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International Atomic Energy Agency

INDC - 11/U

INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

TECHNICAL MINUTES OF THE FIFTH INDC MEETING

IAEA Headquarters, Vienna, Austria
17-21 July 1972

Compiled by

R. Joly (CEN Saclay, France)
Executive Secretary

Aided by

P. Ribon (CEN Saclay, France)

C.L. Dunford (IAEA)
Local Secretary

J.J. Schmidt (IAEA)
Scientific Secretary

April 1973

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

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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 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
G.A. Kolstad, Washington, USA
K. Nishimura, Tokai Mura, Japan
G. Paic*, Zagreb, Yugoslavia
G. Ricabarra, Buenos Aires, Argentina
B. Rose, Harwell, UK

2. Scientific advisers

G. Bartholomew, Chalk River, Canada
B. Grinberg, Saclay, France
W.W. Havens Jr., New York, USA
V.A. Konshin, Minsk, USSR
P. Ribon, Saclay, France
J.L. Rowlands, Winfrith, UK
R.F. Taschek, Los Alamos, USA
G.B. Yankov, Moscow, USSR

3. Observers

A.H.W. Aten, Geel, Belgium (Euratom)
C. Dunford, Vienna, Austria (NDS/IAEA) Local Secretary
F. Fröhner, Saclay, France (NEA/OECD)
J. Rosen, Paris, France (NEA/OECD)
Z. Sujkowski, Warsaw, Poland

* Ad hoc member replacing I. Slaus

I. INTRODUCTORY ITEMS

Dr. Finkelstein, Deputy Director General of the IAEA for the Department of Research and Isotopes welcomed the participants to the Fifth INDC meeting on behalf of the Director General. He outlined the primary goals of INDC, namely examination of the needs of nuclear data, compilation and dissemination of experimental and evaluated data, and consideration of future problems which arise in the nuclear data field. He emphasized the work already accomplished by INDC in the last few years, particularly in the exchange of measured data. An important step had been accomplished in the exchange of evaluated data since the previous meeting and he expressed the hope that the situation in this field would improve rapidly. He also mentioned the first steps taken to enlarge the scope of INDC to the consideration of non-neutron nuclear data which had resulted in the creation of an "International Working Group on the Compilation, Evaluation and Dissemination of Nuclear Structure and Reaction Data" (IWGNSRD) and in the decision for a Symposium, to be held in March 1973, on Applications of Nuclear Data in Science and Technology.

Dr. Finkelstein expressed the Agency's gratitude to Dr. G. Kolstad for his efforts as Chairman of INDC in the course of the last two years; he welcomed Professor L.N. Usachev as the new Chairman of INDC and wished him a successful term of office for the next two years.

Dr. Schmidt mentioned to the Committee the broad and high level of knowledge of Professor Usachev and his responsibilities as Director of the nuclear physics programme at FEI Obninsk and as Deputy Chairman of the Nuclear Data Commission of the USSR.

II. COMMITTEE BUSINESS

II.B. Preparation of Technical Minutes of INDC Meetings

A sub-committee was appointed to discuss the production of Technical Minutes and its proposals (Appendix IV) were approved by the Committee.

III. PROGRESS REPORTS

III.A. Draft report by NDS/INDC Secretariat on proposals for participation in experiments using underground nuclear explosions

The proposals for participation in experiments using an underground explosion were collected by NDS and reported in the INDC(SEC)-26/G document. A supplement to this document was sent by Dunford to INDC members on June 30, 1972.

Most of the proposals were made by CEN-Mol and BCMN-Geel laboratories. Aten was then invited to discuss the proposed experiments. He first pointed out the very preliminary character of the proposals. No preliminary experiments have been done to check the feasibility of the proposed experiments and no governmental sponsorship has been given. It was on a purely scientific and technical basis that a group of physicists from Belgium, France, Germany, Italy, Netherlands and BCMN met at Geel on July 7, 1972 to discuss the proposed experiments and to try to establish an order of "priority". In this respect, the degree of experimental feasibility seemed to be a good criterion because it is closely linked to the cost. The following order of priority was agreed upon:

- priority I: Measurement of fission product yields for ^{235}U using the spinning wheel technique. This experiment is an extension of Cowan's wheel experiment but it is intended to measure at least 22 mass chains by using non-destructive methods based on either γ-ray spectroscopy with Ge (Li) detectors, (Van Assche (Mol) proposal) or X-ray spectroscopy with Si(Li) detectors (Ribon (Saclay) proposal). Information on the J and K quantum numbers for individual resonances are expected from this experiment.

- priority II: Measurement of the ratios of ternary to binary fission ($^T/B$ ratios) for ^{233}U, ^{235}U, ^{239}Pu and ^{241}Pu (Deruytter (Geel) proposal) with the aim of studying a possible correlation with spin J in the resonance region and of investigating the general trend in the $^T/B$ ratios with excitation energy up to a few MeV.

- Investigation of systematics on fission barrier parameters in the lower actinide region (joint proposal from Geel and Mol). The aim is to check Strutinsky calculations predicting reduced shell effects on the nuclear deformation below the scission line for isotopes with $88 \leq Z \leq 91$. Measurements of σ_F and if possible of σ_γ and σ_n are proposed.

- Priority III: Resonance parameters of fission product nuclei (joint proposal from Geel and Mol). ^{93}Zr, ^{99}Tc, ^{101}Ru, ^{107}Pd, ^{135}Cs, ^{147}Nd, ^{147}Pm and ^{151}Sm were proposed because of their importance in fast reactor burnup calculations. This experiment was supported by RCN Petten and considered as important for the evaluation of integral measurements in STEK, done in connection with the combined Belgian-Dutch-German fast breeder programme.

- Measurements of total and partial neutron cross sections of ^{226}Ra and ^{227}Ac (Ceulemans (Mol) proposal). This experiment is related to the joint proposal of Geel and Mol on systematics of low Z element fission barriers. Samples are available and measurements of σ_T are underway for low energy neutrons.

Aten mentioned also a proposal from Karlsruhe for measuring cross sections of transuranium elements, with a particular emphasis on ^{241}Am and ^{242}Cm (see Appendix V). With the adopted definition of "priority" (namely: difficulty of the experiment), this experiment should be classified as priority II.

In his conclusion, Aten indicated that Deruytter had visited the physicists concerned in the USA, discussed in detail the different proposals and come back with the feeling that many of the experiments would be possible as joint experiments between European and American scientists. In particular, part of the equipment could be supplied by the USA physicists. Aten also indicated that as Dr. Diven will be in Europe in November 1972, it would be very useful to hold a similar meeting at that time with Diven's participation.

He also emphasized that the interested European laboratories were able to carry out only a very small part of the envisaged programme but that, at this stage, it was not necessary to make a selection among the proposed experiments. Cierjacks indicated that this comment also applied to the Karlsruhe proposal. His laboratory is unable to perform all their proposed experiments. Cooperation with other laboratories is needed and the official support of Karlsruhe authorities has to be obtained. He asked Committee members to think about their possible interest in Karlsruhe's proposed experiments (Action 6). His opinion is that, in a cooperative programme, the Karlsruhe laboratory would be able to provide two physicists and most of the needed samples. Yankov expressed interest in underground nuclear explosions as very intense neutron sources but indicated that for practical reasons the USSR will not be able to participate in a joint programme using this technique. An exchange of opinion took place about the interest in the experimental proposals from nuclear data standpoint on one side and from fundamental physics on the other side.

It was concluded that the distinction is in general not straight forward and that practical considerations (such as availability of samples, techniques, equipments, etc.) have to be taken into consideration. The time schedule for future underground nuclear explosions for scientific purposes is also very important. Kolstad indicated that the 1973 USAEC budget does not contain funds for such a shot but that the expression of interest of the international scientific community will be important in planning for possible inclusion in the 1974 budget. Members were invited to keep Taschek informed on further developments in their respective countries on interest in participation in experiments in 1974 (Action 7). Taschek added that the interest already expressed has been forwarded to the General Manager of the USAEC but that the Commission has not yet agreed on having foreign physicists attending or participating in the next shot for physics experiments which may take place in the first half of 1973.

III.B. Reports from Members on neutron data activities and experimental facilities

Argentina

Two category G reports were submitted: INDC(ARG)-2/G and INDC(ARG)-3/G. Ricabarra mentioned the following activities:

- Department of Nuclear Physics (Buenos Aires): Study of short lived fission products: work on ^{138}Xe and ^{86}Br decay has been completed and will be published. Future programme includes studies on the 143 mass chain, ^{139}Xe, ^{91}Kr and ^{93}Kr decay.

- Neutron and reactor physics group (Bariloche): Three main lines of research are carried out with a 30 MeV Linac: time-of-flight measurements of neutron spectra; neutron total cross section measurements; neutron die away experiments.

- Reactor Physics Division (Buenos Aires): Work is concentrated on integral experiments:
  - for ^{74}Ge and ^{76}Ge, the measured resonance integral values disagreed by a factor of 3 with calculated values but this discrepancy has been resolved by a careful evaluation of the unresolved resonance contribution.
  - for ^{146}Nd, ^{148}Nd, and ^{150}Nd, activation resonance integrals were measured and compared with the values calculated with the resonance parameters obtained by time-of-flight in other laboratories.
  - a letter to the Editor of "Nuclear Science and Engineering" on the spin assignment of the 301 eV resonance of ^{96}Zr was also mentioned.

- for ^{100}Mo, the measured resonance integral is a factor of about 2 less than the calculated value from resonance parameters given in KFK 120. The measured value was also compared to the results obtained by Baumann (Savannah River Lab.) using boron filters. A careful evaluation has shown that 50% of the resonance integral comes from energies above 1 keV. The present result is in agreement with Baumann's experiment but disagreement still exists with values calculated from BNL 325 or KFK 120 resonance parameters.

Australia

A category G progress report has been issued: INDC(AUL)-17/G. Gemmell reported the following activities:

- $\bar{\nu}$ for spontaneous fission of ^{252}Cf: This absolute measurement was made with a large liquid scintillator counter. A great deal of effort was devoted to measuring the detector efficiency, using the H(n,p) scattering reaction, and to investigating the corrections to be applied to the measured data. The preliminary result given, $\bar{\nu}$ = 3.73, is in good agreement with the results obtained with the manganese bath method and with the boron pile method. No explanation has been found for the discrepancy with values obtained in previous large liquid scintillator measurements. The error assigned to this preliminary value includes 0.2% for the effect of delayed γ-rays, 0.1% for the so-called "French effect"; another small error is introduced by the dead time correction of the counter and by the correction due to the hole penetrating the tank. An estimated over-all figure is 0.3 - 0.4%.

- A joint programme with ORNL, performed at ORNL, on high resolution capture cross section measurements on Na, Si, Ca, Ti from 3 keV to 500 keV has been carried out with a "Macklin detector". This experiment was complemented by capture γ-ray measurements. Analysis is in progress.

- The neutron capture γ-rays of several nuclei (F, Al, Si, S and Cl) having a (2s, 1d) shell structure have been studied. For these elements p-wave resonances can be expected to be observed.

Canada

The Canadian progress report was distributed as a G document: INDC(CAN)-10/G. Cross reported first on new facilities:

- The tank of the NRU reactor is being replaced by a new tank with improved beam facilities. The thermal column will be modified to permit the installation of a cold neutron source. A shut down of the reactor for about a year will be needed.

- A new accelerating tube has been installed on the AECL Tandem to improve current and voltage: 16.5 MeV has been obtained.

Concerning the studies performed, a progress report now in a draft form covering the period July 1971 - July 1972 will be distributed as a U document. Therefore Cross restricted his comments to a few points:

- ^{59}Co and ^{58}Ni (n,α) cross section: These measurements were undertaken to check if these reactions could be responsible for the high He content found in highly irradiated stainless steels. In the case of ^{59}Co, the (n,α) cross section is too small by several orders of magnitude to explain the observed effect. For ^{58}Ni, the (n,α) cross section is considerable but no figure can yet be given.

- ^{64}Zn(n,p) cross section: This cross section, which appears with a high priority in RENDA, Has been measured from threshold to 20 MeV and a paper has been submitted for publication to the "Canadian Journal of Physics".

- ^{96}Zr thermal neutron cross section: This measurement was undertaken to resolve the discrepancy between the value calculated from resonance parameters (200 mb, by Good and Kim) and a measured value (5.7 mb by Ricabarra). The result obtained (19.8 ± 2.9 mb) is in very good agreement with a recent result (20 ± 3 mb by Fulmer).

France

As the French activities will be reported in a joint progress report from EURATOM countries cover the year 1971, Ribon restricted its presentation to the most important or recent results:

- In the resolved resonance energy range, two groups of activity can be discerned:

  - the first one concerns the multilevel analysis of ^{241}Pu and ^{235}U resonance data. In the case of ^{235}U it appears that the fission widths resulting from a multilevel analysis are much greater than those obtained with the single level formalism.

  - the second one consists of two experiments to measure $\bar{\nu}$ in the resonances of ^{239}Pu. They confirm the results of Weston, i.e. that there is no correlation with the spin. It appears that there is an anticorrelation between $\bar{\nu}$ and the average total energy E_γ released by the prompt γ-rays accompanying fission.

  - In the fast neutron energy range:

    - at Cadarache, Sazbo et al. have found a systematic discrepancy in their measurements of the ^{235}U fission cross section. In the energy range from 20 keV up to 2 MeV, the values obtained by using a fission chamber borrowed from White (Aldermaston) are 2 to 3% higher than those obtained with a fission chamber equipped with a fission foil prepared and calibrated by the BCMN-Geel. This difficulty is now being investigated. One can remark that, when a good accuracy on the neutron flux measurement is realized, the main sources of errors are due to the sample thickness and to the multiple scattering corrections, and errors of this nature still existe when ratios between two fission cross sections are measured.

- at Bruyère le Châtel, Soleilhac, Fréhaut et al. have found a source of error in the estimation of their background; their new results on $\bar{\nu}$ (^{235}U) are greater by 1 to 3% than the previous ones in the energy range 1.5 - 7 MeV. A similar effect is expected for ^{239}Pu and new measurements will be carried out before the end of this year.

- Concerning standards, the disagreement between Harwell and Cadarache on the 250 keV resonance of ^{6}Li has not disappeared. Both laboratories fit their own (n,α) cross section and all the other data. It seems that Cadarache gives a higher weight to the scattered neutron angular distribution, while Harwell obtains a better description of the total cross section at the peak of the 250 keV resonance. The parameters used by Fort have been recently published as an EANDC report (EANDC(E)-148U).

- Fission spectrum: The studies of the fission neutron spectrum are continuing at Limeil (for ^{238}U, fission induced by 4 to 7 MeV neutrons) and have started at Cadarache (for ^{235}U and ^{239}Pu, with ~40 keV neutrons). Results are not yet available.

- Concerning equipment, two experimental installations, both based on the "MAIER-LEIBNITZ" type detector, will permit capture cross section measurements. The first one, at Cadarache, is running, and data on natural iron show much more structure around 200 keV than previously reported. The second one, at Saclay, will be in operation next year. It must be noted that this sort of detector requires a weighting function which depends on the binding energy. Thus experimenters should use separated isotopes.

- Lastly, a library of nuclear data on fission products, which contains information on 600 nuclei, will be computerized. The data (yield, period, decay scheme, energy and intensity of radiations) will be recorded in a format derived from the ENDF format.

  Answering questions from Schmidt, Ribon specified that in this library only one value is proposed for each quantity (it is, however, not an evaluation because internal consistency between all the data was not envisaged), that a distinction was made between thermal neutron induced fission and "fast neutron" (fission spectrum) induced fission and that Dr. Devillers is in charge of this library. Rowlands mentioned the existence of a similar computerized library at Harwell. The compilation of the data is now complete and it is expected that an evaluation of the data will be issued by the end of 1972.

Germany

Cierjacks distributed a preliminary document containing the contributions of the GfK Karlsruhe and of the Hamburg University. After being supplemented by contributions from other German laboratories, the information will be included in the joint 1971 progress report from EURATOM countries (EANDC-E-150 report). Cierjacks selected for his presentation the most important topics:

1. Work done at the 3 MeV Van de Graaff at Karlsruhe

   - Absolute measurement of ^{235}U fission cross section between 500 and 1200 keV neutron energy. The H(n,p) cross section was taken as a standard using a gaseous scintillator. The data are available (accuracy 2 to 3%) and they are higher by 3 to 5% than the Szabo results (Cadarache). It is expected that the corrections announced by Szabo for his results will eliminate this discrepancy.

   - Measurement of the fission cross section ratio $\sigma_f(^{241}Pu)/\sigma_f(^{235}U)$ between 13 keV and 1130 keV. The data are available.

   - Neutron total cross sections of the separated isotopes ^{54}Fe, ^{50}Cr, ^{52}Cr, ^{62}Ni and ^{64}Ni between 10 and 300 keV. The data are available and measurements of capture cross sections of these isotopes are in progress.

   - Measurements of capture to fission cross section ratios for ^{235}U and ^{239}Pu: Data are available from 8 to 60 keV and measurements in progress up to 200 keV.

   - Measurements of the total cross section of boron and of the capture cross section of ^{238}U are in progress in the 20 to 200 keV energy range.

   - Measurements of $\bar{\nu}$ for ^{239}Pu are in preparation. Two methods will be used; measurement of the masses of both fission fragments and the conventional method using a thin and a thick sample.

2. Work done at the isochronous cyclotron at Karlsruhe

   - Measurement of the fast fission cross section ratio $\sigma_f(^{238}U)/\sigma_f(^{235}U)$: data are available in the neutron energy range from 0.8 MeV to 30 MeV. They are in good agreement with Los Alamos data but in substantial disagreement with recent data of Whalen between 2 and 5 MeV.

   - Determination of γ-ray production cross sections from $(n,n'\gamma)$ reactions: Data are available for ^{27}Al and ^{56}Fe. A measurement is planned for ^{238}U but is expected to give significant results only for a few γ-lines below 1.5 or 2 MeV.

3. Work at the Hamburg Van de Graaff

- Angular distribution and cross section of $^{11}B(n,\alpha)$ ^{8}Li at 14 MeV.

- Excitation functions of some (n,2n) and (n,α) reactions between 13 and 18 MeV neutron energies.

- Angular distribution of the reaction Cs I (n,α) at 14 MeV: This study was undertaken because this reaction is involved in measurements using a Cs I detector for the determination of absolute neutron flux.

Usachev asked whether the experimental data on α (^{239}Pu) measured at Karlsruhe had been compared with existing measurements and with Sowerby's evaluation. Cierjacks replied that these comparisons have been started but, from the recent Las Vegas ANS Meeting it appears that some changes in the previously published data (Gwin) are likely to be made. No definite conclusion can be given at present. Answering a question of Schmidt, Cierjacks indicated that the German progress report will be supplemented by some work done at Munich at 14 MeV neutron energy and at the Geesthacht reactor on accurate measurements of total cross sections at thermal energies. The discrepancy between Cadarache and Karlsruhe data on $\sigma_f(^{235}U)$ was discussed with the conclusion that further contacts were needed involving BCMN, Karlsruhe and Cadarache physicists.

India

A progress report on nuclear data activities in India, covering the year 1971, was distributed as a G document (INDC(IND)-17/G). Divatia outlined the following items:

1. New facilities

a) A zero energy fast reactor facility has been put into operation at Trombay in May 1972. The volume of the core is 3 litres and the critical mass is 21.6 kg of Pu in the form of 180 plutonium oxide pins. This reactor will be used for integral measurements.

b) A pulsed fast reactor is being designed and will be installed at Kalpakkam (near Madras).

c) The construction of the 224 cm variable energy cyclotron in Calcutta is proceeding according to schedule. The machine is expected to go into operation in 1974. User Committees have been formed to promote the utilization of the machine in different fields such as physics (in particular neutron data work), chemistry and biology. Answering several questions concerning this machine, Divatia gave some supplementary information:

- the energies specified in the project are 6 to 60 MeV for protons; 12 to 65 MeV for deuterons; 25 to 130 MeV for α particles.

- the acceleration of heavy ions (up to C at least, but not much higher) is intended but the design of the ion source is not frozen. In particular, the information received from Berkeley indicating that the acceleration of heavier ions was possible by a modification of their internal ion source is considered with great interest.

- concerning the utilization for neutron measurements, two types of reactions are being considered for neutron production: Li(p,n) reaction and "white source".

- the utilization of the cyclotron for medical applications (irradiation by fast neutrons or with deuterons) is being explored.

2. Experimental studies

The following studies were mentioned:

a) Calculations of the anisotropy in the emission of prompt neutrons from fast neutron induced fission. For a 30% fragment anisotropy, the neutron anisotropy is about 7% and varies linearly with the fragment anisotropy. It is important to take this effect into account for correcting measured $\bar{\nu}$ values in order to get the high accuracy in $\bar{\nu}$ needed for the estimation of breeding ratios in fast reactors.

b) Energy and angular distributions of long-range charged particles in thermal fission of ^{235}U.

c) Studies of highly asymmetric binary fission of Uranium with reactor neutrons.

d) Measurement, at the BARC Van de Graaff, of the $^{29}Si\ (\alpha,n)^{32}S$ cross section: this cross section was obtained by detecting the emitted neutrons in a 4π geometry up to an α incident energy of 5 MeV in 5 to 10 keV steps. Using reciprocity, the (n,α) cross section of ^{32}S could be deduced.

3. Nuclear data evaluation activities of the BARC Reactor Physics Division

A report on these activities is given in Appendix XVIII.

Italy

Benzi mentioned that the activities of the Italian laboratories are included in the joint 1972 progress report issued by EURATOM countries (EANDC-E-150). He outlined the following activities:

(Italy)

- Measurements of the neutron differential inelastic scattering cross-sections for angles greater than 150° at 14 MeV have been carried out for ^{16}O and ^{28}Si by the Turin Group. The analysis of the data is underway.

- A tangential beam tube of the 1 MW TRIGA reactor has been used by means of thermal neutron capture. The reactions ^{35}Cl (n,γ), ^{203}Tl(n,γ) and ^{175}Lu(n,γ) have been studied.

- The experimental study of the peak energy of light particles in ternary fission of ^{233}U, ^{235}U and ^{239}Pu by the Genoa Group (see Minutes of the Fourth INDC Meeting) continues.

Japan

Nishimura said that a progress report covering the period September 1971 - August 1972 is now being prepared and will be distributed within three months.

1. Facilities

The 120 MeV Linac at JAERI is now under test. It is an S band machine (2857 MC) of 5 sections. Each section is fed by a RCA 8568 Klystron (20 KW; 20 MW at peak).

The pulse widths range from 5 ns to 2 μs, with a maximum repetition rate of 900 Hz. The zero current energy is E_o = 190 MeV and the maximum efficiency is expected at 100 MeV with a current of 0.75 A.

At the moment, the following characteristics have been reached:

E = 120 MeV with I = 60 mA

E = 170 MeV with I = 5 mA

The research programme includes: neutron experiments, radioactive isotope production, neutron diffraction experiments and photonuclear reaction studies. For the neutron experiments 5 flight paths will be available, the longer one extending to 200 meters. Total, fission and capture cross sections will be measured. For capture, a large liquid scintillator (about 4000 liters) has been constructed.

2. Experiments

Nishimura said that the experiments he wanted to present will be discussed in the topical discussion, namely:

- Analysis of fast neutron scattering using the coupled channel theory.
- A multiple angle time-of-flight spectrometer.
- Study of energy levels of ^{120}Sn through the (n,n'γ) reaction.

Sweden

The Swedish progress report was distributed as a G document, INDC(SWD)-4/G. Condé outlined the following items:

1. Facilities

- Studsvik Van de Graaff: the accelerating tube has been replaced, resulting in an improvement of performance and reliability.

- Uppsala Tandem: a new time-of-flight facility has been installed and will be partly used for neutron cross section measurements over about 5 MeV.

- The fast power reactor facility at Studsvik was closed down in January 1972.

2. Experiments

- Measurements of fast neutron elastic scattering have been continued and angular distributions measured at 7 MeV for 12 elements ranging from Mg to Bi; data are analyzed using optical model calculations.

- Neutron differential elastic scattering cross sections were measured for Cr, Fe, Ni, Al, Co and Y relative to C at 7 different angles within the energy region 500-1400 keV.

- γ-rays from neutron-induced reactions in N have been studied at 4.2, 5.9 and 6.9 MeV and the angular distribution studied at 6.9 MeV.

- A systematic study of inelastic fast neutron scattering has been continued. Data on 21 elements in the energy range 2 to 4.5 MeV are analyzed using the statistical compound nuclear theory.

- Measurements of σ_f and of the angular distribution of fission fragments near the fission threshold for ^{232}Th and ^{231}Pa have been carried out.

- Measured prompt $\bar{\nu}$ values for ^{235}U and ^{239}Pu in different fast neutron spectra are, within the 1.5% experimental error, in good agreement with calculated $\bar{\nu}$ values deduced from recent sets of evaluated σ_f and $\bar{\nu}$ data.

- The prompt fission neutron spectrum, induced by 0.5 MeV incident neutrons on ^{235}U, was measured with a good statistical accuracy from 0.9 MeV to 15 MeV. The shape is in better agreement with the Watt distribution than with a Maxwellian distribution. The departure from a Maxwellian distribution at high energy (above about 5 MeV) - which is in opposite directions in the Studsvik and Harwell data - was discussed. Condé suggested the hypothesis that the high British values could be due to their neutron detection system (neutron-γ discrimination). Rose said that the Harwell measurement will be repeated. The best Maxwellian fit to the Studsvik data corresponds to a temperature of 1.42 MeV which is substantially higher than the value usually used (1.30 MeV); Cross enquired whether a better agreement could be obtained by giving less weight to the low energy part of the spectrum but this seemed unrealistic to Condé because this part is measured with the best accuracy.

- Measurements of capture cross sections in the keV range, using a large liquid scintillator were undertaken. Preliminary data were obtained for Ag (relative to Au) at 200 keV. Ni, Cr and Fe will be studied.

- The study of the fast neutron capture mechanism was continued. A discrepancy of a factor of 2 to 3 was found between experimental data and calculations based on the semidirect capture mechanism. It is intended to make more measurements in the giant dipole resonance (8 to 11 MeV) and for a wider mass range.

Poland

A category G progress report has been submitted (INDC(POL)-5/G) containing information on neutron data only because the NDS request for information on non-neutron nuclear data came too late to include them in the progress report. Sujkowski will try to prepare a progress report including non-neutron nuclear data activities for the next meeting.

Sujkowski summarized the nuclear activities in Poland, namely:

1. Facilities

Most of the work is concentrated at Warsaw and Cracow in laboratories belonging to the Polish Atomic Energy Commission and to the Physics Institutes of the Universities.

Main facilities are:

- in Warsaw: a 2.5 MeV Van de Graaff; a 10 MeV proton linac; a few 14 MeV neutron generators; a new material testing reactor now under construction (operation scheduled for 1974); a betatron and a 9 MeV electron Linac for applied work

- in Cracow: a cyclotron giving 28 MeV alphas (14 MeV deuterons, etc. ...); a few 14MeV neutron generators

2. Experiments

- Non-neutron nuclear data:
  - Nuclear structure work through the (α,xn) reaction mainly in the region $A \sim 82$
  - on-line isotope separation in the transition region (mass differences and decay energies for nuclei far from stability)

- decay scheme studies mainly in the deformed nuclei region
- elastic and inelastic α scattering studies
- magnetic moment measurements of excited states
- fission of μ-mesic atoms
- compilation work on structure data of nuclei in the transition region; on atomic data for activation analysis by the fluorescence method

- Neutron nuclear data:
  - ternary fission work: A relatively high emission rate of α particles in the direction of the fission fragments has been observed and tentative explanations based on the emission from highly excited fragments in flight have been given.
  - Search for the existence of super-heavy elements in nature. Techniques have been developed for detecting fissile super-heavy elements at a concentration of 10^{-16} gr per gram. The method consists basically in separating the hypothetical super-heavy elements with a mass separator. The collector is a plate of synthetic quartz which is irradiated in a reactor and used as a fission fragment track detector. Partly in the framework of this experimental research, theoretical work on fission theory is also carried out, in liaison with the Lund Group (Sweden), considering octupole (and higher) static deformations of fissionable nuclei.
  - compilation of fast neutron cross sections.

United Kingdom

Two UK progress reports were distributed as G-category documents, INDC(UK)-14/G and 15/G. Rose spoke only about the most important items of the UK work:

- Measurements of the inelastic neutron scattering of ^{238}U have been carried out at seven neutron energies between 1.13 and 2.37 MeV. This work was reported in the topical discussion.

- The calculated neutron detection efficiency of the Harwell "black detector" (re-entrant sphere made of a mixture of boron and petroleum jelly) has been experimentally tested in the neutron energy range 60 keV - 2 MeV. In the energy range below 700 keV, where the efficiency can be calculated, the agreement is quite satisfactory. Additional measurements made since the progress report was prepared show that the systematic difference in efficiency shape suspected in INDC(UK)-15/G is not correct.

- On the $^6Li(n,\alpha)$ cross section, previous inconsistencies, when using different thicknesses of Li glass, among the first Harwell results have been resolved. The discrepancy with the Cadarache results could now be removed by a shift of the energy scale of about 5 keV.

If agreement on the energy scale can be obtained, a systematic difference of the order of 5% will still exist between the two sets of data (normalization problem).

- The ^{235}U fission cross section has been measured from 1 keV to 1 MeV, using the "black detector". The relative values obtained have been normalized between 10 and 30 keV, using the evaluated data of Sowerby et al.
- The ratio $\sigma_f(^{235}U)/\sigma_f(^{239}Pu)$ has been measured at the same time in the same energy range.
- The prompt fission neutron spectra of ^{235}U and ^{239}Pu have been measured. In the case of ^{235}U, a double Watt fit using different parameters for the two fission fragments, is necessary to represent the measured data. Answering questions concerning such a 4 parameter fit, Rose expressed the opinion that the important quantity for reactor calculations is neither the parameter introduced in the double Watt fit, nor the uniqueness of the fit but the value of the average energy of the neutron fission spectrum. In the case of ^{239}Pu, a single Watt fit is sufficient for a correct representation of the experimental data.
- The capture cross section of ^{238}U has been measured at NPL for four neutron energies between 150 and 600 keV.
- At NPL, absolute measurement of $\bar{\nu}$ for ^{252}Cf spontaneous fission is in progress. A provisional value is 3.72 but a final figure is expected before the end of 1972.
- At the electron linac of Glasgow University, some measurements, not reported in progress reports, have been performed. The inelastic neutron scattering cross sections of ^{31}P and ^{56}Fe have been measured by observing γ-rays and the elastic neutron scattering cross sections for ^{40}Ca, ^{28}Si and ^{32}S have also been measured. The energy range covered is between 0.6 and 4 MeV.
- Funds have been obtained to complete the design study for replacing the present Harwell electron Linac and booster system but the project is not yet approved.

USSR

Konshin presented the USSR research work which is summarized in abstracts distributed at the meeting in the form of two documents (collected Abstracts no. 11 and no. 12 issued by the Nuclear Data Centre, USSR State Committee on the Utilization of Atomic Energy). The following items were mentioned:

1. Measurements using the lead slowing down spectrometer:

   - Fission cross sections of ^{235}U and ^{239}Pu from thermal up to 60 keV. For ^{239}Pu, the data are in agreement with values obtained by other methods up to 6 keV but, above 6 keV, they are considerably lower

(12 to 15%). A similar effect also exists for ^{235}U data (9 to 12% discrepancy). To investigate the reasons for these disagreements, the poor resolution function of the lead spectrometer is being applied to the published good resolution data, in order to facilitate the comparison. Konshin underlined that self screening corrections are important for measurements done with the lead slowing down spectrometer.

- Capture cross sections of Ag, Au, ^{232}Th and ^{238}U in the neutron energy range from thermal to 50 keV. The expected accuracy of the data is 8 to 10%, depending essentially upon normalization.
- Measurements of α for ^{235}U up to 60 keV: The accuracy of the data obtained is 20 to 30%. Above 10 keV, these data are higher than the values obtained in Van de Graaff measurements.

2. Measurements of α for ^{235}U and ^{239}Pu from 10 keV to 1 MeV: These measurements were done at a Van de Graaff accelerator with a large liquid scintillator (Cd loaded). For ^{239}Pu, the agreement with ORNL data (de Saussure) is good above 40 keV; below 30 keV, a specific and distinct structure was found, which confirms the indications obtained at ORNL, with a statistical accuracy insufficient for a definite conclusion.

   For ^{235}U, a similar structure was found at 25 keV and 235 keV.

3. Absolute measurements of α for ^{235}U and ^{239}Pu at 2 keV (Sc filter) and 24.5 keV (Fe filter): for ^{239}Pu, data are in agreement with values obtained at ORNL.

4. Studies of Γ_γ for ^{238}U: Measurements of total and capture cross sections were carried out on a 500 m flight path at the Dubna pulsed reactor, with an electron Linac as an injector. These measurements were undertaken to check the results obtained by Glass with underground nuclear explosions, which indicated large fluctuations between the extreme values 12 meV and 33 meV. The Dubna results give an average value of Γ_γ = 24 meV and fluctuations which do not exceed the measurement errors (~ 10% for most of the resonances).

5. Measurement of the fission cross section of ^{249}Cf as a function of neutron energy in the range 0.1 MeV to 2 MeV. For this same isotope the prompt fission neutron yield was measured. At thermal energy the value obtained is $\bar{\nu}$ = 2.44.

6. Transplutonium element studies including ^{244}Cm and ^{249}Bk: Neutron yields, neutron angular distributions and cross sections were measured from thermal up to 14 MeV.

7. Studies of the Sm isotopes at the Dubna pulsed reactor time-of-flight spectrometer: Transmission and several γ-ray yields were measured and average parameters and strength functions obtained.

8. Determination of the resonance parameters from σ_T and σ_γ measurements at the Dubna pulsed reactor time-of-flight spectrometer (flight path 1200 m): Values were obtained from 0.3 to 50 eV for ^{235}U and from 9 to 100 eV for ^{239}Pu.

9. Measurement of the energy dependence of $\bar{\nu}$ for ^{235}U from 1 MeV to 6 MeV: The accuracy is 1.5 to 2% and the "French effect" for the detector was studied with great care. This effect is not negligible for the determination of absolute values but it does not affect the variation of $\bar{\nu}$ as a function of incident neutron energy.

Yankov supplemented Konshin's report by the following remarks:

1. The studies mentioned by Konshin on time of flight fission neutron spectra are continued at Obninsk for an incident neutron energy of 14.3 MeV. The spectrometer has a 5 to 8 ns resolution with a 2 meter flight path. Results are obtained from 30° to 150° with an angular resolution of 8°.
2. At the same incident neutron energy, differential scattering cross sections were measured for Cr, Mn, Fe, Co, Ni, Cu, Zr, Nb and W. The measured scattered neutron spectra are contaminated with the neutrons emitted in (n,2n) and (n,pn) reactions.

3. At the Kurchatov Institute, nuclear data for thermonuclear reactors are investigated. In this respect, studies for obtaining mono-energetic neutrons in the range from thermal up to 15 MeV are performed. A paper on this subject will be presented at the forthcoming Budapest Conference.

Answering several questions, the USSR delegates gave the following information:

- All numerical data concerning the experiments abstracted in Nuclear Abstracts Nos 11 and 12 can be obtained through the established channel (that is to say through NDS which will refer to the Obninsk Nuclear Data Centre).

- The α-values obtained by the filter technique are:

  at 2 ± 0.35 keV : 0.49 ± 0.04 for ^{235}U and 1.35 ± 0.09 for ^{239}Pu
  at 24.5 ± 1 keV : 0.43 ± 0.14 for ^{235}U and 0.30 ± 0.09 for ^{239}Pu

- Concerning the Γ_γ values for ^{238}U, the necessity for getting the associated Γ_n values was stressed. Since both transmission and capture cross section measurements were carried out at Dubna, the Γ_n values have also been obtained and can be made available through the established channel.

U.S.A.

The U.S.A. research is summarized in the report INDC(USA)-36/U, dated November 1971, and a draft report, dated May 1972, was distributed at the meeting. Taschek reported on fast neutron work.

1. Argonne National Laboratory

   - Measurements of absolute fission cross section values and of the energy dependence of the fission cross section ratio $\sigma_f(^{238}U)/\sigma_f(^{235}U)$ have been continued and data are available in the energy range 1 to 5 MeV.

Cierjacks compared these data with the Karlsruhe data near threshold, the Karlsruhe values are in good agreement with the recent data obtained by Whalen; the data by Stein are about 30% lower. At higher energies, the agreement with Stein's values is: 1 to 2% between 2 and 4.5 MeV; 3 to 4% between 4.5 and 5.5 MeV.

- As a continuing part of the ANL activities total, elastic and inelastic cross sections were measured for a large number of elements.

- The capture cross sections of Nb, Mo, Zr, Cd and ^{238}U have been measured with the large liquid scintillator tank technique from 400 to 1500 keV. The neutron flux was measured with the Poenitz "grey detector". Particular care was devoted to the calibration of the energy response of this detector. Between 1 and 9 MeV, the overall decrease of efficiency is less than 10%. However, a "structure" of the efficiency curve may affect some of the results.

- A study of the ^7Li (p,n) reaction as a monoenergetic neutron source has been made. It appears that, above an incident proton energy of about 5 MeV, an increasing number of neutrons, emitted in the ^7Li (p,n, ^3He) ^4He three body break-up reaction, contaminate the monoenergetic neutron groups.

2. Gulf Radiation Technology

The ^{10}B $(n,\alpha)^7Li$ and ^{10}B $(n,\alpha,\gamma)^7Li$ cross sections have been measured from 1 keV to 1 MeV and a report on this work will be distributed in the near future.

3. Los Alamos

- The programme for measuring the absolute fission cross section of ^{235}U from 1 to 15 MeV is continuing. Up to 6 MeV, the neutron flux determination was made by using the H(n,p) reaction as a standard and the results will appear soon. Above 6 MeV, a proton telescope will be used and data are not expected before about one year.

- The T (p,n) and T (d,n) reactions were very carefully studied. Relative cross sections were measured at various laboratory angles relative to the value at 0^o for proton and deuteron incident energies from 5 to 16 MeV. Absolute values at 0^o were also measured. These data could be used for intercomparison of absolute neutron flux measurements between different laboratories.

- An interesting computation was done by Devaney in order to check a formula derived by Moldauer relating the transmission T to the channel with Γ_i and the level spacing D_i, namely: $2\pi\frac{\Gamma_i}{D} = \mathrm{Log}\ (1-T)$.

With the type of potential used (square well), this formula is verified with a great accuracy ($\sim$ 1%).

4. National Bureau of Standards

- A laboratory for the standardization of neutron sources has been established.
- The total cross sections of ^{235}U, ^{238}U and ^{239}Pu from 0.5 MeV to 15 MeV have been measured and are being analyzed.
- A 1 mg ^{252}Cf neutron source has been calibrated with an accuracy of 1.6% relative to the NBS primary Ra-Be photoneutron standard source.
- The capture cross section of hydrogen at thermal energy has been measured in order to check if the discrepancy between the calculated and the measured values (24 mb) could be explained by capture followed by the emission of two photons. The upper limit for this two photon capture was 1 mb only.

5. Oak Ridge National Laboratory

Taschek emphasized the very large amount of work which has been done at ORELA. He particularly pointed out the simultaneous measurement of the fissión and capture cross sections for ^{235}U from 8 eV to 10 keV. Regarding capture the data from different laboratories are now in agreement within $\pm$ 5% except in the keV range where differences rise to $\pm$ 12%; for fission, the cross section can be considered as known with a 3% accuracy in the entire energy range.

6. Rensselaer Polytechnic Institute

A great deal of effort was spent on the filter technique for obtaining monoenergetic neutron beams, particularly for capture cross section measurements. With an Fe filter, the window (about 2 keV wide) obtained at 24.3 keV has been used to measure relative capture cross sections of U, Au, In and Ta.

In the discussion of Taschek's presentation, particular interest was shown in the LASL studies on the T (p,n) and T (d,n) reactions in view of their application for getting a simple tool for absolute neutron flux measurements. Taschek thinks that a 3% accuracy could be achieved in the wide energy range covered (5 to 16 MeV).

Havens drew attention to the change of the name of the US Committee which has the responsibility to prepare the USA Progress Report. The name has been changed from "AEC Nuclear Data Cross Section Advisory Committee" to "US Nuclear Data Committee". This change reflects the fact that several laboratories which are not under the direct responsibility of the USAEC are active in the nuclear data field, that non-neutron data have an increasing importance and that non fission reactor people (fusion, safeguards, medical applications, etc. ...) are becoming more and more concerned with nuclear data. The composition of the Committee has been changed accordingly and part of the Committee's work will probably be carried out in separate Sub-Committees.

The following work was described:

- A careful study of the "windows" appearing in the Fe total cross section has been carried out at Columbia and published in Nuclear Science and Engineering (March 1972). The knowledge of these "windows" is of particular importance for shielding applications. The measurements were then repeated at ORNL and RPI and give results in good agreement with those of Columbia.

- The extensive Columbia work started in 1970 on resonance parameters of ^{238}U and ^{232}Th has been completed. It will be published in Physical Review (probably in October 1972). Tables of the resonance parameters are given in the US progress reports (see in particular INDC(USA)-36/U). The value obtained for $\langle \Gamma_\gamma \rangle$ of ^{238}U is 22.9 $\pm$ 0.5 meV (statistical) and $\pm$ 0.9 meV (systematic) which, within the error bars, is in good agreement with the Russian value presented at this meeting. The value obtained by Glass (19.1 mb) seems definitely too low but this value was always considered as subject to large uncertainty because the efficiency of the Li-glass detector used to monitor the neutron flux was only accurate to $\sim$ 15%. Another aspect of the Columbia data is the absence of significant Γ_γ fluctuations, which is also in agreement with the Russian results. Havens was asked to review the different USA data on Γ_γ for ^{238}U (Action 9).

<u>Kolstad</u> mentioned US documents provided to INDC, since the previous meeting.

- INDC(USA)-37/G which concerns fission neutron spectra and has been prepared for the IAEA consultants meeting on this topic.
- INDC(USA)-38/L: ^{238}U to ^{235}U fission cross section ratio from 1 to 5 MeV
- INDC(USA)-40/G: Los Alamos intense 14 MeV neutron source
- INDC(USA)-41/G: Interactive Graphics at the RPI Linac and four years of remote batch operation from the RPI Linac to the Courant Institute CDC 6600
- INDC(USA)-42/U: Structure of neutron resonances
- INDC(USA)-44/G: Fission cross section of ^{238}Pu
- INDC(USA)-45/G: Sub-barrier fission resonances in Th isotopes
- INDC(USA)-46/G: "Physics in Perspective"; this document is excerpted from a much more detailed volume which will be the final report of the "Physics Survey Committee" (D.A. Bromley, chairman) and which will contain an examination of the status, opportunities and problems of physics in the U.S.A.

Kolstad reported on USA facilities for nuclear data measurements. His presentation is summarized in Appendix VIII.

Answering questions about facilities, the following information was given:

- The expected new characteristics of the Nevis cyclotron are:
  - E_p = 550/565 MeV (370 MeV previously).
  - Pulse repetition rate: 300 Hz (70 Hz previously).
  - Pulse width 8 to 10 ns.
  - Average current: 40 μA but possible limitation to 10 μA because of shielding problems.
- The NBS Linac will be equipped with a new electron gun and its beam power will then exceed ORELA. The staff for this machine will also be increased.

Yugoslavia

A draft version of the Yugoslavian Progress Report was distributed. It covers mainly the work done at the Ljubljana and Zagreb Institutes with 14 MeV neutrons.

1. During the last years these laboratories have carried out a joint project to study the systematics of capture cross sections at 14 MeV as a function of the mass of the target nuclei. Two methods were used, namely:

   - activation method, giving σ_{act}
   - integration of the prompt γ-ray spectra, giving σ_{int}.

   The expected difference between the results is only a few tenths of a per cent. In fact, the experimental results gave values of σ_{act} up to 20 times higher than σ_{int} values. The variation as a function of A exhibits also marked differences. This behaviour is not clearly understood but it is thought that more accurate data on σ_{act} are needed. Such a programme is being carried out at Zagreb and data for ^{23}Na, ^{27}Al, ^{37}Cl, ^{51}V, ^{55}Mn, ^{41}K and ^{127}I have been obtained.

2. Emulsion plates were used as a 4 π detector to study the break-up reaction of ^{12}C into three α particles by means of the $^{12}C(n,n')^{12}C$ reaction. The three α correlation spectra for the ^{12}C resonances at 9.6; 11.8; 12.7 MeV were presented. The main conclusion is that the 11.8 MeV level must be $J^{\pi} = 1^-$.

3. The isomeric cross section ratios for (n,p) reactions induced by 14 MeV neutrons in Te isotopes were measured and compared with theoretical calculations.

4. An effort is being developed for fast neutron dosimetry along two lines: calibration of a dosimeter for low level fast neutron dosimetry and calibration of a tissue equivalent proportional counter.

5. In collaboration with CEN-Grenoble (France), it is intended to remeasure the break-up of the tritium nucleus. As a first step, the (n,T) elastic scattering cross section has been measured at 14 MeV with a higher precision than previously obtained.

6. Concerning facilities: A 16 MeV deuteron classical cyclotron is in operation at Zagreb. During the past year, efforts were centered on the utilization of the deuteron beam to obtain a directional high intensity fast neutron beam for medical purposes.

7. Answering a question of Cross, Paic gave the following information on the cooperation between Yugoslavia, Austria, Hungary and Italy for establishing a "Joint Center for Nuclear Physics":

   - The main facility would be a 100 MeV cyclotron for protons and heavy ions.

   - Yugoslavia has decided to contribute to the project but the other parties have not yet confirmed their decision. The problem is now being discussed at a governmental level.

III.C. Reports from countries not represented on INDC

Schmidt asked for Progress Reports from the "Liaison Officers" of the 36 countries concerned, in April 1972. The request was for nuclear physics activities and was not restricted to neutron work. Among these 36 countries, 25 belong to the NDS service area and 11 are outside the NDS service area.

Out of the 25 countries of the NDS service area, 8 reports were received (Poland, Hungary, Romania, Bulgaria, Iraq, South Africa, Korea and Brazil) and 6 were expected but not received (Czechoslovakia, Egypt, Iran, Israel, Mexico, Pakistan). From outside the NDS service area, reports were received from Turkey, Greece and Norway. The absence of contributions from Spain, Portugal, Austria, Switzerland, Belgium, Denmark and Netherlands was noted. As most of these countries belong to the EANDC (OR) Group, Condé as Chairman of the OR Subcommittee of EANDC was asked to request that the concerned countries submit an annual progress report (Action 12). The important points of the submitted progress reports were mentioned by Schmidt:

Hungary

A progress report was distributed as a category G document, INDC(HUN)-9/G.

- At Kossuth University, Debrecen, work concerns mainly threshold reaction studies in (n,n'γ) reactions and measurements of (n,t) cross sections at 14 MeV.

- At the Institute of Nuclear Research, Debrecen, the most important activity concerns the non-neutron field: studies on (d,p) and (d,α) reactions in the hundreds keV region.

- At the Central Research Institute for Physics, Budapest, the main research of interest to INDC is an extensive programme on thermal neutron capture γ-rays and calculations and measurements of the prompt fission neutron spectra.

Romania

A progress report was distributed as a category G document, INDC(RUM)-3/G. Nuclear data activities are carried out at the Institute of Atomic Physics and at the Institute for Nuclear Technology. Schmidt limited his presentation to an important new development, namely the establishment of a laboratory for evaluated nuclear data which in close cooperation with IAEA and other evaluation centres works on evaluation, preparation of a nuclear data library, development of group constants and reactor calculations.

Bulgaria

A progress report was distributed as a category G document, INDC(BUL)-3/G. All the nuclear data activities are centered at the Institute of Physics, Sofia. Schmidt outlined the importance of the Bulgarian effort in physics, as it appeared from a recent meeting and exposition in Vienna on the equipment and physics achievements of Bulgarian laboratories.

- Neutron work concerns measurements of the diffusion length in water surrounded ducts, development of safeguards techniques and evaluation of ^{239}Pu resonance parameters.

- Non-neutron work includes essentially nuclear spectroscopy studies on a number of neutron deficient isotopes: measurements of γ-spectra, of conversion electron spectra and of lifetimes (using the recoil-distance Doppler shift method).

Iraq

A progress report was received for the first time and distributed as a category G document, INDC(IRQ)-1/G.

The main activity is extensive work on nuclear spectroscopy by studying thermal neutron capture γ-ray spectra at the Iraqi Atomic Energy Commission reactor. A laboratory for activation analysis, well equipped to handle both routine analysis and research work, carried out an extensive programme in particular on the determination of impurities in Iraqi crude oils and, more generally, on geological research.

South Africa

A progress report was distributed as a category G document, INDC(SAF)-4/G. Schmidt drew particular attention to the extensive investigations of the level structure of a number of nuclei using the (n,n'γ) reaction. This work was carried out at the pulsed 5.5 MeV Van de Graaff of the Southern Universities Nuclear Institute (Faure) and at the pulsed 3 MeV Van de Graaff of the Atomic Energy Board (Pelindaba). It includes γ-spectroscopy with (Ge-Li) detectors and scattered neutron time-of-flight spectra measurements. Information on level energies and γ-ray intensities has been obtained. Of particular importance, data on ^{232}Th and ^{238}U were mentioned.

Korea

A progress report was distributed as a category G document, INDC(KOR)-2/G. Schmidt outlined the following activities:

- 14 MeV neutron investigations of (n,p) and (n,α) reactions in Ge.
- The evaluation of ^{238}U, ^{237}Np and ^{232}Th neutron-induced fission cross sections from threshold to 20 MeV (in cooperation with IAEA NDS).

Brazil

A progress report was distributed as a category G document, INDC(BZL)-4/G. There are a number of well equipped institutes in Brazil and Schmidt restricted his presentation to a brief summary:

1. Instituto de Energia Atomica (Sao Paulo)

   A 5 MeV swimming pool research reactor is used for (n,γ) spectroscopy and also for (γ,n) studies with monochromatic γ's obtained from thermal neutron capture by selected elements.

2. Instituto de Fisica (Universidade de Sao Paulo)

   The Herb Pelletron Accelerator (22 MeV protons, 27 MeV alphas, etc....) is equipped for neutron time-of-flight studies. (^{3}He,n) reactions have been studied and a research programme with heavy ions is undertaken.

   - The 3.5 MeV electrostatic accelerator was used to measure neutron capture cross sections for a number of elements in the energy range 30 keV - 300 keV.

- The electron Linac is being redesigned to improve its characteristics (70 MeV energy expected). The programme includes e^- and γ induced fission studies and nuclear spectroscopy.

3. Centro Bresileiro de Pesquisas Fisicas (Rio de Janeiro)

The elctron Linac (28 MeV; 60 µA average current) is used for radionuclide production, for nuclear spectroscopy studies and for neutron time-of-flight experiments.

4. Pontificia Universidade Catolica (Rio de Janeiro)

- A HVEC - KN 4000 Van de Graaff (0.5 to 4 MeV; 3 keV resolution, 200 µA intensity) is expected to be operational in September 1972.
- A number of level scheme investigations have been carried out.

5. Instituto de Engenharia Nuclear (Rio de Janeiro)

- The Argonaut reactor (10 KW) is used for a large variety of studies. In the field of neutron cross section measurements, a crystal spectrometer is in operation (parameters obtained for the ^{176}Lu resonance at 0.141 eV were given).
- A pulsed neutron generator (10^9 n/cm^2/s; repetition rate up to 5 HZ; pulse width 0.1 µs to 10 ms) has been used for measuring the thermal neutron diffusion parameters in spherical water systems.

IV. REPORTS OF SUBCOMMITTEES

IV.A.1. Subcommittee on Standards

The final version of the Subcommittee report, giving the list of the participants, of the items discussed and of the recommendations made to the INDC appears in Appendix VII. It must be noted that this final version was not made available at the time of the INDC meeting and, as a consequence, was not fully discussed during the meeting.

Aten gave his own general impressions on several points from which the following are extracted:

- Fast neutron induced fission for ^{235}U. Even if the situation is not yet completely clarified, the accuracy is improving rapidly. All members are urged to send their most recent results to NDS, before November 1972, in order to have them considered in the "Panel on Neutron Standard Reference Data" (Action 17).

- Thermal fission cross sections. For ^{235}U, the situation is now satisfactory and no change is likely to take place in the future. For ^{239}Pu, the situation is not so clear and data could be affected by new half life values obtained from recent measurements.

- $\bar{\nu}$ (^{252}Cf). New results indicate a value as low as 3.72/3.73 for prompt $\bar{\nu}$ (compare page 37 under A.4).

- Au as a fast capture standard. In the USA and in the USSR it has been decided to maintain Au as the primary standard, at least between 10 keV and 1 MeV.

- ^{6}Li (n,α) cross section. The previous discrepancy between the Harwell measurements made with different Li glass thicknesses has been removed. Nevertheless, there is not a general agreement for a single interpretation of all published data. An appreciable amount of work is still in progress in different laboratories.

- ^{10}B (n,α) cross section. Work is in progress in USA and in France. The four recommendations of the Subcommittee meeting were endorsed by the INDC. Havens insisted particularly on the importance of recommendation 4, namely the necessity for INDC to consider standards other than neutron cross sections (fission yields for example) and also non-neutron data (Action 18).

IV.A.2. Report on the preparations for the Second IAEA Panel on Neutron Standard Reference Data, Vienna, 20-24 November 1972

Lemley presented the working paper (Appendix IX) prepared by the NDS and asked INDC members for comments on the proposed Agenda. He added that IAEA, as usual, has invited countries to propose participants through their Official Missions in Vienna. Answers were received from USA, UK, France and Australia.

Concerning the agenda, Schmidt indicated that in drafting this agenda, the basic idea was to restrict the subject to the points which seemed the most urgent or discrepant, in contrast to the broad "tour d'horizon" made for instance at the Argonne meeting in 1970. Therefore the H(n,p) cross sections, ^{10}B (n,α) and ^{6}Li (n,α) at thermal energy were excluded. However, the Agenda, as presented in Appendix IX was not frozen and INDC recommendations will be carefully considered.

Taking into account these comments and the general discussions of the agenda, INDC proposed to NDS:

1. To add as point A under item III, a session on absolute neutron flux measurements.

2. To enlarge the discussion on the problem of fast neutron capture cross section standards. Particular interest in ^{197}Au was recognized but, for example, In, Ta, I neutron capture cross sections might also be discussed because, in the past, many measurements of capture cross sections were made relative to these elements.

3. To include an item on neutron fission spectra for both (^{235}U + n) and ^{252}Cf, as new results are expected, in particular from Sweden, France and UK, at the time of the Panel (Action 15). Schmidt took this occasion to outline the high quality of the papers presented at the Consultants Meeting on Prompt Fission Neutron Spectra (23 - 27 August 1971). The proceedings of this meeting will be issued in the IAEA Conference Series (Appendix XI gives the table of contents).

4. To restrict the discussion of the item 2200 m/s fission and capture cross sections to a minimum, NDS is convening a specialists meeting on this topic during the week preceding the Panel. A brief account of the conclusions of this specialists meeting was considered as sufficient (Action 16).

IV.A.4. Status of second IAEA updating of 2200 m/sec fissile isotopes constants and recommendations of the IAEA Panel on Fast Reactor Burn-up Physics

1. Updating of 2200 m/sec fissile constants (compare Appendix VII,p.2-3):

A consultants meeting has been tentatively proposed from the 15 to 17 November 1972. Since the input data were carefully reviewed in the previous review led by Hanna and Westcott, it is intended to concentrate on the points where new experimental data are available and input data expected to be modified. The most important changes will then probably concern:

- An increase of the ^{235}U fission cross section, related to the confirmed lower value of the ^{234}U half-life.

- A possible increase of the ^{239}Pu fission cross section, due to recent indications for a lower half-life of this isotope.

- A "stabilization" of $\bar{\nu}$ for ^{252}Cf around 3.72/3.73 resulting from recent experimental data on $\bar{\nu}$ for ^{252}Cf (Axton, Boldeman). The indirect value obtained from ^{235}U α and η values and $^{235}U/^{252}Cf$ $\bar{\nu}$ ratios, will remain up to 2% higher; but this indirect value has now less weight compared to the improved direct measurements.

- Four specialists have been invited to participate in the evaluation: Leonard (g-factors, scattering cross sections, etc.), Story (standards), Deruytter (σ_f), Axton ($\bar{\nu}$). Other specialists (Konshin, de Volpi, Boldeman, etc.) will be also consulted by correspondence.

2. IAEA Panel on Reactor Burn-up Physics, Vienna, 12-16 July 1971

Four recommendations were made to NDS and to Evaluation Centers as a result of the Panel (see Appendix B of INDC(NDS)-45/L). Lemmel summarized these recommendations:

- The NDS review for fissile isotopes should not be restricted to 2200 m/sec values but extended to the whole thermal energy range (in particular for the 0.3 eV resonance of ^{239}Pu).

- The accuracy of the thermal neutron capture cross sections and of the fission yields should be improved for a large number of nuclides, with particular emphasis on $^{146,148,150}Nd$, ^{140}Ba, ^{137}Cs, ^{95}Zr, ^{90}Sr and ^{144}Ce.

- Better recommended values for the energy released in fission of ^{232}Th and the U and Pu isotopes are needed.

- More accurate energy dependent cross sections are needed for $^{241,243}Am$, $^{242,244}Cm$, $^{236,238}Pu$, ^{237}Np.

Schmidt outlined the importance of the effort needed to fulfill the Panel recommendations. Regarding NDS contributions to this effort in 1972 and the first half of 1973 priority will be given to the review of the 2200 m/sec fissile isotope constants. Action on other items will be initiated later.

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

IV.B.1. Report of Subcommittee on outstanding high priority data needs and discrepancies

Rowlands, as chairman of the Subcommittee, presented a report (Appendix XII) on possible objectives of the Subcommittee. His report is based on Priority I requests in RENDA 72 which were classified according to different categories and, possible headings under which the status of the principal required nuclear data could be reviewed were listed (together with comments on specialists meetings or reviews of these topics). He added to his presentation the following remarks:

1. The report was not discussed by the Subcommittee and therefore represents the personal views of its Chairman.

2. Under the item "flux measurement and detector", the discrepancies existing between the Priority I requests in RENDA and the requests considered of particular importance by the "Working Group on Reactor Radiation Measurements" (Appendix J of INDC(NDS)-45/L) are surprising. INDC should either refer back this problem to the Working Group or try itself to make recommendations on the cross sections which should be given the highest priority (Action 19).

3. It might be appropriate to consider a panel on cross sections of structural materials in about a year.

4. Tomlinson intends to revise his review on delayed neutron data by February 1973.

IV.B.2. Status of fission neutron spectrum data

Hjärne, Scientific Secretary of the IAEA Consultants Meeting held in Vienna in August 1971, presented this item (cf. pages 5/6 and Appendix C of INDC(NDS)-45/L). Among the 18 recommendations of the Panel, Hjärne drew particular attention to the following ones:

- The high priority to be given to the determination of the ^{252}Cf fission neutron spectrum. The "clean" conditions with which this spectrum can be measured (by comparison to $^{235}U + n$) could make it the best standard.

- Discrepancies between microscopic data and data obtained from integral experiments call for more accurate microscopic data (the fission cross sections of ^{238}U above 500 keV and of ^{235}U and ^{239}Pu are of particular importance in order to enable a more accurate interpretation of integral experiments). A more careful intercalibration of detectors used in both sets of experiments should be made.

- The insufficient accuracy of the present fits of experimental data (for example simple Maxwellian fit for fission neutron spectra) was recognized. Hjärne pointed out the high quality of this Meeting and apologized for the delay in issuing the Proceedings, due to problems outside the control of the NDS.

All members were invited to send fission neutron data obtained in their respective countries to the Data Centres (Action 58).

IV.B.3. $\bar{\nu}$ versus E and resonance spin

The NDS review by Manero and Konshin was distributed as a category G document: INDC(NDS)-34/G. While presenting this NDS review, Manero outlined the following points:

- The document includes not only the numerical data but also the essential physics information related to the measurements.

- The experimental data have been renormalized to recommended standards (Hanna and Westcott review on 2200 m/sec fissile isotopes constants).

- Very recent information has not been considered, namely

  a) $\bar{\nu}$ values of Savin for ^{238}U from 1.5 to 7 MeV.

  b) New measurements of Fréhaut et al. for ^{240}Pu and ^{235}U between 1.5 and 15 MeV. In particular, for ^{235}U, these new values are 1 to 3% higher than the previous Soleilhac data between 1.5 and 7 MeV.

  c) The recent data by Trochon and Ryabov on $\bar{\nu}$ in the resonance region which indicate no correlation between $\bar{\nu}$ and J, contrary to the Weinstein data and the previous Ryabov data.

A limited distribution (G document) was given to this important review because it will be published in the Atomic Energy Review, after revision to include the latest published data. This publication is expected for the end of 1972 in the December issue of Atomic Energy Review and all members are invited to inform Manero of the most recent data obtained in their respective countries (Action 25).

IV.B.4. Alpha ^{239}Pu; recent experimental and evaluation work

Konshin indicated that the extensive evaluation, carried out in cooperation with Sowerby and distributed at the previous INDC meeting has been modified and will be issued in the December 1972 issue of Atomic Energy Review. New data from Gwin, which seem to indicate higher values below 10 keV will not be included and, more generally, only published data will be taken into account in the evaluation. The evaluation should be revised when new definite data will appear. But, with the present techniques, it seems difficult to obtain an accuracy better than 10% which is the present achievement of the evaluation. This claimed 10% accuracy was considered by some participants as controversial. For instance, at 2 keV, the evaluation gives 0.921 whereas the recent Russian data, using the Sc filter, give 1.35 ± 0.09.

Konshin admitted the existence of discrepancies in experimental data up to 40% but estimated that the evaluated data are reliable to about 10% in the standard energy intervals used for averaging.

IV.B.5. Fast ^{239}Pu fission and ^{238}U capture cross sections; recent experimental and evaluation work

1. Rowlands reported on the evaluation carried out in the UK by Sowerby, Patrick and Mather concerning the fission cross sections of ^{235}U, ^{238}U, ^{239}Pu and the capture cross section of ^{238}U. This evaluation is a simultaneous fit of the direct absolute measurements of the cross sections and, of the ratios of these cross sections to $\sigma_f(^{235}U)$, $\sigma_{capt}(Au)$ and the Li (n,α) cross section. The results will appear in an INDC document which will be issued in the near future. The main conclusions are (all accuracies referred to are standard deviations):

   - For the ^{239}Pu fission cross section :

100 eV - 1 keV:	accuracy 3 to 3.5 %
1 keV - 10 keV:	accuracy 4 %
10 keV - 100 keV:	accuracy 4 to 7 %
100 keV - 1 MeV:	accuracy 6 to 7 %

     Above 1 MeV : the uncertainty increases further, particularly above 3 MeV. In the vicinity of 14 MeV, however, the accuracy is 2%.

   - For the ^{238}U capture cross section, it must be noted that none of the measurements agrees within the 5% stated accuracy. The results of the evaluation are:

     - 1 keV - 100 keV : accuracy 6% with some larger discrepancies between 30 to 40 keV.
     - above 100 keV : uncertainty increases to 7% at 1 MeV.

Recommendations made for further measurements were incorporated in the document attached as Appendix XII of these Minutes.

2. Byer made some comments relative to the ^{239}Pu fast fission cross section evaluation performed by the NDS. After incorporation of remarks made by Sowerby, this work will be issued as a category G document and published in the December 1972 issue of Atomic Energy Review. This work consists in a simultaneous evaluation of data on $\sigma_f(^{239}Pu)$ and the ratio $\sigma_f(^{239}Pu)/\sigma_f(^{235}U)$ between 1 keV and 10 MeV. It includes also a comparison with the evaluations of Davey, Sowerby and al., Green and al., and Hart. Generally, the evaluation is consistent with the evaluation of Sowerby and al., except for $\sigma_f(^{239}Pu)$ in the energy range 200-800 keV. In this region, Sowerby's evaluation gives the lowest values of all the above listed evaluations and the NDS results are the highest. This leads to a discrepancy of 5 to 6%. In this energy region, the NDS evaluation follows Szabo's experimental data. Rose referred to very recent new measurements at Harwell concerning the absolute fission cross section of ^{235}U and the ratio $\sigma_f(^{239}Pu)/\sigma_f(^{235}U)$ from 1 keV to 1 MeV. These data were too recent to be taken into consideration in any of the mentioned evaluations. The fission cross section of ^{239}Pu which can be deduced is, in the energy range 200-800 keV, about 7% higher than the recommended Sowerby data and thus in close agreement with the NDS evaluation.

3. Konshin reported on the progress in the evaluation of $\sigma_{capt}(^{238}U)$ carried out at Obninsk based on measurements of the ratio $\sigma_{capt}(^{238}U)/\sigma_f(^{235}U)$. The ratio measurements, reported at the Helsinki Conference in the energy range 24 keV to 145 keV, have been extended up to 4 MeV, with the same technique. The same quantity was also measured with the lead slowing down spectrometer between 200 eV and 235 keV. Other measurements by the activation technique give, for $\sigma_{capt}(^{238}U)$, good agreement with Poenitz' data below 500 keV and discrepancies up to 10% in the energy range 500 keV - 4 MeV. However, this method is subject to uncertainty because background effects are important and difficult to correct. It is then recommended to carry out new measurements, using the above mentioned techniques, even for energies as low as 100 keV.

Konshin emphasized the fact that measurements are not yet completed and then, that the evaluation has a preliminary character.

IV.B.6. Neutron capture in structural materials

Rose reported about an evaluation carried out by Moxon on Ni isotopes, which complements the evaluation issued in 1970 on Ni and Fe (no new work has been done on Fe). Moxon's evaluation will soon be published and the main remarks are:

- Up to 40 keV, the resonance parameters are given to calculate the capture cross sections. For s wave resonances, all the large resonances have been observed in the σ_T measurements and most of the small ones in σ_{capt} measurements. For p and d waves, all the major resonances have been detected in ^{58}Ni and ^{60}Ni (up to 40 keV) and ^{61}Ni (up to 7 keV) but data are missing for ^{62}Ni and ^{64}Ni. To take into account missed levels, it is suggested to add one mb. to the capture cross section in the 7-40 keV energy range.

- From 40 keV to 200 keV, the s wave cross section has been calculated and higher ℓ-values added by an averaging method.

- Above 200 keV, only average values are given.

The present data give an accuracy of $\pm$ 30% in the resonance region, which is not sufficient to fulfill the UK request ($\pm$ 10% below 100 keV; $\pm$ 20% up to 1 MeV).

Recommendations were made to improve this situation, essentially:

- accurate measurements of σ_T for all isotopes (specially for ^{58}Ni and ^{60}Ni) up to several hundred keV and analysis of the data in terms of resonance parameters for the calculation of self-screening corrections to the capture data.

- identification of J and π for narrow resonances by studying γ-ray spectra or angular distributions of scattered neutrons.

- improvements of σ_{capt} for all isotopes.

From the discussion concerning the $\pm$ 30% present accuracy of the data, it appears that this figure is realistic ($\pm$ 20%, due to the possible sensitivity of the detector to scattered neutrons; $\pm$ 10% due to the resonance parameter values deduced from σ_T and σ_{capt} analysis).

IV.B.7. Status of neutron data for reactor neutron flux measurements and radiation damage studies

A meeting of the International Working Group on Reactor Radiation Measurements (IWGRRM) was held in Vienna in April 1971. It was recommended that the NDS prepare a report on the status of the experimental and evaluated data for about 50 cross sections considered by the IWGRRM as of particular importance for reactor radiation measurements and radiation effect investigations.

Vlasov (NDS) is preparing this report for submission to the next Working Group meeting (Seattle, November 1972). For the experimental data, great use has been made of CINDA 72 - to be issued very soon - for finding the appropriate sources of information. For the evaluated data, the main sources were the UK library, BNL-325, and also evaluations done in a specific field, for instance the ENDF-B files made available to the NDS, the Simons and McElroy library, the ^{232}Th, ^{237}Np and ^{238}U evaluations of NDS, the (n,p) and (n,α) compilations of Neuert (Hamburg), USSR evaluations referred to in CINDA 72, etc. ... The list of cross sections considered as important by the IWGRRM is given in Appendix J of the document INDC(NDS)-47/L, where the reactions of particular importance are indicated.

IV.C. Subcommittee on nuclear data for safeguards

Cierjacks, reporting for the Subcommittee, mentioned that, since the IVth INDC meeting:

1. The IAEA has received official request lists from the USA, USSR, and Federal Republic of Germany.

2. The NDS published a request list, combining the lists of these three countries, as a category G document (INDC(NDS)-44/G). This document contains also the views of the Division of Development in the Department of Safeguards and Inspection of the IAEA on the form, the content, the scope and the priority criteria defined by the INDC.

3. From other countries, Japan is working on this subject but it is unlikely that a definite list could be sent to the IAEA before July 1973. No UK list is to be expected in the near future.

The reasons for having only 3 countries reports on nuclear safeguards were extensively discussed:

- The UK and French position was that the safeguards problems are so intimately connected with the problem of processing plant operation that it is difficult to specify a safeguards request which is not, at the same time, a "reactor system request". This opinion was disputed by the US members. As an example, the control of waste disposals, which will be a problem of very rapidly increasing importance, was cited.

- In India, no working group and no coordinated activity exist at the moment.

- In Italy, it is considered that this problem has to be treated in the framework of Euratom and contacts have been established.

Dr. Sanatani was then invited to outline the views of the Department of Safeguards and Inspection concerning the nuclear data needs for safeguards. He mentioned that, among the many problems involved in safeguards activities, the active methods of interrogation - which justify most of the nuclear data requests - were not very much considered up to now. However, these methods might appear as important in the future. Cierjacks considered that they will be important and Taschek said that they are already of sufficient interest to justify, for example, an extensive programme on delayed neutron studies and research for new original methods (use of mesons for exciting mesic X rays).

As a conclusion, the summary of the deliberations of the Subcommittee (Appendix XIV) was adopted, with the recommendation to all members (except Kolstad, Usachev and Cierjacks) to re-examine the position in their respective countries for the time of the next INDC meeting (Action 26).

V. TARGETS AND SAMPLES FOR NUCLEAR DATA MEASUREMENTS

Hjärne initiated the discussion.

The recommendations of the INDC on the IAEA targets and samples programme are given in Appendix XVII.

VI. NEUTRON DATA CENTRE ACTIVITIES

VI.A. Report from data centres

1. National Neutron Cross Section Center (U.S.A.)

The report on the activities of the NNCSC was presented by Havens (Appendix XX). Kolstad added that a new compilation of experimental data is in preparation. This succession of BNL-325 will consist of 2 volumes: one of recommended thermal cross sections and resonance parameters, the other of energy dependent data in condensed graphical form. The technical work on the first volume is more than half completed.

2. NEA Neutron Data Compilation Center (OECD)

The report on the activities of the NDCC was presented by Fröhner (Appendix XXI).

3. Nuclear Data Section of the IAEA

Schmidt referred to the document INDC(NDS)-45/L, section E, which describes in detail the activities of the NDS Nuclear Data Center. He outlined the following points:

- an unusually large turnover in the staff of the NDS and the delays in filling the vacant posts.
- the clear definition of the respective EXFOR responsibilities of the 4 Neutron Data Centres, which was the result of discussions at the last Four Centre meeting.
- the preparation of a revised EXFOR manual.
- the development of a comprehensive checking programme for EXFOR entries.
- the editing of CINDA 72 which will contain about 75,000 entries.
- the preparation of the RENDA 72 edition, in close cooperation with NDCC.

4. Obninsk Nuclear Data Center (USSR)

The report on the activities of the Obninsk Nuclear Data Center was presented by Usachev (Appendix XXII).

VI.B. Report on the Four Centre Meeting at Brookhaven, October 1971

It was the Seventh in a series of meetings held annually under the sponsorship of the IAEA. Schmidt demonstrated that the cooperation in the field of nuclear data is steadily increasing.

As the full minutes of the meeting have been distributed (INDC(NDS)-41/G), Schmidt mentioned only a few points:

- EXFOR format. A revised manual on EXFOR has been prepared by NDS and approved by the meeting. The EXFOR data scope will be extended to include fission product yields.
- Compilation of capture γ-ray data. No decision was taken but contacts are being established with scientists working in this field.
- World Newsletter on Evaluation; The meeting was favourable to this edition (cf. point XI/E below).
- RENDA. The four Centres were invited to submit technical proposals in time for the next Four-Centre Meeting (October 1972, Vienna).
- The diversification of the problems considered in the meetings (for instance, data for safeguards and fusion were discussed). It was felt that compilation specialists in other fields than neutron data must be invited. The Brookhaven meeting was attended by Dr. Horen, Head of the Oak Ridge Nuclear Data Project.

VI.C. EXFOR system operation

Already discussed under items VI.A.

VI.D. Extension of scope of EXFOR

Two points were considered:

- Fission product yield data. Correspondence is under way with Crouch (Harwell) and it is expected that a classification of the data to be compiled will be produced in a near future in order to have these data effectively entered in the Centres' files (Action 28).
- Neutron fission spectra: some users of the Centres services complained about the absence of such data in the Centres files. First steps have been taken at NDCC and NDS to compile these data (Action 58).

VI.E. Requests and dissemination of data

This point was extensively discussed under item VI.A. and figures are given in the progress reports from the Data Centers.

- For NDS, Schmidt emphasized the large difference in the dissemination of evaluated data (about 1,055,000 data points) relative to experimental data (about 65,000 data points) for the period 1971/1972.

- For NDCC, Fröhner mentioned that the requests are growing in complexity, with the corresponding necessity for an increasing number of retrievals from the computer. A striking aspect is the rapid increase of requests for inelastic scattering data. The very small number of requests from unversities and industries has to be noted.

- For the Obninsk Center, Usachev made a remark similar to Schmidt's remark. Many more requests concern evaluated data than experimental ones. Konshin, expressing the users point of view, drew the attention of the four Centres representatives to the very important aspect of replying more speedily and more efficiently to requests. This problem is in fact complex, for it has several aspects:

  - contacts between requestors and the appropriate Compilation Centre
  - correspondence from Centre to Centre
  - in some cases, correspondence between a Centre and an experimenter who may be reluctant to release his data because he considers them as having a preliminary character even if the experiment concerned has been described in a Conference.

VI.F. Status of CINDA

Lemmel reported that CINDA 72 was being printed. This new issue will have two volumes, due to the increase in number of entries. For CINDA 73 the master file will be re-organized at NDCC for two reasons: the fast increasing size of the CINDA file requires greater sophistication in file maintenance; and the possibility will be introduced to give accession numbers to numerical data files together with the relevant bibliographic references (connection CINDA-EXFOR). The distribution of CINDA and its economical basis depend on bulk orders from geographical areas (mainly USA, USSR, Western Europe). It is important that these bulk orders remain at the same level at least for the next few years.

The price of CINDA has slightly increased (from 24 dollars in 1971 to 28 dollars in 1972).

VII. RECENT DEVELOPMENTS OF INIS AND UNISIST

Due to shortage of time, this item was deferred for consideration to the next INDC meeting (Action 56).

VIII. TOPICAL DISCUSSION

The programme of the topical discussion is given in Appendix XXIII. The proceedings will be issued as an INDC(SEC) document (Actions 29 and 30).

IX. NON-NEUTRON NUCLEAR DATA

It was decided to discuss first point IX.B. of the Agenda (item 1 below). In the course of the discussion, points IX.A,C,D,E,F and G (item 2 below) were in fact considered together, due to their close relation to INDC interest for applied non-neutron nuclear data.

1. Report on the first meeting of the IWGNSRD (Vienna, March 1972)

Reporting on this meeting, Hjärne referred to document INDC(NDS)-46/U, which summarizes the results of the meeting and, in particular, gives full details on:

a) a survey of existing compilations on nuclear structure and reaction data.

b) a tentative description of the non-neutron nuclear data needs in various applied fields. By comparison of these two aspects of the problem, it was clear that the needs for data are by far not fulfilled at the present time. The possibility for establishing a system of computerized storage and retrieval for experimental non-neutron nuclear data, similar to the system existing in the neutron data field, was considered. However, it was recognized that the volume of data involved was so large that for budgetary reasons this possibility could not be considered at the present time.

c) the difficulty for Data Centres to find the appropriate information in published papers. A letter to the editors of nuclear physics journals giving guide lines to the authors and referees was drafted (Appendix D of INDC(NDS)-46/U).

d) the possibility of publishing a newsletter on compilation and evaluation of non-neutron nuclear data.

Bartholomew, Chairman of the Working Group, summarized this presentation in saying that the usefulness of the IWGNSRD might be:

- to act as a communication link between originators and users of non-neutron nuclear data;
- to influence the development of better and more uniform standards in publications in the relevant fields;
- to act as a focal point in and to stimulate international cooperation in compilation and evaluation activities in the non-neutron nuclear field.

2. INDC interest in non-neutron nuclear data and future of IWGNSRD

Taschek proposed that the three following problems should be considered.

a) Is there any interest in the existence of an international non-neutron nuclear data working group ?

b) If such an interest exists, what would be the functions of this group and its organizational structure, and how should it fulfill these functions ?

c) If this organizational structure can be established, what would be the most appropriate working methods for managing its activities.

It was recognized that the third question cannot be answered before clear answers are given to the first two questions.

On the first point, it was generally agreed that the International Symposium on Nuclear Data for Applications in Science and Technology (Paris, March 1973) will be a test for determining whether there is a real requirement to be satisfied. The purpose of the Symposium is to learn about the needs of the users (with emphasis on non-neutron nuclear data). Only on the basis of the users' requirements (and not of the compilers' points of view) would it be possible to decide if further steps are necessary in the field under consideration. In the meantime, the INDC members considered that the main task - and, for some of them, the only task - of the IWGNSRD would be to concentrate on the organization of the Symposium and to make it successful.

The consideration of the second point was an occasion to exchange information on activities in the non-neutron nuclear data field.

In the USA, upon the initiative of Horen and Pearlstein, it was decided, about one and a half years ago, to develop a closer cooperation between the various non-neutron nuclear data centres and the National Neutron Cross Section Center. A first meeting was held at BNL, about one year ago, with the participation of the Photonuclear Data Centre (NBS), the Radiation Shielding Information Centre (ORNL), the Table of Isotopes Centre (LRL) and others. A second meeting took place in spring 1972. These meetings resulted in no formal recommendations but have to be considered, at present, as a forum for contacts, exchange of information, and discussion of problems of common interest. Kolstad distributed a status report on the activities of the US non-neutron nuclear data centres (Appendix XXIV) and added that, if international cooperation is developed in the field of applied non-neutron nuclear data, these contacts would be aided if the USA activities were represented by a single organization. In the USSR, several activities in the compilation of non-neutron nuclear data have developed in different laboratories, as reported in INDC(NDS)-46/U. The Centres, where these activities are carried out, are working in close contact with the Obninsk Nuclear Data Centre (CJD) in order to benefit of its experience, in particular on technical problems (computerization of data files, handling of Western formats, etc. ...). However, at the present time, there is no official approval for a formal organization of these activities and the problems are treated on an informal basis between scientists. Concerning other IAEA countries, activities have developed in a variety of fields at different laboratories and in some cases, a cooperation exists between these laboratories on an inofficial basis.

As a conclusion, Cross, Taschek and Usachev were asked to draft a recommendation (Appendix XXV) expressing the INDC position relative to the promotion of international cooperation in non-neutron nuclear data activities. It was agreed that Schmidt should arrange, immediately after the March 1973 Paris Symposium, an informal meeting consisting of some members of INDC and of IWGNSRD with the tasks to draw conclusions from the Symposium and to prepare recommendations to the INDC for further actions in the non-neutron nuclear data field. This meeting will be held in Paris on March 17th. In the meantime and for the same purpose the INDC endorses the action already initiated by the IWGNSRD (page 61 of INDC(NDS)-46/U) and the recommendations made by this Working Group (pages 2,3 and 4 of INDC(NDS)-46/U) with the exception of the recommendations 3 (establishment of a request list for non-neutron nuclear data for fission reactors) and 10 (publication of a newsletter on non-neutron nuclear data) which seemed premature to INDC.

IX.H. IAEA Symposium on Nuclear Data in Science and Technology (Paris, March 12-16, 1973)

According to Schmidt, the Symposium should have two aims:

- The users should inform the various groups of compilers and evaluators concerned about their requirements.

- The compilers and evaluators should make the users aware of what data is actually available (services, data tables, etc. ...).

For most INDC members, the first point was considered to be, by far, the most important one. For attracting users, the suggestion was even made to allow them to speak about their technical problems in order to illustrate why they need nuclear data. For some members, the compilers and evaluators should be invited to participate only in order to listen to the users needs and to express opinions about the possible inadequate or inaccurate state of the situation in their particular field of interest. It was, however, generally agreed that the wording of the first notice advertising the Symposium had emphasized too much the compilation and evaluation aspects of the Symposium and could have given the feeling that it would be a meeting of compilers and evaluators.

X. ASSESSMENT OF NUCLEAR DATA NEEDS AND PRIORITIES

X.A. Review of draft world request list (RENDA) for neutron data measurements for reactors

Neutron nuclear data requests from OECD and Non-OECD countries have been merged in a single document prepared in cooperation between NDCC and NDS : INDC(SEC)-25/G (April 1972).

Dunford made the following remarks:

- a complete revision of the USA request list was received after the publication of this draft edition of RENDA.
- several comments, corrections and additions were received, in particular from Story and Aten.

In spite of the fact that the present RENDA list is incomplete and not up to date, the INDC agreed to have it distributed as an L-document (Action 21) and asked NDS to issue a corrected version, RENDA 73, by April 1973 (Action 22). For this RENDA 73 issue, Fröhner added that the NDCC will take care of the modifications received from the UK and from Euratom countries and the NDS will prepare corrections for the USA entries.

X.D. Relationship between required accuracies of nuclear data and reactor design parameters

Usachev expressed his opinion on the proper way for establishing a request for microscopic data. He commented on the ideas which he developed in a paper he presented at the Panel on Neutron Nuclear Data Evaluation (Vienna, August 1971) and which are summarized in the document INDC(CCP)-25/U. A nuclear data measurement request must be based on a well defined economic requirement. This requirement should be expressed as the accuracy needed in the important parameters for a given type of reactor. These accuracy requirements should be supplied by reactor physicists. A mathematical method then must be developed correlating accuracies in nuclear data to accuracies in reactor parameters. The first step of this process is clearly the task of the reactor physicists while the second one can only be properly done by evaluators.

Rowlands pointed out the difficulties for reactor designers to fix the target accuracies required on reactor parameters. Nevertheless, the problem has been carefully considered in the UK and conclusions have been drawn on measurements and evaluations programmes. For instance, integral measurements have been undertaken to fulfill the requirements for predicting reactivities and fuel enrichments. Other properties (like breeding gains, temperature coefficients, etc...) can be more easily obtained from basic nuclear data. The UK request list for nuclear data (which is in fact separated in two parts, namely requests for measurements and requests for evaluations) is in fact based on a procedure similar to that suggested by Usachev. The most difficult problem in deciding the accuracy requirements for data (whether they result from integral or from microscopic measurements) is probably the balance to be established between the losses in reactor revenue resulting from penalties in its construction and its operation due to insufficiently accurate data and the cost of the experimental programme needed to improve the quality of the data.

More generally, it was said that several papers were published on this subject during the last decade for instance by Greebler (Helsinki Conference 1970) in the field of fast reactors and by Kinchin in the field of thermal reactors (Paris Conference 1966).

In a more direct relation with the present WRENDA it was recommended to adopt a uniform definition of the accuracy for a neutron data request. A definition of one standard deviation seemed the most appropriate as it is the definition already adopted for the UK requests and for most of the USA requests.

X.E. Status of nuclear data request list for thermonuclear fusion

A working paper on this subject was prepared and distributed by Lemley. The NDS has taken preliminary steps to establish a list of nuclear data requirements for controlled thermonuclear research (CTR) by sending a letter to members of the International Fusion Research Council (IFRC). The replies to this letter received in early 1971 were of a rather general nature, outlining the importance of certain types of nuclear data and reactions and giving lists of potential materials of interest. Since that time, the nuclear data requests for CTR have become much more specific. CTR requests from several countries appeared in RENDA. One national request list was received together with preliminary versions of other request lists issued by IAEA Member States or by laboratories working on CTR. Lemley asked then for the INDC recommendation on the following alternatives, publication of a collection of national lists or publication of an international list of the RENDA type (namely a list arranged according to atomic weights, type of requested data for each Z-A value). The INDC unanimously agreed upon the second suggestion. In this case, the following problems were raised by Lemley:

1. The official approval of IAEA Member States to participate is needed, not only for sending data requests but also for screening and updating these lists.

2. Common priority criteria for CTR requests are necessary for merging national lists.

3. The presentation of the CTR request list (format) and its distribution have also to be considered.

The first and second point will be referred to the next IFRC meeting (August 1972, Grenoble). In particular, the proposed priority criteria which have been written by the NDS (Appendix XXVIII) taking into account the variety of opinions which have been received from the INDC, the IFRC and scientists involved in CTR, will be submitted to IFRC for approval (Action 33) and the NDS will have to inform the INDC (Action 34).

Concerning the presentation of the CTR request list, the INDC agreed to separate it from RENDA which will require removal of CTR requests presently included in RENDA. A presentation similar to RENDA seemed convenient.

The distribution of the international CTR request list was touched upon. Without going into details, it was considered that such a list would have to reach all the interested people: experimentalists, plasma physicists, physicists working on design and control of fusion reactors, evaluators and compilers of nuclear data and agencies supporting these activities.

X.F. Request lists for non-neutron nuclear data and priorities

The Chairman proposed that this item be discussed at the next meeting after the conclusions have been drawn from the March 1973 Paris Symposium.

XI. EVALUATION

XI.A. Progress reports on evaluation

1. Argentina

Ricabarra pointed out that the effort in evaluation is limited to the field of resonance integrals and connected with the experimental activities in this field. Resonance integrals have been evaluated for ^{74}Ge, ^{76}Ge, ^{146}Nd, ^{148}Nd, ^{150}Nd, ^{44}Zr, ^{46}Zr, ^{100}Mo. Work on the fission resonance integrals of ^{233}U, ^{235}U, ^{238}U, ^{239}Pu and Ni are under way.

2. Australia

Gemmell reported on the extensions of the fission product library. A considerable number of requests has been received concerning nuclei which are not present at the moment in the current data file and it is envisaged to complete it by 1974. In particular, it is necessary to improve the predictions for level densities, Γ_γ, strength functions and the accuracies for capture cross sections above 1 MeV.

3. Canada

Cross mentioned a review by Walker on the fission product yields for thermal neutron induced fission of ^{233}U, ^{235}U, ^{239}Pu, ^{241}Pu. This review will be issued in the near future.

Bartholomew referred to the neutron capture γ-ray compilations done in cooperation with physicists of the Kurchatov Institute and published in Nuclear Data. He has been approached by the editors for a new edition of this compilation. He intends to discuss the problem of correcting, updating and issuing the revised compilation within one year with his USSR colleagues at the Budapest Conference.

4. France

Ribon mentioned the following activities:

- Continuing work on a library of data for fission products (yields, half lives, branching ratios, energies and radiation intensities. The library is expected to contain information on some 600 nuclei and will be computerized in a format derived from ENDF.
- In the UK format, evaluation of ^{241}Am data and slight revision of ^{239}Pu and ^{240}Pu evaluations.

- Studies on the ^{235}U resonance parameters which will complete the KEDAK work.
- Studies on inelastic neutron scattering and resonance parameters for Fe.
- Translations between formats (KEDAK to UK for ^{235}U and Mo; ENDF to UK for Eu).

5. Germany

Cierjacks limited his presentation to work done at Karlsruhe, namely:

- Re-evaluation of data for ^{235}U, concerning in particular σ_f, $\bar{\nu}$, σ_T and α values.
- Re-evaluation of data for ^{239}Pu, concerning in particular σ_T and $\bar{\nu}$ values.
- Re-evaluation of the data (total, capture and differential cross sections) for H from .001 eV to 15 MeV.
- Re-evaluation of the data (σ_T, σ_α, $\sigma_{n'}$) for C in the region of 4.5 MeV.

6. India

Divatia distributed a short report on evaluation activities in India (Appendix XVIII).

7. Italy

Benzi mentioned the following items:

- The evaluation of the capture cross sections of fission product nuclei is continuing. In addition, calculations are underway to extend up to 15 MeV the previously estimated cross sections.
- A systematic analysis of data on (n,2n) and charged particle emission by means of evaporation and direct interaction models has been started.
- The analysis of the angular distributions of neutrons scattered by Na at 8, 9.7 and 14 MeV, measured at Padua, together with the Perey and Kinney data (ORNL) by using the generalized optical model and the statistical model was carried out and completed.
- The analysis of the (n,n') cross section of ^{238}U has been started.
- A re-evaluation of the Cu, ^{63}Cu and ^{65}Cu files has been carried out.

8. Japan

Nishimura mentioned the following work:

- The evaluation from 10 keV to 15 MeV of cross sections (σ_T, σ_f, σ_γ, $\sigma_{n'}$, ...), $\bar{\nu}$ and for the ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu nuclei has been continued within the framework of the JNDC, as well as the evaluation of fission product nuclear data.

- The standard cross section ^6Li (n,α) T has been analyzed up to 500 KeV. An interference effect between the "negative" resonance near binding energy and the resonance near 250 keV is investigated and attention is given to discrepancies existing in the 10 to 100 KeV energy region.

9. Sweden

Condé said that the evaluation activities are limited to the continuing actions resulting from the IAEA Panel on Neutron Nuclear Data Evaluation (September 1971).

10. UK

Rowlands reported on evaluation activities in the UK:

- Simultaneous evaluation of the fission cross sections of ^{235}U, ^{239}Pu and ^{238}U and the ^{238}U capture cross-section in the energy range 100 eV to 20 MeV. The report of this work will be issued shortly.

- An evaluation has been made of the (n,α) cross sections for Cr, Fe, Ni and Mo. Nuclear theory and systematics have been used and the data adjusted to fit the reactor spectrum average measurements made by Freeman et al. (INDC(UK)-15/G, p.51).

- A computer library of fission yield data has been compiled. A programme has been written to retrieve the data for different fission products and reactions. A further programme has been written and is being tested which calculates the mass yield curve which gives a best fit to the data (INDC(UK)-15/G, p.44).

- Resonance parameter evaluations for Fe and Ni have been completed up to about 300 KeV. Above this energy, ENDF/B data have been adopted.

- Resonance parameter evaluations, corresponding to the simultaneous fit work, have been produced for ^{239}Pu and ^{238}U. Further studies of the resonance parameters of ^{238}U are in progress (Moxon, Harwell).

- Thermal scattering law studies for C and H_2O have been carried out by Butland (Winfrith).

- Conversion of ENDF/B files to the UK format. A programme has been written to convert data from ENDF/B to UK format (MISSIONARY). The following files have been converted: V, ^{234}U, ^{236}U, ^{238}Pu, ^{241}Am, ^{243}Am and ^{244}Cm. The conversions have not been completely automatically done. In particular, the automatic conversion of secondary energy distributions is not entirely satisfactory and these data are produced separately.

- Files produced in Australia, France and Italy in the UK format have been incorporated in the UK library.

11. USSR

The evaluation activities were presented by Konshin. They include:

- A complete evaluation of the ^{238}U cross sections by M.N. Nikolaev, A. Abagyan et al. (Obninsk). The report on this work and the data tape have been made available to the NDS and can be obtained on request.

- The evaluation of σ_f for ^{235}U in the energy region 1 KeV - 15 MeV by V.A. Konshin, M.N. Nikolaev et al. (Obninsk and Minsk joint work). The report has been made available to NDS and the data tape will be released soon.

- The evaluation of the capture cross section of ^{232}Th in the energy region 10 keV - 15 MeV by A.N. Davletschin, V.A. Tolstikov et al. (Obninsk). A report has been distributed as an INDC document.

- The evaluation of $\bar{\nu}$ for ^{233}U and ^{239}Pu in the energy region 0 to 1.6 MeV by N.P. Kolosov, B.D. Kuzminov et al. The work is described in Atomnaya Energiya 32 (1972) 83.

- A multilevel analysis of ^{239}Pu cross sections in the resonance region by A.A. Lukyanov (INDC(CCP)-31/U, p.6). The Adler-Adler formalism has been used for a simultaneous fit of σ_T and σ_f below 100 eV.

- A re-evaluation of the capture cross section of ^{238}U by A.I. Abramov, V.A. Tolstikov (INDC(CCP)-31/U, p.8). Preliminary results were presented at the Helsinki Conference covering the energy range from 1 keV to 14 MeV.

- The evaluation of ^{239}Pu cross sections in the energy region 10^{-4} eV - - 15 MeV by V.A. Konshin, L.A. Bachanovich, A.P. Benderskii, G.B. Morogovskii. Work is in progress to obtain a complete file of the ^{239}Pu data.

- Other evaluations are in progress at the Obninsk Nuclear Data Centre. In particular an evaluation of the Fe data for neutron energies above 5 MeV is expected to be completed in the middle of 1973. A re-evaluation of the α data for ^{235}U and ^{239}Pu in the 100 eV to 1 MeV range has been undertaken to include new data from experiments performed after the Sowerby-Konshin evaluation.

Usachev outlined that the "Bulletin on Nuclear Constants" which is regularly issued (no. 7 has been recently distributed) contains all information on evaluation work in the USSR and that all evaluated data files will be made available to the NDS.

12. U.S.A.

Kolstad said that complete ENDF/B-III files for six isotopes used as standards - namely H, ^{3}He, ^{6}Li, ^{10}B, ^{197}Au, ^{235}U - had been sent to NDS in April 1972 for world-wide distribution.

The ENDF/A Library has been expanded to include the United Kingdom Nuclear Data Library (UKNDL), the Karlsruhe Microscopic Neutron Cross Section Data File (KEDAK), the library for 198 fission product nuclides prepared by J.L. Cook (Australian Atomic Energy Commission), and the SAND-II Library of dosimetry data prepared by W. McElroy (Hanford Engineering Development Laboratory).

An evaluation of neutron-induced gamma-ray production cross sections for ^{238}U has been completed. This effort was done in conjunction with efforts to develop suitable nuclear model techniques for predicting secondary gamma ray spectra resulting from neutron interactions.

An evaluation of neutron absorption cross sections of Krypton and Xenon isotopes is under way to explore the possibility of locating leaky fuel elements in reactors by "tagging" them with various mixtures of isotopes of these gases.

Rowlands raised the question of a possible adjustment of the ENDF/B-III data files on the basis of information from integral experiments. He expressed the opinion that - at least for standard cross sections - only microscopic data should be taken into account as it is the case for the whole UK library. This position was strongly supported by Usachev because adjustments on integral experiments can introduce correlations between files concerning different isotopes. Dunford thought that some adjustments were made but within the limits of experimental errors of microscopic measurements. He will further inquire about this problem (Action 41) and all members are invited to consider the question of the use of "clean" integral experiments in the establishment of evaluated data files (Action 40).

In addition to Kolstad's presentation, Taschek mentioned a number of evaluations carried out at Los Alamos, which will be available in the near future:

- Total cross sections of natural W and W isotopes from 20 keV to 22 MeV.
- Total cross section and elastic cross section of O.
- ^{27}Al (n,p) ^{27}Mg and ^{27}Al (n,α) ^{24}Na cross sections. This constitutes a re-evaluation of the ENDF/B-III data, mainly near the threshold.
- Translation into ENDF/B format of the Tritium and Deuterium cross section evaluations of Stewart et al.
- Translation into ENDF/B format of the evaluation of Stewart et al. on γ-ray production cross sections of ^{235}U and ^{238}U.
- Re-evaluation of ^{239}Pu data (σ_f, σ_γ, $\bar{\nu}$).
- Re-evaluation of the total cross section of ^{7}Li up to 15 MeV.
- Investigation of neutron cross sections of basic importance in nuclear data normalization and standardization applications, in particular ^{6}Li (n,α), ^{10}B (n,α), σ_f (^{237}Np).
- Evaluation of the ^{9}Be (d,n) ^{10}B cross section, which is of interest for getting a neutron source for medical applications.

13. Yugoslavia

Paic mentioned that all the experimental data are sent to NDS but that no evaluation activities are carried out in his country.

XI.B. Report on results of IAEA Panel on Neutron Nuclear Data Evaluation (Vienna, September 1971)

Byer presented a summary of the Panel in the form of a category G document (INDC(NDS)-42/G) and announced the publication of the complete proceedings for the end of 1972. The panel was attended by 24 participants from 11 countries and 25 papers were presented and will be included in the Proceedings.

The highlights of the panel appear in:

- a review paper of the NDS on evaluation activities (needs and problems) in 23 countries;

- a report of a sub-group on status and quality control of evaluations which includes the status of the present evaluated neutron data libraries, a discussion of the influence of macroscopic experiments and adjustments on the different evaluated neutron data files;

- a summary of the Panel's deliberations on international co-operation and coordination in the field of evaluation activities.

XI.C. Progress on exchange of evaluated neutron standard reference data

As this matter was considered under item XI.A., Dunford summarized the situation as it came out from the countries reports:

- UK and KEDAK files are freely available

- USA has sent complete files for 6 standard elements as reported by Kolstad

- USSR has sent a file on ^{238}U which will be dispatched by NDS to the three other cooperating Centres.

XI.D. Evaluated neutron nuclear data exchange

The problem was largely discussed under item XI.A. The general consensus is that the availability of a particular data file has to be treated case by case, due to the fact that an evaluator frequently includes in his work some work done by another evaluator. Then, even if he is willing to make his work freely available, he has to request the agreement of his colleague for the part of the evaluation which is not his own.

From a technical point of view, Ribon said that the multiplicity of the formats used for evaluated data files is a considerably handicap for exchanges of such files. He insisted on the absolute necessity of a clear definition of the formats and he mentioned the inconveniences resulting from modifications of these formats. Usachev insisted on the fact that the cooperation in the evaluated data field is not uniquely a problem of exchange of computerized data files. For example evaluated data are subject to uncertainties of different nature (standardization; statistical errors; systematic errors) and a critical examination of this problem of uncertainties has to be considered in international cooperation.

XI.E. International newsletter on evaluation

Dunford reported that one of the recommendations of the Evaluation Panel concerned the publication by the NDS of an "International Newsletter on Evaluation" of the type currently edited by Ribon for the OECD countries. After a long and controversial discussion, the problem of the publication of an Evaluation Newsletter by the NDS was postponed to the next INDC meeting (Action 42). In the meantime, the NDCC will continue to issue its Newsletter in its present form.

XII. MEETINGS AND CONFERENCES

Due to lack of time, only a few agenda items were considered.

XII.B.5. Third IAEA Symposium on the Physics and Chemistry of Fission

It is planned to hold this Symposium at the University of Rochester (USA) on 13-17 August 1973. The fission nuclear data relevant to the 1974 IAEA Conference on Nuclear Data will be explicitly excluded.

XII.B.6. Panel meeting on fission product nuclear data (FPND)

The interest for having this meeting was originally stressed by Benzi. The meeting will be held in 1973 in Bologna and it is expected to have the participation mainly of FPND users, integral measurers and evaluators. A preliminary indication of the topics to be considered is given in the document INDC(NDS)-45/L, page 11.

XII.B.8. Third IAEA Conference on Nuclear Data

A working paper by Dunford and Schmidt on the proposed agenda, including comments on the general theme and philosophy of the Conference was sent to the INDC members on 6 June 1972 (Appendix XXIX). Schmidt explained that, for budgetary reasons, a decision has to be taken now for a Conference proposed for 1974. He noted in particular that the Agency's Scientific Advisory Committee would still have to approve the Conference at its next meeting in December 1972. Subject to this approval he asked for comments on the proposed agenda and, if a positive conclusion is reached for holding the Conference, for the nomination of a Programme Committee. The INDC reaction on the principle of having a Conference on nuclear data in 1974 was positive but it was felt that it should not be a conference based on WRENDA, as it could appear from the NDS proposal. Kolstad mentioned some written comments from USA physicists where it is proposed to give less emphasis on neutron data for reactors than it has been the case for the two previous IAEA Conferences on Nuclear Data. The letters he received - which will be forwarded to the NDS for the benefit of the Programme Committee - emphasized the interest for broadening the subject in taking into consideration other types of applied data (for example data for fusion, safeguards, etc. ...). He noticed the complementary aspect of the 1973 Paris Symposium - where it is expected to have the users expressing their needs for nuclear data in a variety of fields - and of the 1974 Conference - where the measurers will be invited to present their results in response to these needs. Dunford pointed out the difficulty to organize a useful conference with a too broad scope. The Programme Committee was formed: Havens, Cierjacks, a representative of the USSR to be designated by Usachev (Actions 44 and 45), a representative of the UK to be designated by Rose (Action 45), and Dunford. Taking advantage of the presence at Paris of several members of this Committee for the 16th EANDC meeting, it was decided that the first meeting of the Programme Committee will be held in Paris on 24-26 November 1972. A second meeting was envisaged at the time of the 1973 Paris Symposium.

XII.B.9. Meeting on nuclear data requirements for shielding calculations as determined from sensitivity studies

The interest for holding this meeting appeared as a consequence of the increasing interest of the reactor shielding specialists for nuclear data. The aim and a list of possible topics to be discussed are given in a working paper prepared by Dunford (Appendix XXX). The main objective is to give the reactor shielding specialists an opportunity to discuss their sensitivity studies and to come to recommendations on nuclear data requirements for shielding. The meeting will be held in early spring 1974 to allow sufficient time for preparation of a summary paper (and contributions) on this subject to the Third Nuclear Data Conference. It will be a fairly small meeting (about 30 participants), co-sponsored by the Reactor Physics Division of the IAEA.

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

Appendix III

June 13, 1972

INDC Members

TECHNICAL MINUTES OF THE INDC

The EANDC has long had a practice of distributing a set of technical minutes. These technical minutes do not require a large amount of time to prepare and have been found to be very valuable for distribution to the nuclear data community. After the Secretary has prepared the full minutes of the meeting, he indicates by a line in the margin those portions he thinks should be included in the technical minutes. The EANDC members (in their normal review of the draft minutes) have a month to review what should be included in the technical minutes and request that sections be deleted. The administrative parts of the full minutes are then removed, the remaining parts put together, and the pages renumbered.

Issuing the technical minutes to a broader segment of the scientific and technical community has been so successful that I recommend that this same procedure be adopted by the INDC. The technical minutes probably should be distributed to all members of local nuclear data committees and Liaison Officers associated with the IAEA.

George A. Kolstad
Chairman, International Nuclear
Data Committee

APPENDIX IV -

Suggested Procedures for Issuing INDC Technical Minutes

Report of Subcommittee

Technical minutes of each meeting shall contain those sections of the minutes, including appendices, having substantial technical content or describing activities and programs supported by the Committee that are of general interest to the scientific and technical community. Administrative matters, relating primarily to the operation of the Committee and its relations with other organizations, and informationsor discussions of a delicate nature, shall be excluded from the technical minutes.

The Executive Secretary shall indicate in the draft of the full minutes those sections which, in his judgment, should be included in the Technical minutes. Suggested changes to the selection of material included, or in wording, shall be submitted by members to the Executive Secretary along with corrections to the draft minutes. The edited Technical minutes shall be given a U distribution and may be issued without further approval of the Committee.

The time for the Executive Secretary to send draft minutes to members ("Methods of Work ", INDC (SEC) - 10/G Section V-3) should be increased from 30 to 60 days. Corrections shall be returned to the Secretary within 30 days.

Gesellschaft für Kernforschung
Karlsruhe
M. Küchle/INR

14. 7. 1972

Proposal for Nuclear Data Measurements of Transuranium Isotopes Using a Nuclear Explosion

In view of the unique capabilities of cross section measurements with nuclear explosions interest exists in the Federal Republic of Germany to participate in an "open shot". The main area of interest are cross sections of Transuranium Isotopes, which cannot be measured by other techniques. The data are needed for a better prediction of isotope build up in spent reactor fuel elements, what is relevant to reprocessing and waste storage problems. A second field is the production of Transuranium Isotopes for utilization in several applications.

A first check resulted in the following request:

Isotopes: ^{231}Pa, ^{233}Pa, ^{241}Am, ^{242}Am, ^{243}Am, ^{244}Am, ^{242}Cm, ^{244}Cm

Data: primarily $\sigma_{n\gamma}$ resonance region, supplementary σ_f resonance and fast region

Accuracy: 30% would be a substantial improvement beyond present knowledge

It would be appreciated if a broad international cooperation could be initiated to tackle this large program. The contribution from Germany could consist of performing one or two experiments.

Most urgent seem to be the data for ^{241}Am and ^{242}Cm. For ^{241}Am both the wheel and the Moxon-Rae detector technique are being considered in order to separate the cross sections of the two isomeric states.

Minutes of the INDC Subcommittee on Standard Reference Data Meeting on July 16, 1972 at 16.00h (IAEA, Vienna)

All members were present : Havens
Yankov
Joly
Rose
Schmidt
Aten

As observers were present : Hjärne
Lemmel
Lemley
Dunford
Konshin

Members declared that they had no objection to the presence of the observers. It was decided to discuss the following items :

A. Points contained in the INDC meeting agenda under IV A :

1. Experimental and evaluation work on ^{235}U fast fission
2. Updating of 2200 m/sec fissile isotope constants
3. Progress in $\bar{\nu}$ (^{252}Cf)
4. Au as a fast capture standard
5. σ $^{6}Li(n,\alpha)$ and $^{10}B(n,\alpha)$ above 100 keV
6. Absolute neutron flux measurements.

B. Recommendations of the Consultants' Meeting on Prompt Fission Neutron Spectra

(The Subcommittee decided to rule out, at present, the other items proposed for discussion in the Chairman's letter, dated May 26, 1972, namely :
Neutron energy spectra except as included under B, $\bar{\nu}$-values except as included under A and B, average cross sections for fission neutrons, thermal cross-sections, resonance integrals, fission yields, decay schemes and information concerning stoichiometry of standard materials used in nuclear research and technology.)

A_1 Experimental and evaluation work on ^{235}U fast fission

Havens : At Los Alamos σ_f is being measured with Van de Graaff neutrons between 1 and 6 MeV. The neutron flux is measured by proton recoil. Results may be available next year.

Rose : Gayther et al. are measuring σ_f with a linac from 1 keV to 1 MeV. They obtain relative values and normalize to Sowerby's evaluation between 10 and 100 keV (Table 1 and fig. 1).

Yankov : In the USSR a new evaluation has been performed between 1 keV and 15 MeV. Results agree with Sowerby's figures within about 3 % up to 1 MeV. Above 1 MeV agreement between different measurements is rather bad and new data in this region are needed.

Joly : At Cadarache σ_f has been measured in 1970 between 17 keV and 1 MeV using a fission chamber borrowed from White (Aldermaston). This cross section was recently remeasured between 15 keV and 2.2 MeV with both the White fission chamber and another fission chamber equipped with an ^{235}U layer prepared and calibrated by the BCMN (Geel). Above 100 keV the results obtained with the Geel fission foil are on the average 2 % lower than those obtained with the White chamber; the disagreement is in the same direction but still higher below 100 keV. A comparison of the two chambers has been recently done at thermal energy on the BR2-reactor (Mol), giving a disagreement as high as 5 %. The origin of this discrepancy is being checked; the use of several fission foils - with the possibility to practice a destructive analysis of some of them - is important to get reliable data.

Schmidt : σ_f for ^{235}U is one of the main subjects for discussion in the IAEA panel in November 1972.
Action : all laboratories should send their information on σ_f for ^{235}U to the Nuclear Data Section, IAEA, before November 1972 !

Aten : Would it be worthwhile to measure σ_f below 1 MeV with photoneutron sources ? This would require a careful study of the spectrum of such neutron sources. Rose felt that the fact that, if it were practicable, this would be an independent method, might be an advantage.

(In connection with this point there was some discussion on Cf-sources. The spectrum is being measured by proton recoil at Obninsk and at Harwell by time-of-flight. It was asked whether there should not be taken a decision to can all ^{252}Cf sources for neutron measurements in a standard way, but the meeting felt that such a decision would be premature until more information would be available concerning the spectrum.)

A_2 Updating of 2200 m/sec fissile isotope constants

In the Nuclear Data Section of IAEA a report is being prepared by : H.D. Lemmel and C. Dunford with
Consultants as co-authors :

- E.J. Axton ($\bar{\nu}$)
- J.J. Deruytter (σ_f and T 1/2)
- B.R. Leonard Jr. (σ_{sc} ang g-factors)
- J.S. Story (standard σ's)

in close contact with V. Konshin, A. de Volpi, J.W. Boldemann and others. These results will supersede those of Hanna, Westcott, Lemmel, Leonard, Story and Attree (Atomic Energy Review 7, nr. 4,3 , 1969).

It is too early to say whether Oetting's new value for the half-life of ^{239}Pu will prove to be correct and will change σ_f. No judgment could be given on de Volpi's evaluation which gives a value for σ_f for ^{235}U different from Deruytter's value. In the case of Deruytter's value one does not see much of a chance that it will change, because the new information concerns essentially the half-life, and here Deruytter's value has been found to be correct by the Canadians.

Yankov mentioned the case of ^{233}U, where σ_f is not known as well as for ^{235}U and ^{239}Pu and the situation for σ_c is even worse. However, for the moment σ_f and σ_c for ^{233}U do not belong to the standard reference data.

A$_3$ Progress in $\bar{\nu}$ (^{252}Cf)

This was a most interesting discussion. Information from several sources indicated that the value should be lowered.

Rose : Axton is working on his data. According to the progress report he finds $\bar{\nu}$ = 3.72. Final results should be available in November.

Lemmel : From a best fit of a number of σ - data one obtains $\bar{\nu}$ = 3.73.

Schmidt : Boldemann has corrected his liquid scintillation observations and now gives $\bar{\nu}$ = 3.73.

A$_4$ Gold as a fast capture standard

Aten : gave arguments for Au and against Ta

Havens : U.S. Nuclear Committee decided to maintain Au as the primary standard for 10 keV to 1 MeV (2 % accuracy required in σ_c).

Yankov : USSR also decided to give priority as a capture standard to Au, in spite of contradictions.

Joly : At Cadarache, σ_c was measured with a C_6F_6 detector between 100 and 200 keV; the results are in agreement with Poenitz's evaluation. To check these data, a measurement of the activation cross section was performed at 170 keV, with the Van de Graaff : the result obtained, which is still preliminary, is 4 % higher than the value given by the scintillation detector.

Schmidt : If σ_f (^{235}U) is calculated from σ_c(^{238}U)/σ_f(^{235}U) combined with σ_c (^{238}U) or from σ_c(^{197}Au)/σ_f(^{235}U) combined with σ_c (^{197}Au) the results agree. If, however, a similar calculation is performed by combining σ_f(^{239}Pu)/σ_f(^{235}U) with σ_f(^{239}Pu a different value is obtained, the first result agrees with the figures of Poenitz for σ_f(^{235}U), the second one with those of White, Szabo and Sowerby. It would be most desirable to measure directly σ_c(Au)/σ_f (^{239}Pu).

Schmidt and Yankov : Criticality arguments indicate that Poenitz's figures are unlikely to be correct for σ_f(^{235}U).

4. -

A_5 $\sigma\ ^6Li(n,\alpha)$ and $\sigma\ ^{10}B(n,\alpha)$ above 100 keV

$^6Li(n,\alpha)$

Rose : The Harwell Measurements with three different thicknesses of lithium glass are now in agreement, they still differ from Fort's. σ_T will be measured to confirm the manufacturer's analysis for the non-Li part of the glass, as a final check on the multiple scattering conditions.

Joly : The Cadarache data were also obtained with lithium glasses of different thicknesses. The ^6Li content of the glasses was determined by two methods : neutron transmission at low energies and comparison with a ^6Li calibrated solution by pile oscillator technique. The $Li^6(n,\alpha)$ cross section obtained was fitted simultaneously with all other available data (σ_T, $\frac{d\sigma(n,n)}{d\Omega}$, $\frac{d\sigma(n,\alpha)}{d\Omega}$). The fit is good except at the peak of the 252 keV resonance for the Uttley's σ_T data, where a 4 % disagreement is observed.

Rose : Additional measurements have been performed at Harwell between 0.15 and 3.9 MeV by Clements and Rickard (See AERE-R-7075) (In this connection it was mentioned that Lane plans to do (n, α) observations with a multi-plate ion chamber at Ohio State University.)

Aten : Measurements of σ_T are being performed again at Geel with a new linac target and a new moderator, which give a much lower gamma-flash.

$^{10}B(n,\alpha)$

Havens : Measurements are going on at Gulf Radiation Technology (Friesenhahn, Carlson, et al.) of the $^{10}B(n,\alpha_0)$ and $^{10}B(n,\alpha_1\gamma)$ cross sections relative to the proton scattering cross section from 1 to 1000 keV. Accuracies will vary from 1 % at 1 keV to 3 % at 1 MeV. Results should be available in fall 1972.

Joly : Measurements with the Cadarache Van de Graaff from 10 to 200 keV give results in good agreement with Gubernator's evaluation; these results are 2 to 3 % different from Sowerby's data. These Cadarache results must be considered as preliminary.

A_6 Absolute neutron flux measurements

Rose : The black detector at Harwell has now been well calibrated against the long counter up to 2 MeV. Results on the shape agree with the calculated curve over the entire range of the latter, i.e. 30-700 keV.

Joly : At Cadarache, fluxes are measured with a directional long counter, which has been calibrated by three independent methods : proton recoil, manganese bath, associated particle for the reactions (p, T) and (D, D); at high energy, the properties of asymmetry of the (D, D) reaction were also used. All these methods are in agreement within $\pm$ 2 % to $\pm$ 4 % from 2 MeV up to 6 MeV.

Yankov : At Moscow this problem has been treated at a congress on neutron metrology in 1971. Preliminary texts are distributed at the meeting, full proceedings will be available later in the year.

B. Recommendations of the Consultants' Meeting on Prompt Fission Neutron Spectra

(The text of the recommendations is contained in Appendix VI)

Hjärne : The discrepancy between differential and integral measurements persists. As many measurements as possible should be made with the same detector on the fission neutrons of ^{235}U and of ^{252}Cf.

Rose : A simple Maxwellian fit is not satisfactory above about 7 MeV. This is shown by new data from Harwell for ^{235}U, which need a double-Watt fit.

Joly : Measurements of the ^{235}U and ^{239}Pu neutron fission spectra were performed at Cadarache using liquid scintillator calibrated relative to the directional long counter; the energy of the neutron inducing fission was $\sim$ 40 keV. The data obtained between 800 keV and 5 MeV can be represented by a single Maxwellian ($T_{U}5$ = 1.32; $T_{Pu}9$ = 1.43). Preliminary results were also obtained down to $\sim$ 400 keV.

Aten : Activation measurements on the ^{252}Cf spectrum above 10 MeV agree with the Maxwellian. The difference between Maxwellian and Watt spectrums is specially important in the difference of the number of neutrons below 1 MeV. At Geel the average energy of the ^{235}U fission neutrons has been found to be 2.06 $\pm$ 0.05 MeV.

Schmidt : Asks for the following :
Action : All laboratories should send data concerning prompt fission neutron spectra to their own data centre and to the Nuclear Data Section at IAEA.

It was decided to make the following recommendations to the INDC :

1. It is recommended to adopt gold as the primary standard for neutron capture between 10 keV and 1 MeV.

2. It is recommended that direct measurements be made for the cross-section ratio $\sigma_c(^{197}Au)/\sigma_f(^{239}Pu)$, primarily in the energy range 10 keV-1 MeV.

3. It is recommended to include among the standard reference data the cross-section for the reaction $^{3}He(n,p)T$, but with a lower priority than the data already figuring in the list.

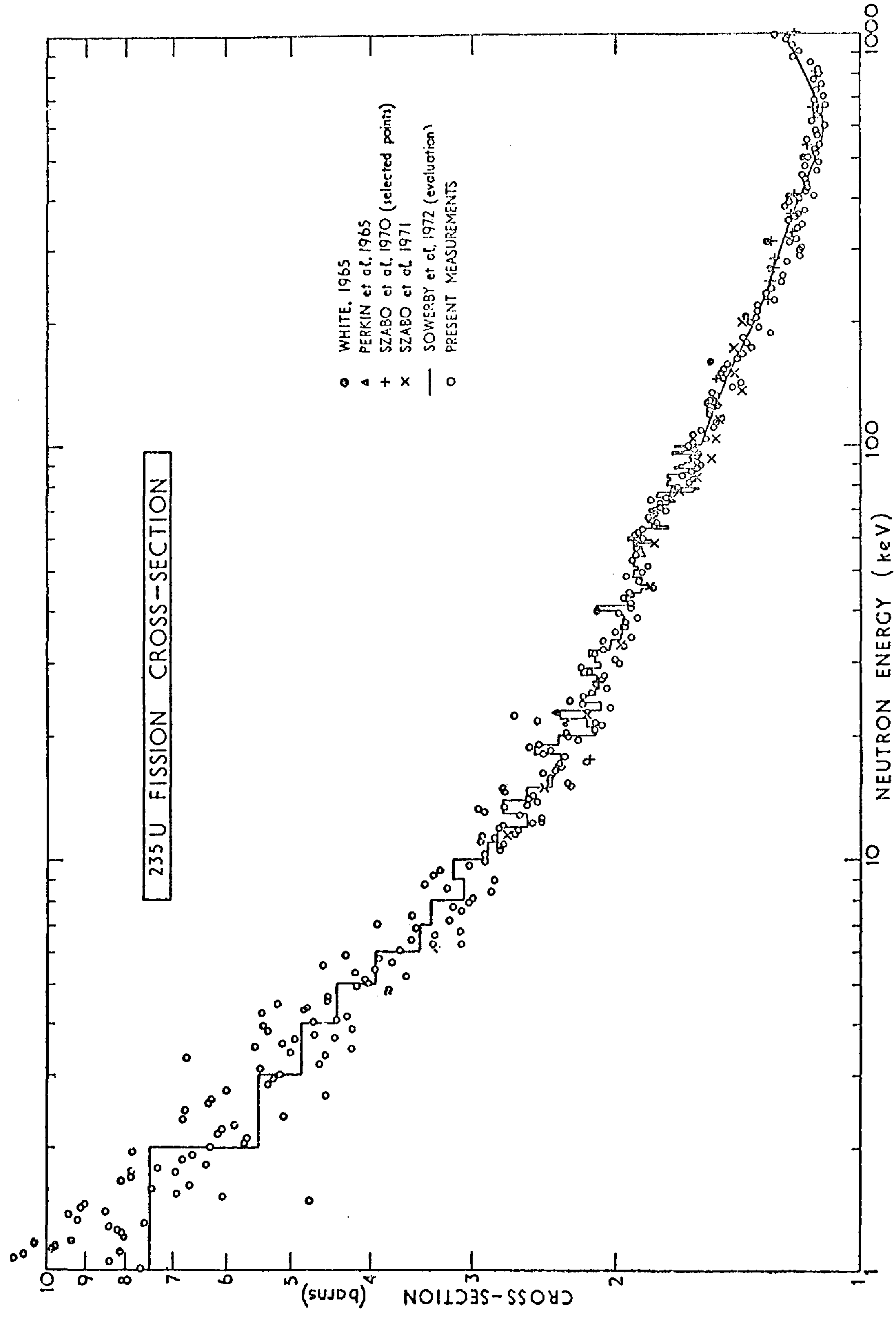
4. It is recommended that INDC consider the possible desirability of including other data (neutron or non-neutron) among the Standard Reference Data.

A.H.W. ATEN.

Table 1

Energy Interval (keV)	Difference between present measurements and evaluation (%)		
	Sowerby et al	ENDF/BIII	KEDAK
1 - 2	+ 3.7	+ 2.7	+ 2.5
2 - 3	+ 4.6	+ 2.8	- 0.4
3 - 4	+ 1.9	+ 0.3	+ 1.4
4 - 5	+ 1.7	+ 0.9	- 1.0
5 - 6	+ 1.0	0.0	- 7.2
6 - 7	- 4.1	- 6.6	-13.6
7 - 8	- 3.7	- 2.5	- 9.5
8 - 9	- 0.9	- 0.6	-14.9
9 - 10	- 2.3	- 3.4	- 8.6
10 - 20	- 1.3	- 8.9	+ 2.0
20 - 30	+ 1.3	- 6.8	+ 3.5
30 - 40	- 0.2	- 9.9	- 3.3
40 - 50	+ 0.9	- 5.4	- 3.3
50 - 60	+ 1.9	- 3.7	- 0.2
60 - 70	+ 2.8	- 1.1	+ 1.2
70 - 80	+ 4.0	- 1.4	+ 0.5
80 - 90	- 1.3	- 5.0	- 3.3
90 - 100	+ 0.7	- 2.5	- 1.3
100 - 200	+ 3.8	+ 0.4	+ 0.3
200 - 300	+ 3.2	+ 1.1	+ 0.1
300 - 400	+ 1.5	+ 0.4	- 1.8
400 - 500	+ 4.1	+ 0.9	+ 0.2
500 - 600	+ 4.2	+ 0.6	- 0.7
600 - 700	+ 1.9	- 0.6	- 1.8
700 - 800	- 1.0	+ 0.6	- 1.9
800 - 900	- 3.6	- 1.2	- 3.4
900 - 1000	- 0.5	- 0.2	- 0.3

$\sigma\ ^{235}U(n, f)$ Gayther et al.


235U FISSION CROSS-SECTION
WHITE, 1965
PERKIN et al, 1965
SZABO et al, 1970 (selected points)
SZABO et al, 1971
SOWERBY et al, 1972 (evaluation)
PRESENT MEASUREMENTS
CROSS-SECTION (barns)
NEUTRON ENERGY (keV)
1
10
100
1000
2
3
4
5
6
7
8
9
10

APPENDIX VIII -

Informations on USA facilities for nuclear data measurements -

G. KOLSTAD

ARGONNE NATIONAL LABORATORY

Fast Neutron Generator

This device is basically a tandem accelerator of the Dynamitron type, having the merits of entirely electrical operation, good stability and high beam power capability. The machine is pulsed (nsec) and sustains DC positive ion beams of up to 200 micro-amps at energies to 8 MeV. It is the only machine of its type in routine research operation. We are pleased to report that operation has generally exceeded specification for over 9,000 hours and that during this period the down time has been minimal due to minor component failures. In every sense an essentially developmental machine has proven very satisfactory during this relatively long period of operation.

The Fast Neutron Generator is presently source-limited in the context of intensity. A new high intensity negative-ion injection system, designed to increase the beam currents by about X 10, is now under bench test. The basic components were made commercially (Cyclotron Corp.) and are being matched to the Generator. The operation will be in both pulsed and DC modes.

Long neutron flight paths are conventionally employed in conjunction with white neutron sources. They also are of merit when used with mono-energetic pulsed sources as the superior time resolution improves the available resolutions and the control of source energy permits precise background determinations. With these advantages a 100 meter flight tube is being installed at the Fast Neutron Generator. All materials are on site and about 40 meters are presently under vacuum test. The facility will be particularly useful in conjunction with the new high intensity injector.

Research topics include:

1) Total Delayed Neutron Yield from Fissile and Fissionable Nuclides
2) U^{238} and U^{235} Fission Cross Section Ratio from 1 to 5 MeV
3) Neutron Scattering and Total Cross Section
4) Polarization in the Elastic Scattering of Neutrons from Medium and Heavy Weight Elements
5) Capture Cross Section Measurements
6) Thick Target Neutron Yields from Proton and Deuteron Bombardment of Be^9

BNL

High Flux Beam Reactor (HFBR)

The nuclear physics neutron program uses the HFBR to carry out a variety of fundamental nuclear experiments. Major capabilities include a Fast Chopper and a Crystal Diffraction Monochromator.

A redesign of the collimation system used at H-2 beam tube (Fast Chopper) has been completed. The aim is to decrease the severe collimation of the beam in the vertical direction from the present value of $\sim$ 7 minutes to about 20 minutes of arc. The result should be an increase in the effective beam current on target by about a factor of two, at the expense of additional shielding requirements around the beam pipe.

Research neutron physics related topics at HFBR include:

1) Search for direct capture in Dy^{162} (n,α) Dy^{163}
2) Channel spin admixtures in Nb^{93} resonances
3) Search for width correlations in Dy^{163} (n,α) Dy^{164}
4) Search for p-wave neutron resonances in tellurium isotopes
5) Boron density profiles by $B^{10}(n,\alpha)$
6) Higher excited states of Hf^{179}, W^{183}, W^{184}
7) Relation between the (n,α) and (d,p) reactions
8) Spins of levels in Sm^{148}
9) Influence of bound levels on intensities of gamma rays from capture of low energy neutrons
10) Test of valence neutron model in Pd^{108} (n,α) Pd^{109}

Double MP Tandem van de Graaff Facility

The Facility is now in full 21 shifts per week operation (one shift = 8 hours) with professional operator supervision throughout. In the past year three-stage acceleration approached nearly routine operation, and the Facility was used in that mode 22% of the total time. It is expected that the fraction of time for three stage operation will increase significantly in the near future; for example, in the month of April 1972 the double MP accelerator system was used in the three stage mode 56% of the total time. Usage by outside research users amounted to 34% of research time.

Acceleration of heavy ions for nuclear and atomic physics research is the dominate usage of the accelerator system. In the past year three stage acceleration of C^{13}, F^{19}, S^{32}, Br^{79}, and I^{127} was obtained in addition to the previously available heavy ion beams.

BNL

A wide range of experimental programs are now being carried out at the Tandems. Some of the particular areas of interest which illustrate the variety of experiments made possible by the Tandem Facility are described below.

The diversity of heavy ion beams and the wide range of available energies stimulate a variety of experiments. Among the most important general areas are the study of high spin states produced by heavy ion compound nuclear reactions, studies of heavy ion reaction mechanisms, production of "exotic" nuclei far from the line of stability, examination of heavy ion induced fission processes, as well as extensive use in Coulomb excitation work. In atomic physics the measurement of x-ray production by heavy ions is of great interest at the present time for both theoretical and practical reasons.

The concurrent availability of many light ion beams with high intensity and excellent energy resolution combined with a wide energy span provide an additional capability. They are particularly useful in providing information on the properties of individual nuclear levels. A major program based on the study of capture gamma rays is in prepatation.

COLUMBIA UNIVERSITY

Nevis Cyclotron

The Nevis cyclotron modification is nearing completion, with an initial test proton beam expected by the end of this year. Final shimming of the floating iron pole pieces has been finished, and testing of the support structure for the tuning iron is in progress, with the insertion and testing of the RF copper ground skin about to start. Work has started on the electrostatic system to deflect the proton beam into a lead target for the production of neutrons.

A short catalogue of resonance energies suitable for the calibration of time of flight neutron spectrometers is being prepared. These resonance energies should be helpful in eliminating possible energy shifts in neutron spectroscopy data which may arise in neutron velocity selector results. The most common shift is due to difficulties in determining the zero point on the timing scale, in which case all calculated energies will be inaccurate by a quantity that varies monotonically with energy.

Research neutron physics related topics at Nevis include:

1) Neutron Resonance Cross Section Measurements
2) Cross Section and Resonance Parameters $A < 80$
3) Cross Section and Resonance Parameters of Th^{232} and U^{238}
4) Fission Cross Section of U^{233}

DUKE UNIVERSITY

Cyclograaff

The Duke cyclotron-tandem van de Graaff accelerator system (the Cyclograaff) is now in routine operation for nuclear and atomic physics research on a 7 days per week - 24 hours per day basis. A beam homogenizer system (a system by which energy variations in the incident beam are compensated by deliberate variations in the electrical potential of the target) for the tandem is under development. An energy resolution of 500 eV at 14MeV has been obtained.

Research topics at the tandem and/or Cyclograaff include:

1) Neutron polarization experiments
2) Proton induced fission measurements for 4 MeV $\leq E_p \leq$ 30 MeV
3) Particle-gamma angular correlation experiments on the s-d and p-f shell nuclei
4) Lifetime experiments in the s-d and p-f shell nuclei
5) (He^3,α) Reaction studies in the s-d nuclei
6) He^3 scattering and polarization studies
7) Gamma decay of isobaric analog resonances
8) Yields of K x-rays as a function of bombarding energy
9) (p,n), (p,2n) and (He^3,n) experiments
10) Studies of (d,t) and (d, He^3) reactions
11) Polarized hydrogen and deuterium beam experiments
12) (p,t) and (p,d) reactions
13) High resolution proton scattering experiments from 5 to 15 MeV
14) Heavy ion experiments using Li^7 and O^{16}

Small van de Graaffs

Research topics at the 3 and 4 MeV Duke van de Graaffs include:

1) Neutron total cross section measurements
2) Fine structure of isobaric analogue states in medium-weight nuclei
3) Statistical properties of nuclei via proton and neutron resonance reactions
4) Gamma decay of fragmented analogue states
5) X-ray production by proton bombardment.

LAWRENCE LIVERMORE LABORATORY

Intense Source of 14 MeV Neutrons

The current status of the Insulated Core Transformer neutron source is described in a recent publication [Nuclear Instruments and Methods 99, 1 (1972)]. The source produces 2 x 10^{12} neutrons/sec for a fresh target and the yield drops to half this value in about 100 hours of operation. Work is in progress to investigate the possibility of increasing the source strength and to extend target life. A larger target has been designed. An attempt to increase the output of the ion source will also be made.

The neutron source has occasionally be operated at 3 x 10^{12}/sec. Neutron flux densities of 1 - 1.5 x 10^{12}/cm^2sec have been observed near the target. The ICT neutron source was manufactured by High Voltage Engineering Corporation.

100 MeV Electron Accelerator Facility

The electron linac is now in routine operation on a 24 hours per day - 5 days per week basis. The positron beam current has been developed to produce 50 nanoamperes; LLL staff anticipate further development will result in a factor of ten increase.

The linac research program is approximately 40% photonuclear experiments, 40% neutron physics experiments, and 20% activation analysis, isotope production, and programmatic experiments.

Cyclograaff Facility

This accelerator system is very nearly in routine operation for research. Time is now divided 50% for experiments and 50% for accelerator development. The experimental program emphasizes measurement of proton elastic cross-sections and (p,n) cross-sections to infer neutron scattering cross-sections.

Three Megawatt Reactor

The experimental program at this pool-type reactor is 50% nuclear physics experiments and 50% applied physics experiments. The nuclear physics program emphasizes (n,γ) and (n,fission) measurements.

LOS ALAMOS SCIENTIFIC LABORATORY

Los Alamos Meson Physics Facility (LAMPF)

On Friday, June 9, 1972, a low intensity 800 MeV proton beam was achieved at LAMPF. This full energy beam was attained three weeks ahead of schedule. LAMPF is now in the final stages of construction of the base project. The experimental program is expected to begin in early 1973.

Principal experimental facilities will include :

1) Energetic Pion Channel Spectrometer
2) Low Energy Pion Channel
3) High Energy Pion Channel
4) Stopped Muon Channel
5) Nucleon Physics Laboratory
6) High Resolution Proton Spectrometer
7) Beam Stop where protons rich nucleides will be produced as well as neutrinos beams and neutron.
8) Biomedical Facility which has been partly financed by the National Cancer Institute
9) Pulsed Neutron Facility

Funds for construction of Biomedical Facility and the pulsed neutron facility, are requested in the fiscal year 1973 (july 1, 1972 to June 30, 1973). The other facilities listed above are included within the base project and are now well into the construction phase.

OAK RIDGE NATIONAL LABORATORY

Oak Ridge Electron Linear Accelerator (ORELA)

This electron linac serves as a pulsed neutron source obtained by a high current, short-burst, electron beam incident on a high-Z target surrounded by a moderator. ORELA has a special evacuated target room, eleven flight paths with flight stations ranging from 5 to 200 meters. Data acquisition equipment is also available capable of accommodating many experimenters simultaneously, and an analysis system for rapid analysis of the data has been recently completed.

The linac was available to experimenters for 5420 hours this past year. The aluminum clad neutron-producing target was replaced by one with beryllium cladding thus removing a significant source of unwanted structure in the neutron spectrum which degraded the cross-section measurements. The new target was mounted on a new target positioner of improved design. The replacement gun tank was installed and electron guns were successfully prepared at ORNL. The data-analysis system was accepted from the manufacturer and put into initial operation.

Present plans call for start of development on high current electron guns. If funds can be made available, a prebuncher will be added to the accelerator system. The data acquisition capability is being expanded by adding hardware and by software development.

The attached table "Current ORELA Flight Path Use" describes the present experimental program.

ORNL

Current ORELA Flight Path Use

Flight Path Number	Station	Experiment
1	80 m	a) Total neutron cross sections b) Angular Distribution of Elastically Scattered MeV Neutrons
1	200 m	Total Neutron Cross Sections
2	Electron Room	a) Fission Fragment Asymmetries from Aligned Fissile Nuclides b) Cross Sections for Polarized Neutrons on Polarized Nuclei
3	30 m	Fission Cross Sections Near Threshold
4	20 m	a) Auxilliary Experiments Other Flight Paths, No. 5 through 8 b) Secondary Gamma-Ray Production
5	20 m	Neutron Cross Section Measurements Using Scinti-llators in Low-Efficiency Geometry
5	85 m	a) Neutron Cross-Section Measurements Using Small Scintillation Tank b) Fast Neutron Inelastic Scattering Measurements
6	40 m	Fast-Neutron Inelastic Scattering Measurements
6	150 m	Neutron Cross-Section Measurements Using Large Scintillation Tank
7	40 m	Neutron Capture Cross Sec-tions for Nonfissile Materials in the keV Range

ORNL

Current ORELA Flight Path Use (con't)

Flight Path Number	Station	Experiment
8	20 m	Precision Neutron Cross Section Measurements
9	30 m	a) Secondary Gamma-Ray Spectra for Shielding Studies
9	50 m	b) Semi-Integral Tests for Cross Sections for Shielding
		c) Neutron Spectrometer Development
11	Electron Room	Gamma-Ray Spectra vs. Energy of Neutron Capture

ORNL

Oak Ridge Isochronous Cyclotron (ORIC)

ORIC is capable of acceleration of heavy ions to an energy $90q^2/A$ MeV, where q is the charge state of the ion in units of the electron charge and A is the mass of the ion in atomic mass units. The cyclotron is operated on a 15 shift per week schedule (one shift = 8 hours) and is presently used for heavy ion acceleration 70% of the available time.

The particle types and energy ranges now available to research groups include 10 - 66 MeV protons, 20 - 46 MeV deuterons, 20 - 91 MeV alphas, 20 - 108 MeV He^3, 31 - 270 MeV Carbon(C^{12}), 5 - 140 oxygen (O^{16} and O^{18}) 4 - 167 MeV neon (Ne^{20}), 10 - 120 MeV nitrogen (N^{14} and N^{15}), 13 - 184 MeV argon (Ar^{40}), 50 - 96 MeV boron (B^{10} and B^{11}), and 12-168 MeV fluorine (F^{19}). For these ions, beam currents in the particle microampere range are routinely available. Smaller beams of O^{17}, Ne^{21}, Ne^{22} and Ar^{36} and isotopes of silicon, sulfur, chlorine, calcium, titanium, chromium, iron, nickel, copper, zinc, krypton, xenon, and tantalum have been accelerated in ORIC. Continued development of ORIC heavy ion beams is in progress.

Research heavy ion related topics at ORIC include:

1) Nuclides far from the line of stability.
2) Isospin multiplets excited in B^{10} + B^{10} reactions.
3) Isotopes of elements with Z = 103 and 104 produced in reactions induced by B^{10}, B^{11}, C^{12} and O^{18} beams.
4) Single nucleon transfer reactions induced by C^{12} as a function of energy.
5) Systematics of energy shifts of K-rays induced by heavy ion bombardment.
6) Coulomb excitation studies on Dy^{162}, Dy^{164}, Hf^{180}, Th^{232}, U^{238}, and Pu^{242} with beams of Ne^{20}, Cl^{35}, and Ar^{40}.
7) Exploratory studies of simulation of neutron damage by means of heavy ion bombardment.

To augment the study of nuclei far from the line of nuclear stability an on-line isotope separator research program is being established at ORIC.

RENSSELAER POLYTECHNIC INSTITUTE

Electron Linear Accelerator

The RPI electron linac continues in routine operation for neutron cross-section measurements. Experimental topics include:

1) KeV Neutron Elastic Scattering Cross-Section in Iron
2) Total Neutron Cross Sections of U^{238} From 0.5 to 30 MeV
3) Total Neutron Cross Sections on Li^6 and He^4 From 0.7 to 30 MeV
4) Neutron Capture Measurements on Fe^{54}, Fe^{58}, Ni^{61} and Ni^{64}
5) KeV Sub-Threshold Fission in Pu^{240}
6) Iron-Filtered Neutron Beams
7) Iron Minimum at 24.3 keV
8) Temperature Dependent Transmission and Self-Indication Measurements Upon Depleted U in the Unresolved Region
9) Measurement of Nubar for U^{233} and U^{235}

The iron-filtered neutron beams are of special interest. Iron filters varying in thickness from 2 to 20 inches were placed in the 25-meter spectrometer of the RPI LINAC; for filters 6 inches and thicker, over ten distinct neutron energy bands were observed below 1 MeV. In particular, the band at 24.3 keV is $\sim$2 keV wide and is separated by more than 45 keV from the next nearest energy band. For the thicker filters the peak counting rate is about 500 times greater than background (as measured in the wings), and this small background can readily be determined, permitting high accuracy cross-section measurements near 24 keV. Measurements using this technique have been made for the total cross section of iron near the resonance-interference minima.

APPENDIX IX

Annex I.

Draft Agenda for the Second IAEA Panel on
Neutron Standard Reference Data

Vienna, 20 - 24 November 1972

I. Opening of the Panel.

II. Reports by participants on neutron standard reference data activities in their countries.

III. Review and detailed discussions of: -

A. Light Element Standards.

1. Li-6(n,α) cross section for fast neutrons.
2. B-10 (n,α) and B-10 (n,α γ) cross sections for fast neutrons.
3. He-3 (n,p) cross section for fast neutrons.

B. Fission and Capture Standards.

1. U-235 fission cross section.
2. $\bar{\nu}$ for Cf-252.
3. Au-197 fast neutron capture cross section.
4. The 2200 m/sec fission and capture cross sections of the fissile nuclides.

IV. Formation of Working Groups to summarize the current status of the topics discussed and to draft recommendations and conclusions of the panel.

V. Discussion of the conclusions and recommendations of the panel and preparation of a draft report to the IAEA.

Outstanding High Priority Data Needs and Discrepancies

J. L. Rowlands

Report from the Chairman of the INDC Subcommittee on Discrepancies in Important Nuclear Data and Evaluations
July 1972

1. Introduction

The subcommittee has not met since the July 1971 Meeting of the INDC.

Comments on the objectives of the subcommittee would be welcome from members of the INDC and, in particular, from members of the subcommittee.

Possible objectives could be:

(a) To review the Priority 1 measurement requests in RENDA and make recommendations to INDC about the need for

(i) Special reviews of existing data or measurement techniques.

(ii) Specialist meetings.

(iii) International co-operation to meet requests.

It might also be appropriate for the subcommittee to recommend that INDC should ask that certain requests be reconsidered by the sponsoring country, or for the subcommittee to take these up directly with the sponsor.

(b) To consider reviews and the recommendations of specialist meetings and bring these to the attention of the INDC. The summaries of the IAEA reviews and specialist meetings are presented to the INDC by the IAEA representatives and and summaries of the evaluations carried out in the member countries are reported by members. The subcommittee could attempt to summarise the highlights of the various reviews.

(c) To monitor reports of measurements and note reported discrepancies. However, these are also brought to the attention of the INDC by member countries.

The present report discusses the Priorty 1 measurement requirements and makes suggestions about ways in which the Request List could be reviewed. Possible subjects for reviews or specialist meetings are then listed.

2. Discussion of the Priority 1 measurement requirements in the World Request List

There are 493 Priority 1 requests in RENDA 72. The Table of Fulfilled Requests contains 4 Priority 1 items. These figures indicate a quite unsatisfactory state of affairs. One of the most important criticisms is that many request show no measurement plans to meet them. This suggests that the originating countries do not take the requests seriously. It is recommended that all Priority 1 requests should state when the originating country plans to meet the request, or what steps it proposes to take. Such a step might be to raise the question of measurement at the INDC, but the originating country should be prepared to contribute towards the cost if the measurement is made in another country. The requests originating from the IAEA are in a separate category. These are background measurements originating from evaluation studies. The INDC should consider how these are to be met.

In Annex 1 the Priority 1 measurement requirements are summarised in a number of different categories. These are as follows:

A. Standards. Most of these requirements are well known.

B. Flux measurement and detectors. A separate review of these is recommended. It is surprising that so many (42) should be considered to be required in Priority 1. The list of reactions for the measurement of reactor radiations described in the NDS report (INDC(NDS)-45L, Appendix J) contains 48 items, 18 of which are considered of particular importance. Some of these are not included as Priority 1 items.

C. The thermal and resonance region ($Z < 90$). In reviewing these requests consideration should be given to those for which reactor spectrum measurements would suffice. (Thermal spectrum and resonance integral)

D. The fast neutron region ($Z \geq 90$). A review of the status of capture data for the principal structural elements would be valuable. Reactor spectrum measurements might suffice for the (n,α) cross-section of Cr, Fe and Ni.

E. The thermal and resonance region ($Z \geq 90$). The thermal values, and the resonance data for ^{235}U, ^{238}U, ^{239}Pu and ^{240}Pu are being given prominent attention. The requirements for Np, Am, Cm, Bk and Cf isotopes and for ^{233}Pa ^{236}U, ^{238}Pu and ^{242}Pu could perhaps be met by reactor measurements of the thermal values and resonance integrals.

F. The fast neutron region (Z ≥ 90). Data for the principal isotopes are being reviewed. Again, the requirements for ^{236}U, ^{238}Pu, ^{242}Pu and the Am and Cm isotopes could perhaps be met by fast reactor spectrum measurements.

The presence of some of these requests in Priority 1 reflects the different standards being applied in different countries. The accuracies and energy ranges requested also differ markedly. For example:

1337	^{241}Am	N,GAMMA	Thermal to 10 MeV	± 10%
1338	^{241}Am	N,GAMMA	100 eV to 100 Kev	± 20%
1339	^{241}Am	N,GAMMA	500 eV to 15 Mev	± 3%

It is possible that the second request could be met by a single measurement, but the third request is in the same high accuracy category as ^{238}U capture. The energy range specified for the first request seems inappropriate for fast reactor applications, as does the upper energy limit in the third request. One could expect some relaxation of the accuracy requirements near the upper energy limits of the first and third requests.

The measurement requests could be reviewed from the following points of view:

(a) Is the measurement requirement sufficiently clearly defined.

(b) Is the requirement already met. (However, the requestor might require further confirmation.)

(c) Might a simpler measurement suffice, such as a reactor spectrum averaged value.

(d) Is the requested accuracy attainable on the required time-scale.

(e) Does the requested accuracy and energy range appear to be consistent with the stated application.

(f) What arrangements have been made to meet the request and is some form of international co-operation appropriate.

To carry out such a review would be a major undertaking, and the work would clearly need to be shared, as has been the policy for the EANDC in its last review of RENDA.

3. <u>Reviews of progress in meeting the measurement requirements for the principal neutron reactions in reactors</u>

In giving special consideration to the principal neutron reactions it must be emphasised that the cross-sections for less significant processes should not be neglected. It is important to provide data for very many reactions within the next few years, as is shown by the large number of Priority 1 requests. The Request List contains requests for almost all the significant reactions, few measurements have been made to the required accuracies. It is necessary to ensure a balance in measurement programmes between the principal reactions, for which a continuing improvement in accuracy might be required for many years to come, and those reactions for which there is at present little or no data and for which data are needed in the next few years.

For the principal reactions an evaluation of data every year or two is required. As well as giving the best recommended data, and assessing the accuracy of the data, recommendations should be made concerning further measurements required to resolve discrepancies or to meet the Request List requirements. Evaluations for the principal reactions are being made at present in several countries, and specialist meetings at which evaluators and measurers meet to discuss the status of the data and make recommendations for further work provide the most satisfactory way of reviewing progress and recognising discrepancies. The specialist meetings which have been held on Pu239 alpha, Nu and Fission Spectra are examples of the success of this approach. It is important to include in these reviews discrepancies between reactor measurements and calculations when these indicate deficiencies in specific items of nuclear data.

Possible headings under which the status of the principal nuclear data requirements could be reviewed are listed below, (together with comments on specialist meetings or reviews of these topics).

1. Standards. (The Second IAEA Panel on Standards will be held in November 1972.)

2. Requirements for reactor flux measurements and detectors. (Should the International Working Group on Reactor Radiation Measurements be invited to comment on these, or do they look to us for advice?)

3. Sodium cross-sections.

4. Cross-sections of structural materials. (In particular, Cr, Fe and Ni.)

   (a) Thermal and resonance region (< 1 Kev).

   (b) Fast.

5. Fission product capture cross-sections

   (a) Thermal and resonance region.

   (b) Fast.

   (An IAEA Consultants Meeting on Fission Product Data is to be held in 1973.)

6. 2200 m/sec cross-sections for U and Pu isotopes. (A new IAEA Review of the 2200 m/sec Fission Constants is to be made this year.)

7. Resonance data

    (a) ^{235}U.

    (b) ^{238}U.

    (c) ^{239}Pu.

    (d) ^{240}Pu.

8. Fast fission cross-sections of ^{235}U, ^{239}Pu and ^{238}U and ^{238}U capture. (The NDS has recently completed an evaluation of ^{239}Pu fission cross-sections and $^{239}Pu/^{235}U$ fission ratios. See the NDS Report.)*

9. Alpha values of ^{239}Pu and ^{235}U (Konshin and Sowerby have recently completely a Review of Fast Pu239 Alpha Data. See the NDS Report and INDC(UK)-16G)*

10. Scattering cross-sections of ^{238}U, ^{235}U and ^{239}Pu.*

11. Values of NU. (The NDS has completed a status review. See the NDS Report.)*

12. Fission spectra. (A Consultants Meeting on Prompt Fission Neutron Spectra was held in August 1971.)

13. Data for Np and transplutonium isotopes.

14. Delayed neutron data. (The NDS has been requested by the IWGFR to review the delayed neutron data for Pu239. A recent review has been produced by Tomlinson, AERE-R 6993, 1972.)

*Evaluations of ^{235}U, ^{238}U and ^{239}Pu cross-sections were discussed at the EANDC-EACRP Evaluation Working Group Meeting held at Harwell in January 1972.

Fast Reactor Physics Division,
A.E.E., Winfrith.

11th July 1972.

Appendix 1

A BRIEF SUMMARY OF THE PRIORITY 1 MEASUREMENT REQUIREMENTS IN THE WORLD REQUEST LIST (RENDA 72)

A STANDARDS

Total cross-section

^{1}H (0.5%) ^{3}He (1%) Pb (2%)
(Request from Japan)

(n,p)

^{3}He (3%)

(n,α)

^{6}Li (< 3%) ^{10}B (1%)

(n,γ)

^{197}Au (5%)

Fission

^{235}U (1%)

Differential elastic

C

NU

^{252}Cf (0.3%)

SPECT FISS (thermal or spontaneous)

^{233}U ^{235}U ^{252}Cf

B FOR FLUX MEASUREMENT AND DETECTORS

(n,γ)

^{45}Sc	^{55}Mn	^{169}Tm	^{197}Au	

(n,p)

^{3}He	^{31}P	^{32}S	^{46}Ti	^{47}Ti
^{48}Ti	^{54}Fe	^{56}Fe	^{59}Co	^{58}Ni
^{64}Zn				

(n,α)

^{6}Li	^{16}O	^{27}Al	^{51}V	^{63}Cu

(n,2n)

^{45}Sc	^{55}Mn	^{59}Co	^{63}Cu	^{65}Cu
^{89}Y	^{169}Tm	^{175}Lu	^{197}Au	^{203}Tl
^{237}Np	^{239}Pu			

(n,f)

^{235}U ^{238}U

Activation

^{175}Lu

Resonance capture

^{19}F (15.3 kev) ^{59}Co (132 eV)

Thermal capture

^{55}Mn ^{197}Au

(n,n^1)

^{93}Nb ^{103}Rh ^{115}In

C THERMAL AND RESONANCE REGION ($Z<90$)

CAPTURE CROSS-SECTIONS OR RESONANCE DATA

Thermal values

^{95}Nb

Thermal region

^{148}Pm	^{152}Sm	^{151}Eu

Resonance integrals

Cr	Fe	Ni	Zr	^{94}Nb
^{95}Nb	^{133}Cs	Gd	^{166}Er	

Thermal and resonance region (including resonance parameters)

^{90}Zr	^{91}Zr	^{92}Zr	^{94}Zr	^{96}Zr
^{99}Tc	^{105}Rh	^{133}Xe	^{143}Pr	^{143}Nd
^{145}Nd	^{147}Nd	^{147}Pm	^{149}Pm	^{150}Sm
^{151}Sm	^{154}Gd	^{155}Gd	^{156}Gd	^{157}Gd
^{158}Gd	^{160}Gd	^{167}Er	^{169}Tm	^{170}Tm
^{174}Hf	^{176}Hf	^{177}Hf	^{178}Hf	^{179}Hf
^{180}Hf				

D FAST NEUTRON DATA ($E \geq$ 1kev) ($Z < 90$)

(n,γ)

^{23}Na	^{27}Al	Ti	V	Cr
^{55}Mn	^{59}Co	Ni	^{58}Ni	^{60}Ni
^{61}Ni	^{93}Nb	Mo	^{147}Pm	^{148}Pm
^{150}Sm	^{181}Ta	^{182}W	^{183}W	^{184}W
^{186}W	(Stainless steel)	(Cross fission products)		

(n,p)

N

(n,α)

^{10}B Cr Fe Ni

keV total or elastic scattering

^{23}Na Fe ^{57}Fe

MeV elastic scattering (including angular distribution data)

^{2}D O Fe Ni

(n,n^{1})

Fe Ba

$(n,2n)$

^{2}D ^{182}W ^{186}W

(n,d)

^{6}Li

Emission cross-section ($E \backsim 10$ Mev)

O Gd W

Non-elastic gammas

^{27}Al Ti Fe Ni W

E THERMAL AND RESONANCE REGION $(Z \geq 90)$

Thermal values

Fission ^{235}U ^{239}Pu ^{241}Pu ^{242}Pu ^{250}Cf

Capture, alpha or absorption

^{235}U ^{239}Pu ^{240}Pu ^{241}Pu ^{242}Pu

^{241}Am ^{242}Am ^{243}Am ^{247}Cm ^{248}Cm

^{249}Bk ^{259}Cf

Nu ^{233}U ^{235}U ^{239}Pu

Eta ^{235}U ^{239}Pu ^{241}Pu

Thermal region

Fission ^{235}U ^{239}Pu

Capture ^{235}U ^{238}U ^{239}Pu

Eta ^{235}U ^{239}Pu

Resonance Region (including total cross-section measurements to obtain resonance parameters. The specified energy ranges in many cases include thermal energies. Resonance integrals may suffice for some)

Capture (or alpha)

^{232}Th ^{233}Pa ^{233}U ^{235}U ^{236}U

^{238}U ^{237}Np ^{239}Pu ^{240}Pu ^{241}Pu

^{242}Pu ^{241}Am ^{242}Am ^{243}Am ^{244}Cm

^{245}Cm ^{246}Cm ^{247}Cm ^{248}Cm ^{249}Bk

^{250}Cf ^{251}Cf

Fission

^{233}U ^{235}U ^{239}Pu ^{241}Pu ^{243}Cm

^{247}Cm ^{250}Cf

ν ^{233}U ^{235}U ^{239}Pu

F FAST NEUTRON DATA ($Z \geqslant 90$)

<u>(n,γ) or alpha</u>

^{232}Th ^{233}U ^{235}U ^{236}U ^{238}U
^{238}Pu ^{239}Pu ^{240}Pu ^{241}Pu ^{242}Pu
^{241}Am ^{242}Am ^{242}Cm ^{244}Cm

<u>Fission</u>

^{233}U ^{235}U ^{236}U ^{238}U ^{238}Pu
^{239}Pu ^{240}Pu ^{241}Pu ^{242}Pu ^{241}Am
^{242}Cm

<u>Total cross-section</u>

^{238}U ^{240}Pu ^{241}Pu

<u>Elastic scattering</u>

^{238}U ^{239}Pu

<u>Inelastic scattering</u>

^{232}Th ^{235}U ^{236}U ^{238}U ^{239}Pu
^{240}Pu

<u>NU</u>

^{235}U ^{236}U ^{238}U ^{239}Pu ^{240}Pu
^{241}Pu ^{242}Pu ^{241}Am ^{242}Cm

<u>FISS SPECT</u>

^{235}U ^{239}Pu ^{241}Pu

<u>$(n,2n)$</u>

^{232}Th ^{235}U ^{238}U ^{239}Pu

<u>$(n,3n)$</u>

^{239}Pu

<u>Inelastic Gammas</u>

^{235}U ^{238}U ^{239}Pu

<u>Delayed neutron fractions</u>

^{235}U ^{238}U ^{239}Pu ^{240}Pu

<u>Spectra of delayed neutrons</u>

^{239}Pu

G MEASUREMENT REQUIREMENTS FOR THE R PROCESS

(Fission cross-sections (± 10%) in the energy range 10 kev to 100 kev)

^{243}Cm ^{245}Cm ^{247}Cm ^{250}Cf ^{253}Es

Annexe II :

Recommendations regarding further measurements of alpha for ^{239}Pu (100 eV to 1 MeV)

M. G. Sowerby, V. A. Konshin

1 - Unless high efficiency fission detectors can be used in the determination of alpha detailed measurements on fission gamma rays and fission fragment angular distributions are required for ^{239}Pu as a function of neutron energy.

2 - Accurate measurements of $\bar{\nu}$ for ^{239}Pu are required between thermal energies and 30 keV.

3 - Additional measurements of ^{239}Pu alpha are required both above and below 30 keV to achieve the accuracy required by the reactor physicists. These, however, should only be performed if the techniques to be used are either new or have been significantly improved.

Annexe III :

Simultaneous evaluation of the fission cross section of ^{235}U, ^{239}Pu, ^{238}U and the capture cross section of ^{238}U (100 eV - 20 MeV) by M. G. Sowerby, B. H. Patrick, D. S. Mather : recommendations for further measurements.

Before recommending in detail the measurements we consider necessary to solve existing discrepancies, there are some general comments we would like to make. The history of scientific measurements shows us that the most recent data are not necessarily correct. Therefore one new measurement is not by itself sufficient to remove a discrepancy unless this identifies the errors in the previous experiments. An integrated world wide programme is obviously desirable for the important quantities and the measurements should be made using as many different techniques as possible. When there is agreement then perhaps the discrepancies have been solved though one must not forget that it is not unknown for experimenters to obtain results close to the value obtained in the better earlier measurements.

The ^{235}U fission cross section is an important standard over the energy range above 100 keV. Improved measurements are required over the whole energy range up to 20 MeV and we would recommend that they should be made using the time-of-flight technique or some equally good neutron energy selection method. In the energy range below 1 MeV in particular there are advantages in using white spectrum neutron sources so that the effects of cross section structure are eliminated. These measurements should help to resolve the discrepancies between fission and capture data in the lower energy region and improve our knowledge of fission cross sections above 1 MeV where there are surprisingly few absolute measurements except in the nergy range around 14 MeV. It would be very nice if a single experiment could span the energy range thermal to 14 MeV as the most accuate measurements have been made at these energies.

The discrepancies in the ^{238}U capture cross section measurements should be reduced mainly by the measurements recommended below 100 keV. However, it is obviously desirable to have further measurements above 100 keV. At the present time virtually all the reliable data in this energy range, except those of Fricke et al which are not particularly accurate, have been made by or relative to an activation measurement. Therefore we recommend that any new measurements of the absolute value of the U-238 capture or its ratio to the U-235 fission cross-section should preferably not use this technique. If other techniques are used then there is the additional advantage that time-of-flight method can be used. In absolute measurements of cross-sections, particularly capture cross-sections, it is recommended that the use of intermediate standards (e.g. Au-197) should be avoided as these only add to the uncertainties.

As plutonium will be the fuel most used in fast reactors, the fission cross-section of Pu-239 is obviously of prime importance. As we have seen there are very few absolute cross-section measurements and we recommend that an experimental programme on Pu-239 fission similar to that recommended for U-235 fission should be performed. Above 1 MeV the ratio of the Pu-239 and U-235 cross-sections is not particularly well-known and measurements are recommended between 1 and 14 MeV.

The measured U-238 fission cross-section appears to be discrepant with integral data though the differential measurements of fission cross-sections all appear to be consistent in the energy range above 2 MeV. An important integral quantity is the average U-238 fission cross-section in a fission spectrum and since the absolute measurements of this are old a further measurement is recommended. Measurements of the absolute U-238 fission cross-section and ratio measurements relative to the U-235 fission cross-section are also desirable. There is a strong case for making the U-238 cross-section the primary fission standard above 2 MeV because the effects of scattered and room return neutrons are small. The comments made about the recommended techniques for the U-235 measurements also apply to U-238.

This list of recommended experiments is very comprehensive and is not placed in any order of priority. However, the principal discrepancies between differential and integral data are associated with the fission and capture cross-sections of U-238. In consequence it would appear that measurements directly commenting on these discrepancies have the highest importance.

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

Summary of Deliberations

The Sub-Committee examined the officially sanctioned and screened requests which the Agency has received from the USA, USSR and the Fed. Rep. of Germany and which have been compiled in document INDC(NDS)-44/G. The Sub-Committee was also informed by Dr. Nishimura that steps are under way in Japan towards drawing up a detailed list of nuclear data requests for safeguards. However, since the requests in this list still have to be screened by an appropriate Working Group it is unlikely that an approved Japanese list could be submitted to the Agency before July 1973.

I - The Sub-Committee considered that the request list presented in INDC(NDS)-44/G now fulfilled the qualitative and quantitative criteria which the INDC had specified at its 1970 meeting. In view of this the Sub-Committee felt that the list in INDC(NDS)-44/G should be approved by the Committee and given a wide distribution to the following four groups: -

1. The requestors themselves, their institutes and the national nuclear data and safeguards authorities in their countries.

2. Other safeguards development groups in Member States and other relevant international organizations.

3. Experimental nuclear physicists and their specific funding agencies, in a position to perform the required measurements.

4. Evaluators (both of neutron and non-neutron data) of experimental nuclear data.

II - The Sub-Committee also considered it desirable that a short introduction to the first official list should be prepared by the Dept. of Safeguards and Inspection. This introduction should outline the role of non-destructive measurements in the accounting function of a safeguards system and should highlight a few selected applications of non-destructive techniques at specific fuel cycle points and outline some of the developmental problems involved.

III - The Sub-Committee finally considered that the request list in its present form should be distributed as soon as possible and a first up-date of the request list should be issued sometime after the sixth INDC meeting by which time the Japanese list would have already been submitted. Furthermore, it was felt that a note should be included in the request list to be issued to the effect that any individuals or groups of individuals planning to undertake or in the process of undertaking any of the measurements or evaluations requested in the list, should communicate this information to the IAEA Nuclear Data Section. This would enable the Agency to monitor the work in progress and the data being acquired to fulfil these requests. The Agency should distribute this information about measurements and evaluations to all groups in the Member States involved in this work.

INDC Recommendations on the Targets and Samples Programme for Nuclear Data Measurements

A. Present programme (1972)

1. The Committee approves the actions taken by the Nuclear Data Section in respect of the list of requests for targets and samples for nuclear data measurements, as summarized in INDC(NDS)-43/G draft.

2. The Committee recommends that in the implementation of the programme the supply of targets and samples to requestors be made taking into account the following criteria:

(i) Available funds
(ii) Available materials
(iii) Priorities in RENDA
(iv) Feasibility of experiment.

3. The Committee suggests that informal contacts be taken for the supply or loan of expensive materials from Member States of the Agency. The initiative to such contacts should be taken by the Nuclear Data Section as well as by individual members of the Committee.

B. Future programmes (1974 and onwards)

4. The Committee recommends that appropriate funding be given to the programme from 1974 and onwards.

5. The Committee recommends that the review of requests received should follow normal practice in the Agency such as in the case of research contracts.

6. The Committee approves the procedure suggested by the Nuclear Data Section as reproduced in the Annex.

7. The Committee urges that IAEA and NEA establish close liaison in order appropriately to coordinate actions on requests from countries which are members of both Agencies.

ANNEX :

(1) Official requests received by IAEA for consideration should be technically complete. The feasibility of the proposed experiments should be clearly demonstrated, the availability of material as well as the costs for fabrication should be specified.

(2) The Nuclear Data Section would be willing to tentatively consider preliminary and unofficial requests and to provide the necessary contacts with experts and suppliers to provide for an official request to be submitted to the Agency.

(3) NDS would keep the INDC members informed of afficial as well as unofficial requests. It is hoped that the INDC members can provide assistance in obtaining the necessary samples material on the basis of the unofficial requests.

(4) IAEA will provide this service to Member States on a continuing basis subject to guidelines agreed upon in advance by INDC and subject to an annual review of previous years' programme by INDC.

APPENDIX XVIII -

Evaluation activities in India (1971/1972)

At present the nuclear data work is concentrated in preparing a 56 group cross-section set for the computer code EPITHERM a lattice calculations code for light and heavy water moderated reactors. The library for this code is being prepared with the help of basic nuclear data received through the courtesy of IAEA and other sources. In particular the point data from the U.K.Nuclear Data File is being used.

The library for U-238 has been prepared for the resonance region. For the preparation of this library, Breit Wigner Formulae were used to obtain point cross-sections employing resonance parameters given in BNL-235 and by Schmidt. With 1/E weighting, fine group cross-sections for about 1600 groups were generated and then used for EPITHERM calculations upto 906.9 eV. Between 906.9 eV and 3519 eV resonances were treated individually while above 3519 eV resonances were treated as unresolved. Averaging over Porter Thomas distribution for neutron width and Wigner distribution for level spacings was carried out for the effective group cross sections in the unresolved range. For the cross-checking of this library, it is proposed to repeat these calculations using the point data for U-238 from U.K. Nuclear Data File DFN 401 A.

For U-235 and Pu-239 energy point data from the U.K. Nuclear Data Files (DFN 66 and 65A respectively) was used. Assuming linear variation between adjacent points and 1/E weighting, fine group cross-sections were obtained and then used in EPITHERM.

For temperature dependent group cross-sections, the program TEMPO was used to Doppler broaden the point data. The procedure indicated above was repeated with the broadened data.

It is also planned to use Th-232 data and Pu-240 (DFN 77A) data from UK file for preparation of the multigroup data.

In the thermal energy region it is proposed to get the group cross-sections using a Maxwellian spectrum at 300°K as the weighting factor and point data from U.K. files.

Apart from this, the US multigroup library GAM and UK multigroup library WIMS were put in proper form for utilization with our computer codes.

Some progress was made in the adaptation of ENDF/B data file obtained from US. In this connection the computer code MC^2 was broken into several overlays. This was done to accommodate it on a 32k machine. The resolved and unresolved resonance part of MC^2 was commissioned and it was tested against the plutonium-239 and uranium-235 data.

BRP bbs/ 13. 7. 1972

APPENDIX XX

Report on the National Neutron Cross Section Center, (USA)

W. W. Havens Jr.

Transmission of experimental neutron data in the computerized exchange format EXFOR has contined at an accelerating pace. During the past year (June 1971 - May 1972) the NNCSC has transmitted to the other three centers 6 tapes containing 113,388 records from 122 experimental works, and has received from the other three centers 3 tapes containing 34,615 records from 132 experimental works. Additional data transmissions and receipts have occurred to meet special demands for data not yet in EXFOR.

Translation of data from the older less detailed SCISRS-I file has been done by computer as far as can be done, into 42 tapes of data in an incomplete EXFOR-type format, involving about 1,371,000 records. These are being given first order corrections such as combining duplicate data sets, correcting data that are markedly discrepant, and checking bibliographic entries. To date, 13 of those tapes, involving 290,000 records, have been thus corrected, leaving 243,000 records; these are all the data for the heavy isotopes (Z > 88). These 13 tapes have now been merged into the CSISRS library for our own use, and they will be sent in EXFOR format as special transmissions to the other three Centers.

A computerized Bookkeeping System for CSISRS is being developed and and put into operation. Among other features, it should keep track of the type of information requested for retrieval from CSISRS by any individual requestor, and it should be able to retrieve the same type of information from material being added to CSISRS in the future. We hope to use this capability to make routine retrievals of new information relevant to the requests made in the U. S. Compilation of Requests, last published as NCSAC-33. If successful in this, we may then be able to make computerized transmission of U. S. requests to the International Requests List.

A meeting of the heads of U. S. Low Energy Nuclear Physics Data Centers was held at Brookhaven in September 1971 to compare problems and approaches in handling such data. Represented were the Nuclear Data Project, Table of Isotopes, Energy Levels of Light Nuclei, Chart of the Nuclides, Charged Particle Information Center, Photonuclear Data Center, Gamma Ray Spectrum Catalogue, and the National Neutron Cross Section Center. Common ground was explored for exchange of basic information. It was evident that computerization was used so differently by these Centers that computerized data would probably not be exchanged among them. Cooperation in literature scanning is possible. Joint efforts to improve the data content of published articles, by stricter editorial standards, were considered to be worthwhile.

Brookhaven hosted the Seventh Four-Center Meeting in October 1971.

Two meetings of the Cross Section Evaluation Working Group were held, in December 1971 and May 1972. The main business of this group during the past year was the development and testing of ENDF/B-III, the third version of the reference Evaluated Neutron Data File. This new library covers 124 materials - many more (especially fission products) than its predecessor, ENDF/B-II. It also has photon interaction cross sections for 78 materials and photon production cross sections for 12 materials. More important, calculations made for a number of different fast reactors show that the cross sections chosen for ENDF/B-III agree better with integral experiments than did those of its predecessor.

The ENDF/B-III files for six materials used as cross-section standards were sent to NDS in April for world-wide use: H, ^{3}He, ^{6}Li, ^{10}B, ^{197}Au, and ^{235}U.

Records of the past two years show that the NNCSC receives typically 27 requests per month for machine retrieval of data: 15 for experimental data, 12 for evaluated data. Many other requests are received and handled on the telephone using listings and other material available at this Center. Analysis of the requests for evaluated data indicates that 44% of them come from U. S. Industry, 22% from U. S. National Laboratories, 16% from U. S. Universities, 8% from U. S. Government agencies, and 10% from abroad.

APPENDIX XXI

Activities of the NEA Neutron Data Compilation Centre, Saclay

(Period June 1971 - June 1972)

1. Introduction

The following report on the activities of the Neutron Data Compilation Centre (CCDN) of the NEA covers the period from June 1971 to May 1972. The main objectives duringthis period were :

- improve response to customers' requests for selective retrievals from the numerical and bibliographic data files ;

- continuation of the effort to update and correct the experimental files, with assistance from outside visitors ;

- exchange of experimental data with the other three neutron data centres under the EXFOR agreement ;

- production and publication of new indices to the experimental and to the evaluated data files ;

- maintenance of the CINDA master file and performance of the necessary computer operations on behalf of the three European data centres, preparation of the tape from which CINDA 72 was printed, development of a new programme system and of a link between the experimental and bibliographic files in order to make CINDA an index to the experimental data available from the four centres as well as a bibliographic index ;

- co-operation with IAEA/NDS on the compilation of the first world-wide RENDA list, performance of all the computer operations, hand-over of the RENDA programme system to NDS ;

- the urgent exchange of disk drives and disk packs in order to provide sufficient external storage capacity for the growing files.

2. Staff

The structure of the CCDN staff - 7 physicists, 2 assistants, 2 programmers, 4 computer and key-punch operators, and 3 secretaries - did not change. Several staff members, however, left the centre and in all cases vacancies existed for several months afterwards. For instance, H. Liskien returned to Geel after his two-year appointment expired on 30th September 1971, whereas his successor as head of the centre, F. Fröhner from KFK Karlsruhe, took up duty on 3rd December 1971. Similarly, H. Willers, the senior programmer, left the CCDN on 31st January 1972 on the expiry of this appointment, and was replaced on 1st June 1972 by C. Rickeby. The table attached as Annex 1 shows that about 1.2 man-years were lost in this way. Nevertheless, all deadlines could be kept - e.g. for the CINDA and RENDA work - thanks to the cooperation and hard work of all staff members.

3. Data Base

The four main files forming CCDN's data base are growing at an accelerated rate. Their approximate dimensions in June 1972 are as follows :

- Experimental data (NEUDADA) : 1,700,000 data points.
- Evaluated data (ENDF, UKNDL, KEDAK, etc...) : 500,000 data points.
- Bibliographic file (CINDA) : 87,000 literature references.
- Request file (RENDA) : 1,400 commented requests.

About 320,000 of the 1,700,000 experimental data points were exchanged in EXFOR, about 210,000 (about 65 %) of them contributed by CCDN (see Annex 2).

3.1. Experimental data

Work on the backlog of data from the CCDN service area is continuing. Two visiting consultants assisted in this effort, P. Winiwarter from Austria and S.-I. Igarasi from Japan, both of them for two months. After completion of the correction and updating work on experimental data from

Austria, Denmark, Finland, Greece, Norway, Spain,
Sweden, Switzerland and Turkey

in the summer of 1971, the files were checked, corrected and brought up to date with respect to

Japan, Belgium, the Netherlands and Euratom

during the following 12 months. Approximately 160,000 new data points from the CCDN service area were entered into the file during that time together with the non-numerical information required for the EXFOR exchange.

A new index to the experimental data was produced and published as CCDN Newsletter N° 13. The preparation of this index was a basic step in the effort to make CINDA a data index.

The number of data successfully exchanged until June 1972 is shown in Annex 2. The Russian contribution is still small, apparently due to difficulties with computer hardware and software. Otherwise, EXFOR seems to function well, although the production of EXFOR tapes is still lagging behind the data production in most areas. At the CCDN material for about 16 EXFOR tapes accumulated since October 1971. The actual preparation of the tapes was delayed owing to other commitments (RENDA, CINDA), manpower problems, and especially lack of disk space prior to the installation of the new disk drives in April 1972.

3.2. Evaluated Data

During the past year the following evaluated data were received :

- new versions of the UKNDL (United Kingdom Neutron Data Library) updated with respect to Fe, Pm-147, Kr-85 and D in D_2O (June 1971), and to Ti-46(n,p), Ni-58(n,p), U-235, U-238, Pu-239 (February 1972) ;

- revised (n,γ), (n,n') and (n,2n) data for fission products in UKNDL format from Benzi (April 1971 and May 1972) ;

- Pu-239, Pu-240 and Pu-241 data in UKNDL format from Ribon (December 1971) ;

- a new version of the Australian fission product library from Cook (January 1972) ;

- version III of the American ENDF (Evaluated Neutron Data File) library (April 1972). This version contains 50 % more evaluations than version II due to the inclusion of files for individual fission product nuclides (with data on ν(E), delayed neutrons, yields), of fission neutron spectra for varying bombarding energies, and of photon production and interaction data.

No new version of the KEDAK (Kern-Daten, Karlsruhe) library has been received since June 1970.

A number of programmes for the manipulation of the main evaluated data libraries - most of them obtained from other laboratories - were implemented in order to improve CCDN's customer service, in particular the response to requests for specific retrievals from the evaluated data files.

3.3. CINDA File

Listings of all entries from given laboratories were sent out to CINDA readers and to some other physicists for correction. The new information obtained in this way was supplemented by information which became available in the course of corrections to the numerical files made by liaison officers and by CCDN staff members. Work was started on a new computer-aided comparison of CINDA with the index to the numerical data.

The basic update and file maintenance programmes for the new CINDA direct-access disc storage system have been completed and tested : the retrieval programmes, however, remain to be written. At present the old programmes are still being used for the production of the CINDA book and for retrievals requested by customers.

3.4. RENDA File

In accordance with the agreements between the EANDC, the INDC, IAEA and NEA, future editions of the RENDA list will be world-wide, reviewed by the INDC and published by IAEA/NDS. The 1972 issue of the request list, however, is being produced in the following way : CCDN compiled new requests and topical reviewers' comments from the EANDC area as well as the requests from the rest of the world sent by IAEA/NDS. These contributions were then merged at CCDN into the existing RENDA file.

A copy of the programme system developed at CCDN for the maintenance of the request file and the production of the RENDA list was handed over to NDS in February 1972.

4. Dissemination of information

The services provided by the CCDN fall into two categories :

- publication of indices to the computer files. e.g. the CINDA book and the index Newsletters ;

- retrievals from the files in answer to specific requests from customers.

4.1. Publications

During the period under review two CCDN Newsletters were published :

- N° 13 (February 1972) containing the new index to the experimental data from the CCDN service area, and

- N° 14 (May 1972) containing the new index to the evaluated data file.

A listing of the recently prepared world-wide RENDA file containing 1,277 requests from the EANDC area and 136 more from the rest of the world was sent to NDS in March 1972, who distributed it to EANDC and INDC members as document INDC(SEC)-25/G Draft.

Tapes for the photo-typesetting of two supplements to CINDA 71 and of CINDA 72 were prepared at CCDN and sent out to the printing office in Frankfurt (Main).

4.2. Retrievals from the files

During the 12-month period beginning 1st April 1971 the CCDN received :

- 143 requests for experimental data ;
- 71 requests for evaluated data ;
- 16 requests for bibliographic references.

Normally the answer could be mailed within three or four days after the request had been received at CCDN. The origin of the requests is shown in the attached table (Annex 1). The total number of requests (230) is only slightly higher than during the previous year (212), but many of the requests necessitated quite sophisticated and extensive retrievals pertaining, for instance, to many isotopes and many types of cross-sections. This is strikingly illustrated by the fact that the 143 requests for experimental data necessitated about 2,200 specific retrievals from the files. The increasing demand for plots, together with the numerical values in the form of listings or tapes, seems to be a consequence of the growing size of the data sets : users need the numerical values for detailed comparisons and computations, but for a quick orientation they find it convenient to have plots in addition to the bulky lists and tables of numbers.

The majority of the requests come from nuclear physicists and evaluators in national research centres. The data types most frequently requested are :

- fission and total cross-sections, α and ν values for fissile nuclides ;
- capture and scattering cross-sections for non-fissile nuclides, inelastic-scattering data being requested almost as frequently as elastic-scattering data.

There is a conspicuous absence of certain groups of potential users : particularly universities and the nuclear industries of some countries seem to be unaware of the service they can obtain free of charge from the four centres.

5. Computer installation

The CCDN continued to rent the IBM 360/30 computer on a one-shift basis (equivalent to 182 hours of CPU* time per month). During the period 1st March 1971 to 29th February 1972 the utilization factor was 98 %. The CCDN's need for computer operations is steadily increasing. This increase would be even more conspicuous if the new disc drives had been available before April 1972 : as mentioned before, the lack of space on the old discs resulted in a postponement of a vast amount of EXFOR work.

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* Central Processing Unit

The new disk drives were installed during the second half of April. The carefully prepared changeover did not create any disturbance to the operations of the Centre.

6. External contacts

The efficiency of the CCDN depends strongly on good relations with the other co-operating centres and with the data producers and data users in the CCDN service area. The following missions served to maintain and to strengthen these relations :

- H. Liskien participated in a Panel on Neutron Nuclear Data Evaluation in Vienna, 30th August-3rd September 1971 and in a meeting on Nuclear Data for Chemistry at Canterbury, 18th-23rd September 1971 ;

- H. Potters and F. Froehner represented the CCDN at the 7th Four-Centre Meeting held at Brookhaven National Laboratory, 25th-29th October 1971

- N. Tubbs discussed CINDA problems at Columbia University, Brookhaven (NNCSC) and at Oak Ridge (DTIE), 29th November-8th December 1971 ;

- S. Valente went to a Working Group meeting on Evaluation of Pu-239, U-235 and U-238 Cross-Sections at Harwell, 26th-28th January 1972 ;

- F. Froehner attended a Working Group meeting on Compilation, Evaluation and Dissemination of Nuclear Structure and Reaction Data in Vienna, 13th-17th March 1972 ;

- L. Lesca discussed technical problems with data compilers and evaluators LRL, ORNL, Columbia University and NNCSC during a visit to the United States, 20th May to 2nd June 1972.

During the period under review the CCDN was visited by Mrs. P. Attree from IAEA/NDS, who familiarized herself with the RENDA programme system and took back a copy of it to Vienna (31st January-4th February 1972). The two visiting consultants, P. Winiwarter from Austria and S.-I. Igarasi from JAERI, Japan, have already been mentioned.

ANNEX 1

Number of man-years spent on various CCDN activities

by	exp. data	eval. data	EX-FOR	CIN-DA	REN-DA	Com-puter	Admi-nistr.	Other tasks	Sum
physicists	1.7	0.9	1.0	1.1	0.2	0.6	0.6	0.8	6.9
consultants	0.3	-	-	0.3	0.3	-	-	-	0.9
all	4.8	1.5	1.5	3.2	1.0	1.3	1.8	2.6	17.7

ANNEX 2

EXFOR TAPES OF ALL CENTRES, DATE 26th MAY 1972

CENTRE	N° TAPES	WORKS	SUBWORKS	BIB REC.	COMM.REC.	DATA REC.	SYST.REC.	TOT.REC.	DATE LAST TAPE
1 NNCSC	7	122	1456	6579	999	92918	15952	116448	15/05/72
2 NDCC	5	113	989	13982	423	142712	10014	167131	08/09/71
3 NDS	3	109	831	6564	222	7799	7940	22525	03/01/72
4 CJD	1	8	59	685	12	1669	725	3091	10/09/71
TOTAL GEN.	16	352	3335	27810	1656	245098	34631	309195 IN	23 MONTHS

ANNEX 3

ORIGIN OF REQUESTS

April 1971 - March 1972

	Type of requested data		
	Experimental	Evaluated	Bibliographic
Austria	3	1	1
Belgium	10	4	-
Denmark	-	-	-
France	46	18	-
Germany	20	13	3
Italy	8	3	1
Japan	4	5	-
Netherlands	-	2	1
Norway	-	1	-
Spain	-	-	-
Sweden	9	6	1
Switzerland	2	2	-
United Kingdom	18	5	4
Other Centres	23	12	5
Total	143	72	16
Grand total			231

APPENDIX XXII -

Activities of the USSR Nuclear Data Center - L. M. Usachev and V. J. Popov

I - INTRODUCTION

In any activity, one must start with the determination of its usefulness : in the field of nuclear data, this consists in the compilation of request lists, analogous to the RENDA list, issued in cooperation by the CCDN and the Nuclear Data Center of the N. D. S.

At Obninsk, we have a somewhat different approach for our RENDA entries. We do not ask our reactor physicists to formulate their requests for concrete microscopic measurements or to share the requested accuracies between the different needed cross sections, because they are not really specialists in this field. We ask them to formulate their requirements, based on technical and economical considerations, for the tolerable uncertainties on the reactor parameters which are, of course, linked to the uncertanties on nuclear data. In addition, we ask them to give us the sensitivity coefficients for the values of reactor parameters as a function of modifications of the nuclear data. These sensitivity coefficients do not include all the needed informations concerning the reactor in view of the determination of the requirements on nuclear data. The problem of the determination of the set of measurements necessary to obtain the reactor parameters with the required accuracies must, from our point of view, be treated mathematically by specialists of the planification theory, working in close connection with specialists of microscopic data measurements and of integral experiments. In order to work out an optimal planing , it is necessary to evaluate the relative costs of the experiments;it is also essential to evaluate correctly the correlations between the uncertainties of the measurements and the estimation of their costs. Moreover, we may know all the informations concerning the present accuracy on the measurements of a given type, first of all for a comparative evaluation of the costs of the experiments and, secondly, for drawing conclusions on the possible necessity for more accurate values by comparing the accuracies which have been reached to the accuracies which are desired.

The accuracies which have been reached can only be given by an evaluation of the nuclear data ; in a similar way, the systematic and unforeseen errors in experimental data generally appear by comparison between results obtained from different techniques.

The evaluation activity is then considered as absolutely necessary for the elaboration of the lists of nuclear data needs. In other words, we consider as impossible to deal with RENDA without having a close connection with the evaluation activities.

An original aspect of the organization of the works in the Centre can be mentioned : the production of data files in the exchange format is divided by subjects and the person in charge of a particular subject is also responsible for the corresponding evaluation and works in cooperation with the specialists of the measurements and specialists of theoretical interpretation in the same field.

II - ORGANIZATION AND COMPOSITION OF THE CENTRE

The Centre employs, at the present time, 31 persons distributed in the following groups.

1 - A group which determines the requirements for the accuracy of the data and the planing of microscopic and integral experiments.

2- A group which is responsible for the creation of computorized libraries and for the evaluation data. The main objectives are : translation of data in the EXFOR format ; preparation of CINDA entries ; collection of experimental and evaluated data for the computorized librairies; preparation of answers to the different nuclear data requests ; tests of computing codes for the calculations and the evaluations of neutron cross-sections;redaction of nuclear data catalogues;elaboration of an automatized system.

3 - A group which deals with the codes necessary to handle the experimental and the evaluated data computorized libraries. The main objectives are : the translation of foreign nuclear data tapes, the elaborations and tests of codes needed in computorized libraries .

4 - A group which has the task to give assistance on mathematical problems : it helps the users of the Computers of the Centre ; it is responsible for the installation of a new dispatcher, of a Fortran monitor and of the supplying of graphic and display codes .

5 - A group which is responsible for the edition problems : edition of the Bulletins of the Centre, of reports and of other documents. He is in charge

of all the information problems and of the Centre Library .

6 - A group which has the charge of the computers operation ;it has also the task of coupling to the computers the tapes (in particular non USSR standard tapes issued in Western countries), disks, display units, . . .

7 - The Head, Deputy-head of the Centre and a consultant in theoretical physics.

III - RECENT ACCOMPLISHMENTS OF THE CENTRE

Recent works, carried out at the Centre, include :

1 - Storage of USSR nuclear data and exchange with IAEA and other Centres. In cooperation with these Centres, the exchange EXFOR format has been elaborated and almost 100 works have been sent to NDS and 30 foreign tapes transfered on our own tapes. For the EXFOR format - in which already about 200 000 experimental data values are included - about 10 codes have been written for checking, translation, research, etc... The KEDAK evaluated data files, containing about 300 000 data points, have been received from NDS, reproduced and distributed to users.

2 - Regular contribution to CINDA : the USSR entries represent about 10% of the total.

3 - In 1972, a new computer, M-222 type, was made available to the Data Centre ; it is equipped with a TA. IM translator and a more efficient and reliable dispatcher. A Fortran monitor is being studied. Works are carried out on a system of automatized evaluations, on different codes for the treatment of data and the theoretical calculations of cross sections, on the connection of a plotter and of a display unit. A part of this programme will be achieved in 1972: it will permit to accelerate the evaluation works and, also, to attract spacialists from other Institutes.

4 - Planification of the experiments and studies on the needed accuracies of nuclear constants : on the basis of the mathematical theory of the experience, the programmes are developped in three directions :

- determination of the accuracies required for microscopic data
- verification of the informations obtained from integral experiments
- adjustments of the nuclear data on both microscopic and integral experiments.

A set of computation codes has been established, in view of the objectives cited above, for the calculation of the sensitivity coefficients, according to the generalized theory of perturbations.

5 - In March 1972, the Centre has edited the volume n° 6 of the Centre Bulletin with different annexes (n°7 is being printed) and the volume n°12 of the " Collection of abstracts on nuclear physics researchs in USSR ". The name of the Centre Bulletin has been changed and will now appear under the title " Nuclear Constants ".

6 - In the 1971-1972 period, the Centre has sent, to 37 users, 494 replies to specific requests, reprints and different manuals, representing more than 59000 pages, generally in the form of photocopies. In these figures, the regular distribution of the Centre Bulletin is not included.

The Center has also completed the evaluation of the fission cross section data of ^{235}U in the fast neutron energy range. A booklet on the evaluation methods has been printed and distributed. Several seminars and meetings (where several Institutes were involved) have been organized on the evaluation methods and on the coordination of works in the evaluation field.

With the purpose to accelerate the creation of the " USSR Evaluated Data Library " the Centre has decided to start with the critical examination of the first files of evaluated data for the elements of primary importance. In this context, the Centre will publish, this year, its works on :" Evaluation of ^{238}U nuclear data " (complete file); " Evaluation of the fission cross section of ^{235}U above 10 keV".

APPENDIX XXIII

Fifth Meeting of the International Nuclear Data Committee
Agenda of Topical Discussion on Inelastic Scattering
of Fast Neutrons

1. A Multi-Angle Time-of-Flight Spectrometer	Y. Yamanouti S. Tanaka
2. On the Validity of the Temperature Law for the Spectrum of Inelastic Scattered Neutrons	J.P. L'Heriteau P. Ribon
3. Inelastic Scattering of Neutrons from U-238	B.H. Armitage J.Rose W. Spence:
4. Remarks on the U-238 Inelastic Scattering Cross-Sections	V. Benzi E. Menapace
5. Inelastic Neutron Scattering Data from Some Recent Measurements	E. Almén B. Holmqvist T. Wiedling
6. Analysis of Fast Neutron Scattering Using the Coupled-Channels Theory	S. Tanaka
7. Study of Energy Levels of ^{120}Sn through the (n, n' γ) Reaction	S. Kikuchi Y. Sugiyama
8. Use of Spectrum Measurements in Fast Media to get Information on Cross Sections	Mrs P. Corcuera M.P. Govaerts J.P.LHeriteau

APPENDIX XXIV

Non neutron nuclear data centres in USA

C. Kolstad

I - PHOTONUCLEAR DATA CENTER, 1972

The Photonuclear Data Center is continuing to maintain current with the published literature its data abstract files and at the same time build up a library of selected cross section data in digitized form. This library now contains data for over 400 cross section curves measured for 87 different materials covering 47 elements. Within its limited resources the Center is furnishing on request both selected annotated indices and bibliographies covering specific types of data or reactions as well as what it considers to be the best available data for specific cross sections for specific nuclei. Data are primarily furnished on data abstract sheets. As the digitized cross section library is developed, information will also be furnished in digital or large scale graphical form.

A listing of new Photonuclear Data Index entries covering the data entered into the Center's files since the publication of NBS Special Publication 322 (Photonuclear Data Index, June 1965-January 1970) will be prepared for distribution to workers in the field at the time of the September 1972 meeting to be held in Sendai, Japan on Nuclear Structure Studies using Electron Scattering and Photoreactions. A complete, updated cumulative index to the published data for the field is scheduled for publication at the time of the Asilomar, California, International Conference on Photonuclear Reactions and Applications (March 1973).

The plans to evaluate the data in the Center's files and publish a comprehensive, annotated compilation of the best available information on the photonuclear interaction have received a big boost with the assignment of a NAS-NRC, Nuclear Information Research Associate to work with the group for a two-year period starting in September 1972. The objective of the proposed "atlas" will be to present, in a uniform format, all of the information relevant to the interaction of photons with nuclei in such a way that it is readily available and useful not only for theoretical and experimental physicists working in the field but also for various applied users of such data in areas of activation analysis, radiation shielding, medical physics, etc.

II - STATUS OF NUCLEAR DATA PROJECT

May 1972

D. J. Horen

References

Scan and keyword all references (including unpublished received at the Data Project) in low-to-medium energy nuclear physics. Maintain computer files of references and keywords.

Publish (journal) references containing nuclear structure information three times per year as "Recent References" in the Nuclear Data Sheets.

Presently working on modifications of the formats so that we will be able to include all references scanned (i.e., papers containing non-structure data such as reaction mechanisms, theory, etc.).

Provide reference lists to the following:

Table of Isotopes (Hollander, LBL); magnetic tapes.
Mass Tables (Wapstra, Holland).
Nuclear Moments (G.H. Fuller, NBS).
NIRA's.
Non-Project mass-chain compilers [A. Artna-Cohen (USA), H. Verheul (Holland), S.C. Pancholi (India), B.S. Dzhelepov (Russia)].

Photonuclear Cross-Section Center (E.G. Fuller, NBS); just commencing.

National Neutron Cross Section Center (BNL); exploring usefulness.

Numerous selected reference lists have been provided on request.

Compilations

Revise about 25 mass-chain compilations per year. (Published in Nuclear Data Sheets.)

In conjunction with NIRA Program, goal is to achieve three-year currency of all mass chains for A > 44 by end of 1975.

"Quickie" Compilations for A = 91-139 published as ORNL reports.

Unpublished decay schemes for eight gaseous fission products (Kr and Xe).

Computerized Data File

Programming for development of a computerized nuclear structure data file is progressing.

Response to Requests for Data

Increasing contacts with applied users of nuclear data. Responded to requests from the following:

Division of Radiological and Environmental Protection (AEC)
Division of Compliance and Regulations (AEC)
U.S. Geological Survey (D.C.)
Molten Salt Reactor Program (ORNL)

III - LIVERMORE COMPILATION

R. J. Howerton

May 12, 1972

The responsibility of my group is to provide the physical data needed by LLL for its programmatic activities. Because of manpower limitations the physical data turn out to be almost exclusively nuclear data and appropriate evaluated integral experiments for testing the data. To this end we maintain an extensive library of the experimental data of neutron induced reactions, corresponding evaluated neutron data, and a library of evaluated integral neutron experiments including critical assemblies and 14 MeV pulsed spheres.

In the area of non-neutron nuclear data we include in our evaluated nuclear data library evaluations for about twenty excitation functions for charged particle induced reactions. These are appropriate to the Controlled Thermonuclear Reaction program of the laboratory. I anticipate that a few dozen more reactions will be evaluated and entered as they are requested.

About a year ago I wrote the coding for a system which can store and retrieve nuclear structure data including isotopic masses, isotopic abundances, level energies, level statistics, lifetimes, modes of decay including transitions and probabilities. I tested the system by entering data from published level schemes for $A < 120$. Manpower limitations forced the setting aside of that program but the code still exists. I suspect that better codes for these data have been w tten, at least for display purposes. I focused on a system which would provide for computerized retrieval by any element of the data. I did not deal with producing ladder diagrams or indeed any other display modes.

IV - STATUS OF THE TABLE OF ISOTOPES

May 11, 1972

We are currently compiling the 7th edition of the Table of Isotopes, which we hope to complete in about 3 years. Half of the mass chains have been compiled.

The production and updating process are being computerized, so that tabular data and level scheme drawings can be produced directly from stored data files. The data files can be easily updated or edited, so that changes can be introduced easily, without the need to redraw level schemes by hand, for example. The programs also provide extensive checking of the input for syntax and, wherever possible, for reasonable values of physical quantities.

The computerization has proceeded to the point where both tabular data and level schemes (in tabular form) are being input. Programming should be substantially complete by early 1973.

1) Title: Energy Levels of Light Nuclei

Address: F. Ajzenberg-Selove, Department of Physics, University of Pennsylvania, Philadelphia, Pa. 19104, USA

T. Lauritsen, California Institute of Technology, Pasadena, Calif. 91109, USA

Staff: C. Busch, Department of Physics, University of Pennsylvania, Philadelphia, Pa. 19104, USA

Subject Matter: Compilation and evaluation of nuclear structure data for light nuclei ($A \leq 20$)

Recent Publications:

"Energy Levels of Light Nuclei, A = 5-10," Nuclear Physics 78 (1966) 1

"Energy Levels of Light Nuclei, A = 11-12," Nuclear Physics A114 (1968) 1

"Energy Levels of Light Nuclei, A = 13-15," Nuclear Physics A152 (1970) 1

"Energy Levels of Light Nuclei, A = 16-17," Nuclear Physics A166 (1971) 1

"Energy Levels of Light Nuclei, A = 18-20," Nuclear Physics (to be published in 1972)

Plans: The revision of A = 5-12 is under way.

Support: Work supported by the National Science Foundation.

2) Title: Nuclear Data Program (NIRA: Nuclear Information Research Associates)

Address: Principal Investigator: Mr. C. K. Reed, Committee on Nuclear Science, National Academy of Sciences, 2101 Constitution Ave., Washington, D.C. 20418

Chairman of the Ad Hoc Panel on Nuclear Data Compilations: Professor Herman Feshbach, Department of Physics, Massachusetts Institute of Technology, Cambridge, Mass. 02139

Executive Secretary of the Ad Hoc Panel: Professor Fay Ajzenberg-Selove, Department of Physics, University of Pennsylvania, Philadelphia, Pa. 19104

Staff: The list of sponsors and of Nuclear Information Research Associates participating in this program is attached. (pages 5 and 6).

Subject Matter: Compilation and evaluation of nuclear structure data for 100 A-chains and several horizontal compilations. The scope of this program is shown on the attached sheets.

Publications:

The mass chains will be published in "Nuclear Data Sheets" (Academic Press, 1972-1975).

Support: National Science Foundation, through the Committee on Nuclear Science of the National Academy of Sciences-National Research Council.

Sponsor	Institution	NIRA	A-Chains
S.S. Ranno	Standford University	Sidney Fiarman	3 and 4
G.N. Temmer	Rutgers University	K.R. Alvar	70-76
L.L. Lee	SUNY - Stony Brook	P.P. Urone	77-83
D. Horen	Oak Ridge National Laboratory	David C. Kocher	92-94
John P. Schiffer	Argonne National Laboratory	L.R. Medsker	95-100
William H. Kelly	Michigan State University	Richard R. Todd	101-106
D.A. Bromley	Yale University	George Holland	149-152
C.W. Reich	Idaho Nuclear Corporation	Larry A. Kroger	153-156
Guy Emery	Indiana University	J.K. Tuli	157-162
H. Enge	M.I.T.	Audrey Buyrn	163-167
E.T. Jarney	Los Alamos Scientific Laboratory	M.M. Minor	174-180
J. Cerny III	Lawrence Radiation Laboratory (Berkeley)	Creve Maples	213-228

K.R. Alvar	Ph.D. in Physics (1971)	Brown University
Audrey Buyrn	Ph.D. in Physics (1966)	M.I.T.
S. Fiarman	Ph.D. in Physics (1967)	Rutgers University
G.E. Holland	Ph.D. in Physics (1970)	Yale University
D.C. Kocher	Ph.D. in Physics (1970)	U. of Wisconsin
Larry A. Kroger	Ph.D. in Physics (1971)	University of Wyoming
C.C. Maples	Ph.D. in Nuclear Chemistry (1971)	Berkeley
L.R. Medsker	Ph.D. in Physics (1971)	Indiana University
M.M. Minor	Ph.D. in Physics (1968)	Florida State University
R.R. Todd	Ph.D. in Physics (1971)	Michigan State University
J.K. Tuli	Ph.D. in Physics (1971)	Indiana University
P.P. Urone	Ph.D. in Physics (1970)	University of Colorado

Sponsor	Institution	NIRA	Compilation/Review
J.J. Kraushaar	Colorado	R.L. Bunting	A = 88-90, A = 136-137
W.L. Talbert, Jr.	Iowa State	G.H. Carlson	A = 116-118*
G. Igo	U.C.L.A.	R.M. Strang	A = 119, 120*
C.P. Browne	Notre Dame	H.R. Hiddleston	A = 130-132*
R.A. Meyer	Lawrence Livermore Laboratory	E.A. Henry	A = 133-135*
R. Segel	Northwestern	L.R. Greenwood	A = 138-139*
J. Rapaport	Ohio U.	J.F. Lemming	A = 142, 143*
M. McEllistrem	Kentucky	T.W. Burrows	A = 144-146*
T.A. Cahill	Davis	J.R. Shepard	A = 147, 148*
J.D. Fox	Florida State	W.J. Courtney	Coulomb Energies, etc.
E.G. Fuller	National Bureau of Standards	H. Van der Molen	Photonuclear Data
W. Haeberli	Wisconsin		Polarization Data

* Preliminary assignment.

March 29, 1972

APPENDIX XXV

INDC recommendations for promoting international cooperation in the applied non neutron nuclear data field .

1 - The INDC considers that promotion of international coordination in the field of applied non-neutron nuclear data is an appropriate concern of the Agency and part of the normal responsibilities of the INDC.

2 - It commends the efforts of the IWGNSRD in attempting to assess the detailed needs in this field and how these may be satisfied, and in contributing to the planning of the " Symposium on Nuclear Data for Applications in Science and Technology".

3 - At present it is not clear whether the compilation and evaluation aspects of an Agency program in non-neutron nuclear data can better be accomplished through a continuing working group or by other means - for example, by promoting direct cooperation between existing groups of compilers and evaluators, in similarity to the existing four-centre system in the neutron data field.

4 - The Committee believes that the above-mentioned Symposium, in March 1973, and action already initiated by the IWGNSRD, will help to clarify the interests and requirements of users of non-neutron nuclear data and make it possible to decide to what extent a continuing program in this field should be pursued.
The INDC recommends that a small meeting between representatives of the ad-hoc Subcommittee of INDC non neutron data and of the IWGNSRD be convened in order to assess the result of the Symposium.

5 - Until this assessment can be made, the prime objective of the IWGNSRD should be to collaborate with the INDC to assure that this Conference is successful.

6 - If, at the next INDC meeting, it is decided that an active non-neutron nuclear data program under the IAEA sponsorship is justified, the Committee believes that it should itself be responsible for the direction of the many aspects of this activity, with an appropriate membership to reflect the broadened technical interest. At that time the relationship between the IWGNSRD and the Committee would be considered.

APPENDIX XXVIII

Proposed Priority Criteria for Nuclear Data Requests in Controlled Thermonuclear Research (CRT)

Priority 1

In general highest (first) priority shall be assigned to those nuclear data upon which some important aspect of CTR is immediately contingent. Specifically Priority 1 shall be assigned to requests for nuclear data which

1.) are required for evaluation of feasibility of a proposed CT reactor concept, or

2.) are required for immediate application of plasma phenomena in a fusion reactor context, or

3.) are related to materials of conceptual importance in CTR, e.g. Li cross sections for tritium breeding, or

4.) are required for an important decision involving allocation of resources or redirection of research effort in CTR programmes, or

5.) are necessary to develop some important aspect of current CTR programmes to a level consistent with progress in other aspects of these programmes.

Priority 2

Priority 2 shall be assigned to nuclear data which

1.) are required for evaluation of materials of high potential utility in current CT reactor designs, or

2.) are expected to contribute to significant progress in CTR or reactor design studies in the near future.

Priority 3

Priority 3 shall be assigned to nuclear data which

1.) are of use in current design studies but are not of crucial importance, or

2.) are not of immediate importance for CTR but which have probability of becoming important as CTR programmes develop, or

Priority 4

Priority 4 shall be assigned to nuclear data which

1.) fill out the body of information needed for fusion reactor technology, or

2.) are of potential interest for CTR but which cannot be assigned more definite priority at present. (This priority will allow the Agency to solicit opinion on specific data and to reflect diversity of response).

APPENDIX XXX

Meeting on nuclear data requirements for shielding calculations as determined from sensitivity studies (Spring 1971)

1) The panel discussion in the Nuclear Data Session of the Paris Shielding Conference should address itself to a discussion of the sensitivity study programmes currently underway or planned at various laboratories. In addition to the fact that the expected results of such studies would help provide the basis for holding an Agency sponsored shielding data requirements meeting, such a panel discussion would in itself be valuable in providing for an important exchange of information among the shielding specialists involved from the different countries.

2) We will consider for possible inclusion in our programme for 1974, a meeting as follows:

a) The topic should be "Nuclear Data Requirements for Shielding Calculations as Determined from Sensitivity Studies";

b) The meeting would have the following main goals:
- Determine shielding data requirements and priorities;
- Recommend a programme for meeting these requirements;
- Recommend in the interest of the shielding community papers and participation for the Third Nuclear Data Conference to be held in the fall of 1974;

c) The meeting would be sponsored by the IAEA, preferably in conjunction with other interested organizations;

d) The meeting would be in the nature of a study group meeting, with restricted participation in order to maximize the output of critically-analyzed information;

e) The meeting would be held in early 1974 so as to allow sufficient time for preparation of contributions to the Third Nuclear Data Conference in late 1974;

f) Approximately, two-thirds of the participants would comprise users involved in the sensitivity studies and one-third would be data measurers and evaluators.

3) Depending on the results of the IAEA Study Group meeting, the Third International Nuclear Data Conference planned for late 1974 would be expected to give adequate emphasis to the question of nuclear data requirements for shielding calculations. This emphasis would be reflected by inclusion of one or two sessions on the topic of shielding data. The presentation of results of the study group meeting would allow interaction of the shielding data requestors with a broad spectrum of measurers and evaluators.