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I N D C INTERNATIONAL NUCLEAR DATA COMMITTEE

Report of the IAEA Nuclear Data Section to the International Nuclear Data Committee for the Period January 2002 – December 2003

Edited by

Alan L. Nichols
IAEA Nuclear Data Section
Vienna, Austria

May 2004

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Abstract

This report contains descriptions of the major activities of the IAEA Nuclear Data Section in 2002 and 2003 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 Centre, coordination of the Nuclear Data Centre 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 2004

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Glossary of Abbreviations

A+M	Atomic and Molecular
ABBN	Russian multigroup library system
ACE	A Compact ENDF library for MCNP Monte Carlo particle transport codes
AGM	Advisory Group Meeting of the IAEA
ALADDIN	A Labelled Atomic Data Interface
BARC	Bhabha Atomic Research Centre
BNL	Brookhaven National Laboratory
CD-ROM	Compact disk with read-only memory
CINDA	Computer Index on Neutron Data
CM	Consultants' Meeting of the IAEA
CRP	Coordinated Research Project of the IAEA (compare RCM)
DBMS	Database Management System
DCN	Data Centre Network
DNS	Domain Name Service
DMZ	De-Militarized Zone
ENDF	Evaluated Nuclear Data File
ENDVER	ENDF Verification software package
ENSDF	Evaluated Nuclear Structure Data File
EPDL	Photo-atomic interaction data library
EXFOR	Computer-based system for the compilation and international exchange of experimental nuclear reaction data (EXchange FORmat)
FENDL	Fusion Evaluated Nuclear Data Library
FOND	Russian library of evaluated neutron data files (by compilation)
GANDR	Global Assessment of Nuclear Data Requirements – computational tools
IAEA	International Atomic Energy Agency, Vienna, Austria
IBA	Ion Beam Analysis
IBANDL	Ion Beam Analysis Nuclear Data Library
ICTP	International Centre for Theoretical Physics, Trieste, Italy
IFRC	International Fusion Research Council
INDC	International Nuclear Data Committee
IPEN	Instituto de Pesquisas Energeticas e Nucleares
IPPE	Institute of Physics and Power Engineering
IRDF	International Reactor Dosimetry File
ITER	International Thermonuclear Experimental Reactor
JEFF	Joint Evaluated Fusion and Fission files
JENDL	Japanese Evaluated Nuclear Data Library
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 Centres
NSDD	Nuclear Structure and Decay Data
NSR	Nuclear Science References, a bibliographic file related to ENSDF
PGAA	Prompt Gamma Activation Analysis
PIXE	Proton-Induced X-ray Emission
PPAS	Programme Performance Assessment
RCM	Research Coordination Meeting (for CRP)
RIPL	Reference Input Parameter Library
TC	Technical Cooperation
TM	Technical Meeting of the IAEA
TECDOC	Technical document published by the IAEA
VMS	Operating systems of the Compaq Alpha Server
WIMS	Winfrith Improved Multigroup Scheme of reactor lattice codes
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. One aim of the Section is 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 (Terms of Reference, January 2001).

The Section is internally arranged into four Units as shown in the organization chart. 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 2002 and 2003. 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 2002 and 2003. Appendix 1 gives a list of meetings and workshops organized by the Section, and Appendix 2 summarizes all of the various publications.

Alan L. Nichols
IAEA Vienna, Austria
May 2004

Nuclear Data Section

Organization Chart
(12 February 2004)

Section Office (and INDC Secretariat)

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

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

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

Nuclear Data 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)
V. Zerkin Nuclear Physicist/ Programmer (21714)	**R. Capote Noy** Nuclear Physicist (21713)	**M. Verpelli** Systems Analyst/ Programmer (21723)	**D. Humbert** Atomic Physicist/ Programmer (21729)
S. Dunaeva Nuclear Physicist (21727)	**vacancy** Nuclear Physicist/ Development Programmer	**M. O'Connell** Applications Programmer (21722)	**K. Sheikh** Database Clerk (21730)
O. Schwerer Assistant Nuclear Data Physicist (21715)	**R. Bojdo** Secretary (21711)	A. Scherbaum Secretarial Support (21710)	
G. Bush Production Programmer (21725)			
M. Wirtz Secretary (21716)			

1. NUCLEAR DATA SECTION: OVERVIEW

As in previous reporting periods, the budget and staffing level of the Nuclear Data Section (NDS) has been relatively stable. The authorized staff level for 2003-2004 is 18, consisting of 11 professionals (P-staff) and 7 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.

Alan Nichols has continued as Section Head during 2002-2003, and the Unit Heads during this same period have been:

Robert Clark, Atomic and Molecular Data Unit,

Liam Costello, Systems Development Unit,

Vladimir Pronyaev, Nuclear Data Unit,

Andrej Trkov, Nuclear Data Development Unit,

all of whom have contributed to the contents of this report.

Significant NDS staffing changes have occurred over the previous two years:

Jeffrey Stephens resigned from his position as an A+M atomic physicist to accept employment at the University of Colorado in Bolder, USA, and was replaced by Denis Humbert (effective from 30 September 2002);

Mike Herman resigned from his position as a nuclear physicist/programmer to accept employment at the National Nuclear Data Center, Brookhaven National Laboratory, USA, and has been replaced by Roberto Capote Noy (effective from 2 February 2004);

both Kevin McLaughlin and Meinhart Lammer retired in 2003, and have been replaced by Marco Verpelli (effective from 7 September 2003) and Svetlana Dunaeva (effective from 12 October 2003);

a nuclear physicist is being sought as replacement for Raquel Paviotti-Corcuera, who resigned in late 2003 (with effect from 11 February 2004) to accept employment at the Instituto Nacional de Pesquisas Espaciais, São José dos Campos, Brazil.

Table 1. Budget and staff summary: 2003-2005.

	2003	**2004**	**2005**
Authorized Staff Level	18	18	18
Actual Staff Level	16	17	18
NDS Staff – Programme Costs US$	410400[+]	397400[+]	395800
NDS Staff – Administration Costs US$	341200[+]	354200[+]	353300
Agency Support Costs US$	482500[+]	482500[+]	485000
Total Staff Costs Budget US$	1234100	1234100	1234100
Programme Budget US$	1143900	1143900	1143900
Total Budget – 2003 Prices US$	**2378000**	**2378000**	**2378000**
Admin + Agency Support Costs US$	823700	836700	838300
Total Programme Costs US$	1554300	1541300	1539700
Total Budget – 2003 Prices US$	**2378000**	**2378000**	**2378000**

[+] specified as 18 members of staff throughout the year.

IAEA NDS costs are shown in Table 1 in two self-consistent forms. Comparisons can only be made by adopting a constant exchange rate (set at 0.9229 Euros ≡ $1 US, despite a fall of approximately 30% in the value of US$ during this time period). Both the staff and programme costs for 2003/04/05 remain virtually unchanged.

Staff costs have undergone additional analysis, based on estimates of individual NDS-staff time dedicated to the various technical programmes as opposed to purely administrative duties, along with the Agency-support overhead; such a breakdown of these data is believed to reflect more clearly the effort expended directly on the technical programmes. Staff resignations and the resulting replacement exercises in 2003 (and 2004) also cause relatively minor fluctuations in the administration and programme costs identified with NDS staff year on year. There has been a modest shift of emphasis in the work of the Section during 2003, with more resources devoted to workshops and other user- training initiatives. Figures for 2005 are provisional, and subject to significant modifications prior to approval in the autumn of 2004.

2. NUCLEAR DATA CENTRE ACTIVITIES

As in previous years, the primary objectives of the NDS Nuclear Data Centre in 2002–2003 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,
- development and maintenance of software, and updating of manuals for internationally-agreed database formats and exchange procedures,
- improvements to the methods by which the data centre provides Member State users with information,
- 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. Since 2002, NDS has assumed a substantial coordinating role in the compilation of these data. As overseer, NDS staff assign data centre responsibilities towards CINDA-EXFOR compilation, ensure implementation of agreed compilation rules, resolve all issues relating to dictionary codes, and augment maintenance of the master files to an adequate quality for their subsequent distribution to other data centres.

The general purpose libraries of evaluated nuclear reaction data are produced and revised under national and regional programmes. After international release, all libraries are checked, documented and placed in the ENDF database. Special purpose nuclear databases, libraries and files are prepared through the IAEA Coordinated Research Projects and various national and regional programmes; these databases are usually documented in detail by the NDS as

IAEA-TECDOCs and INDC reports. Data intercomparisons, integral tests and benchmarks are often performed before the data files are disseminated online or through CD-ROM.

2.1.1. CINDA

The CINDA 2002 book covering documented bibliographic information on neutron-induced cross section data for the period 1988-2002 was prepared by the NDS staff. A PostScript electronic version has also been assembled as CINDA 2003 by NDS staff, and was published as hardcopy by the NEA Data Bank. Furthermore, a CD-ROM version of the complete CINDA database (from 1935 to 2003) has been produced by the NEA Data Bank, and enclosed within this book.

In 2004 the CINDA database will be substantially extended from an exclusively neutron-induced to neutron-, gamma- and charged-particle-induced reaction bibliography using available data from EXFOR.

For the purpose of CINDA-compilation coverage control, the NDS staff scan over 40 journal titles (mainly through the Internet). In 2002-2003 there were 3146 CINDA entries prepared and transmitted, either as direct input to the CINDA file (work in the area of NDS responsibility) or for further processing after submission by other responsible data centres.

2.1.2. EXFOR

With the arrival of Svetlana Dunaeva to replace Meinhart Lammer in the last quarter of 2003, EXFOR compilations of charged-particle data were re-initiated at NDS, along with a small amount of new neutron-induced cross-section data. A significant increase of NDS compilation activity can now be envisaged, and should subsequently become evident in the statistics for 2004 and beyond.

During 2002-2003, 29 new neutron- and charged-particle EXFOR entries were compiled at NDS, with experimental data inputs from Algeria (1), Argentina (2), Australia (3), Bangladesh (1), Brazil (2), China (7), Germany (2), Hungary (3), India (6), and South Africa (2). Furthermore, NDS staff checked and finalized 5 compilations from the China Nuclear Data Center, 6 compilations undertaken at the Ukrainian Nuclear Data Centre, and 47 data sets compiled at ATOMKI, Debrecen, Hungary prior to network submission, and 48 revised entries were also transmitted. 75 EXFOR transmission files (TRANS) containing 887 neutron entries (406 new and 481 revised), 1038 CPND entries (806 new and 232 revised) and 27 photonuclear entries (10 new and 17 revised) were checked and included in the database. Finally, the EXFOR/CINDA dictionaries were regularly updated and distributed to the network.

2.1.3. Evaluated data libraries, files and programs

Various new evaluated data libraries, files and programs for data checking, processing and graphical presentation were added to the NDS IAEA Web-site and distributed on CD-ROM:

- ENDF/B-VI Library, release 8 (last for ENDF/B-VI library),
- POINT2003, a temperature-dependent version of the ENDF/B-VI library, release 8,
- FOND-2.2 Evaluated Neutron Data Library; Russian library for generating ABBN group constants,

- updates to EPDL97 library of photon and electron interactions with atoms and atom relaxation libraries,
- theoretical evaluation of neutron- and proton-induced fission cross ections for Pb-Pu targets in energy range 20-200 MeV,
- EMPIRE-II nuclear reaction code, version 2.18,
- JEFF-3.0 General Purpose Library,
- JENDL-3.3, Japanese Evaluated Nuclear Data Library,
- Minsk Actinide Library - evaluated neutron reaction data library for Th-232, Pa-231, 233, U-232, 233, 234, 238, Np-238, Pu-238, 242, Am-241, 242g, 242m, 243, Cm-243, 245, 246,
- ENDF utility codes, release 6.13,
- WIMSD-IAEA-69 and 172-group libraries in WIMS-D format,
- DROSG 2000 Neutron Source Reactions, version 2.2,
- ENDVER verification codes - updates of November 2002,
- EXFOR+CINDA/Java2 on CD-ROM,
- PREPRO-2002 ENDF/B pre-Processing codes,
- RIPL-2 Reference Input Parameter Library,
- IBANDL Ion Beam Analysis Nuclear Data Library,
- PGAA database for prompt gamma-ray neutron activation analysis.

2.1.4. Future tasks

CINDA: complete transition to the new CINDA compilation/exchange format in 2004; publication of full neutron book in 2004/05 (covering the period 1935-2004; last publication in hardcopy form); extension of CINDA to include gamma- and charged-particle-induced data.

EXFOR: full implementation of NDS role in data compilations, including database coordinator and compilation functions (aim to compile at least 150 entries per year).

Evaluated data: continue update of general purpose libraries after their release by national and regional data centres; extend applications-oriented data libraries obtained through the work of IAEA Co-ordinated Research Projects.

2.2. Nuclear Data Services

2.2.1. Developments

Main improvements to user services in 2002-2003 are as follows:

- All INDC reports are now also published electronically.
- Notification of publication of any INDC report is sent by e-mail to users in accord with their expressed interests. Users who wish to receive reports in electronic format receive them as attachments to their e-mail.
- All databases libraries and files are available through Web and on CD-ROM; databases and retrieval systems distributed on CD-ROM generally do not require installation.

2.2.2. Statistics

A wide variety of requests are made that require various media to maintain data services to our many users. These communications include: standard mail for hardcopy documents, CD-ROMs, e-mails with attached retrieved data or electronic documents, and on-line transfer of data retrieved directly by users through the Web interface. Overall statistical analyses of user services are listed in Table 2 for the previous four years.

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

	2000	2001	2002	2003
Internet retrievals from the main Agency nuclear databases	9642	12894	20773	29913
Access through Internet to other Agency files and information	11472	16153	18135	20752
Requests for CD-ROMs	648	883	1108	852
Off-line retrievals	2557	2231	2548	2340

On-line retrievals from NDS databases are made directly by external users through Web access to the libraries, files and reports. Each registered retrieval contains at least one homogenous piece of information: one report; a set of data retrieved from one library; database; computer code; or package of codes. On-line retrieval corresponds to a user creating output and either downloading successfully at the user's local machine or browsing the retrieved data in screen mode. Statistics for CD-ROMs include only CD-ROMs sent on request; these data do not include the regular distribution of CD-ROMs by the NDS according to the expressed interests of users. Off-line retrievals include dispatch by ordinary mail of hardcopy reports or computer outputs prepared by NDS staff. As seen from Table 2, even with an increase in the number of user retrievals through the Web, the number of off-line and CD-ROM retrievals continue at a level of 3,000 requests per year.

Figure 1 shows various representations of user access to the IAEA-NDS Web server and the mirror system in Brazil, including definition by geographical area and technical topics. The total number of data retrievals has increased by 80% in 2002–2003 when comparing with equivalent data from the previous 2 years. This increased demand arises mainly from customer requirements for the evaluated general purpose and special applications libraries. Another noteworthy feature is that the number of queries from developing countries shows substantial growth in 20002/3, and 7% increase in their share of all NDS retrievals. More detailed Web statistics are available, including user access from individual countries, monthly access, and retrievals from individual libraries.

The following trends are also noted for 2002/03:

- Even users with good Web access work with CD-ROMs either to ensure their use of "frozen" data libraries or to avoid the problem of substantial downloading times when handling large data sets. The distribution of CD-ROMs reduces on-line retrievals, but creates a convenient working environment for the users.
- Large growth is observed in the retrieval of evaluated data for nuclear reactions and nuclear structure in various formats.

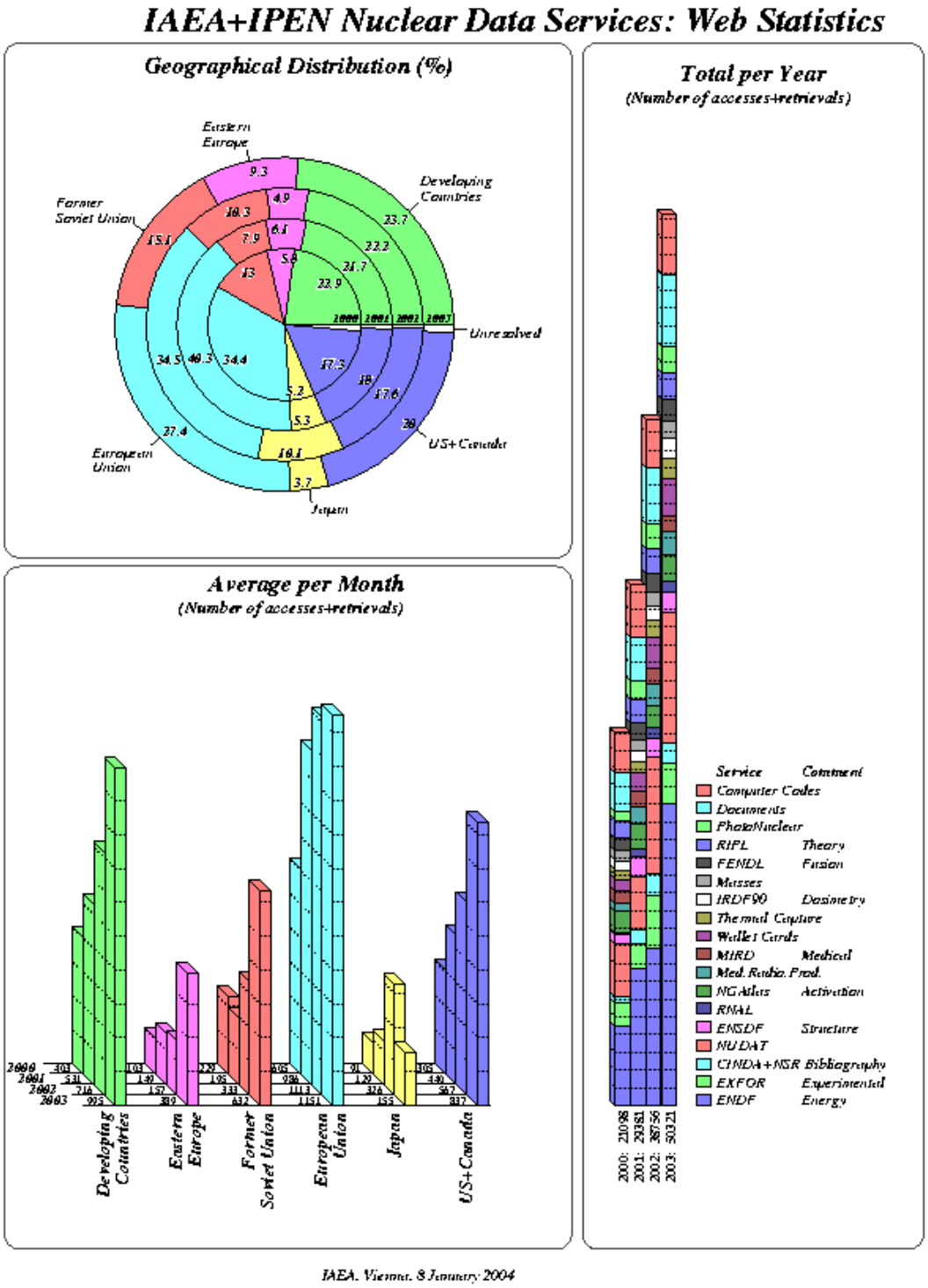

Figure 1. IAEA Nuclear Data Services: Web Statistics.

2. 3. New Generation of Nuclear Databases and Services

2.3.1. Migration of nuclear databases and services

Significant benefits were judged to accrue from moving the NDS nuclear databases and services from VMS/DBMS to other platforms. This proposal was initiated in 1999, and provided for significant revisions of the functionality of the existing data services to extend and implement them on an advanced level. Modern software and hardware systems permitted the formulation of a new and more ambitious approach to the original task of modernization, and so develop multi-platform nuclear data systems to a higher level of accessibility and reliability.

The major features of the final product are:

- universal and cost-effective solutions for users: Nuclear Data Centres (Web), laboratories (LAN), individuals (CD-ROM and PC);
- improved service based on high-quality software;
- protected future (several platforms, high level of portability);
- extensive possibilities for applications development and software exchange.

2.3.2. System design

The system design is based on the usage of relational databases and platform-independent system components:

- languages: Java, SQL, C, html;
- operating systems: Linux, Windows, VMS;
- databases: MS-Access, MySQL, SyBase;
- Web-server: Apache with Tomcat/Java.

2.3.3. Implementation

The project is being developed in close co-operation with NNDC (USA). NDS is responsible for the primary nuclear reaction databases (EXFOR, CINDA, ENDF), while NNDC staff will implement the nuclear structure and decay databases (ENSDF, NSR, NuDat).

Status:

Database\Software	Administrating	Web-interface	CD-ROM
EXFOR	completed	completed	completed
CINDA	80% completed	completed	completed
ENDF	planned in 2004	planned in 2004	planned in 2004

Significant progress can be reported during 2002/03, including:

- CINDA-relational: utilities and Web retrieval;
- EXFOR+CINDA/Java2: CD-ROM with stand-alone integrated databases and retrieval systems for Linux and Windows on MS-Access and MySQL;
- Universal Graphical User Interface for database management and applications (EndVer);
- ENDF-relational: administrating utilities and Web interface at first stages;
- full EXFOR and CINDA: installed in NDS and NNDC (with source codes);
- Web interface to EXFOR and CINDA: adopted to VMS and open for public access.

2.3.4. Future tasks

Other features would further improve user services, and are proposed for implementation in 2004-2005:

- complete the development of the main reaction databases (EXFOR, CINDA, ENDF); full package for maintenance, Web service and CD-ROM retrieval systems;
- install these products in NNDC (with agreed functionality and requirements);
- install new products at NDS (EXFOR, CINDA, ENDF, ENSDF, NSR, NuDat) on new hardware with OS – Linux, and start regular maintenance and Web service for the world (in co-operation with NNDC);
- install the new system in Member States' Nuclear Data Centres (India, Obninsk) and begin packaging the system for general distribution;
- Develop an easy-to-use system for updating local users' databases.

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 are primarily devoted to this topic. Bilateral visits and consultancies are also used to solve any problems in data exchange and database development.

A first-ever workshop on "Relational Databases for Nuclear Data Development, Dissemination and Processing: EXFOR Implementation, Maintenance and Compilation" was held at IAEA Headquarters in December 2003, devoted largely to EXFOR compilation activities of direct interest to the NRDC network (see Section 6.2.6).

3.1.1. NRDC network meetings

IAEA Technical Meeting on Network of Nuclear Reaction Data Centres, at the NEA Data Bank, Issy-les-Moulineaux, France, 27–30 May 2002 (INDC(NDS)-434): focused on reorganization of the work to avoid backlogs in data compilation, and a new reaction data centre protocol was agreed to coordinate these efforts.

IAEA Technical Meeting on Co-ordination of the Network of the Nuclear Reaction Data Centres was held at the IAEA Headquarters, Vienna, 17–19 June 2003 (INDC(NDS)-446): technical matters were considered in detail; 46 actions and 34 conclusions were agreed (focus on CINDA-EXFOR compilation rules, and migration of new generation databases).

Detailed information about the NRDC network activities can be found in INDC(NDS)-401 (Rev. 4), "The Nuclear Data Centres Network", August 2003.

3.1.2. Bilateral visits

- V. Zerkin (IAEA NDS) to NNDC, Brookhaven
  development of common software for the management and compilation of CINDA and EXFOR:
  4–15 March 2002, 28 October – 8 November 2002;
  10–21 March 2003, 20–31 October 2003.
- V. McLane (NNDC, Brookhaven) to IAEA NDS, co-ordination of the NDS and NNDC activities on software development for CINDA and EXFOR, 21–24 May 2002 and 12-16 June 2003.

3.1.3. Future tasks

Completion of the following task would improve co-ordination within the NRDC:

IAEA NDS Workshop: Installation and maintenance of joint relational nuclear reaction database (CINDA-EXFOR-ENDF) for Web service; data exchange and management of new generation of databases and services (end of 2004).

3.2. Network of Nuclear Structure and Decay Data Evaluators

The international network of nuclear structure and decay data (NSDD) evaluators is coordinated 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 NSDD network includes more than 20 centres and groups. NDS staff organize and chair these network meetings, along with regular workshops designed to assist in the training of new mass-chain evaluators.

Data evaluated by NSDD network participants are included in the Evaluated Nuclear Structure Data File (ENSDF), and published in various forms within Nucl. Phys. A and Nuclear Data Sheets. All of these recommended values are available to users through various media, such as through the Web, CD-ROMs, wall charts of nuclides, handbooks and nuclear wallet cards. Both the ENSDF master database and Nuclear Science References bibliographic database are maintained by the US National Nuclear Data Center 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. These regular debates also assist in the maintenance and improvements to the agreed methodology and rules governing NSDD evaluations. 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 decay characteristics for a well-defined set of nuclei) and data dissemination.

Detailed information about NSDD network activities can be found in INDC(NDS)-421, "Nuclear Structure and Decay Data (NSDD) Network", compiled by V.G. Pronyaev, March 2003.

3.2.1. NSDD network meeting

Co-ordination of International Network of Nuclear Structure and Decay Data Evaluators, Summary of an IAEA Technical Meeting, Vienna, 10-14 November 2003 (to be published as INDC(NDS) report): actions and conclusions focused on new assignments of responsibility for mass-chain and nuclide evaluations, solutions to technical problems, and need to attract and train new mass-chain evaluators.

3.2.2. Bilateral visit

- D. Winchell (NNDC, Brookhaven) to IAEA NDS, software development for shared nuclear databases, 3–7 June 2002.

3.2.3. Future tasks

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

- biennial IAEA-ICTP workshops on nuclear structure and decay data: theory and data evaluations,
- provision of initial support in the form of individual research contracts to new groups for the nuclear structure and decay data evaluation of mass chains and individual radionuclides.

4. ATOMIC AND MOLECULAR DATA

A primary goal of the Atomic and Molecular (A+M) Data Unit is to provide data relevant to fusion energy and other related nuclear energy activities. This aim is achieved through the A+M Data Unit carrying out a number of different activities to enhance the databases and to make them accessible to users in the fusion energy community.

The databases maintained by the A+M Data Unit include interactions of isolated atoms and molecules and their ions with other particles, particle-surface interactions, and materials property data. These last two sets are combined under the term plasma-material interaction data.

The A+M Data Unit supervises Co-ordinated Research Projects (CRPs) with associated Research Co-ordination Meetings (RCMs) as well as co-ordinating the work of a Data Centre Network (DCN). Data gathered from these sources and from Consultant Meetings (CMs) are evaluated and added to the databases maintained by the A+M Data Unit. All activities of the A+M Data Unit are supervised and reviewed by the Atomic and Molecular Data for Fusion Subcommittee of the International Fusion Research Council (IFRC) on a biennial basis.

4.1. A+M Database Development

Three CRPs are currently active in the Unit:

(1) CRP on "Tritium Inventory in Fusion Reactors" held the first RCM in 2003. A very thorough review of the current status of research has taken place, and estimates were made of the total amount of tritium uptake in a machine such as ITER. Much research is needed to prevent uptake of tritium and to remove tritium periodically from the wall material in order for the ITER project to succeed. A comprehensive work plan for the next two years has been developed in this area.

(2) CRP on "Molecular Processes in Edge Plasmas" held a second RCM in 2003 at which significant results were reported. These research activities also resulted in the identification of several areas in which data are either needed or remain uncertain. A comprehensive review of these areas has been made, and a proposal was approved for a 1-year extension to this work.

(3) CRP on "Atomic and Molecular Data for Fusion Diagnostics" held a second RCM in 2003. Data for a number of processes were reported, along with a review of the status of the data. As a consequence of the collaborations formed within the CRP, good progress has been made in addressing the data needs. A proposal was approved for an extension to this work, with an additional RCM to be held in 2004.

Results from previous CRPs have been published in the journal *Atomic and Plasma-Material Interaction Data for Fusion* as volumes 10, 11 and 12 (for 2002 and 2003):

Volume 10 – Charge Exchange Cross Section Data (2002);

Volumes 11 and 12 - Radiative Cooling Rates of Fusion Plasma Impurities (2003).

4.2. Co-ordination of A+M Data Centre Network

A+M Data Centre Network (DCN) consists of 12 members from USA, Russia, Japan, France, Germany, Italy, China, and Korea. This network meets every two years to discuss data needs and to co-ordinate DCN activities. Each Data Centre gives a report on recent activities, and a list of data needs and priorities is reviewed and updated (available through the A+M Unit home page (*www-amdis.iaea.org*)). A proposal has been made to develop a new uniform format for A+M data in XML, and a small working group was formed to develop a specific proposal to be presented at the next ICAMDATA meeting.

4.3. Other A+M Activities

Besides the normal data gathering activities of the Unit, several other significant activities have taken place including improved access to the databases, various publications and presentations at scientific conferences, and an extra-budgetary project.

The web interface has greatly expanded: there is now a general Internet search engine for numerical A+M data, which allows users to request data from multiple databases around the world. The search engine reformulates the request to meet the format requirement of different databases, and returns the data to the user. A similar search capability is now possible for bibliographic information.

At times there is a need for data that have never been measured or calculated. A user can now generate such data by running calculational tools through the Internet. An early example is the use of an approximation method developed by Peek and Mann, and provided to the A+M database by Peek. An interface was written to allow a user to run this computer code to generate cross sections for electron impact excitation of atomic ions. This code is very general and allows calculations to proceed on nearly any electronic configuration of almost any ion. Similar capabilities are under development at the Los Alamos National Laboratory for electron and photon processes in atoms and atomic ions, and such an interface is also being prepared for heavy particle collisions.

The Unit continues to issue data documents in the *Atomic and Plasma-Material Interaction Data for Fusion* series (see Section 4.1). Additionally, the Unit prepares and publishes the *International Bulletin on Atomic and Molecular Data for Fusion*, containing bibliographical information for fusion-related A+M physics data (Volume 62 was issued in August 2003).

Staff have attended and presented papers at several international scientific conferences. The new search capabilities have also proven to be extremely valuable in locating data - statistics show significant usage of A+M data, and on-line calculations of cross sections have been undertaken at least several times a week (indicating a significant need for data not yet included in the databases).

A training workshop on A+M data for fusion was held at the International Centre for Theoretical Physics in Trieste, Italy, September 2003. There were 12 participants and 4 instructors. Major topics of interest in fusion research were considered in detail, and a number of problems were assigned that required a knowledgeable use of databases to make estimates of the properties of fusion plasmas. Lecture notes and exercises were distributed to the participants on CD.

The A+M Data Unit continues to maintain the “International Database on Irradiated Graphite Properties”. A meeting of the Steering Committee was held in September 2003 at which priorities for additional data were established, and new features of the database interface were demonstrated and discussed. The A+M Data Unit continues to co-ordinate the activities of the members of this project.

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 2002 and 2003, and are still on-going. One planned CRP was cancelled (as recommended by expert consultants). Two CRPs have been approved, 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	Completed after 1 year extension, preparation of document and database continues	5.1.1
2	Update of X-ray and gamma-ray decay data standards for detector calibration and other applications	1998-2002	8 (3)	Herman/ Nichols	Completed, preparation of documents and database continues	5.1.2
3	Reference Input Parameter library (RIPL-II)	1998-2002	8 (3)	Herman/ Nichols	Completed, documents and database prepared	5.1.3
4	Prompt-gamma activation analysis (PGAA)	1999-2003	5 (2)	Paviotti/ Nichols	Completed, documents and database prepared	5.1.4
5	Light element cross-section standards	2002-06	9(3)	Pronyaev	On-going	5.1.5
6	Nuclear data for Th-U fuel cycle	2002-06	11(6)	Trkov	On-going	5.1.6
7	Nuclear data evaluation for emerging technologies (RIPL-III)	2003-06	4(3)	Capote Noy	Approved, additional contracts/agreements pending	5.1.7
8	Nuclear data for production of therapeutic radionuclides	2003-07	9(4)	Capote Noy	On-going	5.1.8

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

Objectives:

- Develop fission yield systematics and nuclear models as a tool for the 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.

Activities:

- Approval was granted for an extension of the CRP by one year (to June 2003). The extension enabled implementation of important improvements that emerged from the CRP studies.
- The TECDOC describing the results of the investigation is in preparation.

References:

Preparation of TECDOC was initiated in 2003 to bring this work to a satisfactory conclusion.

5.1.2. Update of X- and Gamma-ray Standards for Detector Calibration (completed)

Objectives:

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

Activities:

- Third research co-ordination meeting was held at IAEA Vienna, Austria, 21-24 October 2002.
- TECDOC describing the updated standards and the evaluation procedures is in preparation.

Reference:

M. Herman and A. Nichols (Eds.): Summary Report of Third RCM to Update of X- and Gamma-ray Decay Data Standards for Detector Calibration and Other Applications, IAEA Nuclear Data Section, INDC(NDS)-437, December 2002.

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

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 TECDOC, and ensure that the library and tools are available on-line and as CD-ROM.

Activities:

- Database is available on the web and on CD-ROM.
- TECDOC describing the database is in preparation.

Reference:

http://161.5.7.109/ripl2/

5.1.4. Development of Database for Prompt Gamma-ray Neutron Activation Analysis completed)

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:

- Third research co-ordination meeting was held at IAEA Vienna, Austria, 24-26 March 2003.
- Evaluation of thermal neutron capture cross sections, resonance integrals and g-factors was performed and published in an INDC report.

References:

S. F. Mughabghab: Thermal Neutron Capture Cross Sections, Resonance Integrals and g-factors, INDC(NDS)-440, February 2003.

R. M. Lindstrom, R. B. Firestone and R. Paviotti-Corcuera (Eds.): Summary Report of the Third RCM on Development of a Database for Prompt γ-ray Neutron Activation Analysis, IAEA Nuclear Data Section, INDC(NDS)-443, April 2003.

5.1.5. Improvement of the Standard Cross Sections for Light Elements (on-going)

Objectives:

- Improve the methodology for the evaluation of the covariance matrix of uncertainty in the R-matrix model fits.
- Update the experimental database prepared by Poenitz for the evaluation of light and heavy element standards (objective added by participants at first RCM in 2002).
- Produce R-matrix evaluations of important light element standards.
- Produce new evaluations of heavy element standards (objective added by participants at first RCM in 2002).
- Produce new evaluations of high-energy standards consistent with low-energy standards (objective added by participants at second RCM in 2003).
- Produce combined evaluation of light- and heavy-element standards, including high-energy standards by the end of 2004 (objective added by participants at second RCM in 2003).

Activities:

- First research co-ordination meeting was held at IAEA Vienna, Austria, 23-27 September 2002.
- Second research co-ordination meeting was held at NIST, Gaithersburg, USA, 13-17 October 2003.

References:

A.D. Carlson, G.M. Hale and V.G. Pronyaev (Eds.): Summary Report of the First RCM on Improvement of the Standard Cross Sections for Light Elements, IAEA Vienna, Austria, 23-27 September 2002, INDC(NDS)-438, January 2003.

A.D. Carlson, G.M. Hale and V.G. Pronyaev (Eds.): Summary Report of the Second RCM on Improvement of the Standard Cross Sections for Light Elements, IAEA Vienna, Austria, 13–17 October 2003, INDC(NDS)-453, to be published.

5.1.6. Evaluated Nuclear Data for the Thorium-Uranium Fuel Cycle (on-going)

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:

- Intercomparison of existing evaluations for ^{232}Th.
- First research co-ordination meeting was held at IAEA Vienna, Austria, 25-29 August 2003.
- Plan prepared and agreed for the sharing of work by CRP participants.

Reference:

A. Trkov (Ed.): Summary Report of the First RCM on Evaluated Nuclear Data for Th-U Fuel Cycle, IAEA Vienna, Austria, 25-29 August 2003, INDC(NDS)-447, December 2003.

5.1.7 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.

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

Activity:

- Scope of the CRP was discussed during the third research co-ordination meeting on RIPL-II (Section 5.1.3).

Reference:

None.

5.1.8. **Nuclear Data for Production of Therapeutic Radionuclides** (on-going)

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:

- First research co-ordination meeting was held at IAEA Vienna, Austria, 25-27 June 2003.

Reference:

J.-Ch. Sublet and R. Paviotti-Corcuera (Eds.): Summary Report of the First RCM on Nuclear Data for the Production of Therapeutic Radionuclides, IAEA Vienna, Austria, 25-27 June 2003, INDC(NDS)-444, June 2003.

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)

Objectives:

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

Activities:

- On-going individual research contract - develop utility codes to Doppler-broaden the cross sections in the ACE libraries; software is under test.
- Consultants' Meeting was held on 10-12 November 2003 at IAEA, Vienna, Austria.

Reference:

R. Forrest and A. Trkov (Eds.): Summary Report of Consultants' Meeting to Maintain FENDL Library fpr Fusion Applications, IAEA Vienna, Austria, 10-12 November 2003, INDC(NDS)-451, November 2003.

5.2.2. International Reactor Dosimetry File: IRDF-2002 (on-going)

Previous tested version of the International Reactor Dosimetry File IRDF-90 V2 was released in 1993. Updating of this 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:

- Technical Meeting was held on 27-29 August 2002 at IAEA, Vienna, Austria.
- Technical Meeting was held on 1-3 October 2003 at IAEA, Vienna, Austria.
- Assembly of the library and preparation of the TECDOC are in progress.

References:

L.R. Greenwood and R. Paviotti-Corcuera (Eds.): Summary Report of Technical Meeting on International Reactor Dosimetry File - IRDF-2002, IAEA Vienna, Austria, 27-29 August 2002, INDC(NDS)-435, September 2002.

P.J. Griffin and R. Paviotti-Corcuera (Eds.): Summary Report of the Final Technical Meeting on International Dosimetry File – IRDF-2002, IAEA Vienna, Austria, 1-3 October 2003, INDC(NDS)-448, October 2003.

5.2.3. 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:

- With minor modifications, the library produced through an earlier IAEA-CRP has been proposed for adoption in the ENDF/B-VII library of the USA.
- Data were processed with NJOY for use in the MCNPX Monte Carlo code.

Reference:

R.E. MacFarlane: Photonuclear Evaluations for ENDF/B-VII, Summary of the 52nd Cross Section Evaluation Working Group Meeting, Brookhaven National Nuclear Data Center, 5-7 November 2002.

5.2.4. Evaluated cross-section database for ion beam applications (on-going)

Objectives:

- Develop recommended data and assess their reliability for all nuclear cross sections of interest in IBA, and make available to the IBA community.
- Prepare proposal for CRP.

Activities:

- Technical Meeting was held at IAEA Vienna, 29-30 October 2003.
- Alexander Gurbich (IPPE, Obninsk) was selected to be Liaison Officer between IBA community and NDS (recommendation of AGM on Long-Term Needs for Nuclear Data, INDC(NDS)-423, November 2000).
- Existing experimental databases (NRABase and SigmaBase) were combined, and made available as IBANDL on NDS web site, December 2003 (A. Gurbich).

Reference:

I.C. Vickridge and O. Schwerer (Eds.): Report of IAEA Technical Meeting on Database of Evaluated Cross Sections for Ion Beam Applications, IAEA Vienna, Austria, 29-30 October 2003, INDC(NDS)-449, November 2003.

5.2.5. GANDR project (on-going)

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:

- Classification of materials into categories that differ in the details of the group structure of the cross sections.
- GANDR system has been initialised on an NDS machine according to the classification of materials.
- Preliminary investigation has been made to prepare input for a GANDR run; additional information has been requested from the author.

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 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: Regional Centre for Nuclear Data Services

See also Section 7.4.

Objectives:

- Provide reliable, fast and easy access to nuclear data by equipping centres in an agreed region with data services.
- 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.

Actions:

- Contact established with Bhabha Atomic Research Centre (BARC), India.
- Suitable server set aside at BARC to run Linux, Apache, Tomcat and DBMS MySQL.
- Further progress dependent on developments in relational databases.

6.2. Workshops

6.2.1. Nuclear Reaction Data and Nuclear Reactors: Physics, Design and Safety, ICTP Trieste, Italy, 25 February to 28 March 2002

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

The five-week workshop is a continuation of a regular series of nuclear data/nuclear physics courses that started in 1978 on a biennial basis, as organised in collaboration with ICTP Trieste, Italy. Covers nuclear reaction model codes, data evaluation, processing and reactor design, with emphasis on thermal power and research reactors.

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 (x 1.5 h) lectures and 29 (x 1.5 h) exercises.
- 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:

- 34 participants from 26 countries received training from 5 directors and 25 lecturers.
- 4 participants attended from developed countries (did not qualify for ICTP financial support).
- Audience was genuinely interested, and actively participated in lectures and exercises.
- Workshop resulted in a large number of requests for nuclear data and nuclear physics codes.

6.2.2. Nuclear Structure and Decay Data Evaluation, IAEA Vienna, Austria, 18-22 November 2002

IAEA Workshop Director: V.G. Pronyaev (IAEA-NDS).

One-week workshop was organized by the IAEA in collaboration with NNDC, BNL, USA. This pilot workshop was held to assist in determining the feasibility of holding a more comprehensive workshop at ICTP Trieste in 2003 (see Section 6.2.5).

Objectives:

- Familiarize students with new experimental data that characterize nuclear structure and decay data, and introduce modern nuclear models.
- Train participants in the methodology of NSDD evaluations, and the production of evaluated nuclear structure and decay data (ENSDF mass-chain evaluations).

Actions:

- Workshop material was presented as lectures (mornings) and exercises (afternoons) on PCs running Windows-operating systems.
- Computer exercises included on-line databases retrieval, use of ENSDF analysis and utility codes in NSDD evaluations (i.e., GTOL, LOGFT, HSICC, FMTCHK and others). Eight PCs with MS Windows-operating system were used. One afternoon session was dedicated to participants' presentations.

Outcomes:

- 8 participants from 8 countries received training from 6 lecturers.
- Audience interested and actively participated in lectures and exercises. Participants were scientists actively working in nuclear structure experiments or with advanced nuclear models.
- 7 participants are now involved in the NSDD evaluation work, and have begun to contribute towards the creation of recommended ENSDF data (some by means of IAEA individual research contracts placed in March/April 2003 (Argentina, Brazil, Bulgaria and India)).

6.2.3. Nuclear Data for Science and Technology: Materials Characterisation and Analysis, ICTP Trieste, Italy, 19-30 May 2003

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

Two-week workshop was organized by the IAEA in collaboration with the ICTP Trieste: third in a series entitled "Nuclear Data for Science and Technology". Previous two workshops covered medical applications (1999) and accelerator-driven waste incineration (2001). This form of workshop represents a unique forum from which scientists and engineers can obtain extensive and up-to-date information on nuclear data in modern nuclear applications.

Objectives:

- Provide an overview of the evaluation methodology and nuclear data libraries of relevance to materials analysis techniques.
- Complement theoretical work with hands-on exercises involving nuclear model codes, ion beam analysis simulation codes, and retrieval of nuclear data from on-line or distributed databases.

Actions:

- 17 (x 1.5 h) lectures and 18 (x 1.5 h) exercises.
- Computer codes used during the workshop exercises were:
  - Isotope Explorer for viewing ENSDF data;
  - PGAA Viewer for the prompt-gamma activation analysis database;
  - SRIM/TRIM calculator of stopping power for ion beam analysis;
  - NRBA/SIGMACALC nuclear reaction database utility;
  - SIMNRA nuclear reaction analysis and Rutherford backscattering spectroscopy;
  - PIXE particle induced X-ray emission analysis code.

Outcomes:

- 36 participants from 21 countries received training from 2 directors and 7 lecturers.
- Audience was genuinely interested, and actively participated in lectures and exercises.

6.2.4. Nuclear Workshop on Atomic and Molecular Data for Fusion Research, ICTP Trieste, Italy, 8-12 September 2003

IAEA Workshop Director: R.E.H. Clark (IAEA-NDS).

Training of 12 students in A+M data, and their application to the design and development of fusion devices.

6.2.5. Workshop on Nuclear Structure and Decay Data: Theory and Evaluation, ICTP Trieste, Italy, 17-28 November 2003

IAEA Workshop Director: A.L. Nichols (IAEA-NDS)

Two-week workshop was organized by the IAEA in collaboration with NNDC, BNL, USA and ENEA, Italy. Contents and structure of this workshop were based on the successful one-week pilot workshop at IAEA Headquarters in November 2002, and the comments of those participants (see Section 6.2.2).

Objectives:

- Familiarize students with new experimental data that characterize the nucleus and with modern nuclear models.
- Train participants in the methodology of NSDD evaluations and in production of evaluated nuclear structure and decay data (as ENSDF mass chain evaluations).

Actions:

- Workshop material was presented as lectures (mornings/afternoons) and exercises (most afternoons) on PCs running Windows operating systems.
- Computer exercises included on-line databases retrieval, use of ENSDF analysis and utility codes in NSDD evaluation (GTOL, LOGFT, HSICC, FMTCHK and others). Three afternoon sessions of 1.5 h each were dedicated to participants' presentations.

Outcomes:

- 24 participants from 12 countries received training from 11 lecturers/demonstrators – nuclear theory, spectroscopic measurements, statistical analyses, data evaluation techniques, and database assembly.
- Audience interested and actively participated in lectures and exercises. Participants were physicists and engineers working on a wide range of nuclear science topics.
- At least 6 participants were strongly interested in becoming involved in NSDD evaluation work (particularly from India).

6.2.6. Workshop on Relational Databases for Nuclear Data Development – Dissemination and Processing: EXFOR Implementation, Maintenance and Compilation, IAEA Vienna, Austria, 1-5 December 2003

IAEA Workshop Directors: V. Zerkin and O. Schwerer (IAEA-NDS).

One-week workshop was organized by the IAEA in collaboration with NNDC, BNL, USA and IPPE, Obninsk, Russian Federation.

Objectives:

- Familiarize students with developments in relational databases and EXFOR in particular.
- Train participants in the implementation, maintenance and updating of relational EXFOR database.
- Train participants in compilation of experimental work.

Actions:

- Workshop material involved introduction to EXFOR data compilation, and maintenance of the relational EXFOR database.
- Participants compiled articles on neutron- and charged-particle-induced nuclear reaction data.
- Computer exercises included creation of new entries, running auxiliary software and maintaining the database.
- Lecturers described all aspects of compilation (formats, definitions, dictionaries, auxiliary software, data exchange and update procedures).
- Workshop materials were presented as lectures and practical exercises (~50% each).

Outcomes:

- 11 participants from 7 countries received training from 4 lecturers on most recent developments concerning new operational features of international nuclear databases (PC based).
- Audience participated actively in the lectures and exercises.

7. COMPUTER SUPPORT

Systems Development Unit highlights during 2002-2003 include the following:

- arrival of a new Systems Analyst into the Systems Development Unit in September 2003;
- acquisition of a Compaq ML530 G2 server;
- assimilation of the systems duties of the Atomic and Molecular Data Unit;
- clarification of the technical requirements and systems needed to migrate to non-VMS services;
- progress in the provision of platforms and technologies for new data services.

7.1. Computer Network

The entire NDS Ethernet remains inside the Agency Firewall in a special network zone known as the De-Militarized Zone (DMZ), in alignment with the Agency-wide computer network security policy. NDS staff work closely with the Agency Network Security Engineer to meet IT security needs, and to ensure the continued efficient provision of NDS data services. The Agency as a whole is now expected to replace the Token-Ring computer network with Ethernet towards the end of 2004. Since the Section already has an Ethernet network, NDS is well placed to join this proposed infrastructure.

7.2. Data Servers

7.2.1. VMS systems

NDS continues to maintain 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.

The Alpha server at IPEN continues to function efficiently with absolutely no down-time over the reporting period. Collaboration between the Systems Development Unit and counterparts at IPEN on its on-going management are excellent, and all tasks are performed quickly and well.

7.2.2. A+M server

A+M staff have traditionally maintained their own IBM AIX server, which was replaced in early 2003 with a new Compaq ML530 2G server running RedHat Linux version 9. All A+M services have been migrated, and the new server went live in October 2003 (http://www-amdis.iaea.org). At the same time, day-to-day management of this system was handed over to the Systems Development Unit.

7.2.3. Linux systems

Following the Workshop on Relational Databases for Nuclear Data held at the NNDC in September 2000 and agreed NDS work in this area, the Systems Development Unit is actively participating in the provision of suitable development environments, tools and knowledge support for this endeavour. NDS is also involved in the enhancement of these services through the additional technologies, which migration off VMS is enabling.

Servers and PCs running Linux and new Database Management Systems have been acquired, and knowledge is being developed on Linux. Experience and understanding of the nuclear data community's needs with respect to new data retrieval and storage methods is also being expanded.

7.3. Multi-Platform Database Management

Figure 2 gives an overview of the entire NDS network in which we support both VMS and new technology servers. The timescale for the relational project indicates the need to continue with some of the VMS services until the end of 2004 and possibly longer.

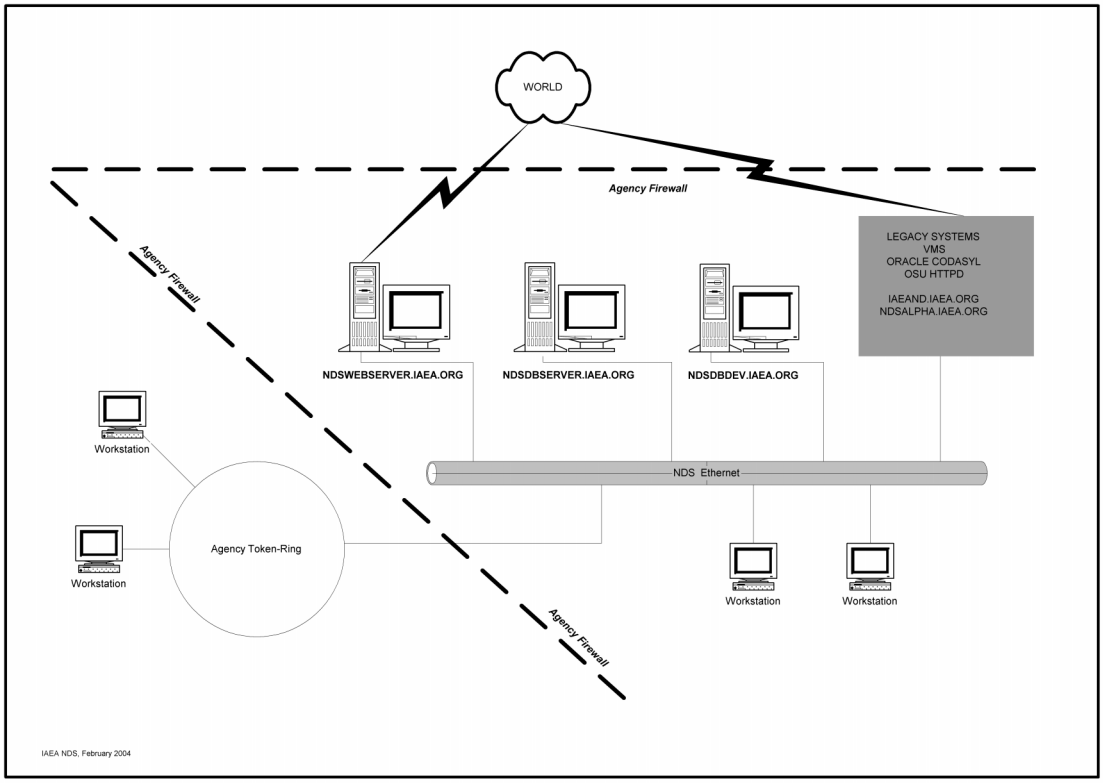

Figure 2. Overview of NDS Ethernet network, Linux and VMS servers: relationship with the Agency network and the Internet.

Figure 3 provides a more detailed view of the new technology servers and how they are arranged:

- user requests will be directed to the front-end web server (NDSWEBSERVER),
- database retrievals will be subsequently directed to the production database server (NDSDBSERVER),
- developers will work on the database/web development server (NDSDBDEV),
- completed work will be posted to the production web or database servers as appropriate.

All of these systems are currently in place, but are not yet advertised to the world via the IAEA Domain Name Service (DNS). The three servers run RedHat Enterprise Linux version 2.1, and Apache, Jakarta Tomcat, Java, SYBASE ASE and other systems facilities required to serve and manage the new relational databases are in place. Further coordination with NNDC is required to tune these systems and ensure that all the required tools are in place.

NDSWEBSERVER is also serving the A+M data services (see also Section 4) through the use of aliases on the Apache web server. The A+M services are physically located on their own RAID disk array, while a separate array has been set aside for the new nuclear data services.

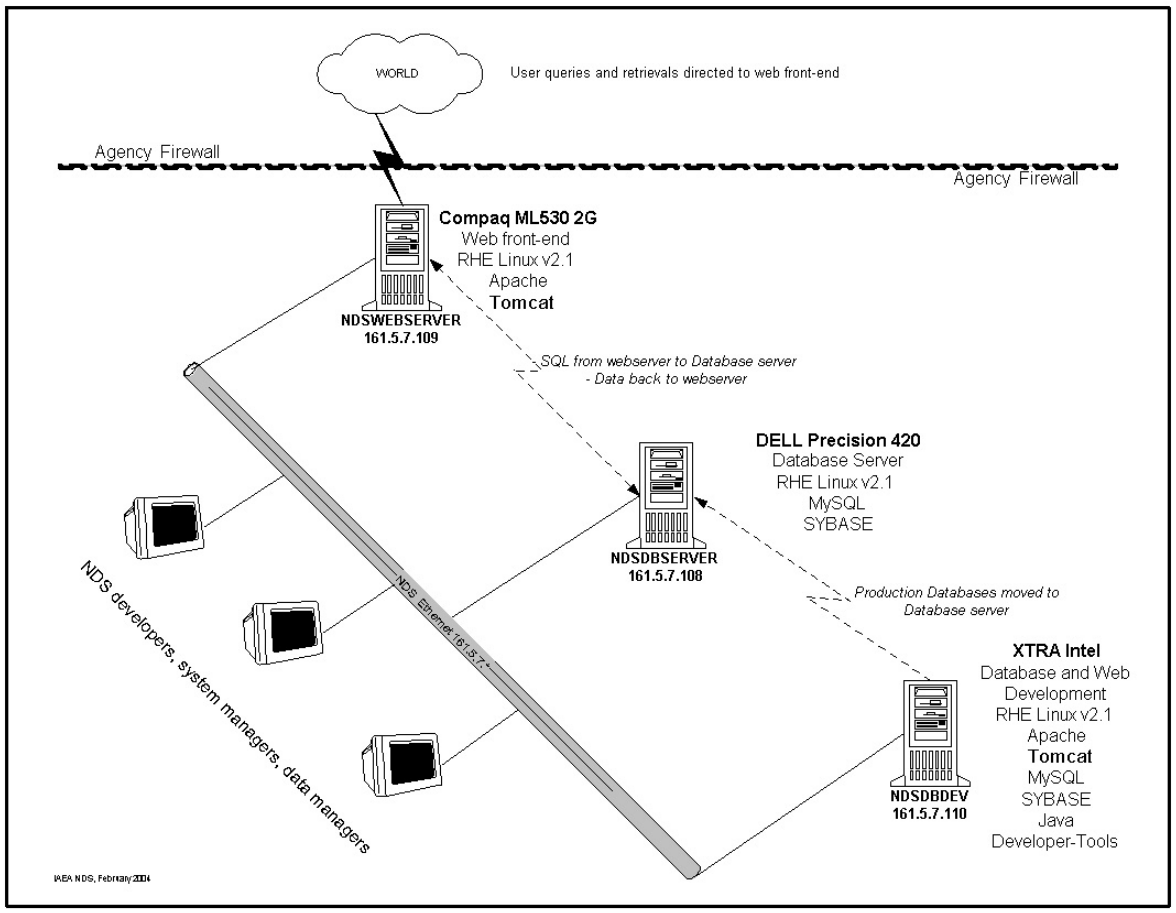

Figure 3. NDS Linux servers.

7.4. Data Service Expansion

Towards the end of 2003 contact was established with counterparts at the IT department of the Bhabha Atomic Research Centre (BARC), Mumbai, India. Given that the relational database project is moving towards a conclusion in early 2004 with the NNDC servers expected to go live at that time, we are now in a position to more clearly understand the technical requirements for the provision of a remote nuclear data server. Thus, BARC staff have set aside a suitable server running appropriate versions of Linux, Apache, Tomcat and the free open source Database Management System (DBMS) MySQL.

Porting existing web pages and flat data libraries to Linux/Apache is straight forward, and has been successfully undertaken. The CINDA/EXFOR relational database is ready for deployment on Linux/Apache/Tomcat using MySQL as the DBMS. The other major databases (ENSDF, ENDF and related products such as NuDat, XUNDL, NSR, etc.) are tied to SYBASE which is a relatively expensive proprietary DBMS. However, counterparts at BARC would nonetheless like to proceed with moving the existing flat (non-DBMS) libraries, web services and the MySQL version of EXFOR/CINDA to their server. This work is on-going.

7.5. Electronic Documents

Staff have investigated the viability of converting all NDS paper documents to electronic form. Most documents are already in either the INIS database or in individual laboratory electronic archives. Documents that remained only in paper form have been identified, and arrangements made with INIS to scan them.

7.6. New and Retired Equipment

All NDS DEC VXT X-terminals have been retired. X access to servers has been replaced with Hummingbird Exceed X-emulation on standard PCs, working from node to node on the NDS Ethernet and from nodes on the Agency Token-Ring to servers in the NDS network over secure firewall tunnels.

Principal computer hardware acquisitions during the reporting period are listed in Table 4. Other acquisitions of note have been:

- several SCSI hard disks were purchased to accommodate new libraries on the development Alpha server. These disks replaced older smaller capacity disks in the primary storage rack, and will allow the removal of the storage expansion box of the Alpha (which cannot be upgraded).

- A 70GB SCSI disk was added to the DELL Precision 420 server, allowing this computer to be used for additional Linux-based tasks, e.g. MCNPX runs.

Table 4. NDS Computer Hardware Purchases from 01/01/2002 to 31/12/2003.

Item	Quantity
Compaq Proliant ML530 G2 Server with two Xeon 2.4GHz CPU, 1GB RAM, two RAID controllers and 250GB disk space.	1
XTRA PCs	11
HP LaserJet 2300D printer	1
FSC Lifebook Laptops	1
Toshiba TDP-P5 Data Projector	1
USB 2.0 Flash Memory Sticks	21
Belkin Multi USB2.0 Flash Card Reader	2
Kingston Compact Flash Cards	3

7.7. Software

NDS has continued to acquire PC and other software as deemed necessary to facilitate the continued provision and enhancement of the Section's data services.

Principal software acquired in 2002-2003:

- upgrade PCTeX to version 5, five-user department license,
- upgrade ABSOFT Professional FORTRAN for Linux to version 8,
- upgrade Lahey/Fujitsu FORTRAN 95 for Linux,
- macromedia Dreamweaver MX2004 – Web design and publishing,
- Paragon MS and Unix disk storage manager – Technician's license,
- Passware for Windows,
- RedHat Linux 9,
- Borland JDatastore 6 Developer Edition,
- Adobe Acrobat 6 Upgrade,
- Adobe Photoshop,
- Vstudio .NET 2003,
- Windows Server Enterprise 2003,
- Visio Professional 2003,
- upgrade SYBASE ASE Enterprise.

8. CONCLUDING REMARKS

Neither the finite Budget nor the nature of staff expertise permit the Nuclear Data Section to undertake at any one time all of the proposed work programmes discussed and recommended by INDC members. Rather our capabilities and manpower levels allow us only to select and explore specific topics debated in previous INDC meetings, pursuing some in a relatively comprehensive manner (e.g., through CRPs or internationally-coordinated efforts), others in a prudent manner (e.g., lower-cost data development projects with relatively modest targets), or undertake a preliminary review in order to assess the real needs with greater confidence. As in previous years, this form of "natural" selection has applied to the contents of the lengthy discussions that took place at the previous INDC meeting in May 2002.

A wide range of nuclear data issues were discussed during the 24th INDC meeting (see INDC/P(02)-23, October 2002), and a number of these topics are selected in order to give the reader a clearer idea of how the NDS attempted to address their wishes and concerns over the course of 2002 and 2003. These efforts were all made while maintaining and progressing other on-going nuclear data projects that had evolved from earlier INDC recommendations and the demands of IAEA Member States. Points of note in no particular order are as follows:

(a) CRP on "Improvement of the standard cross sections for light elements" began in 2002, and has been subsequently expanded to the full-scale evaluation of all standard neutron reaction cross sections (Table 5).

Table 5. Standard Neutron Reactions.

Reaction	*Neutron Energy Range*
H(n, n)	1 keV to 200 MeV
^{3}He(n, p)	0.0253 eV to 50 keV
^{6}Li(n, t)	0.0253 eV to 1 MeV
^{10}B(n, α_0)	0.0253 eV to 1 MeV
^{10}B(n, $\alpha_1\gamma$)	0.0253 eV to 1 MeV
C(n, n)	0.0253 eV to 1.8 MeV
Au(n, γ)	0.0253 eV, and 0.2 to 2.5 MeV
^{235}U(n, f)	0.0253 eV, and 0.15 to 200 MeV
^{238}U(n, f)	threshold to 200 MeV

The drive is to ensure that these data become a major input to the future evolution of new and comprehensive national databases for nuclear applications.

(b) Significant progress has been made in moving forwards towards developing the desirable environment for the creation of a good quality ion bean analysis databases through a TM and the formulation of a suitable starting file (see INDC(NDS)-449, and a consultancy in late 2003 to consolidate and merge SIGMABASE and NRABASE); a Co-ordinated Research Project has been proposed as the next appropriate step.

(c) After further debate, the preparation of "Minor actinide neutron reaction data for closed fuel cycles" is seen as a suitable candidate for a CRP starting in 2007. Experience from the CRP on "Evaluated nuclear data for the Th-U fuel cycle" will be useful because this on-going project is addressing some of the data needs for the lighter minor actinides. Therefore, future work could focus on other minor actinides that are relevant to closed fuel-cycle reactor concepts.

(d) As proposed previously, a CRP on "Updated Decay Data Library for Actinides" is in the planning stage for initiation in 2005.

(e) Good progress was made in identifying the means of updating and extending the FENDL database: CM meeting was held in November 2003, and the needs and sources of new data were specified in detail. The necessary updates to the library will be carried out through special service agreements (SSAs) and staff work during 2004. A Döppler broadening utility package for the ACE files will also be ready within 12 months.

(f) INDC concerns (both WG1 and 2) about the NDS computer systems and staffing levels in this particular area have been addressed– a systems expert was successfully recruited in September 2003, while another member of staff was dedicated fulltime to the creation and administration of NDS/NNDC relational databases throughout 2002 and 2003. NDS staffing levels in this area are arguably better than they have been for many years, particularly when combined with those of the A+M Unit.

(g) INDC members have regularly expressed their interest in and support of IAEA technical workshops at ICTP, Trieste, Italy.

- Urgent need for "new blood" to fortify the Nuclear Structure and Decay Data Evaluators' Network has been of particular concern. There can be no doubt that NDS has addressed this problem with some considerable success: an extremely successful pilot workshop was held at IAEA Headquarters in November 2002 (see INDC(NDS)-439), and a larger gathering was sponsored at ICTP in November 2003 that required significant preparative work and administrative input from NDS staff. IAEA individual research contracts have subsequently been placed with four new teams of mass chain evaluators in Argentina, Brazil, Bulgaria and India, with possibly more to follow.

- As requested, NDS also organised ICTP workshops on the following topics:

  Nuclear Reaction Data and Nuclear Reactors – Physics, Design and Safety, Feb-March 2002 (4 weeks; to be repeated in 2004);

  Nuclear Data for Science and Technology: Materials Analysis, May 2003 (2 weeks).

(h) NRDC activities continue under rigorous review – a staff member of NDS has taken on the role of co-ordinator of the worldwide compilation process to combat delays and other problems. NDS has also recruited a dedicated CINDA/EXFOR compiler in order to honour our commitments in this area of database assembly.

MEETINGS AND SCIENTIFIC VISITS IN 2002

Month/Duration	Responsible Officer	Type	Meeting Title/Type of Visit	Home Institute	Location
<u>February/March</u>					
25 – 27	Paviotti	CM	Nuclear Data for Production of Therapeutic Radionuclides		Vienna
25 February to 28 March	Herman	WS	Nuclear Reaction Data and Nuclear Reactors: Physics, Design and Safety		Trieste, Italy
<u>May</u>					
14 – 17	Nichols	TM	24th International Nuclear Data Committee		Vienna
21 – 24	Zerkin		Consultant: V. McLane	BNL, USA	Vienna
27 – 30	Pronyaev	TM	Network of Nuclear Reaction Data Centres		Issy-les-Moulineaux, France
<u>June</u>					
3 – 7	Zerkin		Consultant: D. Winchell	BNL, USA	Vienna
17 – 28	Trkov		Consultant: D. Cullen	LLNL, USA	Vienna
<u>August</u>					
19 August to 6 September	Clark		Consultant: H. Summers	University of Strathclyde, UK	Vienna
27 – 29 August	Paviotti	TM	International Reactor Dosimetry File: IRDF-2002		Vienna

Month/Duration	Responsible Officer	Type	Meeting Title/Type of Visit	Home Institute	Location
<u>September</u>					
23 – 27 September	Clark		Consultant: J. Abdallah	LANL, USA	Vienna
23 – 27 September	Pronyaev	RCM	Improvement of the Standard Cross Sections for Light Elements		Vienna
<u>October</u>					
21 – 24	Herman	RCM	Update of X- and Gamma-ray Decay Data Standards for Detector Calibration		Vienna
<u>November</u>					
4 – 6	Clark	RCM	Tritium Inventory in Fusion Reactors		Vienna
18 – 22	Pronyaev	WS	Nuclear Structure and Decay Data Evaluation		Vienna
25 – 29	Lammer	RCM	Fission Product Yield Data Required for Transmutation of Minor Actinide Nuclear Waste		Vienna
25 November to 6 December	Trkov		Consultant: S. Ganesan	BARC, India	Vienna

MEETINGS AND SCIENTIFIC VISITS IN 2003

Month/Duration	Responsible Officer	Type	Meeting Title/Type of Visit	Home Institute	Location
March					
24 – 26	Paviotti	RCM	Development of a Database for Prompt Gamma-ray Neutron Activation Analysis		Vienna
May					
19 – 30	Herman	WS	Nuclear Data for Science and Technology: Materials Analysis		Vienna
June					
12 – 16	Schwerer		Consultant: V. McLane	BNL, USA	Vienna
16 – 18	Clark	RCM	Atomic and Molecular Data for Fusion Plasma Diagnostics		Vienna
17 – 19	Schwerer	TM	Co-ordination of the Network of Nuclear Reaction Data Centres		Vienna
25 – 27	Paviotti	RCM	Nuclear Data for Production of Therapeutic Radionuclides		Vienna
August					
25 – 29	Trkov	RCM	Evaluated Nuclear Data for the Th-U Fuel Cycle		Vienna

Month/Duration	Responsible Officer	Type	Meeting Title/Type of Visit	Home Institute	Location
<u>September</u>					
8 – 12	Clark	WS	Atomic and Molecular Data for Fusion Energy Research		Trieste, Italy
<u>October</u>					
1 – 3	Paviotti	TM	International Reactor Dosimetry File: IRDF-2002		Vienna
6 – 7	Humbert	TM	17th Meeting of the Atomic and Molecular Data Centres and ALADDIN Network		Vienna
6 – 10	Humbert		Consultant: Y. Ralchenko	NIST, USA	Vienna
9 – 10	Pronyaev		Consultant: G. Manturov	IPPE, Russia	Vienna
13 – 17	Pronyaev	RCM	Improvement of the Standard Cross Sections for Light Elements		Gaithersburg, USA
29 – 30	Schwerer	TM	Database of Evaluated Cross Sections for Ion Beam Applications		Vienna
13 October to 7 November	Trkov		Consultant: D. Lopez Aldama	Centro de Gestion de la Informacion y Desarollo de la Energia, Cuba	Vienna
<u>November</u>					
10 – 12	Trkov	CM	Maintain FENDL Library for Fusion Applications		Vienna

Month/Duration	Responsible Officer	Type	Meeting Title/Type of Visit	Home Institute	Location
November (cont'd)					
10 – 14	Pronyaev	TM	Co-ordination of the International Network of Nuclear Structure and Decay Data Evaluation		Vienna
10 – 14	Clark		Consultant: R. McCarroll	Universite Pierre et Marie Curie, France	Vienna
11 – 30	Pronyaev		Consultant: D. Smith	ANL, USA	Vienna
17 – 21	Clark		Consultant: J. Abdallah	LANL, USA	Vienna
17 – 21	Clark		Consultant: U. Fantz	Institut für Physik, Augsburg, Germany	Vienna
17 – 28	Nichols	WS	Nuclear Structure and Decay Data: Theory and Evaluation		Trieste, Italy
December					
1 – 5	Zerkin	WS	Relational Databases for Nuclear Data Development, Dissemination and Processing		Vienna
4 – 5	Clark	TM	Assess and Co-ordination of Modelling Needs and Data Providers		Vienna
8 – 12	Clark		Consultant: J.P. Hansen	University of Bergen, Norway	Vienna
8 – 12	Clark		Consultant: A. Dubois	Universite Pierre et Marie Curie, France	Vienna

Month/Duration	Responsible Officer	Type	Meeting Title/Type of Visit	Home Institute	Location
December (cont'd)					
8 – 19	Schwerer		Consultant: A. Gurbich	IPPE, Russia	Vienna
8 – 19	Humbert		Consultant: K. Olsen	NIST, USA	Vienna
15 – 19	Pronyaev		Consultant: Zhenpeng Chen	Tsinghua University, China	Vienna
15 – 19	Pronyaev		Consultant: E. Gai	IPPE, Russia	Vienna

Appendix 2

Scientific Papers and Publications 2002/2003

Parameters for Nuclear Reaction Calculations by M. Herman, paper presented at Workshop on Astrophysics, Symmetries and Applied Physics, 11-13 March 2002, Joint Institute for Heavy Ion Research, Oak Ridge, Tennessee, USA.

Panel on Database Access through the Web by R.E.H. Clark, D.P. Humbert, Y. Ralchenko, paper presented at Int. Conf. on Atomic and Molecular Data and Their Applications, 24-27 April 2002, Gatlinburg, Tennessee, USA.

Recent developments at the Atomic and Molecular Data Unit by R.E.H. Clark, paper presented at XIII Symposium on Atomic and Surface Physics and Related Topics, 17-23 February 2002, Going, Austria.

International Reactor Dosimetry File: IRDF-2002 by R. Paviotti-Corcuera, V. Zerkin, E.M. Zsolnay, K.I. Zolotarev, W. Mannhart,. L.R. Greenwood, P.J. Griffin. Pp. 654-661 in: Reactor Dosimetry in the 21st Century (Eds: J. Wagemans, H.A. Abderrahim, P. D'Hondt, C. De Raedt), Proc. 11th Int. Symposium on Reactor Dosimetry, 18-23 August 2002, Brussels, Belgium, World Scientific, Singapore (2003).

IAEA Nuclear Databases for Applications by O. Schwerer, 25th Workshop on Nuclear Physics, 31 August – 4 September 2002, Sao Pedro, Brazil, *Braz. J. Phys.* **33** (2003) 231-237.

EMPIRE-II: Application to Radiative Neutron Capture by M. Herman, pp. 514-521 in Proc. 11th Int. Symposium Capture Gamma-ray Spectroscopy and Related Topics, Eds: J. Kvasil, P. Cejnar, M. Krtička, 2-6 September 2002, Pruhonice near Prague, Czech Republic, World Scientific, Singapore (2003).

Verification of Monte Carlo Calculations of the Neutron Flux in the Carousel Channels of the TRIGA Mark II Reactor by R. Jacimovic, M. Maucec and A. Trkov, Int. Conf. Nuclear Energy for New Europe, 9-12 September 2002, Kranjska Gora, Slovenia.

Isothermal Temperature Reactivity Coefficient Measurement in TRIGA Reactor by T. Zagar, M. Ravnik and A. Trkov, pp. 302.1-302.6 in Proc. Int. Conf. Nuclear Energy for New Europe, 9-12 September 2002, Kranjska Gora, Slovenia.

Progress in Nuclear Well Logging Modelling Using Deterministic Transport Codes by I. Kodeli, D.L. Aldama, M. Maucec, A. Trkov, pp. 308.1-308.8 in Proc. Int. Conf. Nuclear Energy for New Europe, 9-12 September 2002, Kranjska Gora, Slovenia.

Validation of the IAEA-WIMSD Library for the LOADF Code on Operation Transients at the Krsko Power Plant by A. Trkov, pp. 310.1-310.6 in Int. Conf. Nuclear Energy for New Europe, 9-12 September 2002, Kranjska Gora, Slovenia,.

Current Activities of the Atomic and Molecular Data Unit by R.E.H. Clark, paper presented at Atomic Data and Analysis Structure Workshop, 20-22 October 2002, Cadarache, France.

Atomic and Molecular Data Unit by R.E.H. Clark, et al., paper presented at Technical Meeting on Atomic on Atomic and Plasma-Material Interaction Data for Fusion Science and Technology, 28-31 October 2002, Jülich, Germany.

Some Recent Activities of the International Atomic Energy Agency in the Field of Nuclear Data by D.D. Sood and A. Trkov, *J. Radioanal. Nucl. Chem.* **255** (2003) 13-19.

Effects of the Neutron Spectrum on the Neutron Activation Analysis Constants for ^{94}Zr and ^{96}Zr by B. Smodis, A. Trkov and R. Jacimovic, *J. Radioanal. Nucl. Chem.* **257** (2003) 481-487.

Verification of Monte Carlo Calculations of the Neutron Flux in Typical Irradiation Channels of the TRIGA Reactor, Ljubljana by R. Jacimovic, M. Maucec and A. Trkov, *J. Radioanal. Nucl. Chem.* **257** (2003) 513-517.

Development of Nuclear Technique for the Detection of Landmines by D.D. Sood, U. Rosengard and A. Trkov; pp. 13-24 in Proc. SPIE, vol. 5089, 21-25 April 2003, Orlando, Florida, USA.

IAEA Co-ordinated Research Project: Update of X-ray and Gamma-ray Decay Data Standards for Detector Calibration and Other Applications by A.L. Nichols, presented at Int. Conf. on Radionuclide Metrology (ICRM2003), 2-6 June 2003, Dublin, Ireland; also published in *Appl. Radiat. Isot.* **60** (2004) 247-256.

IAEA Nuclear Data Section: Provision of Atomic and Nuclear Databases for User Applications by D.P. Humbert, A.L. Nichols and O. Schwerer, presented at Int. Conf. on Radionuclide Metrology (ICRM2003), 2-6 June 2003, Dublin, Ireland; also published in *Appl. Radiat. Isot.* **60** (2004) 311-316.

Nuclear Data Requirements for the Actinides and Fission Products Build-up and Burn-up by V.G. Pronyaev and A. Trkov, Proc. XII International Conference on Selected Problems of Modern Physics, 8-11 June 2003, Joint Institute of Nuclear Research, Dubna, Russian Federation.

Quantifying Uncertainties by V.G. Pronyaev, Proc. XII International Conference on Selected Problems of Modern Physics, 8-11 June 2003, Joint Institute of Nuclear Research, Dubna, Russian Federation.

Contribution to Plutonium Futures: Work of the IAEA (G. Andrew) by A.L. Nichols and A. Trkov, Proc. Conf. on Plutonium Futures, 6-10 July 2003, Albuquerque, New Mexico, USA.

DANSE and GENIE: Two Atomic and Molecular Data Web Search Engines for Fusion and Plasma Physics by D.P. Humbert, Y. Ralchenko, R.E.H. Clark and K. Katsonis; Proc. 30th European Physical Society Conference on Controlled Fusion and Plasma Physics, 7-11 July 2003, St. Petersburg, Russian Federation.

Updates to the Atomic and Molecular Data Unit Databases by R.E.H. Clark, paper presented at the International Conference on Photonic, Electronic and Atomic Collisions, 23-29 July 2003, Stockholm, Sweden.

IAEA Nuclear Data Activities: Services and Emerging Databases by A.L. Nichols and O. Schwerer, presented at V Latinamerican Symposium on Nuclear Physics, 1-5 September 2003, Santos, Brazil.

Temporal Variation of the Neutron Flux in the Carousel Facility of a TRIGA Reactor by A. Trkov, Proc. Nuclear Energy for New Europe 2003, 8-11 September 2003, Portoroz, Slovenia.

IAEA Activities Related to Nuclear Data for P&T and ADS by A. Trkov, presented at ADOPT – Int. Workshop on P&T and ADS Development, 6-8 October 2003, Mol, Belgium; proceedings: http://www.sckcen.be/sckcen_en/activities/conf/conferences/20031006/cd/.

IAEA Nuclear Data Section: Data Development Activities and Services by A.L. Nichols, V.G. Pronyaev and O. Schwerer, presented at EU Enlargement Workshop NEMEA, Neutron Measurements and Evaluations for Applications, 5-8 November 2003, Budapest, Hungary.

Series and No.	**Titles**
Annual Publications	CINDA 2002, CINDA 2003
Periodicals	Bulletin on Atomic and Molecular Data for Fusion N^{o} 62
	Atomic and Plasma-Material Interaction Data for Fusion Issues 11, 12
Newsletter	Nuclear data newsletter N^{o} 33, 34, 35 and 36
IAEA-TECDOC-1285	Reference Neutron Activation Library (April 2002)
INDC(NDS)-431	Third IAEA Research Co-ordination Meeting on Nuclear Model Parameter Testing for Nuclear Data Evaluation
INDC(NDS)-432	IAEA Consultants' meeting on Nuclear Data for Production of Therapeutic Radioisotopes
INDC(NDS)-433	Report of the IAEA Nuclear Data Section to the International Nuclear Data Committee
INDC(NDS)-434	IAEA Technical Meeting on Network of Nuclear Reaction Data Centres
INDC(NDS)-435	IAEA Technical Meeting on International Reactor Dosimetry File (IRDF-2002)

IDNC(NDS)-436 13th Meeting of the IFRC Subcommittee on Atomic and Molecular Data for Fusion

INDC(NDS)-437 Third IAEA Research Co-ordination Meeting on Update of X- and Gamma-ray Decay Data Standards for Detector Calibration and Other Applications

INDC(NDS)-438 First IAEA Research Co-ordination Meeting on Improvement of Standard Cross Sections for Light Elements

INDC(NDS)-439 Workshop on Nuclear Structure and Decay Data Evaluation

INDC(NDS)-440 Thermal Neutron Capture Cross Sections, Resonance Integrals and g-factors

INDC(NDS)-441 IAEA International Database on Irradiated Nuclear Graphite Properties

INDC(NDS)-442 First IAEA Research Co-ordination Meeting on Tritium Inventory in Fusion Reactors

INDC(NDS)-443 Third IAEA Research Co-ordination Meeting on Development of a Database for Prompt Gamma-ray Neutron Activation Analysis

INDC(NDS)-444 First IAEA Research Co-ordination Meeting on Nuclear Data for the Production of Therapeutic Radionuclides

INDC(NDS)-445 IAEA Technical Meeting on Atomic and Plasma-Material Interaction Data for Fusion Science Technology

INDC(NDS)-446 IAEA Technical Meeting on Co-ordination of the Network of Nuclear Reaction Data Centres

INDC(NDS)-447 First IAEA Research Co-ordination Meeting on Evaluated Nuclear Data for Th-U Fuel Cycle

INDC(NDS)-448 Final Technical Meeting on “International Reactor Dosimetry File: IRDF-2002”

INDC(NDS)-449 Report of IAEA Technical Meeting on Database of Evaluated Cross Sections for Ion Beam Applications

INDC(NDS)-450 IAEA Technical Meeting on Technical Aspects of Atomic and Molecular Data Processing and Exchange (17th Meeting of A+M Data Centres and ALADDIN Network) (in preparation)

INDC(NDS)-451 IAEA Consultants’ Meeting to Maintain FENDL Library for Fusion Applications

Other INDC Reports, 2002/2003

Report	Country of Origin	Number of Reports
INDC(AUS)	Austria	3
INDC(BLR)	Belarus	5
INDC(CCP)	Russia	6
INDC(CPR)	China	3
INDC(GER)	Germany	2
INDC(JPN)	Japan	3

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FENDL2 for FTP file transfer of FENDL-2.0;
RIPL for FTP file transfer of RIPL.
NDSONL for FTP access to files sent to NDIS “open” area.
Web: http://www-nds.iaea.org