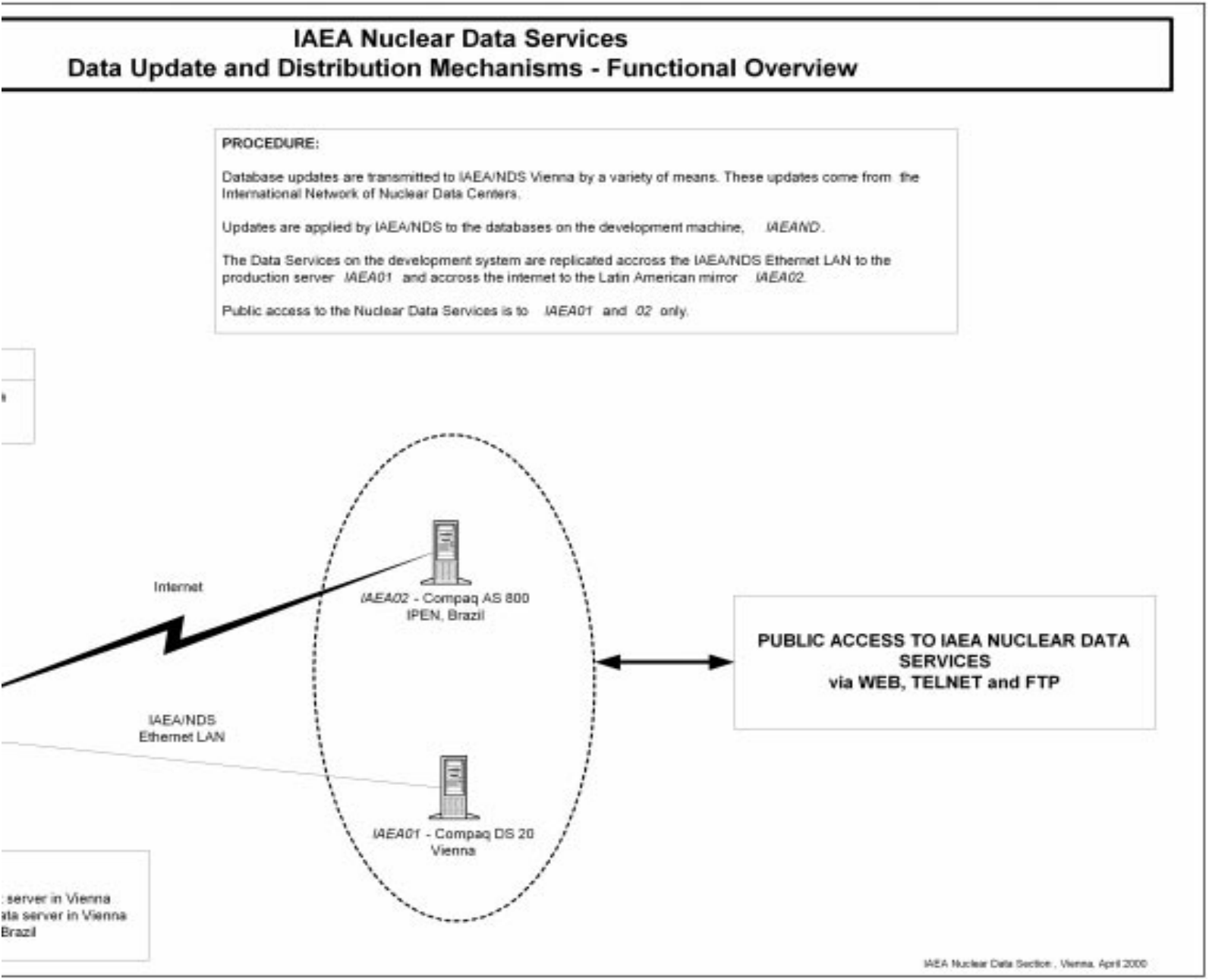

Figure 2. Functional Overview of the IAEA Nuclear Data Servers

7.2 Network

The entire NDS Ethernet was moved inside the Agency Firewall to a special network zone known as the De-Militarized Zone (DMZ), in keeping with the Agency-wide network security policy. A beneficial side-effect of this move was to provide the section with a full Class-C sub-network and a new range of 250 IP addresses. This arrangement provides adequate room for the future development of the NDS Ethernet. All the NDS Ethernet nodes were renumbered, but DNS names were retained to provide continuity.

A set of firewall rules has been established for all NDS data servers in keeping with Agency networking security guidelines. All NDS Ethernet–based computers have been grouped into functional sets within the Agency's firewall management software. Network access rules have been assigned based on group properties, with dedicated atomic and nuclear data servers being the most 'open'. The positioning of the Section within the Agency firewall is shown in Figure 3.

The Ethernet network has been successfully upgraded to 100Mbps. All devices on the Ethernet are now capable of operating at this higher rate. A number of old DEC network components were removed from the circuit and also from maintenance during this upgrade.

Additionally, as part of an Agency-wide review of all networking, the existing Agency-standard Token-Ring network will be completely replaced with Ethernet, permitting NDS to dispense with the need to have two PCs on many desks. The Section is now well placed to participate in the proposed Agency-wide Ethernet.

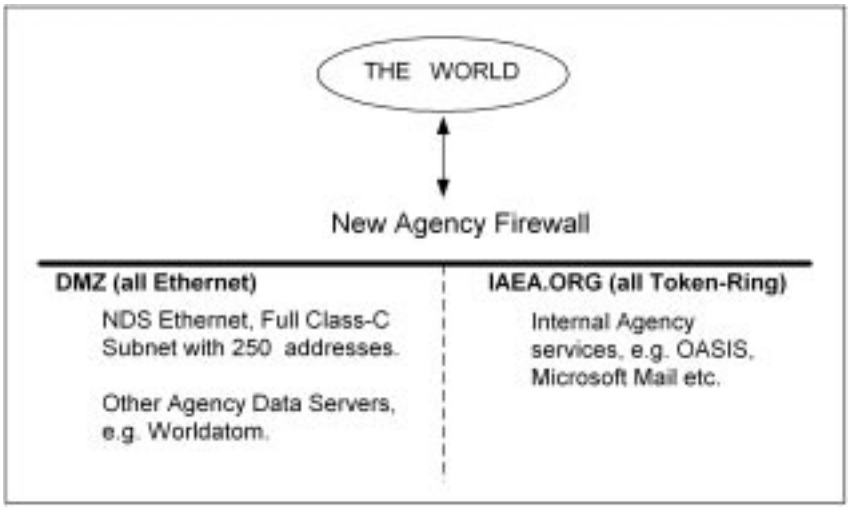

Figure 3. Positioning of NDS Ethernet within the IAEA firewall

7.3 New Multi-Platform Database Management Systems

The migration of VMS-specific databases to a generic form was agreed at the Workshop on Relational Databases for Nuclear Data, held at the NNDC in September 2000. The NDS Systems Development Unit is actively participating in the provision of suitable development environments, tools and knowledge support for this endeavor.

PCs running Linux and new alternative Database Management Systems have been acquired. Knowledge in alternative operating systems such as Linux is being developed. Experience and understanding of the needs of the nuclear data community with respect to new data retrieval and storage methods is also being expanded. Inevitable pressures on current staff levels and expertise resulting from this expansion are described in the section on staffing below.

7.4 Data Service Expansion – New Initiative

NDS has initiated a project to provide a nuclear data server to India. This project will proceed independently from Agency Technical Cooperation and will be funded in the main by the Indian Government. This initiative provides an interesting test case for the practical implementation of the new technologies emerging from the multi-platform database initiative. Additionally, successful implementation will undoubtedly influence future NDS/TC projects. Initial technical negotiations between the Systems Development Unit and counterparts at the Bhabha Atomic Research Centre, Mumbai are presently underway.

7.5 New and Retired Equipment

The Section took delivery of a Linux-based Dell Precision 530 MT Intel Zeon 1.5GHz computer with 90GB of fixed disk in November 2001. While this system is primarily intended for the GANDR research project, the powerful capacity is being utilized by NDS for other work, e.g. NJOY runs, Empire and atomic/molecular analyses.

Since the last INDC report, we have requisitioned a total of ten new Agency-standard personal computers. Eight of these devices were used to replace out-of-date PCs, and two were used to provide Linux platforms for code porting and experimentation with new ideas relating to the multi-platform database initiative.

Three new laser printers have been acquired, among which was a Xerox/Tektronix Phaser 2135 color laser printer for the production of CD labels, transparencies, address labels and small documentation print runs. Three CD writers were also purchased to facilitate the production of data CDs.

A Sony VAIO Z505 Notebook computer was acquired for workshop and other presentations, while a new HP Scan Jet 6390C scanner was purchased to facilitate the conversion of documents into digital form when necessary.

7.6 Software

NDS continues to acquire PC and other software as deemed necessary to facilitate the continued provision and enhancement of the data services. Since the last INDC meeting, the following major software has been acquired: Microsoft SQL Server, Microsoft Access 2000, Sybase SQL Anywhere Studio, Sybase PowerBuilder Enterprise and Sybase Anywhere Internet Access. These software kits allow NDS to explore the development of data services on alternative platforms and in more cost-effective and convenient forms.

Other acquisitions of note were: Compaq Visual FORTRAN and Absoft Pro FORTRAN. Finally, a ten-user license pack for Hummingbird eXceed was purchased to allow for the increased use of the X protocol on the NDS Ethernet.

7.7 Staffing

7.7.1 Visit

L. Costello (NDS) to NNDC Brookhaven 11-29 September 2000: participation in Workshop on “Relational Databases for Nuclear Data”.

7.7.2 Other Issues

The Systems Development Unit has applied for a cost-free Junior Professional Officer (JPO) to assist with the development of alternative multi-platform data services.

NDS continues to support both Divisional and Department Director IT needs through the provision of man-hours in the form of a Divisional IT Coordinator (ITC). The Agency has recently begun the migration to Windows 2000, and the Division also has a growing need for the continuing support and maintenance of WorldAtom Web services. This places an increasing demand on the Unit.

Furthermore, the decision to begin the provision of services on alternative DBMS and operating system platforms has highlighted the need for additional technical expertise to support this development. Therefore, the Unit has requested that this need for additional staffing be considered in the 2004-2005 budget cycle.

MEETINGS AND SCIENTIFIC VISITS IN 2000

Month/Duration	Responsible Officer	Type	Meeting Title/Type of Visit	Home Institute	Location
<u>January</u>					
17	Pronyaev		Discussion about IRDF-2000 Seminar with Presentation of 'SPALLDOS"		Vienna
26	Muir	Visit	Klaus Guber	ORNL, USA	Vienna
<u>February</u>					
16 - 18	Obložinský	CM	Validation of Photonuclear Data Library		Culham, UK
<u>March/April</u>					
13 March to 14 April	-4 nan	WS	Workshop on Nuclear Reaction Data and Nuclear Reactors: Physics, Design and Safety		Trieste, Italy
25 April	l		Consultant: A. Trkov	Institut Jozef Stefan, Slovenia	Vienna
1 April to 31 May	Muir		Consultant: A. Lone	Chalk River Nuclear Laboratories, Canada	Vienna
<u>May</u>					
8 - 9	Clark	TCM	12th Meeting of the A+M Subcommittee of the International Fusion Research Council (IFRC)		Vienna
8 - 12	Clark		Consultant: R.K. Janev	National Institute for Fusion Science, Japan	Vienna

Month/Duration	Responsible Officer	Type	Meeting Title/Type of Visit	Home Institute	Location
May (cont'd)					
10 - 12	Herman	RCM	Update of X- and Gamma-ray Decay Data Standards for Detector Calibration		Braunschweig, Germany
15 - 19	Pronyaev	AGM	Network of Nuclear Reaction Data Centres (NRDC)		Obninsk, Russia
24 - 26	Muir/Lone	TCM	23rd Meeting of the International Nuclear Data Committee		Vienna
June					
12 - 16	nan	RCM	Nuclear Model Parameter Testing for Nuclear Data Evaluation (RIPL: Phase II)		Varenna, Italy
19 - 20	Clark	CM	Plasma Diagnostics and Molecular Processes		Vienna
August					
14 - 25	Stephens		Consultant: W. Eckstein	Max-Planck-Institut, Germany	Vienna
September					
7 - 8	Stephens	TCM	Technical Steering Committee of the International Irradiated Nuclear Graphite Properties Database		ORNL, USA
25 - 29	Clark	RCM	Charge-Exchange Cross Section Data for Fusion Plasma Studies		Vienna
25 - 29	Trkov	CM	Monte Carlo Transport in Radiotherapy: Nuclear Data Needs		Vienna

Month/Duration	Responsible Officer	Type	Meeting Title/Type of Visit	Home Institute	Location
<u>October</u>					
16 - 17	Clark	RCM	Plasma-Material Interaction Data for Mixed Plasma Facing Materials in Fusion Reactors		Vienna
<u>November</u>					
13 - 17	Trkov		Consultant: J. White	ORNL, USA	Vienna
28 November to 1 December	Herman/Muir	AGM	Long Term Needs for Nuclear Data Development		Vienna
<u>December</u>					
4 - 7	yaev	AGM	Network of Nuclear Structure and Decay Data Evaluators (NSDD)		Vienna
8 - 13	Costello		Consultant: T.W. Burrows	BNL, USA	Vienna

MEETINGS AND SCIENTIFIC VISITS IN 2001

Month/Duration	Responsible Officer	Type	Meeting Title/Type of Visit	Home Institute	Location
April					
2 - 4	yaev	CM	Improvement of the Standard Cross Sections for Light Elements		Vienna
2 - 29	Trkov		Consultant: U. Kannan	BARC, India	Vienna
May					
14 - 17	Paviotti	RCM	Development of a Database for Prompt Gamma Ray Neutron Activation Analysis		Vienna
14 - 18	Paviotti		Consultancy: A. Lone	Chalk River Nuclear Laboratories, Canada	Vienna
21 - 30	Schwerer		Consultancy: V. McLane	BNL, USA	Vienna
28 - 30	Schwerer	CM	Co-ordination of the Nuclear Reaction Data Centres		Vienna
July					
2 - 3	Clark	AGM	Assessment of New Data for Tritium Retention in Fusion Reactor Materials		Vienna
September					
12 - 14	Stephens		Consultancy: D. Humbert and Y. Ralchenko	Universite Paris, France Weizmann Institute, Israel	Vienna

Month/Duration	Responsible Officer	Type	Meeting Title/Type of Visit	Home Institute	Location
Sept. (cont'd)					
10 - 11	hens	AGM	16th Meeting of the A+M Data Centres and ALADDIN Network		Vienna
10 - 21	Herman	WS	Nuclear Data for Science and Technology: Accelerator Driven Waste Incineration		Trieste, Italy
27 – 28	Clark/Stephens	TCM	Technical Steering Committee of the International Irradiated Nuclear Graphite Properties Database		Vienna
October					
18 - 19	Clark	RCM	Data for Molecular Processes in Edge Plasmas		Vienna
29 October to 2 November	Lammer	RCM	Fission Product Yield Data Required for Transmutation of Minor Actinide Nuclear Waste		Vienna
November					
12 - 13	Clark	RCM	A+M Data for Fusion Plasma Diagnostics		Vienna
December					
3 - 7	Herman	RCM	Nuclear Model Parameter Testing for Nuclear Data Evaluation (RIPL: Phase II)		Vienna
3 - 14	Schwerer		Consultancy: S. Takacs	Institute of Nuclear Research, Hungary	Vienna

Month/Duration	Responsible Officer	Type	Meeting Title/Type of Visit	Home Institute	Location
Dec. (cont'd)					
10 - 14	Pronyaev		Consultancy: J.K. Tuli	BNL, USA	Vienna
18 - 21	Pronyaev		Consultancy: I.N. Boboshin	CDFE, Russia	Vienna
18 - 21	Zerkin		Consultancy: L.J. Chervonna	Institute for Nuclear Research, Ukraine	Vienna

Appendix 2

Publications 2000/2001

Series and No.	Titles
Annual Publications	CINDA 99, supplement 2 to CINDA 97 (1988-1999)
Periodicals	Bulletin on atomic and molecular data for fusion Nos 58, 59, 60, 61
Newsletter	Nuclear data newsletter Nos 29, 30, 31, 32
IAEA-TECDOC-1168	Compilation and evaluation of fission yield nuclear data (December 2000)
IAEA-TECDOC-1178	Handbook on photonuclear data for applications cross-sections and spectra (October 2000)
IAEA-TECDOC-1211	Charged particle cross-section database for medical radioisotope production: diagnostic radioisotopes and monitor reactions (May 2001)
INDC(NDS)-409	Summary report of the third Research Co-ordination Meeting on compilation and evaluation of photonuclear data for applications
INDC(NDS)-410	IAEA Advisory Group Meeting on technical aspects of atomic and molecular data processing and exchange
INDC(NDS)-411	Development of a database for prompt gamma-ray neutron activation analysis
INDC(NDS)-412	Measurement, calculation and evaluation of photon production data
INDC(NDS)-413	IAEA International database on irradiated nuclear graphite properties
INDC(NDS)-414	Report of the IAEA Nuclear Data Section to the International Nuclear Data Committee for the period January–December 1999
INDC(NDS)-415	Update of X- and gamma-ray decay data standards for detector calibration and other applications
INDC(NDS)-416	Nuclear model parameter testing for nuclear data evaluation (reference input parameter library: phase II)
INDC(NDS)-417	Summary report on the first regional workshop on online access to nuclear data
INDC(NDS)-418	Report of the IAEA Advisory Group Meeting on network of nuclear reaction data centres

INDC(NDS)-419 Workshop on advanced nuclear data online services

INDC(NDS)-420 IAEA Technical Committee Meeting: 12th meeting of the IFRC Subcommittee on atomic and molecular data for fusion

INDC(NDS)-421 Nuclear structure and decay data (NSDD) network

INDC(NDS)-422 Co-ordination of the international network of nuclear structure and decay data evaluators

INDC(NDS)-423 Summary report of the Advisory Group Meeting on long term needs for nuclear data development

INDC(NDS)-424 Development of a database for prompt gamma-ray neutron activation analysis

INDC(NDS)-425 Summary report of the Consultants' Meeting on improvement of the standard cross sections for light elements

INDC(NDS)-426 Second (final) IAEA Research Co-ordination Meeting on charge exchange cross section data for fusion plasma studies

INDC(NDS)-427 Report on the IAEA Consultants' Meeting on the co-ordination of nuclear reaction data centers (technical aspects)

INDC(NDS)-428 Long term needs for nuclear data development. Texts of papers presented at the Advisory Group Meeting

INDC(NDS)-429 Second (final) IAEA Research Co-ordination Meeting on plasma-material interaction data for mixed plasma facing materials in fusion reactors

INDC(NDS)-430 Report on the IAEA Advisory Group Meeting on technical aspects of atomic and molecular data processing and exchange (16th meeting of the A+M data centres and ALADDIN network)

Other INDC Reports, 2000/2001

Report	**Country of Origin**	**Number of Reports**
INDC(CCP)	Russia	7
INDC(CPR)	China	6
INDC(GER)	Germany	2
INDC(HUN)	Hungary	1
INDC(JPN)	Japan	4
INDC(SUD)	Sudan	1
INDC(UK)	United Kingdom	2