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INDC - 15/U

International Atomic Energy Agency

INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

TECHNICAL MINUTES

OF THE SIXTH INDC MEETING

Vienna, 8-12 October 1973

Compiled by

R. Joly (CEN Saclay, France)
(Executive Secretary)

Aided by

C.L. Dunford (IAEA)
(Local Secretary)

J.J. Schmidt (IAEA)
(Scientific Secretary)

and

A. Lorenz (IAEA)
(INDC Secretariat)

October 1974

IAEA NUCLEAR DATA SECTION, KÄRNTNER RING 11, A-1010 VIENNA

MEMORANDUM

To: INDC U-Distribution — 8 January 1975

From: INDC Secretariat

Subject: INDC-15/U Corrections

Please make the following corrections in the "Technical Minutes of the Sixth INDC Meeting", INDC-15/U, dated October 1974.

1. Page 5, line 8

   Replace ... Institute of High Energy Nuclear Physics,...

   by ... Saha Institute of Nuclear Physics,...

2. Page 32, line 18

   Replace ... 1052 ± 31 mb ...

   by ... 1052 ± 7 mb....

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Introduction

The International Nuclear Data Committee (INDC) at its Fifth Meeting in Vienna in July 1972 decided to issue henceforth a "Technical Minutes" of each of its meetings for distribution to scientists interested in the production, evaluation and use of nuclear data. These minutes contain information of a technical nature which was presented and discussed at the INDC meeting. The numbering of items in the table of contents is in accord with the item numbers on the INDC agenda.

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LIST OF APPENDICES

LIST OF PARTICIPANTS

1. INDC members

L. N. Usachev, Obninsk, USSR (Chairman)

R. Joly, Saclay, France (Executive secretary)

J. J. Schmidt, NDS, IAEA (Scientific secretary)

V. Benzi, Bologna, Italy

S. Cierjacks, Karlsruhe, Germany

H. Condé, Stockholm, Sweden

W. G. Cross, Chalk River, Canada

A. S. Divatia, Trombay, India

W. Gemmell, Lucas Heights, Australia

K. Nishimura, Tokai Mura, Japan

G. Ricabarra, Buenos Aires, Argentina

G. L. Rogosa, Washington, USA

B. Rose, Harwell, UK

I. Slaus, Zagreb, Yugoslavia

2. Scientific advisers

B. Grinberg, Saclay, France

A. Michaudon, Bruyères le Chatel, France

H. T. Motz, Los Alamos, USA

J. L. Rowlands, Winfrith, UK

A. B. Smith, Argonne, USA

S. I. Sukhoruchkin, Moscow, USSR

T. Wiedling, Studsvik, Sweden

G. B. Yankov, Moscow, USSR

3. Observers

D. Berenyi, Debrecen, Hungary

C. Dunford, (NDS/IAEA) Local Secretary

F. Fröhner, Saclay, France (NEA/OECD)

H. Liskien, Geel, Belgium (Euratom)

S. N. Rapeanu, Bucharest, Romania

J. Rosen, Paris, France (NEA/OECD)

I. INTRODUCTORY ITEMS

. Prof. Glubrecht, Head of the Department of Research and Isotopes and specialist in radiation botanic and biophysics at the University of Hannover welcomed the participants to the Sixth INDC meeting on behalf of the Director General. Prof. Glubrecht outlined the importance of " Nuclear Data " which, on one hand, represent the basic laws of nature and, on the other hand, constitute a necessary tool in many scientific and applied researches. In the past, following the guidelines given by the INDC, the efforts were almost uniquely directed towards neutron data, in view of their interest for fission reactors, and an efficient international cooperation in this field has been established: the compilation and the dissemination of these data on a world-wide scale is a very useful and successful achievement. It appears, however, that the scope has now to be widened to a greater variety of applications, for example nuclear data used in safeguards, in controlled fusion research, in nuclear medicine, in nuclear methods for agriculture and general biology, in industrial equipments etc.... This necessity simply arises from the fact that in these specialities, many scientists who have to make use of nuclear data are not in a position to know which are the most reliable data available or, at least, in which margins these data have to be used. The "Symposium on Applications of Nuclear Data in Science and Technology", organized by the IAEA Nuclear Data Section (NDS) at Paris in March 1973, clearly demonstrated not only a continuing need for neutron data but also an increasingly important need in fields such as nuclear structure, decay scheme and reaction data. This Symposium as well as the recommendations of the IWGNSRD, can be considered as the first step in the development of a carefully conceived extension of the IAEA programme in a broadened nuclear data domain and its manyfold applications.

Speaking on behalf of the Director General of the IAEA Prof. Glubrecht solicited advice from the INDC regarding the form to be given to the implementation of this extended programme and, in particular, to the policy to be followed. This advice will help the Director General to decide on:

- The tasks and membership of the INDC for its new three years term, beginning in January 1974.
- The definition of the precise programmes of the NDS in the forthcoming years. Without pre-empting any decision the INDC may take during its meeting, Prof. Glubrecht expressed his own view on possible future actions, namely :
  - assessment of realistic requirements for nuclear data in the numerous applied fields outside the domain of fission reactors; an encouraging start has already been made with the establishment of the request lists for nuclear data for safeguards and controlled fusion research.

- examination by the INDC of the potentialities for nuclear data measurements and their coordination, particularly in developing countries

- organization of specialists' meetings on well defined important subjects such as the " Fission Product Nuclear Data " panel convened in Bologna (November 1973) by the N D S. The results of these specialists' meetings will benefit to the member states by the direct contacts established between their specialists and by the possible actions which could be undertaken by the IAEA following the recommendations of the meetings.

II. COMMITTEE BUSINESS

II. E. Organization and aims of National Nuclear Data Committees

Yugoslavia

Yugoslavia has no Nuclear Data Committee. As a member of INDC, Prof. Slaus has however the task of coordinating the tasks of the three Institutes which are the producers and the primary users of nuclear data, namely the Institutes of Belgrade, Ljubljana and Zagreb; he also thinks that, in the future, this coordination could be strengthened by the institution of a National Committee.

U. S. A.

Changes have taken place within the USNDC : they are described in the document INDC (USA)-59 G (see in particular Appendix C). The extension of the role and of the tasks of the USNDC is also presented in the paper SM-170/4 of the " Symposium on nuclear data in science and technology " (Paris - March 73). However, Rogosa outlined that, since the

Committee was formally established on its new basis, only one meeting was held and that it will probably take some time to evaluate the success and the interest of the extension of the tasks to the many different areas which are now under the scope of the USNDC. He specified that, at this first meeting, about 80% of the discussions were still related to neutron data for fission reactors and that nuclear data needs for fusion studies and for safeguards took a large part of the remaining time : in fact, needs for nuclear data, outside the domain of fission reactors, have been identified but, up to now, there was not yet much progress towards discussing in detail and satisfying these needs. The tasks of the USNDC could still evolve in the future and itscomposition would be changed accordingly.

U.K.

Rose explained that, in the UK, it was also decided to change the role of the Nuclear Data Committee. The foreseen new organization will be very flexible : it will include a " major committee ", responsible for the national coordination and the international connections, and some Sub-committees responsible for specific subjects : fission reactors, biological and medical applications, controlled fusion, etc... However the ideas are to proceed slowly, to take advantage of the already existing instances (for example in the biological and medical fields) by establishing appropriate links with them, and to avoid the difficulties which could result in trying to cover too many subjects at once. It is hoped that the UKNDC, in its new structure will be able to meet within six months.

USSR

The Nuclear Data Committee of the USSR is called the "Commission on Nuclear Data ". This Commission which is composed of leading specialists of the various Institutes and chaired by Prof. Kusnetsov was organized in 1969 to coordinate the activities in the nuclear data field : compilation and screening of requests, coordination of measurements, collection and dissemination of measured and evaluated data and also promotion of international cooperation; the working body of the Commission is the " Nuclear Data Centre " in Obninsk. The Commission meets several times a year and its recommendations are taken into account when planning work on nuclear data. Untill recently, the Commission had two " Coordination Working Groups " dealing with the two following problems :

- nuclear data for reactors and shieldings.
- measurements and evaluation of nuclear data.

Recently, a third group, chaired by Prof. Zelenkov, has been organized for coordinating the work in the field of non-neutron nuclear data; its working body is the " Centre for Non-Neutron Nuclear Data " at the Kurchatov Institute. The first task for the near future is to explore the needs for non-neutron nuclear data.

At the present time, the "Coordination working group for measurements and evaluation "has shared the tasks into 8 subgroups covering distinct topics in their various aspects (analysis of the nuclear data needs; analysis of the status of the requested nuclear data; examination of the different ways to fulfil the requests; transfer of data into the Nuclear Data Centre).

At the request of different participants, Usachev said that he will be able to issue and distribute a document giving more details on the activities and the composition of the Commission and its Coordination Working Groups .

SWEDEN

As a result on an investigation of the needs of nuclear data, Condé announced the formation of a Swedish Nuclear Data Committee which held its first meeting in December 1972. It consists at present of 10 members representing, on one hand, users of nuclear data within the reactor, shielding, fusion, medical and biological fields and, on the other hand, producers of data from national institutions and universities. The Committee meets twice a year and fulfills a task of information, coordination and consultation; it will publish annually a progress report on nuclear data activities and compile request lists of nuclear data needs in the different fields covered; in particular, it will issue the Swedish contribution to WRENDA.

JAPAN

The Japanese Nuclear Data Committee has been established almost 10 years ago with the task to coordinate the nuclear data activities in Japan and to facilitate the exchange of scientific information between measurers, evaluators and users. The JNDC is headed by Prof. Momota; it is composed of about 30 scientists and divided into 3 Sub-committees according to the following subjects:

- Neutron nuclear data (about 30 nuclear physicists)
- Reactor group constants (about 20 physicists, most of them are reactor physicists)
- Safeguards techniques (14 physicists, most of them are nuclear structure specialists).

The " Safeguards Subcommittee " has been recently organized and its first task is to screen the request list for safeguards.

It is envisaged to establish a fourth Subcommittee to deal with nuclear data for controlled fusion.

ITALY

There is no nuclear data committee in Italy and no plan to establish an activity of this kind in the near future. Contacts in the nuclear data field are maintained by the CNEN laboratory at Bologna on an informal basis.

INDIA

The nuclear data problems are treated by a Group formed almost ten years ago and composed of members from the Bhabha Atomic Research Centre, the Institute of High Energy Nuclear Physics, the Tata Institute for Fundamental Research and the University of Bombay. The task of this Group is essentially to coordinate the activities and to compile the works in the form of printed reports which contain information not only on neutron nuclear data but also on charged particle data. Since about two years the Group has noticed the increasing interest for non-neutron nuclear data and has tried to stimulate the formulation of the nuclear data needs in different disciplines, (biology, biophysics, health physics, etc...) by organizing seminars where specialists of these disciplines were invited. This diversification has not yet affected the composition of the Group but some re-organization may take place within the next six months to cover a broader field; the activities will, however, remain the same, namely coordination and evaluation.

HUNGARY

There is no special committee for nuclear data purposes. There exist, however, nuclear physics Committees at the Hungarian Academy of Sciences and at the Hungarian Atomic Energy Commission and also a Committee for radioisotopes applications : they have a role of coordination for nuclear data in their respective fields.

FRANCE

A French Nuclear Data Committee has been created in 1968; it is composed of representatives of the French Atomic Energy Commission laboratories, concerned with the use or with the production of neutron nuclear data (measurements; calculations; evaluations). The Committee meets 2 or 3 times a year and the number of participants varies between 25 and 30; its programme concerns the establishment and the screening of request lists, the examination of proposals for new equipments or improvments of existing equipments, the exchange of information on subjects relevant to nuclear data (experiments for microscopic and integral data; evaluations; model calculations; samples; etc...). Connections have been established with other data users, in the following fields :

- fusion : a request list has been forwarded to the N D S

- biological and medical applications; it is hoped that a request list will be ready by the end of 1973 : at first sight, it seems that the needs concern mainly decay schemes.

FEDERAL REPUBLIC OF GERMANY

In the Federal Republic of Germany, there exists no formal nuclear data Committee; however, Committees exist for the following projects : fast reactor , safeguards, controlled fusion; the membership of these Committees includes users, evaluators and measurers. Recently, discussions have taken place between people concerned in various applied programmes on the need for a National Nuclear Data Committee : these discussions are in progress and a proposal will probably be made to the German authorities to establish such a Committee.

Liskien mentioned the existence, inside the E. E. C, of a " Joint European Nuclear Data and Reactor Physics Committee " (JENDRPC) which, since the beginning of the EANDC and EACRP, has a task of information and of coordination of the activities for the members states of the Community. In the past, this Committee has been very useful in giving an opportunity for measurers, evaluators and reactor physicists to meet and to discuss problems of common interest. The consequences, for the JENDRPC,of the extension of the Community will be discussed in a meeting to be held in November 73.

CANADA

In the past, the nuclear data activities have dealt exclusively with data for fission reactors and, like the activities in this field, are concentrated within the " Chalk River Atomic Energy Project "; the Canadian Committee is a " Chalk River Committee ", rather than a " National Committee ". The extension to a National Committee is now under consideration, with the inclusion of biomedical problems, industrial applications and, perhaps, fusion, depending on a decision which will be taken in the next few months on whether Canada will pursue a fusion research programme; safeguards will probably be excluded because, in this field, the present programme does not include techniques of interrrogation. Before setting up a National Committee - which will hopefully be done within the next year - the Canadian authorities will however wait and see which areas the INDC will support in the non-neutron nuclear data field.

AUSTRALIA

The situation is very similar to the Canadian one, namely: there exists no formal Nuclear Data Committee; problems of data for fission reactors are treated inside the framework of the Australian Atomic Energy Commission, discussions are in progress for an extension of the scope to applications, for instance, in the medical and industrial fields. Gemmell insisted on the fact that the nuclear data field is large and so diffuse that a country, which has limited activity in this field, can efficiently contribute only within the confines of an organization like the INDC.

ROMANIA

Nuclear data activity in Romania is going on at:

- the Institute of Atomic Physics where a national library for evaluated neutron data of 16 elements is being established;
- the Institute for Nuclear Technology where group constants are being prepared.

At the Institute for Atomic Physics, it is intended to establish compilation and evaluation activities for non-neutron nuclear data in the fields where the Institute has experimental activities.

ARGENTINA

There exists no national nuclear data committee; however coordination has been established between the groups working inside or outside the Atomic Energy Commission in the following fields: nuclear spectroscopy, reactor physics, neutron physics, activation analysis, burn-up physics.

In response to the general interest to promote the exchange of information concerning the activities of national nuclear data committees, the INDC approved a proposal from Schmidt to compile a list of these committees. It is agreed that each member will send to the NDS a list of the nuclear data committee(s) existing in his own country with information on the covered scope and the membership (action 2); it is intended to cover all nuclear data committees: for example, in the USA, information will be given by Rogosa not only on the USNDC and its Subcommittees but also on the "Cross section evaluation working group", on the "Advisory Committee on reactor physics", etc... Some countries (USA, India, etc...) can provide the required information almost immediately; for some others, where the situation is not completely settled (UK, USSR, etc...) some delay is inevitable: for this reason, the information has to be sent to the NDS "as soon as feasible" (with a copy to all the INDC members). After compilation of all of the information, the NDS will issue it as an INDC document, with an L distribution. (action 3)

II. F. 1. Report on the highlights of the IAEA Symposium on Applications of Nuclear Data in Science and Technology

Schmidt referred for detailed information to the document INDC (NDS)-52/L and to the presentation by Dr. W. Lewis in the summary session (see also INDC (NDS)-53/L page 7) and restricted his remarks to a few highlights:

- the participation included specialists (users, measurers, compilers, evaluators) from practically all fields in which nuclear data are applied; can be imagined.
- the attendance at the various sessions was very high for a Symposium covering an extremely diversified field, which is an encouraging sign of interest for the whole area of nuclear data problems for applications;
- the role of the IWGNSRD was essential for the scientific preparation of the Symposium and, particularly, for the designation of highly competent specialists for reviewing the data needs in other fields than reactors.

Concerning the scientific aspects of the Symposium, Schmidt emphasized the following two points:

- There was a clearly expressed need for a hand-book covering neutron and non-neutron nuclear data used for activation analysis. The NDS decided to respond to this need by the publication of such a hand-book in 1974 (Appendix IX); it will cover neutron cross sections, resonance integrals, fission spectrum averaged cross sections, excitation functions for nuclear reactions induced by neutrons, charged particles and gammas; the contributions will come essentially from the USA, Sweden and the FRG; depending upon the response it may be envisaged to publish a more comprehensive version 2 or 3 years later.

- A distinction has to be made between " basic nuclear data " (such as level schemes, nuclear structure data, etc...) and " repackaged nuclear data " representing the translation of the " basic nuclear data " in a form which is directly usable in the applications. With this distinction, it appears from the Symposium that the initial emphasis would have to be made on " basic nuclear data " because there is a backlog - which can be estimated to nearly 5 years - in the compilation and the evaluation of these data.

Yankov considered that the Organizing Committee of the Symposium achieved a great success in establishing a good balance between reactor and non-reactor applications on one hand and between the reports on requests for the various applications and the reports on compilation and evaluation on the other hand. He added that a detailed review of the Symposium has already been published in Atomnaia Energia (August 73) and that all the data published at the Symposium have been entered in the appropriate USSR Data Centre (the Obninsk Centre for neutron data and the two Non-Neutron Nuclear Data Centres set up recently.

Grinberg outlined that many nuclear data users are very interested to have at their disposal tabulations of data which are easy to consult but are not fully aware of the importance for these tabulations to contain evaluated data. He thinks that this problem will become evident to the users in the forthcoming years and that one of the roles of the INDC should be to draw their attention on their real needs and to prepare for their future satisfaction.

III . Short additions to progress reports which were submitted prior to meeting

III. A . Addition from members on nuclear (including neutrons) experimental data activities and facilities .

YUGOSLAVIA

Slaus referred to the Yugoslavian progress report which is included in the document INDC(SEC)-35/L and mentioned that it still continues to be primarily directed towards the study of nuclear forces, of few nucleons systems, and the measurement of neutron data at 14 MeV.

Answering a question on the neutron-neutron scattering length, he said that the latest measurements are in agreement with the " best value " recommended by Wilkinson et al. at the Los Angeles Conference, namely 16. 6 fermis (with an error of about 1 fermi); the most important problem would be the determination of the effective range for which no experimental data exist at present.

U. S. A.

An extensive discussion on the facilities, the results and the programmes of a number of US laboratories is given in the report of the meeting of the USNDC held at Oak Ridge in June 73 (document INDC-(USA)-56/U). Further information is included in the Technical Minutes of the USNDC (document INDC-(USA)-59/G). Only some significant highlights on these works were reported by Smith and by Motz.

- Aerojet Nuclear Company (Idaho) : measurements of the resonance integral of 17 fission product isotopes.

- A. N. L. : studies using fast neutrons in medical applications, including development of intense fast neutron sources (therapy) and of neutron radiography technics (diagnosis).

-Extensive studies on standard cross sections : ^{6}Li (n, α) from 90 to 1500 KeV; fast fission cross section of ^{235}U for which results are given from 35 KeV to 3500 KeV; capture cross section of ^{3}He.

- B. N. L. : continued effort in resonance statistics studies in particular to check the valence model near A = 98.

- Columbia : some difficulties in completing the Nevis synchrocyclotron in its improved version; obliged to postpone the report to September 74, at the earliest, on the first neutron run for which an improvement of the neutron source by a factor of at least 10 is expected. Measurements of σ_T, σ_F and σ_c are contemplated.
- Accurate determination of the (n,p) capture cross section at 2200 m/s giving 332.6 ± 0.7 mb.

- Intelcom Radiation Technology (San Diego) : improvement of the previously measured B^{10} (n, α) cross section (cf. Budapest Conference).

- Preparations for precision measurements of the ^{6}Li (n, α) cross section from 1 to 1700 KeV.

- Continuing activities in photofission studies which are a part of the safeguards programme.

- Livermore : continuation of the programme for measuring σ_F (^{235}U) from 2 to 20 MeV, relative to the (n, p) scattering cross section.

- Development of intense sources of fast neutrons (8 to 14 MeV) for applications.

- N. B. S. : extensive programme on standards owing to the fact that the N. B. S has at its disposal both a white neutron source (Linac) and monoenergetic neutron sources.
- Measurements on ^{252}Cf: age of spontaneous fission neutrons which has given an average fission neutrons energy of 2. 15 MeV in agreement with the " group " of low energy values ; accurate measurement of the decay life time.

- R. P. I. : measurements of $\bar{\nu}$ for ^{233}U, ^{235}U, ^{239}Pu in the resolved resonances region.
- Study of the subthreshold fission of ^{238}U.

- Los Alamos : results not included in the US progress report are given in appendix II. They concern :

- a tabulation of the ^{235}U fission cross section (1 to 6 MeV)
- the spin assignements to a number of ^{235}U resonances determined at ORELA in cooperation with R.P.I. by using a technique of transmission of polarized neutrons through a polarized target; the disagreement with indirect methods is very important, except with one of them (Corvi's method based on population of low excited states).
- the capture cross section of ^{7}Li for thermal neutrons measured on a facility having an unusually low background; the

value obtained (45.4 ± 3 mb) differs from the recommended (37 ± 4 mb) BNL-325 value which is largely based upon an old measurement of D. J. Hughes and which can be considered as wrong. For these high accuracy measurements, one must be very careful with the impurities contained in the samples; unexpectedly, the Li sample contained non-negligible amounts of B and Hg which were controlled by neutron capture γ -ray measurements.

UNITED KINGDOM

The UK Progress Report (INDC (UK) 20/L) covers the period April 72/ March 73; it contains for the first time a contribution from Winfrith. Rose restricted his comments to a few points :

- Fission and capture cross sections of ^{238}U : concerning fission, the measurements of the ratio $\sigma_f(^{238}U) / \sigma_f(^{235}U)$ carried out, from threshold up to ~ 20 MeV, at the Harwell synchrocyclotron agree with the Karlsruhe data, except around 7 MeV where the Karlsruhe data are higher. Concerning capture, the values measured at N. P. L. and the preliminary data of Moxon and Pearlstein suggest that the ^{238}U (n, γ) values given in Sowerby's evaluation are too high in the region above 100 KeV. The existing measurements of $\sigma_c(^{238}U)$ are all consistent and they were obtained by two different techniques (measurement of ^{239}Np activity and use of large liquid scintillator) and can be considered as correct; however, it is not possible to get consistency between the measurements of $\sigma_F(^{235}U)$, $\sigma_c(^{238}U)$ and the ratio $\sigma_c(^{238}U) / \sigma_F(^{235}U)$.

- Total cross section of Fe : Measurements done at the synchrocyclotron have shown a large number of new narrow resonances (presumably p - waves) below 350 KeV. Above this energy, the agreement with other data is quite reasonable.

- Li (n, α) cross section : The Harwell and Cadarache data still disagree by about 5 KeV in the energy of the resonance at about 250 KeV ; if one allows an energy normalization, the magnitude of the cross section agrees within the measurement errors (3 to 4%). Measurements of σ_T of ^6Li and of the ratios of the (n, α) cross sections of ^6Li and ^{10}B are envisaged. Rose noticed that some kind of systematic discrepancy on the energies between Linac measurements and Van de Graaff measurements appeared - but could not be explained - in a European meeting of Linac and Van de Graaff users held in Spring 1973.

- Fission-neutron spectra of ^{235}U : Final results differ in shape from Swedish results and the uncertainties in the efficiency of the neutron detectors at high energy is not sufficient to explain the discrepancy. Wiedling outlined that the uncorrected Harwell and Studsvik data are in fairly good agreement but that the disagreement appears when comparing the corrected data. From the discussion on fission neutron spectra, it appeared that :

a) The shape of the spectrum does not depend on the energy of the neutrons inducing the fission (Karlsruhe results and preliminary Los Alamos results concerning ^{235}U and ^{238}U fission induced by neutrons of energy between 1 MeV and 22 MeV).

b) The fit of the spectrum by a Maxwellian is bad above about 6 MeV (Karlsruhe results and preliminary results published by Green at the ANS meeting in June 73 on spontaneous fission of ^{252}Cf). However, Wiedling mentioned that when trying to obtain the best Maxwellian fit of the Swedish data on ^{235}U neutron induced fission, one finds a temperature of 1.40 MeV when taking all the data points between 0.6 and 15 MeV and a temperature of 1.44 MeV when restricting the fit to the energy region 0.6 to 2.25 MeV.

Rose added to his report on UK activities that some work on medical applications has begun related to the possible use of the variable energy cyclotron for neutron (~20 MeV) therapy and of the synchrocyclotron for pituitary treatments with 150 MeV protons.

U. S. S. R.

Sukhoruchkin distributed the publications n° 15 and 16 of the Obninsk Nuclear Data Centre and the proceedings of the First Kiev Conference on Neutron Physics; he announced the edition of the proceedings of the Second Kiev Conference for the first half of 1974. He outlined the following aspects of the recent USSR works :

- α for ^{239}Pu : Table I (Appendix XI) gives the following values: column 2 is an evaluation from results known up to 1971 ; column 3 gives the data measured on the Dubna pulsed reactor ; column 4 is the result of the Sowerby and Konshin evaluation ; column 5 gives the data measured by Yankov et al. at the Kurchatov Institute of Atomic Energy (IAE). Earlier measurements taken on the old Linac of the Kurchatov Institute and at the Institute for Physics and Energetics at Obninsk (FEI) are given in the last column. Konshin, who analyzed the results arrived at the conclusion that the α-values of ^{239}Pu are known with an accuracy of 10 to 15%. Integral measurements were also done at Obninsk; the experimental result is compared with values calculated from three different sets of cross sections (the 26 groups constants of Obninsk ; the experimental data of ORNL; the experimental data of Harwell) : the integral value agrees with the value calculated from the ORNL results (Table II of Appendix XI).

- Capture cross section of ^{238}U . Table 3 of Appendix XI gives the results of the measurements at F.E.I. Obninsk and compares these results to the ORNL data. The average discrepancy over the whole energy interval is 8.5%. Table 4 of Appendix XI compares different data at 30 KeV.

- $\bar{\nu}$ measurements : Data concerning ^{252}Cf were reported at the Second Kiev Conference. For ^{239}Pu, no difference was found (within an accuracy of 1%) between the $\bar{\nu}$ values at the 0.3 eV resonance and in the energy range 1 to 40 eV.

- Comparison between the achieved accuracies and the needed accuracies on ^{239}Pu and ^{238}U nuclear constants : This comparison is shown in table 5 of Appendix XI; the required accuracies for fast reactors resulted from the works of Usachev et al. (Second Kiev Conference) and of Trofanov et al. (First Kiev Conference). To meet the requests of reactor physicists, it is necessary to improve by a factor 2 to 3 the accuracy of the existing data.

Yankov complemented this information by comments on fast neutron works basically reported at the Second Kiev Conference :

- Scattering of 2.9 MeV neutrons at the Institute of Nuclear Physics of the Ukrainian Academy of Science (T. M. Fedorov): cross sections and angular distributions (30° to 135°) were measured by time of fligth techniques on some even-even isotopes of Fe, Cr and Zn; accuracies of 10 to 15 % were obtained on the total scattering cross sections.

- Scattering of 14.7 MeV neutrons at the U. F. T. I of Kharkov (A. I. Tuntubaline) : cross sections and angular distributions (10° to 130°) were measured on ^{54,56}Fe, ^{59}Co, ^{58,60}Ni.

- Study of the reactions, producing α particles, induced by 14.7 MeV neutrons at the U. F. T. I of Kharkov (G. P. Dolej): values are given for ^{52,53,54}Cr.

- Calculations were made by N. P. Balabanov et al. (Dubna) on the accumulation of He in reactor structural materials, due to (n, α) reactions,in the neutron energy range 0.4 eV to 1 MeV. Numerical data are given for the He content after irradiation in a neutron fission spectrum (integral dose 10^{22} n/cm^2) in the following elements : Ti, Cr, Fe, Ni, Zn, Se, Nb, Mo, Zr.

- Differential neutron (1.9 MeV to 4.0 MeV) cross section for γ-ray production in Al, Pb, Fe at the Radiation Institute of Leningrad (Y. G. Degtyarev).

- Fission isomer studies :

At Dubna, Zen Tchang Bom et al. tried to detect an isomeric state in ^{236}U produced by irradiation of ^{235}U with 60 KeV neutrons : an upper limit of 1.5 10^{-4} was found for the ratio $\sigma_{isom} / \sigma_{fission}$.

At the Atomic Energy Institute of Moscow, P. E. Vorotnikov performed a similar experiment with 1 MeV incident neutrons : the upper limit for the isomer production relative to ^{235}U fission was found equal to 3. 10^{-5}.

- Study of the ^{226}Ra + n fission at the Radium Institute in Leningrad (E. A. Zhagrov): for neutron energies between 5 and 7 MeV the assymetric fission is predominant; when the incident neutron energy is increased (up to 15 MeV), the assymetric fission grows up slightly and the symmetric fission rapidly.

- Fission cross sections :

At Obninsk, B.I. Forsov et al. measured the ratio $\sigma_F(^{238}U)/\sigma_F(^{235}U)$ for neutron energies between 1.4 and 7.4 MeV with an accuracy of 2.5 % ; their results are in good agreement with Meadow 's data, but higher (about 3%) than Stein's results.

At the Radium Institute in Leningrad, the fission cross section of ^{238}U induced by 14.8 MeV neutrons has been found equal to 1.209 $\pm$ 0.014 by A.D. Alkhazov et al. At the same Institute, I.M. Kurks et al. measured the absolute value of the fission cross section of ^{235}U induced by 2.5 MeV neutrons : their result (1.30 $\pm$ 0.05 barn) is in good agreement with the Los Alamos value and the KFK evaluation.

- $\bar{\nu}$ and fission neutron spectra :

I.D. Zhuravlev et al. (at N.I.N.A.R., Dimitrovgrad) measured these quantities for the spontaneous fission of the 244, 246 and 248 isotopes of Cf and for the thermal neutron induced fission of the 243, 245 and 247 isotopes of Cm.

At the Kurchatov Institute for Atomic Energy (Moscow), the variation of v for ^{235}U has been studied by M.V. Savin et al. in the 0.2 to 1.0 MeV neutron energy range. Results were compared with Soleilhac data : the agreement is good between 0.2 and 0.7 MeV, but, above 0.7 MeV, the present work gives 2.5 % higher values.

The absolute value of $\bar{\nu}$ for the spontaneous fission of ^{252}Cf has been measured by three independant technique at the Radium Institute in Leningrad : a preliminary value is $\bar{\nu}$ = 3.770 $\pm$ 0.045.

Concerning facilities for neutron works in the resonance region, Sukhoruchkin mentioned :

- The 1 GeV protons synchrocyclotron at Gatchina which can deliver 20 ns bursts of 10^{20} neutrons at a rate of 50 Hz.

- The Electron Linac at the Kurchatov Institute of Atomic Energy (Moscow) which is under construction with the expected characteristics 60 MeV ; 1 A bursts from 50 ns up to 5.5 μs at a repetition rate from 50 to 900 Hz. Operation is expected in the beginning of 1974.

- At Dubna, the construction of the IBR2 pulsed reactor is expected to be in operation in about 2 years ; it will be used either separately or coupled with a Linac and give an improvement by two orders of magnitude for the neutron source relative to the present IBR 30 pulsed reactor.

For fast neutron research, Yankov restricted his presentation to a few installations :

- At the Institute of the Academy of Science of the Ukraine, a pulsed and bunched Van de Graaff (5 MeV; 1 mA peak current; 1 ns ; 4 MHz) and the modification of a U-240 cyclotron for its use as a pulsed neutron source. This cyclotron will deliver 1 ns burst of protons (100 MeV ; 50 μA average current) at a rate from 1 to 100 KHz.

- At Dubna, experiments are made to couple two cyclotrons : it has been possible to accelerate Xe ions to an energy of 7 MeV per nucleon and an intensity of 2. 10^{10} particles per second.

The two main questions on the USSR progress report concerned :

- the capture cross section of ^{238}U : Rowlands outlined that integral data measurements suggest that this quantity must be, by comparison with Sowerby's evaluation, $\sim$12% lower between 1 and 25 KeV and $\sim$6% lower above 25 KeV.

- the integral measurement of α for ^{239}Pu : Sukhoruchkin specified that this measurement cannot be considered as a test of the differential data in particular due to the uncertainties in the neutron spectrum ; it is only an indicative supplementary information.

SWEDEN

The Swedish progress report was distributed as a G - document, INDC (SWD)-5/G. Condé outlined the following items :

- The systematic studies of elastic and inelastic neutron scattering have been continued by Holmqvist and Wiedling at Studsvik; the study also includes a measurement of neutron elastic scattering at forward angles from 10° to 40°.

- The reaction studies of fast neutron capture by Bergqvist and Nilsson have been extended to the giant resonance above 6 MeV ; the measurements are made on the Tandem accelerator at Upsala. The same group has also studied the serious discrepancy between earlier neutron capture cross section measurements at 14 MeV made by activation and γ-ray spectrum techniques; the present measurements indicate that earlier activation works have given too high values by a factor of 5 to 10, depending on a background due to low-energy neutrons.

- The prompt fission neutron spectrum measurements have been continued, by Johansson et al. at Studsvik on ^{238}U and ^{235}U at different incident neutron energies. A joint experiment - done at Harwell - between Studsvik and Harwell is underway for ^{235}U to hopefully settle the discrepancy between these two groups.

- Measurements of γ -ray production cross sections and of relative fission cross sections, including fission fragment angular distribution studies, are underway in the neutron energy region above 5 MeV, at the Tandem Accelerator Laboratory, Upsala.

- A measurement, not described in the Progress Report, has been done of the lifetime of the compound nucleus ^{239}U, formed in the ^{238}U (n, f) reaction, by a joint group from Aarhus (Denmark) and Lund (Sweden); the technique of blocking the fission fragments in single crystals is used.

- The OSIRIS project, at Studsvik, by Rudstam et al. for measuring the decay properties of fission products is underway : a list including 115 isotopes can be made available on request.

- Concerning facilities, were mentioned: the modifications of the 225cm cyclotron of the " Research Institute for Physics " (Stockholm) to permit the exploitation of heavy ions and the allocation of the budget for installing a 6 MeV Tandem-Pelletron in late 1974 at the University of Lund.

ROMANIA

The information from the different Romanian laboratories is included in the " Consolidated Progress Report for 1973 in the NDS service area " (document INDC (SEC) - 35/L).
Rapeanu restricted his presentation to two items :

- The installation of a Tandem FN 15 accelerator (15 MV; 8 μA) which will be mainly used for studying the reactions (p, p), (α, α), (d, α), (p, α).

- An accurate measurement of the total cross ection of Zr for cold neutrons, showing a Bragg cut off at $\lambda = 4.6$ Å

JAPAN

The nuclear data activities in Japan are reported in document INDC (JAP)-17/L. Nishimura outlined the following results :

- At JAERI, the new electron Linac was used for measuring total cross sections (natural U), capture cross sections (Ta relative to Au) by the large liquid scintillator technique, scattering cross sections (W) with ^{6}Li glass and ^{7}Li glass scintillators. Measurements of the capture cross sections of ^{151}Eu, ^{153}Eu and ^{53}Cr are contemplated.

- At JAERI, the following experiments were performed on the 5.5 MeV Van de Graaff : differential cross sections for neutron elastic scattering on ^{94}Mo for 5 to 8 MeV incident energy; study of the polarization of 1.5 MeV neutrons elastically scattered by Gd, for which a spin flopping superconducting solenoid was constructed; study of elastic and inelastic neutron scattering by ^{207}Pb, which have shown no distinct intermediate structure; measurements of elastic and inelastic scattering of 18 MeV neutrons by C, which are analyzed by the coupled-channel theory.

- At Tohoku University, the total neutron cross section of ^{238}U was measured from 2 to 8 MeV with the Linac by Momota et al ; data are available through the C. C. D. N. data centre.

- At Kyushu University, a new time-of-flight spectrometer has been installed for the measurement of the scattering of 14 MeV neutrons: its energy resolution (~ 260 KeV) is the best reported so far .

ITALY

The activities of the Italian laboratories are included in the Joint Progress Report issued by EURATOM Countries as EANDC(E) 157 "U". Benzi outlined the following activities .

Padua University : A measurement has been completed of the elastic and inelastic scattering of neutrons by Sodium at 8. 0, 9. 7 and 14. 1 MeV. The experiment is an extension to higher energies of a previous work by Fasoli et al. (Nucl. Phys. A 125 (1969) 227)in the energy interval 1. 5 to 6. 4 MeV.

The experimental results were analysed in terms of a generalized optical model and statistical theory, taking into account also the results obtained at Oak Ridge by F. G. Perey and W. E. Kinney (Report ORNL-4518, 1970).

In addition, the total and inelastic scattering differential cross section and phase shift analysis for Carbon in the energy range 2. 1 to 4. 7 MeV has been completed.

A paper has been published in Nuclear Physics (1973).

Coceva Group at Geel (CNEN-BCMN cooperation) : The following measurements are underway:

a) Resonance parameters of Zr-91 and Zr-96 up to 15 keV.
b) α measurement for U-235 up to ~ 20 keV.

In addition Coceva is planning to make measurements of levels and strengh functions (J > 1) for nuclei with A in the range 20-100, by means of a threshold photoneutron technique. For this purpose a new electron linac in Bologna set up by the National Council for Research will be used.

INDIA

The activities of the Indian laboratories are included in the general document INDC (SEC)- 35/L. Divatia restricted its presentation to a few points .

Concerning facilities :

- Pulsed Fast Reactor : Since the criticality of the PURNIMA critical facility at Trombay (May 72) several measurements have been carried out for optimizing the physics parameters of the Pulsed Fast Reactor. The mean prompt neutron life time of the Pu O_2 fuelled reference core has been measured as 50 ns.

- 224 cm variable energy cyclotron : The construction of this cyclotron at Calcutta has made further progress during the year ; the different components are nearing completion or being assembled. The cyclotron is expected to go into operation towards the end of 1974.

- 100 MW Reactor R 5 : It is proposed to construct a heavy water thermal reactor at Trombay using natural uranium fuel. Flux expected is 2.10^{14} n/cm^2 sec, to be compared to the flux available at the present CIRUS reactor (7.10^{13}).

Concerning measurement programmes at Trombay, the following experiments have been carried out:

- Study of the $^{40}Ca(\alpha,\gamma)^{44}Ti$ reaction for isobaric analog state research.

- Study of the states in ^{33}S by measuring the total cross section for the $^{29}Si(\alpha,n)^{32}S$ reaction.

- (p, n) reaction cross sections on ^{50}Ti, ^{54}Cr and ^{59}Co.

- Study of the number distribution of γ -rays emitted in the spontaneous fission of ^{252}Cf using an ion chamber and Na I (Tl) detectors : it is concluded that the probability distribution is well represented by a Gaussian shape with the average at 10. 3 and FWHM of approximately 10.

- High resolution study of prompt γ -rays in the spontaneous fission of ^{252} Cf accompanied by light charged particles : a striking feature of this type of fission is that the intensities of some low energy γ -lines are noticeably altered, although they appear intensely in binary fission.

- Study of the angular distribution of fission fragments as a function of fragments mass ratio in the 2. 2 MeV neutron induced fission of ^{235}U : data analysis is in progress.

Details on these experiments are available in the " Annual Report of the Nuclear Physics Division ", Bhabha Atomic Research Centre, B. A. R. C.- 694 (1973).

Concerning data for reactors :

- Energy points and multigroup cross sections were generated in the unresolved resonance region for ^{239}Pu, ^{240}Pu and ^{241}Pu and ^{238}U by taking averages over the Porter-Thomas distribution of neutron and fission widths and over the Wigner distribution of level spacings. Multigroup (17 groups) cross sections were also generated for the fuel, coolant and moderator elements from the resolved resonance parameters from the ENDF/B and UKNDF libraries.

- Based on optical and statistical models inelastic scattering cross sections were calculated for ^{235}U at 1.0 MeV neutron incident energy with five rotational bands. The role of spins and parities in the cross section evaluation was also examined. It was concluded that the parity of a level had a pronounced effect whereas the spin of the level did not have such an effect.

- Multigroup cross-sections for ^{232}Th and ^{233}U have been generated and used in the study of 500 MW Fast Breeders.

HUNGARY

Berenyi briefly commented the " Hungarian Progress Report ", document INDC (HUN) - 11/L. There are five institutions in Hungary dealing with nuclear data measurements and all of them, except one, are equipped with a neutron generator; a 5 MV Van de Graaff has been recently installed at Debrecen. Regarding the data, there is a rather substantial activity in the fields of fast neutron cross sections, and of nuclear reaction and decay scheme studies. Some works were recently started at the border line of solid state and nuclear physics which can be of interest for application of nuclear methods in industrial or some other applied fields.

FRANCE

Joly referred to the document EANDC (E) - 157 U Volume 2 edited by the BCMN (Geel) which contains the information on nuclear data from the French laboratories in 1973; he restricted his presentation to information of direct interest to the INDC.

In France, neutron data are measured at Saclay (60 MeV Linac), Cadarache (5 MeV Van de Graaff), and Bruyères le Chatel (12 MeV Tandem and 4 MeV Van de Graaff).

- At Saclay : The total cross section (measured at Geel) and the fission cross section (measured at Saclay) of ^{241}Pu were simultaneously analysed with a shape analysis code using Monte Carlo method and based on the Reich and Moore formalism . In the covered energy range (1 eV to 104 eV), the resonances can be separated into two groups according to their fission widths :

49 levels (probably 3^+) giving $\langle \Gamma_f \rangle$ = 49 meV

33 levels (probably 2^+) giving $\langle \Gamma_f \rangle$ = 595 meV

- The fission cross section of ^{233}U has been measured up to 30 KeV and a single level analysis of the data was done between 6 and 124 eV : parameters of 139 levels clearly identified are given but approximately 25 % of the levels are missed in this energy region.

- The total and fission cross sections of ^{241}Am have been measured and partially analysed : up to 150 eV for σ_T (190 resonances) and up to 25 eV for σ_F (32 resonances).

- A measurement of the ratio $\sigma_F(^{238}U) / \sigma_F(^{235}U)$ has been undertaken up to 3 MeV, with an energy resolution of 5 KeV at 1 MeV.

- At Cadarache : The results of a capture cross section measurements on natural Cr, Ni, Fe, Au between 70 KeV and 550 KeV using a Maier-Leibnitz type detector, were published in a C. E. A. note. These measurements were recently extended in the energy range between 10 KeV and 70 KeV and also to Na, Mn, Rh, Ta and ^{238}U.

- For the Au capture cross section obtained by activation technique (100 KeV to 500 KeV), the discrepancy, mentioned in the Progress Report, with the data obtained with the Maier- Leibnitz type detector has now been removed.

- The measurements of the fission neutron spectra of ^{235}U and ^{239}Pu, reported up to 5 MeV in the Progress Report, have been extended up to 14 MeV. Taking into account this higher part of the spectra the average energy is increased.

- The works on the absolute measurements of the ^{235}U, ^{239}Pu and ^{241}Pu fission cross sections are continued. For ^{235}U, the definite results are those presented at the Knoxville Conference after renormalization by multiplying the data by a factor 1. 02 to take into account the new value of the ^{234}U half life. A complete set of data for the 3 isotopes in the neutron energy range 10 KeV to 2. 6 MeV was presented at the Kiev Conference in June 1973.

- For Bruyères Le Chatel, activities were presented by Michaudon. The activities previously carried out at Limeil and Bruyères le Chatel have been re-grouped at Bruyères le Chatel in a unique Division. The main equipments are an E. N. type Tandem Van de Graaff (presently 6 MV at the terminal; modifications to obtain 7 MV at the beginning of 1974) and a 4 MV Van de Graaff; both machines are pulsed and associated with a neutron hall for time of flight experiments. A group of about 10 theoreticians and evaluators is associated to the experimentalist teams. The site- belonging to the Division for Military Applications - has been declassified in May 73 and is now accesible under similar conditions as the other C.E.A. Centres.

Experimental results are described in the EANDC (E) - 157 U document and supplementary information has been given at the Kiev Conference. Very briefly, works are carried out in the following fields: neutron elastic and inelastic scattering; cross sections for neutron induced γ ray production; $\bar{\nu}$ measurements (recent values have been obtained for ^{241}Pu in the energy range 1 to 14 MeV with a 1% accuracy); (n, 2n) reactions studies; reactions induced by charged particles and emitting neutrons such as (p, n), (d, n), (^{3}He, n); deuteron break up studies through measurements of the following reactions: d+d → n + p + d; p+d → p+p+n; n+d → n+n+p; study of the fission process through the ^{239}Pu (d, p f) reaction (anisotropy and mass distribution of the fission fragments).

A general question was raised concerning the availability to the INDC of the " Progress Report on nuclear data research in the European community " which includes the contributions from Belgium, France, Germany, Italy, Netherlands and BCMN (Geel). Joly recalled that Aten decided, in a previous INDC meeting, to make this document available to all the INDC members: this was apparently not done for the edition covering the year 1972. Liskien agreed to send a sufficient number of copies of this document (action 5) to the NDS which will assume its distribution (action 6). For the future editions, Liskien will investigate the possibility of a wider distribution as an INDC category L document (action 7).

GERMANY

Cierjacks gave some complements to the information contained in the document EANDC (E) - 157 U - Vol. I.

At Karslruhe :-On the 3 MeV Van de Graaff, the measurement of the fission cross section of ^{239}Pu between 0.5 MeV and 1.2 MeV was continued and results are expected at the end of 1973; the study of the $\bar{\nu}$ energy dependence of ^{235}U and ^{239}Pu between 100 KeV and 1300 KeV has shown no deviation from a linear law within the 1% accuracy; the capture cross section programme on structural materials was continued with an increased energy resolution (0.5 ns/m) by changing the characteristics of the large liquid scintillator tank : data are available for some Fe, Cr and Ni isotopes and for ^{238}U between 20 and 600 KeV; in connection with this programme, some additional experiments are intended with a Moxon-Rae detector to check possible systematic errors.

- On the isochronous cyclotron, final data on the toal cross sections of O, Al, Mg and Fe measured with an energy resolution of 0.01 ns/m have been completed and will be sent to the CCDN: particular emphasis was given to a careful study of "windows" in the Fe cross section; a complete angular distribution of elastic scattering of neutrons on C and Ca have been measured; a new programme on γ-ray production cross sections has been started: the first data concern the Ni and Cr isotopes and their analysis is in progress.

- On the FR 2 reactor, the measurements of γ spectra from thermal and average resonance neutron capture by several fissile isotopes have been completed: results are available for ^{235}U, ^{239}Pu, ^{241}Pu (target nuclides) and fulfill the safeguards requirements which were formulated one year ago; at the thermal column of the reactor, the prompt fission neutron spectra of ^{235}U and ^{239}Pu (and in addition the neutron spectrum of a ^{252}Cf spontaneous fission source) have been measured: the new data (not included in the Progress Report) are not yet available.

At the University of Münich , the main interest always concerns the study of decay schemes from neutron capture reactions, with a particular emphasis on nuclei in the transition region between undeformed and deformed nuclei.

At the University of Hamburg, the interest is moving to charged particle works on the new variable energy cyclotron (protons up to 28 MeV with an average current of 100 μA) and at the Kernforschungsanlage Juelich, there are no new nuclear data measurement programmes.

Concerning facilities available for neutron works, the most important point is the improvment of the characteristics of the Karlsruhe cyclotron: it is now possible to accelerate 50 MeV deuterons with an average current of 1 mA from the source.

CANADA

The Canadian Progress Report was distributed as a G document, INDC (Can)-13/G.

Cross reported on new facilities which are not included in the Progress Report :

- The TRIUMPH meson factory (500 MeV; 100 μA) is still on schedule and an initial low current beam is expected in March 74; beam will then be increased to 100 μA over about a year. Experiments on neutron production from spallation reactions, that will be of use to the thermal breeder Canadian programme (based on Th cycle) are expected when the current will be sufficient.

- A number of improvements have been made to the 13 MeV Chalk River Tandem accelerator which is used primarily for heavy ion studies. These include : a new terminal foil stripper (higher currents), a beam pulser, a new type of belt (higher voltage), a down-charging system (better stability).

- The NRU reactor is being rebuilt: for certain beam holes, an increase of the flux by a factor 50 is expected, giving results comparable to HFBR. A cold neutron source is being installed on the thermal column.

- A Bremstrahlung monochromator using the " tagging " technique has been tested at Chalk River and is now being installed at the Toronto Linac. It will cover the energy range from 4 to 40 MeV.

- A cryogenic photon spectrometer using photoneutrons produced by photons on liquid deuterium is being tested on the Linac of the National Research Council (Ottawa).

Concerning the results, the Progress Report covers essentially neutron reactions and γ -ray results closely related to capture γ -ray studies. The following aspects were outlined by Cross :

- The difficulties encountered is measuring the ^{103}Rh (n, n') ^{103}Rh cross section between 14 and 20 MeV : the Ti backing of the Ti-tritium targets bombarded with 3 MeV deuterons produces a very important neutron background correction.

- The reaction ^{127}I (n, 2n) ^{126}I has been studied for it appears to be very convenient for monitoring moderately long irradiation with 13 to 19 MeV neutrons.

- The production of ^{4}He in various Ni alloys and stainless-steel has been further studied: it is now believed that this production is probably due to Li and B impurities rather than to the energetically possible (n, α) reactions on ^{58}Co and ^{59}Ni.

- The evaluation of Walker on fission product yields has been issued as INDC(Can)-12/G document.

- A review article by Bartholomew et al. on γ -ray strength functions will be published, by the end of 1973, in " Advances in Nuclear Physics "; it is expected to be useful for predicting the intensities of γ -ray spectra from neutron capture in the 2 to 9 MeV region for nuclei for which no experimental data exist.

AUSTRALIA

Gemmell said that the information contained in the joint Progress Report edited for the NDS document INDC (SEC)-35/L is fairly up-to-date regarding information from Australian laboratories; he restricted then his presentation to two points :

- $\bar{\nu}$ value for the spontaneous fission of ^{252}Cf : possible sources of systematic errors were re-investigated (variation in the efficiency of the scintillator as a function of neutron capture position; effect of the axial hole of the tank; dead time correction) with the result that the previously published value - namely $\bar{\nu} = 3.735 \pm 0.014$ - has not to be changed
- a joint programme with ORNL on measurement of capture cross sections at ORELA is underway: preliminary results for ^{134}Ba, ^{40}Ca and ^{44}Ca have been obtained: they show that $\langle\Gamma_\gamma\rangle$ values differ by a factor of at least 2 between s-waves and p-waves.

ARGENTINA

The Progress Report from Argentina has been issued as INDC (ARG)-8/G.

Ricabarra indicated that he has officially asked the nuclear physicists in his country to send their non-neutron nuclear data to the "Nuclear Data Project" at ORNL and outlined the following information given in the Progress Report :

- The excitation function of the $^{113}I\ (d, 2n)\ ^{113}Sn$ reaction has been measured above 27.5 MeV deuteron energy and compared with the semi-empirical values by Lange and Münzel : the measured cross section is much larger than the calculated one .

- The decay schemes of ^{91}Rb and ^{91}Sr (produced by β-decay of the fission products ^{91}Kr and ^{91}Rb respectively) and of ^{141}Cs and ^{141}Ba (produced by β decay of ^{141}Xe and ^{141}Cs respectively) have been determined.

- Values are given for the neutron thermal absorption cross section of Cl and Ba.

- The activation resonance integrals of ^{146}Nd, ^{148}Nd, ^{150}Nd have been measured and evaluated : for ^{148}Nd, the obtained value (and the $\langle \Gamma_{\gamma} \rangle$ value), is about half the previously recommended value.

- The activation thermal cross sections and resonance integrals for activation of ^{112}Sn, ^{122}Sn, ^{124}Sn have been obtained by activation technique.

Ricabarra drew the attention to the problems which are encountered when computing resonance integrals from resonance parameters and neutron radiative capture cross sections: these problems are discussed in paper SM-170/2 presented at the " Symposium on nuclear data in science and technology " (Paris, March 73).

CENTRAL BUREAU FOR NUCLEAR MEASUREMENTS (GEEL)

The information on the relevant activity of CBNM up to the end of 1972 is given in the document EANDC (E) - 157 U Vol. 1 . Liskien made the following comments to up-date this information:

- Precision σ_T measurements on ^6Li, ^7Li and C (2 KeV to 2 MeV) : slighth corrections to the present data have to be done and the experiments will be repeated under improved conditions.

- σ_F for ^{235}U (1 to 500 KeV) : a preliminary run has been made (using a thin foil plastic scintillator as fragment detector) relative to $^6Li\ (n, \alpha)$ reaction).

- Resonance parameters of ^{242}Pu : data have been published in Nucl. Phys. A 207 (1973) 342.

- Resonance parameters of ^{236}U : analysis of the data up to 4. 1 KeV gave the following results :

$\bar{D}$ = (21. 6 ± 0. 23) eV ; S = (1. 00 ± 0. 1) x 10^{-4} ;

$$\bar{\Gamma}_{\gamma} = [23.0 \pm 0.5\,(\text{stat.}) \pm 1.0\,(\text{syst.})] \text{ meV.}$$

- Study of ^{237}Np: transmission and elastic scattering measurements have been completed and radiative capture measurements (with $C_6 F_6$ liquid scintillator) were started.

- The study of the resonance parameters of ^{177}Hf (including 99 resonances) indicates a strong energy dependence of the strength function for the J = 4^- resonances.

- Partial cross sections of ^{238}U : preliminary results on σ_c up to 1. 8 KeV (using $C_6 F_6$ detectors) have been obtained; elastic scattering measurements (using ^3He gaseous scintillator) are in preparation.

- Empirical formula giving $\bar{\Gamma}_{\gamma}$ for neutron resonances ($40 \leq A \leq 247$): the formula given in the report (based on statistical model) has been completed by adding a second term which takes into account valency nucleon contributions which are correlated with the strength function values.

- The 2200 m/s fission cross section measurements of ^{239}Pu were finalized (to be published in Annals of Nucl. Sci. and Eng.).

- Ratio of ternary to binary fission cross sections for ^{239}Pu : the measurements have been extended down to 20 meV; only the 15. 5 eV resonance has a significantly higher ratio value than all the others, from which it was assumed $J^{\pi} = 0^+$ for this resonance in agreement with the channel theory.

- The ^{51}V (n, α) ^{48}Sc cross section has been measured between 10 and 20 MeV (letter to the editor of AIKE).

- To reduce the ~ 10% discrepancy for the ^{197}Au (n, γ) cross section around 1 MeV, measurements have been performed by activation technique between 0. 5 and 2. 2 MeV : at about 1 MeV, the results are in perfect agreement with data from the National Physical Laboratory at Teddington, UK.

- Energy spectrum of the ^{252}Cf spontaneous fission neutrons : two separate measurements in the energy range 0. 15 to 15 MeV were made by time of flight technique; in both cases, the shapes agreed with a Maxwellian distribution ($\bar{E}_n$ = 2. 13 ± 0. 08 MeV).

- The re-evaluated data on the neutron source reactions T(p, n)^{3}He, D (d, n) ^{3}He and T (d, n) ^{4}He have been published in Nucl. Data Tables n° 11, 569. A preliminary evaluation for the reactions ^{6}Li (p, n) ^{6}Be and ^{7}Li(p, n) ^{7}Be* will be issued shortly.

- An experiment to determine the total cross section (0. 1 to 2. 4 MeV) and the differential elastic scattering cross section (0.25 to 1 MeV) of ^{6} Li has been performed : data analysis is underway.

- New measurements of the ^{233}U half-life gave a value which was several tenthsof a per cent higher than that of previous investigations (1.586. 10^5 y $\pm$ 1%) : this work is continued.

III. B. Additions from countries not represented on INDC.

Schmidt said that, according to the action put on the NDS/INDC Secretariat at the 5 th INDC meeting, the countries relevant from the NDS service area were asked to send their progress reports, three months in advance of the meeting. The received progress reports were combined in the document INDC (SEC)-35/L. The Progress Reports from Argentina and Hungary arrived too late to be incorporated; no information came from Bulgaria, Pakistan, Poland, Irak and Israel who had contributed regularly in the past. For the first time, Bangladesh, who became a member of the IAEA about one year ago, sent a contribution covering essentially works done on the 3 MV Van de Graaff at Dacca. Schmidt added that, this document illustratesthe fact that there exists a non-negligible potential for measuring nuclear data in the concerned countries and a good knowledge of the work done elsewhere: these are encouraging features for supporting the development of measurement programmes in these countries as will be discussed later in the meeting. Schmidt also mentioned the publication by the NDS of a consolidated progress report covering the activities of the European countries outside the NDS service area (document INDC (SEC)-36/L).

III. C. General policy problems on Progress Reports.

The following problems were raised by Schmidt :

1 - When asking their contributions to the countries inside the N.D.S service area, information was requested not only for neutron data but also for non-neutron nuclear data, and much of the information of this nature is included in the consolidated progress report; on the other hand, almost all other progress reports are restricted to neutron data. There is then a problem of homogeneity in the submitted information.

It was generally agreed that all the informations given in the document INDC (SEC)-35/L was of great interest because it gives a better view of the activities in the concerned countries. However, in the larger countries, the magnitude of the programmes in non neutron nuclear data is so broad that this field cannot be covered without restrictions; a kind of restriction adopted in the UK progress report was to mention non-neutron nuclear data only when connected to energy programmes. This restrictive view would probably have to be changed, in consideration of the extension of the INDC activities to non-energy applications of nuclear data. It was, however recognized that it was not possible, at present, to delineate the type of non-neutron nuclear data to be included in the progress reports: this will be one of the tasks of the standing INDC Subcommittees on energy application and on non-energy applications of nuclear data.

2 - Heavy ion accelerators receive, in several countries, an increasing support as part of their low energy physics programmes : when reporting about facilities, would it be of interest to mention these types of machines ? It was agreed that works done with heavy ions would probably not have applications in a near future and have then not to be reported; probably in some years, heavy ion physics would find some applications (such as ion implantation; better understanding of fission physics; etc...) and, then, become of interest to INDC , but this field is now premature for INDC consideration.

3 - There will probably be an evolution on the amount of measured neutron data (with a direct impact on the activities of the Compilation Centres) : the problem is to know in which way this evolution can be foreseen.

Rose mentioned that, in UK, the number of physicists employed in neutron data measurements will be reduced, with a probable decrease in the amount of data produced. Cierjacks and Usachev pointed out that the new powerful machines are producing more data in a given time : they expect an increase in the production of neutron data in their respective countries. In the USA, Rogosa mentioned that the USAEC Research Division is planning to make a special effort to provide some modest increase in the support of nuclear data - and especially neutron data - activities : the amount of nuclear data to be obtained over the next several years will not likely decrease.

4 - The different Progress Reports are issued at different dates and cover different periods : adjusting the publications of the Progress Reports to the dates of the INDC meetings, was considered as a useful suggestion; but, it is necessary to take into consideration the EANDC meetings (which are systematically held during the Spring) and also the problem of annual reports that several laboratories have to issue at a fixed date for their own authorities: it seemed then not possible to carry out such an adjustment.

III . D. Participation in experiments using underground nuclear explosions.

Rogosa briefly recalled that, in the past, a great deal of attention has been given at the INDC to the possibility of having a nuclear explosion where foreign physicists would be invited to participate in carrying out unclassified physics experiments. In fact, this participation was envisaged in two steps :

- first, attendance of observers to a shot, which can be called an " observers' shot".

- secondly, participation of foreign physicists in physics experiments done on a shot which would be mainly devoted to this kind of experiments and which can be called an " open shot ". There has been an estimate of the cost of such a test ranging from 5 to 10 million dollars. As the Division of the USAEC, responsible for military applications of underground explosions (D.M.A) has not sufficient interest to fund an "open test", it appeared that the Division of Physical Research should be responsible for covering the cost of this experiment; within a budget which is not increasing, it is rather difficult for this Division to find the necessary funds: this would imply a re-programming action which would have consequences on the funding of equipment now supported by the Division. Under these conditions, the decision was recently taken by the USAEC to have no "open shot" in 1973 and probably also in 1974. Moreover, considerations were given to the attendance of foreign physicists to an "observer shot", for instance in Spring 1974: the result of these considerations, communicated to LASL in September 1973, was that the invitation for foreign physicists to a test to be carried out will be withheld until definite plans and funding arrangements for an "open test" have been formulated.

Cierjacks drew the attention of the US delegation on the difficulties which will result for foreign physicists, in case the USAEC will decide to have an " open shot "-say, in 1976-if the opportunity is not given to them to be conveniently prepared by attending an " observer shot " sufficiently in advance. Rogosa answered that this problem was carefully considered : however, the decision which has been taken was mainly motivated by the fact that invitations to an " observer shot " could encourage foreign physicists to develop programmes for an " open shot " which the USAEC could not carry out.

Michaudon outlined that the French position for participating in physics experiments on an " open shot " has moved in a very positive way. Untill recently, the interest of French physicists in nuclear physics experiments using underground explosions was expressed on a purely individual basis, without any official endorsement. This situation has now changed : the High Commissioner has given approval for a declaration showing a definite interest in scientific experiments using underground explosions ; this interest is not limited to nuclear physics measurements but also covers such fields as the study of the equation of state of materials subjected to high pressure and high temperature. The general scheme of the cooperation which is envisaged is not different from what has been previously discussed at the INDC, namely : attendance of one or two observers to an " observer shot ", then definition of a programme to be performed, in cooperation with the American physicists, on an " open shot". The French contribution could, for instance, consist in sending a team of a few physicists who will participate in the preparation at Los Alamos and in the execution on the test site of the joint programme ; this team would provide the equipment (or part of the equipment) needed for carrying out the experiments.

To conclude, Rogosa said that :

- it was considered by the USAEC that " observer shot " and " open shot " are two aspects of the same problem, which cannot be separated.

- he, himself, considers that this problem is not definitely closed by a negative decision. Then, he would encourage interested physicists to continue to think about possible experiments, particularly experiments for which nuclear explosions are the unique possible tool, and to keep him informed on a personal and non official basis. On his side, he will continue to inform the INDC members about a possible evolution of the situation in the USA (action 4).

IV - Reports of Subcommittees.

IV. A. Subcommittee on standards

IV. A. 1. Report on the Second IAEA Panel on Neutron Standard Reference Data, Vienna, November 1972 :

Lemley mentioned a brief report of the panel, included as appendix B in the document INDC(NDS)-53/L and a more complete document on summaries, conclusions and recommendations of the panel which has been distributed to the INDC members and the participants of the panel and which, after minor corrections, will be issued by the IAEA, presumably before the end of 1973. His general feeling was that improvements in the standard data are now coming as the result of improvements in several areas connected with the measurement rather than as the result of a single significant break - through.

IV. A. 2. More recent experimental and evaluation works on neutron standards:

Liskien indicated that there was no formal meeting of the Subcommittee on standards since the V^{th} INDC meeting and he presented the information on neutron standards which was not known at the time of the Panel, adding that a number of them are, in fact, inlcuded in the Progress Reports.

a - $^{1}H(n,n)^{1}H$: The total scattering cross section which can be derived from the measurements of the differential scattering cross section at 14. 7 MeV by Tanaka (1970) must be significantly increased by 2. 3 %. This is due to the fact that the total scattering cross section is much more accurately derived by subtracting the capture from the total cross section; there is however no reason to suspect the anisotropy measurements of Tanaka (INDC (JAP) - 16 G). Smith recalled the extensive review of R. Wilson published in the proceedings of the "EANDC Symposium on neutron standards and flux normalization " (Argonne, October 1970). This work has been continued and a paper will be shortly issued (probably in Physical Review) on the physics aspect of the ^{1}H (n, n) ^{1}H cross sections; it can be summarized by saying that the discrepancies in the basic parameters, necessary for the application of the Hopkins and Breit procedure to compute the cross sections, have been removed: between 14 and 20 MeV, the total cross section and, also, the angular distributions can be calculated to an accuracy of the order of 0.2%. It is always important to verify such calculations by measurements, but an accuracy much better than 1% would be necessary and is certainly very difficult to achieve.

Answering a question by Rose, Liskien said that the accuracy of the experimental values of the differential scattering cross sections is probably of the order of 5 % but that the resulting uncertainty of neutron flux measurements using the telescope technique is much lower ($\sim$ 1% depending on the telescope geometry).

b - <u>^{3}He (n, p) T</u> : The evaluation by Liskien and Paulsen on the proton angular distribution has not been modified; no new data are available. Liskien pointed out that a standard cross section is valuable only if there is some device which allows to use it : in the case of the ^{3}He (n, p) T reaction, high pressure scintillation detectors have been developed for time-of-flight measurements (fast reponse), but they suffer from bad pulse height discrimination and, then, difficulty for threshold setting, Cierjacks mentioned the study, at Hamburg University, of a liquid scintillation detector but it is too early to have a clear opinion on the device.

c - <u>^{6}Li (n, α) T</u> : The discrepancy between measurements obtained at the Harwell Linac using 1 mm and 9.5 mm thick glasses have been removed : it was due to count rate dependent losses in the timing electronics. New measurements, entailing the use of 0.5 mm thick glass, are now in agreement. Harwell calculations have shown that a single level description, with only the $5/2^-$ level at 0.25 MeV, does not allow a correct description of the total and (n, α) cross sections simultaneously : Uttley gets consistency in taking also into account the recently confirmed $5/2^-$ level at 6.64 MeV above the groundstate of ^{7}Li.

The Harwell and Cadarache (n, α) data are now in reasonable agreement : it persists, however, a displacement by about 5 KeV. Another problem may come up from the ^{6}Li content of the glasses : using two different techniques (pile oscillation and low energy neutron transmission), a preliminary determination of the ^{6}Li content of the glass used for the Cadarache measurements gives a figure 10 % lower than it was assumed in the published data.

Concerning new measurements, it was mentioned :

- the relative measurements of Clements and Rickard (Harwell), when normalised to the most recent data in the range 300-400 keV, are considerably lower than all other measured or deduced values above $\sim$600 keV.

- a measurement (to be published in J. of Nucl. Energy) done at A. N. L using a 0. 1 mm thick ^{6}Li glass ; a careful assay of the ^{6}Li content was done by chemical method and by a measurement at thermal energy : the agreement is 1. 5 %. The paper includes comparison with other results : in particular, above 500 KeV, the ANL results are higher than the Cadarache results.

- a measurement from 1 to 1700 KeV which is in preparation at Intelcom Rad Tech (San Diego).

The following problems were also discussed :

- possibility for organizing an intercomparison of the ^{6}Li glasses used by the different experimenters.

- interest to study (for example by looking at their thermal neutron capture γ -ray spectra) the impurities of the ^{6}Li glasses, which have a high neutron capture cross section and can then cause errors in certain method of analysis of the ^{6}Li content of the glasses.

- the urgency for the experimenters to send their data on this important standard cross section to the relevant Compilation Centre ; in particular, Rose was asked to send the most recent Uttley data to the CCDN (action 8).

d - ^{10}B (n, α) ^{7}Li : Liskien said that no new results have been published since the Panel. However, according to the recommendation of the Panel, measurements of the ^{10}B (n, α) ^{7}Li branching ratio have begun at the N. B. S. , with the objective to resolve the discrepancies existing above 50 KeV. A similar experiment is planned at Harwell.

e - ^{197}Au (n, γ) : Since the Panel, the discrepancies existing between the two sets of data, obtained by direct γ detection and by activation technique, have been reduced considerably; the preliminary results from activation technique were in error due essentially to neutron background problems.

Another discrepancy concerns the region around 1 MeV : very accurate results were obtained by Robertson et al. (N. P. L. , UK) by irradiating a gold foil surrounding a (γ , n) source calibrated by the Mn bath technique; their results are 10 to 15% lower than the results published by Fricke et al. at the Helsinki Conference. A new measurement by Liskien and Paulsen (Geel) from 500 KeV to 2. 2 MeV (accuracy 5%) gives an excellent agreement with Robertson 's results.

Smith tentatively explained the disagreement with the Fricke data by indicating that the technique which was used integrates the (n, γ) and (n, γ , n') process. He added that :

- a new measurement is in progress at ORNL (6 KeV to 600 KeV): preliminary data were reported at the APS Conference in September 72.

- plans are developed at ORNL and BNL to measure the ^{197}Au (n, γ) cross section at 2 KeV and 24 KeV using Sc and Fe filters in reactor beams.

f - ^{235}U (n, f) : Liskien reported on three sets of data which were preliminary at the time of the Panel :

- the LASL results (1 to 6 MeV) are now finalized and are slightly higher than the other existing data.

- the Cadarache results (10 KeV to 2.6 MeV) obtained with a fission chamber borrowed from Aldermaston and a fission chamber containing foils calibrated by the BCMN were not in agreement. Final consistent results are now available.

- the ANL results (30 KeV to 5 MeV) are now in a final shape and they are reported in the document INDC (USA)-57/G ; three independent methods were used to calibrate the neutron flux and a number of assays have been done to intercompare the fission foils .

- Yankov mentioned two recent results obtained at Leningrad :

  - a value of 1030 $\pm$ 5 mb at 2.5 MeV
  - a value of 1052 $\pm$ 31 mb for an average over the fission neutron spectrum of ^{252}Cf.

g - $\bar{\nu}$ for ^{252}Cf : Since the Panel, there is a new Soviet result still preliminary, namely 3.770 $\pm$ 0.045 which is in agreement within the error bars with the 3.733 $\pm$ 0.008 value recommended by the Panel. Smith added that a new measurement of the half-life of ^{252}Cf has been done at N.B.S. :the result is in agreement with the value-which was considered as low - adopted by de Volpi for his $\bar{\nu}$ measurement; the importance of this standard was recognized by the USNDC which formed a study group to look into the problem and, if necessary, to implement new measurements.

h - Fission neutron spectra: Lemley referred to considerable discussions in the Progress Reports on (^{235}U + n) and ^{252}Cf fission neutron spectra. He also recalled that the "Panel on neutron standard reference data" specifically recommended to include fission neutron spectra among the standards and that a similar recommendation was also done previously by an IAEA meeting convened on this particular topic. Rowlands specified that, in applying the results of integral measurements to reactor physics predictions, an important quantity is the relative shape of fission neutron spectra for different isotopes: a standard fission spectrum would then be desirable for intercomparison of different reactor physics experiments. For this purpose, any reference spectrum would be satisfactory and probably the (^{235}U + n) fission neutron spectrum would be the most convenient; however, the choice of a standard is mostly a matter of convenience for the measurers and, for example, the fission neutron spectrum of ^{252}Cf would be quite acceptable as well as the relative shapes of the neutron fission spectra of different isotopes. An accurate knowledge is required of the spectrum for ^{235}U or ^{239}Pu to help to resolve discrepancies between measured and calculated values of the ^{238}U fission cross section averaged in a fission spectrum. Rose recalled that this problem was extensively discussed at the last Standard Subcommittee meeting with the conclusion that a better knowledge of the fission neutron spectra was needed before being able to choose an appropriate standard: the choice was then deferred pending clarification of experimental results, in particular of the existence of structure in certain spectra. This problem of a standard fission neutron spectrum was generally considered as pertaining to the scope of the Standard Sub Committee.

IV. A. 3. Status of second IAEA updating of 2200 m/sec. fissile isotopes constants.

The third evaluation of the 2200 m/sec fissile isotopes constants was started by convening a Consultant Meeting in Vienna (November 1972), with the participation of Axton (UK), Story (UK), Leonard (USA), Deruytter (BCMN, Geel), Dunford (NDS) and Lemmel (NDS).

Lemmel refered to the document INDC (NDS)-53/L, page 27, where a brief outline of the problems encountered in this evaluation is given. The experimental data responsible for the discrepancies are essentially :

1) The high η value measured by J. R. Smith and the low $\bar{\nu}$ value coming out of several recent measurement.

2) The high α value obtained at Chalk River by Lounsbury and the low α value calculated from the capture cross section and the high fission cross section reported by Deruytter.

More explicitely, one can calculate the $\bar{\nu}$ prompt value for ^{235}U from the following relations :

$$\bar{\nu}\,(^{235}U) = \eta\,(1+\hat{\alpha})\,\frac{g_f}{g_a} - \bar{\nu}_{delayed}.$$

$$\bar{\nu}\,(^{235}U) = \frac{\bar{\nu}\,(^{235}U)}{\bar{\nu}\,(^{252}Cf)} \times \bar{\nu}\,(^{252}Cf).$$

In the first relation, η is the value obtained by J. R. Smith; $\hat{\alpha}$ is the Chalk River value, measured in a Maxwellian spectrum, which has then to be corrected by the Westcott g-factors; $\bar{\nu}$ delayed is taken from Keepin's review and is not critical. In the second relation, the two factors $\frac{\bar{\nu}\,(^{235}U)}{\bar{\nu}\,(^{252}Cf)}$ and $\bar{\nu}$ (^{252}Cf) are very accurately known from several concordant experiments.

When the $\bar{\nu}$ (^{235}U) value is calculated from this two relations, one finds a discrepancy of 1.1 %. The different factors entering these relations have been carefully reviewed by the participants of the " Consultants Meeting" and it seems that the only solution is a revision of the g - factors; in fact, for ^{235}U, the g_f - factor seems well established in particular owing to recent Deruytter measurements, and to remove the discrepancy, one has to assume a larger value for the g_a - factor.

Another problem concerned the half lifes : for ^{233}U and ^{235}U, it seems that the recent Geel data solve the problem but there is still some doubt for ^{239}Pu with a resulting uncertainty of about 1% in the ^{239}Pu fission cross section.

General problems in this kind of simultaneous fit of a number a data are correlations of errors and not sufficiently documented data.

In the discussions which followed this presentation :

- Sukhoruchkin outlined that it is very improbable to have large fluctuations of the cross sections in the sub-thermal energy region but that, with the presently available neutron sources, measurements are very difficult.

- Rose mentioned a work in progress at Harwell on the ^{239}Pu half-life : an accuracy of 0.5% is expected and preliminary results seem to confirme the calorimetric measurement of Oetting;

- Rowlands indicated the interest of the thermal reactor physicists in the shape of the η variation at low energy : it is felt that the present data are not correct and, then, cannot be used for improving the g - factors calculations ; new measurements are needed and feasibility studies are been made in Harwell.

Answering a question on the availability of the new set of 2200 m/sec fissile isotope data, Lemmel said that it was expected to publish these data before the end of this year for possible inclusion in the ENDF-B III file depending on a decision by CSEWG; the difficulties on the g-factors appeared only recently and a careful revision of these quantities are needed: a preliminary version of the data could be issued shortly but its reliability is questionable.

IV. A. 4 . Progress in absolute neutron flux measurements .

1) Several laboratories have reported to be engaged in absolute flux measurements and their activity in this field was not repeated here. New informations were however given by :

- Yankov on the Radium Institute (Leningrad) concerning :

a- the calibration of a ^{252}Cf neutron source (precision : 0.9%) by two independant methods, namely the manganese bath technique and the use of a graphite sphere calibrated by the associated particle technique in the (d, t) reaction.

b - the measurement of neutron flux by the associated particle technique in the (d, d) and (d, t) reactions (accuracy better than 1% at 14 MeV).

- Cierjacks on the KFK (Karlsruhe) concerning :

a - the development of a proton telescope for flux measurements on the Van de Graaff which appears to be a very reliable device between 500 KeV and 2 MeV.

b - the development of another proton telescope for flux measurements, on the cyclotron, from a few MeV up to 30 MeV.

2) Concerning the international cooperation under the auspices of the BIPM (Sèvres) Liskien summarized the present situation. The directing ideas and principles of this cooperation were proposed at the " EANDC Symposium on neutron standards and flux normalization ", held in Argonne (October 1970). The basic idea is to circulate one or several " transfer instruments" among different laboratories which claimed that they are able to measure monoenergetic neutron flux to a certain accuracy : the counting rates of the transfer instrument obtained by these different laboratories will then be compared to check if certain systematic errors are not hidden behind the claimed accuracies. As a first trial, it was decided :

a - to limit the participating laboratories to the following: NPL (UK); NBS (USA); NRC (Canada); IMM (Leningrad); Braunschweig Institute (Germany); CEN - Cadarache (France); ETL (Japan); CBNM (Geel); BIPM (Paris).

b - to select three neutron energies where the flux will be compared, namely 0.25 MeV; 2.5 MeV; 14.8 MeV. The allowed energy spread has been fixed to $\pm$ 2 %.

c - to choose the following transfer instruments :

- at 0.25 MeV and 2.5 MeV, a BF_3 counter surrounded by a sphere of 20 cm moderating material: the BIPM is responsible for this detector. Another transfer instrument is also foreseen: an ^{3}He proportional counter which will be provided by the NRC.

- at 14.8 MeV, iron foils : the NPL is responsible for the distribution of these Fe foils for which the activity at saturation will be measured (^{56}Mn activity from ^{56}Fe (n, p) reaction); another transfer instrument is envisaged: a ^{235}U fission chamber which will be provided by the NBS.

IV. A. 5. <u>Non neutron nuclear data standards (e. g standards for fission yields; decay schemes; level energies ; half lives; radiation standards)</u>

Yankov introduced the discussion by the following remarks :

- the elaboration of non-neutron nuclear standards is, as in the neutron field, a necessity to compare measurements of the same quantities made in different laboratories.

- for non-neutron nuclear data, the field of activity for standards is much larger than it is for neutron data and needs a greater effort;

- it is desirable that an international organization (such as NDS) or several international organizations encourage activities and cooperations in this field and that compilations of non-neutron nuclear standards are made.

Lammer indicated that some activities on non neutron nuclear data standards have already been undertaken by the NDS. The following items have been studied :

1) Gamma ray energy calibration standards (Appendix XII)

This study covers the energy range from ~ 50 KeV up to ~ 3. 6 MeV and is mainly intended for Ge (Li) detector calibration; this energy range is sufficent for γ decay measurements but not for capture γ ray measurements. The primary standard is the annihilation radiation which is calculated from fundamental constants; however, this γ- ray has the disadvantage to be relatively large. For this reason, two other primary standards were defined: the K α_1 line of W (which is known to an accuracy of ± 5. 9 p. p. m) and the 411 KeV ^{198}Au γ -ray (which is known to an accuracy of ± 19 p. p. m). The energies of the γ rays tabulated in Appendix X were measured relative to one or the other of these two lines and must be considered as " sub standards": in all cases they are evaluated values taking into account not only the error bars on the primary standards but also other causes of errors such as the non-linearity of the Ge (Li) detectors .

For higher γ -ray energy calibration, Yankov referred to the paper SM 170/23 presented at the " Symposium on Nuclear Data in Science and Technology " (Paris, March 73) which gives not only the energies but the relative intensities of γ transitions in the energy range 3 to 10 MeV; these transitions are neutron capture γ -rays from the reactions ^{14}N(n, γ) ^{15}N and ^{28} Si (n, γ) ^{29}Si. According to Motz, the ^{14}N (n, γ) ^{15}N is probably the best " standard " because this reaction has been extensively studied : all transitions have been observed and fitted in a comprehensive decay scheme; this reaction is particularly useful for checking the linearity of a detector. Similarly the ^{12}C (n, γ) ^{13}C reaction (only 3 transitions fitting a well known decay scheme) and the ^{9} Be (n, γ) ^{10}Be reaction (transitions covering the energy range 0. 7 to 6. 8 MeV) can be used : in these cases, however, the thermal capture cross sections are quite low and all detector systems are not able to detect the γ -rays. In practice, different sets of " sub- standards"are needed for different types of experiments. To conclude, the consideration of γ -ray energy standards was forwarded to the " Subcommittee on Nuclear Standard Reference Data ".

2) Standards for Ge (Li) detector efficiency calibration (Appendix XIII)

In the list prepared by Lammer, all values must be considered as primary standards, in the sense that they do not depend upon a previous detector efficiency calibration but are derived with high accuracy from the decay schemes of the considered nuclides. Two remarks were made :

- the advantage to replace ^{203}Hg by ^{133}Ba which has - for about the same γ -ray energy lines - a more convenient half-life and gives sources having a better stability. It was, however, admitted that the decay scheme of ^{133}Ba requires more accurate studies ;

- the importance to extend the list to energies lower than 59 KeV (down to ~20 KeV).

3) Half life standards.

The definition of a half life standard is not quite clear ; it is however important for measurements of very long half lives extending over a long period of time, to have a radionuclide suitable for testing the stability of the counting system. A ^{226}Ra source was suggested for this purpose.

4) Fission product yields.

Lammer mentioned that:

- in radiochemical measurements of fission yields, ^{99}Mo and ^{140}Ba are most frequently used as " standards ". He recommanded ^{140}Ba being used as primary standards because the measured values are in better agreement than for ^{99}Mo; moreover, there are some discrepancies (1 to 2 %) in the half life of ^{99}Mo;

- in mass spectrometer measurements, the ^{148}Nd yield is commonly used for burn up calculations : its main interest comes from the fact that this yield does not depend very much on the energy of the neutron inducing fission and is nearly the same for ^{235}U and ^{239}Pu fission. However, discrepancies above 1 % exist among the reported values : for this reason, Lammer does not recommend ^{148}Nd as a suitable fission yield primary standard.

Lammer added that data concerning ^{137}Cs fission yield exhibit large discrepancies and recommended to reject it as a standard.

A list of fission product yields suitable for reference data (Appendix XIV) was proposed for consideration by the " Subcommittee on Nuclear Standard and Reference Data ".

IV. B. Subcommittee on Discrepancies in Important Nuclear Data and Evaluations.

1) Report of the Sub-Committee

Rowlands, chairman of the Subcommittee explained that contributions on the various items have been received and collected in a working paper distributed to the participants of the meeting; however, as the Subcommittee had not the opportunity to meet and discuss these contributions, he proposed that each author comment on his own contribution:

1 (a) . Fission cross sections of ^{235}U above 100 eV (Nishimura)
Nishimura stressed the three following points:

- the discrepancies between the different experimental data are shown on the figures given in Appendix XV and the evaluated data of Konshin et al are represented for comparison.

- the experimenters have used different normalization procedures and it would be valuable to renormalize all the experimental data to get a clear idea of true discrepancies.

-some measurements of Pönitz are based on a new method for obtaining the absolute neutron flux (^{51}Cr activity): it may be useful to repeat these measurements.

1 (b) . Fission cross sections of ^{239}Pu and ^{238}U above 100 eV (Rowlands):

- σ_f (^{239}Pu) : New data have been published by Pönitz et al (relative to ^{235}U) and by Szabo et al (absolute); measurements by Gayther et al below 1 MeV are in progress. The discrepancies are of the order of 3% between the different direct measurements and, also, relative to values derived from the ratio measurements to ^{235}U. Rowlands proposed to await the completion of a new evaluation by Sowerby et al before making further recommendations.

Cierjacks mentioned, new measurements at Karlsruhe between 0. 3 and 1 MeV.

- σ_f (^{238}U) : New ratio measurements, relative to ^{235}U (reported by Meadows and by Poenitz) and preliminary results by Cierjacks et al and by Coates et al (included in the Progress Reports) have improved the confidence in the data up to 12 MeV; in particular, in the range 2 to 5 MeV, the accuracy is now $\pm$ 2 % (1σ): however, a new absolute measurement by Kuks et al gives a value 6 % higher at 2.5 MeV. As for σ_f (^{239}Pu), Rowlands proposed to await completion of Sowerby's evaluation before making further recommendations.

1(c) . Capture cross section of ^{238}U and ratio to ^{235}U fission cross section (Cierjacks)

An extensive review has been recently published by Sowerby et al (AERE-R-7273). Below 600 KeV, the disagreements with previous evaluations is up to 7%; above 600 KeV, the situation seems better but the number of available data is very limited. Cierjacks thinks that the discrepancies cannot be removed by further evaluations and recommends new measurements of σ_c (^{238}U) : some measurements are undertaken at Karlsruhe (20 to 600 KeV), A. N. L. (above 500 KeV) and in the USSR (see Progress Report); he also suggests that the recommendation of the USA evaluators to only rely on σ_f (^{235}U) should not be followed but rather recommends to measure σ_c (^{238}U) with as many methods and relative to as many standards as possible for cross checks.

Rose called the attention to the discrepancy between Sowerby's evaluation and experimental values obtained in a ratio measurement of σ_c (^{238}U) / σ_f (^{235}U) reported in the document INDC (UK)-20/L : this measurement has been made by an activation method (^{239}Np counting) and the discrepancy could be due to uncertainties in the ^{239}Np decay.

1 (d) <u>α values for ^{239}Pu and ^{235}U (Sukhoruchkin)</u>

- α (^{239}Pu) : Sukhoruchkin mentioned recent measurements done in the USSR at the Atomic Energy Institute in Moscow (3 to 200 KeV) and at Dubna (thermal to 30 KeV): within the experimental errors, these data are in agreement with the evaluation of Konshin and Sowerby stating an accuracy of $\pm$ 15%. He also drew the attention of the Committee to one of the recommendations of the Panel on α (^{239}Pu) organized in 1970 by the IAEA : this recommendation specified that the IAEA should ensure a prompt exchange of information in the related field; in fact, data concerning experiments, reported quite a time ago, (for example from LASL and ORNL) are not available even to the members of the Subcommittee on discrepancies. Motz replied that the ORNL data (on σ_f, σ_c and α) have been sent to the BNL Compilation Centre and will be made available to the NDS.

- α (^{235}U) : Sukhoruchkin refered to recent simultaneous measurements of σ_f and σ_c for ^{235}U, performed at ORNL between 8 eV and 10 KeV. A comparison of the obtained data with previous data has been made : for σ_f the agreement with recommended values is within $\pm$ 3%; for σ_c, all the results agree within an error band of $\pm$ 5% below 200 eV and $\pm$ 15% in the KeV energy region.

1 (e) <u>Resonance parameter data of ^{238}U, ^{235}U, ^{239}Pu (Joly)</u>

- ^{238}U : All the available data files (ENDF/B version III ; UKNDL; KEDAK; SOKRATOR; Livermore evaluation) are based on experimental data measured before 1971. For a new re-evaluation, Joly recommended to consider the following sets of experimental data : σ_T and σ_c from Columbia (re-analyzed in 1972 by the authors), from Dubna and from Geel; σ_c from ORNL. As examples of the large existing discrepancies, a comparison of the $\langle \Gamma_n^0 \rangle$ and S values published at Geel and Columbia is given in appendix XVI (table 1).

- ^{235}U : Resonance parameters are given up to 150 eV only and, above ~ 60 eV, a number of levels are missing. A number of experiments are not taken into account in the existing evaluations ; the most significant are σ_f from Livermore (Bowman et al) ; σ_f from Columbia (Felvinci et al); σ_f and σ_c from ORNL (Gwin et al); σ_f from Obninsk (Samsonov et al). The discrepancies are illustrated by the table 2 of appendix XIV, given in a report from de Saussure; there are largely due to the different methods for analyzing the experimental data (single level or multilevel fits). In the case of ^{235}U, a multilevel analysis is necessary but was made difficult by uncertainties in the spin determination of the resonances. At the Rochester Conference on fission, Keyworth et al published values of the spins for 54 resonances, obtained by a direct (then not controversial) method : a new multilevel evaluation using this primordial information on spins is needed.

- ^{239}Pu : The most complete analysis of experimental data has been published by Saclay : the resonance parameters (including spins) of 254 resonances from 0.4 to 660 eV have been obtained by a simultaneous single level fit of σ_T and σ_F . Moreover a multilevel analysis has been carried out up to 200 eV.

Ribon (EANDC - E - 154 report) has compared two sets of evaluated data based on a single level Breit-Wigner formalism : Saclay evaluation (up to 660 eV) taking into account the σ_T and σ_F Saclay measured data and ENDF evaluation (up to 300 eV) taking into account the same data and, in addition, the σ_F and σ data from RPI. The agreement is good for the average parameters D, S_0,$\langle\Gamma_\gamma^c\rangle$but$\langle\Gamma_f\rangle$values disagree strongly; this is not surprising since it is known that a multilevel analysis is necessary to get the proper Γ_f values. Until completion of the evaluation in progress, at ORNL (de Saussure et al), Joly recommended to adopt the Saclay resonance parameters.

1.(f) $\bar{\nu}$ values for ^{235}U, ^{238}U and ^{239}Pu (Schmidt)

A detailed review by Manero and Konshin has been published in the December 72 issue of the Atomic Energy Review and Schmidt restricted his presentation to a few additional points of a document prepared by Manero and Lemmel :

- the accuracy on $\bar{\nu}$ (E) depends critically on the accuracy with which the standards are known : one of these standards is obviously $\bar{\nu}$ (^{252}Cf) - previously discussed in the meeting - but, another one is the value of the fission cross section of ^{235}U at 2200 m/s which appears in fitting all thermal neutron data of the fissile nuclides.

- for ^{235}U, the slight discrepancy between the measurements showing a step-like structure in the low MeV region and the measurements which do not see this structure still persists: Savin et al data seem to confirm the structure and the recent Karlsruhe data does not. Schmidt thinks that a smooth variation is more likely for the number of channels opened for fission is very great (greater than for ^{239}Pu which exhibits no structure in the $\bar{\nu}$(E) variation).

- the experimental data for the three nuclides allow to define the shape of $\bar{\nu}$ (E) up to 15 MeV and, according to the evaluations, the accuracies are 0.7 to 1% (1 σ) for ^{235}U and ^{239}Pu and 2% for ^{238}U. However, above 6 MeV, it seems that there exists only one set of data (Soleilhac). Moreover, between 30 KeV (for ^{235}U) and 80 KeV (for ^{239}Pu) and the eV region, there is no experimental data; in this energy range the extrapolation of the fits obtained at higher energies is, however, supported by the measurements of Widen and Condé of average values of $\bar{\nu}$ in several reactor spectra.

- in the eV region, the fluctuations of $\bar{\nu}$ from resonance to resonance are small for ^{235}U and ^{239}Pu and the correlation with the spins is very small, if it exists at all.

- concerning délayed neutron emission, recent ANL works have confirmed a decrease of the yields when the neutron energy increases from $\sim$ 4 to 15 MeV.

Schmidt concluded by saying that the present accuracies (values given above) are not sufficient to meet the requirements of the reactor physicists who ask for accuracies better than 0.5 %; in particular more experimental data are needed above 6 MeV.

1 (g) Inelastic scattering data of ^{238}U (Smith)

Smith summarized a report, he had recently written (" Comments on the inelastic scattering of ^{238}U ", 24 september 73), which he can make available on request (action 9). His approach was to derive a consistent description of the total, elastic and inelastic cross sections by using both measured data and available models. For this study, the two following precepts were adopted :

- only formally documented information was considered: qualitative or preliminary information was systematically rejected.

- the ENDF-B III file was taken as a common reference for comparison : this does not imply any judgement on the value of this evaluation but the basic idea is to have a unique reference .

The main conclusions of this study are the following :

- the total cross section from 0.1 to 20 MeV can be considered as well known and well represented by the ENDF-B III file (standard deviation $<$ 2% over the whole energy range).

- for the elastic cross section, there are a number of new measurements, not included in the ENDF-B III evaluation. However, the observed data often contain contributions from inelastic scattering and fission processes and the corrections are difficult. A model (deformed coupled channel calculations) has then been checked on the W data. For ^{238}U, the elastic scattering cross section, evaluated by this method , is not consistent with ENDF-B III in the range 1 to 2.5 MeV and only marginally so at higher energies.

- for the inelastic scattering cross section , the data above 1 MeV, as derived from σ_T and σ_{el} , are not consistent with ENDF-B III, particularly in the energy range 1 to 2.5 MeV. It is suggested that the contribution of the first excited state at 45 KeV (2^+) is not properly taken into account in the ENDF-B III evaluation which underestimates this contribution by about 20%. It is then recommended to study the threshold behaviour of the excitation of this 45 KeV state.

Commenting on this recommendation, Motz recalled that this study has been tried at ORNL without succes : the 45 KeV transition is highly converted and the observation of the ^{238}U X rays or of the internal conversion electrons needs an extremely thin sample; the counting rate is then very low, even if the efficiency of the detectors is high.

1 (h) Capture cross sections of Cr, Fe and Ni (above 100 eV)

(Fröhner)

The capture cross sections of structural materials were recently reviewed at a "Specialists meeting" held at Karlsruhe (May 1973). Fröhner presented the high - lights of this meeting ; there were three parallel sessions :

- Experimental data : several new sets of data were reported namely :

- KFK data from 7 to 220 KeV on practically all enriched isotopes of Cr, Ni and Fe (except ^{58}Fe) ; the analysis in the resolved resonance region is now fairly complete and the cross sections regenerated from the parameters is in satisfactory agreement with the R. P. I. data (15 to 20 %). They, however, disagree violently with the older measurements using the lead slowing down spectrometer technique and the activation technique : both give values 40 % lower. The measurements of the capture cross sections of Au, done at Cadarache, confirms the values used by KFK and RPI to normalize their data and gives confidence for these data.

- Cadarache data from 70 to 550 KeV were obtained with a Maier Leibnitz type detector on natural elements Fe, Cr and Ni ; results must be taken with caution because the weighing function which must be used to get the detector efficiency is dependent on the total binding energy of the compound nucleus. This difficulty, will therefore, not exist for enriched samples.

- Harwell data were essentially a reanalysis and a check of previously obtained data. The Harwell group contribution helped to clarify the problems encountered in capture measurements on isotopes for which scattering is much more probable than capture and for which a detecting system extremely insensitive to scattered neutrons is needed. In the resolved energy region, the agreement between RPI and KFK data and the very low value of the capture cross section between resonances were considered as a check of a correct background subtraction for the scattered neutrons. At higher energies, where resonances overlap, an additional check should be made ; use of thick C samples with black resonance filter in the beam ; use of monoenergetic neutrons together with purely scattering samples and with samples having known ratio of scattering to capture; placing the neutron producing target at the sample position inside the detector. Considerations were given to some other experimental problems :

- the multiple scattering and self-shielding effects were not considered as a serious possible source of errors : computing codes for correcting these effects can be taken with confidence.

- the efficiency calibration of the detectors is a source of uncertainty ; the Cadarache detector (C_6F_6 liquid scintillator) has been calibrated relative to standard γ-ray sources and Le Rigoleur estimates the combined errors, on the weighting function he has to use, to 2 to 4 %; the RPI and KFK were measured relative to Au : it is estimated that the accuracy is $\sim$ 5% at 30 KeV and raises up to 10% at higher energies.

- an even more serious source of uncertainty for tank measurements, is a possible fluctuation of the γ-ray spectra from resonance to resonance. In the time-of-flight measurements at KFK, such fluctuations were clearly seen and appropriate corrections were done : it is hoped that this effect does not introduce uncertainties greater than 5 to 10 %.

- Evaluated data : The main points which were outlined are the following :

- there is an extremely long delay between the publication of new data and their introduction in evaluations ; this remark applies especially for resonance parameters.

- the estimated accuracy on the cross sections at low energy ($^1/v$ range) is about 10% for Ni and Fe from recent UK evaluations; between 10 and 100 KeV, the uncertainties rise up to 30%.

- the importance of small resonances was emphasized : their contributions are predominent above $\sim$ 20 KeV.

- Γ_γ values for s-wave resonances are probably known to 20% accuracy ; the situation is worse for p-wave resonances. It was also noted that Γ_γ varies notably from resonance to resonance. A number of recommendations and suggestions were done, concerning in particular : the necessity to introduce resonance interferences when calculating the cross sections and the importance of a better knowledge of p - wave and even d- wave resonances.

- Reactor physics requirements.

- For the calculations of breeding gains for large liquid metal cooled breeders, with the needed accuracy, the requirements on the structural materials capture cross sections is $\pm$ 10% in the range 1 KeV to 1 MeV. This means that the Fe data must be accurate to this extent with a less stringent demand for Ni and Cr.

- Shielding properties are, as expected, not influenced by uncertainties in the capture data of the considered materials.

- The analysis done at Cadarache of integral data from different Zebra cores, has shown that it is impossible to increase the capture cross sections of all the structural materials as suggested by the differential measurements done by Le Rigoleur at Cadarache. However, the self shielding factors used in the Cadarache analysis are probably too high : ENDF-B III data and the newest UK evaluation indicate a tendency to lower values.

Cierjacks indicated that Kusters is editing, in the form of a KFK report, the proceedings of this meeting; it will be available within a few months upon request (action 10).

1 (i) Na capture cross section in the 3 KeV resonance (Rowlands)

Large discrepancies exist between the Γ_γ measurements, namely :

- Moxon et al. (1966) : Γ_γ = 0.6 eV
- Friesenhahn et al. (1968) : Γ_γ = 0.34 and 0.38 eV
- Yamamura et al. (1970) : Γ_γ = 0.47 eV

The value deduced by assuming that the thermal capture is due to this resonance (using a single level fit) is Γ_γ = 0.34, in agreement with Friesenhahn value. Moreover, the Moxon measurements suggest an asymetry in the shape of the capture resonance, with a low energy enhancement; the two other experiments do not show this asymetry. Rowlands suggested that, perhaps, there is not really a discrepancy : there are good grounds for believing that Moxon's data and, to a lesser extent, Yamamura's data are inaccurate and that one can rely on Friensenhahn's data. Fröhner added that the resonance integral value also supports a low value of Γ_γ for the 3 KeV resonance in Na. Smith mentioned plans for measuring the Na capture cross section at ANL (Bollinger et al).

Answering a question of Usachev, Rowlands outlined that the uncertainty in the Γ_γ value of the 3 KeV resonance is not of primary importance for Doppler effect but affects the sodium temperature coefficients and also the sodium removal effect : for example, in a Na cooled reactor, a factor 2 on Γ_γ would result in an uncertainty of perhaps 20 to 30% on the sodium removal effect, when a precision of the order of 10% is required.

1 (j) Fission neutron spectra of ^{235}U, ^{239}Pu and ^{238}U (Rowlands)

Rowlands recalled some of the information included in the Progress Reports :

- For ^{235}U, the Harwell and Studsvik data are now in agreement up to 10 MeV and a joint experiment is being made at Harwell to resolve the remaining discrepancy (~ 5%) above 10 MeV; it is expected to be completed by the end of 1973.

- For ^{235}U and ^{238}U, preliminary information has been reported in the US Progress Report (LASL) at several incident neutron energies.

- For ^{235}U and ^{239}Pu, measurements are extended up to 14 MeV.

As a conclusion, Rowlands estimates that a review of the subject would be appropriate in one or two years from now.

Liskien commented on the fission neutron spectrum of ^{252}Cf. Two discrepancies were existing; one of them, concerning the shape is not yet resolved the other one concerned the average energy for which two groups of results (one around 2.10 MeV, the other around 2.37 MeV) were reported. Three new measurements at Harwell (2.13 MeV), at Geel (2.13 MeV) and at Battelle Atomic Power Laboratory (2.13 MeV) confirm the lower value.

As a general conclusion of this Agenda item IV.B.1, it was agreed that the reviewers will send a copy of their presentation to the Chairman of the Subcommittee who will arrange the collected papers in a document to be issued by the NDS (action 11, 12 and 13).

2) Important nuclear data for shielding (Rogosa)

Rogosa took preliminary contacts with Prof. Goldstein: he will inform INDC members of further developments either by correspondence or at the next INDC meeting (action 14).

3) Status of neutron data for in pile neutron dosimetry and results of Consultants' meeting (Vlasov)

Vlasov presented a report on the status of neutron cross section data for reactor radiation measurements which was prepared by the NDS at the request of the " International Working Group on Reactor Radiation Measurements " (IWGRRM) for its November 72 meeting (document INDC (NDS)-47/L - Part I). This report gives information on 18 reactions considered as the most important (for damage studies, irradiation experiments, shield assessments, etc.) in a list prepared by the IWGRRM. Information on other reactions of this list were reported in a working paper presented at the " Euratom Working Group for Reactor Dosimetry " meeting (Brussels, April 73) and will be published as part II of the INDC (NDS)-47/L document.

The general aim is the establishment of an internationally accepted file of reaction data for reactor radiation measurements. To help in the preparation of this file, the NDS organized a " Consultants' Meeting on Nuclear Data for Reactor Neutron Dosimetry " (Vienna, September 73); the objectives and the agenda of this meeting are given in the document INDC (NDS)-53/L (page 13 and Appendix H). Vlasov outlined briefly the most important conclusions :

- necessity, in the field of reactor dosimetry, of an international agreement on the most important reactions and, for these reactions, on the energy range to be covered.

- unsatisfactory situation in the present accuracy of the greatest part of the concerned data.

- inconsistency between measured integral data and calculated integral data (from differential cross sections).

- role of benchmark experiments to obtain additional information to decide for new measurements of differential data or for new evaluations of these data.

- recommendation for a free circulation of the evaluated data files, through the Four Neutron Data Centres framework, related to dosimetry problems; the ENDF-B/IV format was considered as the most suitable for this type of data.

An INDC document, including all the papers presented to this meeting, its conclusions and recommendations will be issued as soon as possible by the N. D. S.

4) IAEA handbook on nuclear data for activation analysis (Schmidt, Calamand) :

Calamand reported on the motivations for publishing this handbook and gave its content (see Appendix IX). Concerning his own contribution (cross sections for fission neutron spectrum induced reactions), he added that it will include a review of all integral measurements available in the literature up to April 73 for (n, p), (n, α), (n, 2n) and (n, n') reactions; whenever possible the cross sections have been renormalized to a standard value of 1250 $\pm$ 70 mb for the ^{235}U fission cross section averaged in a thermal fission neutron spectrum of ^{235}U. He intented to issue his contribution as an INDC report within a few weeks; (document INDC (NDS)- 55/L).

IV. C. Subcommittee on Nuclear Data for Safeguards .

1) Report of the Subcommittee (Cierjacks)

The report of the Subcommittee was presented by Cierjacks; (Appendix VII); the deliberations were based essentially on the " Request list of nuclear data for safeguards development purposes " prepared by the NDS (document INDC (NDS) - 50/U + S). The point 5 of this report - referring to the paper SM/170/1 presented by Berenyi to the Paris Symposium - was especially discussed. Berenyi explained that the aim of this paper was to compare the requests for safeguards, concerning half lives and decay data, with the existing data. The requested data, including the claimed needed accuracies, were drawn from the document INDC (NDS)-44/G, published in June 72 by the NDS. For each request, the most recent data, obtained mainly from the " Oak Ridge Nuclear Data Project" are given for comparison and the estimated most accurate value is underlined : however no evaluation or averaging of the existing data have been made.

Yankov welcomed the interest in this work which, in particular, shows that some requests can probably be considered as fulfilled; however such conclusion can only be definitely accepted when an evaluation of the existing data is carried out; moreover, " recommended values " accepted by all the physicists involved in safeguards experiments are necessary : this is particularly true when several laboratories are taking part in a joint programme (for example, intercomparison of the determinations of the Pu content of a sample which is calculated among several laboratories for checking their analysis techniques).

Cierjacks pointed out the difficulty for a clear and concise presentation of request lists for safeguards; for example, when the level scheme of a certain isotope is needed, the interest of the requestor can be focused on certain γ -lines, in general among the more intense. If one wants to fully document his request, the comments will have to be very lengthy and if the request is not properly documented, these can be misunderstood on the side of the experimenters. Motz agreed on the fact that all details cannot be included in the comments but expressed the opinion that a direct communication between the requestor and a physicist wanting to work on the request will favorably replace any amount of details which can be included even in a thick report.

2) <u>1973 Nuclear data request list for safeguards</u> (Dunford)

A revised version of the request list has been issued by the NDS, in March 1973, as document INDC (NDS) - 50/ U + S . It contains the requests from Germany, USA and USSR. Updated versions will be issued when appropriate (action 50).

3) <u>Status of the Japanese request list for safeguards</u> (Nishimura)

Presentation of request data for safeguards techniques to the International Atomic Energy Agency has been urged for the Japanese users and researchers by Dr. K. Nishimura since 1971. In 1972, nuclear data for safeguards techniques were requested by several staff members of Japan Atomic Energy Research Institute, and they were collected and compiled by Dr. M. Hirata and Dr. H. Natsume. The total number collected of the data requested were 132. These data are needed for burn-up determination by non-destructive or destructive measurement.

In order to examine and screen these request data, a Nuclear Safeguards Subcommittee has newly been organized under the Japanese Nuclear Data Committee since February, 1973.

The members of the Subcommittee have examined and screened the collected requests by surveying the present nuclear data available. From the 132 requests, 25 were withdrawn for the following reasons:

- More than two data sets, which satisfy the accuracies requested originally, have already been reported.

- The requests for fission energy release are considered to be **macroscopic** data, and dependent on a specific type of reactor.

- The request for η can be deduced from other nuclear data i.e., α and ν .

Some of the original accuracies and priorities requested are changed through the discussion with the requestors under the consideration of present status of experimental techniques concerned. The criteria for priority are the same as those of INDC(NDS)-50/U+S. Finally, 107 data requests remain; they are presented in the document INDC(JAP)-18/G, following the format of INDC(NDS)-50/U+S. The requests which belong to priority I and II are 57 and 50, respectively. Burn-up determination is possible with the accuracy of 2-3 %, if each request is satisfied within its accuracy requested.

The Subcommittee is now collecting further requests for safeguards techniques from all over the Japanese users and researchers. These request lists will be examined and filtered in due course.

The lists of the requestors of nuclear data for safeguards and of the members of Japanese Nuclear Data Subcommittee on safeguards are given in Appendix XVII.

4) Nuclear data needs for safeguards in countries other than F.R.G., Japan, U.S.A and USSR (member concerned)

- In the UK, there are several requests related to safeguards, in the sense that they concern burn up determinations and chemical plant reprocessing requirements. However - it is a matter of " philosophy " - these requests have been incorporated in the general UK request list for reactors. This position may change in the future : the UK Safeguards Group is discussing improvement of existing techniques and development of new techniques and has recognized that there are needs for some improved nuclear data. The issue of a separate request list for safeguards is, however, not expected in a near future.

- In France, there are very few requests for safeguards and they are included in the general request list for reactors. No change of this position is expected at the present time.

5) Recent developments in safeguards techniques and new requirements for nuclear data (all members)

Cierjacks mentioned that some of the developments in safeguards techniques in the F.R.G. are included in the "Progress Report on Nuclear Research in the European Community " (document EANDC (E) 157 U - volume 1).

Yankov gave information on some of the works which are done in the USSR in cooperation with the IAEA:

It has been demonstrated, on a water cooled power reactor, that the safeguards techniques can be applied to control the amount and the composition of the fuel.

- Similar experiments are being prepared on critical and sub-critical fast reactor assemblies; various methods have been studied: one of them is to look at the fission neutron decay after injecting a short burst of neutrons inside the assembly.

- The Radium Institute in Leningrad will take part in an international intercomparison for the determination of the Pu content of different samples (solid samples, solutions, layers, cladded fuel elements, etc...) which will be supplied by the IAEA.

Answering a question of the Chairman, Yankov said that these works will probably require new requests for nuclear data but that it is too soon to specify them at present.

V - Neutron Data Centre activities.

V. A. Report of the Ninth Four Centres Meeting - Moscow/Obninsk, June 1973 (Dunford)

The minutes of the 9th meeting have been distributed as a category G document (INDC/NDS-54/G) and there is a summary of the 9th - and also the 8th - meeting in the document INDC(NDS)-53/L (pages 23 and 24).

One of the main problem discussed at the Ninth Four Centres Meeting was the completeness of EXFOR. It was recognized, by some checks done by the NDS and confirmed by the CCDN, that the completeness is still only around 50% even for data measured since 1970. It is, however, hoped that the situation will improve in the next year : a suggestion was made to prepare a list of the most important data sets, which are known to exist but which are missing from the files, and to ask help and advice for getting these data in the files; the list has not yet been prepared.

V. B. Progress reports from Neutron Data Centres : additional information to V. A.

1- Problem of non-availability of data from authors.

Smith considered as a matter of grave concern that even for data presented in papers at an IAEA sponsered conference - e.g. Helsinki Conference - there remain large blocks of important data which cannot be found in any Centre files and that users are forced to the disastrous procedure of extracting these data from a little curve published in the proceedings ! He suggested that, at least for the IAEA sponsored conferences, a condition for accepting a submitted paper should be that the data be transmitted to the appropriate Data Centre. The following points were discussed in many details.

a) Incompleteness of the Centre data files : This incompleteness was generally recognized as a very serious problem for which urgent steps should be taken. This problem has several aspects :

- in many cases, physicists are quite willing to talk about their data and to have them discussed in a Conference but they are very reluctant to send these data to the Data Centres, even when they are explicitely asked for doing so. This a problem of " philosophy " from their side : some experimenters do not want to have their data compiled until their works are really completed in all their aspects; Fröhner indicated that the incor poration of a label " priliminary data " has not improved significantly the situation.

- another aspect is the effective inclusion of the received data in the Centres files. According to Lemmel, all the data received in the NDS from its own service area are included in a very short time in the EXFOR system, available to the requestors of this service area and sent to the other Centres. Froehner said that the data from the CCDN service area are also included within a few days in the internal NEUDADA format; data received from outside are also translated almost immediately in an " internal transmitted format ". However, EXFOR is still a matter of concern for the CCDN : works are in progress for automatic conversions from NEUDADA to EXFOR and from EXFOR to NEUDADA. Rose added that, if some years ago there had been some criticism in the UK towards the CCDN, the situation is now much better. Lemmel described the present situation for fulfilling a request; the staff situation is such that, when a request comes to a Centre, the only possibility is to make a retrieval from the files and send it to the requestor. He thinks that it is not the proper way to deal with the requests: the Centre should, first of all, write to the requestor to learn in which form he wants the data, to convert the data from the files into the required form and to make a completeness check for verifying if the data available in the Centre files are really fulfilling completely the request; at least, the Centre should have to inform the requestor about the references, related to its request, for which no data are in the files. Such an " ideal operation " would be very time consuming (Lemmel's estimate is, on the average, two men weeks per request) and it is, at present, completely hopeless to get the Centres sufficiently staffed to render this service. As a major re-enforcement of the Centres seems out of question, a partial solution to this problem could be obtained by making CINDA a fully operating bibliographic index for EXFOR : in the last CINDA book, references for which data are available in the Centres are marked with a cross and, in the EXFOR format, there is provision for entries correponding to CINDA references for which no data were sent to the Centres; these entries would say " no data available " and, if possible, specify the reason for this situation. A more elaborated "flagging system " for CINDA was discussed, with different marks for data not sent to the Centres, for data having a preliminary character and for data not sufficiently documented. However, Fröhner drew the attention of the Committee to the fact that the present system, which is just coming into operation, needed nearly two years of work : a more complicated system would not only imply re-programming but also developing an elaborated book keeping system to exchange the " flags " when appropriate.

b) Problem of " preliminary data " : This problem was also considered as a very serious one. Smith mentioned cases of evaluations of considerable importance which were based on preliminary data and which have been used for years in reactor physics calculations - involving expenses of hundreds thousands dollars - in spite of the fact that these evaluations were based on obsolete data and known as wrong; in the USA, it was recently decided to use experimental data sets in evaluations only when they are properly documented. There was a general consensus of opinions that " preliminary data " are useless without additional text but that it is necessary to keep them in the Data Centres files with proper documentations (e.g. indications on further works in progress, estimation of possible sources of errors, etc...); every recipient can then make adjustments to these data. From a more technical point of view, Lemmel considered that the EXFOR system provides a good means to deal with preliminary data. In the NDS service area, it is tried to obtain the data at the earliest stage and they are entered in the EXFOR system with the mark " preliminary data ". If a more final version of these data is received afterwards, each recipient of the preliminary version (requestors of the NDS service area and the three other Centres) receives automatically the up dated version, so that they are told to remove the earlier version from their files; it is not, however, clear if such a service is in operation at the other Centres: for example, if a requestor of the CCDN service area has received the preliminary version, the NDS has no control to know if this recipient also gets the second version from the CCDN.

Another problem concerned the removal of " preliminary data " from the files when this final version has been included; Smith outlined that he has examples where the preliminary data were still sent to the requestors, together with the final version, in spite of the fact that the producer has explicitely asked to remove them. Cierjacks cited a good method which has been experienced in some cases by the CCDN: the producer of the successive versions of a set of data was invited to the Centre for checking which is the good set to be further exchanged and the file was cleaned up accordingly.

c) Checking of data : This remark of Cierjacks introduced the more general question of data checking. Smith said that for an experimental data set of some complexity (e.g. differential inelastic scattering cross sections measured at different incident neutron energies), it is just impossible for the producer of this set to check correctly the listing he receives back from the Centre. Fröhner thought that the easiest way to have data checked up by the producer is to provide him with data plots; however , it is extremely time consuming for the Data Centres, especially when the data are of the kind mentioned by Smith, and require a great number of curves for one data set. For this reason, the CCDN only asks the experimenters to look at the bibliographic part (comments, quoted publications, authors' names, etc...) which is attached to every data set and to check the beginning, the end and a few parts chosen at random of the listings. The N. D. S philosophyis somewhat similar:the authors are only asked to check the additional comments (e.g. concerning error analysis) and good reponses are generally received; it is not considered their responsibility to control the data tables number by number : this is done by the N. D. S; it is, however, recognized that the problem for the N. D. S. is not so complicated as for the other Centres because, in general, they have not to deal with large sets of data.

The question of a unified choice for the units was also raised : this will considerably simplify the check up of the data. However, in EXFOR, the decision has been taken to provide for a large variety of units for a given physical quantity in order to stay as close as possible to what the authors are sending to the Centres or are publishing in the literature. This kind of " compromise " on the EXFOR presentation is certainly a problem to be considered in the Four-Centres meetings.

As a general conclusion, it was agreed that a number of technical problems are still pending for consideration in the Four-Centres meetings, one of the most urgent being related to references for which data remain for years as " preliminary data " in the Centres files (action 15). The INDC strongly supported the compilation of preliminary data by the Centres and all members agreed to re-enforce their action to have data sent to the relevant Centre in the shortest delay (action 45).

2 - Statistics for requests and dissemination of data .

Detailed information is given in the " Report on the Ninth Four-Centre Meeting " (document INDC(NDS)-54 G).

As far as the N. D. S service area is concerned, figures concerning the request statistics for experimental and evaluated data are given in INDC(NDS)-53/L; there is a general tendency for requesting evaluated data and, in addition, most recent data not already included in the evaluations; this kind of request creates a difficult problem because one has to go inside the evaluated files in order to know which experimental data have been included. Lemmel added that, due to the EXFOR system resulting in a very fast growing of the data files, the N. D. S is reconsidering its data handling programmes for producing a standardized output format; this format will probably be very similar to NEUDADA (same computer configuration at N. D. S. and C. C. D. N.).

Complementary information from the other Centres is given in Appendix XVIII for the CCDN, Appendix XIX for the NNCSC; for the CJD, Usachev said that, before the end of 1973, two data tapes will be produced and distributed, both of them containing more than 30 pieces of works.

V. C. Usefulness of EXFOR information to evaluators, measurers, reactor designers and other users of neutron data :

The information for EXFOR documenting is apparently treated differently in the four Centres. Lemmel explained that the N. D. S. is putting a very hard (and personnel consuming) effort for having a documentation as complete and unified as possible for its EXFOR tapes ; he gave different examples of the tasks the N. D. S is now carrying out :

- for data published in several references (progress reports, local reports, conference proceedings, journals, etc ...), search for the most recent and reliable one is done when the successive published data sligthly differ, which is quite often the case.

- for data not sufficiently documented in the literature, questions are asked to the authors to get additional information which is often of great importance to the users.

- for preliminary data, information is requested and added, which cannot be found elsewhere.

The CCDN has a rather similar philosophy whereas the NNCSC compiles the data reference by reference and leaves then to the users the task to go back to the references. The question is then to know if the effort devoted by some of the Data Centres is useful for the users and must be continued. Several opinions were expressed :

- for data for which no publication exists at all or for which information is very incomplete (in general preliminary data), it was generally agreed that an effort of the Data Centres is useful .

- for data which are better documented in the literature, the opinions were not unanimous : some members considered that there is some interest to have a kind of uniform presentation of the comments in the EXFOR files; for others, an evaluator must in any case come back to the original publications for correctly weighing the experimental data and the EXFOR comments can be made very short (e. g. restricted to the exact references to publications) without any harm for the users; Smith expressed even the view that some disadvantage must result from transforming EXFOR in a kind of "computerized journal publication" which will incite the users to rely entirely on the EXFOR comments which unify physics, analysis and data and not to come back to the original publications.

Liskien expressed his feeling that it is too early to judge the value of the effort developed for a full documentation of EXFOR because, at the moment, only a part of the EXFOR files is fully documented whereas, in many cases, the users have still to go back to the articles to pick up the information.

As a general conclusion, it was agreed that :

- the first priority must be put on the completeness of the data files.

- the documentation of the files is a second priority. It was asked therefore to maintain the present documentation system in use in the different Centres (action 16) until clearly expressed views are given by the users.

V. D. Status of CINDA:

Fröhner gave a general statement on the evolution of CINDA since 1965 up to the last 1973 issue (see Appendix XVIII-paragraphe 3. 3); in the next issues, it is expected to eliminate all the few errors which still remain. Lemmel added that the N. D. S is since 1971 responsible for the publication and the distribution of the CINDA books and has two problems:

a) Completeness of CINDA: The completeness of CINDA has been extremely good until 3 years ago but the situation has been deteriorating progressively, in particular with regard to internal reports. Although no definite figures can be given, the situation can be described as follows :

- for the NDS service area, it is thougth that the completeness is satisfactory : all laboratory reports from small countries are available at the IAEA library and are referenced in CINDA.

- for the CCDN service area, the completeness has suffered from the effort put on the file conversion; however, this work being now achieved, the situation is improving rapidly.

- for the Obninsk service area, entries are regularly done for all USSR journals and also conferences but the coverage of USSR laboratories reports and preprints is still insufficient.

- for the USA and Canada service area the coverage of laboratory reports seems to be fairly incomplete.

b) Distribution of CINDA : The U. S. A bulk order dropped from 400 copies for CINDA 71 to 275 copies for CINDA 73. This was partly compensated by a free sale market by a New York sale agent for the IAEA publications. However, if this tendency to a decrease in the official support of CINDA should continue in the USA and should appear in other countries, the financing of the CINDA publication which is still based on the bulk orders from NEA, USAEC and USSR would be in danger.

The INDC considered that CINDA has been an outstanding success and that, if it is in danger, either for its incompleteness or for its financing, it is a very serious concern for the Committee. All members were asked to report to NDS about problems of CINDA entries and CINDA usefulness in their respective countries (action 17) and the Heads of the four Centres were asked to take the necessary steps to maintain it as the handy and vital tool it has been up to now (action 18).

VI . Nuclear Data requirements .

VI. A. Report on WRENDA .

A report on WRENDA, prepared by Dunford (Appendix XIX), gives information on the past activities and future publications. Basically, the N. D. S assumes now the complete responsibility for WRENDA, with the cooperation of the other Neutron Data Centres. On page 3 of the Appendix XX, an example is given of the proposed layout of the future WRENDA editions: similar requests from different requestors are grouped together; an accession number of 6 figures is attached to each request: the two first figures indicate the date of the request, the third one designates the service area (1 for USA + Canada; 2 for CCDN; 3 for NDS; 4 for USSR), the three last figures are sequential numbers in the individual lists from the different service areas. As the WRENDA book is not considered as the most appropriate means for reviewing the requests, each data centre will receive, on an annual basis, a retrieval of the requests coming from its own service area for revision (page 2 of Appendix XX). This revision will be done through the four Centres network : each Data Centre will have to transmit to the officially designated national contact the retrieval of the requests issued by his country, to collect the revised list and to sent it back to the N. D. S. All members are asked to send their comments to Dunford on his proposed concepts for future presentation of WRENDA (action 20) and to designate the official national contact for the operation of the proposed system (action 21).

VI. B. National screening procedures and official channels for submitting WRENDA requests to IAEA.

The chairman outlined that this question was already settled as a result of the decision taken on point VI A. In countries where a " National Nuclear Data Committee " does already exist, the " official national contact " is obviously this Committee; in other countries, it has to be designated as stated by action 21. As far as the USSR is concerned, a particular effort will be made in the future for having requests as well documented as possible with a particular attention to the problem of the needed accuracies; the paper of Usachev and Bobkov - document INDC (CCP) - 33/L - describes the mathematical procedure which will serve as a basis for obtaining a more strict and uniform definition of the needed accuracies.

Rogosa added that the USNDC, at its June 73 meeting, has agreed on the proposed procedure for dealing with WRENDA ; the USNDC would concern itself with technical matters related to the U. S. A requests (screening, up-dating, revision, etc...); the liaison with the N. D. S and, in particular, the discussion of presentation and edition problems of the USA list, will be left to the NNCSC.

More information on the deliberations of the WRENDA problems by the USNDC can be found in document INDC (USA)-59/G.

A continuing action (action 47) was left on each member to ensure an appropriate screening of Wrenda in its own country.

VI. C. Unique definition of requested accuracies and priorities of future WRENDA requests :

The chairman introduced the discussion by indicating that, as far as priorities are concerned, there are, in the introduction to WRENDA, clear definitions of what is meant by priority 1, 2 and 3 ; the Committee agreed that this point needed no further discussions.

For the definitions of " requested accuracies ", the problem was discussed in the past but not solved at all so far. Rowlands made a brief historical review of this problem in the UK: about 10 years ago, when the nuclear data requirements were formulated for the first time, the results of integral experiments were ignored; a few years ago, the requirements were revised to take into account integral data and, for a fast reactor in its initial state, it is thought that k_{eff} and breeding gain can be predicted with a sufficient accuracy, on the basis of existing differential data and integral measurements. There remain, however, two problems:

- first of all, because, in some cases, differential data were adjusted more than the claimed accuracies would have permitted, more measurements of nuclear data are needed to give a proper basis to the extrapolations.

- secondly, requirements remain for data corresponding to burn up effects (fission products, higher Pu isotopes), to alternative structural and control materials; in addition, a better understanding is needed for the differential data in the resonance region for prediction of other effects, such as the Doppler effect.

Rowlands recognized that the accuracies corresponding to the UK requests are only rough estimates, based on the following procedure : reactor physicists define their " targets "; then the available differential data are carefully evaluated, considering to what extent the errors are systematic or random over a wide energy range; afterwards, one can assess the consequences of these two types of errors and try to define the required accuracies on differential data, which remains a difficult problem because, very often, the quantities needed by reactor physicists are the results of complicated relationships between differential data. The USSR approach to this problem represents a considerable amount of work by Usachev et al and has been presented at the " Conference on Nuclear Data in Science and Technology " (Paris, March 73), at the " Neutron Physics Conference " (Kiev, July 73) and in the document INDC(CCP)-33/L. The conclusions are, in some cases, different from Rowland's statements: as an example, it is believed that the integral measurements generally permit to reduce the accuracy requirements on differential data but obtained accuracies of integral experiments are not sufficient to do it actually. Rowlands, however, agreed with Usachev on the importance to distinguish between the statistical errors, which have a slight effect on reactor physics parameters, and systematic errors which have a considerable effect. In the general discussion, two divergent points of view were expressed:

- for some members, it must be admitted that one does not really know the influence of microscopic data on reactor parameters; then, we should only insure that the WRENDA comments are sufficiently explicit to express what the requestors are actually asking for.

- for other members, there is a danger in ignoring that the main purpose of WRENDA is to give clear targets to evaluators and measurers : the three aspects of the " accuracy problem " (accuracy in requests, in measurements and in evaluations) must be treated in a consistent manner.

The difficulty to arrive at a unique definition of accuracies was however unanimously recognized and all members (particularly the USSR delegation which has already devoted a great deal of effort in this field) were asked to make proposals for the next meeting (action 22).

VI. D. <u>Separation of WRENDA into two lists (one for evaluations and one for measurements</u>).

Such a separation exists only in the UK and, according to Rose, this situation arose from the fact that, some years ago, it was felt that the effort on measurements was too large as compared to the effort on evaluations. The committee which formulates the request list of the Reactor Group of the AEA, now known as DIDWP (Differential and Integral Data Working Party), decided to pay considerable attention to the needs for evaluation and drew up separate lists for evaluation and measurement. This committee, which has a strong common membership with UKNDC, consists of differential and integral measurers, evaluators, compilers, theorists and reactor physicists so that the decision to include a request in either one of the two lists is taken by representatives of the whole community. The list is then transmitted to the UKNDC which finds the separation into two parts very suitable for distribution of the tasks of evaluation and monitoring, planning of new experiments, etc. Rose has however no objection to merging the two UK lists into a unique WRENDA if there is any advantage in doing so.

Dunford recalled that the publication of WRENDA has a very clear aim, namely to encourage some actions to fulfill the requests: one can expect to get measurements done in other countries (and in particular in developing countries) than the requesting country; WRENDA must then be already screened for requests which could be satisfied by evaluations: this would avoid experiments being done which are not really needed.

It was, however, recognized that an " integrated system " (similar to the UK system) for screening the request list does not exist in many countries and, therefore, it is not always clear if an evaluation or a measurement is needed. Moreover, there is, very often, no clear dividing line : a request for a measurement can be transformed into a request for an evaluation when new measurements become available and the same situation can also happen if the urgency of a request is changed.

It was then decided to maintain a unique list with special care in flagging properly - in the WRENDA comments - the requests which are specifically directed to evaluators.

VI. E. Topical review of WRENDA requests.

The Chairman started the discussion by proposing that the N. D. S. make an attempt to introduce, in the status comments of WRENDA, the main information of the review works done by the Sub-committee on discrepancies and by the IAEA Consultants Meeting on Nuclear Data for Reactor Neutron Dosimetry. Dunford agreed to make such an attempt (action 23), so that the INDC members will be able to talk, in their National Data Committees, about the value of such status comments and report, at the next INDC meeting, on their interest to participate in a more extensive WRENDA review. A preliminary discussion took place on this possible extension of reviewing WRENDA and a distinction was made, among data producers, between measurers and evaluators. As far as measurements are concerned, when an experiment has been completed, published and data made available to the Data Centres, the status comment which can be appended to WRENDA cannot be more than a summary (or a repetition) of the corresponding CINDA entry: its interest is then very limited. This is not the case for experiments which have not yet been completed : a brief comment on a " measurement in progress " indicating some estimation of the completion date, the energy range, the expected accuracy would be very useful.

For evaluations, the problem is more complicated, for two reasons; first of all, the evaluations are, at the present time, not fully available all over the world; moreover, the evaluations are documented by an " Evaluation report " which has a very technical nature and includes information on the experimental data and theoretical aspects taken into account, on mathematical procedures which have been used, on formats, etc. This report is extremely useful for the experts making use of the evaluation but it would be very difficult for the Data Centres to extract from it the few key informations to be introduced in WRENDA as status comments. On the first point, there were divergent opinions : some members thought that, when an evaluation is not fully available, it is of no interest to make reference to it in WRENDA status comments; for other members, it is already a valuable information, for data users who have not access to the evaluation, to learn that an evaluator has arrived at the conclusion that, on the basis of the existing data, a certain quantity is thought to be known with a certain accuracy: it can guide the decision for new measurements or for evaluating the existing data. On the second point, it was agreed that it should not be too difficult for an evaluator to prepare a condensed version of his " Evaluation report " giving the key information in a few lines which can be incorporated in the WRENDA status comments. On these various problems, no decision was taken. However, the INDC members agreed to encourage, through their National Data Committees, both experimenters (for measurements in progress) and evaluators to prepare status comments in the form mentioned above; these comments will be incorporated in the national request lists transmitted to the regional Data Centres and, when collecting all this information for WRENDA edition, the NDS will study the most appropriate way to integrate them in the WRENDA status comments.

VI, F. <u>1973 Nuclear data request list for thermonuclear fusion</u>.

The " International Nuclear Data Request List for Fusion " was prepared by Lemley and will be distributed as an INDC document (action 25) after a few small changes communicated to him during the meeting. This list consists of two parts :

- the first one is a merger of data requests received through official channels from the appropriate national authorities in five countries (Federal Republic of Germany, France, UK, USA, USSR). This list contains, with one exception, requests for data associated with neutron reactions and is sorted by Z - A of the target nucleus and by quantity requested, according to the procedure recommended at the last INDC meeting.

- the second one contains charged-particle data requests prepared by J. Rand McNally, Jr., of Oak Ridge National Laboratory. It is used with permission of the author and the USAEC.

When the new WRENDA system becomes operational, the Fusion List will be stored in the WRENDA format for convenience of maintenance and manipulation. For the present the Fusion list will be published separately from other requests in the WRENDA system.

Except for the charged-particle request list, which is based on the need to evaluate other possible fuel cycles, all the national lists are based on the D-T fuel cycle and contain requests almost exclusively for neutron data. Among the various materials considered for construction of the containment vessel, the List shows no definite consensus even within the individual national programmes.

Some requests contain detailed information concerning the status of existing data. Other requests are " for information ", and no review of existing data or experiments in progress has been attempted.

The priorities assigned to the requests do not follow a single set of criteria. In some cases the Agency-developed criteria have been used ; whereas in other cases an undefined three-step - most-important, important, less-important-system has been used.

The philosophies behind the priority assignments also vary. The USA has deleted all priority assignments as premature. Other assignments seem based on the premise that if a fusion reactor were to be constructed, then the priority assignments represent the relative importance of the data requirements to the best of present knowledge.

Some requestors attempt to put nuclear data into the context of the fusion program as a whole. In general their requests are for data necessary to evaluate various materials and concepts and have rather liberal accuracy requirements. Since the primary goal of fusion research- demonstration of scientific feasibility - apparently does not depend upon improved nuclear data, their priority assignments are generally low.

NDS plans to maintain the Fusion List as long as interest continues in the Member States. However it is the Member States who must decide which data are needed and important whithin the contexts of their own fusion programmes.

Commenting on a remark of some members on the apparently low interest in nuclear data expressed by the fusion physicists working on national programmes, Lemley agreed that nuclear data is not the first priority in fusion researches, relative to other aspects. However the International Fusion Research Council has shown a continuing interest in the work done by N. D. S. in this field : it has supported the preparation of the request list at its last meeting (summer 73) and asked to be kept informed of this activity at its next meeting (beginning 74). Lemley will provide the INDC with all reaction and attitude which will be expressed during this meeting towards the interest and this technical aspect of the nuclear data request list.

In the meantime, it was agreed to maintain the list in an up-to-date manner with the last informations sent by member states. Nishimura indicated that discussions have taken place in Japan between fusion specialists and the J. N. D. C : it is hoped, in a near future, to establish a Subcommittee for fusion, which will prepare a nuclear data request list to be sent, after normal screening procedure, to the N. D. S. (action 24).

VI. G. Request lists versus other means for adequate transmission of data needs from data users to producers in fields other than reactors, safeguards and fusion.

It was agreed that this problem was one of the important matter to be discussed by the "Sub-Committee on non-energy applications of nuclear data" and, then, left for consideration by this Sub-Committee.

VI . H. Subcommittee on WRENDA policies .

Some discussions have already taken place on items VI A, B, C, D and E. It was agreed to leave this problem for further considerations to the "Sub-Committee on Energy applications of nuclear data."

VI. I. INDC recommendations on potential WRENDA request measurement programmes for smaller countries .

The report prepared, with the help of Dr. O'Neal (IAEA), by the "Ad-hoc Subcommittee on nuclear data measurement programmes for developing countries " and adopted by the INDC is given in Appendix VIII. Schmidt explained the general motivations which guided the Sub-Committee : first of all, many cross section measurements are already done in developing countries and, by linking their efforts together with WRENDA, the efficiency would be better; moreover, it was felt that many WRENDA requests could be in principle satisfied by measurements in developing countries if they can receive some help in the form of targets, samples, advices, etc... The importance of the problem was fully recognized and, also, its difficulty, particularly with regard to practical implementation and fundings.

Schmidt outlined that the resources of the N. D. S to support this programme were strictly limited to the funds available for the target and sample programme (17 000 US dollars for 1974); a formal recommendation was then addressed to the Director General of the IAEA to explore the possibility for additional fundings outside the Agency (Recommendation III. 3 of Appendix III and action 33). The different points of the Sub-Committee report conclusions were discussed in detail :

Point 1 . As all the conclusions imply short term actions, it was agreed that there is no need for a standing Sub-committee at the present time and the ad-hoc character of the Sub-committee should be maintained.

Point 2 . An attempt to specify a few measurement programmes related to INDC interest (actions 30 and 31) was considered as one of the first tasks to be undertaken by the Sub-committee.

Point 3 . Bilateral arrangements between countries should be encouraged (action 32) although it was recognized that such arrangements already exist : payment by a developed country for the visit of a scientist from a developing country to work on a programme of common interest; funding the visit of an experienced scientist from a developed country to guide a particular programme; supply of research materials; etc....

Point 5 . The best way to compile a listing of available facilities and major programmes in developing countries was left to the discretion of the NDS (actions 28 and 29). Schmidt proposed to compile all the information which he will be able to extract from various sources (progress reports, for example) and to send this information for being completed to the Liaison Officers and INDC members.

A possible role of the Trieste Centre was also discussed : this Centre receives students from developing countries for training them in theoreticel physics; then, when coming back to their countries, these students have probably a sufficient level of knowledge to perform model calculations for evaluations and to help, in this way, the international community of evaluators. All INDC members were therefore asked to inform the NDS about possible problems on nuclear structure and nuclear models to be proposed to the Trieste Centre, having in view further applications in evaluation (action 26); Schmidt will then contact the Trieste Centre (action 27).

VII. Targets and samples for nuclear data measurements

VII. B. National screening procedures for sample requests.

Dunford indicated that submissions were received either from liaison officers or directly from scientists who have already been in contact with the N. D. S. He expressed the wish that the quality of the requests (" documentation " for them) and their applicability to the IAEA programme be improved . Liaison Officers and INDC members from developing countries might get the proposed programmes known, in their countries, to all the scientists who could be interested and also, promote and encourage the type of requests which the INDC has recommended for N. D. S support.

This discussion was enlarged by several remarks :

- the small amount of sample requests in 1972 seemed surprising and, if the reason is a lack of interest of developing countries for implementing or expending cooperative programmes in the field of applied nuclear data, this must be a very serious concern for the INDC. Dunford agreed on this remark but outlined that 1972 has to be considered as a trial period and that the problem will have to be reviewed at the next INDC meeting when information on the requests received for the 1974 targets and samples programme will be available.

- there is often a considerable difference between the cost of the basic material needed for a sample and the cost for having the sample prepared in a suitable form : all the requestors have to be made well aware of this aspect of the problem .

- some sample requests correspond to measurements which seem very ambitious and, perhaps, beyond the capabilities of the requesting countries. Dunford said that, in case where the NDS have some doubts on this aspect of the problem, advices from the competent INDC members would be very much appreciated. Smith volunteered to review at the discretion of the N. D. S, all the requests in the area of fast neutron scattering and Motz agreed, in the same consensus, to act as an intermediary within the USNDC to find appropriate reviewers for sample requests in other areas.

- the proposals made by the NDS (page 4 of Appendix XX) for getting the information supporting a sample request were also discussed. It appeared that, in some cases, a country could be ready to supply, free of charge, the basic materials for sample preparation but would like to have more information such as time for the loan, possible modifications of the materials (activation, contamination, modification of the chemical or physical form), estimation of possible losses, etc... All members were then asked to make proposals to Dunford on informations which should be added to his draft proposals (action 34).

VII.C . Support of non-neutron nuclear data measurements.

It was agreed that sample requests will be considered by the N. D. S. only if they ensure data needs. The request lists are then the basis for judgement and first priority will be given to sample requests for nuclear data measurements which are required in the official request lists : in this respect, no discrimination will be done between neutron and non neutron nuclear data. As a second priority, if possibilities and funds remain, sample requests for other measurements, which may have an application, could also be considered.

VIII . Neutron Data Evaluation

VIII . A. Progress Reports on evaluations

As most information is included in Progress Reports and other available documents, the Chairman asked for limiting the presentations to the outstanding points .

1- U. S. A. : A summary report on works related to ENDF/B is given in Appendix XXI.

Complementary information on evaluation activities in the USA can be found in the " Technical Minutes of the USNDC meeting " held in June 1973 (document INDC(USA)-59/G from which Appendix XXII is extracted).

2- U.K. : Evaluation activities are described in the " UK Nuclear Data Progress Report " (document INDC (UK) -20/L) :

- on page 29, evaluations of the cross sections of several actinides are reported: fission and capture cross sections of ^{241}, ^{242}, ^{243}Am and ^{242,243,244,245}Cm up to 10 MeV have been included in the UKNDL files.

- the evaluation of the neutron cross sections for ^{7}Li (10 KeV to 15 MeV) has been carried out by T. W. Conlon (report AERE-R. 7166).

3- U. S. S. R. : The most recent evaluations were reported at the " Second National Conference on Neutron Physics " (Kiev, May 1973); they concern :

- ^{239}Pu cross sections : the evaluation report and the data files will be soon available .

- the thermal neutron cross sections of nuclei significant for the Thorium cycle in a thermal neutron reactor.

- ^{238}Pu, Am and Cm isotopes cross sections.

- improvement of the previous ^{238}U evaluated data which have been distributed in the SOKRATOR format.

In addition :

- evaluations on Fe, Na and O are in progress.

- the evaluation of the Re cross sections has been completed and published in one of the Obninsk Bulletins which are regularly provided (for translation and distribution) to the N. D. S; the published data are in the form of a 80 group constant set but the microscopic data will also be made available.

Answering questions, Usachev said that :

- as far as microscopic data are concerned, a great effort is being done for entering all evaluations in the SOKRATOR format; it is hoped to issue the total file for ^{239}Pu in a near future and, later on, the files for the ^{235}U fission cross section and for the angular distribution of scattered neutrons for more than 40 elements.

- group constant sets (in general 80 groups; in some cases 26 groups) have been or will be made available to the N. D. S. for a number of elements (Re, ^{238}Pu, ^{241}Am, etc...) in tabulated form.

4- Sweden : A status report of the evaluated neutron data libraries at the A. B. Atomenergi is given in the document INDC(SWD)-5/G (page 62); it describes the BUXY-library (for thermal reactors) and the SPENG library (mainly for fast reactors).

5- C. B. N. M - Geel : Evaluations concern neutron producing reactions :

- T (d, n); D (d, n); T (p, n) reactions from 0 to 10 MeV (published in Nuclear Data Tables).

- ^{7}Li (p, n) reaction from 0 to 7 MeV (just completed).

- Neutron producing cross sections for Be (in cooperation with Geiger from Ottawa).

6 - Romania : There is no neutron evaluation activity but codes for group constant calculations, obtained from the Federal Republic of Germany, Italy and Sweden , are used at the " Institute for Nuclear Technology ".

7 - Japan : A status report on Japanese evaluations is given in the document INDC (JAP)-17/L (pages 24, 25 and 27).

- Evaluations on ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu are reported in the JAERI -1228 report; evaluation on ^{241}Pu is just being started.

- The evaluation of the neutron cross sections of 28 fission product nuclei (1 KeV to 15 MeV) is continued ;these nuclei are estimated to provide about 80% of capture cross section times mass yield ratio of all fission product nuclei. Results presently available will be reported at the " IAEA Panel on Fission Product Nuclear Data "(Bologna , November 1973).

- A code (SPLINT) has been written for plotting on the same graphs evaluated and experimental data; evaluations are accepted in the UKNDL, KEDAK and ENDF/B formats.

8 - Italy : The evaluation work in Italy is routinely carried out at the Nuclear Data Laboratory at Bologna.

a) A comparison between single level and multilevel calculations of scattering cross sections in the resonance region for Cr, Ni and Fe has been recently completed and presented at the " Meeting on Structural Materials " (Karlsruhe, May 73).

b) The following works are in progress :

- (n, n') and (n, charged particle) cross sections have been evaluated for ^{63}Cu, ^{65}Cu and Cu natural elements; the evaluation reports are being prepared and the data files in the UKNDL format will be made available to the CCDN by the end of 1973.

- The evaluation of Gd has been undertaken for the application of a more rigorous coupled channel model (e. g. Jupitor code) in the energy region where the spherical optical model and adiabatic approximation have shown their inadequacy. Some problems have to be solved in order to reduce the computing time.

- A comparison of experimental values of $\langle \Gamma_{\gamma} \rangle$ with the predictions of various theoretical formulae has been carried out; the result will be presented at the IAEA Panel on Fission Product Nuclear Data " (Bologna, November 1973).

9 - India : Information is given in the document INDC (SEC)-35 L (page 87).

10- Hungary : Information is given in the document INDC(HUN) - 11L (page 3).

11- France : Information is given in the document EANDC (E) 157 U - Volume II (page 13 and following) which will be made available to the participants of the INDC meeting (action 5). Main points concern :

- a contribution to the UKNDL (translation from KEDAK format to UKNDL format of the ^{235}U and Mo evaluations; evaluation of the ^{151}Eu and ^{153}Eu data).
- evaluation of ^{241}Am data.
- evaluation (still in progress) of the total, elastic, inelastic, capture and (n, 2n) cross sections for 22 fission products for neutron energies from thermal up to 15 MeV; for this evaluation, works of Cook and Benzi, contained in the UKNDL file, have been used.
- a file of nuclear data in the ENDF/B format, has been prepared for a number of fission products; this library includes independent yields, half-lives, decay scheme data for fission products from thermal and fast neutron induced fission of ^{235}U and ^{239}Pu and fast neutron induced fission of ^{238}U.

12 - Federal Republic of Germany : Evaluation works are described in the document EANDC (E) -157 U-Volume I (page 36). Main evaluations concern :

- ^{240}Pu, ^{241}Pu, ^{242}Pu in cooperation with Israel.
- (n, p), (n, α), (n, 2n) threshold reactions for the stable Cr, Fe and Ni isotopes; data have been incorporated in the KEDAK library.
- ^{6}Li and Pb : data have been tested and incorporated in the KEDAK library. Works are in progress on ^{238}U (total and inelastic cross sections).

Answering questions, Cierjacks added that :

- there have been changes in the personnel of the Karsruhe Evaluation Group which is limited to two physicists at the present time but will be expended up to 5 physicists.
- the KEDAK library is in continuous evolution and, in particuler, the high resolution total cross section data from Karlsruhe have been entered in KEDAK.

13 - Canada : The main feature is the evaluation of the cumulative fission product yields for thermal neutron induced fission of ^{233}U, ^{235}U, ^{239}Pu and ^{241}Pu; this work of Walker is reported in the document INDC (Can) - 12/G; data are given in tabulated form.

14 - Australia : Gemmell reported on:
- evaluation of KeV neutron capture γ -rays.
- evaluation of s and p wave neutron strength functions, published by Musgrove as an AAEC report which will be made available to the NDS.

15 - Argentina : Ricabarra outlined that the evaluation activity in Argentina is very limited (for example : resonance integrals of Nd isotopes). There is however a great interest for microscopic evaluated data files ; up to recent times, the multigroup cross section set from KFK was used but, for the future, it appears necessary to generate multigroup cross section sets adapted to the nuclear energy programme in Argentina. The USAEC has agreed to make its evaluated data files available to Argentina; however, many scientific and technical problems are still pending to implement the codes needed to use these files for obtaining multigroup sets.

VIII. B. Progress in exchange of evaluated neutron data .

The situation has not changed very much since the last meeting and the discussion was centered on the intercomparison of evaluated data from different sources. It was generally agreed that an " evaluation of evaluations" is not explicitely needed because when an evaluation is started, all the previous works (and in particular available evaluations) are taken into account. Moreover, an " evaluation of evaluations " would be sensible only when there are different evaluations based on the same sets of experimental data: if not, the " non-objective component " of the evaluations, which results in the rejection of certain experimental data sets by an evaluator and its acceptance by another, will not be removed and nothing will be gained. It was also said that, because an evaluation cannot be totally objective, the user will in general rely upon evaluations done by physicists who have direct contacts with him (evaluators of his own country or evaluators he had experienced in the past).

As a completely free exchange of evaluations is not practised at the present time, it was considered that a first step for intercomparison of evaluations could be achieved in the field of standard cross sections : the ENDF/B-III data files for such data have been made freely available and Rogosa confirmed that possible up-dating of these files will be sent regularly to the N. D. S.

IX . Non - Neutron Nuclear Data.

IX. A. Programme for IAEA Study Group Meeting on Non-Neutron Nuclear Data Compilation .

Schmidt recalled that the consideration of Non-Neutron Nuclear Data by the IAEA was a consequence of the " Symposium on Nuclear Data in Science and Technology " (Paris, March 73) and of the informal discussions which took place in Paris after the Symposium between INDC members, IWGNSRD members and other concerned scientists. From further correspondance with the participants in this discussion and with national and international organizations compiling and evaluating nuclear data, the NDS drafted a proposed Agenda (Appendix VI) for an IAEA Study Group meeting. The general aim is that the field of applied nuclear data is so broad that it is certainly not possible to cover the whole field in only one meeting. The INDC then recommended to have a general framework which will allow the consideration of all possible nuclear data for applications; under this framework, meetings could be convened for technical discussions on one or a few particular topics. The choice of the first two topics to be considered (namely : nuclear level schemes and decay data, as proposed by Schmidt) was approved (recommendation III. 2 to the Director General of the IAEA - Appendix III), with the following comments :

- other topics were recognized as having an equivalent applied interest but two very important fields are already covered : Münzel has just published (Landolt- Börnstein editors) a very comprehensive compilation on charged particle excitation functions and the N. D. S. is editing an " Activation Analysis Handbook " which includes many neutron, charged particle and photon cross sections; for the moment, it seemed best to wait for the impact of these two compilations on the users.

- even restricted to the two proposed items, it is not expected that the subject will be fully covered in one meeting. The INDC will have to discuss the results of this first meeting and the future developments in the two fields under consideration, together with the inclusion, in the scope of the Study Group, of new items.

- the existing national Centres in the two relevant fields (for example the " Nuclear Data Project " at ORNL) are compiling data without any practical applications in mind; it was not considered, by the INDC, as a responsability of the Study Group to make a distinction between "applied" and " pure physics " nuclear data. The work of the Study Group would have to be essentially technical : discussion on keywords, formats and rules for compilation and transmission of experimental and evaluated data, etc. . . . The applied aspects of the data should be the concern of the relevant INDC Sub-Committees.

IX. B. Progress Reports on non neutron nuclear data compilation and evaluation including cooperation between groups and centres .

The Chairman recalled that all the relevant information was given, for the U. S. A. , at the last INDC meeting (Appendix XXIV of the Fifth INDC meeting). Concerning the other countries - and in particular the USSR - information is included in papers presented at the " Symposium on Nuclear Data in Science and Technology "(Paris-March 73). It was then agreed to refer to these documents and reports.Yankov added the following complementary information on the USSR Centres :

- the Centre in the Kurchatov Institute employs 11 people (among them, 5 are physicists) and it is expected to double the technical personnel within one and a half year.

- the Centre in Leningrad is working in cooperation with the " Nuclear Data Project " of ORNL and an exchange of data is now in operation.

Concerning international cooperation, Grinberg presented a joint work of the BCMN (Euratom, Geel), the LMRI (CEA, France), the P. T. B. (Federal Republic of Germany) and the I. K. O (Netherlands). This work is a critical evaluation of the decay properties of three radionuclides having important applications, namely ^{58}Co, ^{60}Co and ^{51}Cr. As the result of this cooperative effort has been recently published by the " Atomic Energy Review " of the IAEA, Grinberg outlined only the most important aspects :

- the list of nuclei for which decay properties are needed with a high priority is very large : 25 nuclides, according to the present estimation of the Group.

- there are several hundred papers published on experimental and compilation works for the most widely used radionuclides : this leads to an important bibliographic effort.

- the evaluations must be done by scientists which are directly involved in experimental work in the field under concern.

- " evaluation rules " must be agreed upon, including , in particular, the rules for assignment of uncertainties ; the authors considered that an evaluation which does not include information on uncertainties is of limited use.

After having agreed on general procedures, two groups worked separately on each of the three radionuclides, they discussed their results and arrived at recommended data. There is no definite decision for completing the project by extending it to other nuclides : it will greatly depend upon the reactions of physicists working in the same field and upon their interest and possibility to contribute to this cooperative effort.

IX. D. IAEA compilation of non-neutron nuclear data compilations and evaluations .

Due to lack of manpower, no activity has been undertaken in this field; the NDS is nevertheless considering further actions, depending upon its possibilities.

IX. E. Requirements and applications of border-line nuclear and atomic data.

A working document has been prepared by Berényi (Appendix X): it will be considered by the standing " Subcommittee on non-energy applications of nuclear data " .

IX. F. Proposed Working Group on Physical Data for Radiation Dosimetry, Radiation Biology and Radiotherapy.

Eisenlohr of the " Life Science Division " of the IAEA explained that a Consultant Meeting was convened in Vienna on November 22/24, 1972 to determine the physical data of importance for radiation dosimetry, radiation biology and radiotherapy (subjects summarized below by the expression " radiation research physics "). The Consultant Meeting was composed by Pr. Dr. D. Harder (Würzburg, R. F. G), Dr. J. A. Dennis (Harwell, UK), Pr. Dr. Linhard (Aarhus, Denmark), Dr. M. G. Soudain (CEA, France).

A critical survey of publications in the field of radiation research physics indicated that the investigators, in evaluating their results, often have to make extensive simplifications and assumptions, because the required physical information was not available. In many cases, even if the information was available, the research groups working in this field are too small to be able to supply themselves with evaluated data by direct reference to the original literature. Progress would be greatly assisted by the availability of more extensive and evaluated data.

The Consultants, on the basis of further discussions with colleagues of their countries have tried to define the physical data needed in radiation research physics : their conclusions are given in Appendix XXIII. They also recommended the compilation and the publication of a bibliography covering the physical data needed in radiation research physics and of data tables in this field. The organization of meetings, by which the work on physical data and tabulations would be promoted, was encouraged. Finally, the Consultant Meeting considered the establishment of a " Working Group " which, under the auspices of the " Life Science Division ", would have the task to promote the knowledge of the interaction of radiation with matter and supply the relevant numerical data for the purpose of physics applied to radiation research : no definite decision has been taken up to now on the establishment of this "Working Group ". In the meantime, the " Life Science Division " has started to work out a more specific and restrictive project which concerns the collection of physical data directly used in medicine; this collection is restricted to data interesting installations effectively used at the present time : for example, depth dose curves for Co sources, Ra-Be sources, etc... are considered but the same quantities for pions are excluded.

The INDC comments concerned essentially the following points :

- the INDC - and especially its Subcommittee for non energy applications - is concerned by the activities described by Eisenlohr but must not deviate too far from its scope: only a part of the data considered by the Consultants Meeting is relevant to its scope.

- for these data it would be extremely useful to have some idea about the accuracies which are required. The Chairman of the relevant INDC Subcommittee and Dr. Eisenlohr were asked to inquire, for the next INDC meeting, about the sensitivity of the uncertainties in the required nuclear data in the field of radiation research physics. (action 38)

X. Information sciences and policies.

X. A. Development of UNISIST.

The INDC Secretariat will continue to keep INDC members informed of UNISIST developments likely to affect the Data Centres (action 49).

X. B. INDC recommendations of guidelines to authors, reviewers, and publishers of journal articles on nuclear data.

Grinberg recalled that, during its March 1972 meeting, the "International Working Group on Nuclear Structure and Reaction Data " (IWGNSRD) deplored that, very often, scientific articles are written in such a way that it is extremely difficult to judge the quality of the work and the value of the reported data : absence of description of the experimental equipments, no indication of the systematic errors or, at least, of elements to estimate them, etc... Therefore, Bartholomew, Chairman of the IWGNSRD, sent a letter to the editors of scientific journals, asking them to draw to the attention of authors of papers on experimental nuclear physics some recommendations which would facilitate the task of the readers (and, in particular, of reviewers and compilers of nuclear data). There were 7 out of 37 journals that published these recommendations (Appendix XXIV) as an editorial note. While this number may seem small, actually these 7 journals represent about 90 % of the physics articles published in English. In addition, Bartholomew approached the Chairman of the IUPAP asking him to use his influence to bring the matter again to the attention of the journal editors.

The INDC took note and approved fully these actions.

XI. Meetings and Conferences.

A- Reports on past meetings:

(a) International Conference on Study of Nuclear Structure with Neutrons (Budapest), August 1972) :

According to Berenyi, the Proceedings will be issued under the responsibility of the " Hungarian Academy of Sciences " in a near future.

(b) International Conference on Few Particle Problems in Nuclear Interactions (Los Angeles, August/September 1972):

A short compte-rendu by Slaus is given in Appendix XXV.

(c) Second National Conference on Neutron Physics (Kiev, May/ June 1973) :

According to Sukhoruchkin, the Proceedings are now being processed at Obninsk and will be published at the beginning of 1974; they will consist in a direct reproduction of the presented papers, in the original language. Dunford mentioned a summary report of the Conference, written by Schmidt as appendix F of the INDC (NDS)-53/L document.

(d) Third IAEA Symposium on the Physics and Chemistry of Fission (Rochester, August 1973)

A summary report of this Symposium, prepared by Whetstone, IAEA is given in Appendix XXVI.

B - Future meetings.

(a) IAEA Panel on Fission Product Nuclear Data (Bologna, 26-30 November 1973).

Lammer, who is responsible for this Panel, recalled that the information on the general organization and on the proposed programme is respectively given in Appendix C and D of the document INDC (NDS)-53 L. The Panel will consist of 16 comprehensive review papers, incorporating not only the own views of the reviewers but also contributions received from relevant specialists in other institutions and countries. Some still missing contributions are urgently needed (action 39). A total number of about 50 participants (users, measurers, compilers and evaluators of fission product nuclear data) is expected. The proceedings, which will include all the review papêrs, the highlights of the discussions and the conclusions and recommendations of the Panel, will be published as "IAEA Technical Report". It is also envisaged to select, among the contributions sent to the reviewers, those which have not been already published and to issue them in the same series.

(b) IAEA Study Group Meeting on Nuclear Data Requirements for Shielding.

Dunford reported that the interest in this meeting was extensively discussed at the June 73 meeting of the EACRP. The general feeling was that the most urgent need for the shielding community was for a meeting on sensitivity studies and methods. Therefore, the NDS, in agreement with the N. E. A, decided to wait for the results of the sensitivity studies and methods and, later on (e.g. in a one to one and a half year delay) to reconsider the interest in a meeting on nuclear data for shielding.

(c) Third IAEA Conference on Nuclear Data .

Dunford recalled that this Conference was recommended by the last INCD meeting but, unfortunately, it was not possible to the " Scientific Advisory Committee " of the IAEA to follow this recommendation. The INDC could review its proposal for 1975; however, one has to consider two national conferences on similar subjects which will take place in 1975 :

- in the USA, a "Conference on nuclear cross sections and technology" will be held in Washington in March 1975; Smith outlined that the preparation of this Conference is already well advanced (organization of a Programme Committee, topics to be covered, date, place, etc...) and that it would certainly be too late to change it now.

- in the USSR, the Conference, which is organized systematically every two years, will probably be held in Minsk or Kiev in May or June 1975. Usachev said that some thougths have already been given to the preparation and that the two years term pattern is considered as appropriate and will probably be maintained in the future.

Dunford added that his own feeling was that, after these two conferences in 1975, there will be not enough new information for an international conference in 1976; in these conditions, 1977 seemed to be the earliest possible date.

Some members expressed the opinion that the large USA and USSR national conferences do not fulfil completely the role of an international conference: the USA participation to the USSR conferences is limited and the reverse is also true; the other countries share their participation between these national conferences. The exchange of information and ideas would thus remain incomplete. Rose proposed a possible synchronisation based on a three year cycle, a conference being organized every year successively by the USA, the USSR and the IAEA; it was of course clear that such a suggestion depends upon the agreement of the authorities concerned in the USA and USSR. As a conclusion, the INDC recommanded to postpone untill 1977 the IAEA Conference on Nuclear Data (recommendation III. 5 of Appendix III).

(d) IAEA Symposium on Research Materials for Nuclear Measurements.

The general information on the proposed Symposium is given in Appendix XXVII. Richman, Head of the Agency's Industrial Applications and Chemistry Section, explained that it is envisaged to organize the Symposium along the lines of three previous meetings on the same subject (held at ORNL, Geel and Harwell) which appeared to be quite successful. Some INDC members remarked that this Symposium was only one of the very numerous subjects which have an indirect impact on the INDC activity. Other members outlined that the problem of samples was intimately connected to one of the most urgent and questionable problems in the framework of the INDC, namely the problem of standard measurements. Richman recognized that the problem of special research materials, of targets, of separated isotopes, etc... has the highest priority neither in the nuclear data field, nor in chemistry, nor in physics; this problem must then be treated at the level of the IAEA Research Department rather than at the level of any specific Section of this Department. The opinion of the INDC is solicited about its general interest and, possibly, about the specific items for which a particular interest may exist.

The INDC members endorsed the proposal for this Symposium to be held in 1975 (recommendation III. 6 of Appendix III) and agreed to send comments - if any - to the NDS before the middle of November 1973 (action 40).

XI. C. INDC suggestions for future meetings.

Schmidt specified that, due to fund and man power limitation, the N. D. S has not the possibility to hold more than one Conference, Symposium or Panel per year. He added the following comments :

- the " Panel on Fission Product Nuclear Data " (Bologna, November 1973) will probably be followed by a consultant meeting on the same subject by the end of 1974 or beginning 1975.

- " Specialist Meeting on Transactinium Isotopes Nuclear Data "has been suggested in the course of the preparation of the " Panel on Fission Product Nuclear Data "; this meeting is envisaged for the first half of 1975.

He recalled that :

- a " Meeting on Nuclear Data Requirements for Shielding " is still envisaged, depending upon the conclusions of the Meeting on Sensitivity Studies and Methods mentioned under XI. B (b) above.

- the subject of nuclear cross section predictions by nuclear theory has never been covered so far.

The INDC recommended to hold, in late 1976, a " Panel on Nuclear Standards " which will be the third one organized by the IAEA (recommendation III. 4 of Appendix III). The possible interest in a panel on nuclear data for non-energy applications was also expressed but, for some members, the primary support for nuclear data will still remain, for some years, in the energy-oriented fields(fission reactors and, may be, C. T. R.); it was then agreed that this problem should first be discussed by the " Subcommittee on non-energy application of nuclear data ".

APPENDIX II - Recent LASL experimental results

LASL σ_f (^{235}U) Data (Final)

(Hansen, Barton, Jarvis, Koontz, Smith)

E_n (MeV)	$\sigma_f(25)/\sigma_s(H)$	% Uncert. Stat.	% Uncert. Syst.	$\sigma_s(H)$ *	$\sigma_f(25)$	% Uncert. Stat.	% Uncert. Syst.
1.0	0.2908	0.8	0.8	4.261	1.239	0.8	1.3
1.1	0.3116	1.0	0.8	4.051	1.262	1.0	1.3
1.2	0.3245	0.8	0.8	3.868	1.255	0.8	1.3
1.3	0.3376	0.8	0.8	3.706	1.251	0.8	1.3
1.4	0.3466	1.7	0.8	3.561	1.234	1.7	1.3
1.5	0.3703	0.8	0.7	3.429	1.270	0.8	1.2
1.6	0.3752	0.8	0.7	3.309	1.242	0.8	1.2
1.7	0.4050	1.0	0.7	3.198	1.295	1.0	1.2
1.8	0.4122	1.1	0.7	3.097	1.277	1.1	1.2
1.9	0.4248	1.1	0.7	3.003	1.276	1.1	1.2
2.0	0.4362	0.4	0.7	2.915	1.272	0.4	1.2
2.2	0.4620	0.8	0.7	2.759	1.275	0.8	1.2
2.4	0.4785	1.3	0.7	2.622	1.255	1.3	1.2
2.5	0.4892	1.4	0.7	2.560	1.252	1.4	1.2
2.6	0.4879	0.6	0.7	2.501	1.220	0.6	1.2
2.7	0.5013	0.8	0.7	2.445	1.226	0.8	1.2
2.8	0.5064	0.7	0.7	2.392	1.211	0.7	1.2
2.9	0.5104	0.9	0.7	2.341	1,195	0.9	1.2
3.0	0.5231	0.3	0.7	2.293	1.211	0.3	1.2
3.2	0.5520	1.1	0.7	2.203	1.216	1.1	1.2
3.4	0.5589	1.2	0.7	2.120	1.185	1.2	1.2
3.5	0.5664	0.6	0.7	2.081	1.179	0.6	1.2
3.6	0.5792	1.2	0.7	2.043	1.183	1.2	1.2
3.7	0.5760	1.1	0.7	2.007	1.156	1.1	1.2
3.8	0.5906	1.3	0.7	1.973	1.165	1.3	1.2
4.0	0.5967	0.6	0.7	1.907	1.138	0.6	1.2
4.2	0.6203	1.4	0.8	1.845	1.144	1.4	1.3
4.4	0.6258	1.2	0.8	1.788	1.119	1.2	1.3
4.6	0.6340	1.3	0.8	1.734	1.099	1.3	1.3
4.8	0.6590	1.2	0.8	1.683	1.109	1.2	1.3
5.0	0.6668	1.1	0.8	1.635	1.090	1.1	1.3
5.1	0.6739	0.9	0.9	1.612	1.086	0.9	1.4
5.2	0.6868	1.0	0.9	1.589	1.091	1.0	1.4
5.3	0.6925	1.0	0.9	1.568	1.086	1.0	1.4
5.4	0.6903	0.7	0.9	1.547	1.068	0.7	1.4
5.5	0.6975	1.0	0.9	1.526	1.064	1.0	1.4
5.6	0.6966	1.0	0.9	1.506	1.049	1.0	1.4
5.7	0.7193	1.1	0.9	1.486	1.069	1.1	1.4
5.8	0.7454	2.1	0.9	1.467	1.093	2.1	1.4
5.9	0.7751	1.5	0.9	1.448	1.122	1.5	1.4
6.0	0.8015	1.8	0.9	1.430	1.146	1.8	1.4

* Yale evaluation reported by Stewart, LaBauve, and Young in LA-4574 [ENDF-14, EANDC-141] . As suggested by Stewart, σ_s (H) is assigned a 1.0% uncertainty and in the 1-6 MeV range this is assumed to be a systematic uncertainty.

TABLE I. ^{235}U spin assignments. The choice of absolute value of spin assignments from the present work is predicated upon the assumption that the quantity μH, where μ is the ^{235}U magnetic moment and H is the hyperfine field, is negative.

E_o (eV)	Present Work	Polarization[a]	Capture[b]	Capture[c]	Capture[d]	Capture[e]	γ-Multiplicity[f]	Scattering[g]	Scattering[h]	Symmetry[i,j]
1.13	4	4	-	-	-	-	3	-	-	-
3.14	3	3	-	-	-	-	3	-	-	-
3.61	4	4	-	-	-	-	3	-	-	-
4.84	4	4	-	-	4	4	4	-	-	-
5.41	4	-	-	-	-	-	-	-	-	-
6.17	3	3	-	-	-	-	-	-	-	-
6.38	4	4	-	4	4	3	4	-	-	-
7.07	4	4	-	3	-	-	3	-	-	-
8.73	4	4	-	-	-	-	3	3	3	-
9.27	4	4	-	3	-	-	3	-	-	-
10.2	4	4	-	-	-	-	3	-	-	-
11.7	4	4	4	-	4	-	4	4	4	-
12.4	3	3	3	4	3	-	4	3	4	-
12.9	4	-	-	-	-	-	-	-	-	-
13.3	4	-	-	-	-	-	-	-	-	-
13.8	3	-	-	-	-	-	-	-	-	-
14.2	3	3	-	-	-	-	-	-	-	-
14.6	3	-	3	-	3	-	-	-	-	-
15.4	4	-	-	3	4	-	3	-	-	4
16.1	4	-	4	3	4	-	4	-	-	4
16.7	4	-	-	3	-	-	3	-	-	4
18.1	3	-	-	-	-	-	3	-	-	-
19.0	4	-	-	-	-	-	-	-	-	-
19.3	4	-	-	4	-	-	4	4	4	4
20.7	4	-	-	-	-	-	-	-	-	-
21.1	4	-	-	3	4	-	-	-	-	4
22.9	4	-	-	3	4	-	3	-	-	4
23.4	4	-	-	4	4	-	-	4	-	} 4
23.6	3	-	-	-	-	-	-	-	-	}
24.2	3	-	-	-	3	-	-	-	-	3
25.6	3	-	-	-	-	-	-	-	-	3
26.4	3	-	-	-	-	-	-	-	-	4
27.8	4	-	-	4	-	-	3	-	-	4
29.7	4	-	-	-	-	-	-	-	-	-
30.6	3	-	-	-	-	-	-	-	-	-
30.9	4	-	-	3	4	-	-	-	-	4
32.0	4	-	3	4	-	-	4	4	-	4
33.5	4	-	-	4	-	-	4	4	-	4
34.4	4	-	-	3	-	-	4	4	-	3
34.9	3	-	-	-	-	-	-	-	-	4
35.2	4	-	-	4	-	-	4	4	-	} 3
35.3	3	-	-	-	-	-	-	-	-	}
38.4	4	-	-	-	-	-	-	-	-	3
39.4	4	-	-	4	-	-	4	3	-	3
40.5	4	-	-	-	-	-	-	-	-	4
41.3	4	-	-	-	-	-	-	-	-	-
41.6	3	-	-	-	-	-	-	-	-	-
41.9	3	-	-	-	3	-	-	3	-	4
42.3	4	-	-	-	-	-	-	-	-	-
42.7	4	-	-	-	-	-	-	-	-	-
44.0	4	-	-	-	-	-	-	-	-	4
44.6	4	-	-	-	-	-	-	-	-	3
45.1	3	-	-	-	-	-	-	-	-	-
46.8	4	-	-	-	-	-	-	-	-	-
47.0	4	-	-	-	-	-	-	-	-	4
48.3	3	-	-	-	-	-	-	-	-	-
48.8	3	-	-	-	-	-	-	-	-	4
49.5	4	-	-	-	-	-	-	-	-	3
51.3	4	-	-	-	-	-	-	4	-	4
52.3	3	-	-	-	-	-	-	-	-	3
55.1	4	-	-	-	-	-	-	4	-	-
56.0	4	-	-	-	-	-	-	-	-	-
56.6	4	-	-	-	-	-	-	3	-	4
58.2	3	-	-	-	-	-	-	-	-	4
58.7	4	-	-	-	-	-	-	-	-	3
Percent Agreement	-	100	80	44	100	50	52	79	50	62*
No. Assignments	65	13	5	18	13	2	23	14	4	29*

*Excluding resonances in brackets

[a] Ref. 2
[b] Ref. 8
[c] Ref. 9
[d] Ref. 10
[e] Ref. 11
[f] Ref. 12
[g] Ref. 13
[h] Ref. 14
[i] Ref. 16
[j] Ref. 17

TABLE I.

Energies and intensities of gamma rays from thermal neutron capture by ^{7}Li.

E_{γ} (keV)	E_{REC} (keV)	E_{TRANS} (keV)	I (mb)	I(γ/100n)	I(γ/100n)[1]	I(γ/100n)[2]
980.6 ± 0.2	0.06	980.7 ± 0.2	4.82	10.6 ± 1	30	9.83
1052.0 ± 0.2	0.07	1052.1 ± 0.2	4.80	10.6 ± 1	20	4.91
2032.5 ± 0.28	0.28	2032.78 ± 0.15	40.56	89.4 ± 1	80	89.33

[1] L. Jarczyk, J. Lang, R. Müller, and W. Wölfi, Helv. Phys. Acta 34, 483 (1961)

[2] V. J. Orphan, N. C. Rasmussen, and T. L. Harper, DASA-2570. This result is presumably inferred from lithium in national abundance.

Table II.

σ(n,γ) for thermal neutron capture by ^{7}Li.

σ(n,γ) (mb)	Reference
45.4 ± 3	This work.
40 ± 12	L. Jarczyk, et al. (1961), reported in BNL-325.
40 ± 8	W. Imhof, et al (1959), reported in BNL-325.
44 ± 10	E. A. Koltypin and V. M. Morozov (1956), reported in BNL-325.
33 ± 5	D. J. Hughes, et al. (1947), reported in BNL-325.
37 ± 4	Recommended value, BNL-325.

Appendix VI

IAEA Study Group Meeting on Nuclear Data for Applications

(International cooperation in the compilation, evaluation, exchange and dissemination of nuclear level scheme and decay data applied in science and technology)

(in former meetings referred to as "X-centres meeting")

Provisional date: 29 April - 3 May 1974

Place: IAEA Headquarters, Vienna

Suggested items for a

Provisional Technical Agenda

(prepared from suggestions received from existing nuclear data centres)

I. Review of recommendations from international meetings and bodies; agreement on general data scope.

II. Framework for an international cooperation in the compilation, evaluation and exchange of nuclear structure and decay data

1. Which centres or groups are or will be available to cooperate ?

2. Centralization versus decentralization: e.g. centralized system with decentralized input ?

III. Bibliographic references (system = keyword and reference system)

1. Review of existing and planned collections, compilations, computerized systems and cooperative links

2. Adoption of a preferred system and detailed discussion of its keyword content

3. Agreement on formats and rules for the exchange of keywords and references

4. Specification of responsibilities [a]

IV. Experimental data

1. Review of existing and planned collections, compilations, computerized systems and cooperative links

2. Agreement in detail on data types and on numerical, physics and bibliographic content to be included in the compilation and transmission of experimental data files

3. Agreement on formats and rules for the compilation and transmission of experimental data

4. Specification of responsibilities [a]

V. Evaluated data

1. Review of existing and planned collections, compilations, computerized systems and cooperative links

2. Agreement on formats and rules for the transmission of evaluated data

3. Specification of responsibilities [a]

VI. Evaluation

1. Who does what for whom ?

2. Rules for evaluation

VII. Existing and planned publications of references and of tables and graphs of experimental and/or evaluated data

VIII. Feasibility and functions of an international data information bureau for applied users

IX. Author's guide

X. International newsletter on compilations and evaluations

Note: [a] are meant responsibilities for

(i) maintaining the masterfile
(ii) input and checking
(iii) providing retrievals
(iv) documenting agreed rules, keywords, etc.

Appendix VII

INDC Standing Sub-Committee on
Nuclear Data for Safeguards Technical Development

Summary of Deliberations

1. Following the recommendations made by the Sub-Committee, which were endorsed by the 5th INDC Meeting, the IAEA Nuclear Data Section had distributed the Request List of Nuclear Data for Safeguards Development Purposes (INDC(NDS)-50/U+S) in March of this year.

   The Request List combines the lists submitted by three Member States: the Federal Republic of Germany, the USA and the USSR.

2. The Japanese Nuclear Data Committee has now produced a request list for data for safeguards techniques. It was noted that this includes data needed for burnup determination by non-destructive or destructive measurement.

   Updating of the German Request List for Safeguards is now in progress.

3. Because the Request List for Safeguards is a recent development and work is in progress which could meet many of the requirements it was considered that frequent revisions of the List would be desirable. It was therefore recommended that the IAEA Nuclear Data Section should be asked to issue a revised list, including the Japanese List and the revised German List.

4. A schedule was proposed for a possible programme for the production of a revised Request List for Safeguards. Revised Lists would be sent to the Nuclear Data Section by 1st April 1974. These would be incorporated in the WRENDA file with appropriate flagging for Safeguards applications. A revised Safeguards Request List would then separately be issued in about June 1974.

5. Attention was drawn to a paper by Berenyi to the Paris Symposium in which it was claimed that many of the requests for half-life data and decay schemes were not clearly defined. Countries were asked to rescreen their safeguards data requests with respect to Berenyi's statements and submit the revisions to the Nuclear Data Section by 1st April 1974.

6. It was recommended that the future of the Safeguards Request List should be considered by the new Subcommittee which supersedes the Safeguards Subcommittee. Noting the wider coverage of the present Request List it was suggested that a List covering the requirements for Safeguards, Burnup Determination and Chemical Plant Reprocessing might be appropriate.

Appendix VIII

Report of the Ad-hob Sub-Committee on nuclear data measurement programmes for developing countries

Members: Schmidt (Chairman), Ricabarra, Divatia, Condé, Rose, Slaus, Motz, Sukhoruchkin, and O'Neal (IAEA).

A. Discussion

Schmidt introduced the discussion by noting that a number of WRENDA requests would lend easily to measurements in developing countries with a double benefit to the user community of nuclear data and to the training and buildup of technical and scientific know-how in the developing countries.

The motivation for such measurements among scientists in developing countries was considered to be threefold:

1. Fundamental Research
2. Use to an applied programme in the relevant country
3. Contribution to the International Nuclear Data effort.

It was felt that the use of nuclear techniques in food supply, disease control, energy and mineral resources and similar fields offered a suitable scope for such measurement programmes. However, since the INDC is just beginning to interest itself in these fields, implementation of such programmes was felt to be a long range task.

It was noted that many WRENDA requests are coupled with fundamental interests and that selection of such requests would provide an enhanced motivation for nuclear data measurements.

It was felt that availability of funds or equipment and exchange of personnel will play an important part in stimulating such measurements.

Bilateral agreements between a developed and a developing country, where the Agency could act as a catalyst, were considered. Sharing of funding among these three parties, on an appropriate basis, was also discussed, where the IAEA share could come from the targets and samples programme suitably linked to WRENDA requests.

Mr. O'Neal pointed out the limitations of funding by the Agency in addition to the support already provided by the targets and sample programme. While nuclear data research would not fall within the scope of the UNDP programme, he suggested to approach UNESCO, the UN Agency for training and education programmes, in this matter.

B. Conclusions

1. The subject was felt to be of sufficient importance to justify the continuation of the ad-hoc subcommittee at least until the next INDC Meeting.

2. The ad-hoc subcommittee members should attempt to specify one or two measurement programmes to concretize the programme.

3. INDC members should informally enquire whether bilateral agreements for such measurement programmes could be arranged.

4. IAEA could supply only very small funding provided the measurements envisaged are closely linked to major nuclear data areas in the WRENDA request lists.

5. The Nuclear Data Section will undertake to compile a concise listing of available facilities and major experimental programmes in developing countries and provide this information to INDC members.

6. The Agency should explore with UNESCO the possibility of additional funding for such programmes.

Appendix IX

IAEA HANDBOOK ON NUCLEAR ACTIVATION CROSS-SECTION DATA

Due to the fast progress of activation analysis in the last decade and its wide applications in medicine, environmental control, industry, agriculture etc... the need has arisen among workers in the field for a small handbook containing the various types of cross-sections values whose knowledge is required for activation analysis. Such a book should also be of special interest for developing countries where well equipped libraries are generally not available.

Following numerous suggestions from outside users, from Agency meetings and from international surveys of data needs, the Agency is currently preparing the publication of such a handbook from outside scientists and from NDS. It will be edited early in 1974 and include the following:

Preface

2200 m/sec Neutron Activation Cross Sections, by R. Sher, Stanford University, Stanford, California, USA

Neutron Resonance Integrals, by M. Drake, Science Associates Inc., La Jolla, California, USA

Tables and Graphs of Cross Sections for (n,α), (n,p) and (n,2n) Reactions in the Energy Region E_n = 1 to 37 MeV, by M. Bormann, H. Neuert and W. Scobel, I. Institut f. Experimentalphysik, Universität Hamburg, Hamburg, Fed. Rep. of Germany

Part I: Tables of recommended (n,p), (n,α) and (n,2n) Cross Sections between 13.9 and 15.1 neutron energy

Part II: Graphs of recommended (n,p), (n,α) and (n,2n) excitation functions between 1 MeV and 37 MeV neutron energy

Cross Sections for Fission Neutron Spectrum Induced Reactions, by A. Calamand, Nuclear Data Section, IAEA

Excitation functions for charged particle induced reactions in light elements at low projectile energies, by J. Lorenzen and D. Brune, AB Atomenergi, Studsvik, Sweden

Photonuclear cross sections, by B. Bülow and B. Forkman, University of Lund and Lund Institute of Technology, Lund, Sweden.

Appendix X

Requirements and applications of border-line nuclear and atomic data

(D. Berényi)

1. One of the main conclusions of the IAEA Symposium on Applications of Nuclear Data in Science and Technology held in Paris in March this year was the great need for data on the border-line between nuclear and atomic data.

   The fact is that there are several fields of application which are connected to, or have an origin in the nuclear techniques, partly already mentioned during this meeting, especially in the report of the ad-hoc sub-committee headed by Dr. Rose (see Appendix IV). Such fields are e.g.

   X-ray data (energy and relative intensity, absorption coefficient, electron and charged particle cross sections, etc.)

   in radioisotope X-ray fluorescence analysis,
   analysis by X-rays excited by electrons and charged particles in accelerators
   ECSA (electron spectroscopy concerned with applications)
   X-ray microprobe analysis, etc.

   Absorption and scattering data for different radiations (cross sections for absorption and scattering, angular distributions, effective atomic numbers, etc.)

   in dosimetry, medical and biological applications, industrial applications, etc.

2. The task is similar as it was in the case of the non-neutron or "non-energy" nuclear data in general, partly carried out last year in IWGNSRD:

   to survey and summarize the tabulations available to discuss whether the tables above meet the claims and needs

   to initiate compiling new tabulations (as e.g. the excellent recent table on X-ray fluorescence yields made by Bambynek and numerous other scientists in an international collaboration) and measurements.

3. Several "energy" and "non-energy" fields are concerned with the data topics in question but it seems to be most adequate that the problems of border-line nuclear and atomic data should be covered by the future fourth "non-energy" sub-committee. Consultations, request lists are, however, necessary with and from experts of the fields concerned.

APPENDIX XI -

Table 1

Comparison of evaluated and measured α values for ^{239}Pu

Neutron energy (KeV)	evaluated data [1]	measured data ITEF [2]	evaluated data (Sowerby and Konshin)	measured data at IAE [3]	measured data at IAE [4] and FEI [5] [6]
0,1-0,2	0,87	0,93	0,845	-	0,94
0,2-0,3	1,05	0,96	0,912	-	1,01
0,3-0,4	1,14	1,15	1,150	-	1,31
0,4-0,5	0,49	0,62	0,483	-	0,64
0,5-0,6	0,74	0,78	0,704	-	0,93
0,6-0,7	1,69	1,58	1,673	-	0,93
0,7-0,8	0,99	1,02	0,973	-	1,25
0,8-0,9	0,80	0,85	0,778	-	
0,9-1,0	0,71	0,93	0,717	-	0,87
1-2	0,94	0,95	0,927	-	1,06
2-3	1,21	1,08	1,108	-	1,06
3-4	1,04	(0,77)	0,895	1,20	-
4-5	0,87	(0,84)	0,821	0,96	-
5-6	0,87	(0,81)	0,867	0,81	-
6-7	0,87	(0,696)	0,816	0,69	-
7-8	0,67	(0,73)	0,629	0,54	-
8-9	0,57	(0,63)	0,575	0,54	
9-10	0,60	(0,65)	0,617	0,43	0,50
10-15	-	(0,63)	0,509	0,48	0,52
15-20	-	(0,50)	0,419	0,40	0,34
20-25	-		0,395	0,36	0,34
25-30	-	(0,42)	0,350	0,32	0,30
30-35	-	-	0,312	0,29	0,27
35-40	-	-	0,280	0,25	0,25
40-45	-	-	0,252		0,24
45-50	-	-	0,232	0,23	0,21
50-55	-	-	0,213	0,20	0,185
60-70	-	-	0,199		0,174
70-80	-	-	0,182		0,171
80-90	-	-	0,165	0,14	-
90-100	-	-	0,159		
			0,160		
150			0,170	0,14	0,115
250			0,126	0,09	(0,103)

[1] S.I. Sukhoruchkine, Atom. Energ. 31,3 (1971) 245

[2] V.P. Bolostsky and al - Second Kiev Conference on neutron physics (28 May-1 June 73)

[3] P.E. Vorotnikov and al -Second Kiev Conference on neutron physics (28 May- 1 June 73)

[4] G.V. Muradyan and al - First Kiev Conference on neutron physics (24-28 May 1971)

[5] V.N. Kononov and al - First Kiev Conference on neutron physics(24-28 May 71)

[6] V.N. Kononov and al. -Bulletin n°9 of the Obninsk. Nuclear Data Centre (page 37).

APPENDIX XI (2)

Table II

Comparison of integral measurements and calculated data from different set of cross sections for the α value of ^{239}Pu

	energy range : 0.1 to 25 KeV	calculated α value	calculated/measured α value
1	26 group constants- Obninsk	0.311	0.72
2	ORNL differential data	0.439	1.00
3	Harwell differential data	0.360	0.84

Result of the integral measurement α = 0.43 ± 0.03

Table III

Measured capture cross section of ^{238}U

Energy (KeV)	F.E.I. data (barns)	O.R.N.L. data (barns)	Ratios(%)
20-30	0,516 ± 0,010	0,551 ± 0,03	7
30-40	0,439 ± 0,012	0,488 ± 0,02	11
40-50	0,382 ± 0,005	0,421 ± 0,02	10
50-60	0,366 ± 0,008	0,341 ± 0,02	- 7
60-70	0,310 ± 0,004	0,296 ± 0,02	- 5
70-80	0,284 ± 0,002	0,257 ± 0,02	- 10
80-90	0,248 ± 0,004	0,234 ± 0,02	- 10

Table IV

Measured and evaluated data of the capture cross section of ^{238}U at 30KeV

Authors	Cross section values (Mbarns)	Ratios (relative to Panitkine)
Panitkine (1973)	474 ± 15	1,00 (reference)
de Saussure (1973)	528 ± 30	1,11
Moxon (1969)	418 ± 29	0,88
Frisenham (1970)	463 ± 23	0,98
Pitterly (evaluation)	456	0,96
Sowerby (evaluation)	468 ± 13	0,99
Price (evaluation)	479	

APPENDIX XI (3)

Table 5

Accuracy on ^{238}U and ^{239}Pu nuclear data

isotopes	quantity	energy range	achieved accuracy (%)	needed accuracy(%)	number of request
^{239}Pu	σ_f	0, 1 KeV-15 MeV	10	4-3, 8	16
	α	0, 1 KeV-10 MeV	-	5-4	7
	σ_γ	0, 1 KeV- 4 MeV	20	5-3, 6	8
	$\bar{\nu}$	thermal - 15 MeV	2	0, 5 - 0, 75	7
^{238}U	σ_γ	0, 5 KeV-14 MeV	10	3, 3-2, 7	9
	σ_f	threshold-20 MeV	6	2	8
	$\sigma_{n,n'}$	threshold-15 MeV	20	-	12
	$\bar{\nu}$	threshold-14 MeV	3	1, 3	3

APPENDIX XII

Gamma ray energy calibration standards

(Lammer - N.D.S.)

The survey given in the table is mainly based on the work of Greenwood et al.[1] and Helmer et al. [2] (up to 1.3 MeV). Measurements of these authors in the range of 1.3 - 3.6 MeV are in progress but yet unpublished.

The work [1,2] is based on the most recent adjustment of fundamental constants by Taylor et al. [3], yielding a value for m_oC^2 of:

$$511.0041 \pm 0.0016 \text{ keV}$$

For crystal spectrograph measurements it is necessary to convert wavelength's measured in X-units into Å. It is agreed to fix the tungsten $K\alpha_1$ line at:

$$\lambda(W\ K\alpha_1) = 208.5770 \text{ XU}$$

There are several conflicting results for the conversion of XU to Å (see discussion by Marion [4]). The best agreement between the $WK\alpha_1$ and m_oC^2 based energy scales was reached (see ref. [1] for detailed discussion) using the following readjusted conversion factors:

$$\Lambda = 1.0020960 \text{ mÅ/XU } (\pm 5.3 \text{ ppm})$$

$$E = 12398.541 \pm 0.041 \text{ eV}\cdot\text{Å}$$

yielding the energy (eV) of the $W\ K\alpha_1$ line:

$$59.31918 \pm 0.00035 \text{ keV } (\pm 5.9 \text{ ppm})$$

The most recent results of direct comparisons of the 412 keV Au-198 γ-ray by Murray et al [5,6] with m_oC^2 were adjusted by Greenwood et al. to the new value for m_oC^2. The result is:

$$411.794 \pm 0.008 \text{ keV } (\pm 19 \text{ ppm})$$

In consequence all primary energy standards obtained by direct comparison with the Au-198 412 keV γ-ray cannot be more precise than $\pm$ 19 ppm. This has to be kept in mind when one comes across experimental results and/or evaluations quoting higher precision. It is common practice to evaluate data using weighted averages of final results (i.e. full energies) and to calculate the uncertainty in this way. If a sufficient number of consistent high precision measurements is available, this procedure could lead to an uncertainty below that of the primary standards. To evaluate the uncertainties correctly, these should be calculated from the weighted averages of measured energy differences, and the uncertainty of the standard has to be added in quadrature.

As Greenwood et al [1] and Helmer et al [2] have taken this into account and have also adjusted other results of direct comparisons and included them in their set of recommended calibration energies, their values up to 1.3 MeV are preferred and reproduced here.

Exceptions are the Th-228d (Pb-212) 238.6 keV γ-ray (adjusted to the new value for Au-198), the Th-228d(Tl-208) 510.7 keV γ-ray and the Ra-228d (Ac228) 911 keV γ-ray which are taken from Marion's evaluation [4].

Above 1300 keV:

Ag-110m data are taken from Helmer et al [7]. The energy of the Co-60 1332 keV γ-ray is the unweighted average of the readjusted data of Murray et al [6] (as adjusted by Helmer et al [2]) and Gunnik et al [8] (adjusted here: difference between double escape peak at 310.5 keV and Ir-192 γ-lines at 308.4 and 316.5 keV. The uncertainty of ± 15 eV quoted by Gunnik et al [8] is based on the uncertainties of the Ir-192 lines adjacent to the double escape peak. Helmer et al [7] have pointed out that the value to be added to the double excape peak to calculate the result for the full energy peak is not 1022.008 ± 0.003 keV due to field effects in the detector and to the annihilation with bound electrons. Therefore the uncertainty quoted by Gunnik et al appears to be unrealistic, and the unweighted average is taken as follows:

1332.515 ± 0.015 [8]
1332.491 ± 0.041 [6,2]
1332.503 ± 0.030

The Bi-207 1770 keV value is taken from Marion [4].

The values for Y-88, Na-24 and Th-228d are those recommended by Heath [9].

All others are taken from Gunnik et al [8] (i.e. La-140, Sb-124, Co-56). Reservations with respect to the precise energy values and the quoted uncertainties have been discussed above.

Note: d after mass numbers mean: γ-rays from daughter products in secular equilibrium with the nuclides listed.

References

[1] R.C. Greenwood, R.G. Helmer, R.J. Gehrke, Nucl. Instr. Meth. 77 (1970) 141

[2] R.G. Helmer, R.C. Greenwood, R.J. Gehrke, Nuclear Instr. Meth. 96 (1971) 173

[3] B.N. Taylor, W.H. Parker, D.N. Langenberg. Rev. Mod. Phys.41 (1969) 375

[4] J.B. Marion, Nuclear Data A4 (1968) 301

[5] G. Murray, R.L. Graham, J.S. Geiger, Nucl. Phys. 45 (1963) 177

[6] G. Murray, R.L. Graham, J.S. Geiger, Nucl. Phys. 63(1965) 353

[7] R.G. Helmer, R.C. Greenwood, R.J. Gehrke, ANCR-1016 (1971) 403

[8] R. Gunnik, R.A. Mayer, J.B. Niday, R.P. Anderson, Nucl. Instr. Meth. 65 (1968) 26

[9] R.L. Heath, "Table of Isotopes", Handbook of Chemistry and Physics, 54th edition 1973-1974 (Chemical Rubber Co.), page B-248.

Energy Calibration Standards

Isotope	Energy (keV)	Isotope	Energy (keV)
Ta-183	52.596 ± 0.001	Ta-182	198.356 ± 0.004
W (K_α - X)	59.31918 ± 0.00035	Se-75	198.596 ± 0.007
Am-241	59.537 ± 0.001	Tc-95m	204.117 ± 0.005
Se-75	66.055 ± 0.009	Au-199	208.196 ± 0.005
Ta-182	67.750 ± 0.001	Lu-177	208.362 ± 0.010
Sm (Gd)-153	69.676 ± 0.002	Ta-182	222.110 ± 0.003
Ba-133	80.998 ± 0.008	Ta-182	229.322 ± 0.006
Ta-183	82.919 ± 0.001	Os-185	234.158 ± 0.010
Tm-170	84.254 ± 0.003	Th-228 d	238.623 ± 0.009
Ta-182	84.680 ± 0.002	Tc-95m	253.066 ± 0.006
Ta-183	84.712 ± 0.002	Ta-182	264.072 ± 0.006
Cd-109	88.037 ± 0.005	Se-75	264.651 ± 0.008
Se-75	96.733 ± 0.002	Ba-133	276.397 ± 0.012
Gd-153	97.432 ± 0.003	Hg-203	279.188 ± 0.006
Ta-183	99.080 ± 0.002	Se-75	279.528 ± 0.008
Ta-182	100.105 ± 0.001	Ta-183	291.724 ± 0.006
Sm(Gd)-153	103.180 ± 0.002	Ir-192	295.949 ± 0.006
Ta-183	107.932 ± 0.001	Tb-160	298.572 ± 0.005
Lu-177	112.954 ± 0.003	Ba-133	302.851 ± 0.015
Ta-182	113.673 ± 0.002	Se-75	303.913 ± 0.007
Ta-182	116.418 ± 0.002	Ir-192	308.445 ± 0.007
Se-75	121.115 ± 0.003	Ir-192	316.497 ± 0.007
Co-57	122.063 ± 0.004	Cr-51	320.078 ± 0.008
Os-185	125.358 ± 0.004	Ta-183	353.999 ± 0.004
Se-75	136.000 ± 0.005	Ba-133	356.005 ± 0.017
Co-57	136.473 ± 0.004	Ta-183	365.615 ± 0.007
Fe-59	142.648 ± 0.004	Ba-133	383.851 ± 0.020
Ta-183	144.127 ± 0.002	Sn-113	391.688 ± 0.010
Ce-141	145.440 ± 0.003	Se-75	400.646 ± 0.009
Ta-182	152.434 ± 0.002	Pb-203	401.315 ± 0.013
Ta-182	156.387 ± 0.002	Au-198	411.794 ± 0.008
Au-199	158.370 ± 0.003	Ir-192	468.062 ± 0.010
Os-185	162.854 ± 0.008	Be-7	477.593 ± 0.012
Ce-139	165.853 ± 0.007	Ir-192	484.570 ± 0.011
Ta-182	179.393 ± 0.003	Th-228d	510.721 ± 0.020
Fe-59	192.344 ± 0.006	m_0c^2	511.0041 ± 0.0016
Ta-183	192.646 ± 0.005	Sr-85	513.996 ± 0.016

Energy Calibration Standards (cont.)

Isotope	Energy (keV)	Isotope	Energy (keV)
Bi-207	569.689 ± 0.013	Ag-110m	937.483 ± 0.020
Tc-95m	582.068 ± 0.013	Tb-160	962.295 ± 0.020
Th-228	583.174 ± 0.013	Tb-160	966.151 ± 0.020
Ir-192	588.572 ± 0.012	Tc-95m	1039.247 ± 0.022
Os-185	592.066 ± 0.014	Bi-207	1063.635 ± 0.024
Ir-192	604.401 ± 0.012	Au-198	1087.663 ± 0.024
Ir-192	612.450 ± 0.013	Fe-59	1099.224 ± 0.025
Os-185	646.111 ± 0.017	Zn-65	1115.518 ± 0.025
Ag-110m	657.638 ± 0.019	Sc-46	1120.516 ± 0.025
Cs-137	661.638 ± 0.019	Ta-182	1121.272 ± 0.026
Au-198	675.871 ± 0.018	Co-60	1173.208 ± 0.025
Pb-203	680.495 ± 0.017	Tb-160	1177.934 ± 0.024
Nb-94	702.627 ± 0.019	Ta-182	1189.022 ± 0.027
Ag-110m	706.669 ± 0.020	Ta-182	1221.376 ± 0.027
Os-185	717.424 ± 0.018	Ta-182	1230.989 ± 0.028
Zr-95	724.184 ± 0.018	Ta-182	1257.390 ± 0.028
Ag-110m	744.254 ± 0.020	Tb-160	1271.850 ± 0.026
Zr-95	756.715 ± 0.019	Ta-182	1273.703 ± 0.028
Ag-110m	763.928 ± 0.019	Na-22	1274.511 ± 0.028
Nb-95	765.786 ± 0.019	Ta-182	1289.126 ± 0.029
Tc-95m	786.184 ± 0.017	Fe-59	1291.564 ± 0.028
Co-58	810.757 ± 0.021	Co-60	1332.503 ± 0.030
Ag-110m	818.018 ± 0.022	Co-56	1360.219 ± 0.040
Tc-95m	820.608 ± 0.019	Na-24	1368.650 ± 0.050
Mn-54	834.827 ± 0.021	Ag-110m	1384.267 ± 0.029
Tc-95m	835.132 ± 0.018	Ag-110m	1475.757 ± 0.034
Co-56	846.751 ± 0.019	Ce-Pr-144	1489.14 ± 0.07
Nb-94	871.099 ± 0.018	Ag-110m	1505.006 ± 0.032
Os-185	874.814 ± 0.019	Ag-110m	1562.264 ± 0.033
Tb-160	879.364 ± 0.018	La-140	1596.200 ± 0.040
Os-185	880.272 ± 0.019	Sb-124	1691.022 ± 0.040
Ir-192	884.523 ± 0.018	Bi-207	1769.71 ± 0.13
Ag-110m	884.667 ± 0.018	Co-56	1771.33 ± 0.06
Sc-46	889.258 ± 0.018	Y-88	1836.13 ± 0.04
Y-88	898.021 ± 0.019	Co-56	2015.33 ± 0.07
Ra-228d	911.07 ± 0.07	Co-56	2034.90 ± 0.06

Energy Calibration Standards (cont.)

Isotope	Energy (keV)
Ce-Pr-144	2185.32 ± 0.05
Co-56	2598.52 ± 0.05
Th-228d	2614.611 ± 0.060
Na-24	2754.10 ± 0.07
Co-56	3202.18 ± 0.07
Co-56	3253.61 ± 0.06
Co-56	3273.16 ± 0.07
Co-56	3451.29 ± 0.10

APPENDIX XIII -

Standards for Ge(Li) detector efficiency calibration

(Lammer - N.D.S.)

The standards shown in the table are only primary standards. Primary standards are nuclides for which the values for absolute gamma ray branching can be calculated from the decay scheme with high confidence. Thus the selected values do not depend on a previous detector efficiency calibration. The values used depend only on:

- values for beta ray branching;
- internal conversion coefficients;
- in some cases on relative intensities of weaker γ-rays feeding or depopulating the the same level, as the γ-ray listed; however, the uncertainty of the intensity of the second gamma ray does not severely influence the uncertainty for the gamma ray listed.

Appendix:

1) Co-60 γ-ray branching.

1173 keV: β-branch to the 2505.7 keV level 99.88 ± 0.02 %
total conversion coefficient: 1.7×10^{-4}

1332 keV: decays to ground state: no β^-
γ-rays: 2158 keV 0.0012 %
total transition 1332 keV: 99.9988 %
total conversion coefficient: 1.3×10^{-4}

2) Ba-140 half life:	12.789 ± 0.006 d	[6]
La-140 half life:	40.27 ± 0.05 h	[1]

References:

1 M.J. Martin, P.H. Blichert-Toft, Nuclear Data A8 (1970) 1

2 J.F.Emery et al, Nucl. Sci. Engg. 48 (1972) 319

3 M.J. Cabell, M. Wilkins, J. inorg. nucl. Chem. 32 (1970) 1409

4 K.F. Walz, H.M. Weiss, Z. Naturf. 25a (1970) 921

5 J.S. Merrit, J.G.V. Taylor, AECL-3512 (1969) 30

6 S. Baba et al, J. inorg. nucl. Chem. 33 (1971) 589

Standards for Ge(Li) detector efficiency calibration
sorted by γ-energy

Nuclide	Energy (keV)	Intensity (% per decay)	Uncertainty (%)	Ref.	Half life 1)	Ref.	Comment
Am-241	59.537	35.3 ± 0.5	1.4	1	433 ± 2a	1	a
Hg-203	74.6	12.8 ± 0.2	1.6	1	46.59±0.05 d	1	a
Co-57	122.063	85.6 ± 0.2	0.23	1	269.8 ±0.4 d	2	b
Co-57	136.473	10.6 ± 0.2	1.9	1			c
Se-75	264.651	59.1 ± 0.2	0.34	1	120 ± 1 d	1	b
Hg-203	279.188	81.5 ± 0.2	0.25	1	46.59±0.05 d	1	b
I-131	364.49	82.4 ± 0.5	0.61	1	8.040 ±0.001 d	2	a,d
Au-198	411.794	95.53± 0.05	0.05	1	2.6946±0.0010 d	3	b
Na-22	511.004	181.08± 0.04	0.022	1	2.60 ±0.01 a	1	b
Sr-85	513.996	99.28± 0.01	0.01	1	64.5 ±0.5 d	1	b
Sb-124	602.71	98.2 ± 0.1	0.1	1	60.20 ±0.02 d	1	b
Cs-137	661.638	84.6 ± 0.4	0.47	1	30.0 ±0.2 a	2,4	b
Nb-95	765.786	99.80± 0.04	0.04	1	35.045±0.005 d	5	b
Co-58	810.757	99.44± 0.02	0.02	1	71.3 ±0.2 d	1	b
Mn-54	834.827	99.978±0.002	0.002	1	312.5 ± 0.5 d	1	b
Co-56	846.751	99.974±0.001	0.001	1	77.3 ± 0.3 d	1	b
Y-88	898.021	93.4 ±0.7	0.75	1	107 ± 1 d	1	a
Co-60	1173.208	99.86 ±0.02	0.02	A	5.272 ±0.002 a	4	b
Na-22	1274.511	99.95 ±0.07	0.07	1	2.60 ±0.01 a	1	b
Co-60	1332.503	99.986±0.001	0.001	A	5.272 ±0.002 a	4	b
Na-24	1368.650	100	-	1	15.030 ±0.003 h	2	b,d
La-140	1596.20	95.6 ±0.3	0.3	1	Ba-140 d	A	b
Y-88	1836.13	99.37 ±0.02	0.02	1	107 ± 1 d	1	b
Na-24	2754.10	99.85 ±0.02	0.02	1	15.030 ± 0.003 h	2	b,d

1) Half life units: h = hours, d = days, a = years
References: A ... see Appendix

Comments:
a ... The accuracy of the intensity is less than 0.5% of the value. However, there is no other more suitable standard in this energy range.
b ... High accuracy intensity value calculated from level scheme.
c ... Low accuracy, but reliable; as calculated from level scheme.
d ... Not very suitable as standard because of short half life and/or difficult to produce.

APPENDIX XIV -

Fission Products with Yields Suitable for Reference Data.

Nuclide	t 1/2	Gamma-ray	Standard	Tracer
$^{91}Sr(+^{91}Sr^{m})$	9.7 hours	0.748 MeV 1.025	^{95}Nb 0.764 MeV ^{137}Cs 0.662 ^{65}Zn 1.115	^{85}Sr
$^{95}Zr(+^{95}Nb)$	65 days	0.724 0.756	^{95}Nb 0.764 ^{137}Cs 0.662	^{88}Zr
$^{97}Zr+^{97}Nb^{m}$	17 hours	0.747($^{97}Nb^{m}$)	^{95}Nb 0.764	^{88}Zr
$^{99}Mo+^{99}Tc^{m}$		0.140($^{99}Tc^{m}$)	^{139}Ca 0.166 ^{141}Ce 0.145 ^{57}Co {0.122, 0.136}	
$^{103}Ru(+^{103}Rh^{m})$	40 days	0.497	^{85}Sr 0.514	^{106}Ru
$^{105}Ru(+^{105}Rh)$	4.4 hours	0.726	^{95}Nb 0.764 ^{137}Cs 0.662	^{106}Ru
^{105}Rh	40 hours	0.306 0.319		^{102}Rh
$^{106}Ru+^{106}Rh$	1 year	0.512(^{106}Rh)	^{85}Sr 0.514	^{105}Ru
$^{131}I(+^{131}Xe^{m})$	8 days	0.364 0.637 0.723	$^{113}Sn+^{113}In$ 0.393 ^{137}Cs 0.662 ^{95}Nb 0.764	^{125}I ^{126}I
$^{132}Te+^{132}I$	78 hours	0.230 0.668 (^{132}I)	^{137}Cs 0.662	
^{133}I	21 hours	0.53	^{85}Sr 0.514	^{125}I ^{126}I
^{134}Cs	2 years	0.605 0.796	^{134}Cs ^{95}Nb 0.764	^{132}Cs
$^{137}Cs+^{137}Ba^{m}$	30 years	0.662 ($^{137}Ba^{m}$)	^{137}Cs 0.662	^{132}Cs
$^{140}Ba+^{140}La$	13 years	0.537 1.598(^{140}La)	^{85}Sr 0.514 ^{40}K 1.460	^{133}Ba
^{141}Ce	33 days	0.145	^{141}Ce 0.145 ^{139}Ce 0.166	^{139}Ce
^{143}Ce	33 hours	0.293 0.668 0.725	^{137}Cs 0.662 ^{95}Nb 0.764	^{139}Ce
^{147}Nd	11 days	0.533	^{85}Sr 0.514	

Fig. 1. ^{235}U fission cross sections in the energy region of 5 keV to 50 keV. The LINAC or BOMB data including more than 60 data points in one experiment are not plotted in the figure. The evaluated curves of Konshin et al. and Davey are shown for comparison.

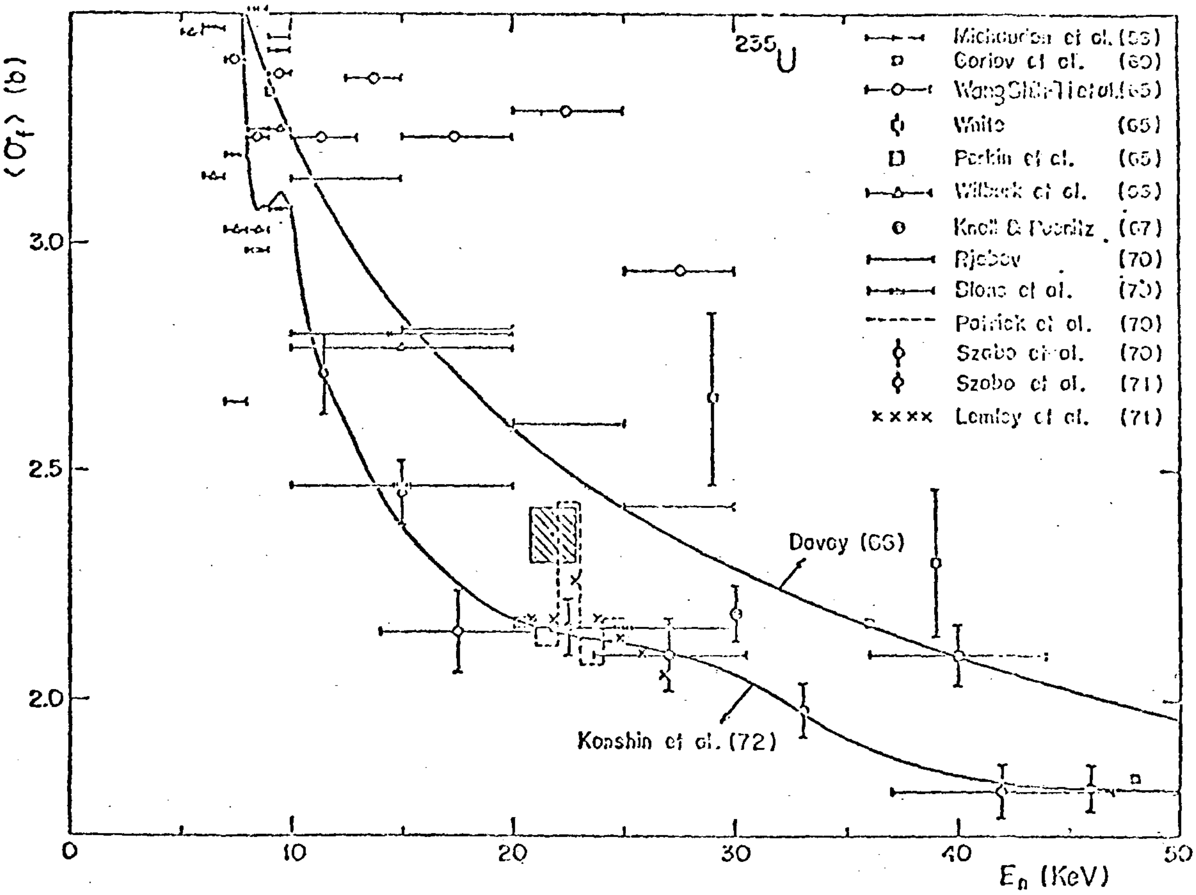
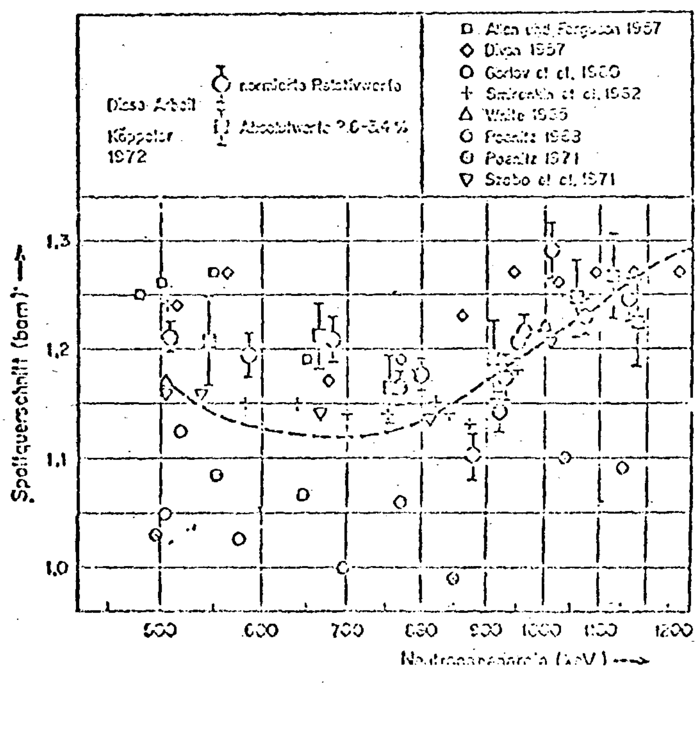


Fig. 2 - Preliminary values for σ_f of ^{235}U. This figure is reproduced from Käppeler and Konshin and Nikolaev's evaluated curve ------ is added.



APPENDIX XVI -

Examples of discrepancies on ^{238}U and ^{235}U data

Table I

Comparison of Geel and Columbia data for $\langle \Gamma_n^o \rangle$ and S_o of ^{238}U

		Geel		Columbia	
		$\langle \Gamma_n^o \rangle$	S_o	$\langle \Gamma_n^o \rangle$	S_o
0 keV	1 keV	1.72 ± 0.2	1.02 ± 0.13	2.15 ± 0.43	1.03 ± 0.2
1 keV	2 keV	2.57 ± 0.2	1.22 ± 0.13	2.36 ± 0.46	1.13 ± 0.22
2 keV	3 keV	2.52 ± 0.2	1.28 ± 0.13	2.36 ± 0.46	1.13 ± 0.22
3 keV	4 keV	2.98 ± 0.2	1.19 ± 0.13	2.13 ± 0.42	1.02 ± 0.21
4 keV	5 keV	1.54 ± 0.2	0.56 ± 0.13		0.41 ± 0.21 *
5 keV	5.8 keV	1.95 ± 0.2	0.52 ± 0.13		

* between 4 et 4.6

Table 2

Average parameters of ^{235}U from different authors

(according to de Saussure, ORNL)

	$\langle \Gamma_n^o \rangle$ meV	$\langle \Gamma_\gamma \rangle$ meV	$\langle \Gamma_f \rangle$ meV	$\langle \Gamma_D \rangle$ eV
Cramer	0.123	37	115	0.322
Blons	0.139	41.5	63	0.443
Krebs	0.143	52	158	0.329
Smith	0.125	36	182	0.198

APPENDIX XVIII -

Activities of the NEA Neutron Data Compilation Centre, Saclay

(Period July 1972 - September 1973)

F. FRÖHNER

1. Introduction

The main developments at the OECD/NEA Neutron Data Compilation Centre at Saclay during the last 14 months were

- introduction of a new system of computer programmes for all CINDA operations in April 1973,
- increasing effort required to cope with the growing volume of data exchanged between the four neutron data centres under the EXFOR agreement,
- steadily increasing number of requests for data,
- publication of the Neutron Nuclear Data Evaluation Newsletter originally published by P. Ribon, since November 1972.

2. Staff

The CCDN staff situation was relatively stable. During most of the past 14 months the centre worked with a full complement of 18 (7 physicists, 2 technical assistants, 2 programmers, 4 computer and key-punch operators, 2 secretaries and 1 administrator).

3. Data Base

The four main files forming the centre's data base have now reached the following sizes:

- experimental data (NEUDADA) 1 900 000 data records,
- evaluated data (ENDF, UKNDL,...) 600 000 " " ,
- bibliographic file (CINDA) 102 000 entries,
- request file (RENDA) 1 356 requests.

3.1. Experimental data

The systematic revision of older data from the CCDN service area continues. This work is now complete with respect to

Austria, Belgium, Euratom, Finland, Greece, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, Turkey.

Work on the remaining data - from France, the United Kingdom and West Germany - is in progress.

Approximately 150 000 new data points from the CCDN service area were entered into the NEUDADA file together with the associated non-numeric information during the last 14 months. Among the more noticeable acquisitions were

- the complete fission yield library compiled by E.A.C. Crouch at Harwell,
- capture and fission product gamma ray spectra measured at Karlsruhe by Michaelis, Weitkamp and others.

The amount of data exchanged successfully under the EXFOR agreemant until September 1972 is as follows.

origin	tapes	works	bibliographic records	data records
NNCSC	20	230	12 570	252 696
CCDN	12	160	21 200	440 820
NDS	9	237	13 536	16 822
CJD	12	109	6 702	13 819

The USSR contribution grew especially fast, but at most centres the production of EXFOR tapes is still lagging behind the data production, partly because data do not reach the centres rapidly (this seems to be the problem at the NNCSC) or because the backlog of data to be converted to EXFOR format could not be reduced to an acceptable level (this latter situation exists at the CCDN, although practically all incoming data are almost immediately available to users in the centre's internal NEUDADA format).

3.2. Evaluated data

During the report period the following evaluated data were received:

- a new version of the Swedish SPENG library (July 1972),
- evaluated molybdenum data in KEDAK format (September 1972),
- scattering-law and other data which were missing on the ENDF/B-III tapes sent to the CCDN (April 1973),
- a new version of the British UKNDL file (May 1973),
- point cross sections for heavy elements and structural materials calculated from resonance parameters in ENDF/B-III format (August 1973),
- the fission product library compiled by C. M. Devillers at Fontenay-aux-Roses (August 1973).

The Soviet evaluation of U-238 received last July was an example illustrating the SOKRATOR format rather than a true evaluation, as Professor Nikolaev explained at the last Four-Centre Meeting in Moscow and Obninsk. A true evaluated file is expected to be available soon.

3.3. CINDA file

Since the first computerisation in 1965, the CINDA file has grown to about 100 000 entries for some 18 000 different literature references. The increasing size of the file and the high rate at which its contents are modified and added to made use of the original rather modest handling programmes increasingly difficult, while development of links between CINDA and other compilations (especially numerical neutron data) was hindered by the relatively small portion of information in CINDA entries which was computer-recognisable, and by the many inconsistencies and errors which had crept in with time.

CCDN began developing programmes for semi-automatic correction and restructuring of the file, and to devise an integrated, disk-based file handling system and an exchange interface with the US, in 1970. Close and most fruitful contact was maintained with the other centres concerned. Although more problems were encountered than we had hoped, file conversion and full transfer of update and retrieval operations to the new system were completed in April 1973, in time for CINDA73 to be produced from a tape supplied by CCDN as input to the NDS Linotron layout routines.

The benefits of the new CINDA programmes are

- vastly increased speed and convenience of all file operations such as retrievals, updates, sorts etc.,
- more elaborate search criteria for retrievals,
- a better file: although a number of new errors were introduced during file conversion many more errors and deficiencies were corrected in the process. It is relatively easy with the new programmes to eliminate the new errors in time for the next CINDA publications.

3.4. RENDA file

WRENDA73 was published on behalf of the four CINDA centres by IAEA in March 1973. Since NDS was not ready to perform the necessary computer operations in Vienna so soon after receiving the RENDA file and the handling programmes from CCDN, we were asked by IAEA to help with the production of WRENDA73. The computer operations were then performed at the CCDN by Dr. C. Dunford from the NDS with help from CCDN staff.

4. Dissemination of Information

4.1. Retrievals from the files

During the 12-month period beginning 1st April 1972 the CCDN received

- 208 requests for experimental data,
- 99 " " evaluated " ,
- 15 " " bibliographic references.

In most cases the answer could be mailed within three days after the request had been received. The number of requests for bibliographic references is about the same as during the preceding 12 months, but that for experimental data is 31% higher, and that for evaluated data even more so, namely 39%. This trend continued since, and for the first time there was almost no slack in request activity during the summer vacation months. New groups of requestors seem to become aware of the neutron data centres and their capabilities. Thus we received requests from hospitals, activation analysts, astrophysicists, university students besides the usual clientele of evaluators and reactor physicists. Since the plotter programmes were improved the CCDN could satisfy about 40 requests for plots and was able to use plots extensively for the centre's own work.

4.2. Publications

The CCDN published during the last 14 months

CCDN Newsletters No. 72-1 (Nov. 1972),
73-1 (April 1973) and
73-2 (October 1973).

These short newssheets report on new editions to the files since publication of the last complete file indexes (Newsletters 13 and 14 for experimental and evaluated data, respectively).

In addition, the Neutron Nuclear Data Evaluation Newsletter (NNDEN), started by P. Ribon at Saclay, is now regularly produced by the CCDN. So far we published

NNDEN/8 (Nov. 1972),
/9 (March 1973),
/10 (March 1973),
/11 (July 1973).

NNDEN/10 was devoted to computer programmes for manipulation and conversion of evaluated data files.

In addition to these regular publications CCDN staff contributed papers to conferences and meetings:

- Proc. 4th Intern. Conf. on Reactor Shielding, Paris, October 1972 - F. H. Fröhner and S. Valente: "On Shielding Calculations with Computer Files of Neutron Data" and C. Dunford, F. Fröhner, R. J. Howerton, O. Ozer, J. J. Schmidt, S. Valente: "A Status Report on Nuclear Data for Shielding Calculations";
- CODATA Symposium on Man-Machine Communication for Scientific Data Handling, Freiburg i. Br., July 1973 - F.H. Fröhner, L. Lesca and C. Rickeby: "Operational Techniques of the Four-Centre Network of Neutron Data Banks";
- Specialists' Panel on Capture Cross S ctions of Structural Materials Cr, Fe, Ni, Karlsruhe, May 1973 - F. H. Fröhner and A. Ernst: "Resonance Capture Measurements on Structural Materials with Large Liquid Scintillators".

APPENDIX XIX - . September 1973

National Neutron Cross Section Center

During the period since the last report the NNCSC has transmitted to the other three centers 14 tapes containing data in the agreed exchange format EXFOR. In addition, thirteen tapes containing data compiled prior to EXFOR converted to the new format were also transmitted.

Two NNCSC representatives were aided by IAEA funds to attend 4 Center meetings held in Vienna and Moscow in October and June, respectively. Substantial progress was made in several areas that included more uniform methods of reporting center statistics, agreement on an input format for the worldwide request list WRENDA, and generalization of EXFOR to include additional data types and multidimensional tables. A problem common to all the centers has been the unavailability of published and other known data sets because the center was unable to obtain the results from the measurer. The NNCSC has over thirty such cases. A few cases have been pursued for over a year. In some instances funding reductions have caused difficulties but in other cases the delay in transmission is not understood.

Finishing touches are being placed on Volume 1 of BNL 325 containing recommended resonance parameters and thermal cross sections. Sections of the book containing data have been printed. Completion of the introduction is expected shortly with distribution of the book expected by the end of 1973.

Two meetings of the Cross Section Evaluation Working Group were held in November 1972 and May 1973. The present concern of CSEWG is development of Version IV of the Evaluated Nuclear Data File (ENDF/B). In ENDF/B-IV the general purpose file will contain data for over 100 materials, the dosimetry file will contain 32 materials, the scattering-law file 10 materials, and the fission product file several hundred nuclides. Special attention has been given to data sets for shielding applications. Over 30 materials will have gamma-production data files that are consistent with the neutron data portion of the file. In addition there are photon-interaction data for all materials. Some of the thermal cross sections will be significantly improved in ENDF/B-IV.

Statistics for data requested from the NNCSC are presented in Tables 1 and 2. The requests for evaluated data outnumber requests for experimental data. Magnetic tapes are a favored retrieval mode indicating that many requestors are prepared to process the data by computer.

Table 1

CSISRS Request Statistics

July 1, 1972 - June 30, 1973

Requests for Experimental Data [CSISRS]:

1. Requests

a) received	151
b) answered	148
c) number of data sets sent	17,232
d) number of data records sent	1,473,788

2. Origin of Request

a) Government Agencies	4
b) Educational Institutions	37
c) Industry	30
d) Four-Center (other than format EXFOR)	7
e) National Laboratories	40
f) Internal (NNCSC Staff)	33
Total	151

3. Mode of Request

a) Magnetic tapes, varied formats	76
b) Computer listings	72
c) Plots	1,403
d) Other	7

Table 2

ENDF Request Statistics

July 1, 1972 - June 30, 1973

1.	Requests	
	a) Number of Requests	184
2.	Origin of Request	
	a) CSEWG Members (other than ENDF/B, i.e., ENDF/A, Doppler broadened data, etc.	86
	b) Government Agency	13
	c) Educational Institution	30
	d) Industry (other than CSEWG)	42
	e) Foriegn Exchange	13
3.	Mode of Request (may be more than 1 per request)	
	a) Magnetic Tapes	98
	b) Computer Listings	51
	c) Cards	5
	d) Plots	11
	e) Other	54

APPENDIX XX -

Report on WRENDA

I. Publications Since Fifth INDC Meeting

In October 1972, RENDA 72 (INDC(SEC)-27/L) was issued with a limited distribution. With the help of the CCDN, nearly 300 data requests from the United States were revised and other known errors in RENDA 72 were corrected in October 1972. A new edition of WRENDA 73 was published with a wide distribution in March 1973 as INDC(SEC)-32/U. The draft safeguards data request list reviewed by the INDC at its Fifth Meeting was issued as INDC(NDS)-50/U in March 1973. A revised introduction was prepared by the Department of Safeguards and Inspection and a few errors found when comparing the 1972 US safeguards data request list with those US requests in the IAEA list were corrected.

II. Future WRENDA Publications

As recommended by the INDC, future WRENDA publications will result from a Four Centre cooperative effort. At the Eighth Four Centre Meeting in Vienna the responsibilities of each Centre were defined and a computerized request format adopted. Each Centre will be responsible for supplying the NDS with new and revised data requests from countries in its service area according to the attached schedule. The NDS will maintain the data files and publish the request lists annually.

The computerized data request storage system has been designed and the contents of the RENDA file at Saclay (essentially WRENDA 73) have been converted. The system was so designed that fusion and safeguards data requests can be stored in the same file. Either merged or separate lists can be produced for publication.

Since no agreement was reached at either the last INDC Meeting or the last EANDC Meeting regarding expert reviews of the status of requested data, the WRENDA status comments will consist of a merge of all comments submitted by national review committees. However, the system is so designed that no changes will be required if expert reviews are undertaken at some future time.

Due to a five month staff recruitment delay, the computer programming effort began only one month ago. Some delay will result. Present plans call for the distribution of the "country" retrievals through the Four Centres for review by the national screening authorities by the end of 1973. It is urgent that the official national contacts be designated as soon as possible.

Attached you will find samples of the proposed "country retrieval" and "book" output formats for WRENDA for your comment.

REQUEST NUMBER: 671025 YEAR: 1967

COUNTRY: USA

REQUESTOR(S): R.T.BAYARD BET
T.SNYDER GEC

TARGET: 60 NEODYMIUM 143

QUANTITY: NEUTRON CAPTURE

INCIDENT ENERGY: 1.00 MV TO 100. KEV

APPLICATION: FISSION REACTORS, CORE PHYSICS

ACCURACY: 10 %

PRIORITY: 1

QUANTITY COMMENT(S):

ENERGIES ABOVE 1 EV OF INTEREST.

ACCURACY AND RESOLUTION COMMENT(S):

ACCURACY 10 PERCENT IN RESONANCE INTEGRAL.

OTHER COMMENT(S):

NEEDED FOR FISSION PRODUCT POISON CALCULATIONS.

STATUS:

CRC WALKER - AECL-3037(9/68) RECOMMENDS 325B FOR THERMAL, RESONANCE INTEGRAL = 60B.

GEL ROHR+ - 71 KNOX 743(3/71) RESOLVED RESONANCE REGION.

Sample book page

60 NEODYMIUM 143				NEUTRON CAPTURE
				671025 MODIFIED (PARTIALLY FULFILLED)
1.00 KV	1.00 KEV	10%	1	USA BET R.T.BAYARD USA GEC T.SNYDER ENERGIES ABOVE 1 EV OF INTEREST. ACCURACY 10 PERCENT IN RESONANCE INTEGRAL. NEEDED FOR FISSION PRODUCT POISON CALCULATIONS.
				692219 NEW
850. EV	10.0 MEV	10%	2	SWD AE R.HAKANSSON ENERGY RESOLUTION 10 PERCENT OR BETTER. NEEDED FOR FAST REACTOR CALCULATIONS.
				692220
5.00 KEV	2.00 MEV	10%	2	GER KFK J.J.SCHMIDT FISSION PRODUCT IMPORTANT IN FAST REACTOR BURN UP CALCULATIONS.

STATUS

CRC WALKER - AECL-3037(9/68) RECOMMENDS 325B FOR THERMAL, RESONANCE INTEGRAL = 60B.

GEL ROHR+ - 71 KNOX 743(3/71) RESOLVED RESONANCE REGION.

60 NEODUMIUM 143 NEUTRON RESONANCE PARAMETERS

etc. etc. etc.

WRENDA Production Schedule

1.	1 Feb.	Country revisions and additions received by NDS.
2.	Feb/March	NDS includes these revisions into Request and Status files.
3.	15 March	File closed.
4.	15 April	Material submitted to publication division.
5.	May/June	NDS prepares country retrievals.
6.	15 June	Country retrievals sent to other centres for distribution.
7.	30 June	Printing of WRENDA completed; distributed by IAEA.

The above schedule will start for the publication of WRENDA 75. WRENDA 73 was issued in March 1973 and we envisage the schedule below for the publication of WRENDA 74.

28 Feb 1973	RENDA master file received by NDS from CCDN.
March - May	File conversion.
June	4-Centre Meeting. Final approval of system and schedules.
July	Clean up Status File.
Nov	Country retrievals made by NDS.
Dec	Country retrievals shipped to other centres.
15 March 1974	Country revisions and additions received by NDS.
	Then continue as in normal schedule above.

APPENDIX XXII -

Report on neutrυn data evaluation in U. S. A.

(Extracted from the Minutes of the USNDC - June 1973)

Pearlstein announced that the ENDF/B-IV would be issued by the end of the year. However, some compromises would be made in order to meet the schedule for the demonstration LMFBR plant. The center would look to DRRD for guidance. Two major tasks forces had taken part in preparation of this file. The first considered the fissile nuclei attempted the best evaluation for ^{235}U emphasizing cross section ratios and also established guidelines for new data sets. New data was considered for the unresolved regions for ^{239}Pu. Guidelines were also established for ^{238}Pu cross sections. The second task force was concerned with fission products. Twenty people participated and formats were established. French efforts to put decay data into the ENDF format will play an important role. 2200 m/s cross sections are a problem. The 1969 IAEA review was used and the matter is still under debate in the IAEA. If their judgement proves unsatisfactory a task force may be set up to deal with thermal cross sections.

More generally the center is considering expansion of ENDF formats to include non-neutron type of data, particularly reactions in which the induced particles are not neutrons. In this case, most of the ENDF system can be carried over. Changes will be attempted to include charged particle reactions, neutron source reactions, and reciprocal reactions. Similar advances are occurring in data exchanges among the four data centers. With new format changes two-dimensional or multidimensional data will be tractable without mathematical obstacles. NNCSC is spending a susbstantial amount of time supporting this work.

APPENDIX XXIII -

Physical data needed for Radiation Dosimetry, Radiation Biology and Radiotherapy

The following is only meant to indicate, by examples, some areas where further knowledge is desirable. The accuracy with which the individual quantities are known varies a great deal, as does the need for improvement.

A. Atomic Physics

a. photon interaction cross sections
   photoelectric cross sections at low photon energy
   attenuation coefficients at low photon energy

b. elastic collisions of charged particles
   elastic collision cross sections (electrons, protons and heavy ions)
   effects of target structure (binding energy, lattice potential) on such cross sections
   displacement probabilities
   multiple scattering distributions, mean values
   collision cascades, types of solid-state damage

c. inelastic collisions of charged particles
   excitation and ionization cross sections,
   especially inner-shell ionization and Auger cascade,
   superexcitation, spectral and angular distributions of delta rays,
   collective excitation
   W values of gases
   effects of target structure on inelastic collisions
   stopping powers (e.g. where the first Born approximation is not valid)
   energy-loss fluctuations, mean ionization potentials, density potentials, density effect
   (Note that elastic and inelastic collisions often cannot be separated).

d. thick absorber data
   slowing down spectra
   detour factors
   transmission coefficients
   backscatter coefficients
   track lengths, practical ranges of particles (e.g. where the first Born approximation is not valid), range distributions
   attenuation lengths for slow electrons

B. Nuclear Physics

a. collision cross sections
   total and differential neutron cross sections in the energy region > 20 MeV
   spectral and angular distributions of charged secondary particles
   nuclear cross sections for other particles(p, alpha, pion)
   photonuclear cross sections

b. radioisotopes
   decay schemes of radioisotopes
   production processes for radioisotopes.

APPENDIX XXIV

RECOMMENDATION TO AUTHORS OF PAPERS ON EXPERIMENTAL NUCLEAR PHYSICS

1) While brevity is a cardinal virtue, the description of the experiment should be in sufficient detail to enable the reader to judge the reliability of the data presented and of the precision claimed. Naturally a reference to such a description in an earlier publication would be equally acceptable.

2) A clear statement of the errors (systematic or statistical) of the result and how they are derived is essential.

3) If the results are relative to or depend on some other measured or calculated quantity this should be clearly indicated, its value(s) and its error given and its origin stated.

4a) Data should clearly stand out from the text, e.g. in tables.

b) Within tables, the authors' new measurements should be kept separate from values derived from other sources.

c) Experimental data should be distinguished from results derived using theoretical nuclear models.

5) If an extensive tabular presentation of the data does not form part of the published paper but is available in a laboratory report or from a data centre this should be explicitly brought out.

6) Previously published material, e.g. abstracts, laboratory reports, conference reports, etc., which are superseded by the paper presented should be explicitly indicated.

APPENDIX XXV

International Conference on Few Particle Problems in Nuclear Interactions

This conference was held in Los Angeles, August 27 - September 1, 1972. It was sponsored by IUPAP, USAEC, USNSF and USONR, and organized by the University of California.

Number of participants : 260

Number of invited papers : 18

Number of contributed papers : 170, and 150 were selected to be published in the proceedings.

60 papers were reported at the conference, while the others were summarized by the rapporteurs.

The proceedings of the Conference were published by North Holland Publ. Comp. in December 1972.

The Conference covered the following topics :

I) Nuclear forces, in particular of the energy shell interaction and the three body force

II) Symmetries

III) Three body problem

IV) Mesons, leptons, photons, and few nucleon systems

V) Multiparticle reactions

VI) Meson physics facilities : LAMPF , TRIUMF, SIN

VII) Applications, in particular : astrophysics, nuclear structure

VIII) Hypernuclei.

APPENDIX XXVI -

Third IAEA Symposium on the Physics and Chemistry of Fission, held in Rochester, N. Y. from 13 to 17 August 1973

by Dr. S. L. Whetstone

STATISTICS

1. ~ 200 official participants from 20 member states
   ~ 110 US, ~65 Europe (0 from USSR!)
2. 62 papers presented, 51 contributed, 11 invited, 105 abstracts submitted.

SCOPE OF MEETING:

The intent was to concentrate, somewhat more than previously, on studies of the fission process (or mechanism) itself. Quoting from the information sheet: "Papers will be accepted that deal with new theoretical concepts or calculations concerning the fission process, or with new experimental results pertinent to the development of such theories".

This concentration was made more explicit by the statement: "Papers deemed more appropriate for consideration at a 3rd International Conference on Nuclear Data for Reactors will not be accepted". (It was thought at the time that such a conference would be held in 1974).

It seems now to be generally conceded that there had been enough accomplished since the previous Symposium in 1967 in this somewhat limited field of basic research, to have warranted holding this Symposium this year.

It has been suggested that a similar Symposium, perhaps with the inclusion of more of the relevant heavy-ion work, would very likely be desirable in about another four years' time.

HIGHLIGHTS -

The summary talk was presented by K. Dietrich. He pointed especially to the success that the experimentalists have had since the last Symposium in furnishing proof that the picture of the double-humped fission barrier, with its far reaching implications, is a true one and that the values of barrier heights and the deformation of the class II states (states in the second well) as calculated from the current theoretical treatments are essentially correct. Particularly important have been the experiments that have given rather direct evidence that the "fission isomers" are indeed metastable states of a nucleus with a deformation considerably larger than that of the ground state - that "fission isomers" are actually "shape isomers". The first successful demonstration was made by a group working in Munich and was reported at the 1st European Conference on Nuclear Physics held in Aix-en-Provence early in the summer of 1972. It was possible, by detecting conversion electrons, to determine rotational bands corresponding to the expected larger deformation. At the present conference, a group from Seattle, Washington, announced the observation of gamma transitions from states in the greatly deformed isomer to states with the nucleus in its "ground-state" deformation. This group also reported on the identification of excited intrinsic states with a deformation corresponding to that of the shape isomer.

It was shown by a joint group from Los Alamos and Oak Ridge that the fine structure peaks belonging to the same intermediate resonance have the same nuclear spin as is required if the observed fine structure is actually produced by the coupling of Class II (isomer) states to the many compound states of class I (ground state deformation). This technique, which utilized polarized neutrons and a polarized target, seems also to have clearly established itself as the authoritative method for determining resonance spins, while demonstrating that a number of the previously used indirect methods were useless.

Another extremely interesting result reported by the Munich group concerning the rapid decrease of peak-to-valley ratio in the mass yield just above the fission threshold for Ra and Ac, which hints strongly at different thresholds for symmetric and asymmetric fission.

Some of the more important results achieved by the theorists was the strengthening of the basis for the Strutinsky shell correction method.

Also a number of extensive and "rewarding" applications of the Strutinsky method were carried out by groups at Lund, Los Alamos, and elsewhere.

The first Hartree-Fock calculations with density-dependent interactions were made at Orsay.

The questions of the dynamics of fission and viscosity in the approach to scission were subjected to a more thorough analysis.

The significant effects of the breaking of symmetries, particularly at the saddle point, on the level densities was pointed out by the Copenhagen school.

APPENDIX XXVII

Proposed IAEA Symposium on "Research materials for Nuclear Measurements" for 1975

This Symposium is being proposed under the auspices of the Industrial Applications and Chemistry Section with the support of the Nuclear Data Section. It is concerned mainly with chemistry aspects of this important subject.

The Agency has long recognized through its Nuclear Data programme the importance of nuclear data compilation and evaluation to the development of nuclear power and, recently through its successful Symposium on Applications of Nuclear Data in Science and Technology in Paris, 12-16 March 1973, to the application of nuclear techniques to other areas of interest.

Underlying the reproducibility and reliability of the data are the experimental methods used and the quality and characterization of the materials studied. Over the years it has become clear that the needs of the researcher are not always sufficiently defined for the materials producer, who is often a chemist working at the limit of the technology available to him. It is necessary that the researcher define the requirements for the success of his experiment in terms of purity, form, interfering impurities, and other physical characteristics so that the desired sample can be prepared at the lowest possible cost and with the best possible results. Similarly it is important for the researcher to understand the "state of the art" for sample preparation so that he can make reasonable requests and plan his work efficiently.

It would be the purpose of this Symposium to disseminate new developments in the area of sample preparation, discuss users'problems, and discuss international co-operation in the research materials field.

A successful International Symposium on this topic was held under the auspices of the U.S. Atomic Energy Commission in 1971 in Gatlinburg, Tennessee, U.S.A.; there also have been two previous symposia, the first sponsored by the Central Bureau of Nuclear Measurements (EURATOM) at Geel, Belgium, and the second by the U.K. Atomic Energy Research Establishment at Harwell, United Kingdom.

Informal discussions with representatives of the EURATOM and Oak Ridge Groups involved in this activity have indicated strong support for such a meeting.