International Atomic Energy Agency

INDC-6/L

436

INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

OFFICIAL MINUTES OF THE THIRD MEETING HELD IN VIENNA

22 - 26 June 1970

Compiled by

G.C. Hanna (AECL, Chalk River)
(Executive Secretary)

Aided by

A. Lorenz (IAEA)
(Local Secretary)

and

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

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

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SUMMARY

The Third Meeting of the INDC was attended by two ad hoc members, one from Austria and the other from Romania, and several IAEA Personnel were present at various sessions. This increased attendance ensured that the Committee was fully informed on many important subjects, but it was found necessary to defer final decisions on some of them, and Subcommittees were formed to assist the Committee in its future work.

All members presented summaries of progress in the measurement of nuclear data, and many countries not represented on the INDC provided written progress reports. The Committee discussed some important scientific topics in detail, notably the energy spectrum of fission neutrons, the status of $\bar{\nu}$ and $\alpha(^{239}Pu)$, and the recently observed fluctuations in $\sigma_f(^{235}U)$ near 22 keV neutron energy. Two Standing Subcommittees were set up, on "Standards", and on "Discrepancies in Important Nuclear Data and Evaluations".

Much information had been presented during the previous week at the Helsinki Data Conference; noting the success and practical usefulness of this conference the Committee recommended the convening of similar ones every 3-4 years. The Committee also endorsed the value of small meetings of experts like the two pre-Helsinki meetings on $\bar{\nu}$ and $\alpha(^{239}Pu)$.

The Committee discussed international cooperation in the use of underground nuclear detonations for nuclear data measurements, but decided to try to obtain more information on costs and possible political difficulties before considering the subject further at its next meeting.

Reports from the four Data Centres were discussed and the agreement on EXFOR, the new data-exchange format, was welcomed. The Committee recommended a new publication format for the CINDA bibliographic index.

Many countries have increased their evaluation activities and the Committee discussed ways of coordinating them more effectively; it appeared that an internationally agreed format

was not imminent. Although more evaluated data were being made available there was some dissatisfaction with the continuing restrictions on free exchange.

After studying the list of requests for data measurements from non-OECD countries, which had been assembled and edited by the NDS, the Committee supported the merging of all requests for neutron data into a single world list, but encouraged more screening of requests.

In February 1970 the NDS had asked 19 countries for information on nuclear data needs for Safeguards technical development. The report of the NDS included an initial request list, and much valuable background material. A Subcommittee, formed to study the problems in detail, recommended setting up a request list for Safeguards data but noted the difficulty of assigning priorities without more information on the relative importance of different measurement points in a fuel cycle. A Standing Subcommittee was set up on "Nuclear Data for Safeguards", which will prepare a report to the Committee before its next meeting.

The Committee asked the NDS to obtain information on nuclear data required for fusion research with a view to preparing a request list.

The Committee strongly reaffirmed its earlier recommendation that the IAEA take an active part in arranging the supply of targets and samples to experimental groups for nuclear data measurements, and reiterated its willingness to advise the IAEA. It was agreed, however, that some problems required further study, especially the one of priorities, and a Subcommittee was set up and asked to report to INDC by 1 October 1970.

LIST OF PARTICIPANTS.

1. INDC Members

A.I. Abramov, Obninsk, USSR
A. Berinde, Bucharest, Romania*
S. Cierjacks, Karlsruhe, Germany
B.E. Clancy, Lucas Heights, Australia
A.S. Divatia, Trombay, India
G.C. Hanna, Chalk River, Canada (Executive Secretary)
R. Joly, Saclay, France
G.H. Kinchin, Dounreay, U.K.
O. Kofoed-Hansen, c/o CERN, Geneva, Switzerland
G.A. Kolstad, USAEC, Washington (Chairman)
K. Nishimura, JAERI, Japan
J.J. Schmidt, NDS, IAEA (Scientific Secretary)
M. Souza Santos, Sao Paulo, Brazil
Z. Sujkowski, Swierk, Poland
P. Weinzierl, Seibersdorf, Austria*

*ad hoc member

2. Representatives of International Organizations

A.H.W. Aten, BCMN, Geel, Belgium
H. Liskien, ENEA/CCDN, Saclay, France
N. Janeva, JINR, USSR was unable to attend

3. Technical Advisers

W.W. Havens, Jr., Columbia University, U.S.A.
G.B. Jankov, Kutchakov Institute, USSR
A. Lorenz, NDS, INEA (Local Secretary)
E. Rae, Harwell, U.K.
R.F. Taschek, LASL, U.S.A.

4. IAEA Consultants and Observers

Members of the IAEA Nuclear Data Section were invited to attend sessions 7, 8 and 9. In addition, T.A. Byer

was present for session 6, L. Hjärne for 5a and 10d, V.A. Konshin for 3d, and H.D. Lemmel for 5a.

J. Dolnicar attended session 5c, G.A. Graves, sessions 3, 5 and 10, and B.I. Spinrad, 3c, 3d(ii), and 5a. Messrs. Gottschalk, Metzendorf and Pelzer attended session 7b.

Dr. R. Rometsch gave a special lecture on the Non-proliferation Treaty and its Impact on IAEA Policies, and session 6 was also attended by several members of the Safeguards Division (including Messrs. Dragnev, Sanatani, Stefanescu, Tamiya and Waligura). Other special presentations were made by H. Seligman on data needs for fusion (session 10a) and by J.E. Woolston on INIS (session 10d).

An informal discussion with the Director General was also attended by Messrs. Finkelstein and Ferronsky of the Department of Research and Isotopes.

1. ORGANIZATION AND ANNOUNCEMENTS

Dr. Eklund, Director General of the IAEA welcomed the participants. He reviewed briefly the history and functions of the Committee and mentioned some of the topics on which the IAEA particularly wanted advice from the INDC.

2. COMMITTEE BUSINESS

2a Consideration and approval of INDC Minutes

The edited but unapproved informal minutes of the second meeting in Brookhaven 1969 were adopted as final, to be issued as INDC(SEC)-9/L.

2b Consideration and adoption of Agenda

The tentative agenda submitted by the chairman was adopted with some reordering and the inclusion of a few sub-items. It was agreed that the Subcommittees required for certain agenda items would be set up as soon as possible (agenda item 2i below).

2c Proposed modification of Methods of Work

At the second meeting of INDC a Subcommittee had drafted a set of modifications to the Methods of Work (section 3 and appendix 6 of INDC(SEC)-9/L). The chairman pointed out that the Committee could only accept or reject these modifications but not amend them at this meeting. The NDS considered that the section on the Distribution and Numbering of Documents (section V-6) was unsatisfactory (see agenda item 2h below) and it was therefore omitted. The other sections were approved for inclusion in the Methods of Work, to be issued as INDC(SEC)-10/G.

2d Consideration of observers and visitors

The chairman noted that Dr. Aten and Dr. Liskien had been invited by the Director General to attend the whole meeting so that they were in effect Committee members. Dr. Janeva, had she been able to attend the meeting, would have had a similar status. The attendance of observers and part-time participants from the IAEA was discussed and settled; a summary is given in section 4 of the list of participants (see above).

2e Actions arising from second meeting

Action 1: Kinchin - "Prepare chairman's two years report and submit it to the next Committee meeting": complete (see item 2f below).

Action 2: Schmidt - "inform Dr. Schäfer from CODATA Central Office about Committee recommendations regarding the relationship between INDC and CODATA; ask him to distribute CODATA Newsletters and the compendium directory survey to INDC members": complete.

Action 3: NDS/INDC Secretariat - "request "Minutes of IWGFR Meetings" and proceedings or reports of meetings that it sponsors to be sent to the INDC Members": minutes for last year's meeting have been distributed and those for this year will be available shortly - a continuing action.

Action 4: IAEA - "draft and send proposal for agenda of suggested 1971 Panel on Methods of Evaluation to INDC members for comments": complete (see page 47 of INDC(NDS)-23/G).

Action 5: NDS/INDC Secretariat - "extend the membership of Liaison Officers to include all interested Member States not represented on INDC": complete. Lorenz had sent out invitations shortly after the meeting and there are now 19 more liaison officers - the 35 listed in INDC(SEC)-7/U plus Professor Aziz of Uruguay.

Action 6: NDS - "prepare working paper on evaluation activities for next INDC meeting": not done, statements to be made under various agenda items below.

Action 7: NDS/INDC Secretariat - "request progress reports to the INDC from NON-INDC Member States at an early date": complete, several progress reports received (see document list).

Action 8: IAEA - "provide pool of information on available targets and foil materials": partially complete, see report INDC(NDS)-22/G which covers needs only.

Action 9: IAEA - "provide a detailed breakdown of the total CINDA cost including details of the proposed free distribution and circulate it together with an estimate of the overall distribution figures to INDC members as soon as possible" : complete, see INDC(NDS)-23/G.

Action 10: NDS - "publish results of discussions of recent Obninsk workshop before next four-centre meeting": complete, travel report was distributed.

Action 11: NDS - "provide Dr. Rastogi from Bhabha Atomic Research Centre with a magnetic tape copy of the Karlsruhe KEDAK file": complete.

Action 12: NDS - "prepare as soon as possible request list for nuclear data measurements from Non-OECD countries": complete, document is INDC(NDS)-20/G.

2f Biennial Report

The chairman's Biennial Report for 1968-69 was approved and Schmidt was asked to ascertain, from the Director General, what distribution it should have. (Now issued as INDC(SEC)-11/G.)

2g Status of Liaison Officers

It was agreed that Liaison Officers should be given more information on the INDC, and a "Compendium of Committee Regulations" will be assembled by the NDS which will list detailed procedures, consistent with the Terms of Reference and the Methods of Work. Since this Compendium will not require formal approval from the IAEA or the Member States it will be easier to keep up to date than the more formal Methods of Work INDC(SEC)-10/G, e.g. the details of document distribution can be handled in this way. Liaison officers will receive this compendium when it is ready, and as amended from time to time; they will also be sent Appendix A of INDC(NDS)-23/G, the "Terms of Reference" for Liaison Officers of the INDC.

2h Document Distribution

The difficult and complex question of document distribution was discussed at some length. The NDS wished to retain its four distribution codes (U, E, G and N, see INDC(SEC)-7U

and INDC(NDS)-23 section B3) where E and U, requiring respectively 111 and 300 copies, distinguish between documents that do, and do not, receive an EANDC distribution. Some Committee members thought that this should be a matter of internal bookkeeping not requiring two separate distribution codes, and supported the system recommended at the last meeting for incorporation in the Methods of Work (see item 2c above).

Abramov asked whether it was useful to distribute 300 copies of documents in the Russian language. Taschek suggested circulating translations of the titles and then providing complete translations if there was sufficient interest. Lorenz mentioned the problems of expense and shortage of translators but noted that the Collected Abstracts of Nuclear Physics Research in the USSR are translated by the IAEA on an ad hoc basis.

Rae recommended that the agenda for an INDC meeting list the numbers and titles of relevant documents. This was agreed to be useful, though the list would inevitably be incomplete.

The NDS agreed to submit a proposal to INDC members, which would reconcile as far as possible the wishes expressed during the discussion, for eventual inclusion in the Compendium of Committee Regulations*.

2i Establishment of Subcommittees

At previous INDC meetings there had often been insufficient time for the (ad hoc) Subcommittees to complete their work. The chairman therefore suggested that those items requiring Subcommittee consideration be identified, discussed briefly, and the Subcommittees appointed without delay.

An ad hoc Subcommittee was set up to consider "Discrepancies in Important Nuclear Data including Standards" consisting of Havens (chairman), Aten, Jankov, Rae, Schmidt and Taschek. They were asked to consider whether a Standing Subcommittee should be formed, or possibly two - to deal with discrepancies and standards separately. Their report is given in Appendix 3.

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* It appears from INDC(SEC)-13/U (November 1970) that the NDS has decided to implement the G, L, U categories recommended in Appendix 6 of INDC(SEC)-9/L.

The desirability of a Subcommittee on "Evaluation" was discussed. It was recognized that many problems in evaluation arise from discrepancies, and it was therefore decided that the ad hoc "Discrepancies" Subcommittee, with the addition of Joly and Nishimura, should also report on the need for a Subcommittee on evaluation (see Appendix 3). Abramov pointed out that evaluation work also involves other problems, such as format.

It was agreed that Schmidt and Hanna should draft a recommendation on the usefulness of specialists' meetings on discrepancies and evaluations such as those held at Studsvik prior to the Helsinki conference. The text of this recommendation, as finally approved by the full Committee, appears in Appendix 1.

After a short discussion it was agreed to postpone the setting up of a Subcommittee on "Nuclear Data for Safeguards" until after Dr. Rometsch's lecture (see agenda item 6b and Appendices 3 and 4).

A Subcommittee on "Targets and Samples for Nuclear Data Measurements" was set up, comprising Divatia (chairman), Abramov, Berinde, Hjärne, Joly, Souza Santos, and Sujkowski. The preliminary discussion and the consideration of their report are given in item 9c below.

3 PROGRESS REPORTS

3a Reports from Members

Most reports from members consisted of references to items in Progress Reports that were either already distributed or would shortly become available. This section, and the next, includes only those items for which the presentation or discussion extended what was already available in published reports and papers.

USSR

Abramov mentioned several of the investigations reported in INDC(CCP)-8/G and -9/G and in the Helsinki Conference Papers CN-26/40, and -/76 through -/82. Jankov referred to a new direction in USSR activities, arising out of an IAEA initiative, to provide nuclear data for safeguards. He reported that Vorotnikov had made measurements of σ_{nf} and the angular distribution of the fragments for ^{232}U between 150 keV and 1.5 MeV, and for ^{249}Bk between 0.6 and 1.8 MeV. The fission cross sections above ~ 1 MeV are 2.2 b and 1.4 b respectively.

Austria

Weinzierl described work at the Seibersdorf laboratory on the proton recoil spectrum from neutron decay which should be producing results by the end of the year comparable in accuracy with the recent data from ANL. They were also starting a parity admixture experiment on ^{203}Tl which would take over a year to complete. In cooperation with AERE they were carrying out measurements on the Harwell linac of σ_γ, and of gamma spectra at different resonances, for separated erbium isotopes.

Regarding facilities Weinzierl said the rotating crystal spectrometer system at Seibersdorf was being improved by the addition of a phased chopper to reduce background, and the Cockcroft-Walton 14 MeV-neutron generator at the Radium Institute had been converted to pulsed operation.

Poland

Sujkowski referred to INDC(POL)-3/G,L and noted that the calculation of fission-barrier penetrability by Szymanski et al

was relevant to the production of super-heavy nuclei. The progress report did not refer to work on the angular distribution of alpha particles from the ternary fission of ^{235}U which would shortly be published.

UK

Rae provided some information on progress since the period covered by INDC(UK)-10G (mid '68 to mid '69) and referred specifically to Helsinki papers CN-26/25, -/26, -/35, -/36, -/105, -/107. In collaboration with Postma's group from the Netherlands, who provided the ^{3}He-^{4}He dilution refrigerator, the Harwell linac group was studying the angular distribution of fission fragments from aligned nuclei; the results for a large number of resonances in ^{233}U, ^{235}U and ^{239}Pu indicated an absence of very low values of K. He also mentioned that measurements at the Harwell synchrocyclotron had shown no sign of the reported oscillations in the (n,p) cross section.

Replying to a question from Joly, Rae said the new liquid scintillator referred to in INDC(UK)-10G (page 5) had been tested and was working satisfactorily. He informed Divatia that the Oxford University Tandem was used for "pure" nuclear physics work; however, the Glasgow electron linac might be used for inelastic neutron scattering and gamma-ray production measurements.

Kinchin, answering Cierjacks, mentioned fusion-reactor calculations on hypothetical systems, especially of tritium breeding in blankets.

Germany

Cierjacks referred to various items in the Euratom progress report for 1969 (EANDC-E-127(U), to be distributed shortly) and to Helsinki papers CN-26/7, through /14. He also mentioned plans to use the KFK isochronous cyclotron to measure gamma-ray production cross sections with a Ge(Li) spectrometer and to repeat earlier measurements of σ_f for ^{238}U and ^{240}Pu with better statistical accuracy.

Australia

Clancy explained that INDC(AUL)-8/G provided a brief summary of what would appear in the Physics Division Progress Report. Answering questions from Taschek and Cierjacks on Boldeman's $\bar{\nu}(E)$ results, Clancy said they believed there were enough data points of sufficient accuracy to rule out earlier claims of structure, though no quantitative statistical-significance analysis had been made.

Romania

Berinde summarized INDC(RUM)-1/G; he explained to Joly that the (γ,xn) cross sections, measured using a $^{10}BF_3$ long counter, were analyzed, into (γ,n) $(\gamma,2n)$ etc, by the extrapolation of excitation-function data. The fine structure had been obtained from a computer program (Cook method) but details requested by Souza Santos on the calculation of the bremsstrahlung spectrum were not available.

Euratom-Geel/Netherlands

Aten referred to the Euratom Progress Report (EANDC(E)127U) and to Helsinki Conference papers CN-26/16 through /21, -/100 and -/106.

France

Joly described work on the Saclay linac, the Cadarache Van de Graaff and the Tandem at Bruyères-le-Châtel, which are used, respectively, 60%, 100% and 20% of the time for neutron measurements. The Saclay linac was upgraded last year to four sections giving 80 MeV at zero current or 60 MeV at full power (8 kW) which resulted in a 2-3 fold increase in neutron intensity (peak currents at 50 nsec (10 nsec) are 1.6 A (3.5 A) and the repetition frequency is 10^3 Hz). New inclined field tubes were designed and installed at Cadarache giving a maximum voltage rating of 5.5 MeV.

During 1970 the Saclay linac was used for σ_t measurements, now completed, on separated Nd isotopes loaned by the USSR. Other work, on fissionable nuclei, was reported extensively at

Helsinki. Joly mentioned that the Saclay measurements of $\sigma_f(^{235}U)$ agreed with ORNL results, but not with the LASL data between 50 and 500 eV which were systematically lower, and Taschek mentioned the existence of discrepancies between the LASL results (based on ^{6}Li) and those from LRL (based on boron).

The work of Leroy at Cadarache was described in CN-26/69 and -/70 (measurements on $\sigma_f(^{241}Pu)$ to follow) and Soleilhac's $\nu(E)$ work at Bruyères-le-Châtel in CN-26/67.

Answering Aten and Taschek, Joly said that the Cadarache long counter had not been inter-compared with long counters at other European laboratories, and that its response showed no fine structure below the energies corresponding to resonances in carbon, which had been seen.

USA

Havens and Taschek summarized the Progress Reports to the NCSAC Meeting of May 1970 (to be distributed in July) and referred to some of the US papers presented at Helsinki (CN-26/42, -/45, and -/46). Havens mentioned a recent run (end of May) on the Nevis cyclotron involving transmission measurements on some 40 substances along with fission and capture experiments. The results, expected to be available in about a year, should be very much better than those previously available. Taschek informed Cierjacks that the σ_γ data from Gulf General Atomic did not support Poenitz's contention that measurements of σ_γ for Au based on ^{10}B tended to be systematically high. Rae asked whether LRL intended to make a flux measurement in connection with their $\sigma_f(^{235}U)$ work but was informed that this would not be done until after the linac is rebuilt. Taschek, answering a question from Kinchin, stated that they had no explanation for the drop in delayed neutron emission between 3 and 14 MeV incident neutron energy that Keepin had observed for ^{233}U, ^{235}U and ^{239}Pu. Schmidt mentioned the revised calibration of the Poenitz gray detector which had reduced the discrepancy between the Poenitz and White measurements of $\sigma_f(^{235}U)$ from 12% to 9%.

Taschek explained to Abramov that the Physics series of underground nuclear explosions was now designated by number since they had not been able to think of any more words beginning with P. Pommard (No.7) had been followed by Physics 8 which was done last winter.

Kolstad presented detailed information on the US facilities. He reported that the 4 MV tandem Dynamitron at ANL was operating very successfully (> 50 μA on target) and the nanosecond pulsing system for the 4 MV single-ended Dynamitron was nearing completion. The two MP tandems at Brookhaven had passed performance tests, and three stage operation was expected shortly. He described modifications to the Nevis cyclotron planned for 1970-71 which should increase beam intensities by a factor of ten or more. The 100 MeV electron accelerator at Livermore was nearing acceptance; it should provide electron pulses of 5 nsec to 3 μsec duration at a repetition frequency of 0 to 1300 pps with a maximum power of 50 kW, and a continuous positron current of 0.1 to 1 μA at 10-80 MeV. The 30 MeV LRL cyclograaff should be in full operation in July 1971. The LASL meson physics facility (LAMPF) was expected to provide an initial 800 MeV beam by the summer of 1972 with all basic accelerator construction completed a year later. The University of Maryland Isochronous Cyclotron had produced external beams of protons at energies of up to 100 MeV. The 400 MeV Electron Linac at MIT should be complete by early 1972; a low energy beam was expected early next year. The ORNL Electron Linac (ORELA) had been accepted in August 1969 and operation had averaged 71% of scheduled time since then.

Rae asked about pulsed systems of the superbooster type and was informed that the major US effort had been discontinued, though Fluharty was continuing some low level studies, and Stein was investigating the LAMPF-type cavity system to find out whether it was stable at high current. It was confirmed that the MTR reactor had been closed down; the physics group at INC were expected to make considerable use of ORELA.

Brazil

Souza Santos reported that the activities in Brazil were somewhat less than in previous years, and were all centred at the Institute of Atomic Energy in Sao Paulo. They included measurements on a single crystal of germanium, which gave results in good agreement with theory, and crystal spectrometer measurements of σ_{tot}(Au) in the range 1.88 to 2.96 Å (good agreement with Gould's results), and of σ_{tot}(Yb) between 0.049 and 0.409 eV (good agreement with existing data).

Total cross sections of polyethylene and H_2O had been measured at room temperature using a slow chopper in the range 0.8 to 10 Å and compared with theory. The scattering cross section per hydrogen atom could be approximated by straight lines ($a + b\lambda$) with values of b equal to 5.1 ± 0.1 and 6.8 ± 0.1 b/Å for polyethylene and H_2O respectively.

Further measurements of the photo-fission cross sections of thorium and natural uranium were being made, using neutron-capture gamma rays, to improve the accuracy of the results reported last year in INDC(BZL)-2/G.

Regarding facilities, Souza Santos reported that the 80 MeV electron linac (obtained from Stanford) would soon be operating. Tests on the new Sao Paulo tandem, which was still in the USA, had been very satisfactory. A 300 MeV electron linac was to be built by the Brazilian Atomic Energy Commission at the University of Rio de Janeiro for meson work.

Japan

Nishimura referred to the supplement, covering activities at JAERI, to the previous Japanese Progress Report INDC(JAP)-4/E. Joly asked about the replacement of the electron linac at JAERI and was informed that this would be starting in August.

India

Divatia referred to INDC(IND)-10/G and -11/E, and distributed a BARC document describing the Variable Energy Cyclotron Project. A facility not mentioned in the preface to INDC(IND)-11/E was a 400 keV Van de Graaff for Benares University.

Canada

Hanna summarized INDC(CAN)-7/G and reported that the calandria of the NRU reactor at Chalk River was expected to be replaced during 1971; some structural changes were planned that would considerably improve neutron and gamma beam intensities.

3b Reports from Countries not represented on INDC

Schmidt spoke to the progress reports that had been received by the NDS, INDC(FIN)-1/G, INDC(HUN)-1/G and its supplement, INDC(BUL)-1/G, INDC(TUR)-1/G, and INDC(SAF)-2/G, explaining that these reports had been received in response to requests made some months ago.

Taschek noted that the report from Debrecen INDC(HUN)-1/G had recommended the formation of an international group of specialists, and Schmidt confirmed that there were plans to start a joint project on nuclear reaction cross sections between Hungary, Yugoslavia, and other East European countries.

There was a discussion on the non-appearance of some expected progress reports, and it appeared that procedures should be modified in some respects, e.g. to avoid confusing some West European countries. It was confirmed that no progress reports had been received from Israel, Pakistan or Yugoslavia, but that one from Switzerland was in preparation.

3c Consideration of neutron data measurements using underground nuclear detonations

Taschek explained that this agenda item was originally intended to cover reports from an IAEA Panel (Vienna, March 1970) on the Peaceful Uses of Nuclear Explosions which in fact had been largely concerned with engineering applications. However, he believed that eventually there could be large scale international participation in nuclear data measurement programs.

Spinrad reported that there had been some discussion at the panel on nuclear data measurements, that France the USA and the USSR had expressed great interest, but that no further "scientific" explosions would be undertaken for some time because of their cost. Regarding cost sharing on an international basis his unofficial impression was that most of the countries having a major interest in nuclear data would be willing to participate if the price was right. Another panel will be meeting in January 1971, and although this will deal exclusively with the engineering applications of peaceful nuclear explosions, Spinrad felt that Committee members might wish to influence their governments in the direction of international cooperation.

Taschek made a rough estimate of the cost of a "shot" as several million dollars (not including the experimental equipment) of which a large fraction is the cost of drilling the hole. However, since about 100 experiments could be carried out with a single shot the cost per experiment might well be tolerable. Taschek also mentioned the discrepancies between results obtained by this technique and results from linacs, which, he believed, would have to be understood before one would want to proceed further.

Rae pointed out that a participating institution would have to build up a really competent team, and the real cost would therefore be much higher than its share of the shot cost.

Kofoed-Hansen raised the question of political problems which would be very severe for some institutions.

Abramov believed that the INDC should only consider the scientific questions, both costs and politics being outside its competence.

In an extensive general discussion it appeared that the requests for measurements requiring underground nuclear explosions were regarded by some members as indispensible, by others as having sufficient economic importance to justify the probable costs, and by others, notably Aten, as failing this economic criterion.

It was finally agreed that Taschek would try to produce some improved cost estimates at an early date, and that Committee members would, at their discretion, make informal approaches to their own institutions regarding possible interest and report back at the next INDC meeting.

3d Status of Outstanding High Priority Needs and Discrepancies

3d(i) The fission neutron spectrum problem

The chairman referred to a letter, dated 26 November 1969 from E. Critoph, chairman of the EACRP, which drew attention to the evidence from integral experiments in favour of a somewhat higher mean energy for the fission neutron spectrum than is currently accepted. Critoph also raised the question of the effect of incident neutron energy, and asked that this topic be raised at the next INDC meeting. Kolstad mentioned correspondence between Committee members, and asked Havens to report on the situation.

Havens referred the committee to the papers by Smith INDC(USA)-16/G and Lubitz and Stewart INDC(USA)-17/L for a detailed discussion. The authors of these reviews were reluctant to accept the results of the integral experiments but found the discrepancy disturbing and suggested further experiments. Havens presented preliminary results from time-of-flight work, currently in progress by Smith at ANL, on the fission of

^{235}U and ^{239}Pu induced by neutrons in the energy range 100-450 keV. Smith is concentrating on the portion of the fission neutron spectrum below 2 MeV. The data so far processed, for the range 0.3 to 1.6 MeV, are well fitted by a "Maxwellian" distribution of mean energy 2.0 MeV (and not by one of 2.4 MeV, the mean energy suggested by McElroy). Havens believed that the problem was with the $\sigma(E)$ data used for the interpretation of the integral measurements.

Aten was sceptical of the assumption of a Maxwellian distribution and suggested that the shape was not well enough known for the apparent discrepancy between microscopic and integral measurements to be taken very seriously.

Abramov cited some indirect evidence obtained in the USSR that cast doubt on the accepted fission neutron spectrum, e.g. a measurement by Bondarenko of the absorption cross section of ^{238}U in a fission spectrum, which did not agree with the value expected from microscopic data, and the most recent data from fast critical experiments which gave a value of the ^{238}U fission cross section some 20% greater than the calculated value. Abramov also expressed a belief that discrepancies in $\bar{\nu}$ values might be due to inaccurate assumptions regarding the fission neutron spectrum. On the other hand he considered that the slowing down length measurements supported the accepted value for the mean energy. He suggested that possibly the generally assumed shape was seriously in error, and that the hard part of the spectrum should be harder and the soft part softer. He referred to the paper presented to the Helsinki conference by Zamyatnin et al. (CN-26/90) where the fission neutron spectrum of different fissioning nuclides had been compared; the data had not yet been fully analyzed or compared with other measurements. He noted that changes in the fission spectrum would affect group-averaged cross sections, and mentioned that Smith's paper INDC(USA)-16/G had been discussed in the USSR and that Smith's recommendations for further measurements were supported.

The desirability of having the data centres collect and collate data on the fission neutron spectrum was discussed. Schmidt and Liskien agreed that all four centres could share the data collection work, but that any evaluation should be the responsibility of one centre. Schmidt emphasized the need to contact experimenters, and Havens recommended a Consultants Meeting between experimenters and evaluators; Abramov supported Schmidt and Havens.

3d(ii) Present status of $\bar{\nu}$ data

Schmidt introduced this topic, and the next one, by referring to the Consultants Meetings, on $\bar{\nu}$ and on $\alpha(^{239}Pu)$, held at Studsvik immediately before the Helsinki Conference. He acknowledged the kindness of the Swedish Government in arranging these meetings at very short notice. He considered them to have been successful enough to warrant similar ones in the future, though there had been some shortcommings due to lack of time and conflict with the meeting of the EANDC(EACRP Joint Subcommittee on Evaluation. It had not been possible to arrange for the experts to receive in advance copies of the papers to be discussed, and some prominent experts had not been able to attend.

The Consultants Meeting on $\bar{\nu}$, 10-11 June 1970, was attended by D.W. Colvin (UK, chairman), H. Condé (Sweden), G.C. Hanna (Canada), V.A. Konshin (IAEA), D.S. Mather (UK), J.J. Schmidt (IAEA), M. Soleilhac (France), S.I. Sukhoruchkin (USSR) and A. De Volpi (USA). Schmidt reviewed the program, which comprised reviews by Hanna on thermal values, by De Volpi on $\bar{\nu}(^{252}Cf)$, by Soleilhac on $\bar{\nu}(E)$ measurements (CN-26/67), by Mather on $\bar{\nu}(E)$ for ^{239}Pu, by Sukhoruchkin on the USSR papers CN-26/40, /74, /78, and /90, by Condé on $\bar{\nu}$ measurements in a fast reactor spectrum (CN-26/59), by Colvin on the status of $\bar{\nu}$ data, and by Davey on evaluated values. A draft of INDC(NDS)-19/N, a review of $\bar{\nu}$ data by Konshin and Manero, was also presented to the meeting. D.W. Colvin had

presented a summary paper to the Helsinki Conference, and was preparing a report to the IAEA containing the Recommendations of the Consultants Meeting, which are given in Appendix 6.

Schmidt drew attention to the effect found recently by Soleilhac in liquid-scintillator measurements of $\bar{\nu}$. The liquid-scintillator is triggered by a "prompt" pulse, and Soleilhac has found that the efficiency for detecting a prompt pulse increases with the number of fission neutrons emitted; $\bar{\nu}$ is therefore overestimated. The magnitude of the effect depends on the details of the apparatus used but errors of up to $\sim$ 1.5% seem possible, which could appreciably reduce the 2-2.5% discrepancy between the high values of $\bar{\nu}$ for ^{252}Cf obtained using liquid scintillators (by Hopkins and Diven, and by Asplund-Nilsson, Condé and Starfelt) and the lower values obtained in most other experiments.

Hanna mentioned that Condé, and Mather, believed that the apparatus they had used would have been subject to considerably smaller errors, e.g. $\sim$ 0.1%. He also pointed out that the thermal values of η and $(1 + \alpha)$ along with $\bar{\nu}$ ratio measurements, which should be very little altered by the "Soleilhac effect", support a high value of $\bar{\nu}$ for ^{252}Cf. He mentioned De Volpi's work on measuring η, which will apparently be abortive since no funds are available to support the processing of the data. However, Spinrad believed that the "clean critical" η values were extremely reliable and that any discrepancies with $\bar{\nu}$ data had to be due to other causes, possibly in thermal neutron spectra.

Taschek asked whether the discrepancies between different measurements of $\bar{\nu}(E)$ could be due to shifts in the energy scale, and Hanna replied that this might be a partial explanation. Abramov mentioned Smirenkin's assessment, made before the consultants meeting, that the available data on $\bar{\nu}(E)$ for ^{235}U were all consistent; this was therefore no longer a problem, except for Boldeman.

3d(iii) Present Status of α for Pu-239

The IAEA Experts Meeting in Studsvik, 12 June 1970, had been attended by V.A. Konshin (IAEA, Scientific Secretary), J.Y. Barré (France), W.G. Davey (USA), G. de Saussure (USA), J.A. Farrell (USA), L. Hjärne (IAEA), J.L. Rowlands (UK), J.J. Schmidt (IAEA) and S.I. Sukhoruchkin (USSR). Four Swedish Observers had also attended. Konshin had reviewed the present status (INDC(NDS)-17/N), and presented the paper (CN-26/124) by Ryabov et al. Presentations by the other experts included papers CN-26/33, /46, /47, /73, /89, and /96. S.I. Sukhoruchkin presented a summary paper to the Helsinki Conference. The recommendations of the meeting are given in Appendix 7.

Konshin reported that the results from the different measuring groups were in fair agreement ($\sim$ 15%) but more detailed evaluation was needed. He mentioned the possible importance of $\bar{\nu}$ variation, of angular anisotropy of fission fragments, of changes in gamma-ray de-excitation cascades over the neutron energy range of interest, and of different methods of treating background. He noted that fission areas ($\sigma\Gamma_f$) agreed better than resonance parameters; Havens agreed that this was always the case, but considered point-by-point comparison of experimental data to be dangerous.

Taschek suggested that integral measurements of α would be of interest, and Schmidt referred to Barré's measurements (CN-26/73,96) which, however, are subject to errors from the neutron spectrum and heterogeneity effects that are larger than the 4-7% errors from the isotopic analysis.

3d(iv) Discrepancies in Neutron Capture in Structural and Canning Materials

Rae, referring to Moxon's Helsinki paper CN-26/32, noted that even for iron there are differences of $\pm$ 30% between experimental measurements of σ_γ in the 1-100 keV range; for nickel, chromium, and vanadium the situation is much worse, with discrepancies of factors of 10. Corrections for self-shielding can be very severe, so that a simple extrapolation of measured

data to zero thickness can lead to large errors, and Rae suggested that some discrepancies might well be reduced by proper calculations including multiple scattering.

Abramov agreed with Rae and noted the difficulty that had been experienced in interpreting measurements on ^{238}U made in the slowing-down-time spectrometer; long thin cylindrical samples had been used and calculations were difficult.

Schmidt asked how one was to carry out self shielding calculations in the "unresolved" range. Rae, noting that narrow p wave resonances could be important, said that Monte Carlo methods had to be used, and this was very expensive of computer time.

3d(v) The possible isomeric state in Pu-241

Hanna outlined the claim made by Nisle and Stepan (INDC USA-14/U, page 67) for the existence of an isomeric state in ^{241}Pu with a half life of 0.34 ± 0.11 y. The claim is based on the shape of a reactivity decay curve, the initial part of which represents ^{241}Pu that was at least two years old; much larger effects should therefore be observable using fresh ^{241}Pu, viz. an apparent fission cross section of about twice the normal value. Hanna had obtained information on the irradiation history of the fresh ^{241}Pu used by Jaffey et al (ANL-5397, 1955) in their pioneer measurements of its thermal fission cross section, and of the ^{240}Pu (containing an appreciable amount of fresh ^{241}Pu) used by Barclay et al (Proc. Phys. Soc. A67, 646, 1954) in their determination of the spontaneous-fission half life of ^{240}Pu. Comparison of these results with modern data gives upper limits to the fission cross section and the spontaneous fission rate of ^{241}Pu much lower than would be required to explain Nisle and Stepan's results.

Rae drew attention to the Harwell work reported by James in CN-26/107. A ^{240}Pu sample was irradiated for 3 weeks in a flux of 10^{14} neutrons/cm^2 and its fission properties then compared with a ^{241}Pu sample that was several years old. The

resonance structure between 0.005 eV and 20 eV was found to be identical, and by normalizing the two sets of data to each other at the 0.24 eV resonance the thermal fission cross sections were found to be equal to within ± 1.5% at a time when the fresh sample was 2 months old.

4 STANDARD DATA

4a Status of Basic Standard Data

4a(i) The n-p cross section

Taschek referred to the recent evaluation by Hopkins and Breit (now available as LA-DC-11153) which provides data for the range 100 keV to 30 MeV. The results are derived from analyses of essentially all available (p,p) and (n,p) data up to several hundred MeV. They indicate a significantly greater anisotropy below 10 MeV than given by the Gammel formula, and an appreciable forward-backward asymmetry above 10 MeV.

4a(ii) The U-235 fission cross section near 22 keV

Havens had mentioned earlier (item 3a) the Livermore measurements by Bowman et al (CN-26/41) which show standard-deviation fluctuations of ~ 10% in the 20-30 keV range. Bowman had estimated that these could only account for errors of a few percent in the measurements of σ_f at ~ 30 keV by Knoll and Poenitz and in those at ~ 23 keV by Perkin et al using a Sb-Be source. Havens noted that Bowman had used a uniform energy average in estimating such effects, which would often be inappropriate, e.g. in Van de Graaff measurements; experimenters should do their own averaging.

Rae stated that the Harwell measurements (AERE-R6350) of fluctuations in $\sigma_f(235)$ agreed with Bowman's to within the experimental errors. Taschek reported that the Physics-8 underground explosion gave results for $\sigma_f(235)$, relative to $^6Li(n,\alpha)$, in almost precise agreement with Bowman.

4b The LASL task group effort to measure the U-235 fission cross section from 1.5 to 20 MeV

Taschek outlined the plans for a measurement, to be carried out by a team including Diven, Hansen, Koontz and Nobles, of $\sigma_f(235)$ against the np cross section in the range 1.5 or 2 MeV up to 25 or 27 MeV. A proton recoil telescope

of modern design will be used and particular attention will be paid to scattering effects since a reconsideration of such effects by Henkel and Nobles had led to revisions of from 6% to 15% in the old LASL measurements. In answer to a question by Abramov, Taschek stated that the energy resolution would be about ± 10-15 keV. The T(p,n) reaction would be used over the most of the range, with time-of-flight employed to discriminate against background.

Rae mentioned that the Harwell boron-vaseline detector, which has a flat response up to ~ 1 MeV will be used in a measurement of $\sigma_f(235)$.

Cierjacks reported that Käppeler et al will be using the KFK 3 MeV pulsed Van de Graaff for a measurement of $\sigma_f(235)$ from 0.3 to 1.3 MeV relative to the (n,p) cross-section.

5 PANELS AND CONFERENCES

5a Reports on Past Meetings

Schmidt reported that Dr. Good had attended the CODATA meeting in Rome (June, 1969) and referred to the summary given in INDC(NDS)-23/G. The program for the next meeting, to be held in St. Andrews, Scotland, in September was not yet available. Kolstad asked whether CODATA could be effective in the nuclear data field, which appeared to be already well coordinated. Schmidt thought it was nevertheless valuable to compare experiences in different fields and it was agreed to maintain contact by continuing to have an INDC member attend CODATA mettings (recommendation 1 of the Second INDC Meeting).

Hjärne had attended the IAEA Symposium on the Handling of Nuclear Information (Vienna, February 1970) which in fact dealt primarily with documentation. The American Institute of Physics was planning an experiment with "users journals", prepared for a relatively small specialized group; information centres would have an important contribution to make to such activities. Hjärne also mentioned the UNESCO-ICSU program UNISIST which is aimed at stimulating cooperative interaction between major science information systems, e.g. INIS. Future UNISIST recommendations might include attempts to relate the functions of data centres to the literature-based systems and the Committee asked Hjärne to keep them informed on such developments.

The Committee agreed to forgo any report on the IAEA Symposium on the Physics and Chemistry of Fission (Vienna, August 1969) since the Proceedings had been available for some time. The IAEA Panel on Peaceful Nuclear Explosions (Vienna, March 1970) had been discussed under Agenda Item 3c.

Graves spoke briefly on the Symposium on Neutron Gamma-ray Spectroscopy (Studsvik, August 1969). This was not an IAEA symposium though the IAEA had provided some financial support, and had published the proceedings (December 1969); it had been organized by the Chalmers Institute of Technology and the

University of Gothenburg with the help of an international advisory committee. A symposium of somewhat wider scope was being organized by Professor Kiss for 1972 in Budapest.

A report on the IAEA Panel on Instrumentation for Neutron Inelastic Scattering Research (Vienna, December 1969) written by J. Dolnicar of the IAEA was distributed to participants. The panel had been concerned with the techniques used in studying the solid and liquid state, and there was no discussion.

Spinrad reported briefly on the meeting of the IAEA International Working Group on Fast Reactors (Cadarache, March 1970), the minutes of which were being sent to INDC members. He mentioned that this group was coordinating the number of meetings and symposia in their field; a specialists' meeting of interest to the INDC is listed under item 5c below. Schmidt recalled the request by C.G. Campbell at the Helsinki conference for more intercomparison of integral experiments. Spinrad reported that the IWGFR had decided, in 1969, not to sponsor intercomparisons but only to encourage individual efforts. Some remarks on the participation of reactor physicists in the Helsinki conference are summarized below.

The Helsinki Conference on Nuclear Data for Reactors (June 1970) was considered to have been very successful and the INDC expressed its appreciation of the organizational efforts of the IAEA and the hospitality of the Finnish authorities. Further conferences of this type were recommended (see Appendix 1). A report on the results of the Questionnaire circulated at Helsinki was being prepared, to be issued by Hjärne as an INDC(NDS) document. Regarding the scope of the conference, Taschek had (earlier) asked about the possibility of increased participation by reactor physicists, and Spinrad had replied that this could well lead to the usual difficulties characteristic of very large conferences; scheduling two related conferences back to back in successive weeks was also difficult because they would have to be approved separately within the IAEA. Schmidt mentioned

the problems raised by the large number of contributions submitted to the Helsinki Conference. Kolstad recommended more use of the rapporteur system, and Havens suggested that some papers could be read "by title", which would lead to discussion, in order to satisfy the requirement of some institutions that a participant must present a paper. Regarding small prior meetings of experts, Kolstad recommended that they be a more integral part of future conferences, which would allow more interested people to attend them. This suggestion raised the problem of providing simultaneous interpretation for parallel or additional sessions. In Havens' opinion there need be no formal obligation to provide interpretation at a specialty meeting accompanying a big meeting. Abramov agreed and cited the procedure adopted at some Dubna meetings - the daily plenary sessions ended early enough to allow the holding of several small parallel seminars each evening when an informal interpretation service was provided by the participants themselves. Taschek asked for more prompt notification of the acceptance or rejection of submitted papers; Schmidt explained that half of the abstracts were received after the official deadline and that he had been reluctant to reject a paper merely because it was late, official channels often being very slow. A suggestion that unofficial channels be used in parallel met with a mixed response.

Lemmel reported on the meeting of the EANDC/EACRP Joint Subcommittee on Evaluation (London, 10-12 June 1970). The main goals of the meeting had been to compile a progress report on evaluations, to set up a newsletter and a request list and to coordinate evaluation activities. Reports on progress in evaluation work are given in item 8 below. The newsletter, organized by P. Ribon of Saclay, will be distributed every four months, starting in July, to evaluators in the OECD area. The Joint Subcommittee recommended that the evaluation request list be incorporated into RENDA at some (unspecified) stage of the RENDA operation, and that coordination be improved by

continued meetings of European evaluators once or twice a year. Liskien supplemented Lemmel's report by mentioning the subcommittee's belief that automatic format conversion was not practicable and that a single internationally agreed format would not be possible for three to five years. He also mentioned a difficulty with request lists - that it is often not clear whether an evaluation of existing measurements would satisfy a request, or whether a new measurement is required.

5b Conclusions and Implications of Totality of Above Meetings

There was no specific discussion of this agenda item.

5c Future Meetings (Scheduled or Proposed)

Lorenz presented the lists of IAEA meetings for 1970 INDC(SEC)-6/G,L and its supplement, which are to be regarded as provisional and possibly incomplete; the next report will be issued at the end of the year. Two reports per year are considered sufficient, and listing for more than six months ahead is impracticable.

Havens mentioned the lists of meetings published in Physics Today (which is sent to the IAEA) and in the Newsletter of the Nuclear Physics Division of the American Physical Society. Graves drew attention to the Quarterly World-wide List of Conferences published by the IAEA.

Graves outlined the plans for the IAEA Panel on Pulsed Neutron Research (Vienna, August, 1970) which was intended to cover the subject very broadly. It was expected that time-of-flight techniques would not be stressed, and it appeared not to be of prime interest to the INDC.

Schmidt referred to the NDS panels proposed in INDC(NDS)-23/G, page 16, and stressed the need for flexibility e.g. the panel on Evaluation Methods might fold in experts meetings on vital topics, and the panel on Standards would be affected by the EANDC meeting on Standards (October 1970). Kolstad asked about the symposium on the collection (etc.) of nuclear data that had been recommended at the Second INDC Meeting

(Recommendation No.7) with particular reference to non-neutron data. Schmidt and Lorenz thought that it was first necessary to establish what was required in this field and Graves outlined plans for a consultants meeting in November 1970, which are summarized in items 10b and 10c below.

Havens described plans for the EANDC Symposium on Nuclear Standards (ANL, October 21-24, 1970) which about 30 people are expected to attend. Review papers will be given on H, ^{3}He, ^{6}Li, ^{10}B, ^{12}C, and fission and capture standards, and there will be sessions on flux measurement techniques and miscellaneous topics, including $\bar{\nu}$ and the fission spectrum. Working groups will formulate recommendations. The proceedings will receive wide distribution as an EANDC document.

Havens also distributed a tentative program for the International Conference on the Statistical Properties of Nuclei (State University of New York at Albany, August 23-27, 1971); this very wide topic will be reduced to essentially "Statistical Properties of Neutron Resonances" and further information will be distributed shortly.

Schmidt spoke briefly on the 1971 Geneva Conference, the Fourth International Conference on the Peaceful Uses of Atomic Energy; nuclear data would be peripheral but some contribution, possibly a review paper, might be envisaged. Several specific suggestions were put forward to the Committee, but were not formulated into a recommendation after Graves had explained that the Geneva Conference would emphasize political and economic implications rather than scientific problems. The agenda had been settled after considerable work by the IAEA's SAC, the UN SAC and the IAEA, and he did not recommend the INDC trying to change it.

There was no further discussion of the next CODATA meeting (see item 5a).

Graves outlined the status of the Regional Study Group

Meeting on Accelerator Utilization which, after postponement from May 1970, will probably take place in February 1971 in Buenos Aires. A five-day meeting is planned, with major accelerator groups in Central and South America submitting reports, and it is hoped that definite recommendations for collaboration, possibly including regional sub-groupings, will be put forward. Some three to five experts from Europe and/or North America may be invited to attend.

Graves also reported that an International Symposium on Controlled Fusion and Plasma Physics will be held at Madison (USA) 21-26 June 1971; details are being worked out with the IAEA. The IAEA's Physics Division has proposed a panel on Charged Particle Capture for 1971 and a Symposium on Neutron Inelastic Scattering (like the Copenhagen symposium) has been approved for 1971.

Rae asked about the Third Conference on Neutron Cross Sections and Technology (Knoxville, 15-17 March 1971) but Kolstad replied that this was only a national conference. Havens mentioned that the final programme will be approved at the October meeting of the Nuclear Physics Division of the American Physical Society.

6 THE NON PROLIFERATION TREATY AND ITS IMPACT ON IAEA POLICIES

In his special lecture Dr. Rometsch briefly outlined the history of safeguards activities. The IAEA was involved some ten years before the Non Proliferation Treaty but a great expansion of their existing activities is envisaged over the next five years. A thirty to fifty fold increase in staff would be required unless considerable rationalization and simplification can be achieved, without, of course, compromising effectiveness.

The four major elements of a safeguards system are:
(i) the safeguarding authority must have knowledge of the facilities in which nuclear material is used,
(ii) the operators of these facilities must keep records,
(iii) reports based on these records must go to the authority,
(iv) inspections are required, essentially to audit the operators' books, and surveillance, to ensure that the material keeps on the track foreseen by the operators, is also necessary.

Two years ago the IAEA set up a Development Division to determine the most important actions and to maximize the ratio of effectiveness to cost. It has been mainly concerned with improving the techniques for specific measurements; optimization of the whole system is a complex and difficult problem. There is also a desire to improve the overall credibility by developing methods for estimating the effectiveness of a system that are based on statistical confidence levels obtained from quantitative measurements rather than having to rely on the judgement of inspectors. All these activities are influenced by the possible conflict between effectiveness and acceptability.

The work of the Development Division is most closely connected with the interests of the INDC in the area of measurements and their verification. Information on the source material, which is required by the facility operator, can be obtained by relatively simple methods, though the older techniques are being replaced, e.g. there has been a considerable advance during the last two years in the non-destructive assay of complete fuel elements. The "next step", measuring what has been produced in a reactor, involves more nuclear data problems. Possible

alternative approaches are:
(i) calculation from reactor codes (which may however be ruled out if the reactor information itself is confidential),
(ii) measurements on irradiated elements (e.g. of gamma-ray activity) for comparison with rough burn-up calculations based on total power, and
(iii) containment of irradiated fuel until reprocessing when a destructive analysis can be made.

The recycling of plutonium from the reprocessing plant through fuel fabrication involves similar problems, and the non-destructive assay of plutonium fuel has also made great progress in recent years.

6a Implications to INDC Interests

In the discussion that followed Dr. Rometsch's lecture Taschek asked about the accuracy required, noting that "one percent of a hundred tons makes a lot of weapons". Rometsch agreed, though the quantities of fissile material with a high "diversion potential", e.g. plutonium, have not yet reached this level in non-nuclear-weapons states. He admitted that keeping track of plutonium through reprocessing plants would be difficult and cited his own experience at Eurochemic, where great efforts had been required to reduce the "material unaccounted for" to about 2%. However, the main intent cannot be to prevent the production of a single bomb but rather to ensure that no important nuclear weapons program can be built up.

Replying to Havens, Rometsch predicted that checking operations would have to grow, by a factor of five to ten in their budget, during the next ten years, but that the effort on instrument development, currently involving some 20 professionals, would probably not expand much. They evaluate work in other institutions, and if there is an immediate need for specific information they will usually arrange a research contract.

Kinchin asked whether any general statement could be made regarding the relation between destructive and non-destructive testing. Rometsch replied that interest in non-destructive testing is increasing, after the minimum of a few years ago, especially for irradiated fuel when codes or containment are not available. Souza Santos was somewhat sceptical of the possibility of achieving an accuracy of 2-3% in gamma ray measurements because of the self-absorption problem and the generally unfavorable geometrical disposition, but Taschek drew attention to the annual report by Keepin at Los Alamos which offers some hope, and also suggested that future reprocessing plants will be so highly automated that continuous automatic reading devices could be devised. Dragnev mentioned the technique of using measurements on several different isotopes to give information on gamma-ray absorption, and Rometsch referred to the Los Alamos technique of the "added gram" in determining plutonium in solid wastes. In answer to a question from Kolstad, Rometsch said that the most significant "points of contact" in the cycle were where the highest concentrations of fissile material were measured.

Weinzierl, voicing some scepticism about effectiveness, asked if test cases could be arranged in which operators attempt to cheat and inspectors try to detect this, a question that had been raised earlier, in a preliminary discussion, by Kofoed-Hansen. Rometsch mentioned some encouraging results from small-scale tests, in particular at a pilot plant for plutonium fuel fabrication.

6b Nuclear Data for Safeguards

In the short discussion that had taken place earlier, in connection with item 2i, it had been noted that the enthusiastic response to the enquiry from the NDS had resulted in a very large number of requests for nuclear data for safeguards. These had been summarized by Byer in INDC(NDS)-21/G together with much supporting information. Having had an opportunity to study this document the committee returned to a consideration

of the problems.

The discussion was prefaced by a short statement from Byer summarizing his report, and included a statement by Jankov on the attitude of the USSR and the work in progress there. This information is contained in Addendum 2 to INDC(NDS)-21/G along with the USSR list of requests, which was received in Vienna during the INDC meeting.

Byer had subdivided the requests into five basic groups of which only two (A and B) were concerned with neutron induced processes and it was established that the types of measurements in group B are only partly covered by the present activities of the four centres. Certainly it would be difficult to merge all the safeguards requests into the present RENDA.

It was generally agreed that the accuracies requested were likely to be unrealistic in many cases but that further experience would improve this situation. However, the problem of assigning priorities appeared to be the most difficult one. Kinchin believed that this was not possible in advance of a systems analysis that would identify the important areas. Kofoed-Hansen drew attention to the lack of any criterion corresponding to the one of economic importance for reactor data requests, and suggested that the highest priority might go to the detection of deliberate cheating. Stefanescu amplified Rometsch's earlier remarks on the most strategic measurement points, but no clear picture emerged. Abramov believed that the INDC would have to leave the assignment of priorities to the safeguards departments and restrict itself to considering the scientific problems; Cierjacks agreed.

An ad hoc Subcommittee was then set up, with Taschek as chairman and other members as listed in Appendix 4, which reported to the full Committee on the afternoon of the next day, the last day of the meeting.

At this final discussion it was decided to appoint a Standing Subcommittee, having the same membership as the ad hoc Subcommittee (see Appendix 3), which would develop a report to

the full Committee for its next meeting. The "Observations and Recommendations" of the ad hoc Subcommittee (Appendix 4) were reviewed and it was decided to modify the wording in section 1.II to reflect the difficulties of providing a request list, and to add section 2.III on the need for filtering the requests. A sentence was added to section 2.V calling for relevant progress reports to be sent to the Subcommittee. Byer was asked to obtain information on the criteria used to establish priorities (section 2.IIB).

7 DATA CENTRE ACTIVITIES

7a Reports from Data Centres

Schmidt spoke to the NDS Progress Report INDC(NDS)-23/G, especially pp.22-24, and noted in particular the rapid growth of the data file, with CINDU-9 referring to some 1500 DASTAR data sets, about half of which originated in the NDS service area. Lorenz presented a summary of the statistical information given in Appendix 4 to the NDS Progress Report.

Kolstad asked Lorenz about the requests for evaluated data received by the NDS, and was informed that some eight countries have made requests, the justification being that they are designing a reactor or starting reactor calculations. Copies of the evaluated data transmitted by the NDS are kept at the NDS in their original format. Usually the magnetic tape is copied and then forwarded after checking its readability; printouts of tapes can be sent to subsequent requestors.

Describing activities at Obninsk, Abramov stated that the main task was the implementation of the centre-to-centre exchange format. There had been an unexplained delay in the delivery of magnetic tape units from West European suppliers but these are now expected by the end of the year. Abramov mentioned the preparation of Vols. 8 and 9 of Collected Abstracts of Nuclear Physics Research in the USSR (distributed to the meeting) and of Vol. 6 of the Information Bulletin of the Obninsk Centre which had just gone to press.

In reply to a question from Lorenz, Abramov described the reorganization of nuclear data committees in the USSR. During the summer of 1969 the Council of the Obninsk Centre had been replaced by the Nuclear Data Commission of the State Committee on the Utilization of Atomic Energy, with V.A. Kuznetsov, the Director of FEI, Obninsk, as chairman. Various institutes are represented on the Commission which coordinates all the work on experimental measurements, compilation, evaluation, and distribution; and develops constants for reactor calculations. The practical work (including data compilation,

CINDA activities, development of data processing and storage programs, and some evaluation) is carried out at the Obninsk Centre, directed by V.I. Popov. There are also two coordinating groups: the first, with V.I. Mostovoy of Kurchatov Institute as chairman, is concerned with measurement activities, the individual members from the different institutes being responsible for the transmission of numerical data to the Obninsk Centre. The second group, chaired by V.G. Zolotukhin (Obninsk) coordinates requests for data for reactor calculations, including the preparation of group-averaged constants. The Nuclear Data Commission meets two or three times a year to receive reports from collaborators and the coordinating groups.

Liskien summarized the Progress Report from CCDN (INDC(ENEA)-3/G). He also mentioned that evaluated data files are not being translated because the situation is considered to be fluid. Overlay graphs, as recommended by the EANDC/EACRP Joint Subcommittee, could not yet be produced by CCDN but might be, with assistance from H. Alter at Atomics International if funds (~ 30 K$) were made available. He noted that the US requests for high energy data had not been entered into RENDA.

Kinchin asked whether there was satisfactory feed back on errors detected by evaluators, and whether turn-around times were acceptable to data users. Liskien mentioned a disappointing experience with a systematic error (caused by a program fault, since corrected) which had drawn no comment, but stated that feedback on errors was regularly received from some evaluation groups (e.g. AWRE and KFK), and from liaison officers. Since October the average turn around time had been reduced to about five days. Lorenz referred to the author proof system used by the NDS and Kolstad said this was also used at NNCSC.

Reporting on activities at the NNCSC Kolstad mentioned that D.E. Cullen had attended the Programmers' Workshop (Vienna, May 1970) which had coordinated the EXFOR programming efforts. He noted that Volume I (Z = 1-20) of the new edition of BNL-400,

"Angular Distributions in Neutron-Induced Reactions", to be issued July 1, 1970, had been produced almost entirely by computer. Many problems had to be solved in order to produce publication-quality graphs with "eye-guides" through the experimental data, and future publications would benefit from this experience. The necessary additions and corrections to the tape library for the contents of Volume II ($Z > 20$) of BNL-400 were almost complete, and preparation of publication output for this volume should begin shortly. The NNCSC had implemented its data storage system on its own PDP-10 computer, a disk-based operating system. Interactive graphics equipment had been purchased to facilitate the maintenance of files and the evaluation of data. A bi-monthly newsletter was being issued containing the latest additions to the experimental and evaluated data files. This newsletter was designed to be produced by computer and is readied for mailing by machine.

7b Status of CINDA: Compilation and Publication

Lemmel summarized the Section E1 of INDC(NDS)-23/G and its Addendum. The IAEA wished to reduce costs by publishing CINDA in a reduced format, the size of the standard IAEA Proceedings, but H. Goldstein had objected on the grounds of illegibility; however, if computer-controlled typesetting were available the reduced format would be acceptably legible. Some technical details regarding computer-controlled typesetting and IAEA publication equipment were provided by Gottschalk and Metzendorf of the IAEA, but it was generally agreed that the INDC should be concerned primarily with the legibility of CINDA, though the question of how future issues of CINDA would be split into separate volumes was also affected by the size of format.

The agreed recommendation of the INDC on format is given in Appendix 1. The splitting of CINDA into two volumes was discussed at some length, but it was not possible to establish firmly when this would have to be done. Kolstad

mentioned the recommendation of EANDC at its October 1969 meeting that CINDA-71 be the last complete volume, and read the letter from H. Goldstein of 5 June 1970 (Appendix 8).

Lemmel asked Kolstad whether the US CINDA activities were to be transferred from DTIE at Oak Ridge to the NNCSC in Brookhaven. Kolstad mentioned Brookhaven's reluctance but Liskien believed it would be desirable from the point of view of having a better representation at Four-centre Meetings of US thinking on CINDA problems, which were becoming more closely linked with EXFOR. Kolstad agreed to look into this.

7c November 1969 Moscow Four-Centre Meeting

Lorenz spoke briefly to INDC(NDU)-16/N. The Moscow Meeting had agreed on the steps to be taken for the implementation of the EXFOR data exchange system and had asked the NDS to prepare a formal agreement (see next item).

7d Exchange of Experimental Data

The Protocol for Four-centre cooperation in the exchange of data is reproduced (in its final form) as Appendix 9. Schmidt reported that a draft version had been discussed by representatives of the four centres at an informal meeting during the Helsinki Conference, and some minor changes in wording had been made.

8 EVALUATION

8a Progress Reports

USSR

Abramov reported that the evaluation work in the USSR had greatly increased since the last meeting. Popov at Obninsk had worked out methods for the interpolation, evaluation, and compact presentation of data on neutron elastic and inelastic scattering; results for a number of elements had been made available via Vienna to other centres. Nikolaev's group at Obninsk had prepared a review of experimental and theoretical results on the angular distributions of elastically scattered neutrons up to 12 MeV, and a report was to be published later this year. A group at the Ukrainian Institute of Physics was analyzing experiments on elastic scattering from medium weight nuclei up to 1.5 MeV neutron energy.

Abramov referred to the paper presented at the Helsinki Conference (CN-26/74) by Smirenkin on $\bar{\nu}(E)$, and to the multi-level analysis of $\sigma_f(^{239}Pu)$ by Lukyanov's group which was being presented to a Soviet-French Seminar (Moscow, June 1970).

In the area of evaluating parameters for cross section calculations, Abramov mentioned optical model work at the Ukrainian Institute of Physics where a six-parameter model had been fitted to total cross section data on 26 nuclei. Anikin and Smirenkin at Obninsk had used an optical model to describe the ^{238}U scattering data from 7.5 keV to 12 MeV. Two papers presented to the Helsinki Conference dealt with level densities and radiation widths.

Work was continuing on the evaluation of integral experiments to provide improved multi-group data sets. The latest Bulletin of the Information Centre contained 21-group cross section data for nuclei from H to Pu.

Abramov expressed concern regarding the format for evaluated data, which were being stored in the form that was received. Discussions were in progress on whether a modified

EXFOR format should be used for evaluated data. (Earlier in the meeting Abramov had stressed the desirability of an internationally agreed format, but Schmidt had been pessimistic; see also Liskien's report from the Joint Subcommittee at the end of item 5a).

UK

Kinchin mentioned the papers presented at the Helsinki Conference by Story (CN26/110) on evaluation in the thermal and resonance energy range for A < 220, by Sowerby (CN26/34) on fission cross sections and the capture cross section of ^{238}U between 100 eV and 20 MeV, by Moxon (CN26/32) on the capture cross sections of structural and cladding materials in the range 1-100 keV, and by Campbell (CN26/116) on the relationship of microscopic and integral data. He also drew attention to the paper by M.F. James on the energy released in fission (J. Nucl. Energy 23, 517 (1969)).

Germany

Cierjacks noted the paper presented at Helsinki by Hinkelmann (CN/15) on the evaluation of data for several actinides in the range from thermal to 10 MeV. Schmidt referred the committee to pages 49 and 50 of the 1969 Euratom Progress Report (EANDC(E)127-U) for a description of the activities at Karlsruhe.

Australia

Clancy mentioned the compilation of fission product data (see INDC(AUL)-8/G) and a paper by Cook on fission product cross sections which will be published as an INDC report.

Romania

Berinde reported that work had started on the evaluation of elastic and inelastic scattering data between 1 and 15 MeV, using the optical model and statistical model, for S, As and Zn.

France

Joly referred to the work of Ribon's group at Saclay, which had been extensively presented at Helsinki; and to the evaluation of data for ^{240}Pu up to 1 MeV by L'Heriteau and Ribon (CEA-N-1273) which took into account both previous evaluations and more recent experimental data.

USA

Taschek reported that the second version of ENDF/B was going ahead, with a number of cross section sets already approved for release by the Cross Section Evaluation Working Group. At Los Alamos the gamma production cross section of hydrogen had been evaluated, and an evaluation of all the partial cross sections of nitrogen, above 100 keV neutron energy, was under way. D.R. Harris was engaged in a comparison of the Wigner-Eisenbud and Kapur-Peierls formalisms. The Hopkins and Breit evaluation of the (n,p) cross section had already been referred to (item 4a(i) above).

At the NNCSC efforts were continuing to produce evaluated data sets for fission product nuclei. The inelastic cross sections for ^{239}Pu and ^{240}Pu had been modified to include discrete level excitations up to 3 MeV and thereby permit a better description of the energy distributions of secondary neutrons.

Brazil

Souza Santos said the only evaluation activity in Brazil concerned the production of fireballs by very high energy particles (10^{11}-10^{17} GeV).

Japan

Nishimura reported that two sets of evaluated nuclear data files had been prepared. The first file, based on the UK Nuclear Data Library, included some re-evaluation in order to obtain a better interpretation of reactor physics phenomena (JAERI-1195, in press). The second file had been designed to provide data with higher energy resolution and at higher temperatures for studying reactivity effects in large fast reactors.

Data for ^{235}U, ^{238}U, ^{239}Pu and ^{240}Pu up to 21.5 keV were already on this file and ^{241}Pu data was to be added later this year.

Other completed evaluations included inelastic scattering for ^{238}U (Helsinki Conference Paper CN-26/27), capture for Cr, Fe, Ni and Mo (Cn-26/28), and the total cross sections of lead (CCDN-NW/10). A bibliography for thermal neutron scattering had been distributed (INDC(JAP)-6/G) as had an evaluation of thermal neutron scattering cross sections (INDC(JAP)-8/G) and a report on level densities (INDC(JAP)-7/G). Evaluations in progress included a compilation and review of σ_t, σ_c, σ_f, σ_{el}, σ_{inel} and $\bar{\nu}$ for ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu and ^{241}Pu between 1 keV and 20 MeV, a review of σ_{tot} for C, an evaluation of σ_{el} and σ_{inel} for Cr, Fe, Ni, Na, and ^{16}O (1 keV-20 MeV), and a review and evaluation of fission product data (decay constants, yields, and cross sections).

India

Divatia referred to INDC(IND)-11/E for a description of evaluation activities in India, and acknowledged the receipt of the KEDAK tapes via the NDS.

Canada

Hanna stated that C.H. Westcott had recently completed a study of the accuracy of the temperature coefficient of g factors (AECL-3605) and that W.H. Walker was still active in fission-product evaluation (CN-26/3).

Following these presentations Hjärne asked if the ENDF/B format had stabilized and Liskien replied that the modifications were decided but not yet published.

8b Exchange of Evaluated Data and Coordination of Activities

Abramov enquired about the extent to which the various libraries of evaluated data were coordinated. Kolstad mentioned the EANDC/EACRP Joint Subcommittee and Hjärne asked whether observers could attend these meetings. Though some observers had been at the London meeting Kolstad believed that more formal arrangements were desirable.

The problem of an internationally agreed format for the exchange of evaluated data was again raised, by Schmidt, but Havens thought it was a technical problem beyond the competence of the INDC, and Joly saw no need for it from the users' point of view - it was a problem for the data centres.

Schmidt asked whether it was still necessary to restrict the exchange of evaluated data. Kolstad replied that the USA was moving in the direction of free exchange, had already provided much information, and would continue to do so on an ad hoc basis, but wished to see more evaluated data from other countries in return. Abramov, however, believed that the time had come for a free exchange on the same basis as experimental data; the USSR had already sent some evaluated data to the NDS and was proposing to begin a free exchange in the spirit of the UN and the IAEA.

9 ASSESSMENT OF DATA NEEDS AND ASSISTANCE TO MEMBER STATES

9a Non-OECD and World Request List for Neutron Data Measurements

Schmidt spoke briefly to the draft request list INDC(NDS)-20/G, and Joly complimented the NDS on the comments it had added to the individual requests. Hanna asked that, in order to avoid confusion with official Canadian requests, his name not be associated with the requests, originated by Lemmel, arising out of the work on the least squares fitting of 2200 m/s data for the principal fissile nuclei. Havens asked whether the non-USSR requests of INDC(NDS)-20/G had been compared with the RENDA requests; there seemed to be considerable overlap. This had not in fact been done, but Liskien pointed out that in any case requests should not be combined because a withdrawal by one of the requestors would then necessitate rewriting the request.

Regarding the possible merging of the non-OECD request list with RENDA, Liskien anticipated no mechanical difficulties, except for lower case letters. Kolstad asked the non-OECD members of the Committee for information on filtering procedures and it appeared that these varied widely. The Committee finally recommended merging the two lists and encouraged filtering procedures. The ENEA will require a corresponding recommendation from the EANDC, and Kolstad will ask for this to be raised at the next EANDC meeting. Meanwhile the mechanics of publication are to be explored by the NDS and the CCDN.

9b Nuclear Data Section Activities in Nuclear Data Surveys and Reviews

Because this topic had been covered in 3d(ii) and 3d(iii), there was no specific discussion of this agenda item.

9c Request List for Targets and Samples Particularly from Developing Countries

The discussion of this item was split into two parts, a preliminary discussion preceding the setting up of the ad hoc Subcommittee (item 2i), and a consideration of this Subcommittee's report (Appendix 5).

At the preliminary discussion Schmidt introduced the draft report INDC(NDS)-22/G which lists the requests for targets and samples; information on what is available has not yet been compiled. Taschek raised the question of how the IAEA would be involved in transactions between supplier and customer, and Joly asked whether decisions would be made on the basis of relevance to "nuclear data" or " pure physics". Abramov suggested that discussion of the list in INDC(NDS)-22/G would be premature, since many requests might disappear when the availability of samples was established, though there might well remain some competing requests on which the Committee's advice would be needed. Liskien believed that many requests could be satisfied from commercial sources, and Souza Santos recommended that any financial assistance from the IAEA should be used for obtaining normally unavailable (e.g. fissile) material. An ad hoc Subcommittee was then set up, with Divatia as chairman and members as listed in item 2i, to consider these questions and especially to develop a policy for assigning priorities for possible funding.

During the discussion of the Subcommittee's report (Appendix 5) Abramov did not support the formation of a Standing Subcommittee to evaluate requests for targets and samples, but preferred this to be a responsibility of the full INDC, which would provide wider expertise. Kinchin recommended circulating requests to INDC members between meetings so as to reduce delays. Divatia accepted the proposal of the full Committee being responsible, though he, along with Kofoed-Hansen and Schmidt, was concerned about the large amount of work involved. Taschek also supported the proposal, but asked that rules be developed governing priorities and procedures, e.g. on the operation of a sample pool. It was finally agreed to ask the Subcommittee to continue its work, especially to develop rules for priorities, and to report by 1 October 1970. Some changes were made in membership and this Subcommittee, still considered to be an ad hoc one, now comprises Hjärne (chairman), Abramov, Aten, Divatia, and Taschek.

Havens, Divatia, and Abramov were asked to prepare a Recommendation reiterating the general support of the INDC for a program of providing targets and samples to interested countries (compare Recommendation 6 of the Second INDC Meeting). The text of this recommendation, as finally agreed to by the full Committee, is given in Appendix 1.

9d Facilities List

The facilities list was considered to be dormant and was not discussed.

10 NUCLEAR DATA ASPECTS OF IAEA ACTIVITIES

10a Data Needs for Fusion, Dosimetry, and Shielding

Dr. Seligman opened the discussion on nuclear data for fusion by referring to a meeting he had recently attended in Trieste where representatives of some ten countries had discussed status and future plans, and had recommended the formation of a "Permanent International Fusion Research Council", to meet yearly. Although it is too early to envisage common projects, this Council may shortly be set up by the IAEA, followed next year by the setting up of subcommittees. Since one of these could be concerned with basic data requirements, the INDC should consider its possible future position regarding nuclear data for fusion and its relationship with the proposed Council.

Kolstad believed that nuclear data for fusion should be included in the responsibilities of the INDC, with requests for such data appearing in the request list, which could be in three parts covering Reactors, Safeguards, and Fusion. Kinchin mentioned the role of local committees in dealing with reactor-oriented requests and thought fusion requests should be handled in a similar way. Kofoed-Hansen drew attention to the very wide field involved, including e.g. atomic physics, and Kolstad agreed that the INDC responsibility should be limited to nuclear data. Schmidt referred to the Helsinki Conference Papers by Chernilin (CN-26/104) and Crocker (CN-26/98), which provided some guidance on what would be required, namely neutron data generally and charged particle data for light nuclei. Jankov and Cierjacks stressed the need for more information on angular distributions.

The question of how to prepare a request list for fusion data was discussed, e.g. whether the NDS should send out a circular letter to workers in the field, as had been done for safeguards, or whether INDC members should make the approach. Taschek observed that writing to an individual laboratory director would probably be fruitless and suggested Dr. R. Gould for US requests. Seligman stated that the Trieste meeting had not discussed detailed procedure, but that he could supply a

list of appropriate people, and it was agreed that the NDS should write to them.

Taschek asked the NDS to send copies of the Helsinki Conference papers on fusion data to INDC members, and this was agreed to.

Regarding data for dosimetry Lorenz referred to his paper on IAEA Programs in the Compilation and Review of Nuclear Data presented to an IAEA Panel meeting (February, 1969) on Nuclear Accident Dosimetry Systems (IAEA-PL-329/15). He did not believe that any specific INDC recommendation was called for. Kolstad mentioned the wide field covered by dosimetry data and Havens agreed that only the fast neutron data requests were closely related to reactor requests.

Kolstad considered any further discussion of data for dosimetry, or shielding, to be premature. Following a suggestion by Clancy, it was agreed that the NDS should write to organizations concerned with dosimetry or shielding and inform them of the present scope of activities in the data centres.

10b Non-Neutron Nuclear Data

A short discussion of this subject took place under item 5c (above) when Kolstad raised the question of a future symposium, and Graves, Lorenz and Schmidt summarized the IAEA attitude as follows. The IAEA does not have the resources to make a large contribution to the monumental task of compiling non-neutron nuclear data, and they understand that Hollander has received funds to allow him to continue. On the other hand they are interested in promoting cooperation in this field, and believe this is best done by organizing a small consultants meeting to find out what is needed; the consultants could then recommend a panel meeting, but a symposium is at present considered to be premature. They are planning a consultants meeting for November 1970 (probable consultants: Hollander, Dzelepov, Wapstra and Grinberg). A meeting of representatives from Euratom countries (including Grinberg, Spernol and Wapstra) had been held in May 1970 but no information was available at the INDC meeting.

Souza Santos and Abramov both believed that the INDC should not be enlarged to cover the wider field of all nuclear data compilation, and no dissenting opinions were expressed. However, Kolstad re-affirmed his belief in the usefulness of a symposium, where e.g. techniques in the neutron and non-neutron data-compilation field could be compared.

10c Physics Section Activities

Graves outlined the activities of the Physics Section, which comprises three professionals. Their main fields of interest are Fission Physics, Fusion Physics, and Solid State Studies by Neutron Inelastic Scattering, and they organize an International Symposium in one of these fields each year; they are also involved in other special meetings (see item 5c). Members of the section serve on the editorial board of the IAEA journal "Nuclear Fusion", and are responsible for administering technical assistance programs for some 20 countries, and for evaluating applications for training and fellowships.

Graves invited comments from the INDC but asked that their limited resources be borne in mind. Schmidt emphasized the close interaction between the Physics Section and the NDS and there were no further comments.

10d Status Report on INIS

Mr. J.E. Woolston (IAEA) outlined the status of the International Nuclear Information System, INIS (for a description see Proceedings of a Symposium "Handling of Nuclear Information", Vienna 1970, page 607). INIS is still in its initial phase, and nuclear properties will not be covered until 1972. It has been operating for three months and though much less than the expected input has arrived, this is improving as the various countries come on stream. The thesaurus, supplied under contract by Euratom, has now arrived.

Rae asked if INIS would replace Nuclear Science Abstracts and Woolston replied that the USA was expected to continue NSA in parallel with INIS for an interim period. In reply to a

question from Joly, Woolston explained that the Euratom Information System comprised keywords and serial numbers only, which requires subsequent reference to a card file, whereas INIS can print out full bibliographical information. However, Euratom has about a million items on file and some countries have expressed interest in having access to this information; an arrangement may be negotiated. Divatia was concerned about the speed of service for an individual requesting information, noting that there were many satisfactory bilateral agreements in operation. Woolston said the exploitation of the INIS data bank would be up to the national nuclear information centres and they would provide the individual scientist with what he requires; he considered bilateral agreements to be expensive and too dependent on the interest of the supplier.

Clarifying some points raised by Hjärne, who expressed reservations about the thesaurus, Woolston explained that INIS was not designed by the IAEA but represented an international consensus. A major breakthrough had been the adoption of English as the "carrier" language, but it was unfair to expect people with an indifferent command of English to follow the NSA indexing system. The Universal Decimal Classification, which has dictionaries in many languages, is always out of date, whereas the system chosen (co-ordinate indexing, which looks at several words) can be modified rapidly as new scientific concepts appear; plans for updating the thesaurus are still under discussion. Regarding translations Woolston pointed out that, while everyone would like an abstract file in his own language, the cost was frightening; interested countries could of course organize and pay for translation.

11 NEXT MEETING: MEMBERSHIP CHANGES

Divatia invited the INDC to hold the next meeting in Bombay, India. Kolstad welcomed this invitation and the week of 12 July 1971 was tentatively agreed on. Later, following a discussion with the Director General of the IAEA, Kolstad reported that there might well be some financial difficulties; these were being investigated.

During the meeting the Committee learned of a recent Italian application for membership in the INDC. The Committee welcomed this application and supported the IAEA proposal to appoint an Italian INDC member.

At the conclusion of the meeting Mr. G.H. Kinchin announced his resignation from the INDC, effective 1 January 1971, and expressed his pleasure at having worked with the members of the Committee.

Appendix 1

Formal Recommendations of the Committee

1.1 Nuclear Data Conferences

Taking into account the success and practical usefulness of the Helsinki Nuclear Data Conference, the INDC confirms its previous recommendation on convening such conferences in the future with an interval of 3 to 4 years upon the condition of clear coordination of dates and agenda with those of other national and international conferences on neutron cross sections and technology.

1.2 Experts Meetings on Discrepancies in Important Nuclear Data

The successful meetings of experts at Studsvik, 10-12 June 1970, on discrepancies in $\bar{\nu}$ and $\alpha(Pu^{239})$ data illustrated the value of such discussions. It is recommended that future meetings of this type should take into account the following desiderata:

a) the problems(s) to be discussed should be well defined,

b) every effort including suitable financial arrangements on the part of the IAEA should be made to ensure the attendance of all experts most concerned with the problem,

c) there should be sufficient preparation to ensure efficient use of the time of the meeting. The NDS can perform a valuable service in this respect by compiling available experimental data, renormalizing them as necessary, and presenting them in the most readily comprehensible form for discussion,

d) the conclusions, as agreed to by the experts, should be disseminated as soon as possible by the NDS; an INDC "L" distribution would generally be appropriate.

1.3 Printing of CINDA

The format for the publication of CINDA recommended by the INDC is sample C of the addendum to Section E1 of Report INDC(NDS)-23/G. The INDC realizes that some technical problems may arise to prevent CINDA-71 from being printed

in this recommended format. In this case IAEA should take whatever expedient steps are necessary to print CINDA-71 in the present format.

4.4 Targets and Samples

The INDC strongly reaffirms its recommendation that the IAEA take an active part in making arrangements for targets and samples to be supplied to experimental groups for nuclear data measurements. The report INDC(NDS)-22/G on "Needs of targets and samples for nuclear data measurements in the Service Area of the Nuclear Data Section" by L. Hjärne summarizes requests for targets and samples. The INDC believes that there is potential for useful nuclear data measurements from the laboratories which have requested targets and samples. To assist in the development of this potential the IAEA should help in the supply of targets and samples to the interested countries. The INDC is prepared to advise the Agency on the most effective way of using available funds for the most important nuclear data measurements.

Appendix 2

Actions arising from the Third INDC Meeting

Action No.	page No. of Minutes	Action on	Action
1	5	NDS/INDC Secretariat	Issue official minutes of the Second INDC Meeting as INDC(SEC)-document with L-distribution.
2	5	NDS/INDC Secretariat	Issue new Methods of Work document (G-distribution) with the approved modifications included and with the section on distribution of documents deleted.
3	6	NDS/INDC Secretariat	Ensure INDC members continue to receive minutes of IWGFR meetings (continuing action 3 from second INDC meeting).
4	6	Hjärne	Provide information on available targets and foil materials (completion of action 8 from second INDC meeting).
5	7	NDS/INDC Secretariat	Forward the INDC Chairman's biennial report for 1968/69 to Director General. Consult the Director General's office regarding its distribution and issue it as INDC(SEC) - document.
6	7	NDS/INDC Secretariat	Establish a "Compendium of Committee Regulations".
7	7	NDS/INDC Secretariat	Distribute Compendium of Committee Regulations, and appendix A of INDC(NDS)-23/G to Liaison Officers.
8	8	NDS/INDC Secretariat	Send proposal on document distribution to INDC members.
9	18	Taschek	Provide at an early date improved estimates of cost of underground nuclear detonations.
10	18	All members	At their discretion, make informal enquiries of their institutions regarding participation in experiments using underground nuclear explosions.
11	27	Hjärne	Inform INDC members of any UNISIST developments likely to affect data centres.

Action No.	page No. of Minutes	Action on	Action
12	27	NDS	Inform INDC members as early as possible on any recommendations of CODATA regarding the relationship between CODATA and INDC.
13	28	Hjärne	Prepare and distribute report on Helsinki Conference Questionnaire.
14	37	Byer	Write to requestors of nuclear data for safeguards to ascertain what criteria were used to establish their priorities.
15	41	Kolstad	Investigate possibility of US CINDA operation being transferred to NNCSC.
16	47	NDS	Issue amended Non-OECD neutron data request list after consultation with the requestors.
17	47	Kolstad	Ask chairman of EANDC that the INDC recommendation to merge request lists be considered at next EANDC meeting.
18	47	NDS	Take the necessary steps to provide for the combined edition of the amended Non-OECD and the OECD request lists for neutron data measurements in one world-wide document as a common undertaking of ENEA/OECD and IAEA (depending on the outcome of action 17 above).
19	48	Hjärne	As chairman of Subcommittee on Targets and Samples to report subcommittee's recommendation before 1 October 1970.
20	51	Lorenz	Write to appropriate individuals to ascertain the need for nuclear data for fusion.
21	51	NDS/INDC Secretariat	Send copies of Helsinki Conference papers on fusion data needs to Committee members.

Action No.	Page No. of Minutes	Action on	Action
22	51	NDS/INDC Secretariat	Inform organizations concerned with dosimetry and shielding of relevant activities of nuclear data centres.
23	60	All Standing Subcommittees	Provide NDS with copies of correspondence.
24	60	NDS/INDC Secretariat	Incorporate requirement re correspondence (action 23) in Compendium of Committee Regulations.

Appendix 3

Subcommittees

In accepting the recommendation of the ad hoc Subcommittee on discrepancies and standards (item 2i) the full Committee decided that members of Standing Subcommittees should be continuing participants in INDC meetings, so as to provide a continuous channel of action. It was recognized that Subcommittee members would frequently delegate work to non-participants, who could be invited to attend meetings as observers on an ad hoc basis. Subcommittees are to provide the NDS with copies of all relevant correspondence.

Subject to these provisos, which are to be included in the Compendium of Committee Regulations, the following Subcommittees were set up:

A Standing Subcommittees

3.1 Standards

Chairman Havens

Members Aten, Jankov, Joly, Lorenz, Nishimura, Rae.

3.2 Discrepancies in Important Nuclear Data and Evaluations

Chairman Schmidt

Members Cierjacks, Jankov, Joly, Nishimura, Rae, Taschek.

3.3 Nuclear Data for Safeguards

Chairman Taschek (initially, chair will rotate)

Members Byer, Cierjacks, Jankov, Souza Santos, Sujkowski.

B Ad Hoc Subcommittees

3.4 Targets and Samples for Nuclear Data Measurements

(to report by 1 October 1970)

Chairman Hjärne

Members Abramov, Aten, Divatia, Taschek.

Appendix 4

Nuclear Data for Safeguards

Observations and Recommendations, 26 June 1970, of the ad hoc Subcommittee, Taschek, Byer, Cierjacks, Jankov, Souza Santos, and Sujkowski assisted by T. Dragnev (IAEA), K. Nishimura (INDC), S. Sanatani (IAEA) and A. Stefanescu (IAEA) including changes agreed on during the discussion by the full committee.

1. Recommendations

I. The Creation of a Standing Sub-Committee on Nuclear Data for Safeguards Technical Development is considered as being highly desirable, so as to provide a channel of continuous liaison for the assessment and evaluation of the Safeguards Nuclear Data Request List.

II. Steps should be taken to provide a suitable Safeguards Nuclear Data Request List embracing the entire scope of the requests.

III. That the Agency actively encourages the Compilation of nuclear data for Safeguards.

IV. That steps be taken to further encourage and increase the Collaboration between the Nuclear Data Section and the Division of Development (Department of Safeguards and Inspection) in those areas of common interest.

V. That Safeguards Nuclear Data Requests pertaining to neutron induced reactions should be Merged into the existing Neutron Data Request Lists.

2. Observations

I. Due to the very wide Scope of the present Safeguards Nuclear Data Requests, problems of a somewhat new nature have been posed to ensure the up-to-dateness and continuous monitoring of the Status of individual requests. In this context, it is felt necessary that, at this early stage, individual requestors should be responsible for maintaining and communicating to the Nuclear Data Section information concerning the Status of each of their requests.

II. Since Safeguards Systems Analysis is as yet not in a position to provide well defined and quantitative criteria concerning the relative importance of different strategic measurement points in a fuel cycle, it is difficult to establish well defined and quantitative criteria for assigning Priorities to specific Safeguards Nuclear Data Requests. So as to arrive at at least broad and qualitative criteria for the assignment of Priorities, two possible courses of action are suggested:

A) That the well defined Priority criteria developed by the European American Committee for Reactor Physics for requests for nuclear data, be transmitted to the Safeguards Nuclear Data Requestors, so as to provide them with qualitative guidelines in establishing their Priorities.

B) That requestors be asked what were their criteria for establishing the priorities associated with their requests.

III. Appropriate steps should be taken in the Member States submitting request lists to examine and filter the requests to ensure that they are properly justified.

IV. That the finally established Safeguards Nuclear Data Request List should be widely distributed to experimentalists and to those actively engaged in developing materials assay techniques for Safeguards. It was also felt that the Safeguards Newsletter, presently being compiled by the Department of Safeguards and Inspection, should also be distributed to Safeguards Nuclear Data Requestors. It is urged that the Laboratory Progress Reports referring to Safeguards Functions having to do with nuclear data should be transmitted to members of the Subcommittee on a regular basis.

V. In considering the question of the Format of the Safeguards Nuclear Data Request List, the Sub-Committee observed that the Format of the photon and neutron induced requests presented in INDC(NDS)-21/G (Draft) was acceptable, however, further consultations were necessary in order to arrive at an agreed Format for the decay scheme, fission yield and half-life requests.

VI. That the question of the Agency Funding some of those measurements, appearing in the Safeguards Nuclear Data Request List and considered to be of great importance, should only be examined at a later stage when there is a greater degree of "feed-back" between the data requestors, the designers and developers of Safeguards instruments and the Safeguards Systems Analysts.

VII. That the requestors should re-examine their requests and supply, where necessary, further information regarding such items as the accuracy, priority, energy range of incident particles and the status of each of their requests.

Appendix 5

Targets and Samples for Nuclear Data Measurements

Draft Recommendations, 24 June 1970, of the ad hoc subcommittee, Divatia, Abramov, Berinde, Hjärne, Joly, Souza Santos, and Sujkowski.

1. Standing Sub-Committee

a. A Standing Sub-Committee for targets and samples for nuclear data measurements is necessary, since it will facilitate a continuous evaluation of the requests for targets and samples.

b. The Standing Sub-Committee should consist of about 8 INDC members.

2. Policy for evaluation of requests

a. The requests may be classified into two categories, as follows

i. Requests for targets and samples for nuclear data measurements directly of interest from the standpoint of peaceful uses of atomic energy. - Category A.

ii. Requests for targets and samples for nuclear data measurements of interest from the standpoint of fundamental physics. - Category B.

b. Requests in Category A should be considered for major funding by the IAEA. They should be evaluated accordingly by the Standing Sub-Committee.

c. Requests in Category B should not be considered for major funding by the IAEA. Such requests should be considered by the Standing Sub-Committee and suggestions should be given to the requestors regarding the methods to be adopted for procurement of targets and samples. The Nuclear Data Section should assist the requestors in this procurement by correspondence, if necessary.

3. Procedure for evaluation of requests

a. The NDS should send a circular, accompanied by a detailed questionnaire, to IAEA member states, asking for proposals

properly forwarded by the respective governments. Copies should be sent to the INDC members.

b. The request proposals should be categorized, compiled and sent to the members of the Standing Sub-Committee, and the Chairman and the Executive Secretary of the INDC. This should be done on a quarterly or half-yearly basis, depending on the number of requests.

c. The members of the Standing Sub-Committee should convey their comments to the Chairman of the Committee, sending copies to the Head, NDS, and the Chairman and Executive Secretary of the INDC, in a period of two months.

d. The Chairman of the Standing Sub-Committee should prepare a summary report and circulate it to the members of the Standing Sub-Committee. He may consult with an outside expert, if necessary.

e. The Chairman of the Standing Sub-Committee should prepare recommendations based on final comments received, and send them to the Chairman, INDC, with copies to all the Standing Sub-Committee members, the Executive Secretary, and the Head, NDS.

f. All such recommendations should be considered by the INDC, and final recommendations should be made to the Director General, IAEA.

Appendix 6

Recommendations of the Consultants Meeting, Studsvik, 10-11 June 1970, on "The status of $\bar{\nu}$ data for important fissionable isotopes"

Edited and communicated by D.W. Colvin (UKAEA, Harwell) Chairman of the Consultants Meeting.

The Meeting recommended that, in the following fields of:

Compilation and Evaluation of $\bar{\nu}$ Data

1. The International Atomic Energy Agency continue its compilation effort on $\bar{\nu}$ along the lines of the draft paper by V.A. Konshin and F. Manero (INDC(NDS)-19/N). This work should be brought up to date and the contents checked with all originators of data, as part of the EXFOR effort. A complete description of all necessary experimental details should be included, in particular for instance to provide information to allow elucidation of the consequences of a genuine "Soleilhac effect" (variation of gamma-ray efficiency with number of emitted fission neutrons in liquid scintillator $\bar{\nu}$ measurements).

2. Along the lines used to promote an earlier evaluation (Hanna et al, Atomic Energy Review 7(4) 3 1969) the IAEA use its good offices to promote in similar manner an evaluation of $\bar{\nu}$ as a function of energy for those isotopes of particular interest to reactor design. This could suitably begin after successful completion of the IAEA Nuclear Data Section compilation by Konshin and Manero, but setting the mechanism up should not await this work. The evaluation would be that of world experts on $\bar{\nu}$.

Absolute and Thermal $\bar{\nu}$ Values

3. The IAEA use its good offices to persuade appropriate experimentalists with large liquid scintillators to carry out investigations of the "Soleilhac effect".

The Agency's Nuclear Data Section collate and circulate the information, in view of the possible light it may throw on the long-standing discrepancies in absolute measurements of $\bar{\nu}$ for ^{252}Cf.

4. The requirement, stated some time ago, for information on delayed gamma-rays from fission, particularly for ^{252}Cf, be again brought to the attention of experimentalists; this is of greatest importance for the $\bar{\nu}$ standard, ^{252}Cf.

5. If the "Soleilhac effect" be shown to be genuine, there may be a requirement to study gamma-rays from fission, as a function of the number of neutrons emitted. Again this is particularly true for ^{252}Cf.

6. More information be obtained on the vexed question of fission fragment counting to resolve discrepancies between the UK measurements of White and Axton, and Axton, and perhaps those of De Volpi at Argonne.

7. Further measurements are required for the actinide elements to confirm the USSR work (Zamyatnin et al, CN-26/90), which has provided the first data on some of these isotopes, in particular californium and curium.

$\bar{\nu}$ as a Function of Energy
in Fission Resonance Region

8. Further investigation should take place on the causes of disparity between the results of Weinstein et al (Physics and Chemistry of Fission, Proc. Symp. Vienna, 1969, p.477) and Ryabov (JINR Report D-3893, p.88), on $\bar{\nu}$ in the resonance region; re-assessment of the old data, as well as new experiments, were suggested.

9. The IAEA take note of the very valuable experiment of Condé and Widēn (CN-26/59) and the Meeting's findings that this should be pursued with all possible vigour; the Meeting was concerned that limitations on reactor time may limit successful conclusion of the experiment.

in keV and MeV Region

10. Further experiments be carried out to resolve the disquieting findings of Boldeman et al (AAEC/TM 523, AAEC/TM 526) of Australia that, contrary to the opinion of almost all other experimentalists, there exists no structure in $\bar{\nu}$ for ^{235}U in the low energy region. Particular attention should be paid to energy standards and energy spreads.

The Meeting regretted that Boldeman could not be present to discuss his experiment in more detail, and compare it with the experiments of earlier workers.

11. More data are required in the low energy region, less than 200 keV, for ^{240}Pu and ^{241}Pu, as well as for ^{235}U and ^{239}Pu.

Fission Theory

12. Further theoretical investigation be initiated on the variation of $\bar{\nu}$ with energy, which might act as a guide to the experimentalist in interpreting data.

IAEA Meetings

13. The IAEA note the Meeting's satisfaction that encouragement given to Australian workers at its first Consultants Meeting* on $\bar{\nu}$, has been followed up by a most extensive and detailed programme of studies on $\bar{\nu}$ by the group at Lucas Heights.

14. The IAEA note the Meeting's opinion that its work might have been more successfully prosecuted if the papers submitted to it had been available well in advance, and that the discussion would have benefited greatly from the attendance of more $\bar{\nu}$ experts (e.g. Axton, Boldeman, and Smirenkin). Further, as a large quantity of information was submitted to the Meeting, and the Agency's Second Conference on 'Nuclear Data for Reactors' that more time (than the 20 minutes suggested) should have been provided at the Conference for the rapporteur to deliver the Meeting's findings.

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* IAEA, INDSWG, Consultants' Meeting on Nuclear Data, Vienna, 22-24 June 1965, INDSWG-75: and Report and Conclusions of Fourth INDSWG Meeting, 10-16 September 1965, INDSWG/R&C/4.

Appendix 7

Recommendations of the IAEA Experts Meeting, Studsvik, 12 June 1970 on "The Status of $\alpha(Pu^{239})$ Data"

(Draft version circulated at the Third INDC Meeting, Vienna 22-26 June 1970.)

1. The intervals, in which average experimental α values ($= \bar{\sigma_\gamma}/\bar{\sigma_f}$) are given, should be standardized to

100 eV between 0.1 keV and 10 keV
1 keV between 10 and 20 keV
2.5 keV between 20 and 30 keV
5 keV between 30 and 50 keV, and
10 keV above 50 keV,

in order to alleviate the comparison of the results of different measurements. The interval lengths have been chosen such that they are large compared to the experimental energy resolution, and small enough in order to reproduce still the fluctuating behaviour due to intermediate structure effects particularly above 1 keV.

2. The average experimental α values in the energy intervals mentioned under 1 as well as the directly measured data, from which these averages are deduced, i.e. fission and capture cross sections or effective fission and capture rates, together with the detailed experimental characteristics, should be sent by each experimenter concerned to the Nuclear Data Section of the IAEA. In particular each experimenter should provide the Nuclear Data Section with those cross section values, capture and fission resonance areas and half widths, he used in the normalization of his measurements.

3. The Nuclear Data Section should collect all these data and experimental conditions and publish an improved review of all available α data before the end of the year. All known experiments have been performed outside the service area of the Nuclear Data Section. Therefore the correspondence between Nuclear Data Section and experimenters should preferably proceed through the other neutron data centres unless time

schedule and effectiveness require direct contacts. Recommended "best" values of α should then be worked out in close collaboration between experimenters and the Nuclear Data Section in a similar way as in the IAEA thermal fission constants review.

4. Each experimenter is asked to provide for a split-up of the total measurement errors in statistical and systematic errors.

5. The available α measurements can be divided into two classes, those which depend and those which do not depend upon $\bar{\nu}$. Possible systematic deviations between both classes of measurements should be investigated more closely. In particular it is recommended to study more conclusively and systematically the spin dependence of $\bar{\nu}$ in resolved resonances.

6. The influence of geometrical self shielding and multiple scattering on the interpretation of α measurements with thick samples in the unresolved resonance region should be investigated more thoroughly in experiment and theory.

7. In order to verify the α values above 10 keV it is desirable to perform new measurements for energies above 10 keV with other methods than in the two available measurements from Los Alamos and Oak Ridge which use Van de Graaff accelerator and liquid scintillators.

8. It is recommended that for energy calibration in α measurements which involve the time-of-flight method, a common set of energies of isolated resonances is agreed upon, such as resonances in Al, Mn etc. used for such calibrations.

9. Finally the possibility of checking the α results obtained by time-of-flight methods by measurements with filtered neutron beams (2 keV resonance in Sc, 28 keV resonance in ^{56}Fe) should be explored more thoroughly.

Appendix 8

Columbia University in the City of New York | *New York, N.Y. 10027*

DIVISION OF NUCLEAR SCIENCE AND ENGINEERING

287A Engineering Terrace
520 West 120th Street

June 5, 1970

Dr. George A. Kolstad
Assistant Director for Physics & Math Programs
Division of Research
USAEC
Washington, D.C. 20545

Dear George,

I am writing to you in your capacity as the Chairman of the INDC to give you my understanding of how it is proposed to split CINDA 71 into two volumes. Fairly early in the history of the CINDA operation, it was anticipated that the day would eventually come when the annual cumulation would have to be divided into two volumes. Through one technical means or other the day could and was postponed as long as possible, but its inevitability was acknowledged by all involved. Accordingly, the three CINDA centers, separately and jointly, considered from time to time how to make such a split with the least annoyance to the CINDA users. I recall discussions on the subject at more than one meeting of the U.S. CINDA Steering Group. The three centers finally came to a general agreement as to how the division should eventually be made. Only a few technical details remain to be decided among the three CINDA centers before the plan is put into effect.

It is proposed that the first volume of CINDA 71 should contain entries for which the date of the main reference is some year X or earlier, while the second volume would contain all entries with main reference data subsequent to year X. Before publication of CINDA 71, every effort will be made to fill the earlier gaps and clean up the entries which go in the first volume. This body of entries will therefore be reasonably close to an asymptotic state, and changes in them from now on should be relatively few. It is expected therefore that the first volume of CINDA 71 would be published in revised form only infrequently, say after an interval of 3 to 5 years. The bulk of the continuous additions and changes to the CINDA library would relate to volume 2 of CINDA which would, as before, be republished in cumulated form every year, with one or two supplements per year to keep up to date. The majority of the users of CINDA, seeking only new or recent data, would, as now, need to refer to only one bound cumulative volume (the annual edition corresponding to Vol. 2 of CINDA 71) plus the current supplement, when there is one. Only the user who makes a complete literature search going back to the start of nuclear physics would have to go through both bound volumes.

The dividing year X must obviously be chosen carefully. If it is too close to the present, then the frequency both of use and revision of Vol. 1 would be out of line with the "archival" purpose of Vol. 1. If it is too far in the past, then the size of Vol. 2 will be very nearly that of the present CINDA and there will not be enough room left for annual growth. On the basis of entry counts by reference year made both at DTIE and Saclay, I have come to the personal recommendation (herewith communicated to the Centers) that the year X should be 1966. About 2/3 of the present main entries in the CINDA library would go in Vol. 1, while the remaining 1/3, covering main reference dates of 1967 or later, should be in Vol. 2. Counting front matter, Vol. 2 of CINDA 71, in present format, should then be less than half the size of CINDA 69. I don't know if the centers will go along with this suggestion. They may possibly prefer to have X=1965 so as to have the 1966 Washington and Paris conferences in Vol. 2. But the division point surely should be somewhere near these dates.

I have probably given more detail than you need or care to plow through in written form. But if you have any further questions or feel more elaborate discussions are needed, I shall be happy to oblige.

Cordially,

Herbert Goldstein
Professor
Division of Nuclear Science
and Engineering

HG:jr

cc: Professor W.W. Havens, Jr.
Dr. G.C. Hanna
Dr. M. Moore
Mr. L.T. Whitehead
Dr. N. Tubbs
Dr. H. Lemmel
Dr. M. Kalos

Final Version
1 July 1970

Appendix 9

PROTOCOL FOR COOPERATION BETWEEN NATIONAL NEUTRON CROSS SECTION CENTER, ENEA NEUTRON DATA COMPILATION CENTRE, IAEA NUCLEAR DATA SECTION AND CENTR PO JADERNYM DANNYM FOR THE SYSTEMATIC EXCHANGE OF NEUTRON DATA INFORMATION

A. DEFINITIONS

1. Neutron Data Information in the context of this protocol is defined to mean measured microscopic experimental data which have resulted from neutron physics experiments, and their associated bibliographic and physical descriptive information.

2. The Exchange Format, or EXFOR, is a computer-compatible set of agreed upon definitions and conventions, designed for the transmission of neutron data information between neutron data centres.

3. The EXFOR Manual, comprising the currently agreed set of EXFOR definitions, conventions, formats and codes, is designed to serve as the basis and guide for the description and coding of neutron data information in EXFOR and for data transmission between neutron data centres.

4. EXFOR data is defined as all neutron data information coded and exchanged in EXFOR.

5. Service Areas of the Four Centres

The responsibility for the collection, compilation and dissemination of neutron data information is shared among the four major neutron data compilation centres, each being responsible for a defined service area. The four centres and their respective service areas are:

a) The National Neutron Cross Section Center (NNCSC), at the Brookhaven National Laboratory, services the USA and Canada.

b) The ENEA Neutron Data Compilation Centre (NDCC), at Saclay (France), services the non-American member states of the OECD, that is Western Europe and Japan.

c) the USSR Centr po Jadernym Dannym (CJD) at Obninsk (USSR) services the USSR.

d) the IAEA Nuclear Data Section (NDS) in Vienna, services IAEA Member States not included in the service areas of the above three centres, that is countries in Eastern Europe, Asia, Africa, South and Central America, and Australia and New Zealand.

B. FOUR-CENTRE COMMITMENT

1. Within the scope of this protocol each centre is expected to compile the data measured in its service area as fast and as thoroughly as possible.

2. The four centres agree that "new" data should be coded in EXFOR (where new is defined as data collected by the centres at the time of, or after, formal transmission of data is initiated). This does not preclude the transformation of "old" data into EXFOR.

3. Each centre may compile data measured outside its service area. Regular transmissions of EXFOR data from anyone centre shall include data only from its own service area.

C. IMPLEMENTATION OF EXFOR

1. Implementation schedule

a) The routine transmission of data tapes in the Exchange Format will start on 1 July 1970.

b) After this date EXFOR data tapes will be exchanged regularly between the four centres at a maximum interval of three months, with the possibility to transmit timely data at more frequent intervals. If deemed necessary, a stricter, or less rigid schedule could be agreed upon at any time in the future.

2. Method of data transmission

a) EXFOR data will be transmitted in accordance with the conventions laid down in the EXFOR Manual.

b) Only the character set specified in the EXFOR Manual is permitted.

c) The working language of EXFOR shall be English, and all free text comments within all EXFOR entries shall be English.

3. Scope of transmitted data

a) The general scope of EXFOR data will be all experimental microscopic neutron data.

b) Modifications to the general scope of EXFOR data can be adopted only as a result of an agreement between the four centres.

D. CORRECTIONS, REVISIONS AND DELETIONS OF TRANSMITTED EXFOR ENTRIES

1. Corrections or revisions

In the event of partial corrections or revisions of an EXFOR entry, the complete work shall be re-transmitted by the originating centre to the other three centres. Specific procedures to correct or revise transmitted data, if deemed necessary, could be considered at one of the next Four Centre Meetings.

2. Deletions

EXFOR works (data sets) can only be deleted from EXFOR with the expressed approval of the author except in the case of duplicate entries. The accession number of the deleted work should not be used for another work.

3. Accession numbers use

Once transmitted, no accession or sub-accession number should be re-used for another work or sub-work.

E. EXFOR DICTIONARIES

1. Updating of Dictionaries

a) To prevent duplications and conflicts, the NDS is responsible for the coordination and the updating of the EXFOR dictionaries.

b) Alterations (meaning additions, corrections or deletions) in EXFOR dictionaries can be consequential, which would entail changes in transmitted data, and thus require Four-Centre approval, and changes which could be termed inconsequential and would not entail changes in transmitted data or Four-Centre approval. Without exception, all changes to Dictionaries 1,2, 4, 10, 11, 12, 14, 16 and 24 are consequential and require Four-Centre approval.

c) Consequential Dictionary Alterations

Alterations of EXFOR dictionary entries which entail changes to data already transmitted cannot be implemented without specific Four-Centre approval.

d) Inconsequential Dictionary Alterations

Proposals for alterations of EXFOR dictionary entries which do not entail changes to data already transmitted, and which do not fall in the Dictionary list given in E.1.b. above, should be submitted by the centres to NDS together with their mnemonic terms and definitions by telex or airmail. Within one week of their receipt, the NDS shall transmit the approved dictionary entries to all centres simultaneously, in the form of photocopies of the input forms used for the NDS dictionary update program.

e) In their function to update EXFOR dictionaries, the NDS is given some latitude in reformulating the definition, but must not change the meaning without the approval of the originating centre. In questionable cases NDS shall consult with the other three centres for their opinions. It is the responsibility of each Centre to update its own sets of Dictionaries.

2. Routine Transmission of Dictionaries

a) The NDS will transmit changed dictionaries to the other three centres every three months, as part of the routine EXFOR transmissions.

b) The keywords "DICTION", "ENDDICTION" and "NODICTION", will be used by the NDS for transmission of changed dictionaries whether they are part of a data transmission or not, other centres will not use these keywords.

F. COMPILERS' MANUAL

In addition to the EXFOR Manual, the Four Centres shall collaborate in the formulation of an EXFOR Compilers' Manual whose primary function will be that of a collection of EXFOR compilers instructions. Specifically, it will include expansions of the definitions of physics terms, their nomenclature and interrelations, and general guidelines for EXFOR compilation.

G. EXFOR COMMUNICATIONS BETWEEN CENTRES

Two forms of documents are used for the proper distribution and referencing of all documentation on EXFOR.

1. Four-Centre Memos for the communication of proposals, programming details and other general considerations which touch upon the over-all aspect of EXFOR. This series of memoranda are numbered as follows:

   Memo-4C-n/m

   (where n is the centre identification number, and m the chronological memo number within the centre).

2. Exchange Format Memos for the transmittal of updating EXFOR Manual pages. This series of memoranda is issued by the NNCSC only, to each of the other three centres, and is numbered as follows:

   Memo-X4-m

   (where m is the chronological memo number).

H. CHANGES AND REVISIONS OF EXFOR

1. No changes in the structure of EXFOR will be allowed without Four Centre agreement.

2. If any one of the four centres proposes an alteration (meaning addition, correction or deletion) in Section I through VII of the EXFOR Manual and of Dictionary 1 and 2 of Appendix D to the EXFOR Manual, which would result in changes of the EXFOR structure and content, it will

be the responsibility of the centre originating such proposal to obtain four centre agreement, following the procedure outlined in Paragraph H.3. below, and to submit the proposed change to the centre responsible for the updating of the EXFOR Manual.

3. The following procedure should be followed by each of the four centres in obtaining the agreement to every one of its proposals to change or revise EXFOR within the context of Paragraph H.2. above; all communications with regard to such proposal shall be in the form of Four-Centre Memos.

   a) The initial proposal should be disseminated to all four centres.

   b) The initiating centre shall then collect and digest all comments, suggestions and counter proposals.

   c) In this review, the initiating centre shall consider such facts which would affect the EXFOR data base and associated computer codes.

   d) The initiating centre shall then distribute a technical evaluation of alternatives to the other three centres.

   e) After receiving the response to this technical evaluation, the initiating centre shall:

      (i) In the case of general agreement, submit the proposed alteration to the centre responsible for the EXFOR Manual updating.

      (ii) In the case of non-agreement, either retract the proposal, or submit it for inclusion in the agenda of the next Four-Centre Meeting.

4. The centre responsible for the updating of the EXFOR Manual is the NNCSC. This centre shall be responsible for producing the updated pages in sufficient number of copies and distributing them in accordance with an established EXFOR distribution list.

I. CHANGES AND REVISIONS OF THIS PROTOCOL

Any change to this protocol which is deemed necessary shall come into effect only with the expressed approval of the head of each of the four data centres.

Appendix 10

A. Progress Reports submitted to the Third INDC Meeting.

The list follows the same order as that in Section 3 of the Informal Minutes.

USSR	- INDC(CCP)-8/G	(Volume of Abstracts No.8)
	- INDC(CCP)-9/G	(Volume of Abstracts No.9)
Austria	- INDC(AUS)-1/G	(not yet received)
Poland	- INDC(POL)-3/L	
U.K.	- INDC(UK)-10/G	(EANDC(UK)120AL)
Germany (FRG)	- -	(see EANDC(E)127U)
Australia	- INDC(AUL)-8/G	
Romania	- INDC(RUM)-1/G	
Netherlands	- INDC(NED)-1/G	(also EANDC(E)127U)
France	- -	(see EANDC(E)127U)
USA	- INDC(US)-22/U	(EANDC(US)143U, NCSAC-31)
Japan	- INDC(JAP)-4/E	(supplement)
	- INDC(JAP)-9/E	(EANDC(J)19L)
India	- INDC(IND)-10/G	(BARC-459)
	- INDC(IND)-11/L	(BARC-474)
Canada	- INDC(CAN)-7/G	
Finland	- INDC(FIN)-1/G	
Hungary	- INDC(HUN)-1/G + Supplement	
Bulgaria	- INDC(BUL)-1/G	
Turkey	- INDC(TUR)-1/G	
Rep.of South Africa	- INDC(SAF)-2/G	
Switzerland	- INDC(SWT)-1/G	(EANDC(OR)93L)
Sweden	- INDC(SWD)-2/G	(EANDC(OR)99L)
ENEA	- INDC(ENEA)-3/G	

B. List of INDC documents received and distributed by the NDS between June 1969 and August 1970.

INDC Document Designator	Date Received	Original Document Identification	Document title, author, other identification numbers, etc. ...	Internal Acc. Number
INDC(USA)-13/E	4 Sep 69	-	Review of Isotopes Target Program, January 1965 - December 1967	300
INDC(GER)-7/E	18 Aug 69	KFK-941	Basic Requirements of Advanced Neutron Data Storage and Retrieval Systems (CSISRS); March 1969; J.J. Schmidt (also EUR 4163e and EANDC(E)-114"U")	301
INDC(NDU)-12/G,L	29 Aug 69	-	Revision of Values for the 2200 m/sec Neutron Constants for Four Fissile Nuclides, by C.C. Hanna et al.	302
INDC(IAEA)-1/N,L	25 Sep 69	IAEA/NDP/5	Meeting of Specialists on the Value of Plutonium Alpha	303
INDC(CCP)-4/G	5 Nov 69	-	Information Bulletin of the Nuclear Data Centre Obninsk, Volume No. 4	304
INDC(CAN)-5/G		AECL-3855	Report on g-factors, by C.H. Westcott; (also EANDC(Can)41)	305
INDC(CAN)-6/E	22 Jan 70	EANDC(Can)40	Progress Report to the EANDC	306
INDC(JAP)-4/E	22 Jan 70	EANDC(J)13B	Progress Report, November 1968 to July 1969 inclusive; edited by T. Momota	307
INDC(NDU)-13/G	23 Oct 69	-	Travel Report on T.A. Eyer's Mission to Latin America	308
INDC(SEC)-5/U	Nov 69	-	INDC Correspondents for the Exchange of Nuclear Data Information	310

INDC Document Designator	Date Received	Original Document Identification	Document title, author, other identification numbers, etc.	Internal Accession number
INDC(SEC)-4/U	Nov 69	-	List of INDC Documents	311
INDC(NDU)-15/D	Nov 69	-	Compilation of σ Capture for ^{238}U; V. Konshin	312
INDC(CCP)-5/G	5 Nov 69	-	Distribution of Resonance Neutrons in Homogeneous Media, L.P. Abagyan et al.; Supplement to the Information Bulletin 1968	313
INDC(NDU)-15/D	Nov 69	CINDU-9	CINDU-9 compilation	314
INDC(CCP)-7/G	16 Jan 70	-	Nuclear Physics Research in the USSR (Collected Abstracts) No. 7, 1969	315
INDC(CCP)-7/U	6 Mar 70	-	English translation of INDC(CCP)-7/G	315E
INDC(CCP)-6/G	16 Jan 70	-	Information Bulletin of the Nuclear Data Centre Obninsk, Volume No. 5, 1968	316
INDC(USA)-14/E	22 Jan 70	WASH-1136	The AEC Nuclear Cross Sections Advisory Committee: Meeting at Rice University, Houston, Texas, September 18-19, 1969, compiled by R.E. Chrien (also EANDC(US)-122U)	317
INDC(JAP)-5/G	22 Jan 70	JAERI 1162	Evaluation of ^{239}Pu Data in the keV and Resolved Resonance Region, June 1968 (also EANDC(J)15AL)	318
INDC(SEC)-6/G,L	28 Jan 70	-	List of IAEA Meetings for 1970	319
INDC(NDS)-16/N	5 Mar 70	-	Report of the Fifth Four-Centre Meeting, Moscow, 17-21 November 1969	320
INDC(U.II)-6/C	10 Mar 70	CINDA 69 Supplement	CINDA 69 Compilation, Supplement	321

INDC Document Designator	Date Received	Original Document Identification	Document title, author, other identification numbers, etc.	Internal Accession number
INDC(USA)-15/G	19 Mar 70	LA-DC-11039	Nuclear Physics Studies with Fast Neutrons: A Survey by John C. Hopkins (also EANDC(US)-134A)	322
INDC(NED)-1/G	13 Apr 70	-	Progress Report on Neutron Physics Work Performed in the Netherlands During 1969	323
INDC(SAF)-2/G	13 Apr 70	-	Republic of South Africa: Progress Report to the INDC, 1969, compiled by D. Reitmann	324
INDC(HUN)-1/G	13 Apr 70	-	Nuclear Data Program at the Institute for Experimental Physics, University of Debrecen, Hungary	325
INDC(HUN)-1/G Supplement	26 May 70	-	Progress Report on Neutron Physics Experiments in Hungary, March 1970	325/Suppl.
INDC(TUR)-1/G	13 Apr 70	-	Progress Report from Turkey to the INDC, compiled by T.B. Enginol	326
INDC(SEC)-7/U	30 Apr 70	-	INDC Correspondents for the Exchange of Nuclear Data Information, April 1970	327
INDC(BUL)-1/G	30 Apr 70	-	Progress Report 1969 from Bulgaria to the INDC, compiled by E. Nadjakov	328
INDC(AUL)-7/G	Jun 70	AAEC/PR31-P	Progress Report of Physics Division, including Applied Mathematics and Computing Section, 1 April 1969 - 30 September 1969	329
INDC(RUM)-1/G	30 Apr 70	-	Nuclear Data Achievements in Romania Within the Year 1969, by A. Berinde	330
INDC(FIN)-1/G	26 May 70	-	Progress Report on Finnish Activities in Nuclear Data 1969, compiled by Anders Palmgren	331
INDC(NDS)-23/G	30 Apr 70	-	Report of the Nuclear Data Section to the International Nuclear Data Committee, June 1969 to May 1970	332

NDC Document esignator	Date Received	Original Document Identification	Document title, author, other identification numbers, etc. ...	Internal Accession Number
NDC(UK)-11/G	26 May 70	AERE-R 6316	The Ratio of the $^{6}Li(n,\alpha)$ to $^{10}B(n,\alpha)$ Cross-Section from 10 eV to 80 keV and Recommended Values of the $^{10}B(n,\alpha)$ Cross-Section, by M.G. Sowerby et al., March 1970	333
NDC(USA)-16/G	May 70	EANDC(US)137/A	Status of the ^{10}B Absorption Cross Section, L. Stewart	334
INDC(USA)-19/G		LA-4372	Fission Cross Sections of ^{237}Np from Pommard, W.K. Brown et al., January 1970; also EANDC(US)140/A, TID 4500, UC-34,Physics	335
INDC(UK)-10/G	May 70	UKNDC(70)P 19	U.K. Nuclear Data Progress Report Mid 1968 - Mid 1969, E.R. Rae; April 1970; also EANDC(UK)120AL	336
INDC(IND)-10/G	29 May 70	BARC-459	Van de Graaff Laboratory Progress Report, compiled by T.P. David	337
INDC(NDS)-21/G (Draft)	3 Jun 70	-	Nuclear Data Requests for Safeguards Technical Development, Trevor A. Byer, May 1970	338
INDC(NDS)-22/G (Draft)	9 Jun 70	-	Needs of targets and samples for nuclear data measurements in the service area of the Nuclear Data Section, L. Hjärne, June 1970	339
INDC(NDS)-20/G (Draft)	Jun 70	-	Non-EANDC Request List for Neutron Nuclear Data Measurements, May 1970	340
INDC(NDS)-24/G + Spec.Distr.	Jun 70	-	Preliminary CINDA index to the papers of the Helsinki Nuclear Data Conference	341
INDC(NDS)-19/N (Draft)	Jun 70	-	Energy dependent $\bar{\nu}$-values for U-235, Pu-239, U-233, Pu-240, Pu-241, and the status of ν for spontaneous fission isotopes, V.A. Konshin and F. Manero, June 1970	342

INDC Document Designator	Date Received	Original Document Identification	Document title, author, other identification numbers, etc. ...	Internal Accession Number
INDC(JAP)-6/G	Aug 70	JAERI 4043	Bibliography for Thermal Neutron Scattering, March 1968 (also EANDC(J)6AL)	343
INDC(JAP)-7/G	Jun 70	JAERI 1183	Average Level Spacings and the Nuclear Level Density Parameter, August 1969 (also EANDC(J)17AL)	344
INDC(JAP)-8/G	20 Jul 70	JAERI 1181	Evaluation of Thermal Neutron Scattering Cross Sections for Reactor Moderators (Summary Report), September 1969, (also EANDC(J)18AL)	345
INDC(CAN)-7/G	Jun 70	-	Canadian Progress Report to the INDC, compiled by G.C. Hanna, 2 June 1970	346
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