433

International Atomic Energy Agency

INTERNATIONAL NUCLEAR DATA COMMITTEE

Edited, but unapproved

Informal minutes of the First Meeting

held in Vienna 13-17 May 1968

Compiled by

J.J. Schmidt (Kernforschungszentrum Karlsruhe)
(Executive Secretary)

Aided by

A. Lorenz (IAEA)
(Local Secretary)

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

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Summary of the main Conclusions and Recommendations of the Seventh Meeting of the Committee.

1. Nuclear data research

Progress reports and contributions on nuclear data research from numerous laboratories and institutions in more than 20 IAEA member states were submitted. The Committee was in particular informed on the progress in nuclear data research and facilities in South Africa, in OR, South American and Southeast Asian member states and recommended a wider distribution of progress reports, results of INDC discussions etc. to these countries (see appendix 5).

Besides $\alpha(Pu^{239})$ (see topical discussion) the following items were particularly extensively discussed:

subthreshold fission: resonance observations on U^{234}, Np^{237}, Pu^{240} and Pu^{242} explainable by Strutinsky's theory on shell modifications of smooth liquid drop model fission barriers.

half lives of fissionable nuclei: recent redeterminations for U^{233} and Pu^{241} led to considerable deviations from previously known values.

$\bar{\nu}(Cf^{252})$: the systematic deviation between the (higher) liquid scintillator and the (lower) $MnSO_4$ bath values are possibly due to an underestimate of the Mn activation (de Volpi).

$\bar{\nu}(U^{235})$, $\bar{\nu}(Pu^{239})$: structure observed in some direct $\bar{\nu}(E)$ measurements below 1 MeV confirmed by $\bar{\nu}$ values calculated from measured average fission fragment energies. The Committee recommends strongly similar systematic measurements on $\bar{\nu}$ for Pu^{239} in the low MeV range.

resonance capture in U^{238}: discrepancy between the new LA Petrel bomb shot results and the previously accepted values of Γ_γ still not solved.

2. Meetings and Panels

a. 1968 Washington Conference

It was pointed out that this conference showed a good interaction between nuclear data measurers and evaluators, but not so much between measurers and reactor designers and, that it would be desirable to have more reactor physics oriented people participating in future data conferences.

b. Second IAEA Nuclear Data Conference for 1970

The IAEA plans to hold a Second Conference on the Physics and Chemistry of Fission in 1969 and a Second International Conference on Nuclear Data in 1970. The Committee took note of the International Conference on Nuclear Physics sponsored by the IUPAP probably to be held late in summer 1970 in Israel. It recommended to hold the IUPAP and the IAEA Nuclear Data Conference closely together in place

and time, if possible, less than a week apart. The programs of both conferences should be closely coordinated (see also formal Committee recommendation to the DG of the IAEA in appendix 5). The program committee for the Nuclear Data Conference should consist of five members, one representative respectively from the UK, USA, USSR and Western Europe and one representative from the host country the latter to be nominated by the IAEA. Taschek and Hanna drafted general guidelines for the program committee which are given in appendix 1.

c. IAEA Panel on Neutron Data Compilation for 1969

Among the suggested topics for an IAEA Panel in 1969 "nuclear data compilation" found general support and was formally recommended by the Committee to the DG of the IAEA (see appendix 5). The Panel should be held in the beginning of 1969 preferably at Brookhaven. A proposed list of participants is given in appendix 2, a proposed program for the Panel prepared by the NDU appears in appendix 3. The Committee also recommended to hold a four-center-meeting in advance of the Panel in September or October 1968.

3. World request list for nuclear data measurements

Konghin of the NDU introduced the preliminary version of the world request list for nuclear data measurements REWDA (INDC/226) which contains also the 150 requests of a new Russian request list prepared at Obninsk. The Committee unanimously agreed on the usefulness of a worldwide request list for nuclear data measurements. It recommended that a full copy of the present REWDA list INDC/226 be submitted to the Committee members only. The Chairman should discuss the present request list status with the Chairman of the EANDC (Weinzierl). New entries should be sent in as soon as possible, so that a first draft of the final world request list can be prepared and circulated by December this year. After comments received the final draft should be prepared and discussed at the next INDC meeting and the final list be published as soon as possible thereafter.

4. Data compilation and evaluation

The Committee took note of the progress made at the four data centres in the establishment of working data storage and retrieval systems, in the successful cooperative preparation of a new and improved CINDA 68 and in the compilation and exchange of data information.

Concerning the future publication of CINDA the Committee recommended, in view of the world-wide nature of CINDA, that its printing and distribution be taken over by the IAEA as early as practicable (see appendix 5). Good stated that this item could only be entered in the 1970 budget of the IAEA.

The Committee recommended that the centres should also collect thermal scattering law data in their respective service areas.

Concerning the exchange of evaluated nuclear data most of the Committee members principally supported the idea of establishing a NDU "post box" of evaluated nuclear data. The Chairmann suggested to the Committee members that for the beginning only small samples of evaluated nuclear data be submitted to the NDU which will not cause too much additional labour to the NDU.

In the question of an evaluation request list no firm conclusion was reached and the Committee decided to take up this matter later after the establishment of the INDC measurement request list.

After a brief status report of Lemmel from the NDU on the 2200 m/sec fission constants review (INDC/229) Kolstad pointed out the benefit to the NDU of such modest evaluation activities making the NDU more critical in the compilation of data. The Committee concluded that there might be some other evaluation topics, e.g. of the nature of standards, which could be suggested to be covered by the NDU in the future.

5. Standards

Spaepen gave an extensive review of the present status of the technical recommendations of the 1967 IAEA Panel on Standards in Brussels. The Committee supported most of these recommendations, but agreed to reject $Au(n,\gamma)$ and $U^{235}(n,f)$ as standards and to drop the corresponding recommendations. It encourages and recommends the study of alternative standards to $Au(n,\gamma)$ and $U^{235}(n,f)$.

With regard to the general recommendations of the Brussels Standard Panel to the IAEA (see appendix 4) the Committee came to the following conclusions. The exchange of personnel or equipment or the provision of some appropriate common facility to resolve a persistent discrepancy recommended by the Panel should be exercised on a few well-defined cases. These should be examined at the next meeting and proposals on sample exchange put forward. The Committee recommended to envisage a second Panel on Standards for 1971. Concerning the recommendation of a complete survey of neutron cross section standards activities to be conducted by the IAEA the Committee agreed to include a request for separate comments on standard activities in the progress reports and to return to this topic at its next meeting. The Committee will also consider at its next meeting possible topics for evaluation to be performed by the Agency in the field of standards. All other general recommendations were accepted by the Committee without modification. The Standards Panel report will be published within the technical and scientific report series of the IAEA.

6. Topical discussion on $\alpha(Pu^{239})$

The various contributions to the topical discussion on the capture/fission ratio in Pu^{239} in the eV and keV ranges of neutron energy gave a complete, up-to-date picture of the present situation. According to the results of the discussion the present knowledge of $\alpha(Pu^{239})$ can be summarized as follows:

1. Except recent Dubna results above 2 keV, which support the low KAPL data, all other recent measurements and evaluations in the high eV and low keV energy ranges show $\alpha(Pu^{239})$ to be definitely higher than the previously accepted KAPL data.

2. The results of various integral experiments support the higher values.

3. In the prediction of the higher α values discrepancies remain which are still not solved and, which appear to be mainly due to the different experimental methods used.

In view of these discrepancies and of the large amount of experimental and evaluation work on $\sigma(Pu^{239})$ still going on at many places in the world, the same topic will be taken up at the next meeting.

7. Facilities list

In reponse to a recommendation of the FAIDC that the facilities list be continued by the IAEA on a world-wide basis the Committee concluded that the list should be continued to be published by the NDU and that it should comprize already existing facilities active in neutron work. Facilities planned, proposed or under construction should be taken up in the progress reports.

8. Sample exchange

In the discussions so far the role of the Agency in the matter of sample exchange and its procedures for loan and purchase of samples remained unclear. There also arose the question of the role of the Committee in this matter, and it was underlined in particular, that the Committee has no competence in administrative, but in scientific matters such as reviewing, whether a particular measurement and the issue of samples for it are reasonable or not. In conclusion it was recommended to the Agency to put forward some proposals preferably well before the next meeting, so that these could be considered before and at the next meeting.

9. Nuclear data for safeguards

This matter suggested by Kolstad as a possible concern of the Committee was only briefly discussed by the Committee; it will be taken up at the next meeting, when the implications on the nuclear data side may be more clear.

10. Methods of work

Kolstad stated that the draft "Methods of Work" had received quite different views from many of the Committee members. It was the general feeling of the Committee that the "Methods of Work" document should only be a guidance and not a firm set of rules. In order to reconcile the different views in this spirit a Subcommittee consisting of Abramov, Divatia, Hanna, Kolstad and Symonds was set up to draft the final version of the document. With a few additional changes the Committee accepted this final version of the document for guidance of its procedures.

There were present

1. Members

A.I. Abramov, Obninsk, USSR
A.S. Divatia, Trombay, India
G.C. Hanna, AECL, Chalk River, Canada
R. Joly, CEA, Saclay, France
G.H. Kinchin, AEE Winfrith, UK (Chairman)
O. Kofoed-Hansen, c/o CERN, Geneva, Switzerland
G.A. Kolstad, USAEC, Washington, USA
T. Momota, JAERI, Japan
J.J. Schmidt, Karlsruhe, Germany (Executive Secretary)
M. Souza-Santos, Sao Paulo, Brazil
J.L. Symonds, Lucas Heights, Australia

2. Representatives of International Organizations

W. Häußermann, ENEA/OECD, Paris, France
N. Janeva, JINR, Dubna, USSR
J. Spaepen, BCMN, Geel, Belgium

3. Technical Advisers

V. Bell, ENEA/CCDN, Saclay, France
W.W. Havens, Jr., Columbia University, New York, USA
E.R. Rae, AERE, Harwell, UK
R.F. Taschek, LASL, USA

4. Others Participating

I. Slaus, Zagreb, Yugoslavia
T. Niewodniczanski, Swierk, Poland
Z. Sujkowski, Swierk, Poland

5. IAEA Nuclear Data Unit Participants

W.M. Good (Scientific Secretary)
A. Lorenz (Local Secretary)
P.M. Attree, L. Hjärne, V. Konshin, H.D. Lemmel (part-time only)

1. Organization and announcements

1(a). Announcements

On behalf of the Director General of the IAEA Dr. Seligman welcomed the participants and expressed his best wishes for a successful meeting. The Chairman thanked Dr. Seligman for the hospitality of the IAEA. He appointed Schmidt as Executive Secretary. Lorenz reminded interested participants of the visit of the Austrian nuclear research centre Seibersdorf scheduled for Wednesday (May 15) afternoon.

1(b). Comments on R&C/6 and IM/6 documents

The draft documents Report and Conclusions (R&C/6) and Informal Minutes (IM/6) of the sixth INDC meeting 1967 held in Moscow were approved without comments.

1(c). Adoption of agenda

The tentative agenda submitted by the Chairman was approved by the committee with the inclusion of "Nuclear Data for Safeguards" as an additional item requested by Kolstad. The Chairman proposed a certain reordering of discussion of the various items of the agenda to facilitate the conduct of the meeting.

2. Progress reports on nuclear data research and facilities

2(a). Discussion of items of particular interest

The following items were each dealt with in several of the submitted progress reports and found particular attention in the discussion.

Subthreshold fission

Subthreshold fission in the resonance range has been studied on U^{234} (Harwell), Np^{237} (Saclay) and Pu^{240} (Geel). In recent high resolution work at Harwell the same phenomenon was observed in Pu^{242}. Spaepen reported on a periodic structure in the recent Geel fission cross section measurements on U^{235} (revealed by autocorrelation studies with the Egelstaff method) which is supposed to be due to intermediate subthreshold fission components. Similar periodic structures have been observed in the recent fission cross section measurements on Pu^{239} performed at Saclay and Harwell. According to theoretical studies of Strutinski (Nucl. Phys. A95, 420, 1967) all of these phenomena observed in subthreshold fission appear to be explainable by shell modifications of the smooth fission barrier shape predicted by the liquid drop model which cause subthreshold fission to proceed through some sort of intermediate structure at the saddle point.

Half lives of fissionable nuclei

There is some reviving interest in the question of the half lives of heavy fissionable nuclei due to recent redeterminations which led to considerable deviations from earlier known values. Rae reported a new value of the half life of U^{233} obtained at Aldermaston by the specific activity method which is about 4% below the previously known value ($1.553 \cdot 10^5$ y compared to $1.62 \cdot 10^5$ y, EANDC(UK)-63"S"). A new mass spectrometric measurement of the half life of Pu^{241} carried out at Harwell yields a value 6 to 11% higher than previously reported values (EANDC(UK)-104"AL"). Hanna said that he had looked at the 10 years old σ_f measurements of Bigham which involved specific activity comparisons and that in those days the accepted values of the half lives of U^{233}, U^{234} and natural U were all selfconsistent. Now it would appear that the shorter half lives found recently for U^{233} and U^{234} still hang together and that one would expect a redetermination on natural U also to give a shorter half life. Havens stated that the half life of natural U had been studied in much more detail and would be much better than for any of the isotopes constituting natural U. He said that the information on this be in a couple of reports dating back to 1943 to 1945 and that he would try to procure for the publication of this old information if it were still available.

$\bar{\nu}(Cf^{252})$

Taschek and Spaepen mentioned a preliminary document of de Volpi and Porges which tries to resolve the inconsistencies between the various experimental $\bar{\nu}(Cf^{252})$ values. According to these authors the systematic deviation between the (higher) liquid scintillator and the (lower) manganese sulphate bath $\bar{\nu}$ data might be due to a precipitation of Mn from the $MnSO_4$ solution during measurement and thus to an underestimate of the Mn activation in the solution and of the Cf^{252} spontaneous neutron emission rate. Correcting for this effect de Volpi gets an average value of 3.803±0.030 (prompt and delayed neutrons) from the available data. Manna and Kinchin expressed some criticism that de Volpi leaves apart the boron pile measurements of Colvin and Sowerby. In view of the outstanding importance of $\bar{\nu}(Cf^{252})$ as primary standard for most other $\bar{\nu}$ measurements the Chairman proposed that the final document of de Volpi should be distributed to the committee members.

$\bar{\nu}(U^{235})$, $\bar{\nu}(Pu^{239})$

Recent Indian measurements by Nadkarni and Ballal (Van de Graaff Laboratory Progress Report B.A.R.C.-291, compiled by T.P. David, Bhabha Atomic Research Centre, Bombay, India, 1967, p. 30) of the average kinetic energy of fission fragments from neutron induced fission of U^{235} in the neutron energy range from thermal to 2.1 MeV and calculations of $\bar{\nu}$ from these data indicate some structure in the energy dependence of $\bar{\nu}$ possibly due to fission channel effects, which, below 1 MeV, agrees within experimental error with the structure observed earlier by Blyumkina et al. Abramov reported on some recent $\bar{\nu}$ measurements at Obninsk on U^{235} and Th^{232} in the energy range between 0.37 and 3.25 MeV and comparisons of these $\bar{\nu}$ values with those calculated from fission fragment average kinetic energies which also indicate some fine structure in $\bar{\nu}(E)$ for these isotopes. For U^{235} in particular, the slope $d\bar{\nu}/dE$ in the energy range between 1 and 2 MeV is about 0.06/MeV, whereas at higher neutron energies it is steeper and about 0.15/MeV; a possible explanation for this behaviour of $\bar{\nu}(E)$ could be the existence of an energy gap in the U^{236} fission channel spectrum. Thus, particularly for U^{235}, there seem to be some real indications for possible slight modification of the simple linear or quadratic energy dependences of $\bar{\nu}$ by the spectrum of available transition states in fission. Since similar systematic measurements on $\bar{\nu}$ for Pu^{239} are still lacking, the committee expressed the strong desirability of measurements of this quantity in the range from thermal to a few MeV in order to study fission threshold effects. Upon questions of Kinchin and Rae, Symonds replied that so far no measurements of $\bar{\nu}_{49}(E)$ had been performed in Australia, but that those measurements would be considered in the future; Abramov stated that it was unclear whether $\bar{\nu}_{49}(E)$ measurements would be performed in the USSR or not and that he would look into this question. Joly said that the former $\bar{\nu}_p$ measurements on U^{235}, U^{238} and Pu^{239} by Fréhaut et al. (EURATOM Progress Report EANDC(E)-89"U", p. 221) in the energy range between 1.5 and 15 MeV will be extended down to 40 keV also on Pu^{239}.

$\alpha(Pu^{239})$

Abramov, Rae and Taschek reported briefly on the recent USSR, UK and USA measurements on $\alpha_{49}(E)$. More ample explanations of these measurements were deferred to the topical discussion.

Resonance capture in U^{238}

The discrepancy between the new Los Alamos Petrel shot capture results on U^{238} (Γ_γ=19.1 meV) and the earlier accepted data (Γ_γ=23-25 meV) provoked some discussion. Havens said that after more careful considerations the systematic error in the Los Alamos measurements of Γ_γ now comes out to about 15% thus giving better agreement within experimental error with former values. Rae pointed to the fact that the Los Alamos measurements cover a much larger energy range than former measurements and that, in view of the regular periodic variations in Γ_γ as a function of resonance position as observed in the Los Alamos measurements, one should be cautious in the comparison of different Γ_γ values.

2(b). Summary of progress reports

Only the more important items, in addition to those discussed under 2(a), will be reported here. For further items and details we refer to the individual progress reports.

Central Bureau for Nuclear Measurements/Geel

The CBNM work during 1967 is described in detail in the EURATOM progress report EANDC(E)89"U" (INDC/210). On a question of Spaepen Good stated that every member of INDC has received this report.

Spaepen started with the Van de Graaff program for precise measurements of neutron fluxes. Since the EURATOM progress report additional measurements have been done which, in the range 1-15 MeV, show a 1% agreement between associate particle and telescope counting, but systematic differences up to 14% to proportional counting. The reasons for this discrepancy are still not known (see also under agenda item 8(a).

The program of measurement of cross sections for neutron induced threshold reactions (Liskien, Paulsen) is proceeding particularly with work on the $Nb^{93}(n,2n)Nb^{92}$ and $Rh^{103}(n,2n)Rh^{102}$ reactions. Scattering cross section measurements continue for C as scattering standard and for Pu^{239}.

United Kingdom (EANDC(UK)-91"AL" = INDC/203)

The progress report referred to in the heading covers the status of nuclear data work in the UK up to mid-1967. Rae said that such progress reports should in future appear at six months intervals the next report being due shortly. More recent work is contained in a short note distributed by Rae to the INDC members.

At Harwell a measurement of $\sigma_T(C)$ in the range 100 eV to 10 MeV has been completed (EANDC(UK)94"AL"; it has been used as a standard in a measurement of $\sigma_n(B^{10})$ from 1 to 80 keV (EANDC(UK)99"AL"). This latter measurement has confirmed the deviation from a 1/v-shape of the B^{10} reaction cross section in this energy range as predicted by Bergman and Shapiro

(JETP 40, 1270, 1961). σ_T measurements on the standard Li^6 in the energy range 70 eV to 1 MeV have just been completed and were fitted in terms of s and p wave contributions. Measurements of neutron elastic and inelastic scattering cross section of Pu^{239} have been completed to a neutron energy of 1.5 MeV (EANDC(UK)-105"AL").

Australia (INDC/222)

Symonds expressed thanks to the Agency for sending Lorenz of the NDU to Australia and stated that the visit had brought up a number of interesting points for future Australian work. He then reported on experimental neutron work particularly at Lucas Heights.

Detailed studies of the energy dependence of $\bar{\nu}$ for U^{235} for neutron energies between thermal and 1 MeV will be completed shortly; the results so far indicate a linear energy dependence. Similar measurements on U^{233} and Pu^{241} are envisaged still for 1968. A study of KX-ray spectra and charge distributions from thermal fission of U^{233}, U^{235} and Pu^{24} is being undertaken at Lucas Heights in collaboration with staff members of the Indian Bhabha Atomic Research Centre. The study of resonance capture spectra has continued on natural Cu, Ni, Ti, Au and Pb, work on Zn, Co and Mn is in preparation. Symonds stated an increasing cooperation of the Australian AEC with groups at the Universities of Melbourne and Townsville. In association with these groups thermal capture γ-ray studies have been carried out on Fe^{56}, Sc, Ca and K by use of the high flux reactor HIFAR of the AEC. The University of Melbourne has continued its Betatron bright line scattering measurements on W and U^{233}.

Canada (EANDC(Can)34"L")

A summary of the above Canadian progress report was distributed to the INDC members; it covers nuclear data work at Chalk River and the McMaster University.

Hanna mentioned first the pile oscillator measurements of the absorption cross sections of the gross fission products of U^{233}, U^{235} and Pu^{239} as reported in AECL-2506 and AECL-2510; their interpretation is being checked by oscillating new samples of aluminium alloys of In, Au, Sm and Gd. Fission product yields have been measured with mass spectrometric methods for 14 MeV neutron fission of U^{238} and for reactor fast neutron fission of Th^{232}. In answer to a question of Joly, Kinchin stated that these yield measurements are not included in the fission product yield report of Croall (AERE-R5086) which covers only data before 1967.

Thermal scattering law results for zirconium hydride at four hydrogen concentrations and for UO_2 at several temperatures (AECL-2915) are available on magnetic tape in three forms: as double-differential cross sections before and after correction for multiple scattering and as fully corrected $S(\alpha,\beta)$ tabulations. These data will be sent to the NNCSC at Brookhaven, which will in turn provide the CCDN at Saclay with the data.

2200 m/sec capture cross sections have been measured for the production of 5.26y Co^{60g} (37.1±0.3b) relative to $\sigma_{act}(Au)$=98.7 b and for U^{238} (2.715±0.012 b) relative to $\sigma_f(U^{235})$=579.5 b.

Poland (INDC/230)

Neutron physics research in Poland is mainly carried out at the Institute of Nuclear Research at Swierk, at the Institute of Experimental Physics at the University of Warsaw and at the Institute of Nuclear Physics in Cracow.

Niewodniczanski gave first a short presentation of very recent work which could not be included in the progress report referring in particular to measurements of cross sections for neutron inelastic excitation of isomeric states in Y^{89}, Rb^{103} and Au^{197} in the ranges 2-5 and 12.6-18.2 MeV and to measurements of the γ-spectra from the $Au(n,\gamma)$ reaction in the early stages of this work. He then handed over to Sujkowski who reported on recent results of ternary fission studies with thermal neutrons on U^{235} at Swierk. Experiments are in progress to determine the cross sections for H^1, H^2, H^3, He^4, He^6, He^8, Li and Be. Heavier nuclei at present cannot be studied because of C and O contaminants in the targets; he expressed the wish that the Agency will help in providing C and O free targets.

Sujkowski then mentioned ternary fission work on the spontaneously fissioning Cf^{252} done in collaboration with CERN. Mass and energy spectra of the fission fragments are measured in coincidence with the light particles. The angular distribution of neutrons with respect to the fission fragments is measured, the neutron yield as a function of the alpha particle energy is determined.

USSR(INDC/232)

The full progress report is still not available; a brief summary was distributed to the INDC members. Concerning work at Obninsk Abramov reported in particular on fission cross section ratios $\sigma_f(U^{233})/\sigma_f(U^{235})$ and $\sigma_f(Pu^{239})/\sigma_f(U^{235})$ measured between 0.3 and 2.5 MeV with an accuracy of about 3%. The delayed neutron yield measurements by Maksyutenko were extended to energies in the 18-21 MeV range; similar irregularities in $\bar{\nu}_d$ were observed as at energies below 10 MeV, but are not yet ascertained. The systematic work on neutron capture is further pursued; in particular σ_γ was measured for Ge^{74}, Se^{80}, Cs^{133} and Os^{195} in the energy range 0.2 to 3.1 MeV. On the new electron accelerator (microtron) a beam with a total energy of 30 MeV and a pulse current of about 80 mA was obtained.

At the Institute for Theoretical and Experimental Physics in Moscow the yields of long-range particles with Z>2 were measured for thermal neutron induced ternary fission of U^{235}. In a chopper experiment σ_T of Th^{230} was studied for energies between 0.015 and 1.2 eV; the results show the presence of a negative level very close to zero neutron energy.

At the Physics Institute of the Ukrainian SSR at Kiev the resonance parameters of Dy isotopes with mass numbers 156, 158 and 160 were measured for energies between 0.5 and 1000 eV.

At the Khlopin Radievyj Institute in Leningrad the capture and fission resonance integrals of Am^{241}, Am^{242} and Am^{243} were measured in thermal reactor neutron flux. Yields, cross sections and angular distributions of the fission fragments of Ra^{226} were measured for neutron energies between 3 and 15 MeV and for photofission.

At the Joint Institute for Nuclear Research at Dubna, from measurements with polarized neutrons and polarized targets, spin values were obtained for 18 resonances of Ho^{165} between 21 and 150 eV. S and p wave strength functions were derived from σ_γ measurements on Eu, Ho and Lu extending up to 50 keV. α has been remeasured for U^{235} in the range 1.5 eV to 30 keV.

Federal Republic of Germany (INDC/240)

Schmidt reported first briefly on the capture cross section work performed at Karlsruhe. A "best" curve of $\sigma_\gamma(Au)(E)$ obtained from three independent measurements with the largest weight attributed to the grey detector measurements (Pönitz) was used in the renormalization of former σ_γ results for Nb, Mo, Pd, Ag, Cd, In, Cs, Hf, Ta, W and Re in the energy range 10 to 150 keV. The grey detector method was also used to measure σ_γ of U^{238} in the energy range 25 to 500 keV; above 100 keV the results are up to 12% lower than previous evaluations and experiments.

The broad cross section structure observed earlier in the Van de Graaff high resolution resonance work on Fe^{57} appears now to be successfully interpretable by due account of the competition of inelastic scattering to the 14.4 keV level in Fe^{57}.

At the Karlsruhe cyclotron neutron total cross sections of C, O, Na, Al, S, Ca, Fe, Bi and Tl were measured by a time-of-flight method with very high energy resolutions varying from $\leq$0.03% at 500 keV to $\leq$0.6% at 30 MeV. An EANDC publication with a detailed graphical display of the experimental results is in preparation. Some modifications are planned for the cyclotron, namely an increase of the repetition rate to 200 kHz and an increase of the flight path to 180 m.

At the Physik Department of the Technische Hochschule at Munich activation measurements of σ_{2n} at 14.7 MeV on various nuclei with atomic weights between 140 and 209 were performed. In addition, relative excitation functions (n,p), (n,α) and (n,2n) were measured for a series of nuclei in the range 13.5 to 14.7 MeV with the particular result, that the observed excitation curves are smooth energy functions contrary to the fluctuating structure observed by Strohal and Csikai (Phys. Lett. 6, 205, 1963; EANDC-50"S", Vol II, paper 102).

At the Institut für Kernphysik of the University at Frankfurt the (n,p) reaction has been studied on Sr^{88} and Pb^{208} at higher MeV energies. The inelastic excitation cross section for the 3.56 MeV level in Li^6 was measured between threshold and 7 MeV.

At the I. Institut für Experimentalphysik of the University at Hamburg the continuous systematic studies of neutron reaction cross sections in the higher MeV range were pursued with measurements of the excitation functions for some (n,2n) and (n,p) reactions in the neutron energy range 13-19 MeV. The variable energy cyclotron of the standard Philips type is near completion.

India (INDC/241)

Divatia mentioned first the "Progress Report on Nuclear Data Activities in India-IV", (B.A.R.C.-305) published in October 1967. The visit of Lorenz from the NDU in various Indian laboratories and his discussions with members of the Indian Nuclear Data Group were felt very helpful in clarifying the important role of nuclear data activity.

In thermal neutron induced fission studies on U^{235} the total K X-ray yield per fission has been determined with the heavy fragments contributing about 79% of the total; furthermore the energy distributions of long range alphas emitted in ternary fission have been studied at different angles to the fragment directions. In binary and ternary spontaneous fission of Cf^{252} the yield and energy distribution of K X-rays emitted by Cf^{252} fragments were studied. The K X-ray yields in ternary fission are found to be greater than in binary fission by 25±6 and 14±6 (%) for fragments in the light and heavy group respectively. From this result it is inferred that the long range α particles do not originate from either of the fragment groups, but from the fissioning nucleus just before or at the instant of fission. Sujkowski repeated that, contrary to the Indian results, the Polish investigations found a strong indication that the ternary particle emission is connected with the lighter fragment group. This conclusion is drawn from a shift in the light fragment portion of the fission product yield curve to lower masses by 2±1 mass units.

Japan (INDC(J)1 = EANDC(J)8"L")

A summary of the Japanese progress report to EANDC for 1967 (EANDC(J) 8"L" = INDC(J)1) concerning compilation and evaluation work only was made available to the INDC members. Momota referred mainly to evaluation work which is mentioned under 6(a). A computer program (COMFORD) has been written for use in the storage and analysis of resonance data (see Washington Conference, March 68, paper G7).

Brazil (INDC/244)

Souza-Santos stated first that, although there is a fair activity in both experimental and theoretical nuclear physics in several Latin American countries, the Atomic Energy Institute (IEA) at São Paulo in Brazil is the only research establishment engaged in experimental neutron physics. This institute is under the National Nuclear Energy Commission and the University of São Paulo and has a total staff of 350 people, out of which 150 with a university degree. Its nuclear physics division is constituted by 27 people (25 physicists, 2 technicians). The main activities since June 1967 are as follos.

The main experimental apparatus available are a crystal monochromator and a neutron time-of-flight spectrometer working both with neutrons from the thermal research reactor IEAR-1. Total neutron cross sections were measured on some rare earth nuclei and on Au in the energy range 10^{-3}-10 eV with particular emphasis on high precision and absorption, scattering and paramagnetic cross sections deduced from these data; the results were incorporated in CINDU and DASTAR. Also the scattering of slow neutrons on natural lead liquid and powder samples and σ_T of UO_2 for neutron energies between 0.003 and 0.03 eV was studied.

During the last year a very careful mathematical study was performed on the resolution of slow neutron spectrometers for calibration purposes. γ-ray spectra from thermal neutron capture in Al, Ti, Fe and Ni were studied with Ge(Li) detectors and energy levels and transition schemes deduced. Monte Carlo calculations were performed on the γ-ray energy dependence of the response function, the photo-fraction value and the efficiency of NaI(Tl) crystals.

The nuclear metrology group of the IEA participated in the international comparison of the activity of Co^{60} solutions organized by the Bureau International de Poids et Mesures. The results were in excellent agreement with the three best measurements among the 17 participating laboratories. The same group also investigated the use of tracers for the absolute measurement of pure β emitters.

Among the work in progress Souza-Santos mentioned the use of MICA-detectors for neutron flux measurements for reactors and other neutron sources. Up to now a 3% agreement with foil measurements was obtained. Very small layer thicknesses of 10^{-3} to 10^{-8} g/cm^2 U can be used so that no self-shielding or beam attenuation problems arise.

Joly asked whether the electron linear accelerator in Rio de Janeiro be used for neutron cross section work or not. Souza-Santos replied that they are planning to do neutron cross section work. They had an 8 MeV Linac in Rio which is now dismantled and installed at the Physics Department of the University of São Paulo; but this machine is mainly used for solid state physics. There is another 50 MeV home made linear accelerator in Rio which should be in operation in a few months. This will part time be used for neutron cross section measurements. Souza-Santos also mentioned a 12 or 20 MeV Tandem accelerator which will be installed at São Paulo in the institute of Professor Sala and which awaits still final decision. The Physics Department of the University of São Paulo also received a very low intensity 80 MeV linear accelerator, which is an old Stanford machine. This machine will be used mainly for electromagnetic interaction studies.

USA

The US progress report had still not arrived. Part of the reported work is to be found in the reports INDC(US)2 and INDC(US)5 submitted to this meeting. Taschek reported on fast neutron work.

Recently Pönitz/ANL made σ_f shape measurements on U^{235} in the energy range 30 keV to about 1.5 MeV, normalized to Knoll and Pönitz's former 30 keV $\sigma_f(U^{235})$ value (2.19±0.06 b). Preliminary results were reported at the Washington Conference in March 1968 in paper D5. Between 300 keV and 1.5 MeV a nearly constant σ_f value of 1.05 b is obtained, which is about 15% below the presently accepted values. Rae was concerned about the actual energy spread of the source. He suggested that Pönitz's low energy points might be too high, if he had a low energy tail in his spectrum. Taschek said that Pönitz did not normalize at 1 MeV, because then his curve would have been higher at lower energies than all other recent measurements in the range. He agreed with Rae in stating that if Pönitz's data are erroneous this might then be due to errors in the fission, rather than in the flux measurements. Taschek showed himself personally still not convinced of the correctness of the data, and wanted the energy dependence of the calibration, which so far is only based on theoretical calculations, to be checked by measurements; Pönitz is just working on this point.

In response to US and EANDC requests a new underground nuclear test has been performed a month ago and the data analysis begun. The following data have been measured:

Quantity	Energy range	Isotope
σ_γ	40eV - 2 keV	Pa^{233}
σ_γ, σ_f	100keV - 2 MeV	
σ_f	~10eV - 1MeV	U^{232}, U^{233}, U^{234}, U^{235}, U^{236}, U^{237}
σ_f	2keV - 2MeV	Np^{237}
σ_f	"	Pu^{238}, Pu^{242}, Am^{243}

The capture and fission data on Pu^{239} and Pu^{241} measured in the same shot are still not available.

Taschek mentioned the photoneutron work going on at the LRL and NBS. (γ,n), $(\gamma,2n)$ and $(\gamma,3n)$ reactions are studied with monoenergetic sources for energies up to 20 MeV. LRL performs in particular (γ,n) and $(\gamma,2n)$ measurements on polarized Ho in order to investigate the giant resonance situation and anisotropies as a function of energy. LRL will get a new linear accelerator for photoneutron work.

Fission cross section measurements for U^{236}, U^{238} and Np^{237} relative to $\sigma_f(U^{235})$ in the energy range 1 to 5 MeV have been performed at Los Alamos and were reported at the Washington meeting in March 1968 (paper D19).

From the extensive α measurements on U^{233} and Pu^{239} performed with the RPI linac by a joint ORNL/RPI group unfortunately data are only beginning to become available. Taschek deferred some more words on these measurements to the topical discussion.

Also at Rensselaer the energy dependence of $\bar{\nu}$ for U^{235} has been measured at a large number of energies between 0.01 and 40 eV. To an accuracy of 0.25% no variation of $\bar{\nu}$ could be found compared to the thermal value.

Concerning the high delayed neutron yields for U^{238} reported in WASH-1079, p. 106, Taschek pointed out that only one of several sets disagreed with the previously accepted data. In the last Los Alamos internal progress report these measurements were no more mentioned. Measurements on $\bar{\nu}_d$ yields of other nuclides are still going on.

Havens reported on slow neutron spectroscopy in US laboratories.

With the Argonnne fast chopper γ-ray energy spectra are continued to be studied for parity and spin assignments to low lying states particularly for rare earth isotopes in comparison to (d,p) work. Furthermore, systematics of resonance fission cross sections of odd-odd nuclei is being investigated; so far no simple correlation between fission cross section and calculated compound nucleus level density could be found. Bollinger continued his studies of parameters of low lying Th^{232} resonances; he found discrepancies to earlier work particularly in Γ_γ.

From Brookhaven there is a report from Chrien and his group on chopper work at the HFBR reactor; they are measuring (n,γ) cross sections and looking at γ-ray energy distributions. Work has been done on Fe^{56}, Fe^{57}, Mo^{96}, Rh^{103}, Er^{166} and Hf^{179}.

At Duke the total cross section work is continued in high resolution and also some lower resolution measurements.

At Columbia the velocity selector has been run between January 1 and April 15 and a large amount of data been accumulated for many elements. Results will become available in several months.

At Gulf General Atomic the neutron capture in the 2.85 keV resonance of Na has been studied in detail with the linac and $\Gamma_\gamma = 0.35$ eV and $\Gamma_n = 410$ eV obtained for resonance spin values J=1 and ℓ=0. Discrepancies between the observed shape of the capture cross section curve and the value of Γ_γ deduced from these measurements and those obtained at Rensselaer and Harwell were discussed at the Washington meeting in March 1968. Resonance cross sections have been studied for Zr and Gd and Γ_n and Γ_γ were obtained for resonances in U^{236} in the energy range 5 to 270 eV. A new facility using a pulsed Linac neutron source has been designed especially for the measurement of cross sections for production of γ-rays in neutron capture and inelastic scattering. Also they have looked in some detail into the prompt γ-rays from neutron fission of U^{235} and Pu^{239} using the large scintillation tank.

At the NTR/Idaho an absolute measurement of η for Pu^{241} has been made using the $MnSO_4$-bath technique. With the fast chopper they concentrated on measurements of the share of the resonances in the total cross section of Pu^{241}. σ_f of U^{233}, U^{235}, Pu^{239} and Pu^{241} has been measured at 2.0±0.4 keV using the Sc filter technique. Results have been obtained on σ_γ of Am^{243} and $\Gamma_n(0)$ values are given. Also some (n,γ) work is being done and e.g. data are given on the level scheme of Hf^{178}.

At LRL the resonance scattering cross section of U^{233}, U^{235} and Pu^{241} has been studied for energies between 1 and 30 eV; the results have been reported at the Washington Conference in paper D10. A new fast neutron detector with a nearly constant efficiency in the energy range 1 keV to several MeV has been used to study σ_f of U^{232}.

At Rensselaer the resonance capture measurements are continued on many materials in the range 150 eV to a few 100 keV. Capture widths respectively capture areas have been determined for resonances in Na, Al, Fe and Ni and resonance results obtained for W isotopes (see Washington Conference, papers E7 and E15).

At Texas Nuclear Corporation much work has been done and is still under way on γ-ray production cross sections.

Kofoed-Hansen drew the attention of the Committee to the fact observed by some people at CERN that the σ_γ data on C^{12} in various books and compilations violate the optical theorem (Wick's limit). The Chairman recommended to look into the various data in order to see whether there be something wrong with the angular distributions.

Kolstad commented on the facility situation in the US. The Double Emperor Tandem at Brookhaven is ready to 85%. The final completion is envisaged for the end of 1969. A new facility, called "Cyclo-Graaff" is being built at Duke as a joint undertaking of the Duke, North Carolina and North Carolina State Universities. It is a fixed energy cyclotron (20 MeV maximum) which feeds a 15 MeV Tandem Van de Graaff. The construction of this accelerator is well underway and will be completed in the fall of 1969. Concerning the Los Alamos Meson Physics Facility (LAMPF) the construction has started this winter; completion is scheduled for summer 1972. Tests on the experimental proton accelerator have shown that the envisaged design specifications (peak current: 17 mA, average current: 1 mA, pulse length: 500 μsec, repetition rate: 120 pulses/sec) can be reached. Also fast neutron work is planned with this machine. The 120 MeV high current linear accelerator facility at Oak Ridge (ORELA) was about 70% ready at the end of 1967. The completion is scheduled for the end of 1968. This machine is primarily intended for neutron nuclear data measurements. The Omnitron has been authorized this spring. The AARR project at Argonne has been killed.

Some facilities are dying out. The Cosmotron at Brookhaven has been closed. The linear accelerators at UCLA and the University of Minnesota and the synchrocyclotrons at the University of Rochester and the Carnegie Mellon University are being closed.

OR countries (Spain, Greece, Switzerland, Turkey, Austria, Sweden, Denmark)

Kofoed-Hansen pointed out that the progress reports of most of the OR countries have been published. The Swedish report is still to come and is most interesting particularly because of new $\bar{\nu}$ measurements on Pu^{239}. From Danish work Kofoed-Hansen reported a new determination of the free neutron half life of 10.8± .16 m. He also mentioned the evaluation work of Als Nielsen on $\sigma_p(He^3)$ published as CCDN-Newsletter No. 6.

Kofoed-Hansen requested a wider distribution of progress reports, results of INDC discussions etc. to the smaller countries. A subcommittee consisting of Good, Kinchin, Lorenz and Schmidt drafted the following recommendation which was adopted by the committee after slight changes:

"We recommend that copies of the edited unapproved informal minutes of INDC meetings, together with the list of documents received by the NDU, not solely for Committee use, be distributed to designated individuals in each member state of the IAEA.
A brief resumé of the topical discussion will be given in the informal minutes, and we recommend that a more comprehensive account be given an appropriate distribution by the IAEA."

The NDU will prepare a suitable list of liaison people in the different member states for the next INDC meeting. The informal minutes of this meeting shall be sent to an appropriate distribution.

France

The French nuclear data work during 1967 is described in detail in the EURATOM progress report EANDC(E)89"U"(INDC/210). Joly pointed to the following main items.

At Saclay the kinetic energy E_K of fission fragments from neutron induced fission in U^{235} has been studied as a function of the neutron energy in the energy range between 1 and 40 eV. Consistently with the observed constancy of $\bar{\nu}(E)$ (see RPI work reported above) no variation of E_K could be found in the resonances. In the resonance work on Np^{237} it was tried to determine the resonance spins by the multiplicity of γ-ray transitions, a method proposed by Bollinger, but no systematic effects could be found. To U^{235} the Bollinger method could be applied with more success, a subdivision of the resonances in two classes could be obtained in agreement with the results of the asymmetric/symmetric fission yield ratio measurements of Cowan at Los Alamos and the σ_n measurements of Poortmans et al. at Mol. σ_f of Pu^{239} was reinvestigated with a cooled sample for energies up to 35 keV. Complete sets of resonance parameters are now available for energies up to 400 eV. In photonuclear cross section measurements big discrepancies were found to LRL results, the (γ,n) cross sections showing a tail above the dipole giant resonance attributed to direct interaction.

Yugoslavia (INDC/258)

Slaus reported on the Yugoslavian nuclear data program. The following research facilities are available: 200 keV Cockroft-Walton accelerators in Belgrade, Ljubljana and Zagreb; measurements performed in these centres use fast neutrons with incident energies around 2.5 and 15 MeV. Additional research facilities are a 10 kW reactor at Belgrade, a 250 kW reactor at Ljubljana, a cyclotron (16 MeV deuterons) at Zagreb, a 2,5 MeV Van de Graaff at Ljubljana and a 1.5 MeV Cockroft-Walton accelerator at Belgrade.

Among the nuclear data studies Slaus mentioned 14.4 MeV measurements of $\sigma_n(\Theta)$, σ_{2n}, σ_p and σ_d for D, T, and He^3; (neutron, charged particle) reaction measurements e.g. on Be^9 and B^{10} with p, d, t, He^3, He^4, He^6, Li^6, Li^7 as emitted charged particles; (n,t) reactions on light nuclei leading to low lying levels of the residual nuclei; (n,d) and (n,α) reactions on light and medium-weight nuclei; (n,2n) activation measurements on various nuclei with atomic weights up to 200; (n,2n), (n,α), (n,p) and (n,d) activation measurements on tin isotopes.

Work is in progress on capture cross sections of H and D at 2.5 and 14 MeV, on capture cross sections for further materials for fast and thermal neutrons, on activation measurements (n,2p), (n,2α) and (n,C^{12}), on the extension of the charged particle energies from hitherto 2 to 5 MeV down to 0.5 MeV in (neutron, charged particle) reactions, on improvements of the angular resolution in these studies by use of position sensitive detectors and multiparameter analysis and, on correlation studies in (n,n'γ), (n,2n) and (n,m charged particles) reactions.

2(c) Contributions from other member states

Some time before this meeting the head of the NDU had sent requests for progress reports on nuclear data research and on new facilities to the liaison officers of several Non-OECD countries not represented by membership in the INDC and received the following informations on which he reported briefly.

Comision Nacional de Energia Atomica/Buenos Aires

There exists only one group working on nuclear data measurements whose activities were not found worthwhile to be described. It is promised to send data from reactor physics laboratories ready for publication to the NDU.

Atomic Energy Centre Dacca/Pakistan

No progress report is available. Dacca is the only place in East Pakistan for neutron physics investigations. A 3 MeV Van de Graaff is available; measurements with this machine are centred around σ_T, σ_n, $\sigma_{n'\gamma}$ and σ_α measurements. Results will be sent to the NDU.

South Africa Atomic Energy Board/Pelindaba

Only two groups are working in experimental neutron physics, one at the Atomic Energy Board with a 3 MeV pulsed Van de Graaff, one at the Nuclear Institute of the Southern Universities at Faure, Cape Province, with a 5.5 MeV pulsed Van de Graaff. Both groups became productive only in the last 2 to 3 years. Final data are transmitted to the NDU by F.D. Brooks at present at the Cape Town University. The neutron data activity is only a very small part of the full activities of both institutions and is covered in annual progress reports. Soon, however, considerably more data will become available. The following current projects deserve mention.

At the Atomic Energy Board time-of-flight studies have been performed or are under way on σ_T and/or $\sigma_n(\Theta)$ and $\sigma_{n'}$ for Au (published), Fe (prepared for publication), Rb, Cs, Sc, Li, Na, Bi, Sb, Tl and V. Furthermore, capture cross section measurements are carried out with fast neutrons and Moxon-Rae detector on many elements.

At the Southern Universities $\sigma_n(\theta)$ is measured between 75 and 400 keV on Al, S and Bi. $\sigma_n(\theta)$ and/or $\sigma_{n'}$ is studied for fast neutrons with energies up to 2 MeV on La and Pr (completed), I, Zn, Ni, Nb, Th and U.

Comision Ecuatoriana de Energia Atomica

Up to now no investigations are done in the neutron data field, since Ecuador does still not dispose of any neutron source. However, for eventual later neutron work, one is highly interested in obtaining all relevant information.

Korea Atomic Energy Research Institute

Korea has a fairly developing program. The available neutron sources comprize a 100 kW TRIGA Mark II reactor, whose power level will be increased to 250 kW this year, and a home-made fast neutron generator modified to a British type high intensity pulsed neutron generator working with T(d,n) neutrons. A 3 MW research reactor is scheduled for completion in three years.

Among others the following investigations are planned: neutron diffraction studies for structure analysis with a double axis crystal spectrometer, neutron spectrum analysis with a time-of-flight spectrometer, σ_T measurements with double reflection crystal monochromators, studies of neutron capture γ-ray spectra of short lived nuclides with home-made Ge(Li)-detectors.

The Seoul University laboratories have activities in the fields of nuclear and solid state physics. The Bulletin of the Atomic Energy Research Institute/Republic of Korea serves as publication organ.

Thai Research Reactor / Bangkok/Thailand

The office of the Atomic Energy for Peace in Bangkok/Thailand submitted a report entitled "Certain Accounts on the Utilization of the Thai Research Reactor" (THAI. AEC-10) to the IAEA Study Group Meeting on Research Reactor Utilization held in Japan in October 1967. The following informations are quoted from this report. Infinite dilute resonance integrals have been measured by the Cd-ratio method for more than 30 isotopes with atomic weights between 75 and 198. Particular emphasis is placed on neutron flux measurements for fast, epithermal and thermal energies. Further uses of the reactor comprize radiation in air monitoring in the reactor bay area, production of isotopes for use as tracers in ground water hydrology, radiochemistry studies, production of short lived isotopes for medical research and student education.

2(d). Progress report from the NDU (INDC/235)

In his progress report on the activities of the NDU Good underlined first that the IAEA has responded to a significant number of the recommendations and suggestions from the INDSWG and the Interim INDC during the three and two year existence of these two groups respectively. Good presented a "Summary of INDSWG and INTERIM INDC Recommendations to IAEA" and gave an outline of which of these recommendations are already implemented by the IAEA.

First he mentioned the numerical data compilation activities of the NDU, which have led to the full operation of the CINDU bibliographic index and the DASTAR data storage and retrieval systems. It is the intention to extend CINDU to an international index. Next, Good mentioned the review of the 2200 m/sec constants for the main fissionable nuclei (see agenda item 7). He also mentioned the consultants meetings between the centres held to promote intercentre information and data exchange. In order to illustrate activity costs he stated that the 2200 m/sec reevaluation so far cost about 2000 $, the February four consultants meeting 1350 $ and the Brussels Panel on Standards about 5000 $.

3. Meetings and Panels

3(a). 1968 Washington Conference

Havens introduced document INDC(US)1G by D. Goldman from the NBS which gives a brief review of the Second Neutron Cross Sections and Technology Conference, held at Washington in March 1968. This report will be published in "Physics Today". Havens said that the proceedings of the conference should be out by about July 15.

In the following discussion Kolstad pointed out that this conference, contrary to the first conference, showed not as good an interaction between measurers and reactor designers as was expected, but more between measurers and evaluators. Havens expressed the desirability of having more reactor physics oriented people participating in such data meetings; in particular he recommended a strong man in reactor physics to attend the committee for the preparation of the next IAEA nuclear data conference. Joly found the inclusion of the astrophysics and radiation damage aspects in the Washington conference a useful tool also for further meetings. Schmidt recommended to strengthen the feedback from integral experiments to differential experimental and evaluated data at the next IAEA nuclear data conference.

3(b). 2nd IAEA Nuclear Data Conference for 1970

Good gave first a review of conferences to be sponsored by the IAEA in the next few years. The IAEA plans to hold a Second Conference on the Physics and Chemistry of Fission in 1969 and a Second International Conference on Nuclear Data in 1970. Divatia mentioned that INDIA has sent a formal invitation to the IAEA for the fission conference.

There was some discussion on time, place and program of the nuclear data conference. Havens reminded the Committee of the International Conference on Nuclear Physics sponsored by the IUPAP probably to be held late in summer 1970 in Israel; the final decision on the time of this conference will be made at the Dubna conference this year. The representative of the DG present stated that the IAEA would welcome a decision upon place and time of the nuclear data conference in a few months from now. Suggested places and times so far are Helsinki (July/August) and Karlsruhe (October). The results of the following discussion can be summarized as follows. The Committee recommends to hold the IUPAP and the IAEA conference closely together in place and time, if possible, less than a week apart. The programs of both conferences should be closely coordinated. According to a proposal of Kofoed-Hansen the program committee for the nuclear data conference should consist of 5 members, one representative respectively from the UK, USA, USSR and Western Europe and one representative from the host country, the latter to be nominated by the IAEA in coordination with the conference place. Suggestions for the other four program committee members should be sent within the next two to three months to the chairman. He shall prepare a list and send it around to INDC members asking for rapid reply. The program committee should meet twice, once for preparing the program and once for selecting papers.

The following formal recommendation to the DG of the IAEA is given by the Committee (see also appendix 5):

"The Committee notes the plan for an International Conference on Nuclear Data in 1970. The Committee strongly endorses this proposal and suggests that so far as possible the program be coordinated with that of the 1970 IUPAP Nuclear Physics Conference."

Taschek and Hanna were asked to draft general guidelines for the program committee. These are given in appendix 1 to these minutes.

Finally Kolstad pointed out, that because of the IAEA Conference in 1970 the third Washington Conference will probably be held only in 1971.

3(c). IAEA Panel on Neutron Data Compilation for 1969

Among the suggested topics for an IAEA Panel in 1969 ($\alpha(Pu^{239})$, statistics of resonance parameters, radiative capture (suggested by Rae) and nuclear data compilation problems) nuclear data compilation found the strongest and general support of the Committee. The following formal recommendation is given by the Committee to the DG of the IAEA (see also appendix 5):

"The Committee recommends that the proposed 1969 Panel be devoted to the subject of nuclear data compilation and be held as early as possible consistent with full participation. In addition, it would appear very desirable to hold a four-center-meeting in the intervening period and to make available the conclusions of the meeting prior to the meeting of the panel."

A proposed list of participants is given in appendix 2. Final participants should be nominated to the IAEA latest in two months (see also 5b).

3(d). Related activities at the IAEA: the function of the International Working Group of Fast Reactors (IWGFR)

Spinrad, Director of the IAEA Reactor Division, gave a review of the aims and activities of the International Working Group on Fast Reactors and a second Working Group on Radiation Measurements, for whose work also nuclear data are important.

The IWGFR is concerned with all aspects of fast reactors, including the physics, technology and development of complete reactors. At the last meeting of the IWGFR a number of conferences and panels was proposed among which a Conference on Fast Reactor Physics at Winfrith in the UK in spring 1969 and, in close connection with this and because of its importance for the breeding performance of fast reactors, particularly of steam cooled fast reactors, a specialists meeting on Pu^{239}-α.

The main aim of the Working Group on Radiation Measurements is the systematic compilation of manuals on neutron fluence and on neutron doses. It meets every three years, and the last meeting was in 1967.

Abramov asked whether the program for the proposed Conference on Fast Reactor Physics had been chosen. Yaschin (member of the IAEA Reactor Division) replied that details of the program are not yet available at the present time. The specialists meeting on Pu^{239}-α should be held 2-3 days directly before or after the Conference. On the question of Joly, Spinrad promised to make available the minutes of the last IWGFR meeting to the INDC.

4. World request list for nuclear data measurements

Konshin of the NDU first introduced the preliminary version of the world request list for nuclear data measurements REMDA (INDC/226), which in addition to the content of the REMDA request list published in January 1968 by the EANDC (EANDC-61) contains the 151 requests of a new Russian request list prepared at Obninsk, which represents about 15% of the total number of requests. The first group of the Russian requests comprizes 10-20% accuracy requests on σ_γ, σ_n and $\sigma_{n'}$, a second group special 1/2-2% accuracy requests on important nuclear data of the heaviest nuclei. Anything in the REMDA list except for the comment is computer retrievable. Good underlined that the REMDA document presented by Konshin is only a sample and that the reason why it has been held back so far, was that all information from all countries should be included. He furthermore stated that work on REMDA is done under contract with the ENEA. Kofoed-Hansen expressed the desirability of centralizing the REMDA activity in one place.

The Committee unanimously agreed on the usefulness of a worldwide request list for nuclear data measurements. There was some discussion on content and use of such a list. Commenting on INDC/238 (Australian Comments on Data Catalogues) Symonds proposed that the request list in an extended form of REMDA contain information on each request on work going on, firstly to produce answers to a request, and secondly to evaluate data. Kolstad mentioned that the Russian requests are lacking names and comments which are necessary for the exchange between measurers and requestors. He wants a "symmetrical" participation to the list with regard to names and comments. On the question of Abramov how Western people would use such a list Taschek pointed to the ANL progress report as an example which shows that measurements are done on request. Kinchin stated that in the UK the request list is used to direct the experimental effort in the neutron data field. A similar statement was given by Schmidt who referred to German fission product σ_γ and Swedish $\sigma_n(\theta)$ measurements done in the fulfillment of corresponding requests. Kolstad asked for more statements on the usefulness of the request list from the laboratories' point of view. In answer to this question Kofoed-Hansen stated that the list helps universities and laboratories particularly also in the smaller countries to justify claims for support and money for e.g. thesis work; Joly concurred with this statement. Havens said that requests for cross sections of some dozen nuclei and not only for one nucleus would help to justify the build-up of new equipment and the development of new experimental techniques. Sujkovski and Slaus supported Havens' statement and underlined the usefulness of the list particularly for the small countries. Divatia said that the Indian (n,p) and (n,α) reaction program was set up on the basis of the request list. Souza-Santos mentioned the very large shortage of equipment in developing countries and the difficulties in getting good samples. Kolstad described the procedure followed

in the US in order to safeguard the request list against casual or unjustified requests. Requests are first examined by the Advisory Committee on Reactor Physics with regard to actual need and priority and are then forwarded to the "USAEC's Nuclear Cross Sections Advisory Committee (NCSAG)" which advises the USAEC regarding the cross section measurements. He mentioned an anti-request-list-attitude in some basic science laboratories, and a pro-request-list-attitude in some other laboratories. Abramov stressed the point that the present Russian list was only one of the first steps. In order to arrive at this list, reactor physics specialists were asked for their opinion; the contributions thus do not represent all potential users. This first experiment showed the interest of the reactor physicists; the priority assignments were made on the basis of importance for reactors. The list has been sent to different institutes in order to examine the reactions of other laboratories. When positive response is received then the work on the request list will be set up on a more regular and systematic basis.

Kinchin raised the question as to the procedure for the publication of the list. Kolstad felt it premature to publish the list now because of the contributions other countries might have, whereas Abramov felt that the present full version should be published as its stands without waiting for further contributions. With regard to the EANDC Häußermann and Kofoed-Hansen pointed to the fact that the EANDC needs the updated request list to be out as early as October this year. As it appeared improbable to have an updated INDC request list out before that date, the following procedure was finally suggested by the Chairman and supported by the Committee. A full copy of the present RENDA list INDC/226 should be submitted to the Committee members only. The Chairman should discuss the present request list status with the Chairman of the EANDC (Weinzierl). New entries are requested to be sent in as soon as possible, so that a first draft of the final world request list can be prepared and circulated by December this year. After comments received the final draft should be prepared and discussed at the next INDC meeting and the final list be published as soon as possible thereafter.

There was general agreement of the Committee to keep the present form of the request list and, in particular, the duplication of requests. Taschek and Hanna recommended that requests be entered in the list without modifications. Only requestors should have the authority to remove their request from the list, and no automatic deletions should be made.

5. Compilation

5(a) Reports from centres

CCDN/Saclay (INDC/231)

Bell reported on the activities of the CCDN/Saclay. He noted first that the period since the last INDC meeting was one of consolidation and that, with a permanent staff of 17 people, the centre had now reached an adequate level to fulfill its statute tasks. The work of the CCDN in the field of neutron data exchange covers the activities of CINDA references, storage and retrieval of experimental neutron data, distribution of evaluated data files and the development of storage and retrieval systems.

CINDA 68 is now in preparation and will be distributed in about July. In this edition many sets of redundant equivalent entries still incorporated in CINDA 67 will have been eliminated and the EVALUATION entries made more complete. The CCDN is engaged with the NDU and the US CINDA Steering Group to improve the quantity list of CINDA and to establish correlations between the CINDA and SCISRS quantity lists.

The recent arrival of some additional physicists made it possible to compile systematically the data from European laboratories. During the last year 50 000 new European data points and 150 000 BNL data points have been incorporated in the main data library, the latter contains now of the order of 10^6 data points. The data exchange with the NNCSC at Brookhaven has been established on a regular quarterly basis. With the extension of the data exchange agreement between IAEA and ENEA in the second half of 1967 the exchange of freely available published information between CCDN and NDU became possible.

Recently CCDN Newsletter No. 7 was published, which contains a new list of evaluations and a list of the evaluated data files presently stored at the CCDN. The library of evaluations has been extended particularly by ENDF/B category I material released since September 1967, by the fission product capture cross sections evaluated by Benzi and extended to low energies by Australian work, by the complete Karlsruhe KEDAK file and by a completely new version of the UK nuclear data file released in February 1968.

Recently, large efforts have been made to remedy defects of the interim data storage and retrieval system. At present two systems are working at the centre. The one, NEUDADA, is essentially based on the SCISRS input format, but has a different file structure; this consists of a comments file, an index file and the actual data library. The other one is the Livermore RCSIL system which has recently been implemented on the IBM 360/30 of the centre. In the longer term the CCDN is going to participate in the development of SCISRS-II.

NNCSC/Brookhaven (INDC/239)

Kolstad presented the progress report of the National Neutron Cross Section Center (NNCSC) at Brookhaven. The initial responsibilities of the NNCSC are the development and maintenance of the data files SCISRS and ENDF for experimental and evaluated data, respectively, the analysis of neutron cross sections using theoretical and empirical models, and the coordination of the interlaboratory Cross Section Evaluation Working Group.

Concerning compilation the incorporation into SCISRS of all cross section information appearing in and subsequent to BNL-325 should be completed by mid 1968. The development of a new data storage and retrieval system, SCISRS-II is in progress.

A major portion of the first version of the ENDF/B library has been released to the US, Canada and ENEA countries in September 1967. The issuing of a complete edition is planned for July 1, 1968.

Concerning the NNCSC computer requirements a proposal for an "inhouse" computer system has been submitted to the USAEC. In the interim, SCISRS-I will be maintained on the IBM 7094, and ENDF and SCISRS-II development will take place on the CDC 6600.

Concerning cross section analysis within the NNCSC the following topics are presently treated: the fitting of resonance measurements by the Reich-Moore and Adler-Adler formalisms, liquid drop model systematics for the prediction of unknown thermal cross sections and resonance integrals of transactinium nuclei and the fitting of angular distributions of deformed nuclei by coupled-channel optical model calculations.

Nuclear Data Information Centre/Obninsk

Abramov reported on the main directions of work of the Nuclear Data Information Centre at Obninsk. Concerning CINDA all USSR journals and scientific conferences are by now covered, and during the last years 770 entries have been made into CINDA and sent to Vienna. Regarding compilation of experimental data 59 requests were received last year from Vienna, 19 of them and additional 29 previous requests were answered. The data information received from the NDU is used in different institutes. The number of requests from within USSR is, however, still not very large.

The fifth issue of the collection of abstracts on "Nuclear Physics Research in the USSR" has been published. A supplement has been issued to the Bulletin on "Nuclear Constants for Reactor Calculations" of the Nuclear Data Information Centre which contains tables with 21 and 80 group constant systems. The fourth Bulletin of the Nuclear Data Information Centre is being prepared for publication and will be issued soon.

5(b) Report from Nuclear Data Unit (INDC/235)

Good stated first the two main objectives of the Nuclear Data Unit which, in the order of their priority as recommended at the Moscow INDC meeting, are a) the systematic coverage of the Nuclear Data Unit Service area, and b) the development of the centre's functions to promote international data exchange and intercentre coordination.

Lorenz stated that in the pursuance of these objectives the NDU during the last 12 months has made a great step forward. Compared to the two first years of the centre's operation before June 1967, the number of entries submitted to CINDA has doubled, the number of CINDU entries and the number of DASTAR tables prepared have doubled, the number of requests received and acknowledged has tripled, the number of DASTAR data sets sent out on request has quintupled.

For the time being, within the scope of service area coverage, the provision of needed data to the scientists within the NDU area proves to be much more important than to collect the data produced in the area because of the fact that the NDU area is composed primarily of developing countries. In addition to the service aspect, the NDU is instrumental in providing a certain amount of coordination in the overall direction of neutron physics research in developing countries.

Lorenz gave a brief description of his extensive field trip to India, Southeast Asia and Australia. This field trip had two objectives. The first was to establish contacts with the pertinent atomic energy authorities of the visited countries, to discuss nuclear data compilation efforts at the IAEA and to consolidate working relationships between these centres and the NDU. The second objective was to establish personal contacts with the scientists in various laboratories of the visited countries, to acquaint them with the nuclear data program of the IAEA, and to promote an efficient system of data acquisition and distribution in the area serviced by the NDU.

In many instances the existence of the NDU service was not known or its exact function unclear. In Taiwan, Korea and Indonesia nuclear research centres were so-to-speak "revealed" and thus the service potential of the NDU still extended. The participation in two Nuclear Physics Conferences in INDIA and Australia gave a favourable opportunity to establish contacts with individual scientists from many different laboratories. Beyond this first success and positive response the real effect of this field trip will only become apparent in the increased use of the NDU by the visited countries.

Lorenz recommended that, not including shorter trips to East European countries and the Near East, one major trip of this magnitude be made once a year alternating between the two areas "India, Southeast Asia and Australia" and"Central and South America and South Africa".

According to Lorenz continuous and systematic efforts have been made to compile simultaneously CINDA entries and neutron data from publications within the NDU service area. A number of experimental groups have been contacted e.g. in South America, India, South Africa and some of their data have already been entered into DASTAR. Out of the 755 experiments referenced in CINDU-7 the significant fraction of 1/3 is of NDU origin. For bookkeeping of the data request correspondence the NDU keeps a computerized Request Log, which is updated periodically and allows a quantitative measure of the demand and response of the international data exchange.

Lemmel reported on the cooperation between the four data centres and pointed out first that there is no duplication of effort but a fruitful cooperation and distribution of labour among all four centres. In quoting specific points of cooperation he mentioned the new CINDA 68 edition which will be so far the best CINDA issue due to a concerted effort of the four centres since the edition of CINDA 67. The total contributions in CINDA 68 are about 25% from Oak Ridge, 50% from Saclay and the remaining 25% from Vienna and Obninsk. At the NDU during the last months, 2 1/2 physicists have been working on CINDA, and it is believed that the back coverage of old literature is now complete.

Concerning the data, Lemmel expects that for various reasons, e.g. different wishes of the data users, different degrees of computer usage and automated data processing, during the next few years different numerical data systems will be operating in the four centres. According to this expectation the following two main problems would have to be solved: compatibility and transferability of data between the various systems in use and the creation of a joint data index for the data held in the four centres. These topics have been discussed at various meetings of staff members of the centres (see also 5(c)) and by extensive correspondence. The result is that there is now quite good agreement on the items of information to be collected and that the form of information storage is not so important provided that the items collected in the 4 centres are the same.

Lemmel then discussed the important question of what data should be kept in which centre. As far as the NDU is concerned, he feels that the number of data requests the NDU receives from its service area is still not large enough to justify holding a SCISRS master file at the NDU. Fast access, however, to the SCISRS files would be essential and, thus the release of SCISRS file information in summer 1967 by the ENEA and in March 1968 by the USAEC was particularly acknowleged by the NDU.

In the discussion following the different parts of the NDU progress report Kofoed-Hansen pointed out a lack of older references in CINDA referring particularly to large gaps in the coverage of neutron scattering on carbon. Lemmel replied to this that during the last half year much effort in the centres have been devoted to complete the coverage of earlier references. Bell said that the CCDN arranged for systematic back coverage, depending, however, on voluntary readers. Hanna reported that the NNCSC is particularly concerned with the incorporation of old BNL-325 references and data into SCISRS.

Kolstad raised the question of the future publication of CINDA by the IAEA. Good stated that this item could only be entered in the ~~1970 budget~~ 1971. Häußermann reported about the favourable reaction of the Saclay CCDN committee for the publication of CINDA by the IAEA. Good formulated the following recommendation to the DG of the IAEA supported with slight changes by the Committee (see also appendix 5):

> "In view of the world-wide nature of the CINDA bibliographical index the committee recommends that the IAEA consider taking over the responsibility for its printing and distribution at the earliest practicable date".

Then there was still some discussion on SCISRS-II and the proposed Panel on Compilation (see also 3(c)). With regard to SCISRS-II Taschek stated that the November 1967 proposal of the NNCSC has received much criticism from users and the Steering Committee of the BNL centre which finally led to the modified March 1968 proposal of the NNCSC. He underlined the necessity of a fully agreed upon list of physics quantities worked out by different people from nuclear physicists to shielding experts. Regarding the Panel the discussion brought out that the earlist acceptable date would be around the turn of the year. The preferred location for the Panel would be Brookhaven, several days duration is supposed. For the four-centres-meeting in advance of the Panel September or October was proposed.

A proposed program for the Panel was prepared by the NDU during the meeting and is given as appendix 3. Committee members were asked to send in comments on the proposed program a few weeks after this meeting.

5(c) Report on February 1968 "four centre" Consultant's meeting

Good reported briefly on a meeting of a cooperative working group of the CCDN and the NDU in February 1968 at Saclay at which in particular problems connected with the establishment of an international index to the data files held in the centres and of a joint list of quantities combining CINDA and SCISRS quantity codes were discussed. The following conclusions were reached at this meeting:

1. The immediate need was recognized for an international index to the neutron data files. This index should be designed in such a way that at a later date the bibliographic index, CINDA, can be easily correlated with it. The framework for such an index was agreed upon.

2. It was agreed that the collecting of information must be expanded, as soon as possible, to meet the needs for BIB in Brookhaven's proposed SCISRS-II.

3. The centres will continue to work towards an agreeable format (along lines of CINDA and CINDU) with codification by which information can be machine transferred from representation to representation or from center to center (without loss of information and with minimum hand labour).

4. In addition to certain codes (e.g., lab codes, reference codes, etc.) which are already used commonly by all centers, the need was recognized for a joint list of quantity codes for use in all centers. For this purpose, NDU and NDCC submitted a proposal which combines the CINDA quantity codes with those of SCISRS, such that the quantity codes are composed of a main quantity (essentially the CINDA quantity) supplemented by a modifier.

5(d) Compilation of scattering law data

Hanna returned to the question of assembling thermal scattering law data. He referred in particular to a joint Canada/UK experiment whose results, a mixture of raw experimental data corrected for multiple scattering and evaluated $S(\alpha,\beta)$ functions, were offered to the NNCSC and the CCDN. Bell said that scattering law data are not merged in the existing data libraries but are kept on the original tapes. Lemmel sees no difficulty of entering those data into DASTAR. In conclusion, the Chairman stated to see no difficulties in transmitting scattering law data to all data centres via the normal communication channels, and it was recommended that the centres collect also thermal scattering law data in their respective service areas.

6. Evaluation

6(a) Review of activities in member states

Australia

Symonds reported first on single and multilevel studies on fission and capture resonances in U^{235} using information from DASTAR. Difficulties arose due to uncompleteness of DASTAR and fitting troubles. Single and multilevel fits have been carried out on U^{233} resonances and have been published (available at IAEA). Fission product cross sections at low energies are being evaluated on an individual isotope basis complementing the work of Benzi at higher energies. A code is being developed which allows the direct automized conversion of microscopic evaluated cross sections into input data for reactor physics calculations in the energy range 10-3 eV to 10 MeV.

Canada

Hanna reported on the continuing activity of Walker on the evaluation of fission product yields, thermal cross sections and resonance integrals. He furthermore mentioned a recent preliminary evaluation of available low energy data for transplutonium elements. Kinchin took the opportunity to point in particular to the severe shortage of evaluations for transplutonium isotopes.

USSR

Abramov reported on multigroup constants work carried out recently at Obninsk. A new 21 group cross section system for elements ranging from the lightest to the fissionable elements has been prepared and published as a supplement to the third Obninsk Bulletin. The same volume also contains 80 group data for σ_γ, σ_f, σ_a, $\bar{\nu}$, α for fissionable elements and for σ_p and σ_α of medium weight elements. A copy of this supplement has been sent to Vienna, but has not yet been received by the IAEA.

UK

Kinchin reported that evaluated fission product capture cross sections for 71 isotopes from Lucas Height (< 1 keV) and Bologna (> 1 keV) have been incorporated into the UK nuclear data file. The work on B cross section evaluation is still continued, B^{11} is completed, B^{10} in progress.

Federal Republic of Germany

Schmidt reported that in the last year most weight was given to the transfer of the evaluated nuclear data documented in KFK 120/I to the Karlsruhe evaluated nuclear data file KEDAK and to the transfer of KEDAK in an appropriate format to the CCDN. Data evaluations on Pu^{240}, Pu^{241} and Pu^{242} performed by the Technion Institute at Haifa/Israel in contract and cooperation with Karlsruhe are completed; the results are being implemented into KEDAK. Future work will mainly aim at the reevaluation of capture and fission cross sections of the main fissile and fertile nuclei and at a systematic evaluation of cross sections for transactinium isotopes.

Japan

Momota mentioned the evaluation of experimental data on σ_T of carbon used as standard in neutron scattering measurements between thermal energies and 2 MeV; more recent data have still to be included in order to finish this work. Furthermore, cross sections for the $Al^{27}(n,\alpha)$, $Fe^{56}(n,p)$, $Cn^{63}(n,2n)$ and $Cn^{65}(n,2n)$ reactions were reviewed in the energy range from threshold to 20 MeV (see Washington Conference, March 68, paper B10).

USA

Kolstad said he had nothing essential to add to the comments given at the last INDC meeting.

France

Joly stated that the French evaluation effort had been rather sporadic in the last years. Recently, a small evaluation group of two full time physicists with small computer support has been created. On a shorter range this group will work on specific questions posed by the fast reactor physicists, on a longer term it will do some more systematic work, probably in the resonance range, in connection with the KFK and AWRE groups.

6(b) Exchange of evaluated data

Lorenz mentioned that the NDU recently received two ENDF/B requests from Israel and India. Symonds said that he was ready to provide the NDU with Australian evaluated data and expressed his interest in the Karlsruhe KEDAK file. Good raised the question of a "post box" activity for evaluated data. Whereas Kinchin and Symonds were in favour of starting such a "post box" activity, Kolstad felt it to be premature; in particular, he stated that it is of primary importance to get the exchange of microscopic measured data fully operative before considering expanding the exchange to include evaluated nuclear data. He thought that the U.S. should abstain from participating in the exchange of evaluated data at least for the present. Abramov stated that at present it would be most important to finish the work on the exchange of experimental data and that the USSR nuclear data committee had still to agree with the exchange of evaluated data. However, he supported the idea of a NDU post box of evaluated data and felt that it would be helpful to have an exchange of evaluated data on a small voluntary scale. Kinchin said that as far as the UK nuclear data file is concerned one would begin with small samples. Schmidt said that the KEDAK file is open to everyone who wants to have it, and that only in view of the large number of data contained in the file it would be reasonable to begin with sending first some sample of it from CCDN to the NDU. The Chairman summarized by suggesting to members of the INDC to start in a small way and to submit evaluated data samples to the NDU without causing too much additional labour to the NDU. At the next meeting the time spent by the NDU on evaluated data and the extent of the exchanges which have occurred will be reviewed.

6(c) Evaluation request list

Kinchin mentioned that in the UK in addition to the measurement request list a separate list exists for evaluation requests, and raised the question whether the INDC would consider it useful or not to have an evaluation request list. Symonds and Kolstad supported this idea in order to avoid duplication of evaluation effort. Bell mentioned that the Joint EANDC/EACRP Subcommittee on Evaluation at its last meeting in March 68 has decided not to continue the list which it had established before, because more labour was involved than benefit. Schmidt mentioned the second conclusion of this meeting in which it is suggested that the CCDN provide lists of evaluations under way to evaluation groups on some regular basis (3 or 4 times a year). No firm conclusion could be reached by the Committee, and it was decided to take up the matter later after the establishment of the INDC measurement request list.

6(d) Relationship with CODATA

The Committee took note of the First International CODATA Conference on "The Generation, Collection, Evaluation and Dissemination of Numerical Data for Science and Technology" to be held at the Evangelische Akademie Arnoldshain near Frankfurt/Germany between June 30 and July 5, 1968. Good gave a short explanation of CODATA and its activity and Schmidt gave a brief description of Conference topics. The general feeling expressed by Havens was that the nuclear data field is far ahead of the data compilation and evaluation activities in other scientific fields and that the relationship between INDC and CODATA would be minimal. Hjärne of the NDU and Schmidt who are going to participate in the CODATA Conference were asked to report on it at the next meeting.

7. Status report on 2200 m/sec fission constants review (INDC/229)

Lemmel introduced the status report on 2200 m/sec fission constants review which is essentially a compilation of unedited comments by C.K. Westcott who coordinates the work. Because the revision of the previous review presented more difficulties and problems than had been supposed before no complete written report could be made available at the time of the INDC meeting. The main problems can be summarized as follows:

a. The discrepancy in $\bar{\nu}$ measurements still persists. A letter recently received by de Volpi (INDC/229, supplement 1) makes some suggestions for measurements to improve the situation which should be considered by the INDC.

b. Scattering cross sections used to deduce σ_a from σ_T are questionable.

c. Half lives of U^{233} and Pu^{241} have become questionable by recent measurements (see iten 2(a) of the agenda).

d. Additional data being provisional or being expected shortly are still questionable (σ_a and η for Pu^{241}, J.R. Smith; σ_f, Deruytter; $\bar{\nu}$, de Volpi etc.). A revised deadline for additional experimental results has been set to June 4.

e. A major problem has been the use of reactor spectrum measurements of η, α etc. A recently arrived manuscript of B.R. Leonard, Jr. et al. (INDC/229, supplement 2) raises serious questions as to the thermalization analysis of integral α measurements.

f. Error- (or weight-) adjustments in case of several correlated inputs to the least squares process shall very carefully be dealt with.

A complete manuscript will probably be ready some time between August and October this year.

Then Hanna reported briefly on recent calculations of the g factors of the Westcott flux convention at 20°C from microscopic data given in several recent evaluated data files. The effects of different fits are found to be small. With regard to the $\bar{\nu}$ question Hanna pointed out that nobody of the participants in the 2200 m/sec effort be an expert in $\bar{\nu}$. Condé's report on the $\bar{\nu}$ situation at the IAEA Panel on Standards in 1967 had been helpful, but de Volpi's opinions are controversial to those of Condé. It would be very helpful, if Boldeman, de Volpi and Condé could get together to clarify the controversies on $\bar{\nu}$.

Finally, Kolstad pointed out the benefit to the NDU of such modest evaluation activities as the 2200 m/sec review making the centre more critical in the compilation of data. There may be some other areas, e.g. of a standard nature, which could be suggested to te done by the NDU in the future.

8. Standards

8(a) Review of Standards Panel report

Spaepen gave an extensive review of the present status of the technical recommendations of the 1967 IAEA Panel on Standards in Brussels. He referred in particular to work going on in laboratories mainly within the EANDC area, furthermore to replies on a circular letter to all participants of the Panel coming from the NPL/UK, the National Defense Department/Sweden, Cadarache/France, Risø/Danmark and the NBS/USA. All these replies contained new information; the Italian participant promised to investigate what is now being undertaken in Italy, and BIPM gave information already contained in the Panel report. The letter of Good to INDC members asking for comments on the Standards Panel report received an answer only from the US; this was submitted to the session as document INDC/236 (=INDC(US)-8"G") and was commented by Taschek.

Spaepen dealt with the technical recommendations of the Standards Panel (INDC/ 2 , p. 17f) item by item:

1) Neutron flux determination

Rec. 1a: $\sigma_n(H)$

Spaepen pointed out first, although it would be hard to obtain the required accuracies that these accuracies are not as high as would be necessary to achieve requested accuracies of 1/2-1% e.g. in fission cross sections. They would just suffice to give already useful acceptable accuracies in σ_f (2% < 40 keV; 3% > 40 keV).

As to actions taken at Geel, the associated particle method, telescope and proportional counter are being intercompared at various energies. Whereas associate particle and telescope counting agree within 1% between 2 and 14 MeV, they both disagree with proportional counting systematically to 14%. Comparisons between AWRE and CBNM proportional counting at 0° showed agreement. The use of proportional counting becomes more and more difficult at backward angles at lower energies. Work at CBNM will be continued with further comparisons of proportional counting with AWRE with the use of Perlow-counters and with the application of the Bennett-technique (γ-discrimination down to 10 keV).

Present differences between different H(n,n) data are still larger than 1%. In this context Spaepen mentioned the cyclotron $\sigma_n(H)$ measurements of Langsford at Harwell at selected energies between 0.6 and 2 MeV with statistical errors of 0.2% and expected systematic errors of 0.1%.

As the efforts made to improve the counting techniques based on $\sigma_n(H^1)$ obviously proved to be quite unsuccessful and very difficult, Spaepen proposed, in order to achieve the required accuracies, that another experimental technique might be tried. In order to get another basis for measurements, say fission cross sections, it has already been proposed at previous occasions, especially by Taschek, to use liquid scintillators as large as to have a nearly flat efficiency. These could be calibrated at a few spot points e.g. with known neutron sources. Then σ_f could be measured with this device and afterwards be used as working standard. Spaepen wondered whether the Committee could not undertake an action by getting together a small group working on this very important problem. Upon a question of Schmidt, Taschek elaborated a bit further on this detector and said the scintillator to be designed would not necessarily have to be a liquid scintillator, but should be one, which, over an energy range of 1 or 2 MeV, shows no or only a so small energy dependence that the theoretical correction for it would be sufficient. For calibration then standard neutron sources like Sb-Be or Na-Be, which presently are thought to be the most accurate measurements of total neutron yield, could be used to get, say four spot points. The sources could be intercompared in a Mn bath or with

one of the very accurate absolute UK standards which at present are known to better than 1%. So in principle one should be able to get a fairly large portion of σ_f, say between 1 keV and 2 MeV, covering thus a region, where measurements are very difficult, where one does not have associated particle techniques and which is not accessible to recoil telescopes or to the general method of H recoil.

Spaepen added that with such a device one would be safe, because above 2 MeV the hydrogen cross section could be used. Taschek said that after return to Los Alamos they would try to invent some kind of a simplified scintillator design and to perform Monte Carlo calculations of its efficiency in order to see whether this scintillator has really a flat response or not.

Rae mentioned that, in the context of black detectors, at Harwell they have made calculations on spherical geometry boron plug detectors. A boron-vaseline mixture is assumed which gives a response still fast enough to be used with linac time-of-flight measurements. Hart at Risley had done a series of calculations that shows that with a kg of B^{10} and a sphere of 15 cm radius one absorbs about 95% of the neutrons certainly up to 1 MeV. As another alternative this detector looked quite promising even if it is not 100% efficient; it should have a nearly constant efficiency from effectively 0 to 1 MeV and be fast enough to be used with slow time-of-flight systems.

Joly mentioned a directional BF_3 in polythene long counter used by Leroy at Cadarache. The efficiency calculations are easy and have shown a flatness of the counter of 5% in the energy range 1 keV to 1 MeV.

Rec. 1b: σ_n (180°)/($\sigma_n/4\pi$)(H)

No action is known. The Hopkins report (INDC/US)-6"U") shows that above 5 MeV the isotropy of the scattering is not as well fulfilled as one had thought before (see also below under $H^1(n,n)$ rec. b).

Rec. 1c: Branching ratio of Be^7

The branching ratio is being measured at CBNM and might be measured at NPL. Smith from Argonne has data on hand which are thought to be good to 1%.

Rec. 1d: Spectra of radioactive photoneutron sources

There has been work on levels in Sb which indicates a low lying level at 37 keV instead of a level thought to exist at 18 keV. Monte Carlo predictions of Sb-Be spectra are dependent on the 18 keV level but not on the 37 keV level.

Rec. 1e: $\sigma(Mn)/\sigma(H)$ at thermal

No action is taken. In a draft paper de Volpi and Porges point out an instability of $MnSO_4$ which by the Szilard-Chalmers effect undergoes a transition to MnO_2. New measurements with stabilised baths give higher results and coincide with measurements by the foil method. In the range 5 keV to 1 MeV NPL intends to use both an $MnSO_4$ bath and a boron pile for collimated neutron beams; an accuracy of 0.5% is envisaged.

Rec. 1f: Development of new tritium targets

Spaepen mentioned inconsistencies Leroy at Cadarache still has with the CBNM tritium targets (T(p,n) reaction) compared to his recent $Li^6(n\alpha)$ measurements.

Rec. 1g: Further development of the associate particle method

NPL (Robertson) is working on associate particle measurements applying the DD reaction in conjunction with recoil proton measurements, an accuracy of 2% is envisaged.

Kofoed-Hansen reported that they had stopping power results from 2 to 12 MeV for several particles with an accuracy of about 0.3 % in dE/dx for about 30 elements most of them scattered over the periodic table, but quite a fraction of them lying in the Fe region. The results show in particular deviations from the principles of the Bethe formula for the stopping power due essentially to an isotope effect which had been expected from measurements on the stopping power of mesons and other particles. Kofoed-Hansen terminated by saying that in case of interest they could easily report on this subject to the Panel, if it still exists, or to the Committee at its next meeting.

Rec. 1h: Multiple scattering corrections for white s measurements

No action is taken. In the context of Sowerby's et al. measurements of the B/Li (n,α) ratio Rae mentioned two different multiple scattering correction calculations for both detectors, one made at Harwell using a code written by Lynn and another one made at Risley with the code which had also been used in the calculations of the efficiency of the spherical geometry flat response detector; both calculations were seen to agree to within satisfactory 2%.

2) Standard material and foils for neutron measurements

Rec. 2a: Stocks at standard laboratories

At CBNM work on the definition of a standard stock for natural Li($LiCO_3$) will be completed this year. The ANL II boron stock at NBS is now being studied. Also at NBS work on new standard boron glass is under-way. Furthermore at NBS the composition of small boron glass heads for fluence measurements is studied.

Rec. 2b: Improvements in the preparation and assay of fission foils

At CBNM the study of fission foils continues. α-counting is no problem and is readily done to 0.1% by two different methods. Chemists, however, have difficulties in determining the quantities which may be in error by 1%. Work on several lines continues.

3. Neutron Standard Cross Sections

$He^3(n,p)$

Rec. a: Verification of $He^3(n,p)$ cross sections from the inverse reaction $H^3(p,n)$

No action is taken. Taschek referred to the recent evaluation by Seagrave (INDC(US)-7"R").

$B^{10}(n,\alpha)$ and $Li^6(n,\alpha)$

Rec. a: Measurements on $B^{10}(n,\alpha)$ below 100 keV

Asami and Moxon from Harwell measured $\sigma_n(B^{10})$ relative to $\sigma_n(C)$. A constant cross section was found between 1 and 10 keV (average value 2.23±0.06 b). Combined with Diment's σ_T results this gives an absorption cross section which deviates from the 1/v-law by a constant amount of (-0.28±0.12) b. At 10 keV this corresponds to a deviation from 1/v of 4%. Above 10 keV this negative constant term will be partially compensated by energy dependent terms. The work did not disprove that the $B^{10}(n,\alpha)$ cross section is 1/v to within 5% up to 100 keV. Also the precision of the constant term being only 50% further measurements are required. Rae mentioned still unpublished B/Li ratio measurements of Sowerby up to 30 keV.

Rec. b: Measurements on $B^{10}(n,\alpha)$ between 100 keV and 1 MeV

Rec. c: Measurements on the inverse reaction $Li^7(\alpha,n)B^{10}$

Work covering the $B^{10}(n,\alpha)Li^7$ reaction between 50 and 500 keV has been finished by Macklin and Gibbons of ORNL and published in Phys. Rev. 165, 1147, 1968; below 100 keV the picture is not clear. Recent preliminary work by Morgan (Texas Nuclear Corporation) finds 5-10% larger $B^{10}(n,\alpha\gamma)Li^7$ cross sections than those obtained by Macklin and Gibbons from the inverse reaction and the α_0/α_1 branching ratios. Morgan's work is continuing. He and also Gulf General Atomic are planning to measure the $(n\alpha_0)/(n,\alpha\gamma)$ ratio.

Rec. d: Measurements on $Li^6(n,\alpha)$ below 100 keV

Smith (ANL) is working on the $B^{10}(n,\alpha)/U^{235}(n,f)$ and $Li^6(n,\alpha)/U^{235}(n,f)$ ratios and will obtain the $B^{10}(n,\alpha)/Li^6(n,\alpha)$ ratio. Results are expected to be published in six or seven months. At ORNL an attempt on the $Li^6(n,\alpha)$ reaction is being made using foils and solid state detectors; difficulties occur above 1 keV. The National Defence Department / Sweden prepares measurements on Li-glass samples which will be analysed at Harwell by transmission. Diment/Harwell measured $\sigma_T(Li^6)$ from 70 eV to over 1 MeV. Furthermore work on Li^6 cross sections is carried out by Farrell and Pineo at Duke and by Hibdon at ANL. At Duke $\sigma_T(Li^6)$ has been measured in the energy range 50 to 650 keV and σ_α extracted from a single level plus 1/v contribution fit to the measured data. Hibdon studied σ_T of Li^6, Li^7 and natural Li in the range from 10 to 1236 keV (Washington Conference, March 68, papers B5 and B6). Block/RPI will make σ_T measurements on Li^6 and Li^7 in about two months. At ORNL accurate thermal transmission measurements on different enrichments are planned for the next year. At Saclay Vidal is working thermal measurements by pile oscillation.

Rec. e: Measurements on $Li^6(n,\alpha)$ above 100 keV

See work of Smith (ANL), Farrell and Pineo and Hibdon mentioned under d. Leroy/Cadarache is resolving the inconsistencies with his associate particle measurements. He plans to use a system of BF_3 counters embedded in paraffin wax calibrated by comparison to a scintillator between 100 and 300 keV which in turn is calibrated by the associate particle method, and at 2.7 MeV by counting protons from the D(d,n) reaction.

The recommendation to measure $\sigma_\alpha(Li^6)$ against $\sigma_f(U^{235})$ or $\sigma_n(H)$ is felt to be rather odd in view of the large uncertainties in $\sigma_f(U235)$ and the unreliability of the techniques which use $\sigma_n(H)$. This recommendation was therefore rejected by the Committee; the measurement should be performed with a flat detector like a large scintillator or a boron pile.

$H^1(n,n)$

Rec. a: New relative differential measurements between 5 and 20 MeV

No action is taken. See also for Hopkins' work under recommendation 1b.

Rec. b: New phase shift calculations [illegible] 5 MeV

Phase shifts were calculated from exis[illegible] nias (1/DC-2578= INDC(US)-6"U"). The anisotropy is lar[illegible] [illegible]ly rep[illegible] and is about 3% already at 5 MeV. [illegible] [illegible] from tant as they affect certain detector [illegible] [illegible]lations.

C(n,n)

Rec. a: Need of further work

The conclusions given by the Brussels [illegible] [illegible] here. Smith/ANL has σ_T data up to 1.5 MeV. [illegible] [illegible] data taken at selected energies above 800 keV at [illegible] [illegible]tions which are not symmetric about 90° in the C.[illegible] [illegible]obably not below 800 keV). NBS also has very pre[illegible] [illegible]. At CBNM angular distributions were measured between [illegible] [illegible] each between 20° and 150° in steps of 10° by co[illegible] [illegible]. It is [illegible] to attain an accuracy of 3.5%. CBNM is [illegible] [illegible] The σ_T measurements by Diment and Uttley at Harw[illegible] [illegible]ight be used for establishing C(n,n) standard cros[illegible]

Nomota mentioned plans for $\sigma_n(\theta)$ mea[illegible] [illegible] the [illegible] Van de Graaff and asked whether thes[illegible] [illegible] felt to be necessary in addition to the Argonne [illegible] [illegible] that, since $\sigma_n(C)$ is used as standa[illegible] [illegible] would be welcomed. Taschek said that the [illegible] [illegible] high [illegible] on C(n,n) should be checked by further mea[illegible] [illegible] then assured that these measurements would be made [illegible] [illegible]ble. A compil- ation on Pb(n,n) data with respect to [illegible] [illegible] scattering cross section will be made by Japanese

$Au^{197}(n,\gamma)$

Rec. a: Need for further measurements

Shape measurements have been made by [illegible] [illegible] grey detector for the neutron flux measurement. Ind[illegible] [illegible]ements have been made relative to $Li^6(n,\alpha)$ and B^{10}([illegible]. [illegible] the data are normalized to a "best" value of 0.596±0.012 [illegible] [illegible], there is a large discrepancy above 100 keV with data [illegible] $\sigma_f(U^{235})$. There is a similar discrepancy between Lockheed d[illegible] [illegible] first on the associated activity method and later on [illegible] Lockheed is continuing with Na-Be photoneutrons ([illegible]). [illegible] mentioned that even the above mentioned 30 keV σ_γ(Au) [illegible] is not assured and pointed e.g. to the higher value measured [illegible]

Rec. b: Structure in σ_γ(Au) between 1 and [illegible]

No action is taken. This recommendation was rejected by the Committee. The general feeling of the Committee was to drop gold as a standard in the keV range, and Kofoed-Hansen, in particular, recommended to look for a better standard in this range.

$U^{235}(n,f)$ and $Pu^{239}(n,f)$

Rec. Need for further measurements above 10 keV

Recent measurements of $\sigma_f(U^{235})$ by Pönitz/ANL with the grey detector have given results above 200 keV which are 15% lower than the White data. Also between 3 and 5 MeV discrepancies up to 15% exist. $\sigma_f(U^{235})$ and $\sigma_f(Pu^{239})$ are also fallout of the CBNM measurements. Condé envisages to measure $\sigma_f(Pu^{239})$ between 10 and 100 keV. Leroy also plans measurements.

Taschek mentioned that R.K. Smith/IA will remeasure $\sigma_f(U^{235})$ from 2 MeV up to 20 MeV by the proton recoil method. He argued that the subthreshold fluctuations in σ_f do not make $\sigma_f(U^{235})$ and $\sigma_f(Pu^{239})$ good standards and that a material like a rare earth element with very small level distances would be much better suited.

Threshold reactions

Rec. a and b: Need for further measurements on $Al^{27}(n,\alpha)$ in the range 8-13 MeV and on $S^{32}(n,p)$ between threshold and 15 MeV

At CBNM relative measurements on $S^{32}(n,p)$ have been done. Work will continue after the flux standard program has been carried out. Also relative measurements on $Ni^{58}(n,p)$ (as an alternative to $S^{32}(n,p)$) were performed and will be continued after the flux standard program. Robertson/NPL is measuring $\sigma_\alpha(Al^{27})$ and $\sigma_p(S^{32})$.

4. $\bar{\nu}(Cf^{252})$, need for further measurements

At NPL $\bar{\nu}(Cf^{252})$ is measured. De Volpi and Porges recently put forward $\bar{\nu}(Cf^{252}) = 3.808$ as a result of the elimination of errors in the $MnSO_4$-bath method (see previous remarks). A cross checking of neutron sources between NPL and ANL would be very important.

In conclusion the Committee agreed to reject $Au(n,\gamma)$ and $U^{235}(n,f)$ as standards and accordingly to drop recommendation b concerning $Au(n,\gamma)$ and recommendation 3e. It encourages and recommends the study of alternative standards to $Au(n,\gamma)$ and $U^{235}(n,f)$.

8(b) Consideration of Panel recommendations

The general recommendations of the Brussels Standard Panel to the IAEA are reproduced in appendix 4. The Committee considered the recommendations item by item and came to the following results.

Rec. 1: Endorsed.

Rec. 2: This should be exercised on a few well-defined cases. These should be examined at the next meeting and proposals on sample exchange put forward (see also below).

Rec. 3: A second Panel on Standards should be envisaged for 1971.

Rec. 4: This recommendation was understood as asking for a survey on what is going on in all countries in the standards area. The Committee agreed to include a request for separate comments on standard activities in the progress reports and will return to this topic at the next meeting.

Rec. 5: The Committee will come back to this item at its next meeting and consider in particular possible topics for evaluation to be performed by the Agency in the field of standards.

Rec. 6: Accepted.

Rec. 7: Accepted.

In conclusion the Committee, with the slight modifications indicated above, accepted and supported the recommendations of the Brussels Standards Panel.

Concerning the publication of the Standards Panel report Good stated that the Publications Committee had put it into the technical and scientific report series. As such 300 copies would be made available according to the standard distribution list, other copies would be available as microfiches for anybody on purchase. The published report would not contain the general recommendations to the IAEA which are not considered of general concern, but the technical recommendations. Holstad said that it might be appropriate to include in the document a page giving the INDC comments on it. Good said that recipients of the document could get those comments in an accompanying letter. Spaepen in particular recommended not to change anything of the Standards Panel Report, as it expresses the opinions of the experts in this particular field.

9. Topical discussion: Capture/Fission in Pu^{239}

Here in the informal minutes only a short account on the very interesting discussion on $\alpha(Pu^{239})$ is given; a more comprehensive report on this matter will be prepared by the IAEA.

Brunson first gave an introduction into the importance of the $\alpha(Pu^{239})$ data in particular for fast reactors. The high α results obtained at Harwell in the lower keV range reported at the Karlsruhe IAEA Fast Reactor Conference in October 1967 and the tendency of the fast reactor development of larger and larger reactor dimensions with softer and softer neutron spectra with large contributions in the "α-range" 100 eV - 100 keV led to a reexamination of the options H_2O steam-Na cooling and oxide-metal fuel. The higher α values not only cause losses in the breeding gain affecting thus particularly H_2O steam cooled designs with particularly soft neutron spectra, they also affect the quality of converter plutonium to be sold to fast reactor centres. Spinrad added that already some time ago reactor people had found a disagreement between older reactor measurements of α and α values derived from data collections like the YOM multigroup cross section set. These old data, e.g. from FBR-I, which gave a high α value, had been reevaluated to give lower α values than originally thought. Then new reactor α data were coming in which seemed to verify the old high data. Incidentally these old data were found to be bad when they were looked at again.

Then, Joly gave a review of α measurements prior to the new Harwell results reported at Karlsruhe referring to recent compilation work on $\alpha(Pu^{239})$ by Ribon, Barre and Héritcau from Saclay. The basis of previously accepted α values were above 20 keV the well agreeing Oak Ridge and Los Alamos liquid scintillator measurements and below 20 keV the old KAPL average spectrum irradiation results. The new Harwell data of Schomberg et al. are above 20 keV up to 50%, below 20 keV up to a factor of two and more higher than these previously accepted values. Hart evaluated α values above 1 keV from Harwell experimental data on σ_f and σ_T and estimates of σ_n and got still higher α values than Schomberg et al., Joly believed Hart's results to be doubtful since the σ_n estimates were only very rough. Ribon et al. performed an evaluation of $\alpha(E)$ using a similar method as Hart, but estimating more carefully σ_n. According to the satisfactorily ascertained Harwell σ_T and the various discrepant σ_f data available they obtain lower and higher estimates of α which below a few 100 eV and above 10 keV join smoothly to the previous α curve and inbetween are above this curve up to a factor 2 with the maximum at about 2 keV. Above 3 keV and below 1 keV the α values obtained are definitely lower than the Harwell results. Physically the steep rise of α above 600 eV is explained by a fall of $\langle\sigma_f\rangle$ more rapid than $1/\sqrt{E}$ and a normal $1/\sqrt{E}$ fall of $\langle\sigma_\gamma\rangle$.

Joly then briefly reviewed the French efforts to improve the α situation. The recent Saclay linear accelerator measurements of $\sigma_f(Pu^{239})$ up to 35 keV will be available to interested NEDC members in a few weeks time. A measurement of $\langle\alpha\rangle$ is planned in the OSIRIS-reactor with a neutron spectrum similar to the PHENIX fast reactor. This measurement will involve Pu^{239} and U^{235} irradiations of four to five months, thus results are expected to become available at the end of the year.

Rae mentioned the two σ_f^{49} measurements performed by James at Harwell using fission fragment detection, and the higher resolution σ_f^{49} measurements of Patrick which use fission neutron detection. He said that James' measurement suffered from scattering by the brass backing of the detector. This trouble had been removed by repeating the measurement with thinner Al backing. He also said that the fluctuations seen in Patrick's data agree with those observed at Saclay. Spaepen said that ORNL plans σ_f^{49} measurements up to a few keV.

Next, Miss Janeva reported on the recent σ_f and α measurements on U^{235} and Pu^{239} performed with the fast pulsed reactor (IBR) at Dubna (published in At. Energ. 24, 351, 1968); we refer here only to the Pu^{239} experiments. The measurements covered the energy range 5 eV to 30 keV with the normal flight path of 1000 m and a resolution of 60 nsec/m. The method used was similar to the previous LA and ORNL α measurements; a large Cd-loaded liquid scintillator (360 l) was used as detector. With few exceptions the results of this experiment differ from all others. Above 2 keV the α results are very low fluctuating around an average value of about 0.4; below 5 keV and above 30 keV the σ_f results are much higher than those of all other authors. The reasons for these discrepancies were still not clear. Miss Janeva terminated her talk by mentioning new α measurements on U^{235} and Pu^{239} which are still going on at Dubna and are expected to be ready in a few weeks time.

In view of the just mentioned discrepancies some discussion arose on the background determination. On questions by Rae and Stevens Miss Janeva stated that the background amounted to 15 or 30% for the two different sample thicknesses used and had been determined by resonance filters (Ag, Co, Mn). Because of the small sample thicknesses (1.3 and $2.7 \cdot 10^{-3}$ atoms/barn) multiple scattering corrections were not considered necessary.

Next, Rae reported on the α_{49} measurements performed at Harwell. The status of these measurements in February 1968 is set out in NEANDC(UK)96"Al" and 100 "Al" which have been circulated to the Committee. The measurements indicate a value of $\langle\alpha\rangle$ in the energy region 1-10 keV of the order of unity. The direct measurements of Schomberg et al. (NEANDC(UK)-100"Al") are continuing. Data have been taken on a third sample thickness, the background being monitored by resonance filters at 4 points in the above energy range as compared with 1 point in the earlier work. A measurement is also being made on U^{235} as an overall check on the method. Rae mentioned in particular that in Schomberg's measurements the signal to background ratio is worse than in the Dubna measurements, amounting in the range 10-15 keV to 40% in the γ-detector and to 25% in the fission detector. However, when one moves up to the 20-25 keV range, the background becomes smaller being about 25% in the γ-detector and about 15% in the fission detector.

Rae then compared various measurements and evaluations of $\alpha(E)$ in the lower keV range. In particular he noted the fact that the α data derived from Patrick's et al. high resolution σ_T and σ_f measurements (NEANDC(UK)-96"Al") are quite well in agreement with Schomberg's direct measurements, this being due to Patrick's relatively low σ_f values compared to other authors. He also mentioned the large discrepancies of the recent Dubna results to all other authors. Finally he briefly introduced a recent Japanese paper on the calculation of the spin and energy dependence of the fission width for U^{235} and Pu^{239} by Y. Kikuchi and S. An (J. Nucl. Sci. Techn. 5, 86, 1968) which represents a good summary of the present knowledge of saddle point states and of the limits of a theoretical prediction of $\Gamma_f(E)$ and $\langle\alpha\rangle(E)$ for these two nuclei.

Joly asked Rae, why Schomberg et al. got for the ratio of detection efficiencies for γ-radiations released by fission(ε_1) (total γ-ray energy about 7 MeV) and by capture (ε_2) (total γ-ray energy about 6.4 MeV) a value as high as 2.5. From the proportionality of the efficiency of the Moxon Rae detector to E_γ and from the above values for the total γ-ray energies released in capture and fission he would have expected a value of about 1.1 for this ratio. Rae answered that the high value for $\varepsilon_1/\varepsilon_2$ is due to the fact that the multiplicity of the fission γ-rays is higher than that of the capture γ-rays and also that the neutrons could give two proton events in the two halves of the detector independently. Sowerby et al. now have three of these detectors which will make a complete annulus effectively; they hope in future studies to do anti-coincidence counting and to reduce the high efficiency of the capture detector for fissions.

Taschek reported on various work on α_{49} in the US. The ORNL/RPI α data by Gwin, de Saussure et al. will be out late in summer. Capture and fission cross section data on Pu^{239} from the recent LA bomb shot will become available in 6-8 months. In a recent study submitted as technical note to Nucl. Sci. Eng. Otter from GCA obtained a new calibration curve for the α measurements of Schomberg et al. by using multilevel parameters to calculate α in the calibration resonances. This multilevel parameter calibration would lead to much lower α_{49} values than the single level parameter calibration used by Schomberg et al. D.K. Butler, M. Bogner and W.B. Loewenstein studied the effect of the new high α_{49} values on the performance of fast breeder reactors and concluded that for Na cooled reactor systems the breeding losses were not so large that they could not be balanced by going to harder neutron spectrum configurations. The results of this study will be presented in a paper submitted to the ANS meeting at Toronto in June. At Brookhaven $Pu-D_2O$ lattices are studied; the theoretical calculations agree better with experiment when α values are used 50% higher than the ENDF/B α values based on the old KAPL results. Similar effects are seen in similar experiments at Atomics International.

Kinchin first mentioned briefly Swedish work on α_{49} contained in a letter and in reports sent by M. de Vroey-Wallin to Goad and stated that the agreement of calculations with integral <α> measurements in the Swedish fast zero power reactor FRO and with integral data from ZEBRA/6A, DIMPLE and ZPR-III/48 is improved when using the new Harwell α data instead of the old KAPL data. Kinchin then mentioned integral measurements at Winfrith on Pu-graphite-boron mixtures; e.g. cross section ratios relative to boron are measured in epithermal spectra centered in the range 10 eV to a few 100 eV.

After these reports on α_{49} work in various countries the Chairman posed the general question of the reliability of the different methods used for obtaining α. He supposed that the method of deriving α from σ_γ and σ_f be subject to larger uncertainties than the direct methods because of the uncertainties in the estimate of σ_η. Havens said that no categoric statement is possible on which method would be better in principle. Rae tried to classify the reliability of the methods somewhat by stating that Schomberg et al. measure essentially (2+α), whereas the RPI and Dubna measurements are somewhat better off in measuring (1+α) and α respectively. Joly then quoted the following uncertainties in σ_γ, σ_f and σ_η and the resulting uncertainties in α when α is derived from these cross sections:

σ_f :	5%	1-25 keV	
	10%	25-100 keV	
σ_T :	2%	1-25 keV	α: 25-30% (at best)
	3%	25-100 keV	
σ_n :	15%	1-100 keV	

Kolstad commented on the α question in stating that one should not dramatize the present situation in view of the preliminary nature of the high α results obtained in the UK measurements. He underlined the need for more carefully made and analysed measurements and mentioned shortly the differential and integral measurements underway in the US. Finally he suggested to continue this topical discussion at the next INDC meeting.

After this discussion the present knowledge of $\alpha(Pu^{239})$ can be summarized as follows:

1. In the energy range between several 100 eV and 10 keV α is definitely higher than the previously accepted data based on the old KAPL measurements. However, above 2 keV a discrepancy between recent Dubna results, which support the low KAPL data, and all other measurements and evaluations has still to be solved.
2. The results of various integral experiments support the higher α values.
3. In the prediction of the higher α values still quantitative differences remain being due to different methods and to different fission cross sections used in the derivation.

The Chairman concluded the discussion in thanking all speakers for their interesting contributions and suggested that, in view of the various experiments still going on, the same topic be taken up at the next meeting when more information will have become available.

10. Facilities list

The Chairman introduced the subject by quoting a letter of the present Chairman of the EANDC (Weinzierl) to him which contains a set of EANDC recommendations. Corresponding to this letter the EANDC supports the continuation of the facilities list on a worldwide basis, it will drop the regional facilities lists and suggests to the INDC to consider the usefulness of this activity and to Vienna to pick up the work. The Chairman asked for comments on the usefulness of a worldwide facilities list. Kolstad said that he wanted the list to be kept up in a loose leaf card compilation and to be released in the form of updated sheets. Abramov said that in the USSR a lot of people are in favour of the facilities list and proposed the NDU to continue this list. He also supported the loose leaf card form for the entering of additions; the old format could be preserved, but Western and Eastern cards should be brought to the same size. Good said that the size problem would be automatically solved and that the work on the facility list would not need too much effort. Souza-Santos asked to include in the list also facilities under construction. Contrary to this Divatia and Kofoed-Hansen wanted new facilities or those under construction to be reported in the progress reports. Kolstad asked for a restriction of the list to those machines doing neutron cross section work.

It was concluded that the facilities list should be continued to be published by the NDU and that it should comprize already existing facilities active in neutron work. Facilities planned, proposed or under construction should be taken up in the progress reports.

11. Sample exchange

11(a). Considerations of existing IAEA procedures

First discussions on this item took place on Monday. Referring to the Newsletter No. 1/1968 Good reported of the increased number of sample requests received by the Agency being mostly on fissionable materials. The IAEA has available fissionable materials, but so far none has been used for basic measurements, because assay or fabrication were sometimes not good enough. In the following discussions the role of the Agency in the matter of sample exchange and its procedures for loan and purchase of samples remained unclear. Lorenz pointed out that one should consult first a booklet published some time ago by the Agency ("IAEA Services and Assistance", 1966) which specifically dealt with these questions. This booklet was subsequently distributed to the INDC members present.
There also arose the question of the role of the Committee in this matter, e.g. whether the Agency would wish to have any advice from the Committee as to whether particular samples should be provided for particular measurements. The Chairman recommended, before further discussions on this matter, to look first at the booklet with the description of the current arrangements and asked Good to draft some recommendations on what advice from the Committee is being sought by the Agency in the matter of sample exchange. Then he ajourned the discussion.

The discussion was taken up again on Thursday. From the Agency Pedersen was then present as expert in questions of IAEA services. Upon the question of the Chairman Pedersen outlined the IAEA procedure concerning sample exchange (see e.g. IAEA document "IAEA Services and Assistance", section G and annex VI). It is important that even for mg quantities a request made to the Agency has to go to the Board of Governors. In this content Pedersen said that for measurements of nuclear data a simplified procedure has been recommended inside the secretariat and will be considered by the Board of Governors. According to this procedure the secretariat would be authorized, on behalf of the Board, to grant requests up to a certain limit. Pedersen ascertained that, if the INDC feels that there is a need for material transfer from one country to another or for having a pool of samples which could be used by different research centres, the Agency would be very willing to consider this possibility.

In the further discussion Taschek and Havens underlined that the Committee has no competence in administrative, but in scientific matters such as reviewing whether a particular measurement and the issue of samples for it are reasonable or not. Kofoed-Hansen reminded of the EANDC procedure which consists in looking at the merits of the experiment in question tying it up with the request lists preferably with a priority numbering. Symonds considered it a useful simplified procedure if a pool of material is run by the Agency and, if the taking out of this pool of a piece of material has not to go through the Board of Governors, but if in the special case of some cross section measurements the reviewing is done by the Agency and the Committee or the NDU depending on what quantities are involved. Taschek also considered it desirable to have a pool of material, say of a few 100 g, available for making samples. Symonds argued that not only the quantity, but also the quality, i.e. enrichment, purity etc, of this material be important. Abramov suggested to consider this matter between now and the next meeting and to come back with some solution for the next meeting. Taking up this

suggestion the Chairman concluded the discussion by recommending to the Agency to put forward some proposals preferably well before the next meeting, so that these could be considered before and at the next meeting.

12. Nuclear data for safeguards

Kolstad suggested that the Committee concern itself also with nuclear data for safeguards purposes. He referred to groups working on safeguards e.g. at Los Alamos, Brookhaven, Karlsruhe and other places and to two reports submitted to Good (LA-3741; WASH-1076) and distributed to the Committee members which cover technical and physical aspects of safeguards. The Chairman recommended to take up this matter at the next meeting, when the implications on the nuclear data side may be more clear.

13. Committee business

13(a). Methods of work: Report of Subcommittee, discussion and adoption of proposed document

On Monday first some general discussions were held. Kolstad stated at the beginning that the draft "Methods of Work" had received quite different views from many of the Committee members. He expressed his hope that a reasonable compromise could be found. With the experience of the EANDC in mind he said that a reasonably clearcut outline of the methods of work should help to minimize discussions on nontechnical matters in future Committee meetings. Concerning the Committee membership he stated that this item was actually out of the scope of the Committee, but recommended to appoint Committee members in such a way as to provide for continuity as well as a reasonable and orderly turnover of the membership. Divatia added some comments particularly on item IV 5 of the draft and proposed that in case the Chairman gets seriously incapacitated between meetings the Director General of the IAEA be asked to designate the INDC member from the country which is next in line for the Chairman as the new Chairman for the remainder of the term. The further comments of Symonds, Kofoed-Hansen and Taschek expressed the general feeling of the Committee that the "Methods of Work" document should only be a guidance and not a firm set of rules. The Chairman suggested a Subcommittee consisting of Abramov, Divatia, Hanna, Kolstad and Symonds to draft the final version of the document.

On Thursday this revised version was submitted to the Committee. The changes compared to the draft consisting mainly in simplifications and rewordings were commented by Symonds. With a few additional changes the Committee finally accepted the document for guidance of its procedures. The final version of the document will be distributed by the Executive Secretary.

13(b). Next meeting: arenda, place, date

Some suggested and/or pending topics for the next meeting, the topical discussion excluded, are given in appendix 6. If the meeting were to be held at Brookhaven the subject of the topical discussion could be radiative neutron capture. Abramov proposed to take the subject of the Panel on statistical properties of resonances for the topical discussion. As this subject was not quite clearly defined, Abramov was asked to work out a more specific program together with Sukhoruchkin and to get into correspondence with Good. Schmidt suggested capture and fission cross sections for important reactor materials, Rae capture γ-spectra as possible topics. Havens will get into touch with Brookhaven nuclear data people and prepare a proposal.

Kolstad suggested the UN seat at New York or the Brookhaven National Laboratory as possible places for the next meeting. The Committee agreed upon Brookhaven. As the date, June 2-6 is scheduled. Visits might include the Columbia Synchrocyclotron, the Yale Emperor Tandem or Rensselaer and side visits to more distant places like Argonne or Oak Ridge. Kolstad and Havens will arrange for this. The Chairman expressed the thanks of the Committee to the US for their offer. As symbol for the INDC the insignium in the centre of the front page of Newsletter No. 1 was adopted.

Reports and documents related to the 7th INDC meeting

The following reports and documents received or presented for the meeting are ordered by the agenda item as they were presented during the meeting. The same order as in the attached agenda is observed.

Item 1

	Tentative agenda
	List of participants and addresses
	Seating plan
	List of documents received by NDU
	List of INDC documents distributed by NDU

Item 2

1)	EANDC(E)89U	Euratom Community Progress Report = INDC/210
2)	EANDC(UK)91AL	UK Progress Report (summary on hand) = INDC-208
3)	INDC/222	Australian Progress Report
4)	EANDC(CAN)34L	Summary of Canadian Progress Report (=INDC(Can)1)
5)	INDC/230	Progress Report on Nuclear data research in Poland
6)	INDC/232	Progress Report from the USSR (summary on hand)
7)	INDC/240	Progress Report from the Federal Republic of Germany
8)	INDC/241	Progress Report from India (1967-1968)
9)	INDC(J)1	Progress Report from Japan (summary on hand) (=EANDC(J)8"L")
10)	INDC/244	Summary of progress report from Brazil
11)	-	Progress Report from the U.S.
	INDC/233	Report to the AEC NCSAC (April 3-4, 1968) = WASH-1093
	-	List of INDC documents released since Jan. 1, 1968
	-	USAEC Press release about release of data to INDC
	INDC/234	Preliminary draft of a Status Report on Heavy Element Cross Sections = EANDC(US)107"A" = INDC(US)-4G
	INDC/237	Neutron capture and gamma-ray production cross sections = INDC(US)-5G
12)	(EANDC(OR)?)	Progress Report from OR countries
13)	EANDC(E)89U	Progress Report from France
14)	INDC/258	Progress Report from Yugoslavia
15)	INDC/235	Progress Report from the Nuclear Data Unit

Item 3

INDC/214	Second Neutron Cross Section and Technology Conference (INDC(US)-1G)
	General Guidelines for 2nd IAEA Conf. on Nuclear Data
	Proposed program for the compilation panel
	Proposed list of participants for compilation panel
	Summary statement by B. Spinrad on IWGFR
	Radiation inside reactors*

Item 4

INDC/226	RENDA (preliminary version)
INDC/238	Australian Comments on Data Catalogues

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* Distributed to INDC for information

Item 5

INDC/231	ENEA Neutron Data Compilation Centre - Progress Report
INDC/239	National Neutron Cross Section Center - Progress Report
INDC/235	Report on the Nuclear Data Unit Data Center Activities

Item 6

No summaries or documents on hand

Item 7

INDC/229 INDC(Can)2	Review of the 2200 m/sec Fission Constants g-factors at 20°C from Evaluated Data files (to be included as supplement 3 to INDC-229)

Item 8

	Report on the Standards Panel
INDC/236	Comments on the US Progress in Making Measurements Recommended by the Brussels Panel on Standards (=INDC(US)8G)

Item 9

Item 10

No summaries or documents

Item 11

IAEA Services and Assistance (booklet)*
USAEC press release on sale of Pu-238*

Item 12

Report submitted by Kolstad
Report " " "

Item 13

INDC/242	Methods of Work
INDC/243	Memo from U.S. delegation to INDC members Recommendations to the DG Subcommittee recommendation to the INDC

* Distributed to INDC for information

APPENDIX 1

General guidelines to be supplied to the organizing committee for the next IAEA Conference on Nuclear Data

by

G.C. Hanna and R. Taschek

Suggested title: Conference on Neutron Physics & its Applications

The subject matter of the conference should include:

1) New data applicable to nuclear energy programs
2) The use of neutron data in reactor physics and technology, in shielding and astrophysical problems and other applications.
3) The compilation and evaluation of nuclear data as pertinent to neutron physics and its applications.
4) New developments in
   (a) Theory
   (b) Measurement techniques (including data acquisition and analysis)
   (c) Interpretation of nuclear data
5) Areas where cross fertilization between the above activities might make valuable contributions.

The program should be so arranged and conducted that maximum useful interaction occurs amongst the various subdisciplines to enhance the mutual understanding of needs and problems.

APPENDIX 5

Panel on nuclear data compilation early 1969

Proposed list of participants

1.	H. Goldstein	(U.S.A.)
2.	M.D. Goldberg	"
3.	S. Pearlstein	"
4.	R. Howerton	"
5.	J.C. Hopkins	"
6.	B.C. Diven	"
7.	A.B. Smith	"
8.	I. Morgan	"
9.	D. Trubey	"
10.	L. Whitehead	"
11.	L. Stewart	"
12.	H. Alter	"
13.	J. Harvey	"
14.	A.I. Abramov	(U.S.S.R.)
15.		"
16.		"
17.	N. Janeva	(Dubna)
18.	V. Bell	(CCDN)
19.	S. Schwarz	"
20.	S. Valente	"
21.	I. Slaus	(Yugoslavia)
22.	E. Pendlebury	(U.K.)
23.	J. Story	"
24.	D. Colvin	"
25.	G.C. Hanna	(Canada)
26.	J.L. Symonds	(Australia)
27.	J.J. Schmidt	(BRD)
28.	R. Joly	(France)
29.		(India)
30.	M. Caner	(Israel)
31.	M. Wallin	(Sweden)
32.	H. Condé	"
33.	R. Nakasima	(Japan)
34.	W.M. Good	(NDU)
35.	A. Lorenz	"
36.	H.D. Lemmel	"
37.	P. Attree	"
38.	L. Hjärne	"

APPENDIX 3

Proposed program for the panel on compilation

(early part of 1969)

A. Experience with existing systems (Introductory session)

B. Proposals for new systems (SCISRS-II)

C. Considerations for the future compilation activity

   1. Boundary conditions dictated by data exchange and services
   2. Scope of compiled information
   3. International Nuclear Data Index and Bibliographic Index
   4. Quantity definitions
   5. Peripheral information (comments)

D. Computer utilization in compilation

   1. Storage and retrieval:computer considerations
   2. Storage and retrieval: physics considerations

APPENDIX 4

Brussels Panel on Nuclear Standards

General recommendations to the I.A.E.A.

1. A number of laboratories and expecially the centres for nuclear standards have special materials and services which they can make available for standards activities. The IAEA should effectively publicize this fact and its related information and if called on, assist with necessary arrangements for obtaining these.

2. In certain circumstances, it may prove desirable to exchange personnel or equipment or provide some appropriate common facility to resolve a persistent discrepancy. The IAEA should consider in such circumstances, if desired, to locate and contract for use of the required facility and make necessary arrangements for the equipment and/or personnel exchange.

3. The IAEA should consider organizing a future panel similar to the present one, in about four years' time.

4. The IAEA should conduct a complete survey of neutron cross section standards activities.

5. In view of the apparent shortage of evaluated data for standards purposes, it is recommended that the IAEA continues or extends support for such activity. This topic, however, was not examined in detail by the Panel.

6. The IAEA should, perhaps through the INDC, seek to monitor the progress in implementing the technical recommendations set forth in this report.

7. The IAEA should seek, perhaps through the INDC to encourage duplication of important measurements.

APPENDIX 5

Recommendations of the Committee

A. Formal Recommendations to the Director General of the IAEA

1. Second IAEA Nuclear Data Conference for 1970

The Committee notes the plan for an International Conference on Nuclear Data in 1970. The Committee strongly endorses this proposal and suggests that so far as possible the program be coordinated with that of the 1970 IUPAP Nuclear Physics Conference.

2. IAEA Panel on Neutron Data Compilation for 1969

The Committee recommends that the proposed 1969 Panel be devoted to the subject of nuclear data compilation and be held as early as possible consistent with full participation. In addition, it would appear very desirable to hold a four-center-meeting in the intervening period and to make available the conclusions of the meeting prior to the meeting of the panel.

3. Printing and Distribution of CINDA

In view of the world-wide nature of the CINDA bibliographical index the Committee recommends that the IAEA consider taking over the responsibility for its printing and distribution at the earliest practicable date.

B. Other Recommendations

1. Distribution of informal minutes and other documents

We recommend that copies of the edited unapproved informal minutes of INDC meetings, together with the list of documents received by the NDU, not solely for Committee use, be distributed to designated individuals in each member state of the IAEA.
A brief resumé of the topical discussion will be given in the informal minutes, and we recommend that a more comprehensive account be given an appropriate distribution by the IAEA.

APPENDIX 6

Suggested and/or pending topics for the next Committee meeting

World-wide RENDA request list for nuclear data measurements.

Progress report on $\alpha(Pu^{239})$.

Second IAEA International Conference on Nuclear Data in 1970, current status of preparations.

Report on the results of the IAEA Panel on Neutron Data Compilation early in 1969.

Brief report on First International CODATA Conference at Arnoldshain/Frankfurt in July 1968.

Final report on 2200 m/sec fission constants review.

Topic for future evaluation work of the NDU.

Exchange of evaluated data.

Evaluation request list.

Current situation of standards (e.g. $\bar{\nu}(Cf^{252})$, possibly de Volpi report).

IAEA pool of separated isotopes.

Nuclear data for safeguards.