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Report of the Nuclear Data Section to the International Nuclear Data Committee March 1983 - August 1984

A. Lorenz, Editor

August 1984

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

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to the International Nuclear Data Committee

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Abstract

This progress report of the IAEA Nuclear Data Section covers the 18-months period March 1983 - August 1984. It describes past, current and planned activities of the Section and presents the status of its nuclear data centre services and technology transfer.

A. Lorenz, Editor

August 1984

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List of Abbreviations

A+M	Atomic and molecular
ADABAS	Data base management system in use at IAEA
CAJaD	Centre for Data on the Structure of the Atomic Nucleus and Nuclear Reactions of the USSR State Committee on the Utilization of Atomic Energy, located at the Kurchatov Institute
CBNM	Central Bureau for Nuclear Measurements, located at Geel, Belgium
CCDN	Centre de Compilation de Donnees Neutroniques, same as NDCC Neutron Data Compilation Centre of the OECD Nuclear Energy Agency at Saclay near Paris; now part of NEA Data Bank
CDFE	Centre for Photonuclear Experiments Data, Institute of Nuclear Physics of the Moscow State University
CIAMDA	Computerized Index to Literature on Atomic and Molecular Collision Data Relevant to Fusion Research
CINDA	Computerized Index of Neutron Data, a specialized bibliography and data index on neutron nuclear data compiled jointly by NNCSC, NDCC, NDS and CJD
CINDU	A Catalogue of Numerical Nuclear Data Libraries available from NDS
CJD	Centr po Jadernym Dannym, the USSR Nuclear Data Centre at F.E.I. Obninsk
CODATA	Committee on Data for Science and Technology
CODEN	International code for the abbreviation of periodical titles used by ASTM, INIS and Chemical Abstracts
CPL	Computer Programme Library operated by NEA, and located at Ispra, Italy; now part of NEA Data Bank
CPND	Charged Particle Nuclear Reaction Data
CRP	Coordinated Research Programme
CSISRS	NNCSC' internal system for handling experimental data; the previous system was known as SCISRS
DASTAR	Data Storage and Retrieval System used originally at IAEA/NDS
DBMS	Data Base Management System
EBCDIC	Extended Binary-Coded Decimal Interchange Code
EGAS	European Group for Atomic Spectroscopy

ENDF/B	Evaluated Nuclear Data File of the United States
ENSDF	Computer-based Evaluated Nuclear Structure Data File developed by US/NDP
EWGRD	European Working Group on Reactor Dosimetry
ESCAMPIG	Europhysics Study Conference on Atomic and Molecular Physics in Ionized Gases
EXFOR	Exchange Format, initially developed for the international exchange of neutron nuclear data, now being extended to charged particle nuclear data
FIZ	Fachinformationszentrum Energie, Physik, Mathematik GesmbH located at the Kernforschungszentrum Karlsruhe in the Federal Republic of Germany
FPND	Fission Product Nuclear Data
IAEA/NDS	Nuclear Data Section of the International Atomic Energy Agency, also NDS
ICPEAC	International Conference on the Physics of Electronic and Atomic Collisions
ICTP	International Centre for Theoretical Physics
IFRC	International Fusion Research Council
INDC	International Nuclear Data Committee
INDL/A	IAEA Nuclear Data Library for Evaluated Neutron Reaction Data of Actinides
INIS	International Nuclear Information System, a bibliographic system operated by the IAEA
IRDF	International Reactor Dosimetry File
IWGRRM	International Working Group on Reactor Radiation Measurements
JILA	Joint Institute for Laboratory Astrophysics
JINR	Joint Institute for Nuclear Research in Dubna, USSR
KACHAPAG	Karlsruhe Charged Particle Group
KEDAK	Karlsruhe Evaluated Neutron Data File
LIYaF	Leningrad Institut Yadernoy Fiziki: Leningrad Nuclear Physics Institute of the USSR Academy of Sciences
NDCC	Neutron Data Compilation Centre (Centre de Compilation de Donnees Neutroniques - CCDN) of the OECD Nuclear Energy Agency at Saclay near Paris; now part of NEA Data Bank

NDP	Nuclear Data Project located at the Oak Ridge National Laboratory (also referred to as US/NDP)
NDS	IAEA Nuclear Data Section, Vienna
NEA	Nuclear Energy Agency of the OECD
NEA/DB	Nuclear Energy Agency of the OECD Data Bank (previously NDCC)
NEACRP	Committee on Reactor Physics of the Nuclear Energy Agency of the OECD
NEANDC	Nuclear Data Committee of the Nuclear Energy Agency of the OECD
NNCSC	US National Neutron Cross Section Centre at the Brookhaven National Laboratory, Upton, N.Y. (now NNDC)
NND	Neutron Nuclear Reaction Data
NNDC	National Nuclear Data Centre of the United States
NRDC	Nuclear Reaction Data Centres
NSDD	NSD data = Nuclear Structure and Decay Data
OECD	Organization for Economic Cooperation and Development
RCN	Now ECN = Energy Research Foundation at Petten in the Netherlands
RIKEN	Institute of Physical and Chemical Research, Saitama, near Tokyo, Japan
SCISRS	Sigma Centre Information Storage and Retrieval System
SOKRATOR	Soviet Evaluated Neutron Data File Format
TND	Transactinium Isotope Nuclear Data
UKNDL	UK Nuclear Data Library
WRENDA	World Request List for Nuclear Data published by the IAEA
ZAED	Zentralstelle fuer Atomkernenergie-Dokumentation: Nuclear documentation and information centre for the Federal Republic of Germany; now FIZ

PREFACE

Twenty Years IAEA Nuclear Data Programme: 1964-1984

The expansion of nuclear technology during the last twenty years has created a growing demand for an organized and easily accessible body of numerical nuclear information needed by the scientific community. Since 1964, the IAEA has operated an international centre for nuclear data under the guidance of the International Nuclear Data Committee. Today, with activities encompassing data assessment and research coordination, data processing and exchange, and data services and technology transfer to developing countries, the centre interacts with scientists in 73 Member States, 51 of which are developing.

In order to ascertain which data are required to what degree of accuracy, the centre maintains contact with more than 200 research laboratories active in the production or use of nuclear data, and convenes two to three scientific meetings annually to assess the status of data and their requirements in specific fields of science and technology. In addition, several coordinated research programmes support the efforts of some 40 groups in research institutes to generate and improve needed nuclear and atomic data, with an increasing involvement of developing countries.

The overall effort to satisfy the extensive nuclear and atomic data requirements of nuclear scientists and engineers is provided by the co-operative action of some 30 national and regional data centres and groups, whose activities at the international level are being co-ordinated by the IAEA nuclear data centre. An example of such co-operation is the shared compilation, exchange, and dissemination of neutron reaction data in the common data base format EXFOR, and the annual publication by the IAEA of the Computer Index to the Literature on Neutron Data, CINDA, on behalf of four contributing data centres. EXFOR contains now more than three million data records, and the current version of CINDA contains references to more than 120 000 original publications. A similar activity has developed in the last five years in the field of atomic data required in fusion research. This has stimulated the development of an EXFOR data base format for atomic collision data and the publication of a CINDA-like index for these data, called CIAMDA.

The ultimate objective of the nuclear data centre is to provide the best available data to users in science and technology. Complementing the service function of the co-operating data centres, the IAEA provides cost-free data centre services and scientific advice primarily to developing countries. In response to more than 5 000 requests received by the IAEA data centre over the last twenty years from individual scientists in more than 60 Member States, (including 45 developing countries), more than 6 000 technical reports, almost half a million sets of numerical data and some 500 data handling computer codes have been distributed, including detailed advice on their use.

The service function of the IAEA nuclear data centre has been extended in the course of the last several years by the implementation of Technical Co-operation projects for the transfer of expertise in nuclear data measurement techniques and instrumentation to developing Member States,

contributing to the development of their scientific infra-structure and strengthening their capabilities to perform accurate nuclear measurements. Also, for the benefit and education of young scientists from developing countries, two series of training courses have been conducted in the field of nuclear data: advanced training courses in applied nuclear theory in 1978, 1980, 1982 and 1984, in co-operation with the International Centre for Theoretical Physics, Trieste, and interregional Technical Co-operation training courses on the production, processing and application of nuclear data in 1982 and 1983.

The Nuclear Data Section takes this opportunity to express its deep appreciation and gratitude to all members and participants of the INDC, all co-operating data centres and groups, numerous research institutions and individual scientists, national and regional nuclear data committees, the International Centre for Theoretical Physics, and other co-operating national and international institutions for the most helpful advice, assistance and co-operation they have rendered to the Agency's nuclear data programme over the past twenty years.

Programme Summary

J.J. Schmidt
Head, IAEA Nuclear Data Section

This progress report on the activities and services of the IAEA Nuclear Data Section covers the eighteen months period from March 1983 to August 1984.

In this reporting period the staff turnover of the Nuclear Data Section (NDS) was small. In December 1983 Dominique Gremillet, programmer in the Atomic and Molecular Data Unit of NDS, left the Section; he will be replaced by John Hughes from the Queen's University, Belfast, Northern Ireland, atomic physicist and programmer, in August 1984. Vladimir Pronyaev, nuclear physicist, and Kosta Katsonis, atomic physicist, will leave the Section in September 1984. While Pronyaev's position will be filled again, Katsonis' post has been requested by the Agency's management to be transferred to another programme within the Agency's Department of Research and Isotopes. An effort will be made, in co-operation with the other atomic data centres, to maintain the atomic and molecular data programme at its current scope and efficiency.

The reporting period was marked by further consolidation of the activities under the Interregional Technical Co-operation Project for Nuclear Data Techniques and Instrumentation (TC/INT/1/018) and by an increase in the number of lectures presented by NDS staff on the Agency's nuclear data activities and services at training courses and conferences, and on visits and advisory missions to laboratories particularly in developing countries. The number of requests received and answered by NDS has reached an average annual figure of 700 or about three requests per working day.

In the framework of the Interregional Project, larger inputs, in terms of expert services and equipment have been provided to several of the more promising laboratories in developing countries, to support and maintain the progress they have achieved. At the same time the support was maintained at optimum level and fellowships promoted particularly for those laboratories which were still in the initial phase of their programmes. The first research coordination meeting on measurement and analysis of 14 MeV neutron nuclear data held at Gaussig in the German Democratic Republic has been very useful in discussing the results, problems and plans of a number of developing laboratories participating in the Interregional Project, and in enforcing interlaboratory co-ordination and co-operation between developing and advanced laboratories. The Training Course and Study Tour on Neutron Physics and Nuclear Data Measurements with Accelerators and Research Reactors conducted in the USSR in September 1983 provided the developing country participants with an overview of the latest developments in the field of neutron physics and nuclear data measurements, in close relationship to the Interregional Project. Concomitant with the activities under the Interregional Project, new liaison officers were appointed in a number of developing countries.

Lectures and papers on Agency nuclear data activities and services were presented and visits for detailed programmatic assistance were paid by the following NDS staff:

- D.E. Cullen (presented by a co-author) at the sixth International Conference of Radiation Shielding, Tokyo, Japan, May 1983;

- H.D. Lemmel and K. Katsonis at the Summer School on Computing Techniques in Physics, Bechyne, Czechoslovakia, June 1983;

- D.E. Cullen and J.J. Schmidt on a one-week invited visit to the Secretariat of Atomic Energy, Tripoli, Libya, September 1983;

- A. Lorenz on a duty trip to Japan at the Tokai University in September 1983;

- J.J. Schmidt at the USSR Training Course and Study Tour in September 1983;

- A. Lorenz at the CODATA/UNESCO Traning Course on Accessibility and Dissemination of Non-bibliographic Data in Science and Technology held at Stockholm, Sweden, in October 1983;

- J.J. Schmidt and M.K. Mehta at the Workshop on Nuclear Model Computer Codes, ICTP, Trieste, January/February 1984;

- J.J. Schmidt by presenting three papers, with A. Lorenz, D.E. Cullen, M. Lammer and M.K. Mehta as (co)authors, at the Ninth CODATA Conference, Jerusalem, Israel, June 1984;

- M.K. Mehta at the Physics Section Technical Committee Meeting on Alternatives to Research Reactors as a Research Tool (accelerators and isotopic sources), Uppsala, Sweden, June 1984

- J.J. Schmidt at the Ninth International Nathiagali Summer College on Physics and Contemporary Needs, Islamabad, Pakistan, July 1984.

With the Consultants' Meeting on Nuclear Data for Bore-hole and Bulk-media Assay Using Nuclear Techniques held in Krakow, Poland, November 1983, NDS has entered a new field. The major conclusion of the meeting was that the existing evaluated nuclear data files developed for nuclear reactor design were not satisfactorily meeting the requirements for nuclear analytical techniques in applied nuclear geophysics. This led to the recommendation that the Agency should issue a comprehensive handbook of nuclear data for nuclear geophysics applications. A second set of major recommendations concerned the development of a programme for the systematic intercomparison, standardisation and collection of macroscopic absorption, transport and slowing-down properties of rocks and minerals.

In the area of coordinated research programmes, the CRP on Validation and Benchmark Testing of Actinide Nuclear Data was started in 1983/84 and its detailed scope defined at the Research Coordination Meeting held at Uppsala, Sweden, in May 1984.

The CRP on the Measurement and Evaluation of Transactinium Isotope Nuclear Decay Data will be terminated at the end of 1984 and a final report on this seven-year co-operative effort be issued in 1985 containing a critically evaluated recommended set of heavy element nuclear decay data.

Upon recommendation by the IFRC Subcommittee on Atomic and Molecular (A+M) Data for Fusion at its meeting in Vienna in June 1984, the CRP on Atomic Collision Data for Diagnostics of Magnetic Fusion Plasmas will be terminated

at the end of 1984 and the results of this CRP including recommendations of data to be used in fusion plasma diagnostics be published in the Agency's Nuclear Fusion Journal.

Following a careful consideration of their scope, and subject to final INDC and internal IAEA approval, two new CRPs on Methods for the Calculation of Fast Neutron Nuclear Data for Structural Materials, and on Measurement and Analysis of Double-differential Neutron Emission Spectra in (p,n) and (alpha,n) Reactions for Determining Nuclear Level Densities are proposed to be started in the near future.

A Specialist Meeting on Format for the Exchange of Evaluated Nuclear Data held in Vienna in April 1984 reviewed and adopted numerous proposals related to the improvement and extension of the existing ENDF formats, particularly concerning multiple-particle producing reactions at higher MeV energies and charged-particle induced reactions.

In the field of charged particle nuclear data (CPND) compilation, the Institute of Physical and Chemical Research, Saitama/Tokyo, Japan, has joined the Nuclear Reaction Data Centre Network with the compilation and evaluation of data on radioisotope producing charged particle nuclear reactions. Extension of the CPND data centre network to other data compiling groups would be desirable in order to cope with the increasing need for application-oriented CPND compilations.

In 1984 three issues of CINDA are being published, CINDA-B, a cumulative issue covering the five-year period 1977-1981, CINDA-84, covering the literature from January 1982 to the present, and a supplement to CINDA-84 to be published in the fall of 1984.

For all data files maintained by NDS documentation reports are now available, issued in the IAEA Nuclear Data Services report series. They are kept up-to-date and continuously improved, and sent together with the data files requested from NDS. Greater flexibility in data services has been achieved: data retrievals in EXFOR, ENDF/B and some other formats can now be made available in "standard" or "edited" format, either on tape or in the form of listings; graphical computer plots can also be provided.

The Nuclear Data Newsletter has been issued about twice a year. Issue no. 6 of March 1984 had a distribution of 2700, 2400 copies thereof to scientists in more than 50 countries in the NDS service area, 300 copies to scientists outside the NDS service area. The newsletter has turned out to be an efficient advertising medium for the services of NDS and has initiated numerous requests for data, documents and data handling codes.

Major progress in the field of A+M data for fusion has been achieved at the recent meeting of the A+M Data Centre Network held in Vienna in June 1984 with the agreement by the data centres to provide systematic input for the publication of the Agency's International Bulletin on A+M Data, and to initiate a systematic transmission of atomic collision data in the A+M EXFOR format where possible.

In the beginning of 1984 the People's Republic of China has joined the IAEA. As a consequence, NDS has taken up full services to the People's Republic of China with respect to data compilation, supply of data retrievals, and participation in NDS meetings and research projects.

A. INDC SECRETARIAT

A.1. Liaison Officers of the INDC

The following changes in the membership of INDC Liaison Officers have occurred in the course of this reporting period:

Costa Rica	Dr. Salazar Matarrita New Liaison Officer
Cuba	Dr. F. Fernandez Nodarse New Liaison Officer
Hong Kong	Dr. J.C. Wright New Liaison Officer
Iran Islamic Republic	Dr. D. Azimi-Garakani New Liaison Officer
Jamaica	Dr. A.A. Chen Membership discontinued
Libyan Arab Jamahiriya	Mr. Ez-Dean Aboughalya New Liaison Officer
Morocco	Mr. L. Erradi New Liaison Officer
Nigeria	Director of the Centre for Energy Research New Liaison Officer
Peru	Dr. Ricardo Espinoza Garcia New Liaison Officer
Philippines	Dr. Zoilo Bartolomé Replaces Dr. Q.O. Navarro
Singapore	Dr. Seung Mun Tang New Liaison Officer
Sudan	Dr. F. Habbani New Liaison Officer
Turkey	Dr. Ergun Gültekin Replaces Dr. C. Ertek
Uruguay	Dr. Jorge Servian Replaces Dr. A. Lalanne

The current list of INDC Liaison Officers, comprising scientists from 48 Member States, is given in Appendix A.

A.2. List of INDC Correspondents and National Nuclear Data Committees

The current list of INDC correspondents for the exchange of nuclear data information is planned to be issued in August 1984. Starting with this issue, this report will also contain the information on National Nuclear Data Committees which had been published separately in the past. This combined report will be published as INDC(SEC)-089.

A.3. List of INDC Documents

The current List of INDC Documents received and distributed by the INDC Secretariat is to be published in August 1984 as report INDC(SEC)-090. In an effort to help reduce the publication load of the Nuclear Data Section, the content of the List of INDC Documents will be reduced to reports which have been published in the course of the preceeding two years, instead of the preceeding five years which were included in previous issues of this report.

A.4. Translation of Documents

Subject to available funds, the IAEA translates a limited number of INDC reports submitted by the Soviet Union in Russian. During the reporting period 21 nuclear data reports of Soviet Union origin have been translated by the IAEA into English and distributed as INDC(CCP) reports. Their full titles are given in the List of INDC Documents, INDC(SEC)-090, to be published in August 1984.

B. DATA ASSESSMENT AND RESEARCH COORDINATION

B.1. Data Status and Requirements

B.1.1. WRENDA 83/84

The World Request List for Nuclear Data Measurements, WRENDA, serves as the main international reference to required nuclear data. It is compiled from input supplied by National Nuclear Data Committees, and is used extensively by scientists and programme directors as guidance for research.

WRENDA 83/84, was issued as report INDC(SEC)-88 and distributed to about 916 scientists in November 1983.

Compared with WRENDA 81/82, the total number of requests decreased from 1674 to 1378: 318 requests were withdrawn, 135 requests were satisfied, 424 requests were modified, and 136 new requests were added. The decrease in the total number of requests is mainly due to a decrease in priority 1 requests from 707 to 435 partly connected with the change of priority 1 to priority 2 requests. The number of priority 2 and 3 requests remained almost constant (762 and 181 as compared to 782 and 185 in WRENDA 81/82).

The correlation between the number of requests related to fission and fusion reactors remained the same as compared with WRENDA 81/82.

In compliance with a recommendation of the INDC, future editions of WRENDA will be issued every four years; the next issue is thus due in 1987/88.

B.1.2. Basic Nuclear Data

B.1.2.a) IAEA Consultant's Meeting on the U-235 Fast Fission Cross Section and the Cf-252 Fission Neutron Spectrum, Smolenice, Czechoslovakia, 28 March - 1 April 1983

U-235. The meeting re-affirmed the importance of the U-235 fission cross section as a primary standard in the energy range 100 KeV to 20 MeV. Accuracy requirements were discussed and current uncertainties established (see: meeting proceedings INDC(NDS)-146/L). There was considerable discussion concerning the main contributions to the uncertainties in the measurements of the cross section and on what steps might be taken to reduce these uncertainties. Lastly, the work required to allow the cross sections to be determined to within the required accuracy was identified.

Cf-252. Since the last review of Blinov, in 1980, improvements in the knowledge of the Cf-252 neutron energy spectrum is remarkable in several aspects, energy-range measurements have been performed over the energy range 1 KeV to 28 MeV using a variety of detectors in overlapping ranges. Spectrum averaged cross sections measured in the Cf-field and interpreted with improved cross section evaluations confirmed the spectral shape in the 1 to 28 MeV energy range. Theoretical understanding was improved by two different approximations of the evaporation model and by Hauser-Feshbach calculations. Consequently the data from independent sources now appear to be in good agreement and a new evaluation is strongly recommended.

B.1.2.b) IAEA Advisory Group Meeting on Basic and Applied Problems of Nuclear Level Densities, Brookhaven National Laboratory, USA, 11-15 April 1983

The meeting was organized by the Nuclear Data Section of the IAEA in co-operation with the Division of High Energy and Nuclear Physics of the U.S. Department of Energy. The main task of the meeting was to consider in detail the present state of knowledge of nuclear level densities including both the results of basic research on nuclear level densities and their application for practical problems.

Fortytwo scientists from 11 countries attended the meeting. The meeting was divided into a number of sessions to consider 12 invited and 8 contributed papers. Two working groups were organized in the last two days of the meeting: the first on nuclear level density theories and nuclear model reaction cross section calculations, and the second on the extraction of nuclear level density information from experimental data. The recommendations of these working groups were approved in the plenary session on the last day of the meeting.

All papers presented at the meeting and working group recommendations were published by BNL in June 1983 (Report BNL-NCS-51694; INDC(USA)-092/L, ed. M. Bhat, June 1983). Fifty spare copies of the proceedings were prepared for dissemination to scientists from developing countries on request.

B.1.2.c) IAEA Advisory Group Meeting on Nuclear Standard Reference Data, CBNM, Geel, 12-16 November 1984

The IAEA Nuclear Data Section, with the co-operation of the OECD Nuclear Energy Agency Nuclear Data Committee (NEANDC), and in co-operation with the Central Bureau of Nuclear Measurements (CBNM) acting as host, will hold this Advisory Group Meeting during the week 12-16 November 1984 at the CBNM in Geel, Belgium.

Compared with previous meetings, held by the Agency in 1967 and 1972, in which only neutron standard data have been discussed, the scope of this meeting will be extended to all nuclear standard reference data, including new standard data such as standard neutron energies as well as gamma ray standards.

Special emphasis will be given to recent experimental results for the standard reference data as well as to improvements in detectors and measuring techniques enabling a more accurate determination and use of standards.

New evaluations of standard data, especially the ENDF/B-VI Standards File, as well as correlations and simultaneous evaluations of standard cross sections will receive full attention.

B.1.3. Nuclear Data for Applications

B.1.3.a) Fission Product Nuclear Data (FPND)

Annual Progress Report Series

Information about activities in the field of measurement and compilation/evaluation of FPND is continued to be published as INDC(NDS)-reports "Progress in Fission Product Nuclear Data". The 9th issue was published as INDC(NDS)-143 in August 1983, the 10th issue, to be published as INDC(NDS)-155, is in preparation.

The time-consuming production of the "table of contents" and "subject index" has been partially automated for the production of the 8th and 9th issue. For the 10th issue, the system will be further improved by making use of newly available computer facilities.

Participation in the NEANDC Specialist's Meeting on Fission Product Nuclear Data at BNL, 24-27 October 1983

M. Lammer participated in this meeting on behalf of the Nuclear Data Section of the IAEA, and, as a member of the Workshop on Fission Yields, took an active part in drafting the conclusions and recommendations of this Workshop. In addition, some information on the latest status of FPND evaluations and data files could be gained from personal contacts with meeting participants.

Information from the meeting of particular interest to NDS are:

- After the retirement of the main fission yield evaluators, B.F. Rider (USA) and E.A.C. Crouch (UK), the compilation and evaluation efforts and maintenance of data files are continued by T. England (USA) and M.F. James (UK).

- Specialized evaluations of FP yields and decay data for applied purposes are recommended.

- Further measurements of yields, decay data and delayed neutron data of short lived fission products are still required in order to remove discrepancies and improve theoretical and semi-empirical estimates, in particular for the evaluation of decay heat. Measurements are underway and a number of new results expected in the near future.

B.1.3.b) IAEA Consultant's Meeting on Nuclear Data for Structural Materials, Vienna, 2-4 November 1983

The meeting on Nuclear Data for Structural Materials was convened by the Nuclear Data Section at IAEA Headquarters, on 2-4 November 1983. The meeting was attended by 19 scientists from 9 Member States and 2 international organizations. The principal objective of this meeting was the review of the status of these data with particular attention given to recent improvements in data measurements and in calculational models used to improve the quality and reliability of evaluated data for structural materials. Materials considered were primarily Fe, Ni and Cr, as well as Ti, V, Mn, Co, Cu, Zr, Nb and Mo. Another aim of this meeting was the formulation of the objectives and scope of a proposed co-ordinated Research Programme on the "Methods for the Calculation of Fast Neutron Nuclear Data for Structural Materials" (see item B.2.7.). The proceedings of this meeting will be published in report INDC(NDS)-152/L.

B.1.3.c) IAEA Advisory Group Meeting on Transactinium Isotope Nuclear Data, Gustaf Werner Institute, Uppsala, Sweden, 21-25 May 1984.

The third Advisory Group Meeting on Transactinium Isotope Nuclear Data (TND) was convened by the IAEA Nuclear Data Section as a sequel to the first two IAEA Advisory Group Meetings on Transactinium Isotope Nuclear Data, held at the Kernforschungszentrum Karlsruhe, Fed. Rep. of Germany, in November 1975 and in Cadarache, France, in May 1979. The meeting was attended by 32 participants and 5 observers from 15 Member States and 2 international organizations.

The primary objective of this third TND meeting was to review the developments which have taken place in the TND field since the last meeting in 1979 and to identify those data which are still discrepant or which do not satisfy the required accuracies. The proceedings of this meeting will be published in the IAEA-TECDOC report series, the Summary Report of the meeting will be issued as report INDC(NDS)-158.

B.1.3.d) Nuclear Data for Geophysics Techniques

Consultants' Meeting on Nuclear Data for Bore-hole and Bulk-media Assay Using Nuclear Techniques, Krakow, Poland, 14-18 November 1983

The first Consultants' Meeting on Nuclear Data for Bore-hole and Bulk-media Assay Using Nuclear Techniques was convened by the Agency's Nuclear Data Section at the Institute of Physics and Nuclear Techniques of the Academy of Mining and Metallurgy at Krakow, Poland, from 14-18 November 1982. The meeting was attended by 27 nuclear geophysicists from 12 Member States representing the interest of relevant Government establishments, oil and other industrial companies, and academic institutes. The main objective of the meeting was to review the requirements and status of nuclear data in mineral exploration, mining and process control.

As a major result of the meeting, it was concluded that the existing evaluated nuclear data files developed for nuclear reactor design do not satisfactorily meet the requirements of nuclear geophysicists for the analysis of the results of their mineral and oil exploration measurements. The meeting, therefore, recommended that the Agency issue a comprehensive handbook of nuclear data for nuclear geophysics applications supplemented by a computer file of relevant microscopic nuclear data. A second set of major recommendations was concerned with the development of a programme for the systematic intercomparison, standardization and collection of macroscopic absorption, transport and slowing-down properties of rocks and minerals.

The proceedings of this meeting have been issued as INDC(NDS)-151 (Jan. 1984).

Consultants' Meeting on Applications of Nuclear Analysis Techniques in Exploration and Exploitation of Natural Resources, held in IAEA Headquarters, Vienna, 14-16 February 1984.

Since some of the recommendations of the Krakow meeting went beyond the scope of the Agency's nuclear data programme, the Director of the IAEA Division of Research and Laboratories, Prof. V. Ferronsky, proposed to convene a small follow-up Consultants Meeting in order to involve other Sections of the Agency into a broader intersectional programme on Nuclear Techniques in Exploration and Exploitation of Natural Resources. This second Consultants' Meeting was convened at IAEA Headquarters in Vienna, 14-16 February 1984.

The conclusions and recommendations of both Consultants' Meetings of concern to NDS are given in INDC/P(84)-9.

B.2. Coordinated Research Programmes (CRP)

B.2.1. CRP on the Intercomparison of Evaluations of Actinide Neutron Nuclear Data

This CRP was concluded at its fifth meeting at Geel, Belgium, 2-3 September 1982. (See NDS report to 13th INDC Meeting,

INDC(NDS)-142, p. 10). Since then the co-operation continued in an informal manner. New actinide evaluations, revisions to earlier evaluations, and related documents continue to be received at NDS and to be distributed by NDS to the previous CRP members.

The 1983 version of the IAEA Nuclear Data Libraries for Actinides, INDL/A(83), was distributed in January 1984, documented in IAEA-NDS-12 (Rev. 7). It contains evaluations for 26 nuclides from Th-232 to Cm-248, thereof 48 "complete" evaluations of all significant reactions in the "full" energy range from 0 to 15 or 20 MeV, plus 24 "partial" evaluations of specific reactions, e.g. (n,2n), or of a specific energy range, e.g. resonance region. The data are mostly in ENDF format (version IV or V), but partly still in KEDAK or UKNDL format.

INDL/A will serve as the basis for the new CRP on Validation and Benchmark Testing of Actinide Nuclear Data (see item B.2.2.). Further updates of INDL/A or supplements will be issued as new evaluations or revisions to earlier evaluations are received.

B.2.2. CRP on Validation and Benchmark Testing of Actinide Nuclear Data

This CRP was started in 1983/1984. The first research co-ordination meeting has been held from 25-26 May 1984 in Uppsala, Sweden, adjacent to the Advisory Group Meeting on Transactinium Isotope Nuclear Data (see item B.1.2.c).

The emphasis of this CRP has been oriented to participants from non-OECD countries; however, to some extent the success of the CRP will depend on support from OECD countries, in particular by providing suitable benchmark data.

Principal investigators are:

Brazil:	R. Paviotti Corcuera, Centro Tecnico Aeroespacial, Sao José dos Campos
Bulgaria:	N. Janeva, Institute of Nuclear Research and Nuclear Energy, Sofia
P.R. of China:	Gu Fuhua, Institute of Atomic Energy, Beijing
India:	S. Ganesan, Reactor Research Centre, Tamilnadu
USSR:	V.A. Konshin, Institute of Nuclear Engineering of the BSSR Academy of Sciences, Minsk
Yugoslavia:	A. Trkov, Institut Jozef Stefan, Ljubljana

The second CRP meeting is tentatively planned for June 1985 in Bulgaria.

B.2.3. CRP on the Measurement and Evaluation of Transactinium Isotope Nuclear Decay Data

The sixth meeting of the participants in the IAEA Coordinated Research Programme (CRP) on the Measurement and Evaluation of Transactinium Isotope Nuclear Decay Data, convened by the IAEA

Nuclear Data Section and hosted by EG & G Idaho, Inc., was held at Idaho Falls, USA, on 21-24 June 1983.

The meeting reviewed the current and projected programmes for the measurement and evaluation of heavy element radionuclide nuclear decay data of each research group participating in the CRP.

In particular, the meeting

- updated the list of proposed heavy element radionuclide half-lives published in the INDC(NDS)-139/NE (December 1982), and agreed on the release of the new update of this list;

- performed a comprehensive review of the measurement and evaluation status of all decay data for the radionuclides identified at the IAEA Meetings on Transactinium Nuclear Data; and

- discussed in detail the format and content of the final report of this project.

The last meeting of this CRP, which will take place in Vienna, 5-9 November 1984, will be devoted to the drafting of the final report of this seven-year co-operative effort. This report, which will contain a recommended set of heavy element decay data based on a critical evaluation of the currently available data base, will be published in the IAEA Technical Report Series in 1985.

B.2.4. CRP on Atomic Collision Data for Plasma Diagnostics

The second meeting of the participants in the IAEA Coordinated Research Programme (CRP) on Atomic Collision Data for Diagnostics of Magnetic Fusion Plasmas was convened by the IAEA Nuclear Data Section on 30 August - 2 September 1983 at the Institute of Plasma Physics, Nagoya University, Nagoya. This Research Coordination Meeting (RCM) was run by the Scientific Secretary K. Katsonis with the assistance of three co-chairpersons, T. Kato, H.B. Gilbody and G. Dunn.

The results of this annual survey provide overall guidelines for the work to be performed by the CRP participants during their further participation in this project, as well as for the use of the existing data by the fusion community.

The third meeting of this CRP was held in Vienna from 18-20 June 1984. The meeting participants reviewed the current status of electron impact excitation, electron impact ionization, electron capture and charge exchange and recombination data. The result of this review is under preparation and will be published in an INDC report.

B.2.5. CRP on the Measurement and Analysis of 14 MeV Neutron Cross Sections for Fission and Fusion Reactor Technology

This CRP has been established with two objectives. The first aim is to improve the status and accuracy of deficient or non-existent 14 MeV neutron nuclear data by specific measurements at established

facilities, including careful validation and error analysis of the results, and, where possible, to compare with other experimental and theoretical evidence and incorporate the final results into the neutron data files of the NDS. The second equally important objective is to train nuclear scientists from developing countries in nuclear data measurement and calculation techniques (INDC/P(83)-15). The scientific scope of the CRP comprises the measurement and analysis, including theoretical calculations, of 14 MeV neutron scattering and reaction cross sections and of secondary particle energy and angular distributions.

At the time of the first research co-ordination meeting held during 21-25 November 1983 at Gaussig, GDR, research contracts and research agreements were concluded with neutron generator groups from seven developing and six developed countries respectively. Presently research contracts with two additional groups from developing countries are being processed.

The first research co-ordination meeting of this CRP was held jointly with the XIII International Symposium on Nuclear Physics - Fast Neutron Reactions organised by the Technical University, Dresden. Participation was therefore not limited to the principal investigators for each contract/agreement and a large number of active workers in the field (both from developed and developing countries) were present, whose participation was very useful in maintaining all technical discussions at a high level.

The main objectives of this meeting were to review the progress and the first results of measurements undertaken under this CRP and to co-ordinate the future measurement programme among the participating laboratories.

The meeting achieved a thorough discussion of 14 MeV neutron cross section measurement techniques, developed guidelines for standardising measurement methodology and recommended an interlaboratory project for intercomparison of activation cross section measurements of particular value to new laboratories in developing countries to test their state of development in the field. A detailed report on the meeting is under preparation and will be issued as an INDC(NDS) document.

B.2.6. <u>CRP on the Measurement and Analysis of Double Differential Neutron Emission Spectra in (p,n) and (alpha,n) Reactions for Determining Nuclear Level Densities</u>

The principle objective of the CRP is to implement a co-ordinated programme to measure neutron spectra arising from (p,n) and (alpha,n) reactions, at bombarding energies between 5 and 15 MeV on suitable isotopes of mass numbers between 100-200, and to analyze the data using appropriate reaction models in order to extract nuclear level density information as a function of excitation energy in the residual nucleus. The secondary objective of the CRP will again be the training of nuclear scientists from developing countries in methods of nuclear measurement and analysis. The CRP will bring

together scientists from developing laboratories which have suitable accelerators with those from well developed laboratories with established programmes in such measurements. This CRP is complementary to the 14 MeV CRP (item B.2.5. above) in the sense that the other CRP co-ordinates programmes at developing laboratories having 14 MeV neutron generators while this CRP will bring together the developing laboratories which have low/medium energy particle accelerators like Van de Graaffs, small cyclotrons etc. into a co-ordinated research programme. A first co-ordination meeting is being planned for later this year or at the time of the Santa Fé Conference in May 1985.

B.2.7. CRP on Methods of Calculation of Fast Neutron Cross Sections of Structural Materials

The proposed CRP on "Methods for the Calculation of Fast Neutron Nuclear Data for Structural Materials" was critically reviewed by the participants in the 1983 Consultants Meeting on Nuclear Data for Structural Materials (see item B.1.2.b). The conclusions of this meeting were as follows:

There is significant potential in the fast energy region for the CRP to contribute toward the development and improvement of calculational methods, particularly for the development of correlated energy-angle nuclear data. Of great interest are efforts aimed at the formulation of unified reaction theories.

Since the theory for the resonance region is well defined, and experimental measurements and analysis are complicated and expensive, it was felt that work in this energy range is not appropriate for inclusion within the scope of the CRP.

In the light of the above conclusions the scope of the proposed CRP has been modified to include the energy range above the resonance region only. If approved, the first meeting of CRP participants will be held in 1985.

C. DATA PROCESSING AND EXCHANGE

C.1. Data Centre Network Coordination

C.1.1. Nuclear Reaction Data

The 7th Meeting of the Nuclear Reaction Data Centres (NRDC) took place in Obninsk and Moscow, USSR, 17-21 October 1983. The Minutes, including status reports of the co-operating centres and numerous conclusions and recommendations, are available in report INDC(NDS)-154. As in previous meetings the agenda included technical discussions on the jointly operated systems EXFOR, CINDA, WRENDA, ENDF, and discussions by the Centre Heads on policies (priorities, planning, workload commitments).

For budgetary reasons, the intervals of these "NRDC Meetings" had been widened from 12 to 18 months. It turned out that these intervals were too long for the technical topics, where certain items (e.g. compilation rules and procedures in EXFOR) require prompt discussions and conclusions, whereas longer intervals may be adequate for the centre-head discussions. To account for these differences it was decided to have two separate meetings and convene

- a technical NRDC Meeting on 19-21 September 1984 in Vienna,

- and the 8th NRDC Meeting with full participation of technical staff and centre heads at the NEA Data Bank in October 1985.

C.1.1.a) Charged-particle nuclear data

The 1983 Obninsk/Moscow NRDC Meeting was attended for the first time by a representative of a new charged-particle reaction data group from the Japanese RIKEN Institute. This group has identified a list of 20 reactions for charged-particle induced radioisotope production (including some undesired parallel reactions) for which it will compile data in EXFOR with the final aim of producing recommended evaluated data. A first EXFOR tape from RIKEN has been transmitted.

The other Japanese charged particle data group at Sapporo compiles data (mainly differential data) into the NRDF system from which the conversion into EXFOR is still in a trial stage.

The main CPND centre is CAJaD, Moscow, compiling not only data from USSR but also important data from other countries.

The active CPND-EXFOR centres, CAJaD, RIKEN, NDS do not cover the full scope previously covered by KACHAPAG (Karlsruhe). The participation of additional CPND groups would be desirable. The need for charged-particle nuclear data for applied purposes is being summarized in INDC/P(84)-12.

C.1.1.b) Photonuclear data compilation

The only centre compiling photonuclear data in EXFOR is CDFE in Moscow; it also issues a bibliography on photonuclear data once a year. An additional photonuclear data centre compiling data into EXFOR would be desirable. NDS has compiled a few entries but has no manpower for a systematic effort. The need for photonuclear data is summarized in INDC/P(84)-12.

C.1.2. Nuclear Structure and Decay Data

The international nuclear structure and decay data (NSDD) network, consisting presently of 17 evaluation groups in 11 Member States and 2 international data service centres, aims at a complete and continuous nuclear structure data evaluation of all isobaric mass-chains on a six-year cycle, the continuous publication of these evaluations and their dissemination to the scientific community. The evaluated mass-chain data resulting from this concerted international

effort are published in Nuclear Physics A and the Nuclear Data Sheets, and comprise the currently recommended "best values" of all nuclear structure and decay data. The international NSDD network has evolved from the pioneering work in the late fourties and early fifties by physicists from the California Institute of Technology (Pasadena), the Rijksuniversiteit at Utrecht (Netherlands) and the Nuclear Data Group in the United States (Washington and Oak Ridge). The US effort is currently coordinated by the US Nuclear Data Centre (Brookhaven).

Periodic meetings of this network have the objectives to maintain the coordination of all centres and groups participating in the compilation, evaluation and dissemination of NSDD, to maintain and improve the standards and rules governing NSDD evaluation, and to review the development and common use of the computerized systems and data bases maintained specifically for this activity.

The sixth Meeting on Nuclear Structure and Decay Data (NSDD) was convened by the IAEA Nuclear Data Section at the Fachinformationszentrum Karlsruhe in the Federal Republic of Germany, 3-6 April 1984. The meeting was attended by 22 scientists from ten Member States and one international organization, representing centres and groups concerned with the compilation, evaluation and dissemination of nuclear structure and decay (NSD) data. A major concern of this meeting was the severe decline in the number of mass-chain evaluations submitted for publication by the NSDD Network. The summary report of the meeting is to be published in INDC(NDS)-157.

C.1.3. Other Data Fields

C.1.3.a) Atomic and Molecular (A+M) Data for Fusion

Fourth Meeting of the A+M Data Centre Network was held in Vienna on 13-15 June 1984. The main conclusions of this meeting were:

(1) Agreement of the data centres to provide systematic input for the publication of the International Bulletin on A+M Data.

(2) Agreement to initiate systematic atomic collision data transmission, in the A+M EXFOR format where possible.

(3) Review of the A+M EXFOR Dictionaries and agreement to define terminology used in the compilation and exchange of A+M data.

The Summary Report of this meeting will be issued as an INDC report.

Third Meeting of the IFRC Subcommittee on A+M Data for Fusion was convened in Vienna on 21-22 June 1984. The principal recommendations of the subcommittee were:

(1) To terminate the Coordinated Research Programme on Atomic Collision Data for Diagnostics of Magnetic Fusion Plasmas.

(2) To convene an Advisory Group Meeting on A+M Data for Plasma Modelling in 1985.

(3) To publish a new edition of the CIAMDA atomic collision data index, in a new proposed format, in 1985.

The Summary Report of this meeting will be issued as an INDC report.

C.1.3.b) Materials Properties Data for Fusion

In response to a recommendation of the International Fusion Research Council (IFRC), the IAEA Nuclear Data Section, at no cost to the Agency, convened a meeting of nominated experts to investigate the feasibility for the IAEA to initiate an international effort to assemble a comprehensive data base of materials properties required for the development of fusion technology. This meeting took place on 5-7 March 1984 at IAEA Headquarters in Vienna.

The recommendation of this meeting called for the establishment of two Task Forces which would initiate the compilation of priority data for fusion breeder and magnet materials and the evaluation of existing data base systems. It is planned to organize and convene a meeting of the Task Forces early in 1985 in the form of a Specialists' Meeting at no cost to the Agency. This proposal was presented formally for the consideration of the IFRC at their next meeting in September 1984.

C.2. Data Processing

C.2.1. Data Compilation

C.2.1.a) CINDA

The compilation work for the CINDA file continues as a routine operation. A considerable increase in the workload was due to the cleanup of the file performed for the preparation of a cumulative issue, CINDA-B, covering the literature from 1977 to 1981.

Part of the work consisted of revision of entries submitted by the USSR CINDA centre through NDS to CINDA Master at NEA-DB. The mechanisms of the USSR CINDA input are being revised to improve the effectiveness of this procedure.

The transfer of coded CINDA information to computer media is presently being changed from batch mode (batches of entries sent on magnetic tape to Saclay for loading into the master file) to interactive mode (with direct input to the CINDA file).

C.2.1.b) EXFOR, experimental neutron reaction data

During 1983 and 1984 compilation of experimental neutron data produced in the NDS service area was complete and prompt. Furthermore, the backlog accumulated earlier due to vacancy of a post in 1982, could be eliminated.

The data compilation continues in close co-operation with the authors who receive proof copies of their data as compiled in EXFOR, together with questions resulting from a critical review of their data. This review concentrates particularly on the error analysis and the standard reference data used.

Data completeness checks are co-ordinated with the US NNDC schedule for the production of cross section handbooks.

C.2.1.c) EXFOR, non-neutron nuclear reaction data

Besides neutron reaction data, EXFOR includes a gradually increasing amount of experimental and evaluated data for nuclear reactions induced by charged particles, heavy ions, or photons. Due to manpower limitations, NDS does not compile such data in a systematic manner but selects data of special importance with emphasis on neutron producing reactions. Some recent examples are:

(alpha,n) data from Argentina, Harwell, Geel (the latter data set with more than 30 000 records was compiled in cooperation with NEA-DB).

(gamma,n) data from Brazil, Israel, Vietnam.

C.2.1.d) Evaluated Data

NDS continued:

- to compile evaluated neutron data in ENDF-5 format;
- to compile evaluated neutron data in EXFOR format ("EXFOR-V" series) wherever the ENDF-5 format was not suitable (e.g. neutron-induced reactions above 20 MeV);
- to convert data received in other formats (e.g. SOKRATOR, ENDL-82) to ENDF-5 format,
- to convert data from ENDF-4 to ENDF-5 format;
- to check and correct ENDF-5 formatted data by computer codes (CHECKR, PHYSCON) and by graphical plotting.

Data which have been compiled in the IAEA Evaluated Nuclear Data Library, INDL, consist of

- INDL/V (various evaluations, general purpose file), documented in IAEA-NDS-31;
- INDL/A (actinides), documented in IAEA-NDS-12 Rev. 7;
- IRDF, international reactor dosimetry file, documented in IAEA-NDS-41 (multigroup form) and IAEA-NDS-48 (energy-dependent form);

- INDL/F, for INTOR fusion neutronics calculations, documented in IAEA-NDS-57.

- EXFOR-V (various evaluations in EXFOR format), documented in IAEA-NDS-34 Rev. 1.

INDL (with the exception of the IRDF Subfile) does not have the status of a comprehensive and internally consistent library of recommended evaluations. It is a collection of existing evaluations of varying quality. Updates and corrections are issued approximately once a year. Where suitable, evaluations are available in different formats, e.g. ENDF-4 or ENDF-5, respectively in resonance-parameter form or as RECENT output [resonance-parameters converted to (E)] or as multigroup data.

In addition, NDS continues to act as repository for other evaluated data files received from various originators. For many of them documentations of data format and file contents are written at NDS for the convenience of the customers.

C.2.1.e) Special Compilations for Reference Files and Handbooks

(i) Nuclear Data for Medical Applications

Dr. Malika Allab from Algeria, currently working at NDS on a voluntary basis as a cost-free expert, has performed a review of existing data for the $^{9}Be(p,n)^{9}B$ reaction of interest to fast neutron radiotherapy. The results of her review were published in INDC(NDS)-153 (March 1984).

(ii) Nuclear Data for Fusion

At the request of INTOR for an internationally available evaluated data file for INTOR calculations, NDS reviewed the currently available evaluated data and assembled and distributed the INDL/F-83 data file for fusion applications. At the same time NDS reviewed the current status of available evaluated data and pointed out areas where the data for fusion applications is deficient.

Both, the file and the list of deficiencies were distributed to Member States participating in INTOR. Users were asked to inform NDS of calculational results and to state whether or not there is sufficient interest to eliminate the indicated deficiencies. To-date NDS has received only very limited feedback from users. As a result, no action has as yet been taken, to improve the data file.

(iii) Nuclear Data for Activation Analysis

The preparation of the Nuclear Activation Data Handbook is in progress. With the exception of the chapters on photo-activation analysis, thick target yields of charged particle activation, and standard reference reaction data for charged particles, all other chapters are expected to be completed by the end of August. The current status of this handbook is described in more detail in INDC/P(84)-15.

(iv) Nuclear Data for Safeguards Applications

In co-operation with staff of the Agency's Safeguards Department, NDS distributed a questionnaire to Safeguards experts to determine the scope and content of the planned handbook on "Nuclear Data for Safeguards". The questionnaire was sent to about 50 safeguards experts in 13 countries and 3 international organizations. About 15 individual and collective replies have been received and are presently being analyzed.

This preliminary survey shows that generally the idea of this handbook is most welcomed and the proposed scope and data contents are considered adequate. However, the data types requested to be included exceed the microscopic nuclear data presently available on data files to NDS.

A first proposal of the layout and contents of the handbook will be presented at the forthcoming INDC meeting. The collection of data to be included will start this year.

The handbook will contain initially the following data in tabular form:

- decay data for fission products and actinides,

- typical cross section values (Maxwellian average, resonance integrals, fission spectrum averages, ...; exact form still to be decided) of fission products and actinides,

- fission product yields, and

- prompt and delayed neutron emission data for actinides.

The handbook will be complemented by a data file for direct computer input, containing cross sections and other data as a function of incident neutron energy.

All the above data are planned to be assembled from existing evaluations.

In addition, the following data types will be included:

- prompt and delayed neutron and gamma multiplicity distributions and time dependent data,

- (n,x), (alpha,n) and (gamma,n) reaction cross sections on light elements,

- non-neutron and macroscopic data (e.g. gamma ray attenuation coefficients, thick target yields, etc.)

(v) Heavy Element Radionuclide Decay Data

The objective of the IAEA Coordinated Research Programme (CRP) on the Measurement and Evaluation of Transactinium Isotope Nuclear Decay Data (see Section B.2.3.), has been to arrive at a consistent set of transactinium isotope nuclear decay data and their uncertainties (including half-lives, branching fractions and gamma ray and alpha emission spectra) which would satisfy the requirements identified by the community of data users.

Since the beginning of this activity in 1978, the scope of radionuclides has widened to include most heavy radionuclides which occur in or result from the nuclear fuel cycle. The heavy radionuclide decay data, reviewed periodically by members of the CRP, have been compiled into a data base which has served as input to the annually issued "Proposed Recommended List of Heavy Element Radionuclide Decay Data" (last issue released in December 1983 as INDC(NDS)-149).

The final recommended list will be published in 1985 in the IAEA Technical Report Series.

C.2.2. Validation of Cross Section Processing Codes

The Agency's project on the validation of cross section processing codes has continued to be carried out on an informal basis between interested participants. To date the results generated by thirteen different processing codes have been compared.

Results indicate that on the first attempt not one single processing code was able to accurately reproduce NDS benchmark results. However, a positive result on this comparison is that by working closely with code designers many problems have been eliminated and there are now five processing codes which can accurately reproduce NDS's benchmark results.

A report on the validation project will be published by NDS in Summer 1984 and will identify those codes which have passed the first round of tests.

Based on the results of these comparisons there is one important question: if individual codes have proven to have one or more errors, what is the probability that codes that have not been included in this intercomparison are error free? For this reason all codes should be included in this validation project.

C.2.3. Data Exchange

C.2.3.a) Specialists' Meeting on Format for the Exchange of Evaluated Nuclear Data, 2-4 April 1984, IAEA, Vienna

In compliance with recommendation 5 of the 13th INDC Meeting, and endorsed by the 7th NRDC Meeting Moscow/Obninsk, 17-21 Oct. 1983 [see item C.1.1.a)], a Specialists' Meeting on the "Format for the

exchange of evaluated neutron nuclear data" was convened on 2-4 April 1984, so that its recommendations could be submitted to the May 1984 meeting of the US Cross Section Evaluation Working Group (CSEWG). The latter was to decide upon revisions of the ENDF-V format to be adopted for the version VI of the ENDF/B library.

Invitations for submitting proposals related to the ENDF format were sent out by the IAEA in November 1983 to scientists in 30 countries and 2 international organizations, who were known to be major users of the ENDF/B format. Numerous proposals presented in 29 working papers were received. Part of the proposals was distributed prior to the meeting and reviewed by the ENDF Format experts R.E. MacFarlane and C.L. Dunford, USA.

The following countries and organizations were represented at the meeting (either by participation at no cost to the Agency, by submitting proposals, or both):

China, People's Rep.	Netherlands
German Dem. Rep.	UK
Germany, Fed. Rep.	USA
Hungary	USSR
India	Yugoslavia
Italy	OECD NEA
Libya	IAEA
Japan	

The conclusions of this meeting are given in INDC(NDS)-156.

The ENDF system combines two functions:

- primarily it is a data input format (monitored by CSEWG) to a large number of computer codes (mostly provided by USA, hopefully with increasing contributions from other countries);

- secondarily, after adoption of this format by Japan, NEA, IAEA and USSR, it has become an international exchange format for evaluated nuclear data.

Whereas more flexibility of the ENDF format is desirable for the international exchange, the existing computer codes using ENDF as input require that format changes are kept to a minimum. It appears that the proposed format changes represent solutions which meet both requirements. Specifically, version ENDF-VI will have new formats and procedures for multiple-particle producing reactions in the higher energy range of interest to fusion applications and for charged-particle induced reactions.

C.2.3.b) Exchange of A+M Collision Data in A+M EXFOR Format

The principal objective of the IAEA programme on Atomic and Molecular Data for Fusion is to provide the required numerical atomic data to the fusion research community for the simulation, modelling and diagnosis of fusion plasma, and the interaction of fusion plasmas

with its containing vessel (e.g. first wall). As one of the priority data types, atomic collision data have received increasing attention by the atomic physics research community. This has created the need for an internationally co-ordinated effort to organize and compile these data into a data base which would serve as one of the principal inputs to an international A+M data base for fusion. In an effort to achieve this goal, NDS has been instrumental in the establishment of an international network of A+M data centres involved in the systematic collection and exchange of A+M collision data in an agreed upon exchange format (e.g. EXFOR). The development of the "A+M EXFOR" format is now completed and documented (IAEA-NDS-AM-15), and has been accepted and adopted by three A+M data centres.

D. DATA SERVICES AND TECHNOLOGY TRANSFER

D.1. Data Centre Services

D.1.1. Documentation and User Services

The services of NDS are advertised to its customers by the "IAEA Nuclear Data Newsletter" of which currently 2 700 copies are distributed about twice a year in intervals that depend on the rate at which important new material is received at NDS. Attached to the Newsletter is a return postcard by which data, reports or other information can be requested.

In order to improve the data services offered to NDS customers, the receipt of new data files or updates to older files, initiates a search of the standing requests recorded in the computerized Request Log, resulting in the dispatch of the new data to the requestor.

Documentation reports, issued in the IAEA Nuclear Data Services report series (with report code IAEA-NDS-...), which describe the format and content of data files, are now available for all data files kept at NDS. These reports, kept up-to-date and continuously improved, are sent together with the data files requested from NDS.

Data retrievals in the EXFOR, ENDF/B and some other formats are available in "standard format" for computer processing, or in "edited format" for easy reading, either on tape or in the form of listings. Graphical computer plots can also be provided. These services are provided primarily to the NDS service area. The exchange of EXFOR, involving maintenance of EXFOR Dictionaries, checking of EXFOR transmission tapes and performing completeness checks, is a continuing inter-centre co-ordination activity of NDS.

D.1.2. Data Requests

As part of its function as a data centre, NDS disseminates on request nuclear data in computerized form, data processing computer programs and reports to Member States within its service area[1], as well as to other requestors in other countries. During 1983, NDS has received 706 requests, which amounts to approximately three requests per working day.

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[1] The IAEA/NDS service area comprises Eastern Europe (except the USSR), Africa, Asia (except Japan), Latin America, Australia and New Zealand.

A "request", as interpreted in the statistics, is defined as any query received by NDS for any one of the following specific categories of experimental data, evaluated data, bibliographic retrievals (e.g. from the CINDA master file), documents and computer programmes. For example: one letter asking for experimental and evaluated data would count as two requests.

Request statistics for each of the considered categories, and statistics showing the total number of requests handled by NDS for each of the last 19 years are given in Table I. Figure 1 shows the request statistics since 1965 in terms of number of requests per year averaged of 3-year periods (i.e., the number for 1983 is the annual average over the years 1981, 1982 and 1983).

D.1.3. Data Dissemination

Data dissemination statistics show what data and associated data information have been sent out as a result of requests received by NDS; numerical data are normally quantified in terms of "data sets".

A "data set" is defined as a set of numerical data of a given type for a given energy range which resulted from a specific data measurement or evaluation. For evaluated data, a data set comprises all data given under one "MAT" number in a given evaluated data library; for EXFOR, a data set comprises all data combined in an EXFOR sub-entry (excluding the first BIB subentry). Averaged over the year 1983, and considering both experimental and evaluated data, a data set comprises an average of 1 230 data points or data records which would represent a typical data set.

The dissemination statistics for data, data processing codes and reports sent out during 1983 are as follows:

Sets of experimental nuclear reaction data (EXFOR subentries)	7 914
Sets of evaluated nuclear data	17 132
Total number of data sets (Experimental + Evaluated)	25 042
Dispatch of data processing computer programs	72
Total number of tapes dispatched to send (above) data and programs	186
Number of individual reports sent on request	1 462
Number of reports sent on distributions* (bulk shipment)	14 547

* Reports sent on distribution consist of INDC reports which are issued in the course of the year by NDS or Member States; during 1983, 72 individual INDC reports were distributed by IAEA/NDS to an average of 202 recipients for each report.

Table I

Data Request and Distribution Statistics 1965 - 1983

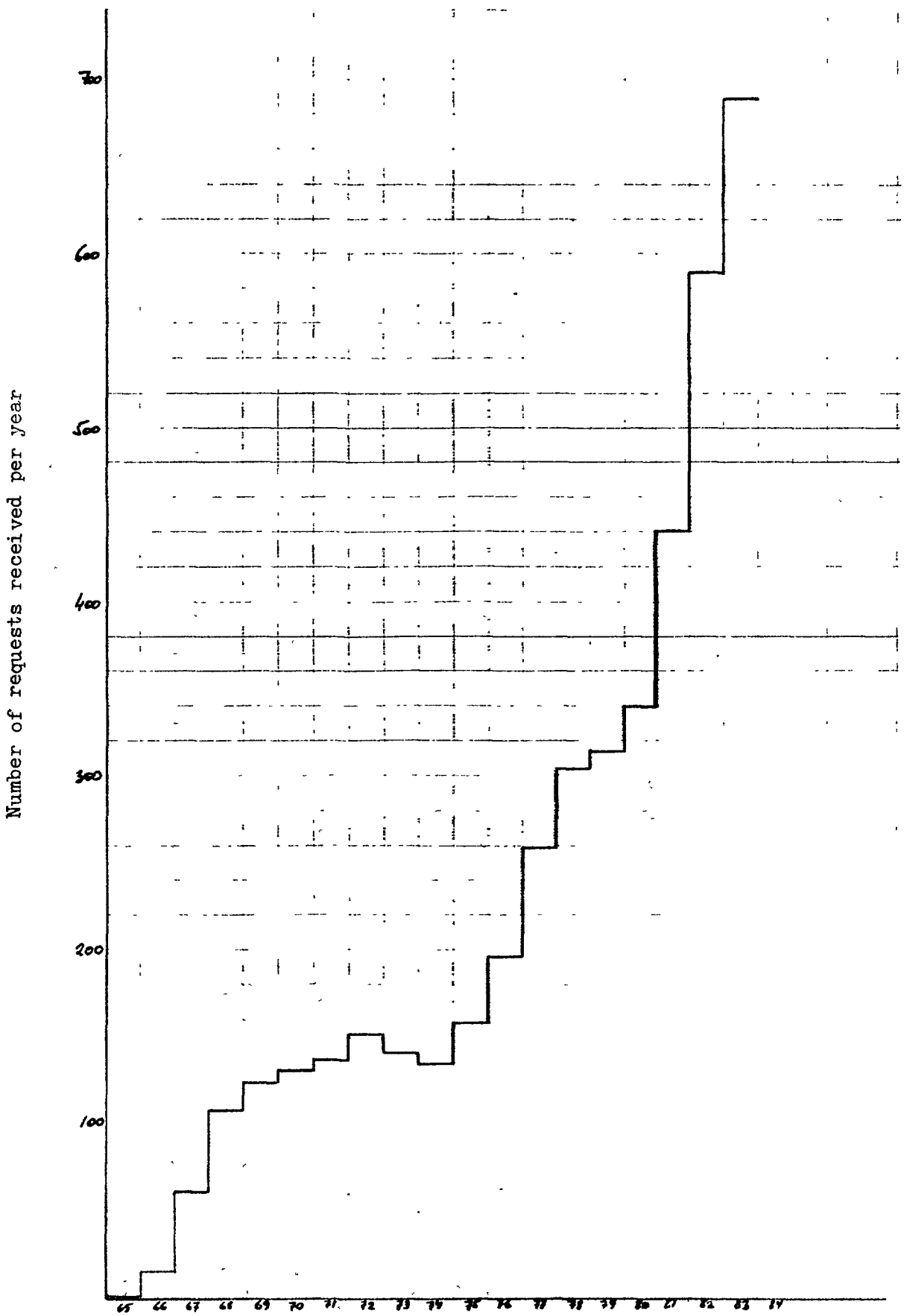
Year	Request Statistics (Number of Requests)							
	Experimental Data	Evaluated Data	Experimental and Evaluated Data	Documents	Other*	Totals per year	Totals (Averaged over 3 years)	Totals Cumulative
1965	3	–	3	–	–	3	1	3
1966	40	–	40	–	5	45	16	48
1967	118	–	118	9	8	135	61	183
1968	119	–	119	16	9	144	108	327
1969	48	15	63	25	5	93	124	420
1970	95	20	115	34	8	157	131	577
1971	76	33	109	43	8	160	137	737
1972	48	23	71	60	8	139	152	876
1973	43	22	65	54	6	125	141	1 001
1974	49	24	73	61	6	140	135	1 141
1975	43	49	92	114	3	209	158	1 350
1976	34	43	77	153	9	239	196	1 589
1977	45	49	94	232	3	329	259	1 918
1978	62	71	133	193	17	343	304	2 261
1979	63	93	156	95	18	269	314	2 530
1980	40	86	128	239	42	407	339	2 937
1981	59	185	244	369	31	644	440	3 581
1982	76	174	250	403	60	713	588	4 294
1983	50	113	163	499	44	706	688	5 000

* Since 1978 this category contains exclusively data processing computer programs, all other, including bibliographies, are included under documents.

Figure 1

Nuclear Data Request Statistics

(each step represents a 3-year average)



D.1.4. Publications

D.1.4.a) CINDA

In 1984, 3 issues of CINDA will be published:

- CINDA-B, a 5-year cumulative issue covering literature published from January 1977 to December 1981. CINDA-B was published in Spring 1984 and supplements the archival issue CINDA-A (the index of literature published up to December 1976).

- CINDA-84, the spring issue of this year, is cumulative for the period January 1982 to the present,

- the fall issue is a supplement to CINDA-84 covering the half year since the spring issue, as usual.

D.1.4.b) Nuclear Data Newsletter

The Nuclear Data Newsletter has been issued about twice a year. Issue no. 6 of March 1984 had a distribution of 2700, thereof

900 copies upon explicit requests received from scientists in 53 countries in the NDS service area

1500 copies to scientists in the NDS service area whose addresses were received from miscellaneous sources

300 copies upon explicit requests received from scientists of countries served by the other three data centres.

The Nuclear Data Newsletter advertises new data libraries, handbooks (CINDA, WRENDA) and nuclear data publications (primarily INDC reports and conference proceedings). Numerous requests for data and documents are received at NDS as a result of this newsletter.

D.1.4.c) IAEA-NDS-documents

All data retrievals sent out upon request are accompanied by documentation of format and content of the data files. Such data library documentations are issued as a series entitled "IAEA Nuclear Data Services" (report code "IAEA-NDS-..."). The whole series is indexed and publicized in

IAEA-NDS-0: Index to the IAEA-NDS-documentation services, and

IAEA-NDS-7: Index of Nuclear Data Libraries available from the IAEA Nuclear Data Section

D.1.4.d) Nuclear Data Standards for Nuclear Measurements

The Nuclear Data Standards for Nuclear Measurements which contains the 1982 version of the Nuclear Standards File of the INDC/NEANDC, summarizes the status of the individual nuclear standards as of May 1983. This report was published as Report No. 227 in the Technical Report Series of the IAEA in 1983.

D.2. Technology Transfer to Developing Countries

D.2.1. Interregional Project on Nuclear Data Techniques and Instrumentation (TC/INT/1/018)

NDS continued the implementation of the Technical Co-operation Interregional Project TC/INT/1/018 "Nuclear Data Techniques and Instrumentation" in the frame of the Agency's Department of Technical Co-operation. The process of consolidation which was started during 1983 has been continued (with very few new additions to the participants list (INDC/P(83)-8)) by providing larger inputs in terms of expert services and equipment to a few promising laboratories where progress made indicated the need to maintain the rate of progress. At the same time the support was maintained at optimum levels for those laboratories which were still in the initial phase of their programmes. The co-ordinated research programme on measurement and analysis of 14 MeV neutron nuclear data (INDC/P(83)-15) is one of the measures taken for bringing about interlaboratory co-ordination and co-operation between laboratories from developing and developed countries in 14 MeV neutron cross section measurement programmes. Similarly, the proposed CRP on measurement of neutron emission spectra from (p,n) and (alpha,n) reactions to obtain experimental nuclear level density parameters is another complementary step in that direction. A detailed report on the status of the project INDC/P(84)-18, is submitted separately for consideration by the INDC.

D.2.2. Targets and Samples

During 1981 and 1982 NDS provided some limited assistance to the nuclear data measurement programmes of a few laboratories from developing countries in the form of targets and samples required by them. During 1983, requirements of those laboratories participating in the Interregional Project on Nuclear Data Techniques and Instrumentation (TC/INT/1/018 - see section D.2.3. below) were fulfilled through the Project.

However, gamma ray calibration sources were provided under this programme to a few laboratories not participating in the interregional project TC/INT/1/018. Some of the contracts under this programme are terminated and the title to the material supplied is transferred to the individual laboratories holding the contracts. Supply of sample material and gamma reference sources is foreseen during the current year.

D.2.3. Training Courses, Workshops, Conferences

D.2.3.a) Training Course and Study Tour on Neutron Physics and Nuclear Data Measurements with Accelerators and Research Reactors, Tashkent, Moscow and other cities in the USSR, 4 to 30 September 1983

This Training Course (TC) was convened in Tashkent at the Institute of Nuclear Physics of the Academy of Sciences of the Uzbek SSR from 4-18 September 1983, and the Study Tour (ST) included visits to scientific laboratories in Moscow, Leningrad, Kiev, Dubna and Obninsk, during the period 19-30 September 1983.

This TC & ST has achieved the primary objectives for which it was planned. The Training Course provided the participants with a good overview of the latest developments in the field of neutron physics and nuclear data measurements, in the studies of neutron-nuclear interactions, and in related technological applications of immediate benefit to their countries.

The Study Tour to well-equipped nuclear centres of the USSR with different neutron sources and instrumentation supplemented the TC satisfactorily. The practical value of the visits to the laboratories was that the participants have gained an insight into the use of the nuclear methods and techniques for a variety of scientific research and industrial applications which have an important economic and training value for developing countries.

The complete typewritten manuscript of the lectures prepared by the Organizing Committee of the Course and distributed to all participants before the course turned out to be very useful for the participants during the lecture programme and will be helpful for their future work. It is recommended that the Agency adopt this practice for such kind of training courses.

A detailed report on this TC and ST is given in INDC/P(84)-14.

D.2.3.b) Workshop on Nuclear Model Computer Codes, ICTP Trieste, 16 January - 7 February 1984

This was the first Agency sponsored workshop to use the new ICTP computer facilities for teaching and training scientists from developing countries. Eight scientists from three developed countries and two international organizations delivered lectures and computer tutorials to 38 scientists from 20 developing countries. During the workshop, each morning was devoted to lectures and each afternoon to computer exercises.

There were several important conclusions that can be drawn from this meeting. First, the participants stated that they felt that this type of workshop, involving the actual use of code computers and interacting with code designers, was very beneficial. Second, although the ICTP computer facilities are moderate in size, the course demonstrated that they can be successfully utilized for this type of course.

A detailed account of this workshop is given in INDC/P(84)-7.

D.2.3.c) Interregional Training Course in Basic and Applied Nuclear Physics, Legnaro, Italy, 1985

This course is being organised jointly by the Physics and the Nuclear Data Section. Following discussions on this proposed course at the 13th INDC meeting in Rio de Janeiro, an outline of the course has been worked out through discussions between Prof. Moschini and his colleagues at Legnaro laboratory and Mr. M. Leiser, Head Physics Section and Mr. M.K. Mehta of NDS. The course is proposed to be

funded through an agreement between the Agency and INFN and will be held during 4 March - 5 April 1985 at Legnaro laboratories. The working paper INDC/P(84)-11 describes briefly the outline of the course.

D.2.3.d) International Conference on Nuclear Data for Basic and Applied Science, Santa Fé, N.M., USA, 13-17 May 1985

The IAEA is co-operating with this conference as it did with its predecessor at Oak Ridge (1979) and with the similar European conferences at Harwell (1978) and Antwerp (1982), by providing an IAEA nominee as a member of the International Advisory Committee (M.K. Mehta from NDS). The principle function of the co-operation is to announce the conference to the Member States in the service area of the NDS and to provide assistance for the attendance of selected scientists from developing countries. The first announcement of the conference was incorporated in the NDS Newsletter sent out in April 1984. The proposed budget will provide for attendance of five or six scientists from developing countries. Other inputs from the NDS are suggestions for topics and speakers for invited talks. A few contributed papers from the NDS are also under consideration.

D.2.3.e) Interregional Training Course on the Evaluation and Processing of Nuclear Data for Reactor Applications

This course was originally proposed to be held in 1983, was deferred to 1984 and is now approved to be held in 1985.

D.2.3.f) Interregional Training Course on Utilization of Neutron Generators, Chiang Mai, Thailand, 1986
(Being planned jointly with the Physics Section)

The Agency has organised two earlier courses on the above topic in 1979 and 1982 at Debrecen, Hungary. While the 1979 course was fully organised by the Physics Section, the Nuclear Data Section was involved in the organisation of the 1982 course. A report on the 1982 course was submitted and discussed at the 13th INDC meeting (INDC/P(82)-5).

The Physics Section is planning a third course as a follow up of the earlier two courses to be held at Chiang Mai, Thailand, in 1986 and proposes to organise it jointly with the NDS, the load to be shared equally between the two sections.

D.2.4. Trainees, Fellows and Cost-free Experts

During the reporting period, the NDS has hosted the following cost-free staff:

Mrs. M. Allab, Professor at the University of Sciences and Technology of Algiers, People's Democratic Republic of Algeria, has participated in the work of the Nuclear Data Section as a cost-free expert since March 1983. Her contribution has been in the compilation and review of charged particle nuclear data needed for medical radiotherapy.

Mr. M. Yaltirik from Turkey, a junior trainee in the framework of the Agency's Junior Traineeship Programme, was selected to be trained in the Nuclear Data Section for twelve months (September 1983 - August 1984). Mr. Yaltirik's training included familiarization with nuclear data files and data processing codes, and with the utilization of the Agency's computer facilities.

Mr. Hussein Al Weshk has worked as a cost-free trainee with the NDS from 1 December 1983 to 30 June 1984, at the request of the Socialist People's Libyan Arab Jamarihiya. Mr. Al Weshk has spent his time to become familiar with computer handling of nuclear data and related subjects.

Starting in September 1984, NDS will host the following scientists:

Mr. Z.T. Bödy from the Institute of Experimental Physics, Kossuth University, Debrecen, Hungary; he will stay one year with NDS as IAEA fellow.

Mr. Qi-Chang Liang and Mr. Lin-Xin Shen from the Nuclear Data Centre of the Institute of Atomic Energy in Beijing, People's Republic of China; they will spend three months at NDS as IAEA fellows;

Junior Trainee. It is anticipated that another junior trainee will join the NDS for a period of one year, in the framework of the IAEA Junior Traineeship Programme.

Appendix A

List of Liaison Officers to the INDC as of August 1984

Argentina	Ricabarra, G.
Austria	Vonach, H.K.
Bangladesh	Islam, M.
Belgium	Poortmans, F.
Bolivia	Rondon, A.
Bulgaria	Janeva, N.
Chile	Morales-Peña, R.
Colombia	Director, Instituto de Asuntos Nucleares
Costa Rica	Salazar Matarrita, A.
Cuba	Nodarse, F.
Czechoslovakia	Rocek, J.
Denmark	Christensen, C.J.
Ecuador	Muñoz, R.
Egypt	El-Nady, M.
Finland	Silvennoinen, P.
Greece	Dritsa, S.
Hong Kong	Wright, J.C.
Hungary	Kluge, G.
Iran	Azimi-Garakani, D.
Iraq	Said, K.I.
Israel	Yiftah, S.
Kenya	Gacii, P.
Korea, Dem. Peoples Republic	Dzang, S.H.
Korea, Republic of	Cho, M.
Kuwait	Shihab-Eldin, A.
Libyan Arab Jamahiriya	Aboughalya, E.
Mexico	Graef Fernandez, C.
Morocco	Erradi, L.
Netherlands	Bustraan, M.
Nigeria	Director, Centre for Energy
Norway	Andersen, E.
Pakistan	Gul, K.
Peru	Espinosa Garcia, R.
Philippines	Bartolomé, Z.
Poland	Sujkowski, Z.
Portugal	Carvalho, F.G.
Romania	Rapeanu, S.N.
Singapore, Republic of	Tang, Seung-Mun
South Africa, Rep. of	Barnard, E.
Spain	Velarde Pinacho, G.
Sudan	Habbani, F.I.
Switzerland	Widder, F.
Thailand	Boonkong, W.
Turkey	Gueltekin, E.
Uruguay	Servian, J.L.
Yugoslavia	Slaus, I.