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INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

REPORT OF THE NUCLEAR DATA SECTION TO THE INTERNATIONAL NUCLEAR DATA COMMITTEE SEPTEMBER 1987 TO FEBRUARY 1989

A. Lorenz, Editor

May 1989

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

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Abstract

This progress report of the IAEA Nuclear Data Section covers the 18-months period September 1987 to February 1989. It describes past, current and planned activities of the Section and presents the status of its nuclear data centre services and technology transfer.

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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
REAL	Reaction Rate Estimates, Evaluated by Adjustment Analysis in Leading Laboratories
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

Programme Summary

J.J. Schmidt
Head, IAEA Nuclear Data Section (NDS)

This progress report on the activities and services of the IAEA Nuclear Data Section covers the eighteen months period from September 1987 to February 1989.

During this reporting period, Darío Gandarias Cruz returned to his home country Cuba to the Nuclear Physics Department of the Institute for Nuclear Science and Technology in October 1988. As successor in his post, Vicente Osorio Fernandez was selected from the same institute; he joined the NDS as a staff member in January 1989. His main responsibilities will be to compile experimental data in the EXFOR system and to monitor the co-operation with external EXFOR compilers, especially the nuclear data group of Gandarias Cruz in Cuba. Nikolai Kocherov from the Khlopin Radium Institute in Leningrad, who was already staff member of NDS in the late seventies, filled the open post of a P-4 nuclear physicist and took over responsibilities in several fields of nuclear data applications such as nuclear data for radiation damage prediction, reactor neutron dosimetry and nuclear geophysics, in fission foil exchange and in the organization of training courses. Monica Seits was appointed head of the Section's Data Center Operations Unit. Madhu Mehta's contract as resident technical co-operation expert was extended to the end of June 1989. He continued to assist NDS mainly in the implementation of the Interregional Technical Co-operation Project INT/1/039 on Nuclear Measurement Techniques and in the organization of the joint IAEA/NDS-ICTP Workshops on Nuclear Data and Reactor Physics.

Among the highlights of the Section's activities and accomplishments during the reporting period were the publication of WRENDA 87/88, the successful beginning of an international co-operation in the development of the Fusion Evaluated Nuclear Data Library (FENDL), the start of a new Coordinated Research Programme on Atomic and Molecular Data for Radiotherapy with scopes and objectives clearly defined at a preceding Advisory Group Meeting on the same topic held in June 1988, the development and adoption of an international fusion-user oriented system for the exchange of atomic and molecular data for fusion called ALADDIN, the start of external EXFOR data compilation in China and Cuba and the joining of the Nuclear Data Group of the Hokkaido University, Sapporo, Japan, into the EXFOR network, the start of electronic mail communication with other data centres and external counterparts, the successful conduct of interregional training courses and workshops in Leningrad and Dresden, and at the ICTP Trieste, and the pursuit of national and interregional technical co-operation projects in nuclear measurement and analysis techniques.

During the reporting period the ninth edition of the World REquest List of Nuclear DAta, WRENDA 87/88, was published from input provided by 18 countries and one international organization. The total number of requests decreased by more than 30 % compared to the 1983/84 edition of WRENDA, with significant decreases in the number of fission and fusion technology related requests.

The Advisory Group Meeting on Nuclear Theory for Fast Neutron Nuclear Data Evaluation held in Beijing in October 1987 provided a comprehensive review of the current status of low-energy nuclear reaction theories and models and their significant impact and use in present-day nuclear data evaluation (IAEA-TECDOC-483). The review of nuclear data for the calculation of fission reactor reactivity coefficients at an Advisory Group Meeting held in Vienna in December 1987 revealed the need for new evaluations of thermal fission and capture nuclear data of ^{235}U and ^{238}U (IAEA-TECDOC-491). The Consultants Meeting on the Physics of Neutron Emission in the Fission Process held in Mito, Japan, in June 1988 reviewed current experimental and evaluation work on fission neutron yields and energy spectra and led to the proposal of a new coordinated research programme on nuclear data on neutron emission in the fission process. The two expert meetings held at Geel, Belgium, in September 1987 and at Darmstadt, Federal Republic of Germany, in September 1988 on the Influence of Target and Sample Properties on Nuclear Data Measurements were particularly successful in bringing together producers and users of targets and samples and in identifying characteristic requirements of the users and confronting them with the technical possibilities and limitations of the producers (INDC(NDS)-200 and -213).

At a Consultants Meeting held in Vienna in May 1988, members of the A+M data centre network and scientists from major fusion laboratories agreed to adopt the ALADDIN system developed at the Princeton Plasma Physics Laboratory as the international system for the storage and exchange of evaluated A+M data and their interfacing with fusion application codes (INDC(NDS)-211). Supporting software and a first manual for ALADDIN are currently being developed in cooperation between the A+M data centre network at the IAEA/NDS A+M Data Unit. In the development of a comprehensive A+M data base for fusion plasma applications significant progress could be achieved through the preparation of sets of recommended data for the collision processes of iron ions (1987 Special Supplement to the Agency's Nuclear Fusion Journal) and of carbon and oxygen ions (to be published in the IAEA Series on Recommended A+M Data for Fusion) with electrons, hydrogen atoms and molecules, and helium. A Coordinated Research Programme (CRP) on the A+M Data for Fusion Edge Plasmas was initiated in September 1988 with the objective to generate sets of recommended A+M data required for modelling and diagnostics of boundary plasmas of present-day large tokamak experiments. In this framework the NDS A+M Data Unit has performed a comprehensive compilation of data on particle exchange reactions occurring in low-temperature tokamak edge plasmas.

Co-operation on the Fusion Evaluated Nuclear Data Library (FENDL) was started at a Specialists' Meeting held in Vienna in November 1987 which defined the specifications and procedures for the review and intercomparison of individual evaluations and their testing in benchmark calculations (INDC(NDS)-201). Since then one or more evaluated data files for 14 fusion-relevant elements and isotopes were received by NDS and checked for completeness and consistency, and benchmarks prepared for the testing of Pb, Li and Nb evaluated data files. From interactions with members of the International Thermonuclear Experimental Reactor (ITER) project team a long-term rather than intermediate need for a unique comprehensive evaluated nuclear data library such as FENDL can be concluded. Foreseeing this later need, FENDL will be developed so as to become a useful tool not only for ITER, but also for other fusion reactor projects. IAEA considers the development of FENDL as a pilot project for international co-operation in nuclear data evaluation.

On the basis of the significant progress achieved in the review of the A+M data needs for radiotherapy at an Advisory Group Meeting held in Vienna in June 1988 a new CRP on A+M Data for Radiotherapy could be started with a Research Coordination Meeting (RCM) held in Vienna at the end of January 1989. The scope of the CRP comprises the basic A+M processes of electrons and ions with atomic and molecular components of the human tissue as well as key substances used in radiation dosimetry. The aim of the CRP will be to generate, collect and evaluate the A+M data required specifically for neutron and proton therapy and its results will be published in the form of a handbook. The RCM succeeded in formulating the CRP programme in very detail and to assign specific tasks to the participants (INDC(NDS)-217).

The complementary CRP on Nuclear Data for Neutron Therapy has made significant progress in the measurement and analysis of medium energy neutron cross section and Kerma data for important elements of human tissue such as C and O which was reviewed at two RCMs held in Vienna in November 1987 and January 1989, respectively (INDC(NDS)-203 and -216).

One of the main data centre tasks of NDS consists in the continued coordination of the data centre networks for nuclear reaction (NRD) and nuclear structure and decay data (NSDD), respectively. Network meetings held in the reporting period (NRD: Brookhaven, October 1987, and Vienna, October 1988; NSDD: Ghent, Belgium, May 1988) discussed and agreed upon a number of technical issues connected with the maintenance of the systems used by the centres and with the rules governing the compilation, evaluation, exchange and publication of the data. The Chinese Nuclear Data Centre in Beijing and the Nuclear Data Group of the Institute for Nuclear Science and Technology in Cuba have started to assist NDS in the compilation of EXFOR entries. The Nuclear Data Group at the Hokkaido University, Sapporo, Japan, has also joined the EXFOR network and data originally compiled in the Hokkaido system NRDF could be successfully converted to the EXFOR system. For NSDD, the previously agreed upon goal of the network of a mass-chain evaluation cycle time of six years was re-iterated and measures to reduce the current cycle time of 8-9 years were agreed upon. The average number of requests processed annually by NDS is still increasing and exceeds now 800.

During the reporting period the use of personal computers within NDS has increased considerably. The ENDF/B pre-processing codes were converted to PC use and widely distributed. Also the ENDF/B utility codes and a variety of nuclear model and nuclear data processing codes are being implemented for PC use. Electronic mail communication with other data centres and co-operating external scientists was successfully started.

In the framework of the transfer activities of NDS, two successful Interregional Training Courses, funded by the Agency's Technical Co-operation (TC) programme, were held in the reporting period, one on "Low Energy Accelerators and their Applications" in Leningrad, USSR, in September/October 1988, and another one on "Applied Nuclear Physics and Nuclear Data Measurements at Neutron Generators" in Dresden, German Democratic Republic, in November/December 1988. A Joint IAEA/NDS-ICTP Workshop on "Applied Nuclear Theory and Nuclear Model Calculations for Nuclear Technology Applications" was held at the ICTP Trieste in February/March 1988.

NDS is currently technically responsible for eight national TC projects dealing with the introduction of nuclear physics and nuclear analytical techniques in seven African countries. Two additional TC projects were continued in the reporting period which are concerned with the establishment of computer-based nuclear data libraries and associated computer codes at the major national atomic energy institutions in China and Indonesia.

The Interregional Technical Co-operation Project TC/INT/1/039 on Nuclear Measurement Techniques was started with some delay with a set of exercises for the measurement and analysis of the elemental composition (major, minor and trace elements) of certified reference samples (sediment, soil, animal muscle and milk powder provided by the Agency's Seibersdorf Laboratory) by one or more of the following methods: neutron activation, X-ray fluorescence analysis, PIXE and low-level counting. The majority of the results received so far from more than 20 laboratories shows large deviations from the Seibersdorf values, thus revealing the urgent need for further training through workshops and/or experts and follow-up fellowship training in the accurate utilization of nuclear measurement and analysis techniques.

A. INDC SECRETARIAT

A.1. Liaison Officers of the INDC

The current list of INDC Liaison Officers, comprising scientists from 47 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 to be issued in May 1989. The report also contains the information on National Nuclear Data Committees. This combined report will be published as INDC(SEC)-097.

A.3. List of INDC Documents

The current list of INDC Documents received and distributed by the INDC Secretariat is to be published in May 1989 as report INDC(SEC)-098. In an effort to help reduce the publication load of the Nuclear Data Section, the content of the List of INDC Documents has been reduced to include only reports which have been published in the course of the preceeding two years. A full list of INDC Documents is available from the Nuclear Data Section on request.

A.4. Translation of Documents

Subject to available funds, the IAEA translates a limited number of INDC reports. During 1987 and 1988, nineteen nuclear data reports have been translated, primarily from Russian, and distributed as INDC reports. Their full titles are given in the List of INDC Documents, INDC(SEC)-098.

B. DATA ASSESSMENT AND RESEARCH COORDINATION

B.1. WRENDA 87/88

WRENDA 87/88 is the ninth edition of the World Request List for Nuclear Data, published in INDC(SEC)-095, 1988. Like the previous issue published in 1983, WRENDA is produced from a computer file of nuclear data requests maintained by the Nuclear Data Section. Input to this request file is provided by official national bodies, such as national nuclear data committees, through the four regional data centres. The requests in this report come from 18 different countries and one international organization.

The following changes to the request file have been introduced since the publication of the previous edition (the numbers in brackets refer to the previous issue): 60 requests listed in the previous edition were modified, 661 withdrawn, 72 satisfied, and 266 new requests were added. The total number of requests is now 937 (1378), of which 326 (435) are Priority 1, 475 (762) are Priority 2, and 136 (181) are Priority 3. There are no Priority 4 requests.

The number of current requests related to fission reactor technology is 605 (902), to nuclear fusion 253 (392), to nuclear materials safeguards 56, and to other applications 23.

The next issue of WRENDA is planned to be published in 1991.

B.2. Data Status and Requirements

B.2.1. Nuclear Theory for Fast Neutron Nuclear Data Evaluation

This Advisory Group Meeting, held on 12-16 October 1987, in Beijing, China, was attended by 39 scientists from twelve Member States and two international organizations. Twenty-six invited and twelve contributed papers were presented. The meeting dealt primarily with the requirements of theoretically calculated fast neutron nuclear data, optical potential, compound theory, pre-compound theories, isomeric state cross sections, and intercomparison of nuclear model computer codes.

The objectives of the meeting were:

- to review the recent developments and current status of nuclear theories used in evaluation and calculation of fast neutron nuclear data;
- to review nuclear structure theories needed in neutron nuclear data calculations;
- to discuss and specify open problems in neutron reaction theories and models;
- to make specific recommendations concerning information exchange, research co-operation programmes, and intercomparison of computer codes.

The proceedings of the meeting, published as IAEA-TECDOC-483 in 1988, contain all presented papers, the summary of the meeting, and the conclusions and recommendations related to the development of applied nuclear theory and the nuclear models used for fast neutron nuclear data computation.

B.2.2. International Nuclear Data Library FENDL for Fusion Reactor Technology

A Specialists' Meeting entitled "Fusion Evaluated Nuclear Data Library Related to the ITER Project" was held at IAEA Headquarters, 14-16 November 1987. It was attended by twenty specialists from ten Member States.

The objectives of the meeting were to discuss the status of current fusion-relevant evaluated nuclear data, available in national and regional data libraries and as independent evaluations, the need for their revision, and the methodology to combine them into the Fusion Evaluated Nuclear Data Library (FENDL). Also discussed was the organization of international cooperation for the intercomparison and review of individual evaluations, the specifications and procedures for benchmark calculations of FENDL files, as well as the interaction with specialists of the International Thermonuclear Experimental Reactor (ITER) project.

The ITER Council has so far not addressed an official request to the Agency for the provision of an ITER-related evaluated data file, but it can be anticipated that such a file will be needed by ITER at a later stage of its development. Foreseeing this later need, FENDL will be developed so as to become a useful tool not only for ITER, but also for other fusion reactor projects. It is considered as a pilot project for international co-operation in nuclear data evaluation.

The Summary Report of this meeting was published as INDC(NDS)-201.

B.2.3. Nuclear Data for the Calculation of Reactivity Coefficients

At its 15th meeting at IAEA Headquarters, 16-20 June 1986, the INDC suggested to review the accuracy with which changes in thermal reactor reactivity resulting from changes in temperature and coolant density can be predicted. It was noted that reactor physicists in several countries had to adjust the thermal neutron cross-section database in order to reproduce measured reactivity coefficiencts. Consequently, an Advisory Group Meeting on Nuclear Data for the Calculation of Thermal Reactor Reactivity Coefficients was held at IAEA Headquarters, 7-10 December 1987. The meeting was attended by 20 participants from 9 Member States.

The meeting defined accuracy requirements for temperature coefficients and identified problem areas in the database, in particular in the thermal cross-sections and eta of U-235 and the capture cross-section of U-238. Careful new evaluations will be required after the completion of some data measurements at low energies at Harwell (eta) and ILL Grenoble (fission). It is likely that Axton's evaluation of the 2200 m/s data and the g-factors for U-235 will have to be revised on the basis of these experiments.

The conclusions and recommendations of the meeting together with the papers presented were published in IAEA-TECDOC-491.

B.2.4. Physics of Neutron Emission in the Fission Process

As recommended by the INDC, a Consultants' Meeting on the Physics of Neutron Emission in the Fission Process was held in Mito, Japan, 24-27 June 1988. The meeting was attended by 21 participants from 9 countries and 2 international organisations. Twenty seven papers were presented which indicated significant progress in experimental techniques and theoretical understanding.

The following topics were considered:

Fission neutron yield:

- energy dependence of nu-bar
- multiplicity distribution and variances
- competition between neutron and γ-ray emission
- fission neutron emission near threshold
- nu-bar in resonances

Fission neutron spectra:

- measurements of neutron-induced fission-neutron spectra
- studies of neutron-fragment correlation in Cf-252 spontaneous fission
- theory of fission-neutron spectra
- evaluation of fission-neutron spectra.

The participants in this meeting formulated the following main recommendation:

The rapid development of modern techniques for multi-parameter measurements of the properties of the fission process provides an opportunity to improve substantially the current understanding of this extremely complicated nuclear process. Furthermore, these measurement techniques provide a real method to aid the transfer of technology not only to the developing countries but also between developed ones. It is proposed therefore that a Coordinated Research Program be established by the IAEA to study "Nuclear Data on Neutron Emission in the Fission Process and its Understanding". A number of laboratories have expressed interest in this suggestion.

The minutes are being published as an INDC report.

B.2.5. Atomic and Molecular Data for Radiotherapy

Following a recommendation by the INDC, an Advisory Group Meeting on this topic was held at IAEA Headquarters, during the week 13-16 June, 1988. Twenty-two participants from eight IAEA Member States attended the meeting.

The most important objectives of the meeting were to investigate the status, explore the availability, and identify the important gaps and deficiencies in the atomic and molecular data needed for radiotherapy, and to consider the detailed programme of a new Co-ordinated Research Programme on "Atomic and Molecular Data for Radiotherapy". The following data, related to the atoms and molecules of human tissue, were reviewed:

- Cross sections differential in energy loss for electrons and other charged particles,
- Total cross sections for ionization and excitation,
- Differential ionization cross sections,
- Subexcitation electrons (especially negative ion formation, thermalization, hydration of electrons etc.),
- Cross sections for charged-particle collisions in condensed matter,
- Stopping power for low-energy electrons and ions,
- Initial yields of atomic and molecular ions and their excited states and electron degradation spectra (for low-energy incident photons and electrons),
- Rapid conversion of initial ions and their excited states through thermal collisions with other atoms and molecules, and
- Track-structure quantities.

The papers presented at the meeting together with the conclusions and recommendations are to be issued as an IAEA-TECDOC-506.

B.2.6. Influence of Target and Sample Properties on Nuclear Data Measurements

An IAEA Specialists' Meeting on this topic was held on 21-24 September, 1987, at the Central Bureau of Nuclear Measurements (CBNM), Geel, Belgium.

The agenda of this meeting consisted primarily of discussions between nuclear physicists and scientists engaged in target fabrication on the importance of target and sample properties related to nuclear data measurements. The summary report of this meeting was published as INDC(NDS)-200 in January 1988.

Following the recommendation of that meeting and with the endorsement of the INDC, the IAEA convened an Advisory Group Meeting (AGM) on The Influence of Target and Sample Properties on Nuclear Data Measurements at the Gesellschaft für Schwerionenforschung GmbH, Darmstadt, Federal Republic of Germany, during the week 5-9 September, 1988. This AGM was held concurrently with the 14th World Conference of the International Nuclear Target Development Society (INTDS) organized in co-operation with the IAEA; INTDS co-operated in the AGM.

The objectives of this AGM were to:

- identify experiences which specialists have encountered with strange measurement results due to failure in sample fabrication and assaying;
- itemize and possibly quantify the influence of sample and target characteristics on the accuracy of the final results of nuclear data measurements;
- underline the importance and the necessity of alternative methods for sample assay, especially for the mass-determination of nuclear samples;
- discuss the need for a supplier's list of targets and samples; and
- discuss the possibility to organize a training course in sample preparation techniques especially for scientists from developing countries.

The contributed papers to the INTDS Conference are to be published in the Journal of Nuclear Instruments & Methods in Physical Research. Selected contributed papers to the AGM together with a summary of the papers contributed to the Conference, and the conclusions and recommendations of the AGM were published in INDC(NDS)-213 in October 1988.

B.2.7. Review of the Results of the REAL-88 Intercomparison Exercise

A Specialists' Meeting on this topic was held in Petten, Netherlands, 24-26 October, 1988. The ultimate goal of this exercise is to produce an internally consistent input data set to be used as a standard in different laboratories for testing neutron spectrum unfolding and radiation damage (dpa) calculations.

The input data sets for this exercise, consisting of reaction rate data, input a priori spectra, their covariances, and the data library to be used in the intercomparison, were distributed among 12 participating laboratories at the beginning of 1988. Results from eight laboratories have been received by the time of the October meeting and were analyzed. It was found that the input set developed during this exercise could still not meet the required accuracy. Details of the necessary changes in the input data were agreed upon during the meeting and actions distributed among the participants. The new input data with all the changes were ready by 1 February, 1989, and several test runs are now in progress at the participating laboratories in Petten, Braunschweig and Budapest. It was recommended to discuss the results of this current round at a workshop during the AGM on Nuclear Data for Radiation Damage Calculations to be held in September 1989 in Vienna.

B.2.8. Atomic and Molecular Data Base and Fusion Application Interface

Following a recommendation of the IFRC Subcommittee on Atomic and Molecular (A+M) Data for Fusion, a Consultants' Meeting was convened on 9-11 May, 1988, with participants from the A+M Data Centre Network and major fusion laboratories in order to adopt an international format for the storage and exchange of evaluated A+M data. The meeting discussed a wide range of possibilities, and finally adopted the Princeton Plasma Physics Laboratory A+M data exchange system "ALADDIN" as the most appropriate for evaluated A+M data management, exchange and interfacing with the fusion application codes. The IAEA A+M Data Unit, as well as the national A+M data centres, are now developing the supporting software for ALADDIN, and are in the process of preparing the first manual for this data management system.

The Summary Report of this meeting has been published in INDC(NDS)-211.

B.2.9. Carbon and Oxygen Collision Data for Fusion Plasma Research

Following another recommendation of the IFRC A+M Data Subcommittee, on 12-13 May, 1988, the Nuclear Data Section convened a Specialists' Meeting to review the data base for the collision processes of carbon and oxygen ions colliding with electrons, hydrogen atoms and molecules, and helium. In addition to a critical review and assessment of the existing data base, numerous contributions to this database were presented by the meeting participants (particularly for the electron-ion recombination processes). The results of this meeting are summarized in INDC(NDS)-210. The contributions to the meeting will be published in a topical issue of "Physica Scripta". The recommended data for the collision processes of these ions will be published during 1989 in two volumes of the planned IAEA report series on Recommended Atomic and Molecular Data for Fusion.

B.3. Co-ordinated Research Programmes

B.3.1. Nuclear Data for Neutron Therapy

The first and second Research Co-ordination Meetings (RCM) of the Co-ordinated Research Programme (CRP) on nuclear data needed for neutron therapy were convened at IAEA Headquarters, during the week of 17-20 November 1987, and the week of 24-27 January 1989, respectively.

The main objectives of this CRP are to improve the status of nuclear data required for neutron therapy. The scientific scope of the CRP includes the following aspects:

- measurement and analysis of neutron data for transport calculations in phantoms including the effect of inhomogeneities, and the

- measurement and analysis of primary and secondary charged particle spectra required to determine variations of absorbed dose at interfaces.

As a result of this programme, it is expected that improved medium energy neutron cross section and Kerma data will be produced and used in the dosimetry protocols for radiotherapy applications of neutron beams as formulated by the European Clinical Neutron Dosimetry Group and the American Association of Physicists in Medicine. The summary report of the first RCM was issued as INDC(NDS)-203. The report of the second RCM is to be issued as INDC(NDS)-216. The next meeting of this CRP is planned to be held in 1991.

B.3.2. Measurement and Analysis of Double-Differential Neutron Emission Spectra in (p,n) and (α,n) Reactions

The second IAEA Research Co-ordination Meeting of this CRP was convened by the IAEA Nuclear Data Section at IAEA Headquarters during 8-10 February, 1988.

The main objectives of this CRP are:

- to extract systematic information on nuclear level densities as a function of excitation energy by analysing the neutron emission spectra from (p,n) and (α,n) reactions on properly selected targets and bombarding energy range, and

- to parameterise this information into appropriate phenomenological models so as to enable reliable extrapolation for general use of level density information in basic and applied nuclear physics related problems.

The first RCM, held in June 1986, formulated the detailed programme and assigned specific tasks to the participants. The second RCM reviewed the status of the implementation of this programme. The summary report was issued as INDC(NDS)-205. The third RCM of this CRP is scheduled to be in November 1989.

B.3.3. Methods for the Calculation of Fast Neutron Nuclear Data for Structural Materials

The Second Research Coordination Meeting of this CRP was convened at IAEA Headquarters during 15-17 February, 1988.

The main objectives of the meeting were the following:

- to review the status of nuclear reaction theory and nuclear models used for the evaluation of nuclear data for structural materials,

- to review the progress of activities of the participants in this CRP, and

- to assess the reliability of the calculational methods, as well as to select and recommend the ones suited for the calculation of neutron nuclear data for structural materials of fast fission and fusion reactors.

The Summary Report on this meeting was published in INDC(NDS)-215. The next RCM of this CRP is planned to be convened in the beginning of 1990.

B.3.4. 14 MeV Neutron-Induced Double Differential Neutron Emission Cross Sections

The main objectives of the CRP are to improve the current status of data for 14 MeV neutron-induced double-differential neutron emission spectra from V, Cr, Fe, Nb, Ta and ^{238}U. Six laboratories have been participating in this programme.

The first research co-ordination meeting of this CRP was held during 20-22 April, 1988, at IAEA Headquarters. The progress of the measurements on U-238, Nb, Ta, V, Fe and Cr at each participant laboratory were reported, and the experimental techniques were discussed in detail. It was pointed out that multiple scattering could be a very large source of systematic error and that the actual neutron flux distribution at the site of the sample would be important. The discussion also revealed that in most cases data below the neutron emission energy of 1 MeV had not been measured. Considering the unsatisfactory status of the double differential cross sections (DDCS) data for Li-6, Li-7, Be-9, Mo, W and Bi and their importance in fusion reactor technology, the participants agreed to include these isotopes in the programme of this CRP. The experimental data for the DDCS of U-238 measured at 14 MeV will be evaluated by the Technical University Dresden Group. The second Research Co-ordination Meeting of this CRP is planned to be held in the first quarter of 1990.

B.3.5. Atomic and Molecular Data for Radiotherapy

The aim of the CRP on Atomic and Molecular Data for Radiotherapy, established in 1988, is to coordinate efforts in the generation, collection and evaluation of the physical data required for neutron and proton therapy. The first meeting of this CRP was held at IAEA Headquarters, during the week of 30 January - 2 February 1989. The next meeting of this CRP is planned to be held in 1991. The final report of this CRP is planned to be published in the form of a handbook.

The atoms and molecules included in the scope of this CRP are components of the biological cell as well as key substances used in radiation dosimetry. They are:

Gases: H_2O, H_2, O_2, Ne, Ar, N_2, CO_2, air, as well as (CH_4) and (C_3H_8),

Solids: C, Be, B, Mg, Al, Si, P, Ca, Fe, Al_2O_3 LiF, CaF, as well as the compounds A-150 TE plastic, perspex, polyethylene and nylon

The physics scope of this CRP comprises the following processes:

- Electron impact ionization,
- Charge transfer,
- Ion-induced excitation and dissociation,
- Photo-absorption and photo-ionization,
- Ion-induced chemical transmutation,
- Stopping powers,
- Yields of ions and excited states,
- Electron degradation spectra, and
- Track-structure quantities.

B.3.6. Atomic and Molecular Data for Fusion Edge Plasmas

As a follow-up of the June 1987 IAEA Specialists' Meeting on A+M Data for Edge Plasma Studies (see INDC(NDS)-199), a CRP on the A+M Data for Fusion Edge Plasmas has been initiated and constituted in September 1988. The CRP includes twelve world leading theoretical and experimental groups from the field of low-energy atomic collisions. The main objective of this three year CRP is to generate most of the A+M data required for modelling and diagnostics of boundary plasmas of present-day large tokamak experiments, and to produce a consistent set of recommended data for fusion applications. An initial review of the status of these data will be made at a Specialists' Meeting scheduled for September 1989.

B.3.7. Gamma-ray Standards for Detector Efficiency Calibration

In 1986, the IAEA initiated a Coordinated Research Programme (CRP) aimed specifically at the production of a single internationally accepted set of X-ray and gamma-ray detector calibration data of improved quality to meet the needs of radioactivity measurements in fields such as safeguards, dosimetry and fuel management. In particular, this programme examines the current status and adequacy of radionuclide decay data used for detector efficiency calibration, identifies additional nuclides which could be appropriate as calibration standards, and initiates appropriate actions, (i.e. required measurements and/or evaluations) to produce the required file of calibration data.

The first official meeting of this CRP was held at the ENEA Headquarters in Rome from 11 to 13 June 1987. Work undertaken by the CRP members was reviewed in detail: specific problems in the evaluations were identified and actions placed on the participants to resolve these issues. The Summary Report of that meeting was published in the report INDC(NDS)-196.

The evaluated decay data (i.e. half-lives and gamma-ray energies and emission probabilities) which have been evaluated by the members of this CRP in the course of the last two years have been compiled in a provisional DBaseIII database and are available from the Nuclear Data Section. The next and final meeting of this CRP will be held on 31 May-2 June, 1989, at the Physikalisch-Technische Bundesanstalt (PTB) in Braunschweig, Federal Republic of Germany.

The gamma-ray standards decay data which will be recommended by this CRP will be published in the IAEA Technical Report Series.

C. DATA PROCESSING AND EXCHANGE

C.1. Data Centre Network Co-ordination

C.1.1. Nuclear Reaction Data (NRD)

C.1.1.a) Nuclear Reaction Data Centre Network

The co-ordination meetings of the network of data centers for nuclear reaction data ("NRDC Meetings") take place annually, in two cycles. Each "odd" year (1987, 1989, ...) there is a "full" NRDC Meeting hosted in turn by one of the centers, attended by technical staff and the center heads. Each "even" year (1986, 1988, ...) there is a "technical" NRDC Meeting hosted by the Agency and convened at no cost to the Agency; it is attended by technical staff only.

The ninth "full" NRDC Meeting was hosted by the NNDC at Brookhaven, 27-29 October, 1987. The proceedings have been issued in INDC(NDS)-204.

The third "technical" NRDC Meeting took place in Vienna, 4-6 October, 1988. The resulting conclusions and actions were recorded in an INDC/P-paper.

Nine data centers participate in the network:

- CAJaD, Center for Nuclear Structure and Reaction Data, Moscow: charged-particle data;
- CDFE, Photonuclear Data Center, Moscow (represented through CAJaD): photonuclear data;
- CJD, Nuclear Data Center, Obninsk: neutron data
- CNDC, Chinese Nuclear Data Center, Beijing: charged-particle data
- Hokkaido University, Japan: charged-particle data;
- NEA Data Bank: neutron data
- NNDC, National Nuclear Data Center, Brookhaven: all nuclear reaction data
- RIKEN Nuclear Data Group, Japan: charged-particle data
- IAEA/NDS: all nuclear reaction data

In addition, three US centers were represented at the Brookhaven meeting 1987 as observers:

- Photon and Charged-Particle Data Center, NIST Gaithersburg
- LANL, Nuclear Data Group
- LLNL, Nuclear Data Group

The discussions at these meetings concentrated on technical details of the EXFOR and CINDA systems and on compilation rules which must be updated continuously to take into account new or more detailed data types to be compiled, such as fission product nuclear data.

C.1.1.b) The CINDA Network

CINDA 88 and CINDA 89 have been published in the traditional way, however, without the Supplements, which were usually published towards the end of the year.

The CINDA file is now accessible on-line to most scientists in OECD countries. As NNDC and the NEA Data Bank, who finance most of the CINDA production through their bulk orders will discontinue their bulk orders, the publication of the Cinda books will have to be discontinued.

Originally, it was planned to conclude the CINDA publication by a final "Archival issue" similar to "CINDA-A" published in 1979. However, the estimated size of such an issue, requiring 4 or 5 volumes of about 1000 pages each, makes this publication impossible; the zero-growth budget of the IAEA and the financial situation of NNDC and NEA prohibit a project of this size. The possibility to have a commercial publisher produce these books is being negotiated but the probability of this is low. CINDA-89 will, therefore, be the last cumulative CINDA publication. From now on, access to CINDA will be available on-line or through specific CINDA retrievals which can be requested from any one of the four CINDA centres. In addition IAEA/NDS contemplates to continue the publication of CINDA in the form of annual current awareness reports.

C.1.1.c) Neutron Data

The neutron data EXFOR operation is now routine, requiring a constant level of manpower for compilation, exchange, file maintenance, and correctness and completeness checking. Due to the limited number of staff, certain data categories, such as neutron-induced gamma spectra, though considered to be important, are not compiled systematically.

During the past year a special effort has been started to convert the "Meek and Rider" file of fission-product yield data into EXFOR. After the file was machine-converted to a raw EXFOR format by NNDC, a review and revision of this file was initiated at NDS by an IAEA fellow (Wang Dao from the Chinese Nuclear Data Center "CNDC"). This review work which will continue at CNDC is needed mainly to provide the correct detailed coding of the data definition in the EXFOR "REACTION" string, and to input the information on the measurement method needed for defining correlations between experimental data. This revised file will form the basis for a CRP on the evaluation of fission-product yield data.

Evaluated neutron data are now mostly available in ENDF format, however, versions ENDF-4, ENDF-5, and more recently ENDF-6, are all in use. The new version of the ENDF pre-processing codes will handle all versions of the ENDF format.

C.1.1.d) Charged-particle Nuclear Data

The main EXFOR compilation of charged-particle nuclear data continues to be done by CAJaD. This centre also co-ordinates the charged-particle data compilation in the RIKEN, CNDC, NNDC, and NDS centres. The main emphasis is on the compilation of reaction data needed for the production of radioisotopes, in particular for medical applications.

C.1.1.e) Photonuclear Data

CDFE (Moscow) is the only active center which compiles photonuclear data in EXFOR format, and publishes CINDA-type bibliographies of these data.

C.1.2. Nuclear Structure and Decay Data (NSDD)

The international NSDD Network, consisting presently of 17 evaluation groups in 12 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 evaluated data in the Nuclear Data Sheets and Nuclear Physics A journals, and their dissemination to the scientific community. This international cooperative effort is coordinated by the NNDC in the USA and the Nuclear Data Section of the IAEA. The periodic meetings of the international NSDD network aim at co-ordinating all centres and groups participating in the compilation, evaluation and dissemination of NSDD, maintaining and improving the standards and rules governing NSDD evaluation, and reviewing the development and common use of the computerized systems and data bases maintained specifically for this activity.

The eighth meeting of the International Network of Nuclear Structure and Decay Data (NSDD) Evaluators was convened by the IAEA Nuclear Data Section at Ghent in Belgium from 16-20 May, 1988. The meeting was attended by 21 scientists from 12 Member States and 3 international organizations, representing centers and groups concerned with the compilation, evaluation and dissemination of nuclear structure and decay (NSD) data.

The main achievements of this meeting were as follows:

- The previously agreed upon goal of the NSDD network of a mass-chain evaluation cycle time of six years was re-iterated and measures to reduce the current cycle time of 8-9 years were agreed upon.
- Problems encountered in implementing the new format for mass-chain publications agreed upon at the Grenoble meeting were discussed. To solve these problems, improved ways of communication between the editors and the evaluators were endorsed by the network. Those parts of an A-chain evaluation which will not appear in the publication, will be agreed upon between the editors and the evaluators at an early stage in the publication process.
- The "up-date format" for evaluations with little new data was approved by the network.
- Increased on-line access to the NSR and ENSDF data bases was noted as an important step in inter-centre data exchange and user services.
- In response to the need of the user community for a new nuclear structure handbook, the network recommended a feasibility study for such a handbook to be performed before the next network meeting.

The Summary Report of this meeting has been published in the INDC(NDS)-206 report.

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

The A+M Data Unit of the Nuclear Data Section continues to co-ordinate the activities of the national atomic data centres, which are organised in an A+M Data Centres Network (DCN). In October 1987, the A+M Data Unit convened the 7th regular meeting of the A+M DCN, which was hosted by the Atomic Data Centre for Fusion at the Oak Ridge National Laboratory. The ongoing and future activities of the A+M data centres were discussed and agreed upon at that meeting. The summary of the meeting is contained in report INDC(NDS)-202.

The policy-making and controlling organ for the activity of the NDS A+M Data Unit is the International Fusion Research Council (IFRC) Subcommittee on Atomic and Molecular Data for Fusion. From 7-8 October, 1988, the IFRC Subcommittee convened its regular 5th meeting in Vienna to review the work of the A+M Data Unit, to endorse some of its initiatives, and to set the Unit's programmes for the next two years. The conclusions and recommendations of the Subcommittee meeting are contained in the report INDC(SEC)-096.

C.2. Data Processing

C.2.1. Data Compilation, Parameterization and Exchange

C.2.1.a) CINDA

The compilation of CINDA entries from the literature published outside the OECD countries and the USSR, is part of a continuing effort at NDS. After the recent revision of the structure of the CINDA network, the computer programs (input checking, file maintenance, exchange with other data centers) have been revised, so that input can be prepared in batch mode for new entries, and on-line for revisions and updates. CINDA input is intimately linked with EXFOR compilation.

C.2.1.b) EXFOR

Experimental neutron reaction data

During the last few years compilation of experimental neutron reaction data produced in the NDS service area was fairly complete and up-to-date. In addition, many of the data compiled earlier were updated in close co-operation with the authors who receive proof copies of their data as compiled in EXFOR. Special attention is given to error analysis and standard reference data.

EXFOR compilation work has been done by fellows/trainees (Tin Maung Kyi from Burma and V. Osorio from Cuba) as well as by regular staff members responsible for EXFOR compilation. Dario Gandarias, who returned to Cuba, will continue to compile data for NDS as part of a technical research contract, and the Chinese Nuclear Data Center (CNDC) has started to compile Chinese neutron reaction data. In Cuba and in China, compilation work is done on a personal computer, and the data are transmitted to NDS on diskettes.

Charged particle and photonuclear data

The EXFOR compilation of charged-particle reaction data and photonuclear data by NDS continues at a low rate with emphasis on neutron production reactions.

The Nuclear Data Group at the Hokkaido University, Sapporo, Japan, under Professor H. Tanaka, has also joined the EXFOR network. The conversion of data from the Hokkaido system NRDF to EXFOR, which presented some difficulties in the past, could be resolved during the discussions at the Mito Conference. A tape with differential charged-particle reaction data converted from NRDF to EXFOR has now been received and could easily be merged into the EXFOR database.

C.2.1.c) Evaluated Nuclear Data

The following evaluated nuclear data files were received and documented for distribution during the reporting period:

- several neutron cross section files for structural materials to be included in the INDL library and in the international fusion data file FENDL (some of these evaluations are in the ENDF-6 format);

- the USSR evaluated neutron data library BROND, (issued in ENDF/B-5 format), which includes evaluations from Obninsk, Minsk (U and Pu isotopes), and Dresden (Si, Nb, Pb). Two documents were prepared for distribution to customers:

  * IAEA-NDS-90: Summary documentation of the BROND file

  * INDC(CCP)-283: English translation of the detailed description of the evaluations

- the ENDF/B-6 Standards Library;

- the Cf-252 spontaneous fission neutron spectra evaluated by W. Mannhart;

- additions to the Chinese evaluated nuclear data library (Am-241); and

- a few other libraries such as the JENDL-3 fission-product file were received and advertised for distribution.

C.2.1.d) Evaluated A+M Data

In the course of preparation of the carbon and oxygen data volumes to be published in the IAEA Series on Recommended A+M Data for Fusion, data for all types of processes have been up-dated and evaluated by the staff of the A+M Data Unit. New, more appropriate, analytical-fit parametrizations have been constructed for the heavy-particle collision data. Analytical-fit representations have also been constructed, and adequate scaling relationships derived, for the cross sections of collision processes involved in the penetration of energetic neutral hydrogen beams in fusion plasmas.

The A+M Data Unit staff has performed a comprehensive data compilation of particle exchange reactions occurring in low-temperature tokamak edge plasmas in the framework of the CRP on A+M data for fusion edge plasmas.

C.2.2. Generation of Special Data Bases and Handbooks

C.2.2.a) Handbook on Nuclear Activation Data

The issue of the "Handbook on Nuclear Activation Data", Technical Report Series No. 273 has been received favourably by scientists working in basic research, as well as in the educational and industrial application fields. In February 1989, the number of copies sold and those distributed free of charge are 563 and 902, respectively.

The following numerical data in the Handbook are available free of charge on IBM standard PC diskette: angular dependences of neutron energies and cross sections for 11 mono-energetic neutron source reactions (Chapt. 1-3), and the evaluated activation neutron cross section data for (n,2n), (n,p) and (n,α) reactions in the energy range from threshold to 10 MeV (Chapt. 2-3).

C.2.2.b) Heavy Element Radionuclide Decay Data

In 1986 the Agency published the results of a Coordinated Research Programme on transactinium isotope nuclear decay data in the Agency's Technical Report Series No. 261. This report contains extensive tabulations of the recommended heavy radionuclide half-lives and branching fractions as well as the energies and emission probabilities of the emitted gamma rays and alpha particles. A review of these data is planned to be performed in November 1989; an amended list of these data will be published thereafter by NDS.

C.2.2.c) Nuclear Data for Fusion Neutronic Calculations

Following the IAEA Specialists' Meeting on the Evaluated Nuclear Data Library for Fusion (FENDL) in November 1987 (Summary Report INDC(NDS)-201), FENDL developed to the following status:

- the following nuclear data files for individual isotopes or natural elements selected for FENDL were received by NDS and checked for completeness and consistency; they were either returned for correction or included in the library:

  N, D, T, Li-6, B-10, C-12, N-14, Si, Ti, V, Zr, Nb, Ba-138, and Pb

- intercomparison of individual files has been performed if two or more evaluations were available for comparison (i.e., the same neutron reaction cross sections or secondary neutron spectra presented in consistent format);

- the FENDL library has been processed with the NJOY-87 system (implemented on the mainframe computer at the Agency); the data are stored in pointwise form and are available upon request;

- the remainder of the evaluations will be processed after their expected release in the middle or at the end of 1989;

- benchmark testing of the evaluated data files is in its initial stage; future plans for cooperation in this field will be discussed at the Specialists' Meeting on FENDL and Benchmark Calculations which is to be held in Vienna, May 8-11, 1989.

C.2.2.d) Nuclear Data for Safeguards

Compilation work on the handbook of "Nuclear Data for Safeguards" is continuing. In view of heavy workload connected with higher priority projects and regular publications (CINDA, EXFOR, FPND), final editing for the publication of these data had to be delayed. Some of the data, which are already available in edited form, have been distributed to safeguards users.

C.2.2.e) Generation of Recommended A+M Data

The NDS A+M Data Unit has prepared and published a comprehensive set of recommended data for the excitation, ionization and charge exchange processes of iron ions (in all stages of ionization) colliding with electrons, hydrogen atoms and molecules, and helium. The data are published in the 1987 Special Supplement to the Agency's "Nuclear Fusion" journal.

C.2.3. Data Base Management

C.2.3.a) System Development

The CINDA and EXFOR systems have been stable throughout the last years; however, modifications and new features continue to be programmed to improve the relevant data checking programs. Additional options have also been programmed for the on-line EXFOR data entry and verification procedures, such as the possibility of entering multi-column data tables one column at a time which is especially useful if more than six columns are present.

The Request & Dissemination Log System is used to monitor incoming requests at NDS and their processing in order to ensure that each request is answered on a timely basis. This log is also used to record detailed information of what has been requested, and subsequently sent out, in order to obtain current request and dissemination statistics. To streamline the data capturing operation as much as possible, a system of on-line screens has been recently programmed, allowing direct updating of the data base and eliminating much of the paperwork.

As of 1988, NDS has also implemented a simple PC-based system for logging all information on the work performed by the Data Centre which is not in direct response to incoming requests (see D.1.3.). This system is used to log outgoing tapes, including all CINDA exchange tapes and EXFOR transmission tapes, as well as outgoing documents sent as a result of PROFILE (see below) retrievals.

The NDS PROFILE system consists of a data file of names, addresses and interest indicators of approximately 6700 scientists who are maintained on any of the Section's distribution lists. The PROFILE is kept current by a continuous updating effort with information provided by the Member States. It is used for producing address labels for documents distribution, for producing name lists and address labels for participants of NDS-organized meetings, and maintaining current lists of committee members or other special interest groups.

C.2.3.b) Use of Personal Computers

In the last year, the use of PC's within NDS has increased considerably. The ENDF/B Pre-processing codes produced by NDS were converted to PC use, and have been widely distributed. Within the Section, they are used to process incoming data. Also, the ENDF/B Utility Codes and a variety of nuclear model and nuclear data

processing codes are being implemented for PC use. Database PC packages are now available for neutron cross sections and secondary neutron spectra. Small data bases are being implemented for statistical and data querying purposes.

D. DATA SERVICES AND TECHNOLOGY TRANSFER

D.1. Data Centre Services

D.1.1. Documentation and User Services

The availability of existing and new data files and reports from NDS is advertised to its customers by the "IAEA Nuclear Data Newsletter" (see D.2.2.). Most of the incoming requests refer to this Newsletter.

Each data library sent out and each selective retrieval from a data library prepared on request is accompanied by "documentation" describing the contents and format of the file and related data processing computer codes. Such documentation is included in the IAEA Nuclear Data Services report series (IAEA-NDS-...). For details see below under D.2.5.

Although the number of on-line customers in the NDS service area is still small, efforts are now being made to extend on-line user services. Most data retrievals are sent out on magnetic tapes. Distribution of data on PC diskettes is increasing, but because of the size of most data libraries, distribution on diskettes is limited to small files or data for individual ENDF materials.

D.1.2. Data Requests

As part of its function as a data centre, NDS processes and fulfills requests received from users in countries within its service area (Eastern Europe - except USSR, Africa, Asia - except Japan, Latin America, Australia and New Zealand) as well as from users in other countries. The average number of requests processed annually by NDS is still increasing, and exceeds now 800.

For the statistics compiled by NDS, a "request" is defined as any query received by NDS for any one of the following specific categories: experimental data, evaluated data, bibliographic retrievals (e.g. from the CINDA master file), documents, and computer programs. For example: one letter asking for experimental and evaluated data counts as two requests, one letter asking for ten EXFOR data sets counts as one request.

Request statistics for each of the considered categories, and statistics showing the total number of requests handled by NDS for each year since 1965 are given in Table 1. The request statistics since 1965 in terms of number of requests per year averaged over three-year periods (i.e. the value for 1988 is the average over the years 1986, 1987 and 1988) is shown in Fig. 1.

Table 1

Data Request Statistics 1965 - 1988

Year	Experimental Data	Evaluated Data	Experimental and Evaluated Data	Documents + Bibliogr. Data	Computer* Codes	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	52	115	167	508	45	713	690	5 007
1984	54	113	167	462	38	667	698	5 674
1985	24	221	245	587	12	844	741	6 518
1986	37	93	130	407	32	569	693	7 087
1987	18	72	90	667	136	893	769	7 980
1988	34	108	142	684	67	893	785	8 873

* Since 1978 this category contains exclusively data processing computer programs.

Nuclear Data Requests

(Number of requests averaged over 3-year period)

Figure 1

TABLE 2

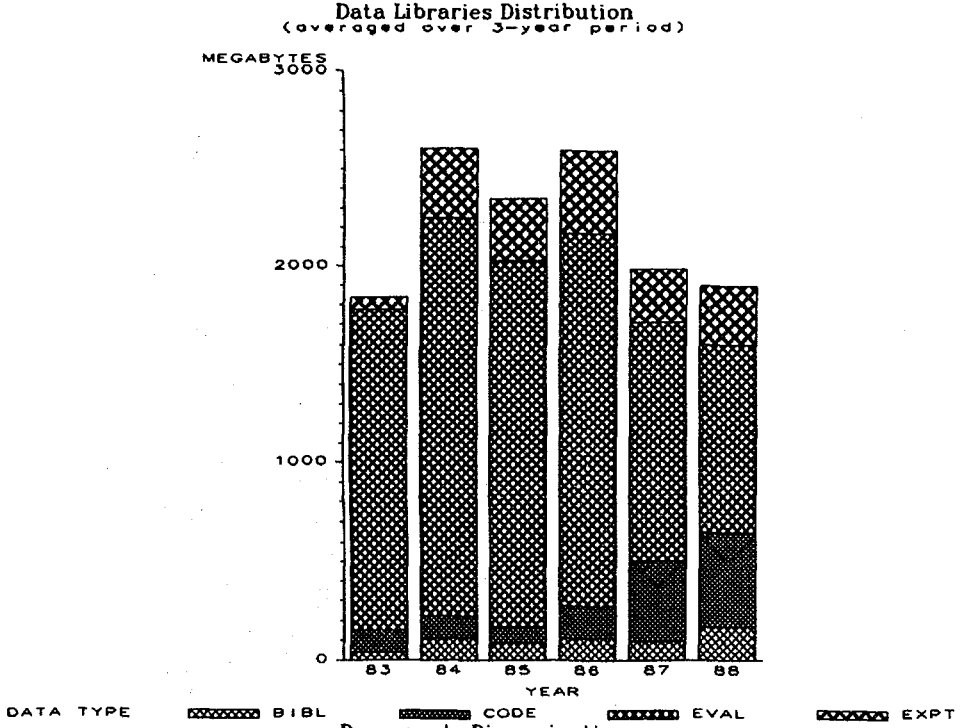
Data Dissemination Statistics 1983 - 1988

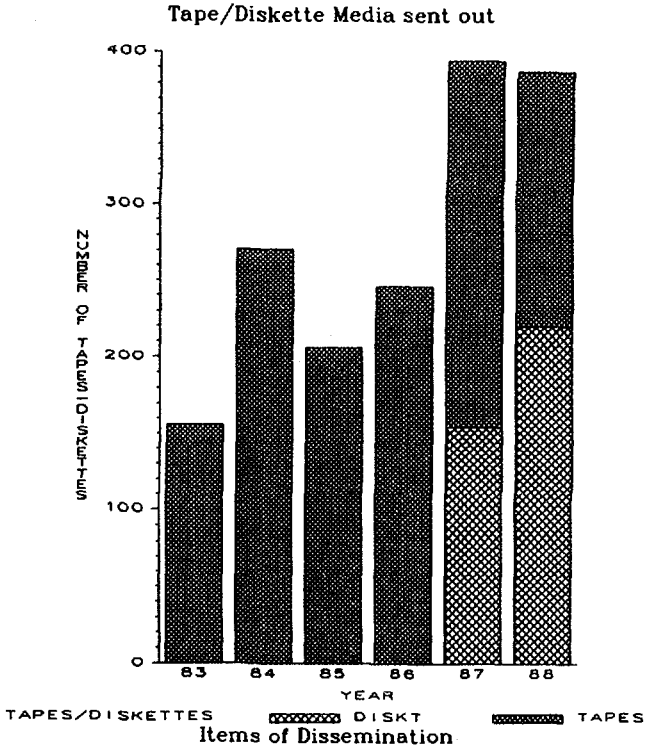
	(1)	(2)	(3)	(4)	(5)	(6)		
Year	Total Experimental=EXFOR data sets (incl. TRANS) (x 1000)	EXFOR TRANS only (x 1000)	Total Evaluated Data Sets (x 1000)	Total Bibl. retrievals (incl. CINDA Exchange)	CINDA Exchange only	Total # Computer Codes	Total Mbytes for columns 1,3,4, and 6	Total Mbytes for columns 2 and 5
1983	10.5	not available	15.1	8	0	56	1 840	not available
1984	60.7	13.6	8.8	37	0	56	3 312	72
1985	48.1	41.3	24.7	14	4	19	1 928	200
1986	71.5	29.9	10.7	101	91	28	2 560	200
1987	18.3	12.4	5.9	46	36	132	1 480	208
1988	51.3	27.6	8.4	167	53	130	1 592	328

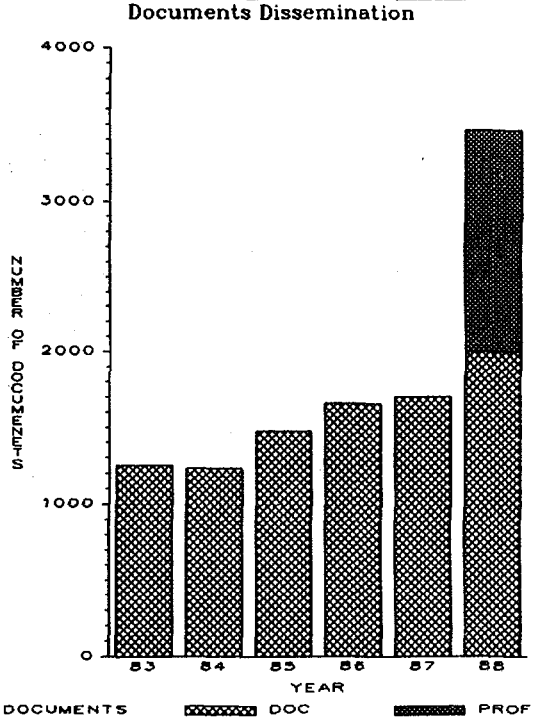
TABLE 3

Documents and Miscellaneous "Item" Dissemination Statistics 1983 - 1988

Year	Documents sent out on Request	Documents sent out on PROFILE distribution	Total # Tapes	Total # PC Diskettes	# of "items" sent out to countries in NDS service area (number of countries in parentheses)	# of "items" sent out to countries outside NDS service area (number of countries in parentheses)
1983	1252	not available	156	0	1 245 (48)	287 (16)
1984	1233	not available	271	0	1 182 (41)	429 (21)
1985	1484	not available	206	0	1 540 (46)	380 (17)
1986	1669	not available	246	0	1 533 (43)	447 (17)
1987	1716	not available	240	155	1 509 (45)	613 (16)
1988	2008	1460	168	220	1 741 (54)	638 (17)


Data Libraries Distribution
(averaged over 3-year period)
MEGABYTES
3000
2000
1000
0
83
84
85
86
87
88
YEAR
DATA TYPE
BIBL
CODE
EVAL
EXPT


Tape/Diskette Media sent out
400
300
200
100
0
83
84
85
86
87
88
YEAR
TAPES/DISKETTES
DISKT
TAPES


Documents Dissemination
4000
3000
2000
1000
0
83
84
85
86
87
88
YEAR
DOCUMENTS
DOC
PROF

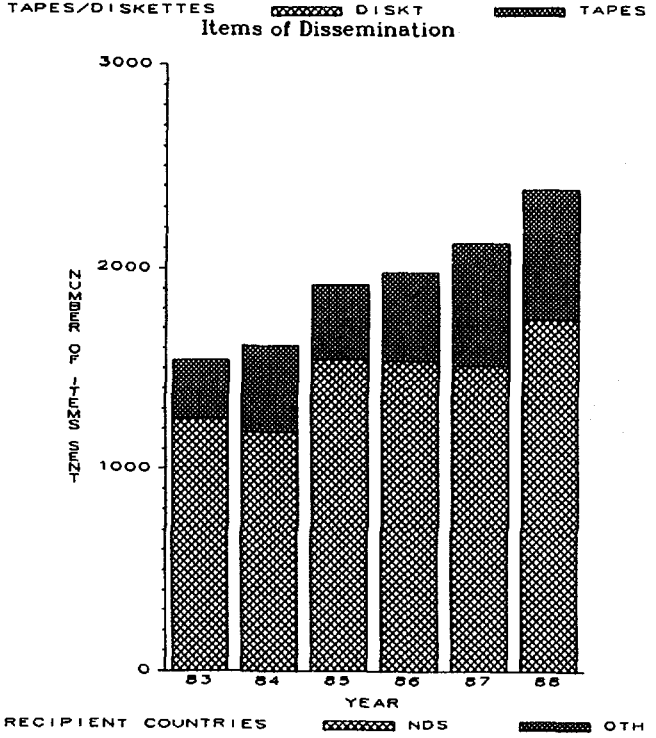

Items of Dissemination
3000
2000
1000
0
83
84
85
86
87
88
YEAR
RECIPIENT COUNTRIES
NDS
OTH

Figure 2

D.1.3. Data Dissemination

In addition to data, computer codes and reports sent out on request, NDS sends out data and reports without having received a specific request. This dissemination activity comprises:

- the regular transmission and exchange of EXFOR and CINDA data between the co-operating data centres;
- the data sent out to previous recipients of particular data libraries when updates or new versions of these libraries have been received at NDS;
- INDC documents that are regularly disseminated by NDS on behalf of Member States; and
- distribution of other documents such as the NDS Newsletter.

Data dissemination statistics are designed to show the quantity of data and reports that have been sent, the number of tapes or diskettes sent out and also which countries they have been sent to. 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 experimental data (EXFOR) a data set comprises all data combined in an EXFOR sub-entry excluding the first BIB (bibliographic) subentry. For evaluated data, a data set comprises all data given under one "MAT" number in a given evaluated data library. As the definition of "data set" is meaningless for bibliographic retrievals (e.g. from CINDA), the values given in Table 2 are the numbers of actual retrievals performed and not data sets retrieved.

Dissemination statistics also include "items" sent out. An "item" is defined as any combination of document or data library sent to a recipient. Each document sent to a requestor counts as one "item", even if multiple copies have been sent. However, each bulk distribution counts as one "item" even though a document may be sent to hundreds of people. Each complete library sent out counts as one "item" and each retrieval from a library counts as one "item" even if hundreds of data sets are selected and copied.

Dissemination statistics for all years since 1983 are given for each of the data types in Table 2; and for documents, tapes, recipient countries and number of "items" sent out in Table 3. Figure 2 shows the dissemination statistics since 1983 in graphical form; the number of Megabytes disseminated for the different types of data libraries are averaged over a three-year period.

D.2. Publications

The following recurring publications are produced by the Nuclear Data Section.

D.2.1. INDC Reports

In the course of the year, NDS distributes approximately 50 INDC reports, most of them on behalf of the Member States. Included in the INDC report series are also reports which originate at the NDS, and which serve to document meetings and results of projects conducted by NDS. A list of INDC(NDS) and INDC(SEC) reports published during this reporting period is given in Appendix B.

D.2.2. The IAEA Nuclear Data Newsletter continues to be published whenever important new data files or documents are received. Its distribution exceeds 3000 in the NDS service area. To OECD countries and USSR it is distributed upon request only (ca. 350 copies) in order not to duplicate services of the other data centres. Attached to the Newsletter is a return postcard by which data, reports or other information can be requested.

D.2.3. Fission Product Newsletter

"Progress in Fission Product Nuclear Data" (FPND), the compendium of information about activities in the field of measurements and compilations/evaluations of FPND, is now published biennially. Contributions to the last issue of this publication (No. 12), collected during 1987, were published in January 1988 as INDC(NDS)-191. The 13th issue of this series will be published in the fall of 1989. The change in the publication frequency of this newsletter from annual to biennial has been accepted by its recipients.

D.2.4. The International Bibliographic Bulletin on Atomic and Molecular Data for Fusion continues to be published by the Nuclear Data Section. During the reporting period three issues of this Bulletin have been prepared and published.

D.2.5. IAEA-NDS-Documents

This series of documents is produced to document contents and formats of data files sent out to customers (see D.1.1. above). An up-to-date list of these documents published during this reporting period is given in Appendix C.

Some of the more important ones are the following:

IAEA-NDS-7 Rev. 88/7:		Index of Nuclear Data Libraries and related computer codes available from the IAEA Nuclear Data Section
IAEA-NDS-29 Rev. 2	:	ENDF utility codes version 6.4 for ENDF-5 and ENDF-6
IAEA-NDS-39 Rev. 3	:	Summary of ENDF pre-processing codes
IAEA-NDS-58 Rev. 1	:	RSIC Photon Interaction Library
IAEA-NDS-76	:	ENDF-6 Formats Manual (preliminary)
IAEA-NDS-88	:	ENDF/B-6 Standards Library
IAEA-NDS-90	:	BROND
IAEA-NDS-91	:	Chinese evaluated fission-product yield library
IAEA-NDS-98	:	The Cf-252 spontaneous fission neutron spectrum evaluated by W. Mannhart

D.3. Technology Transfer to Developing Countries

D.3.1. Interregional Technical Co-operation Project TC/INT/1/039 on Nuclear Measurement Techniques

Complementary to other IAEA TC projects dealing with the maintenance of nuclear instrumentation, this project is designed to provide training to nuclear scientists and technicians in developing countries in the accurate utilization of nuclear measurement and analysis techniques, with an emphasis on neutron activation analysis, X-ray fluorescence analysis, PIXE and low-level counting. Objectives and initiation of this project have been described in detail in the last report of the Nuclear Data Section to the INDC dated September 1987 (INDC(NDS)-197/LNA,p.26.f.).

In response to the Agency's invitation letter for participation in the project sent out in July 1987, positive replies from more than 30 laboratories were received. As a first step of project implementation, a set of intercomparison exercises was formulated in consultation with the Chemistry Section of the IAEA Seibersdorf Laboratory and the Chemistry and Physics Sections of the Division of Physical and Chemical Sciences. From the stock of reference materials maintained by the Seibersdorf Laboratory samples of sediment, soil, animal muscle and milk powder of known and certified composition were selected in November 1987 and (with some unfortunate but unavoidable delay) were sent to the relevant interested laboratories for remeasurement and analysis during the first half of 1988. The counterparts were simultaneously informed about the procedures to be followed for carrying out the measurements. Procurement of sets of γ-ray and X-ray detection calibration sources for each counterpart was also initiated at the same time.

The results received from more than 20 laboratories (the majority using fast neutron activation analysis using 14 MeV neutron generators, and XRF analysis, only a few PIXE and low-level counting) are a striking demonstration for the need for this project. Only very few laboratories sent in satisfactory results, with figures within the confidence level range of the Seibersdorf values. The majority obtained results which, even for major sample constituents, are often highly discrepant from the Seibersdorf values, indicating in a first comparative analysis of the results, serious deficiencies particularly in sample preparation and data analysis techniques.

A second set of exercises, for the neutron generator laboratories, was started in June 1988 asking for the determination of the angular dependence of the energy of the emitted neutrons with respect to the deuteron beam. Zr, Nb and Al foils were sent to the counterparts for this exercise. Only very few results were obtained so far, most of them are still being analyzed.

The results so far received under this project reveal an urgent need for further training in accurate nuclear measurement and analysis techniques, particularly in neutron activation and XRF analysis. Discussions with the Technical Assistance Cooperation Division are being conducted so as to determine the most appropriate way of implementing such training: these consist of workshops tailored to individual analysis techniques and/or short expert missions to individual laboratories, and training through fellowships to more advanced laboratories.

In the future, it seems to be appropriate to pursue the project on a regional rather than interregional basis because of regional similarities in the problems encountered, and the easier handling of the project on a regional basis. It is currently envisaged to continue the project in the Latin American area under a similar ongoing ARCAL TC project (ARCAL = Regional Co-operation Arrangements for the Promotion of Nuclear Science and Technology in Latin America) technically handled by the Chemistry Section, and in the African area as a separate new regional NDS TC project; these two developing areas exhibit the strongest need for manpower training in nuclear techniques.

D.3.2. Training Courses and Workshops

D.3.2.a) Joint IAEA/ICTP Workshop on Applied Nuclear Theory and Nuclear Model Calculations for Nuclear Technology Applications, Trieste, February/March 1988

This Workshop was organised jointly by IAEA/NDS and the International Centre for Theoretical Physics (ICTP) Trieste. It was convened at the ICTP, Trieste, Italy, from 15 February to 18 March 1988 and was directed by J.J. Schmidt, M.K. Mehta, V. Goulo (IAEA/NDS) and D.E. Cullen (Lawrence Livermore Laboratory, USA) with the assistance of Profs. H.R. Dalafi (ICTP) and L. Fonda (ICTP and University of Trieste) as local organizers. 64 nuclear scientists - 56 from developing and 8 from developed countries - attended the Workshop, while the number of lecturers was 21, 13 from Western Europe and USA, 5 from Eastern Europe and 3 from developing countries.

This Workshop was held in continuation of the series of Winter Colleges on Advances in Nuclear Theory and Nuclear Data for Reactor Applications organized biennially since 1978, and was planned as a follow-up of the one held in 1984 on Nuclear Model Computer Codes and complementary to the one held in 1986 on Applications in Nuclear Data and Reactor Physics. It was designed to familiarize participants with recent developments in the analysis of neutron resonances and in fast neutron nuclear reactions and models and associated modern computer codes which are widely used in the analysis and computation of nuclear data needed for nuclear technology applications. The Workshop also provided an opportunity to participants to discuss their local operating experiences and problems encountered in the use of nuclear reaction model computer codes.

The main thrust of the Workshop, like its predecessors in 1984 and 1986, was on operational and practical use by the participants of several selected nuclear reaction model codes in carrying out well defined computational exercises every afternoon. A series of lectures in the morning (two to three per day) were held, (a) to provide a general review of the current status of various nuclear reaction models by eminent researchers in the field, and (b) to discuss the specific theory and detailed organization of the computer codes to be used in the exercises by the authors of the codes or by persons well experienced in the use of the codes.

The topics covered in the lectures were: resolved and unresolved resonances, optical and pre-equilibrium models of nuclear reactions, nuclear fission and some other general aspects of nuclear theory. The exercises in the afternoon covered 11 nuclear reaction model computer codes and utilized 13 personal computers, a few of which were on-line to the ICTP's main frame GOULD computer. The NDS computer staff provided valuable assistance for the implementation of this part of the programme.

D.3.2.b) IAEA Technical Co-operation Group Scientific Visit and Training Course on Low Energy Accelerators and their Applications, Leningrad, USSR, 1988

This group scientific visit (GSV) and training, jointly organized by the IAEA and the USSR State Committee on the Utilization of Atomic Energy, was held at the D.V. Efremov Scientific Research Institute of Electrophysical Apparatus in Leningrad, from 26 September-15 October, 1988.

The objective of this GSV was to train a group of scientists from developing countries who had either worked with low energy accelerators, or were planning to initiate studies in the field of accelerator technology and its applications. Twenty six scientists from fourteen developing countries were selected to participate in this GSV. Twenty-four of them attended the whole course.

The lectures were alternated with practical presentations. Eight lectures on charged particle accelerators and their applications were given by experts from the Efremov Institute. The following topics were covered:

- High voltage accelerators designed at the Efremov Institute and the main fields of their applications;
- High voltage accelerators for radiation technology;
- Intense neutron generators;
- Nuclear-physical methods of analysis using high-voltage accelerators;
- Linear resonance electron accelerators;
- Electron accelerators for industry and medicine;
- Linear induction accelerators - their parameters, design and applications.

Thirteen practical presentations on charged particle accelerators and their applications were given at the Efremov Institute, the Radium Institute, the Izhora Plant, the Roentgen Radiology Institute and the Leningrad Institute of Nuclear Physics. Sixteen accelerator sites were visited.

All participants attended the Sixth All-Union Conference on Applied Accelerators, Leningrad, 11-13 October 1988. The main emphasis of the Conference was on applications of accelerators to medical and industrial uses. A detailed report of this GSV is available from the Nuclear Data Section in the form of a Travel Report (dated 12 December 1988).

D.3.2.c) IAEA Technical Co-operation Interregional Training Course (ITC) on Applied Nuclear Physics and Nuclear Data Measurements at Neutron Generators

This Training Course was jointly organized by the IAEA and the Technical University Dresden, GDR, from 28 November - 9 December 1988.

Fourteen scientists from nine developing countries (Bulgaria, China, Hungary, Iraq, Peru, Sudan, Syria, Vietnam and Zambia) participated in the Training Course.

The objective of the Training Course was to train scientists from developing countries to make quantitative nuclear measurements using neutron generators, with special attention given to shielding and radiation protection, including tritium target handling and personnel dosimetry.

The following topics were covered in thirteen lectures and related practical exercises:

- The description of a simple nuclear reaction model for statistical multistep processes (SMC, SMD) and its application for the calculation of secondary neutron emission spectra; computer code EXIFON.
- Theoretical calculation of fission neutron spectra; computer code GMNM.
- Shielding of fast neutrons: A simple relaxation-length method; computer Code Shield 1.
- Neutron time-of-flight spectroscopy and measurements of double differential neutron emission cross sections.
- Proton recoil spectroscopy, including n-γ discrimination and unfolding of proton recoil spectra.
- Associated alpha-particle method for determination of the absolute neutron yields; computer code QELL.
- Determination of fast neutron detector efficiency by the ^{252}Cf-method, and n-p scattering method.
- The intense neutron generator INGE-1 and its computer control system.

The practical exercises gave the participants the opportunity to use and calibrate neutron dosimeters and neutron spectrometers, to estimate neutron shielding (Code Shield 1), to calculate the neutron energy in the D-T reaction, and to get acquainted with the necessary devices for handling tritium targets.

D.3.3. National Technical Co-operation (TC) Projects

NDS is currently technically responsible for eight national TC projects dealing with the introduction of nuclear physics and nuclear analytical techniques in seven African countries. Appendix D gives a short description of these projects. (The numbers in brackets following the project titles are the TC project numbers as appearing in the list of Agency TC projects).

D.3.4. Fellows and Trainees

During the reporting period, NDS has hosted three IAEA fellows, funded under the Agency's Technical Cooperation fellowship programme, Wang Dao and Zhang Dongming, from China, and Mr. José Martinez Rico from Mexico, and two trainees under the junior trainee programme of the IAEA, Mr. Vicente Osorio Fernandez from Cuba, and Mr. U Tin Maung Kyi from Burma.

Dr. Wang Dao and Mr. Zhang Dongming spent one year (from September 1987 to August 1988) on IAEA fellowhips, 8 months at the University of Birmingham in the UK and 4 months at IAEA/NDS in Vienna. Dr. Wang Dao received training in data centre operating procedures and in data evaluation procedures for fission product nuclear data. Mr. Zhang Dongming received training in nuclear data processing systems, graphic display and data base management systems to set up and develop a nuclear data base for fission product nuclear data.

Mr. Martinez Rico spent one year (from May 1987 to April 1988) as a fellow with the NDS. During that time he has received training on the implementation and utilization of computerized data base systems for the compilation, processing, analysis and evaluation of nuclear data.

Mr. Osorio Fernandez spent six months (1 July - 31 December 1988) as a trainee in the NDS; he received on-the-job training in all aspects of compilation and analysis of nuclear data, including the use of computer terminals and personal computers for nuclear data processing.

Mr. Kyi spent ten months with the NDS from February to December 1988; during that time he received training in all aspects of nuclear data compilation and analysis, and in the preparation of nuclear data computer files for the calculation of design and operation of nuclear power reactors and other applications.

List of Liaison Officers to the INDC as of March 1989

(* Currently being renominated)

	Argentina	Ricabarra, G.
	Austria	Vonach, H.K.
*	Bangladesh	Islam, Shafiqul
	Belgium	Poortmans, F.
	Bolivia	Rondon, A.
	Brazil	Auler, L.T.
	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	Munoz, R.
*	Egypt	El Nady, M.
*	Finland	Silvennoinen, P.
*	Greece	Dritsa, S.
	Hongkong	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	Gruppelaar, H.
	Nigeria	Salau, A.A.M.
	Norway	Andersen, E.
*	Pakistan	Gul, K.
	Peru	Espinosa Garcia, R.
*	Philippines	
	Poland	Sujkowski, Z.
	Portugal	Carvalho, F.G.
	Romania	Rapeanu, S.N.
	Singapore, Republic of	Tang, Seung-Mun
	South Africa, Rep. of	Mingay, D.W.
*	Spain	Velarde Pinacho, G.
	Sudan	Habbani, F.I.
	Thailand	Boonkong, W.
	Turkey	Gueltekin, E.
*	Uruguay	Servian, J.L.
*	Yugoslavia	Slaus, I.
	Viet Nam	Than Quoc Thuong

INDC DOCUMENT DESIGNATOR	DATE OF DISTRIB.	ORIGINAL DOCUMENT ID.	DOCUMENT TITLE, AUTHOR, OTHER IDENTIFICATION NUMBERS, ETC...	ACC.NO
INDC(NDS)-191/G+P	88		PROGRESS IN FISSION PRODUCT NUCLEAR DATA NO. 12 INFORMATION ABOUT ACTIVITIES IN THE FIELD OF MEASUREMENTS AND COMPILATION/EVALUATION OF FISSION PRODUCT NUCLEAR DATA (FPND) BY M. LAMMER JANUARY 1988 (100 PAGES)	1572
INDC(NDS)-192/L	88		COVARIANCE METHODS AND PRACTICES IN THE FIELD OF NUCLEAR DATA PROCEEDINGS OF A IAEA SPECIALISTS' MEETING ON COVARIANCE METHODS AND PRACTICES IN THE FIELD OF NUCLEAR DATA HELD IN ROME, ITALY, 17-19 NOV. 1986 (IN CO-OPERATION WITH NEA/OECD) BY V. PIKSAIKIN JANUARY 1988 (118 PAGES)	1573
INDC(NDS)-193/L	88		PROCEEDINGS OF THE IAEA RESEARCH COORDINATION MEETING ON METHODS FOR THE CALCULATIONS OF NEUTRON NUCLEAR DATA FOR STRUCTURAL MATERIALS IN CO-OPERATION WITH THE CENTRO DI CALCOLO DEL ENEA, BOLOGNA, ITALY, 7-10 OCTOBER 1986 BY V. GOULO JANUARY 1988 (165 PAGES)	1574
INDC(NDS)-194/L	SEP 87		THE CF-252 SPONTANEOUS FISSION NEUTRON SPECTRUM IN THE 5-20 MEV ENERGY RANGE BY H. MAERTEN, R. RICHTER, O. SEELIGER, TECHNISCHE UNIVERSITAET DRESDEN, GDR W.D. FROMM, ZENTRALINSTITUT FUER KERNFORSCHUNG, ROSSENDORF, GDR K. BOETTGER, H. KLEIN, PHYSIKALISCH-TECHNISCHE BUNDESANSTALT BRAUNSCHWEIG, FRG JANUARY 1987 (20 PAGES)	1575
INDC(NDS)-195/GZ	88		PROCEEDINGS OF THE IAEA CONSULTANTS' MEETING ON DATA REQUIREMENTS FOR MEDICAL RADIOISOTOPE PRODUCTION IN CO-OPERATION WITH THE INSTITUTE OF PHYSICAL AND CHEMICAL RESEARCH (RIKEN) TOKYO, JAPAN, 20-24 APRIL 1987 BY K. OKAMOTO JANUARY 1988 (199 PAGES)	1576
INDC(NDS)-197/LNA	SEP 87		REPORT OF THE NUCLEAR DATA SECTION TO THE INTERNATIONAL NUCLEAR DATA COMMITTEE MARCH 1986 - AUGUST 1987 BY A. LORENZ SEPTEMBER 1987 (31 PAGES)	1585
INDC(NDS)-198/LFR	NOV 87		ANALYSIS OF THE REAL-84 INTERCOMPARISON EXERCISE SUMMARY OF THE SPECIALISTS' MEETING ORGANIZED BY THE INTERNATIONAL ATOMIC ENERGY AGENCY AND HELD IN JACKSON HOLE, USA, 27-29 MAY 1987 BY V. GOULO OCTOBER 1987 (10 PAGES)	1593
INDC(NDS)-199/GA	JAN 88		IAEA SPECIALISTS' MEETING ON "ATOMIC AND MOLECULAR DATA FOR PLASMA EDGE STUDIES"- SUMMARY REPORT VIENNA, 8-10 JULY 1987 BY J.J. SMITH DECEMBER 1987 (33 PAGES)	1599
INDC(NDS)-200/G,MY	FEB 88		IAEA SPECIALISTS' MEETING ON THE INFLUENCE OF TARGET AND SAMPLE PROPERTIES ON NUCLEAR DATA MEASUREMENTS (IN CO-OPERATION WITH THE CENTRAL BUREAU OF NUCLEAR MEASUREMENTS (CBNM) AND THE INTERNATIONAL NUCLEAR TARGET DEVELOPMENT SOCIETY (INTDS) - SUMMARY REPORT BY K. OKAMOTO JANUARY 1988 (59 PAGES)	1614
INDC(NDS)-201/GF	FEB 88		IAEA SPECIALISTS' MEETING ON THE FUSION EVALUATED NUCLEAR DATA LIBRARY RELATED TO THE ITER ACTIVITY IAEA HEADQUARTERS, VIENNA, AUSTRIA, 16-18 NOV. '87 SUMMARY REPORT BY V. GOULO AND A. LORENZ JANUARY 1988 (15 PAGES)	1605
INDC(NDS)-202/GA	MAR 88		SEVENTH MEETING OF THE ATOMIC AND MOLECULAR DATA CENTRE NETWORK OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TENN. 9-11 NOVEMBER 1987 - SUMMARY REPORT BY J.J. SMITH FEBRUARY 1988 (54 PAGES)	1615
INDC(NDS)-203/GZ	MAY 88		NUCLEAR DATA NEEDED FOR NEUTRON THERAPY THE FIRST RESEARCH CO-ORDINATION MEETING ORGANIZED BY THE IAEA, VIENNA, 17-20 NOVEMBER 1987 BY K. OKAMOTO MARCH 1988 (16 PAGES)	1621
INDC(NDS)-204/G+SP	APR 88		REPORT ON THE 9TH IAEA CONSULTANT'S MEETING OF THE NUCLEAR REACTION DATA CENTRES; HOSTED BY THE US NATIONAL NUCLEAR DATA CENTER AT THE BROOKHAVEN NATIONAL LABORATORY, 27-29 OCTOBER, 1987; INCLUDING THE 20TH FOUR-CENTRES MEETING OF THE NEUTRON DATA CENTRES AND THE 10TH MEETING ON CHARGED PARTICLE NUCLEAR DATA COMPILATION (152 PAGES)	1633
INDC(NDS)-205/G+SP	JUN 88		MEASUREMENT AND ANALYSIS OF DOUBLE-DIFFERENTIAL NEUTRON EMISSION SPECTRA IN (P,N) AND (ALPHA,N) REACTIONS SUMMARY REPORT OF THE SECOND RESEARCH CO-ORDINATION MEETING ORGANIZED BY THE IAEA AND HELD IN VIENNA, 8-10 FEBRUARY 1988 BY K. OKAMOTO AND M.K. MEHTA MAY 1988 (13 PAGES)	1623

INDC DOCUMENT DESIGNATOR	DATE OF DISTRIB.	ORIGINAL DOCUMENT ID.	DOCUMENT TITLE, AUTHOR, OTHER IDENTIFICATION NUMBERS, ETC...	ACC.NO
INDC(NDS)-206/GE	OCT 88		CO-ORDINATION OF THE INTERNATIONAL NETWORK OF NUCLEAR STRUCTURE AND DECAY DATA EVALUATORS SUMARY REPORT OF A CONSULTANTS' MEETING ORGANIZED BY THE INTERNATIONAL ATOMIC ENERGY AGENCY AND HELD AT GHENT, BELGIUM, 16-20 MAY 1988 EDITED BY J. J. SCHMIDT OCTOBER 1988 (95 PAGES)	1643
INDC(NDS)-207/L	JUL 88		MEASUREMENT AND ANALYSIS OF 14 MEV NEUTRON-INDUCED DOUBLE-DIFFERENTIAL NEUTRON EMISSION CROSS SECTIONS NEEDED FOR FISSION AND FUSION REACTOR TECHNOLOGY. SUMMARY REPORT OF THE FIRST RCM, IAEA, VIENNA 20-22 APRIL 1988. PREPARED BY WANG DAHAI, M.K. MEHTA (15 PAGES)	1636
INDC(NDS)-208/G+P	SEP 88		FISSION YIELD EVALUATION - SUMMARY REPORT OF A SPECIALISTS' MEETING DRGANIZED BY THE IAEA, HELD AT STUDSVIK, SWEDEN, 11,14 AND 15 SEPTEMBER, 1987. PREPARED BY M.LAMMER, NDS, IAEA. SEPTEMBER 1988 (17 PAGES)	1640
INDC(NDS)-209/GZ	OCT 88		STATUS ON THE COMPILATION OF NUCLEAR DATA FOR MEDICAL RADIOISOTOPES PRODUCED BY ACCELERATORS O. GONDARIAS-CRUZ AND K. OKAMOTO OCTOBER 1988 (123 PAGES)	1645
INDC(NDS)-210/GA	SEP 88		INDC INTERNATIONAL NUCLER DATA COMITTEE IAEA SPECIALISTS' MEETING ON "CARBON AND OXYGEN COLLISION DATA FOR FUSION PLASMA RESEARCH" VIENNA, 12-13 MAY 1988 PREPARED BY R.K. JANEV SUMMARY REPORT (22 PAGES)	1646
INDC(NDS)-211/GA	SEP 88		IAEA CONSULTANTS' MEETING ON "ATOMIC DATA BASE AND FUSION APPLICATIONS INTERFACE" VIENNA, 9-13 MAY 1988 SUMMARY REPORT PREPARED BY R.K. JANEV SEPTEMBER 1988 (60 PAGES)	1647
INDC(NDS)-213/G+M3	OCT 88		THE INFLUENCE OF TARGET AND SAMPLE PROPERTIES ON NUCLEAR DATA MEASUREMENTS IAEA ADVISORY GROUP MEETING IN CO-OPERATION WITH THE INTERNATIONAL NUCLEAR TARGET DEVELOPMENT SOCIETY (INTDS), DARMSTADT, FEDERAL REPUBLIC OF GERMANY, 5-9 SEPTEMBER, 1988 EDITED BY K. OKAMOTO OCTOBER 1988 (74 PAGES)	1644
INDC(NDS)-214/LJ	JAN 89		STATUS REVIEW OF METHODS FOR THE CALCULATION OF FAST NEUTRON NUCLEAR DATA FOR STRUCTURAL MATERIALS OF FAST AND FUSION REACTORS TEXTS OF INVITED PAPERS PRESENTED DURING THE SECOND RESEARCH CO-OPOINATION MEETING, VIENNA, 15-17 FEBRUARY 1988 COMPILED BY V. GOULO JANUARY 1989 (125 PAGES).	1662

INDC DOCUMENT DESIGNATOR	DATE OF DISTRIB.	ORIGINAL DOCUMENT ID.	DOCUMENT TITLE, AUTHOR, OTHER IDENTIFICATION NUMBERS, ETC...	ACC.NO
INDC(SEC)-093/UN	SEP 87		INDC CORRESPONDENTS FOR THE EXCHANGE OF NUCLEAR DATA INFORMATION AND MEMBERS OF NATIONAL NUCLEAR DATA COMMITTEES (SUPERSEDES INDC(SEC)--091/UN) SEPTEMBER 1987	1581
INDC(SEC)-094/UN	SEP 87		LIST OF DOCUMENTS RECEIVED BY THE INDC SECRETARIAT (SUPERSEDES INDC(SEC)-092) SEPTEMBER 1987	1582
INDC(SEC)-095/URSF	AUG 88		WRENDA 87/88 - WORLD REQUEST LIST FOR NUCLEAR DATA WANG DAHAI, IAEA, EDITOR (PUBLISHED ON BEHALF OF NNDC, BROOKHAVEN, USA; NEA DATA BANK, SACLAY, FRANCE; NUCLEAR DATA SECTION, VIENNA, AUSTRIA; NUCLEAR DATA CENTER, OBNINSK, USSR.) AUGUST 1988; (APPROX. 115 PAGES)	1639
INDC(SEC)-096/SK	OCT 88		FIFTH MEETING OF THE IFRC SUBCOMMITTEE ON ATOMIC AND MOLECULAR DATA FOR FUSION IAEA HEADQUARTERS, VIENNA 7-8 OCTOBER 1988 SUMMARY REPORT EDITED BY R.K. JANEV(27 PAGES).	1673

IAEA-NDS-Documents

Each magnetic tape file sent out to requestors is accompanied by an "IAEA-NDS" document summarizing contents and format of the magnetic tape file. During the reporting period, IAEA-NDS-documents were issued for the following tape files.

Document	Titel and Author resp. Editor
IAEA-NDS-0 Rev. 88/6	Index to the IAEA-NDS Documentation Series H.D. Lemmel
IAEA-NDS-7 Rev. 88/6	Index of Nuclear Data Libraries available from the IAEA Nuclear Data Section H.D. Lemmel
IAEA-NDS-39 Rev. 3	Summary of ENDF/B Pre-Processing Codes D.E. Cullen (Rev.1, available as INIS microfiche) See IAEA-NDS-69 for implementation on a Personal Computer
IAEA-NDS-51 Rev. 1	JENDL-2 fission-product nuclear data libraries: 1. neutron cross-sections, 2. decay data, 3. fission yield data. Contents and Documentation H.D. Lemmel
IAEA-NDS-58 Rev. 1	RSIC Photon Interaction Library of 1983 H.D. Lemmel Rev. 0 referred to the LLL Photon Cross-Section Library (ENDF/B-4), which is superseded
IAEA-NDS-69	ENDF/B Pre-processing Codes: Implementing and Testing on a Personal Computer P.K. McLaughlin (Compare also IAEA-NDS-39)
IAEA-NDS-76	ENDF-6 Formats Manual. Preliminary and still incomplete. US National Nuclear Data Center.
IAEA-NDS-78	Codes CONV45 and CONV56 for a PC. V. Goulo (Converting ENDF-4 to ENDF-5 and ENDF-5 to ENDF-6)
IAEA-NDS-79 Rev. 1	Program PLOTC4. Plots evaluated nuclear data from ENDF format and/or experimental data in a computation format. D.E. Cullen, Sept. 1986, Rev. 1 June 1987

Document	Titel and Author resp. Editor
IAEA-NDS-81	Computation format computer codes X4TOC4 and PLOTC4: Implementing and testing on a Personal Computer. P.K. McLaughlin, May 1987
IAEA-NDS-82	Program PLOTTAB. General plotting program. D.E. Cullen
IAEA-NDS-83	Implementing and testing program PLOTTAB. D.E. Cullen
IAEA-NDS-84	LINTAB, HEATER and PLOTTAB code package Computer codes for model parameters and cross-section data. D.E. Cullen, J.J. Smith
IAEA-NDS-85	Implementing and testing the LINTAB, HEATER and PLOTTAB code package. D.E. Cullen, J.J. Smith
IAEA-NDS-86	GRAZ-87. A data library for evaluated cross-sections and reaction rates of charged particle reactions with light elements. Z=1 to 5, by R. Feldbacher, Technical University of Graz, Austria. K. Okamoto (ed.)
IAEA-NDS-87	DROSG-87. Charged-particle induced neutron source reactions data, for angular dependences of neutron energies and cross-sections, data evaluated by M. Drosg. O. Schwerer (ed.)
IAEA-NDS-88	ENDF/B-6 Standards Library. Summary of contents and documentation. H.D. Lemmel, P.K. McLaughlin
IAEA-NDS-89	XCOM: Photon cross-sections on a PC, version 1.2 of 87/5/9, by M.J. Berger and J.H. Hubbell. (H.D. Lemmel ed.)
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IAEA-NDS-95	EMPIRE, pre-equilibrium/compound nuclear model code, version for PC. V. Goulo
IAEA-NDS-98	Cf-252 neutron spectrum. The californium-252 spontaneous fission neutron spectrum evaluated by W. Mannhart, PTB Braunschweig. (H.D. Lemmel, ed.)
IAEA-NDS-99	STAPRE, statistical pre-equilibrium code, and SCAT2, optical nuclear model code, version for PC. V. Goulo
IAEA-NDS-103 Rev. 88-1	EXFOR Manual V. McLane, NNDC
IAEA-NDS-109 Rev. 88.10	CINDA Manual I. Forest, NEA Data Bank
IAEA-NDS-112	Decay data for detector efficiency calibration; documentation of the GAMDEC dBase-3 database. A. Lorenz

Appendix D

NATIONAL TECHNICAL CO-OPERATION (TC) PROJECTS

CAMEROON

Training in Nuclear Physics (CMR/1/003)

Under this multi-year project initiated in 1987, the Agency is assisting the Department of Physics of the University of Yaounde in establishing a nuclear physics laboratory for student experiments and demonstrations with the aim of introducing academic courses in nuclear physics leading to an advanced degree. As nuclear physics is a new subject in the curriculum, there is a need for further Agency assistance in connection with the setting up of experiments, the organization of the laboratory and the supervision of course work. The Department of Physics has basic equipment for measurement of low-level activities, an electronics laboratory, an adequate budget and staff.

For 1989, the Agency has been requested to provide minor items of equipment and electronic components as well as further expert services in the use of equipment for demonstrations and experiments. Additional fellowship training is foreseen.

It is expected that the project will lead to the establishment of nuclear physics as a course of study in the university curriculum and to a strengthening of the Department's capability for providing related instruction.

COTE D'IVOIRE (IVC/0/003)

Nuclear Science Laboratory

Since 1982, the Agency has been supporting the establishment of a nuclear science laboratory at the Research Institute for New Energies, University of Abidjan, with the objective of introducing nuclear physics into the University's syllabus and of developing an analytical capability for use in support of the mining industry, research programmes and other users. The recipient institute has an established nuclear analytical laboratory, adequately staffed and equipped with an X-ray fluorescence and spectroscopy systems. There is, however, a need to upgrade certain nuclear analytical techniques.

For 1989, the Agency has been requested to provide some equipment, including a redistilled water generator and spare parts, and expert services in X-ray fluorescence analysis. Fellowship training is also foreseen.

It is expected that this additional assistance will strengthen the analytical capability of this laboratory with a view to meeting local demand and will improve the scientific expertise of the staff.

KENYA (KEN/0/003)

Nuclear Science Laboratory

A Centre for Nuclear Science Techniques has been established at the Faculty of Engineering of the University of Nairobi for training graduates in nuclear sciences and for carrying out analyses of various materials for outside customers. With assistance from the Agency since 1979, the Centre now has the capability to determine trace elements and light elements in biological, geological and environmental materials by means of tube-excited X-ray fluorescence analysis (XRF). It plans to expand this capability to allow samples from outside customers to be analysed routinely. Appropriate staff have been assigned to the work and the Government has funded the conversion of a building to house the X-ray equipment.

In 1989, the Agency has been requested to provide a computer system and expertise in computerized data processing. Assistance is also to be given in preparing a long-term programme for applications of XRF. Provision of some electronic components and spares for the equipment are foreseen. Fellowship training in advanced XRF and in instrumentation is planned.

The project is expected to develop skilled manpower in the nuclear sciences and to promote the application of advanced analytical techniques in Kenya.

MADAGASCAR (MAG/1/005)

Applied Nuclear Physics

Many national organisations in Madagascar are interested in the analysis of geological samples and the analysis of mineral elements in biological samples. At present these analyses are carried out abroad. The Laboratory for Nuclear and Applied Physics at the University of Madagascar has been working with the X-ray fluorescence technique for several years and could, with assistance from the Agency, carry out locally the analytical measurements now being sent out, thereby developing the national economy. The X-ray Spectroscopy Department is well staffed and has two rooms for sample preparation and measurements set aside in the new premises of the Laboratory which also runs a small electronics workshop.

The Agency has been requested to assist the X-ray Spectroscopy Department of the Laboratory to become a national analysis and control centre for geological, biological and aerosol samples. For 1989, it is planned to improve the tube-excited X-ray analysis system to permit a large number of samples to be analysed routinely, and to install a total reflection X-ray spectrometer. In 1990, it is hoped to introduce analysis of trace elements. Appropriate equipment and expert services have been requested. Fellowships in total reflection analysis and computerized evaluation of data are foreseen.

The project will develop the X-ray Spectroscopy Department of the Laboratory for Applied and Nuclear Physics into a national control laboratory suitably equipped and staffed for analysing geological, biological and aerosol samples.

NIGERIA (NIR/0/003)

Nuclear Science Laboratories

The Centre for Energy Research and Training was recently established within Ahmadou Bello University, Zaria, as a specialized centre in nuclear science. At its inception, the Agency was requested to provide assistance to strengthen the national effort in developing the activities of the Centre. Assistance has been provided under this multi-year project for the repair, installation and operation of the neutron generator which was already available. An expert was provided to develop a programme for neutron activation analysis, while training for national staff is being provided under the Agency's regional fellowship programme.

The assistance requested for 1989 is along the lines envisaged in the plan of work for the implementation of the project and aims at introducing additional nuclear analytical techniques. Provision of X-ray fluorescence equipment together with expert services concerned with sample preparation and data interpretation are foreseen.

It is expected that the project will strengthen the capability of the Centre to provide training to support research and to promote nuclear applications and the use of appropriate analytical techniques in Nigeria.

Nuclear Physics (NIR/1/003)

The Department of Physics, Obafemi Awolowo University, received Agency assistance under previous programmes which provided a data acquisition system, expert services and training of staff by fellowships in support of its teaching and research activities. The Department acquired from its resources a neutron generator. A laboratory building to house this and related facilities has recently been completed.

The Agency has been requested for 1989-90 to continue assistance by providing expert services to assess the technical status of the available equipment and to assist in repair and maintenance work and in the training of counterparts in the development of computer-based data acquisition systems. Additional support for which assistance is also being requested under this project is related to the installation of the neutron generator and its utilization for elemental neutron activation analysis in materials of local interest as well as for applied neutron physics research.

The project will contribute significantly to manpower training in neutron physics and to provision of elemental analyses to meet national needs.

SUDAN (SUD/0/006)

Nuclear Science Laboratory

A Nuclear Science Laboratory has been established with Agency assistance at the University of Khartoum. The laboratory is a multi-disciplinary facility for post-graduate teaching, research and applications and is used by the University as well as by Government institutions, including the Atomic

Energy Commission. The Agency provided under a previous project several significant items of nuclear analytical equipment, such as a neutron generator, X-ray fluorescence equipment, Moessbauer spectroscopy system, and an atomic absorption spectrometer. Several Agency experts visited to provide training for local staff, this being supplemented by Agency fellowship training. The main activities being currently undertaken include the utilization of the neutron generator for nuclear data measurements and neutron activation analysis.

The Agency has been requested to provide, in 1989 and 1990, further assistance for the purpose of consolidation and further development of the analytical techniques already in use. The equipment provision will be used for the purchase of spare parts and maintenance for the various items of equipment since, owing to a lack of foreign exchange, the country is not in a postion to provide essential spares from its own resources. Short-term expert services have also been requested to support, inter alia, measurements of Moessbauer spectroscopy and sample preparation. It is expected that this assistance will consolidate the activities of the Nuclear Science Laboratory and improve the utilization of the facilities provided.

ZAMBIA (ZAM/0/005)

Nuclear Analytical Laboratory

The Radioisotopes Research Unit of the National Council for Scientific Research has established, with assistance from the Agency, a national nuclear analytical laboratory. Several analytical techniques, such as flame atomic-absorption spectrophotometry, X-ray fluorescence spectroscopy, fast neutron activation analysis, gamma spectrometry and Moessbauer spectrometry have been introduced. The Council wishes to develop the full potential of these analytical techniques both for educational purposes and for industrial applications. A new laboratory complex was inaugurated in 1988 to receive, inter alia, the neutron generator and most of the equipment provided by the Agency. Six nuclear scientists with advanced degrees and two with first degrees are employed in the Radioisotopes Research Unit as well as two technical officers. To fully utilize the equipment, more scientists are required, and it is hoped that the shortage of manpower can be overcome by involving more university graduates in the research and development programme.

For 1989, the Agency has been requested to provide short-term expert services in X-ray fluorescence and in Moessbauer spectroscopy, as well as accessories to upgrade the equipment. Similarly in 1990, short-term expert services are foreseen in neutron physics and fast neutron activation analysis, together with certain accessories and spares for the equipment. It is expected that the project will be reviewed towards the end of 1990. Fellowship training has been planned for 1989-90 in low-level measurements and fast neutron activation analysis.

The project is seen as strengthening the local infrastructure for the application of nuclear techniques in education, research and development.