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International Atomic Energy Agency

INDC - 9 / L

INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

OFFICIAL MINUTES OF THE FOURTH INDC MEETING

BHABHA ATOMIC RESEARCH CENTRE, TROMBAY, INDIA

12 - 16 July 1971

Compiled by

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Aided by

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SUMMARY

The fourth INDC meeting was held from July 12 to 16, 1971, in the Bhabha Atomic Research Centre, Trombay, India. Eight of the fourteen members, including two ad hoc members, were new to the Committee. Four scientists from the BARC staff participated as Scientific Advisors or official observers, and six others were invited to attend specific sessions.

The Committee approved several changes in the "Compendium of Committee Regulations" and modified the section of the "Methods of Work" that deals with the location of meetings.

The U. S. Member reported that the possibility of international participation in nuclear measurements at an underground nuclear explosion was under discussion in the US and may be feasible for 1975. Costs and other aspects of such experiments were discussed by the Committee and members were asked to determine the interest of their countries in participating. This information will be assembled by the IAEA's Nuclear Data Section.

Reports on new measurements, evaluations and facilities were presented by members and by the subcommittees on Standards and on Discrepancies in Important Nuclear Data. In discussing the technical aspects of these reports, the Committee's greatest concern continued to be with the fission and capture cross sections of ^{235}U, ^{238}U and ^{239}Pu from .01 to several MeV, the values of $\bar{\nu}$ and the spectra of fission neutrons. Despite several new measurements and critical surveys during the year, uncertainties in absolute cross sections of about 10% still persist for energies above 150 keV. While new microscopic measurements of fission spectra support older results, the discrepancies with integral data remain unexplained. Several measurements of the "Soleilhac effect" indicate that it is very unlikely to account for present discrepancies between different measurements of $\bar{\nu}$. Further measurements and critical reviews on most of these problems are in progress and a meeting to discuss fission spectra is planned.

The Subcommittee on Nuclear Data for Safeguards reported that request lists for Safeguards data were now available from several countries. Criteria for assigning priorities have recently been modified in the U. S. and are under discussion in the Agency. Procedures for screening data from the Safeguards standpoint, before they are presented to the INDC, have been proposed by the IAEA. The Committee agreed with these proposed procedures and recommended that a Safeguards request list be produced as soon as possible.

The Committee discussed the development of its role in nuclear data areas other than those of prime importance to fission reactor programmes - e.g. those arising from fusion programmes, Safeguards and industrial and medical applications. It supported the Agency's establishment of an International Working Group on Nuclear Structure and Reaction Data (IWGNSRD) but considered that this group should report to the IAEA through the INDC. Revised Terms of Reference for the Group were proposed. An ad hoc subcommittee on Non-Neutron Nuclear Data was set up, to report to the next INDC meeting. Among its responsibilities are the establishment of criteria to determine priorities for compiling and evaluating such data, the determination of the way in which the INDC will interact with relevent groups and the representation of the INDC on the IWGNSRD.

A major part of the work of the four data centres has been arranging for the processing and transferring of data in the EXFOR format. Some EXFOR exchange has already taken place and cooperation among the four centres appears to be good. There is increased interest among member states in evaluated data but so far no format for exchanging such data has been agreed on.

A formal recommendation to the Agency endorsed the importance of standard reference data and suggested that the Agency encourage measurement of such data. The U.S. member proposed, and the Committee approved, free and full exchange of evaluated neutron standard reference data for the isotopes ^{1}H, ^{3}He, ^{6}Li, ^{10}B, ^{12}C and ^{235}U. If this exchange proves mutually beneficial, further exchange of evaluated data will be considered. The exchange will be implemented by sending data to the IAEA's Nuclear Data Section which will then distribute these data.

The Committee approved the merging of RENDA and the non-OECD request list into a single World Request List, as agreed to by the EANDC, and agreed that the INDC would assume responsibility for its review. Some details of the reviewing procedure were discussed, for both the first and subsequent editions. The first World list will be drafted early in 1972, distributed to INDC and EANDC members and advisors, and the reviewed list will be issued by the end of the year. The NDS will have the major responsibility for its compilation and production and NDS and CCDN are in agreement on the cooperation required. A recommendation was made that the NDS be provided with additional staff to handle these increased responsibilities.

During the meeting a Topical Conference was held on "Neutron Induced Fission". Papers were presented by members of the Committee and by physicists from BARC and the Tata and Saha Institutes. Opportunities were provided for members to visit BARC and TIFR laboratories and to have individual discussions with Indian physicists.

LIST OF PARTICIPANTS

1. INDC Members

V. Benzi, Bologna, Italy
S. Cierjacks, Karlsruhe, Germany
N. Cindro*, Zagreb, Yugoslavia
H. Condé, Stockholm, Sweden
W.G. Cross, Chalk River, Canada (Executive Secretary)
A.S. Divatia, Trombay, India
W. Gemmell, Sutherland, Australia
G.A. Kolstad, Washington, USA (Chairman)
K. Nishimura, JAERI, Japan
E.R. Rae, Harwell, UK
P. Ribon*, Saclay, France
G. Ricabarra, Buenos Aires, Argentina
J.J. Schmidt, Vienna, Austria (Scientific Secretary)
M.F. Troianov, Obninsk, USSR

2. Scientific Advisors

V.C. Deniz, Trombay, India
W.W. Havens Jr., New York, USA
S.S. Kapoor, Trombay, India
B.P. Rastogi, Trombay, India
R.F. Taschek, Los Alamos, USA
J.L. Rowlands, Winfrith, UK

3. Observers

A.H.W. Aten**, Geel, Belgium (Euratom)
M. Balakrishnan, Trombay, India (Local Secretary)
N. Sodnom, Dubna, USSR (JINR)

*N. Cindro and P. Ribon attended as ad hoc members in place of I. Slaus and R. Joly, respectively.

** Attended part of session III.B and subsequent sessions.

4. Other Observers

The following scientists from the BARC were invited by the Committee to attend specific sessions:

S. B. Garg, III. A, IV. A to D, V. D, VI, VII, VIII
E. Kondaiah, IV. A to D.
M. P. Navalkar, IV. A to D, VI, VII, VIII
M. V. Ramaniah, IV. A to D, V. D.
M. Srinivasan, III. A, IV. A to D, VI, VII, VIII
N. Veeraraghavan, III. A, IV. A to D, VII.

I. ORGANIZATION AND ANNOUNCEMENTS

The Director of the B.A.R.C., Dr. H.N. Sethna, welcomed the participants. He described some of the active fields of nuclear research in India and the benefits Indian scientists had received through a nine-year cooperation with the INDC and INDSWG. The text of this address is given in Appendix 4.

For the benefit of new INDC participants, the Chairman outlined the history of the INDC, its primary goals and current problems. At his suggestion, members introduced themselves and each described briefly his position and work in his home organization.

II. COMMITTEE BUSINESS

II. A Consideration and Approval of minutes of the Third INDC Meeting

There was some discussion of the first sentence of page 52, in which belief was expressed that "the INDC should not be enlarged to cover the wider field of all nuclear data compilation". Kolstad felt that there had been some dissenting opinion to this and that non-neutron nuclear data with practical applications (e.g. for Safeguards, fusion, medical applications, etc.) could not be excluded from the INDC's responsibilities. Troianov warned of widening the scope of these responsibilities beyond the Committee's capabilities. On Schmidt's suggestion, it was agreed that these points of view would be expressed approximately by underlining the word "all" and that the question would be discussed in detail later (Section V.A).

After some minor corrections, the edited but unapproved informal minutes were adopted as final, to be issued as an INDC document by the Secretariat (Action 1).

II. B Consideration and Adoption of Agenda for present meeting

After minor additions and changes of order, the tentative agenda submitted by the Chairman was adopted. An ad hoc subcommittee on Non-Neutron Nuclear Data was set up, with Taschek as chairman, to consider the relationship between the International Working Group on the Compilation, Evaluation and Dissemination of Nuclear Structure and Reaction Data (IWGNSRD) and the INDC and to report later in the meeting (Section V.B). Members were: Cierjacks,

Divatia, Schmidt and Troianov, with Havens as a Consultant.

II. C Attendance of Observers

Divatia presented the names of BARC scientists who had special interests in the topics of various sessions. It was agreed that Sessions III. B, III. C, IX. A and IX. B would be open and that other non-executive sessions could be attended as described in Section 4 of the list of participants.

II. D Review of Actions arising from Third Meeting

1. NDS/INDC Secretariat - "Issue official minutes of the Second INDC meeting as INDC(SEC) - document with L distribution." Complete.

2. NDS/INDC Secretatiat - "Issue new Methods of Work document (G distribution) with the approved modifications included and with the section on distribution of documents deleted". Complete. See also II. F.

3. NDS/INDC Secretariat - "Ensure that INDC members continue to receive minutes of IWGFR meetings (continuing action 3 from second INDC meeting)". Minutes of 1970 meeting distributed and those of May, 1971 meeting will be distributed when ready. A continuing action (Action 50,1971).

4. Hjärne - "Provide information on available target and foil materials". No report has been written. Hjärne and Schmidt have discussed with groups at BCMN and ORNL the requests received prior to Third INDC meeting. Most materials requested will be available from both laboratories, at $300-$500 for normal targets to about $4000 for more specialized targets. A catalogue was also obtained from a Moscow firm. Target lists were sent to the original requesters. Kolstad felt that the Committee would be interested in a list of all requests to the IAEA for separated isotopes. A continuing action (Action 51,1971).

5. NDS/INDC Secretariat - "Forward the INDC Chairman's biennial report for 1968/9 to Director General. Consult the Director General's office regarding its distribution and issue as an INDC(SEC) document." Complete Kolstad pointed out that, as discussed under II. E, this should have an INDC designation rather than INDC(SEC) designation.

6. NDS/INDC Secretariat - "Establish a Compendium of

Committee Regulations". Draft Proposal issued as INDC(SEC)-15/L and discussed under II. E. Complete.

7. NDS/INDC Secretariat - "Distribute Compendium of Committee Regulations and Appendix A of INDC(NDS)-23/G to Liaison Officers". Appendix A incorporated into Compendium. Draft proposal given G distribution. After approval (and revision - see II. E) it will be distributed also to Liaison Officers (Action 2(1971)) Partly complete.

8. NDS/INDC Secretariat - "Send proposal on document distribution to INDC members". This is given as the foreword to INDC(SEC)-17/U - Complete.

9. Taschek - "Provide at an early date improved estimates of cost of underground nuclear detonations". Available data is discussed under III. A. A continuing action (Actions (1971) 7 and 8.)

10. All members - "At their discretion, make informal enquiries of their institutions regarding participation in experiments using underground nuclear explosions". Discussed under III. A. A continuing action (Action 5 (1971)).

11. Hjärne - "Inform INDC members of any UNISIST developments likely to affect data centres". See INDC(NDS)-38/G. A continuing action (Action 52, 1971).

12. NDS - "Inform INDC members as early as possible on any recommendation of CODATA regarding the relationship between CODATA and INDC. See INDC(NDS)-27/G. Complete.

13. Hjärne - "Prepare and distribute report on Helsinki Conference Questionnaire". See INDC(NDS)-26/L. Complete.

14. Byer - "Write to requesters of nuclear data for Safeguards to ascertain what criteria were used to establish their priorities". Byer received only a few answers. Screening in general discussed under VII. A. See also (1971) Actions 20 and 21. Complete.

15. Kolstad - "Investigate possibility of US CINDA operation being transferred to NNCSC". This appears to be impossible at present, for budgetary and administrative reasons. Complete.

16. NDS - "Issue amended Non-OECD neutron data request list after consultation with the requesters". USSR was asked for new requests. A few answers indicated old requests were still valid. An extensive new USSR list received from Nicolaev, Obninsk, in June '71. Discussion on this subject deferred to Session VII. A. See (1971) Action 23. Not complete.

17. Kolstad - "Ask chairman of EANDC that the INDC recommendation to merge request lists be considered at next EANDC meeting". Complete.

18. NDS - "Take 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 outcome of Action 17 above)". Discussed in VII. A. See also Appendix 14. Complete.

19. Hjärne - "As Chairman of Sub-committee on Targets and Samples, to report subcommittee's recommendations before October 1, 1970". Recommendation (Appendix 10) sent to Director General. Complete.

20. Lorenz - "Write to appropriate individuals to ascertain the need for nuclear data for fusion". See Appendix of INDC(NDS)-31/L. Discussed in VII. C. See also (1971) Actions 26 and 27. Complete.

21. NDS/INDC Secretariat - "Send copies of Helsinki Conference papers on fusion data needs to Committee members". Complete.

22. NDS/INDC Secretariat - "Inform organizations concerned with dosimetry and shielding of relevant activities of nuclear data centres". Complete.

23. All Standing Subcommittees - "Provide Chairman, Secretary and NDS with copies of all correspondence dealing with committee and subcommittee business". Except on Safeguards, little correspondence was given to Chairman and Secretaries. See next action. Complete.

24. NDS/INDC Secretariat - "Incorporate requirement re correspondence (Action 23) in Compendium of Committee regulations." See INDC-2/L. Complete.

II. E Consideration and Approval of "Compendium of Committee Regulations"

Schmidt explained that although this draft Proposal had been sent only to Committee members, it was given an "L" designation to avoid renu mbering after approval. Schmidt and Havens were asked to revise Section 5, to explain the difference between ad hoc and standing sub-committees. The names of sub-committee chairmen will be removed, as they will change from time to time. Kolstad proposed, and it was agreed, that the (SEC) designation be omitted on documents originating from the Committee (Methods of Work, Compendium of Regulations, Minutes, Chairmen's Reports) to dist inguish them from documents originating from the Secretariat. It was agreed that distribution lists would be changed (Section 2. 6, second paragraph) only with the approval of the appropriate INDC member or Liason Officer. In connection with the second paragraph of Appendix B, Section 3, Kolstad suggested that issuing of draft agenda was the responsibility of the Chairman. Schmidt said it was understood that no agenda would be issued without the Chairman's approval. The Secretariat was authorized to revise the Compendium as discussed and distribute it (Action 2).

II. F Consideration of Matters pertaining to the Committee's "Methods of Work"

Kolstad referred to Finkelstein's letter of April 13th, (Appendix 5) on the frequency with which the Committee should meet in Vienna and elsewhere, and mentioned two considerations - the costs of holding a meeting in different areas and the advantages of interaction between the Committee and the Agency. The cost of an INDC meeting outside Europe is roughly double that of one held in Vienna although, as Divatia pointed out, part of the difference might be borne by the host country. It was agreed to modify Section IV of the Committee's "Methods of Work" as follows, to reflect more accurately the language of the INDC Terms of Reference:

"Meetings shall normally be held once a year. It is desirable that the Committee meet from time to time away from IAEA headquarters, to familiarize itself with nuclear data activities in IAEA Member States".

A revision of page 4 of the Methods of Work will be issued to committee members and Kolstad will inform the Director General (Actions 3 and 4).

III. PROGRESS REPORTS

III. A Reports by Members on Participation in Experiments using Underground Nuclear Explosions

Kolstad reported that a plan, under the Plowshare Program, for the use of nuclear explosives for scientific experiments on an open basis, was under discussion by the USAEC. This would include the use of nuclear explosions for neutron physics experiments, heavy element production, geophysical and seismological investigations. Funds will be requested for the fiscal year 1973-74, by the AEC's Division of Peaceful Nuclear Explosions, in preparation for an explosion in 1975 that will probably be open to international participation. Further details may be available in a few months.

Taschek discussed the matter of costs. The cost of the explosion would be borne by the AEC. Participating groups would provide their own experimental facilities, although assistance with data recording could probably be provided by the Los Alamos Scientific Laboratory. While it is difficult to specify a "typical" cost to a participant, an example was given of an explosion some years ago at which four experiments were done by outside participants for $470,000. Of this, $167,000 was for hardware. A rough estimate for a minimal program was $100,000 per experiment, including salaries of two scientists, administration and hardware. However the figures might be quite different for groups from other countries. (Further information, provided by Taschek after the meeting in accordance with Action 7, is given in Appendix 19.) There might be 20 to 25 experiments for one explosion, one "experiment" including measurements over the whole energy range of interest. Proposed experiments would be screened on the basis of scientific merit, feasibility and whether the information could reasonably be obtained by other means. Kolstad suggested that the Agency might assist in this screening.

Taschek mentioned some of the measurements made at the Physics 8 explosion and referred to INDC(USA)-25/U for details. Cierjacks expressed interest in obtaining cross sections of Am and Cm isotopes and of short lived actinides. German physicists were also interested in n-n scattering as a test of charge independence, but Cindro felt that the n-n scattering length might better be obtained from the π^--n reaction. The measurement of short-lived fission product cross sections was mentioned by Ribon, but Rae thought that the most important of these could probably be measured by cheaper methods. Replying to Kapoor's question on the feasibility of heavy element synthesis, Taschek said that this had not yet been pursued much, because of technical difficulties.

There was considerable interest in the results obtained from previous explosions. Taschek quoted from Diven's article in the Annual Review of Nuclear Science (Vol. 20, 1970) and agreed to supply members with information on results, accuracies, energy ranges and typical costs of previous experiments and the

facilities that might be provided (Action 8). It was agreed that each member would then inform NDS about their country's requests, comments and interest in participating in such a program (Action 5). NDS would assemble this information and circulate a draft document for approval at the next meeting (Action 6).

III. B Reports from Members

USA

Referring to progress reports submitted to the NCASC meeting in April (INDC(USA)-30/U), Taschek mentioned the following fast neutron measurements:

- Elastic and inelastic scattering cross sections of C, Ti, V, Fe, Co, Ni, Cu, Nb and ^{238}U, from 1.8 to 3 MeV (Argonne).
- (n,p) cross sections of ^{58}Ni, ^{56}Fe and ^{47}Ti, to 4.5 MeV (Argonne).
- Inelastic cross section of ^{240}Pu at 140, 300, 600 and 900 keV (Argonne).
- Fission spectra from ^{235}U and ^{239}Pu (Argonne) - see INDC(USA)-27/L and IV. B. a.
- Fission cross sections of ^{235}U and ^{238}U from 2 to 5 MeV (Argonne).
- High resolution gamma spectra from (n, γ) reactions in Fe and Al, at 1 to 11 MeV (Gulf General Atomic).
- Total cross sections of Be and Si to 20 MeV (Nat. Bureau of Standards)
- Total cross sections of Sr, Ba and radio-Pb at 50 to 875 keV (Triangle Universities).
- Total cross sections of ^{16}O and ^{40}Ca (Oak Ridge).
- Capture cross sections of H and D, to 20 MeV (Rensselaer Polytechnic Inst.) and of ^{207}Pb from 300 to 600 keV (Oak Ridge).
- Small angle scattering from C, N, O and Pb, of 7.5 to 9.5 MeV neutrons (Nuclear Effects Lab.).
- Structure of ^{23}Na and ^{25}Mg photoneutron cross sections, to 30 MeV with 200 keV (E_γ) resolution (Livermore).

Among experiments carried out at the Physics 8 nuclear detonation by Los Alamos were:

- Sub-threshold fission of ^{238}U
- Fission cross section of ^{235}U and ^{252}Cf and resonance parameters of ^{252}Cf.
- Elastic scattering from ^{3}He
- ^{239}Pu alpha.

Replying to Divatia, Taschek said that the first neutron experiments with LAMPF would be in the hundreds of MeV region. Low-energy experiments would be done later if the proposed time-of-flight facility is built.

Kolstad described improvements in and experience with US facilities during the year. The Argonne 4-MV Dynamitron operated 2343 hours over a one-year period. The Brookhaven double tandem Van de Graaff achieved 20 μA of 30-MeV protons in June 1970 and has since been used for proton reactions and particularly for heavy-ion experiments. Completion of the Nevis synchrocylotron's conversion to a spiral, sector-focused machine is expected by the end of 1971. The expected average extracted beam is 10 to 40 μA of 550-MeV protons. Among other things, it will be used for neutron spectroscopy with emphasis on resonance

reactions and should give a 10-fold improvement in intensity. The Duke cyclograaff (15-MeV cyclotron plus 7.5-MeV tandem Van de Graaff) has run about 64% of the total time over the last two years. At Livermore, the new 100-MeV electron linac has met or exceeded all specifications except as a positron accelerator and is now on a 24-hour/dav schedule. The Livermore cyclograaff, which can produce 27-MeV protons, obtained a beam in late spring 1971. A beam of 100-MeV protons was extracted from the sector-focused cyclotron at the University of Maryland in April 1970. Since then, the beam transport system has been completed and experiments have begun. Schedule of the 400-MeV electron linac at MIT calls for 100-MeV beam tests in October 1971 and 400-MeV tests in the spring of 1973. The injector system has operated very satisfactorily. Operation of the Oak Ridge electron linac (ORELA) continues on a 24-hour basis, with improved electron-gun experience. Facility design and the data acquisition system have made it possible to run and set up 6 to 8 experiments simultaneously.

Some of the low energy neutron experiments in the US were described by Havens in the Topical Conference (Paper 2-1). The organization of nuclear data activities in the US is given in Appendix 18.

Italy

Benzi reported on recent experiments at 5 centres. At Padua, neutron differential elastic scattering and polarization were measured for ^{12}C, at energies 1.9 to 5.2 MeV. For ^{23}Na, n,n and n,n' cross sections were measured near 8 and 10 MeV, and for ^{23}Na, ^{27}Al and ^{28}Si differential cross sections were measured at 14 MeV. Small angle scattering from Bi and Pb was studied in detail, using partially polarized ^{7}Li (p,n) neutrons.

At Catania, the angular distributions of fragments from neutron-induced fission of ^{238}U were measured with nuclear emulsions, for $1.2 \leq E_n \leq 2.66$ MeV. Angular distributions, measured between 12.3 and 18.1 MeV, are well represented by $W(\theta) = C_o + C_2P_2(\cos\theta)$. The anisotropy, $R(E_n)$, has been analyzed, to investigate the contribution of the (n, 2n'f) reaction.

The configuration of ^{252}Cf in the various modes of ternary fission was investigated at Pavia by measuring energy distributions of emitted ^{3}H, ^{3}He, ^{6}He and the related fragments. Spectra of ^{6}He particles emitted in thermal fission of ^{233}U and ^{235}U were also measured. At Casaccia, capture in ^{35}Cl and ^{175}Lu of thermal neutrons from the TRIGA reactor was used to study level schemes. At Bologna, in cooperation with the Harwell Physics division, the $\langle 110 \rangle$ axial blocking in Ge was used to measure reaction times for inelastic scattering of 5 to 6 MeV protons from ^{70}Ge and ^{72}Ge. The times obtained were $\sim 10^{-17}$ sec $\pm$ 20%.

India

Divatia, referring to BARC 553, 543 and 557, described some experiments and new facilities. The latter included a variable energy cyclotron under construction for Calcutta and a proposed 30 kW (average), pulsed, fast reactor, to serve as an intense neutron source (10^{15} n/sec peak). The addition of a pre-injection e/m analyzer to the BARC Van de Graaff will provide ions up to 11 MeV. Kapoor outlined experiments at BARC in which X-rays were used to probe the fission process. Yields, multiplicities and time distributions of X-rays from fission fragments of identified nuclear charges were measured (BARC 557). Studies of angular correlations between delayed gamma rays and fission fragments are in progress. Angular correlation between fission fragments and specific energy groups of long-range alpha particles has been studied, for thermal fission of ^{235}U. Current theoretical work on fission, including the addition of shell structure effects to the stochastic theory of mass and charge distributions, and the excitation energy dependence of shell effects, was described by Kapoor and in more detail in the Topical Conference. Troianov enquired about earlier plans to measure alpha for ^{235}U and ^{239}Pu, using a beam of Sc-filtered neutrons, but no information on this was available.

Germany

Commenting that a written report would be submitted later, Cierjacks mentioned the following recent measurements at Karlsruhe.

Total cross sections of ^{10}B and ^{6}Li, at energies up to 1 MeV at resolutions of 0.2 to 0.5 nsec/m (in progress).
Analysis of resonance capture in the main Ti, Fe and Ni isotopes.
Ratio of fission cross sections of ^{241}Pu and ^{235}U from 5 keV to 1 MeV.
Fission cross section of ^{235}U at 440 and 530 keV.
Alpha for ^{235}U and ^{239}Pu, at 10-60 keV (this will be extended to 400 keV).
High resolution study of gammas produced by inelastic scattering of 0.8 to 30-MeV neutrons from Fe and Al.
Fission cross section of ^{238}U relative to ^{235}U and to the n,p cross section, from 0.8 to 32 MeV.
Elastic scattering from Ca and Cu, below the inelastic scattering threshold. Resonance parameters were obtained by comparing resonance shapes at different angles.

At Hamburg, activation measurements of various n,x cross sections have continued, for 12 to 19 MeV neutrons and targets with A = 90 to 130. At Julich, delayed gamma emission from the thermal

fission of ^{235}U has been studied.

France

Ribon reported that the only significant new facility was a 4 MV Van de Graaff which is in operation at Limeil. Nuclear Data measurements include:

Saclay: The conclusion of a study of the so-called "French effect"* was that the correction to $\bar{\nu}$ (absolute value) would be of the order of 0.1% for the liquid scintillator tank used at Saclay.
Measurement of the fission cross sections of ^{235}U, ^{241}Pu and ^{233}U, using the linac, have continued, as has their analysis (multi-level for ^{239}Pu and ^{241}Pu).
Measurements of α-accompanied fission of ^{235}U have been started and will be extended to ^{239}Pu.
Cadarache: The fission cross sections of ^{235}U, ^{239}Pu and ^{241}Pu have been measured in the tens of keV range.
Earlier results on the ^{6}Li (n,α) cross section are being checked but the origin of discrepancies with Harwell data below 250 keV remains unknown.
The ^{23}Na capture cross section has been increased by 15-25% as a result of renormalization.
Bruyères-le-Châtel: Precise measurements were made of the total cross section of Ni, ^{235}U, ^{238}U and ^{239}Pu between 1.2 and 6 MeV.
The differential inelastic cross section of ^{238}U was measured for 14-MeV neutrons.
Measurement of the "French effect" for the scintillator used gave a correction of 0.6%.
Limeil: The neutron spectrum from ^{238}U fission induced by 14-MeV neutrons has been measured.
Fontenay-aux-Roses: The fission yield of ^{148}Nd was determined for ^{235}U, ^{238}U and ^{239}Pu, for thermal and fast neutrons.
The ^{233}U cross section has been measured for thermal neutrons.
Measurements of the ^{241}Am capture cross section are in progress.
Additional recent work has been reported at the Helsinki and Knoxville Conferences.

*The "French" or "Soleilhac" effect is the increase in efficiency for detecting the prompt triggering pulse in a liquid scintillator with the number of neutrons emitted per fission. It results in an overestimate of $\bar{\nu}$.

Australia

Referring to INDC(AUL)-12/G, Gemmell mentioned Boldeman's measurements on the variation of $\bar{\nu}$ of ^{239}Pu with incident neutron energy, from thermal to 2 MeV. The energy dependence was similar to that found previously (J. Nuc. Energy 24 191 (1970)) for ^{235}U. Boldeman plans to remeasure ^{235}U up to 1 MeV, with 10 keV resolution on incident neutrons. Gamma spectra following capture of keV neutrons in Ti, Ni and Fe have been measured for individual resonances resolved by TOF. Partial capture widths were determined for most known resonances from 15 to 60 keV.

Argentina

Ricabarra referred to INDC(ARG)-1/G. Activation resonance integrals, measured for $^{146,148,150}Nd$ and $^{74,76}Ge$ disagree with those calculated from resonance parameters. Epithermal self-shielding has been measured for ^{96}Zr. Branching ratios, following thermal neutron capture, were studied for Nd, Y, Ti and As. Gamma spectra from short lived fission products were used to determine conversion coefficients of about 35 transitions as well as level assignments, for $^{133, 135, 136}Xe$, $^{135, 137, 139}Cs$ and ^{138}Ba.

Japan

Nishimura said that the 1971 report (updating INDC(JAP)-9/G) was expected shortly and referred to a supplement (distributed to members) that covered JAERI activity only.

A 120-MeV electron linac is under construction and scheduled to be tested early in 1972. Its main purpose is for neutron cross section measurements, with flight paths up to 190 m. A computer for on-line data acquisition will also operate early in 1972. Fast neutron experiments with a 5.5-MV Van de Graaff include energies and assignments of levels excited by inelastic scattering of 0.5 to 1.2-MeV neutrons from ^{133}Cs, and differential cross section measurements for elastic and inelastic scattering of 1.5 to 3.5 MeV neutrons from La, Pr, Er and Bi.

Sweden

Condé referred to the draft version of INDC(SWD)-3/G. The systematic studies of fast neutron elastic scattering by Holmqvist and Wiedling (Studsvik) have continued. The studies cover measurements on about 20 elements in the mass region 27-209 at a neutron energy of 8 MeV and also, for selected elements (V, Cr, Fe, Ni), measurements at several energies between 1.8 and 8 MeV. The results have been compared with optical model calculations using local potentials.

A systematic study of neutron inelastic scattering is in progress by Wiedling et al. Measurements have been made on about 20 elements for the incident neutron energies of 2 to 4.5 MeV. Gamma rays from inelastic scattering in N and O, at incident energies between 4 and 8 MeV, were measured by Lundberg et al at the Research Institute of National Defence.

Values of $\bar{\nu}$ for neutron-induced and spontaneous fission of ^{236}U have been measured, with special attention given to the threshold region. Within 1-1.5%, no correlation was found between structure in the energy dependence of $\bar{\nu}$ and in the fission cross section. Measurement of fission neutron energy spectra is continuing at Studsvik by Almén et al, using a time-of-flight technique. Preliminary results agree with earlier differential data. An experiment is set up at the Studsvik Van de Graaff by Hellström et al to measure fast neutron capture cross sections. A large liquid scintillator, arranged as a Moxon-Rae detector, is used for the gamma rays. Because of intensity limitations only elements with large capture cross sections have been measured so far.

United Kingdom

Rae referred to INDC(UK)-12/G, which the present report updates. New facilities include a 100-MeV electron linac at Glasgow, now in use part time as a pulsed time-of-flight facility for neutron elastic and inelastic scattering. A 4-MV Dynamitron is being installed at Birmingham.

Experimental work at the Harwell linac has been restricted by concentration on evaluation. Capture cross sections of natural Ni, ^{58}Ni and Er isotopes (the latter in collaboration with the Univ. of Vienna) were measured below 100 keV with a Moxon-Rae detector at 30 m. The steel tube of the scintillator tank used at 100 m gave too much parasitic capture and is being replaced by a Be tube. Total cross sections were measured at 15 m for ^{58}Ni, Fe, $Er^{166,7,9}$ and Tm. High resolution measurements above 10 keV, on Ni and Fe, are in progress on the synchrocyclotron. The fission cross section of ^{235}U has been determined from 100 eV to 1 MeV, by measuring fission neutrons.

The $^{6}Li(n,\alpha)$ reaction was studied using thin and thick ^{6}Li-glass detectors (see IV.A.2). The ^{10}B $(n,\alpha\gamma)$ cross section was measured at 120 m. the flux being determined with a "black" boron-vaseline sphere now being calibrated against the Harwell long counter. Evaluation of the ^{6}Li cross section below 1 MeV now includes angular distributions of reaction products and scattered neutrons.

Following recommendations at Helsinki, a program was written for generating resonance, total, fission and capture cross sections with inclusion of Doppler and resolution broadening for testing data analysis systems. Elastic and inelastic scattering cross sections of ^{238}U were remeasured from 0.07 to 1.6 MeV with the Harwell Van de Graaff. Measurements of the neutron spectrum from ^{235}U fission have begun, using a carefully calibrated detector. Fission fragment angular distributions were measured for resonance fission of oriented ^{233}U, ^{235}U and ^{237}Np nuclei. Resonance-capture gamma ray spectrum studies led to spin assignment of resonances in ^{181}Ta, ^{167}Er, ^{133}Cs and ^{169}Tm and to a revision of conclusions concerning the supposed correlation between Γ_n and Γ_γ^1. A small photonuclear program has continued and theoretical studies of fission isomers have been made.

USSR

Troianov commented that much of the USSR work is summarized in abstracts sent to the NDS for translation (Collected Abstracts No. 10, Nuclear Data Information Centre, USSR State Committee on the Utilization of Atomic Energy).

At Obninsk, fission cross sections of ^{235}U and ^{239}Pu were measured (in collaboration with the Lebedev Institute) from 0.1 to 40 keV, using the slowing down spectrum from a Pb cube. The ^{238}Pu fission cross section has been measured below the fission barrier. Measurement of fission fragment angular distributions gave information on spin effects and on the double humped fission barrier. Polarization effects, determined from small angle scattering, agreed with optical model calculations. Angular distributions were measured for the photofission of ^{239}Pu. Delayed neutrons from ^{239}Pu and ^{238}U were measured for fission induced by 18-21 MeV neutrons.

At the Kurchatov Institute, cross sections and fragment anisotropies were measured for ^{232}U at 0.1 to 1.5 MeV. Values of $\bar{\nu}$, from an experiment originally described at Helsinki, are given in the abstracts for ^{235}U, ^{239}Pu and ^{240}Pu. At Leningrad, an absolute measurement of the fission cross section of ^{238}U was made at 2.5 MeV, with $\pm$ 4% accuracy, and the spontaneous fission half life of ^{252}Cf has been determined. At Kiev, scattering cross sections of Cu, Ge and Re isotopes were measured for slow neutrons. Neutron resonances in ^{136}Ce, ^{138}Ce, ^{151}Eu and ^{153}Eu, and fast neutron radiative capture cross sections in ^{69}Ga, ^{71}Ga, ^{139}La and ^{141}Pr have been measured.

Among experiments reported at the Kiev Conference in May '71 (Proceedings to be distributed - see Actions 31 and 32) were six on alpha measurements. Kononov has made very detailed absolute measurements for ^{235}U and ^{239}Pu, from 10 keV to 1 MeV. The results agreed with USA data except around 20 keV, where there were discrepancies and structure was noticeable. In another experiment, a Pb-cube source was used for measurements to 20 keV. Mostovoy and Muradyan's ^{235}U experiment, reported at Helsinki, has been repeated for ^{239}Pu. For ^{235}U, alpha measurements from 5 to 50 keV and at 130 keV, were made at the Kurchatov Institute. At Obninsk, a beam of Sc-filtered neutrons was used to determine alpha for ^{235}U and ^{239}Pu.

Angular distributions for n,n' and n,2n reactions were measured for 14-MeV neutrons scattered from Mg, Co and Bi. The temperature of the spectrum was measured and the contribution of direct processes was estimated. For 4.37-MeV incident neutrons, angular distributions were measured for elastic and inelastic scattering from Li, B, Na, Cr, Ni, Sr and Nb. Inelastic spectra were measured for 9.2-MeV neutrons scattered from Al, Co, Nb, ^{232}Th and ^{238}U at 30°.

Other experiments described at Kiev included measurement of (1) the capture cross section of ^{238}U from 24 keV to 1 MeV (Obninsk). (2) an average capture width of 24 meV for ^{238}U (Dubna), (3) $\bar{\nu}$ of ^{235}U (Kurchatov Inst.), (4) fission cross sections of ^{235}U from 2 to 60 eV, at room temperature and at 80°K. (Kurchatov Institute)

Replying to questions, Troianov said that a 100-MeV isochronous cyclotron at Kiev was under construction, but did not know the completion date. Sodnom, replying to Divatia, mentioned a new accelerator under development at Dubna by Sarantsev using the collective method of acceleration. Alpha particles have been accelerated and they hope to accelerate heavy ions. A Na-cooled, pulsed, fast reactor, with an average output of 5 MW, is expected to operate in 1973.

Yugoslavia

Cindro noted that a written report would be submitted soon by Slaus (INDC(YUG)-2/G). He described a new low-scatter facility, at the Rudjer Bošković Institute, for 14-MeV neutron measurements. Measurements of "rare" reactions [(n,2p), (n,t), (n,^{3}He)], produced by 14-MeV neutrons in targets throughout the periodic table, gave cross sections of 20 to several hundred μb. An upper limit of 400 μb per steradian (at 30°) has been determined for the bremsstrahlung produced in the scattering of 14-MeV neutrons by protons. Capture cross sections for 14-MeV neutrons have been measured by two methods - activation and integration of the prompt gamma radiation. The discrepancies between the results of the two methods, observed for some nuclides, were discussed briefly under

IV. B. (e) and preprints were distributed.

The mechanism of emission of alpha particles following the bombardment by 14-MeV neutrons and 13-40 MeV protons (the latter in collaboration with the Univ. of Manitoba) was investigated by studying energy spectra and angular distributions.

Canada

Referring to INDC(CDN)-9/G for a description of experimental work, Cross drew attention to the completion of a half-life measurement on ^{234}U. The result, in good agreement with recent values from Argonne and Geel, will affect the 1969 IAEA value of the ^{235}U fission cross section by perhaps 2 barns. The first scheduled replacement of the moderator tank of the NRX heavy water reactor was carried out during the winter, without incident and on schedule. A new beam tube to be installed in the tandem Van de Graaff in December is expected to give 5 μA of protons at 26 MeV.

Euratom

Aten referred to the 1970 Euratom Progress report and described work at Geel, Petten and Amsterdam. Activities at BCMN are divided among neutron measurements, radionuclide standardization and sample preparation. Nuclear measurements include:

Spectral measurements of neutrons from a uranium-graphite assembly with a proton recoil counter and TOF, and comparison with calculations (collaboration with Cadarache).

Total cross sections of ^{233}U, ^{238}U and ^{241}Pu, fission cross sections of ^{233}U, ^{239}Pu and ^{241}Pu, capture cross sections of ^{238}U and ^{237}Np and elastic scattering from ^{235}U and ^{237}Np.

Sub-threshold fission of ^{241}Am using a spark counter.

Total cross sections of ^{6}Li, up to 1 MeV.

Further work on the ratio of (n,α) cross sections in ^{6}Li and ^{10}B is under discussion and remeasurement of the $^{58}Ni(n,p)$ cross section is planned.

Work at Petten and Amsterdam included scattering of polarized neutrons, fission of oriented ^{233}U, ^{235}U and ^{237}Np nuclei, and measurement of the ^{252}Cf fission spectrum.

Aten asked for guidance on selecting topics for investigation in the nuclear standards field and was referred to the report of the Standards Sub-committee. He also asked for advice on replacement of a Van de Graaff with a higher energy accelerator to provide neutrons in the presently inaccessible range 8-12 MeV. Havens remarked that the need for standard reference data will increase in future, that such measurements are more suitable for a government laboratory than for a university and that, while standards measurements need not cover all energies, the INDC might well stress the importance of standard data laboratories' having all the necessary facilities although it cannot act as an advisor for a specific project. Schmidt felt that fusion requests would increase the importance of "filling the gap" between 8 and 14 MeV.

III. C Reports from countries not represented on INDC

Referring to reports submitted by Liaison Officers, Schmidt described the nuclear activities in Brazil, Uruguay, Poland, Romania, Bulgaria, Hungary, South Africa, Iran, Turkey, Korea and Finland. (A list of these reports, including some that arrived after the meeting, is given in Appendix 17.) Activities in Belgium and the Netherlands were considered sufficiently well known to the Committee that they were not described. Information from additional states was received by letter. Reports were expected, but not received, from China, Czechoslovakia, Israel, Mexico, Pakistan, Thailand and the UAR.

Schmidt and Taschek commented on how much some of the smaller countries were achieving and the Committee generally felt that they deserved commendation for valuable contributions. The NDS plans to assemble all reports from its service area and distribute them as a single report. Divatia asked that a list of laboratories and facilities in these countries be provided and it was decided that the report would include this (Action 10).

Cindro described efforts to establish a joint Centre of Nuclear Physics among institutes in Austria, Hungary, Italy and Yugoslavia. Romania and Poland were less interested. The Centre would depend heavily on existing facilities, purchase a 100-MeV variable energy cyclotron and cost about 15 million dollars over 10 years. The initiative had come from individuals in the four countries. The governments have been approached and favourable responses received. Answering Kolstad, Cindro said that this activity would probably be related to nuclear power in the future.

IV. REPORTS OF SUBCOMMITTEES

IV.A Subcommittee on Standards

1. Report of Subcommittee

The report, based mainly on the conclusions from the EANDC Conference on Nuclear Standards, held at the Argonne Laboratories in October 1970, was presented by Havens with the assistance of Rae, Taschek and Condé. In addition to the written report (Appendix 6) a review on the Status of Fast Fission Cross Sections by M. Moore was distributed (Appendix 7). Reference was also made to Landon's paper at the Knoxville Conference (Proceedings, p. 528). A recommendation emphasizing the importance of standard reference data and suggesting that the agency encourage their measurement was approved. (Appendix 1.2)

2. Conclusions and Recommendations from the EANDC Standards Symposium

Conclusions on light nuclei were summarized by Rae and are given in detail in Appendix 6. Rae agreed with Cierjacks that more accurate angular distributions were needed for n,p scattering above 10 MeV. A Los Alamos report by Leona Stewart, in which the anisotropies were unexpectedly large, was mentioned by Havens.

Rae referred to some measurements on $^{6}Li(n,\alpha)$ done since the Argonne meeting. Experimental measurements of the "250 keV" resonance have in the past given a wider peak, centred at a higher energy, than that predicted from fits to the total and scattering cross sections. Three recent measurements using thinner ^{6}Li glass detectors, 1 and 2 mm thick (Harwell) and 0.5 mm thick (Oak Ridge), gave closer agreement with theory. On the other hand, a Cadarache group, also using a relatively thin (3 mm) detector, got a higher energy than predicted. A possible but untested explanation is that some detectors contain an impurity with a nearby resonance.

3. Recent work on ^{235}U Fission Cross Section

Moore's paper on the Status of Fast Fission Cross Sections (Appendix 7) was summarized by Taschek. The main problem is still the fission cross sections of ^{235}U and ^{239}Pu and their measured ratio. As discussed by Byer and Konshin at Knoxville (to be published as INDC(NDS)-33/G), the various results are consistent to within 4-5% up to 150 keV but the agreement is still poor at higher energies. Pitterle recently evaluated the fission and capture cross sections of ^{238}U. The former depends on the Los Alamos $^{238}U/^{235}U$ fission ratios of R. K. Smith et al (revised by Hansen) which Pitterle considered accurate to 2-5% - an accuracy which Taschek

questioned. In any case the fission cross section of ^{235}U above 150 keV requires further work. Two new measurements were mentioned by Cierjacks and Rae: Käppeler (Karlsruhe) was starting a measurement of $\sigma_f(235)$ relative to the n,p cross section, up to 1 MeV; Gayther (Harwell) was using a "black" detector to measure $\bar{\nu}\sigma_f(235)$ from 100 keV to 1 MeV.

Troianov asked why $\bar{\nu}$ for ^{252}Cf had not been considered as a standard reference datum. Rae had not included this because A. B. Smith's summary gave no recommended value but urged that further measurements be made both with a liquid scintillator and with a Mn bath.

Condé mentioned recent work on $\bar{\nu}$ for ^{252}Cf. De Volpi's review at the Argonne meeting gave a value about 1% lower than Hanna et al (IAEA Atom.En.Review, 1969). Axton's recent measurement with a new ^{252}Cf source gave a value 1% higher than he had obtained with an earlier source. Schmidt remarked that Axton had recently quoted 3.72 (in near agreement with De Volpi) and that Boldeman plans further measurements.

4. Recent work on 2200 m/sec fissile isotope constants

Schmidt referred to an assessment of the current status in INDC(NDS)-31/L (E.4.a). A recent Romanian measurement of the fission cross section of ^{239}Pu, critically reviewed by Deruytter, was in good agreement with the 1969 review value of Hanna et al. Updating of this review is committed for the second half of 1972, in order to meet an ENDF/B deadline.

5. Recent French work on "Soleilhac effect" in liquid scintillator $\bar{\nu}$ measurements

Preprints of a paper to appear in Nuc. Insts. and Methods were distributed. The authors (Signarbieux et al) obtained a smaller variance in the $\bar{\nu}$ distribution than was found by other investigators and a correction to $\bar{\nu}$ of about 0.1% due to the "French effect" (Soleilhac effect). Schmidt mentioned that Boldeman had recently obtained - 0.14% for this correction and that all 4 experiments done since the effect was observed gave results between 0.1 and 0.6%. The effect is therefore most unlikely to account for observed differences between measurements of $\bar{\nu}$ with a liquid scintillator and with a Mn bath.

IV. B Sub-Committee on Discrepancies in Important Nuclear Data and Evaluations

Schmidt's report (Appendix 8) summarized the conclusions of several NDS reviews carried out during the year and outlined topics proposed for future consideration of the sub-committee. The goal was to identify the major sources of discrepancies. Schmidt referred also to the summary of Goldstein et al (INDC(USA)-31/G), who reached similar conclusions.

(a) Fission Neutron Spectrum

The agenda of a Consultants' Meeting on the Status of Prompt Fission Neutron Spectra, to be held in August, was outlined (Section 3.2.b INDC(NDS)-31/G). The main aim of the meeting is to examine possible causes of the discrepancies between microscopic and integral measurements by bringing together experts on both methods. An NDS review of microscopic measurements, to be presented at the meeting and published in INDC(NDS)-35/L, confirms the older Los Alamos data (as does A.B. Smith in INDC(USA)-27/L) and gives $\bar{E}$ for ^{235}U slightly below 2.0 MeV. Use of too low a ^{235}U fission cross section, as the basis for normalizing the cross sections of threshold detector reactions in the MeV range, was suggested as a possible explanation of the discrepancies.

Rowlands asked if values of $\bar{\sigma}_f$ for ^{238}U in a "pure" fission spectrum would be considered, mentioning discordant results obtained by Leachman (310 mb), by Fabry (350, 370 mb) and at Harwell (280 mb). Schmidt referred to a recent paper of Kimura et al (J. Nuc. Sci. and Tech. 8 59 (1971)) that supports Leachman's

fission spectrum results and Taschek mentioned that Grundl is repeating earlier measurements of σ_f for ^{235}U.

(b) $\bar{\nu}$ Data

The NDS review of $\bar{\nu}$ values, submitted to the 1970 Studsvik Consultants Meeting, has been updated and enlarged to include more nuclides, including many produced by burn-up. It will be reported in the IAEA Atomic Energy Review early in 1972. The importance of having accurate $\bar{\nu}$ values is illustrated by the incorrect k_{eff} values estimated for ^{239}Pu and ^{235}U critical assemblies. Schmidt emphasized the importance of the ^{252}Cf standard.

(c) Alpha ^{239}Pu

The draft of an extensive review by Sowerby and Konshin on ^{239}Pu alpha measurements has been circulated to experimental groups concerned and a revision will be published in the Atomic Energy Review early in 1972. The goal is to extract the best values (0.1 keV to 1 MeV) of alpha from present experiments, particular attention being paid to systematic errors. A total uncertainty of ± 10-15% is expected. Troianov referred to recent USSR measurements on both ^{235}U and ^{239}Pu. The results had not yet been critically compared with those discussed at Studsvik but no discrepancies were expected above 30 keV. Schmidt will check if Sowerby and Konshin have all these data. Troianov advised that the 1 keV intervals suggested by some at Studsvik for alpha data in the 1-10 keV region were too wide and recommended equal intervals in lethargy.

(d) ^{239}Pu Fast Fission and ^{238}U Capture Cross Sections

NDS reviews on these cross sections, presently being carried out by Byer and Konshin, isolate results that depend on the fission cross section of ^{235}U from those that do not. Preliminary conclusions are that ^{235}U fission cross sections derived from ^{238}U and ^{197}Au capture, and capture/fission ratios, support Poenitz' results while those derived from Pu data are about 15% higher. Measurement of gold capture to Pu fission cross section ratios might help to explain the discrepancy. NDS is prepared to review the ^{235}U fission cross section measurements and recommends that the IAEA Standards Panel, scheduled for 1972, should emphasize this problem.

(e) Neutron Capture in Structural Materials

Rae reported that Moxon is continuing evaluation of keV capture, particularly in Fe and Ni. Recent Ni data tend to confirm the higher cross sections of Spitz et al (Nuc. Phys. A121, 655 (1968)) rather than those derived using slowing-down spectra. To fit ^{60}Ni data above 100 keV requires either an abnormally small P-wave strength function or a small radiation width.

Cindro drew attention to the apparent large differences for some nuclides between capture cross sections of 14-MeV neutrons obtained by (1) activation and (2) integrating the prompt gamma emission. The difference appeared to be correlated with shell closure. A possible explanation, involving secondary capture of low energy neutrons, was mentioned by Benzi.

(f) Neutron Data for Reactor Radiation Dosimetry

Schmidt referred to the April meeting of the IAEA Working Group on Reactor Radiation Measurements (WGRRM). An informal report on this meeting by Keddar, the IAEA Scientific Secretary of WGRRM, has been sent to INDC members. The group proposed that NDS prepare a survey of existing experimental and evaluated data on the various cross sections, resonance integrals and half lives needed for reactor radiation measurements. N, α cross sections have special importance for the calculation of He build-up in fusion reactor vessels. NDS expects to distribute their report in mid-1972. Taschek suggested that the Committee should confine its activities to the nuclear data required and not become involved in problems of energy deposition.

IV. C Subcommittee on Nuclear Data for Safeguards

Taschek, reporting for the subcommittee, referred to a recent US report, listing US requests for Safeguards and discussing modifications in the criteria of priority assignments (INDC(USA)-33/G). He mentioned also a quarterly progress report from the Office of Safeguards and Materials Management and a review paper to be given at the Geneva Conference ("Development of Techniques and Instrumentation for the Non-Destructive Assay of Fissionable Materials and Field Assay Experience" by Keepin, Bramblett and Higinbotham). The report of the Subcommittee is given in Appendix 9.

The work of the Agency is described in INDC(NDS)-31/L (Section D.5). Referring to this, Schmidt described the joint Safeguards and nuclear data group set up within the Agency to consider priority criteria and to screen requests for nuclear d data for Safeguards before submission to the INDC. A meeting on "The Coordination of the Development of Instrumentation for Safeguards Purposes" will be held at the end of August, with special emphasis on gamma spectrometry techniques. He mentioned also a contract with Beyster to review safeguards assay techniques, and said that a report with the results of this review could be expected early in 1972. After some discussion, the committee decided to make a formal recommendation to the Agency for the preparation of an official international request list as soon as practicable (Appendix 1.1).

On Divatia's request, it was decided that the results of Beyster's contract should be sent to INDC members (Action 11). Cierjacks reviewed German progress on Safeguards, on wnich a document will be submitted to the Agency. Priority criteria have been discussed and a request list is in preparation. Japanese progress, described by Nishimura, includes organization of committees on burn-up measurements, nuclear data and political aspects of Safeguards techniques.

It was agreed that INDC members would urge their respective countries to submit any request for Safeguards data to the Department of Safeguards and Inspection of the IAEA (Action 12).

IV. D Ad Hoc Sub-committee on Targets and Samples for Nuclear Data Measurements

Reporting for the Subcommittee, Divatia referred to an INDC report, submitted by the subcommittee to members at the beginning of 1971. ("Recommended Policies and Procedures for the Handling of Requests for Targets and Samples for

Nuclear Data Measurements"- Appendix 10) The report was approved by the Committee by correspondance and forwarded to the Director General by the Chairman on January 22, 1971. Hjärne had very recently sent out a circular letter asking for requests for Targets and Samples.
Schmidt will send a list of the requests to the Committee members (Action 13) who will then send comments on these to the Chairman (Action 14). The Agency has $15,000 budgeted for 1972, for supplying targets and samples to developing countries, and nothing in the budget for 1973. The Agency would like to see how the situation develops before committing further funds. Balakrishnan pointed out that many Indian Institutes had expressed less interest in the priority measurements represented by categories A and B than in basic physics measurements (category C) and this was also true of Argentina. However, the general feeling of the Committee was that the priorities stated in the Policies and Procedures should apply. Gemmell suggested that the Agency might assist those small countries that could pay for samples by arranging their procurement. Answering Ribon's question, Schmidt stated that the Agency would not stock samples but would help requesters (by providing information or financially) to procure them from suppliers like ORNL or BCMN. Information on materials available from BCMN was distributed by Aten.

Block and Smith's recommendation on modular metallic samples (INDC(USA)-34/G) was briefly discussed. Rae approved the principle but thought the basic thickness proposed was about 10 times too large. Havens argued that, for thin samples, special preparation would always be necessary. Aten, reporting discussions at Geel, and Cierjacks, felt that experimenters would prefer to design their own shapes and thicknesses. It was agreed that no action on this matter would be taken by the Committee.

IV. E Appointment of Sub-committees

The Sub-committee on Standards was renamed the Sub-Committee on Standard Reference Data. Membership in the three standing sub-committees was altered, the new members being listed in Appendix 3. The Chairman reminded the sub-committees to remember their responsibilities between INDC meetings and to provide the Chairman and secretaries with copies of all correspondence. An ad hoc Sub-committee on Non-Neutron Nuclear Data was appointed in Agenda item II. B, to report later in the meeting. A second ad hoc Sub-committee on Non-Neutron Nuclear Data was appointed in V. B, C, to report to the next INDC meeting.

V. NON-NEUTRON NUCLEAR DATA

V. A Report on the November 1970 Vienna Consultants Meeting on Non-Neutron Nuclear Data

As background to discussion, the Chairman reviewed events preceding and subsequent to the consultants meeting. Prior events were Hollander's 1968 proposal to the Agency and the recommendation at the 1969 INDC meeting of a Symposium emphasizing non-neutron nuclear data. The Agency felt that such a symposium should be preceded by smaller meetings to explore the interests of member states and, at the 1970 INDC meeting, proposed a consultants meeting. Details are given in Appendix 11a, b, c.

The consultants meeting, attended by representatives from Euratom, France, the IAEA, the Netherlands and the USA, has been reported in INDC(NDS)-30. Its principal recommendation to the IAEA was that an International Working Group on Compilation, Evaluation and Dissemination of Nuclear Structure and Reaction Data (IWGNSRD) be formed and long term objectives and scientific terms of reference for this group were proposed (INDC(NDS)-30, Appendix 1). The Agency, accepting this recommendation, invited (Appendix 11d) 15 member states and 4 international organizations to nominate members of this working group and sent out Draft Terms of Reference and a Provisional Agenda for a first meeting in January 1972* (Appendix 11e, f).

V. B Terms of Reference and Programme of the International Working Group on Nuclear Structure and Reaction Data and IAEA policy

V. C Priorities in non-neutron nuclear data needs, particularly for applied science and technology

These two Agenda items were discussed together.

Kolstad's letter of June 23rd to the Director General (Appendix 11g) expressed concern that, in setting up the IWGNSRD, the Agency might be creating an independent international committee whose responsibilities were already covered by those of the INDC and suggested that the working group might somehow be brought under the cognizance of the INDC. Finkelstein, replying in the Director General's absence, stated that the working group was "supposed to report its deliberations and conclusions to INDC" (Appendix 11h).

Taschek, reporting as chairman of the Ad hoc Subcommittee on Non-Neutron Nuclear Data, was concerned that the special interests of members of such a working group might lead to the establishment of priorities different from those of the IAEA. He suggested that Finkelstein's letter gave the INDC the responsibility for identifying the functions of the group and their mode of

* This meeting was subsequently scheduled for 13 - 17 March, 1972, to avoid conflict with the All-Union Conference in the USSR.

interacting with the INDC. Schmidt emphasized that the Agency would only support data activities that were related to applied needs of its member states, particularly of developing countries, and that considerable areas of such non-neutron data did exist (e.g. for reactors, fusion, Safeguards, health and medical physics, industrial applications). There was some discussion on the appropriateness of trying to separate data that had obvious application from other data, with the conclusion that it was a matter of assigning priorities.

Kolstad proposed, and Cindro supported, formation of an INDC sub-committee to consider priorities and guidelines for the working group and Schmidt agreed that INDC, which had already faced the problems of neutron data exchange, could give useful advice to the group. Questioning the objectives of the proposed subcommittee, Troianov felt that detailed consideration of the working group's activities was premature until the responsible authorities in each country had an opportunity to express their opinions on the Agency's proposal. He stressed that successful international cooperation over the whole range of nuclear data must be preceded by coordination on national levels, which was complicated and would take time. Troianov asked if the working group's activities would overlap those of other international organizations (e.g. CODATA) but Schmidt had already obtained CODATA's agreement that these activities should be the responsibility of the Agency. It was agreed that a second ad hoc sub-committee on Non-Neutron Nuclear Data would be formed, to exist until the next INDC meeting. Members of this were Taschek (Chairman), Aten, Divatia, Joly (or Ribon), Rae, Schmidt, Slaus (or Cindro) and Troianov. Troianov would discuss the possibility of a USSR replacement on returning home.

The sub-committee might require a consultant with special expertise in the field of nuclear structure and reaction data. It was considered desirable for one or more members of the sub-committee to attend the first meeting of the working group, to represent the needs of data users, and the broader interests of the INDC and Schmidt was asked to extend an invitation(Action 16).

A draft of the revised Terms of Reference for the IWGNSRD, prepared by the first ad hoc sub-committee on Non-Neutron Nuclear Data, was discussed in detail and a revised version was agreed on (Appendix 1.5). According to this, the working group would report to the IAEA through the INDC, which would assist it in identifying needs and establishing priorities for data. Some work on needs and priorities had already been done by NDS. Troianov felt that all these arrangements should be contingent on the approval of member states.

Taschek was asked to develop guidelines for the second ad hoc sub-committee on Non-Neutron Nuclear Data (Action 15) and his preliminary report (Appendix 12) was discussed very briefly at the end of Session VIII. E. It was suggested that transferring some of the listed responsibilities to the working group might enhance the cooperation between it and the Committee.

V. D Planned Symposium on the Collection, Compilation, Indexing Evaluation and Distribution of Nuclear (including Neutron) Data (early 1973).

This proposed symposium, first mentioned at the second INDC meeting, had attracted considerable support from groups in the USSR and USA. It had been approved by the Agency for 1973.

Taschek regretted that the INDC had not had an opportunity to consider this meeting in detail before it was scheduled, and Havens proposed that INDC should suggest guidelines for the meeting agenda. Havens was asked to draft a possible program for the Symposium, and this draft (Appendix 13) was discussed at the end of Session VII. B. Havens considered the draft very preliminary and thought that the working group might have very different ideas about the program. Suitable speakers could easily be found for the topics listed. The use of data for applied programs was emphasized. The inclusion of a paper on INIS* was mentioned by Ribon. It would be useful if only to explain why INIS was not suitable for this type of data.

Kolstad suggested that Schmidt should be Chairman and Havens serve on the Program Committee for the Symposium, and Troianov was asked to find a USSR representative (Actions 29, 30). Schmidt would then ask the USSR State Committee on Atomic Energy to make an official nomination. As one or more members of the IWGNSRD are expected to serve on the program committee, the latter will probably meet just after the working group meeting in March, 1972. The IAEA has no funds to cover the program committee's expenses. Further comments on the program could be sent to Schmidt or Havens.

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* It appeared later that UNISIST was meant.

VI. DATA CENTRE ACTIVITIES

VI. A Reports from Data Centres

NNCSC, Brookhaven

Kolstad reported that the use of the EXFOR format had greatly assisted the transmission of experimental data between NNCSC and the other three centres. An Experimentalists' Guide, consistent with EXFOR, has been written to help in the preparation of data to be sent to NNCSC. This should reduce the labour and time for processing incoming data. In 1970, 230 tapes of evaluated data were sent out (some to other data centres), while 96 tapes were sent in the first three months of 1971. All old data in the 7094 machine-language system (SCISRS) has been transferred to EXFOR. Interactive graphics equipment, expected to be operational in October, should help in data evaluation. Volume 2 (third edition) of BNL400 ("Angular Distributions in Neutron Induced Reactions") has been produced essentially by computer and issued.

In cooperation with several laboratories, an attempt is being made to develop data sets for the fissile elements that are consistent with both integral and microscopic measurements. At high energies where experimental information is scant, values are taken from nuclear model calculations.

CJD, Obninsk

Troianov reported that CJD had experienced considerable technical difficulties, partly because of incompatibility between tapes and recording equipment. One EXFOR tape is prepared and a second is expected to be finished in July. Last year, the centre replied to 40 requests for data from the USSR and 35 from the Agency. CJD contributed 370 entries for CINDA last year and 170 in the first five months of 1971. A Fortran translater is being prepared so that programs from other centres can be used. The main task now is automation of evaluation work which should go more quickly when a new computer is operational.

Bulletin No. 6 has been published and a supplement to Bulletin No. 7 has been prepared which will include neutron fission spectra and theoretical research on prompt radiation accompanying fission. A collection of preprints has been sent to Vienna for translation.

Schmidt enquired about the status of the first EXFOR tape which Popov had taken back for revision after its preliminary check at NDS, and Troianov agreed to find out when it would be sent to the other data centres (Action 17).

CCDN Saclay

No oral report was presented. A written report (INDC(ENEA)-4/G) has been submitted.

NDS Centre, Vienna

Referring to INDC(NDS)-31/L (pp. 23-29), Schmidt noted that the main activity during the year was the compilation of new data and conversion of old DASTAR entries into EXFOR, which has come into full operation during the past year. The NDS data index, CINDU, was maintained and the next edition, CINDU-10, should be published this summer. Data files covered by CINDU are listed in the above INDC report. Lemmel had visited 12 institutes in Eastern Europe, to describe the data exchange activities of the NDS, discuss cooperation and establish contacts for evaluation. Details are given in Appendix J of INDC(NDS)-31/L.

Member States had shown increased interest in obtaining evaluated data. While there were no requests from the Saclay and Brookhaven-serviced areas, 141 evaluated data sets were requested by and sent to the Obninsk area and 200 to the NDS area (Asia, Australia, Eastern Europe, the Middle East, South Africa and South America). Kolstad emphasized that any data at NDS was available to any member state. Evaluated data on elastic and inelastic cross sections had been received from the USSR.

Answering Rowlands' question on why the number of experimental data sets was so large, Schmidt explained that, until all data was coded in EXFOR, requests for partial sets of data had to be answered individually rather than by sending out the complete file. Schmidt reminded the Committee that new data from outside the NDS area should be sent to the local area centre, rather than to Vienna.

VI. B Paris Four-Centre Meeting (October 1970) and Vienna Consultants Meeting on Nuclear Data (December 1970)

Hjärne's report on the Paris meeting (INDC(NDS)-28/G) was presented by Schmidt. The main subject discussed was details of the EXFOR exchange format. Trial tapes had been exchanged earlier and, from the brief experience with them, a number of changes were agreed on. It was regretted that no CJD (Obninsk) representative was present, as the intention was to formulate decisions binding on all four centres. However, all centres have since approved the recommendations of INDC(NDS)-28/G. The Brookhaven centre is to update the EXFOR manual and a Compiler's Manual (LEXFOR) is being written by NDS. Schmidt noted that EXFOR data tapes are being exchanged between the four centres every three months. They do not include evaluated data, for which there is no internationally agreed exchange format.

Drake, Popov, Ribon and Zelenkov were present at the Vienna Consultants meeting. Of particular interest was the information presented on Obninsk's problems and on evaluation work in the USSR. It was decided that exchange would be facilitated by having a programmer and physicist from Obninsk visit NDS. Some discussion was held on non-neutron nuclear data. Schmidt commended the cooperation of CJD, despite technical difficulties. Details of the report are given in INDC(NDS)-31/L.

At the next four-centre meeting in Brookhaven, October 25-29, 1971, the agenda will include experiences of EXFOR exchange, CINDA as EXFOR index, technical details involved in the exchange of evaluated data, four centre cooperation on RENDA and cooperation between neutron and non-neutron data centres.

VI. C,D EXFOR System Operation and Request and Dissemination of Data

Some aspects of these two topics were discussed briefly under VI. A and VI. B, details being given in INDC(NDS)-31/L and INDC(NDS)-28/G.

Ribon expressed regret that EXFOR does not cover photoneutron and photofission data and Schmidt explained that NDS does not have these data. Kolstad commented that, in the U. S., Fuller (Nat. Bur. of Standards) and Bowman (Livermore) were planning an equivalent of BNL 325 for this kind of data. Schmidt agreed to bring the interest of reactor scientists to their attention. Kolstad also had information on a proposed U. S. photonuclear data centre. It was agreed that all members would send information on the status and plans of any non-neutron nuclear data centres in their respective countries to all INDC members (Action 18).

The question of whether fission product yields should be treated as neutron or non-neutron data was raised by Rae. Schmidt said that Obninsk was very much interested in these data and Rae agreed to investigate the possibility of including these yields in the data files of the four data centres (Action 19).

VI. E Status of CINDA

Schmidt, referring to INDC(NDS)-31/L, reported that CINDA 71 was printed by a photo-typesetting process, from film made from the original tape. The new method saved considerable printing space and cost. About 1800 copies have been printed, of which 400 went to the USAEC and 500 to the ENEA. Two 200-page supplements will be issued, the first at the end of August and the second early in 1972. CINDA 72 may be in two volumes, separated by atomic weight. It will be issued in mid-1972 and followed by a supplement at the end of the year.

VII. ASSESSMENT OF NUCLEAR DATA NEEDS AND ASSISTANCE TO MEMBER STATES

VII. A Non-OECD and World Request List for Neutron Data Measurements

Kolstad referred to the EANDC Chairman's letter which had been circulated to the Committee last November (Appendix 16). The EANDC had agreed that the non-EANDC request list be combined with RENDA, the combined World Request List (WRL) being a cooperative effort between the IAEA and ENEA. Screening of requests would be done by appropriate local data committees, with the responsibility for review passing from the EANDC to the INDC. Caution in extending the request list to cover safeguards, fusion and medical applications was recommended, lest the list become so long as to be useless.

It was agreed that it was the responsibility of each member to ensure that adequate screening methods were established in his own country (Action 20) and Cindro, Divatia and Gemmell were asked to report at the next meeting on the procedures used in Yugoslavia, India and Australia (Action 21).

Troianov mentioned that, because of developments in fast breeder reactors, the USSR expected to broaden the area of their requests in future, and outlined a USSR problem on accuracies specified in requests. Earlier calculations had shown that electricity costs were not very sensitive to errors in microscopic nuclear data. Accuracies of 1% in k_{eff} and 2% in breeding ratio (leading to a 10% error in doubling time) were therefore chosen as the basic criteria and the nuclear data accuracies required to give these were calculated on the assumption that the uncertainty in each datum contribute equally to these two quantities. This led to unreallistically accurate requirements for some data (e.g. $\pm$ 0.1% on $\bar{\nu}$ ^{252}Cf). Relaxing the requirements for some data and tightening them for others gave a more reasonable compromise and the matter of accuracy to be demanded was still under discussion. Rowlands suggested that, if too accurate data were requested, it would not be available until after the reactors were built and the doubling time measured directly and Troianov agreed that this would be true of the first reactors.

There was discussion on whether a request in the WRL should be specifically identified as being for evaluation of existing data or for new experiments. Ribon and Troianov thought that it was impossible for the requester to know if an evaluation alone would result in the required accuracy. Rowlands suggested that an "evaluation" included a decision on whether or not new experiments were needed to meet the accuracy demanded, so that an evaluation request might in fact lead to a new experiment. It was generally felt useful for a requester to indicate conclusions he had reached on what was required - e.g. that present data was certainly not good enough, that the required accuracy necessitated a new experiment, or that the situation required study and further evaluation before the decision on more experiments could be made.

Kolstad summarized the discussion by proposing that comments in the WRL should state (1) if an evaluation had already been carried out, (2) if the request was strictly for new experimental data and (3) if an evaluation should be made before initiating a new experiment. There would be no requests for evaluation alone. No objections to this proposal were raised.

A second question was whether requests should be arranged according to their application (e.g. reactors, fusion, safeguards, medical science) or just by isotope and reaction. Schmidt favoured separate lists according to application, at least initially, and supporting opinions were expressed by Cierjacks, Aten and Troianov. While this could produce duplication in the lists themselves, retrieval of all requests for given data could easily be handled by computer. It was agreed that the first WRL should contain only requests for reactors and, that requests for fusion and safeguards applications should be in separate documents.

Kolstad, noting that a new request list had recently been received from the USSR, raised the question whether a second non-OECD request list should be assembled and reviewed by the Committee before merging these requests with RENDA. Schmidt agreed that this should be done, proposing that all non-OECD requests be punched on cards, given to CCDN to merge with RENDA, retrieved by computer and reproduced by NDS. Draft copies of both the complete WRL and non-OECD lists would then be issued to members and discussed at the next INDC meeting, the latter list from the point of view of studying the screening procedures used. This proposal was approved (Actions ?2 and 23).

The Committee also agreed with Troianov's suggestion that, in order to get feedback from a wider circle of data users, extra copies be provided to members for distribution, at their discretion, to groups concerned. The following number of copies were requested:

Aten	7	Gemmell	2
Benzi	1	Kolstad	10
Cierjacks	10	Nishimura	8
Cindro	2	Rae	6
Condé	5	Ribon	5
Cross	3	Ricabarra	2
Divatia	10	Troianov	10.

Introducing Lorenz' draft proposal for merging the World Request List and RENDA, Schmidt explained that this differed from the interim arrangements discussed above in that it provided for handling requests on a year to year basis, as follows. New submissions,

after screening by local data committees, will be passed to the data centres, put in computer format and sent to NDS which will submit lists to INDC members well in advance of the next meeting. After review, INDC will submit comments and relevent information to NDS which will distribute the reviewed requests (always going through the data centres) to local committees. Revised requests will be returned to NDS, assembled and issued.

Full agreement has been reached between CCDN and NDS on the cooperation required.

The question whether updating should be done every year or every two years was raised but not discussed. There was some discussion on what the Committee's "review" would consist of and how it would be handled. Aten suggested that, in many cases, requests with comparable requirements could be combined and duplications in supporting information (e.g. references) removed. He urged that the present defects of RENDA should not be repeated. Ribon and Rae questioned whether the Committee had the right to alter any accuracies or priorities. It was finally agreed that the Committee would handle the review and that details of how this would be done could be deferred until the next meeting. Modifications to Lorenz' proposal were approved and Lorenz was asked to send a revised version to the Executive Secretary, for inclusion in the Draft Minutes (Action 48). This is given in Appendix 14.

Schmidt remarked that NDS might need additional staff in order to cope with the increasing workload connected with the production of the world RENDA list and with the increase in the exchange of evaluated data. The Committee agreed that this should be brought to the attention of the Director General. A recommendation, suggesting that NDS be provided with additional staff, was drafted and approved at the end of Session IX. B (Appendix 1.4).

The timetable for production of the first WRL was considered. EANDC members would have to submit revised RENDA requests to CCDN by an early date to be decided between CCDN, NDS and Havens. Havens was asked to inform EANDC members of this (Action 26). The draft WRL would be available early in 1972. It was agreed, but not unanimously, that corrections to this would be made on the basis of the Committee's comments, without further reference to the local committees originating the requests. The WRL could then be issued by the end of 1972 (Action 25). Aten asked if a French list of requests submitted at the end of 1970 would be merged with RENDA in time to be included in the first WRL. Ribon was requested to discuss this with Liskien (Action 24).

VII. B Nuclear Data Section Activities in Nuclear Data Surveys and Reviews

There was no discussion. Information on this topic is given in Section E.4, INDC(NDS)-31/G, and much of it was considered in Sessions IV. A and IV. B.

VII. C Survey of Data Needs for Fusion Reactors

Schmidt referred to Lorenz' letter to members of the International Fusion Research Council, asking for nuclear data needs and priorities for fusion reactor development and for comments on the usefulness of existing request lists. (Text and distribution of the letter are given in Appendix G, INDC(NDS)-31/L.) Most recipients replied. An analysis of the replies and a draft request list will be published as INDC(NDS)-37/L by the end of 1971. This will be submitted first to the fusion council and then to the next INDC meeting (Action 27).

The main interest in neutron cross sections is for n, 2n (multiplication in blankets) and n,α (He build-up and damage) in the energy range 5-15 MeV. Charged particle cross sections of importance were discussed at the Helsinki Conference (Proceedings, Vol. I, p. 67).

Taschek noted that the number of requests for fusion data could be expected to increase tremendously when and if fusion reactors proved feasible. Agreeing, Cierjacks mentioned that Karlsruhe, with the cooperation of Nève de Mévergnies at Mol, was preparing a fusion list for Germany, and that even this was too extensive for proper screening. It was agreed that all members concerned would submit requests for nuclear data for fusion to NDS by October 1, 1971, to be included in Lorenz' draft report (Action 28).

VII. D Nuclear Data for Safeguards

There was no discussion. Troianov commented that the USSR had no new requirements since the last list was submitted. This subject was considered in Session IV. C. The work of NDS is described in Section D.5, INDC(NDS)-31/G.

EVALUATION

VIII. A Progress Reports on Evaluation

India

Rastogi, referring to INDC(IND)-12/G, described work done in the Theoretical Physics Section of the Reactor Engineering Division at BARC. Total, elastic and inelastic cross sections of 11 materials of practical importance for reactors have been calculated in the energy range 0.1 to 10 MeV, using the optical and statistical models. Evaluated data libraries (KEDAK, ENDF/B) and processing codes are being adapted to the CDC-3600 computer. Group cross sections in a power reactor spectrum have been calculated for 20 materials and those for fissile nuclides re-evaluated, making use of recent data. A library of group resonance integrals has been generated for ^{238}U and will be extended to other fissile nuclides.

Italy

Benzi reported that all evaluation work in Italy is done at the CNEN Computation Centre in Bologna. Radiative capture cross sections for stable nuclides with $29 \leq Z \leq 79$ have now been estimated over the range 1 keV to 10 MeV and compared with experiment. Excitation functions up to 10 MeV, for inelastic scattering, n, 2n and n,γ reactions, were calculated for 18 fission product nuclides and are being extended to another 25. All these results have been sent to the CCDN. Gamma spectra following radiative capture of 14-MeV neutrons have been analyzed, using a model that includes both collective and direct processes (Nuovo Cim. 67A 356 (1970)), and the results for Si, Rb, Sr and Y have been compared with experiment (Nuc. Phys. A154 243 (1970)). Angular distributions of 14-MeV neutrons scattered from the first levels of ^{10}B and ^{11}B were analyzed. Computer codes developed for these calculations (Fortran IV, for IBM 360/75) include a convolution of groups of inelastic cross sections at a given angle, to simulate observed cross sections. Interactive graphics display is used to determine optimum parameters and level assignments.

Germany

Cierjacks referred to the work of Hinkelmann and Meyer at Karlsruhe. Evaluation has been completed for the cross sections of (1) hydrogen, from 0.7 to 15 MeV, (2) Fe, Co and Ni (total) from 10-15 MeV, (3) Mo, up to 15 MeV, (4) ^{235}U (fission) above the resolved resonance region. The total cross section of ^{235}U over this region is being evaluated. In the near future, evaluations will be done for total cross sections of Na, Cr, Fe, Ni, Mo, above the inelastic scattering threshold, alpha values for ^{235}U on the KEDAK file from the eV to the MeV range, and angular distributions of elastically-scattered neutrons for several KEDAK materials.

France

Ribon noted that French evaluation activities would be described in the 1971 progress report to the EANDC. The main work during the last year has been

Contribution of data on ^{239}Pu, ^{240}Pu and ^{241}Pu to the UKAEA library,

Study of the influence of the fission intermediate structure on self shielding in fast reactors,

Study of the angular distribution of neutrons scattered by Fe,

Compilation of spectroscopic data on fission products,

Study of the energy spectra and emission probability of delayed neutrons.

Euratom

Aten referred to evaluation activities performed with the Geel computer and telephone link to ISPRA. Transmission and fission cross sections, from time-of-flight measurements, have been analyzed, for ^{241}Pu between 12 and 100 eV, using the single-level shape-fitting program of Atta and Harvey and the Saclay 032S program. Fission cross sections of ^{235}U and ^{239}Pu in the resonance region were renormalized very satisfactorily by using integrals over restricted energy ranges, e.g. 7.8 to 11 eV for ^{235}U. Some decay-scheme evaluation has been started by a group of experts from EURATOM countries.

Replying to Schmidt's question, Aten said that ^{65}Zn data would be ready for publication in a few months, but had no information on ^{51}Cr work.

Australia

Gemmell reported that re-evaluation of capture and total cross sections, for all fission product elements in the AAEC library, was completed and the data had been sent to NDS and NNCSC. Cook has fitted cross sections with a new multilevel theory that uses exact Adler-Adler parameters and separates direct and compound nuclear contributions. From recent $\bar{\nu}$ ^{239}Pu measurements, Boldeman has concluded that, below 2 MeV, the energy variation is adequately fitted by two straight lines, as was the case for ^{235}U (J. Nucl. Energy 24 191 (1970).

Argentina

No report was presented.

Japan

Referring to a progress report supplement distributed to the Committee, Nishimura described three projects.

1. Evaluation of the total cross section of carbon, from 1 eV to 2 MeV. Up to 1.8 MeV, a fourth-order polynomial fit gave an estimated uncertainty less than 2-3%.

2. Analysis of total cross sections of nuclei with $33 \leq Z \leq 73$, over the range 100 keV to 16 MeV, to study systematics in optical model parameters. Using Engelbrecht and Fiedeldey parameters (Ann. of Phys. 42 262 (1967)) for $A \leq 140$, and parameters determined by an automatic search program for larger A, good agreement with experimental values was obtained.

3. Elastic and inelastic cross sections of Pu, U, Na and O, from 10 keV to 15 MeV, have been compiled for future evaluation. Compilation of Cr, Fe and Ni data is in progress.

Sweden

Condé referred to a paper by Wallin, to be presented to the Vienna Neutron Nuclear Data Evaluation Panel in August. This describes the organization of evaluation activities, the available data libraries and some of the processing programs. The main evaluation work is the continual revision of the SPENG library by including new experimental results in the data fitted by calculated cross section curves.

United Kingdom

Rowlands said that new files for the UKAEA library had been compiled for H, D, C, ^{235}U, ^{238}U and ^{239}Pu. Patrick, Sowerby and Mather have made a simultaneous fit of the fission cross sections of ^{235}U, ^{238}U and ^{239}Pu and the capture cross section of ^{238}U, for neutron energies from 100 eV to 20 MeV. Sowerby has evaluated α ^{239}Pu over the same range. These results, as well as re-evaluation of n,n', n,2n and n,3n cross sections by Douglas, have been used to revise the library files for these 3 nuclides. Pope and Story have extended the evaluation of Fe to 200 or 300 keV and Moxon has evaluated the total and capture cross sections of Ni to 200 keV.

USSR

Troianov reported that evaluation of the capture cross section of ^{232}Th was completed and a report had been given to Schmidt. Evaluation of the ^{238}U capture cross section was described at the Kiev Conference and will be discussed at the Vienna Panel Meeting in August. However, more recent measurements by the same authors will require that a further revision be made. A new evaluation of the ^{238}U fission cross section has been finished and put on tape. It is hoped that a complete ^{238}U file will be ready by the end of the year. Smirenkin has evaluated $\bar{\nu}$ for ^{235}U.

Nicolaev's group has studied resonance self-shielding and has developed methods of evaluation. This group has also evaluated elastic scattering for 42 elements, of which NDS has the results for 7. Work in the resolved and unresolved resonance regions, reported at Helsinki, is continuing.

Troianov agreed to make copies of the Proceedings of the Kiev Conference available to NDS as soon as they were printed (Action 32). These will be issued as an INDC(CCP)-G document (Action 33).

Schmidt introduced and commented on a bound collection of 6 Obninsk reports recently received ("Collection of USSR Reports on Nuclear Data Topics"). Four of these summarize the state of the art at Obninsk in dealing with unresolved resonances, a fifth shows the effect of nuclear data uncertainties on reactivity and the last illustrates feedback from integral to microscopic data. Together, they give a good idea of reactor physics and nuclear data activities at Obninsk. It was agreed that these, and also the Report on ^{232}Th capture cross sections, should be translated by the Agency and given an L distribution (Actions 34 and 35).

Canada

No report was presented.

USA

Kolstad gave a brief history of evaluation efforts in the USA. The goal of the ENDF/B Version I file was not necessarily to produce the correct values but to produce quickly a standard evaluation. In ENDF/B-II, the object was to add a consistent set of data for fissile nuclides, but difficulties were soon discovered. The principal problems were that the ^{239}Pu fission cross section was seemingly too low, the ^{238}U capture cross section was probably too high and the fission neutron spectrum probably too soft. The purpose of a task force meeting in February 1971 was to bring together measurers, evaluators and reactor

designers, including de Saussure (Oak Ridge), Block (Rensselaer), A. B. Smith (Argonne), J. R. Smith (Idaho Nuclear) and Farrell (Los Alamos). Integral tests were given considerable weight and used to modify microscopic data sets as far as permitted by the assigned errors of the latter. Various data sets were adjusted to improve the agreement in the integral bench mark tests. The purpose of the Cross Section Evaluation Working Group (CSEWG) meeting, May 1971, was (1) to verify the agreement produced by the broad group changes with the new microscopic data files produced by the task force meeting, (2) to decide the content and schedule for ENDF/B-III, and (3) to resolve the various annoying discrepancies among group-average cross sections calculated by different processing codes. Schmidt distributed the summary of Pearlstein's report on this meeting to the Committee.

VIII. B Status and Quality of Evaluated Data Libraries

Schmidt commented that basic questions were how far evaluated data files really reflected present experimental data and why the gap remained. It was decided that this could more usefully be discussed at the Vienna Panel on Neutron Nuclear Data Evaluation in August.

VIII. C Considerations of Evaluated Data Exchange and Format Questions

Noting that standards were of great importance to all countries, Kolstad proposed that, as a first step towards the free exchange of evaluated nuclear data, complete exchange be established immediately in the area of neutron nuclear data standards. Havens suggested H, He^3, Li, B, C, and ^{235}U as standards and, in reply to Ribon, specified ^6Li and ^{10}B. Schmidt and Cierjacks were in favour of including ^{238}U, ^{239}Pu and ^{197}Au but Havens felt that ^{238}U was not a standard and that ^{197}Au was at present unsuitable because of uncertainties in its decay scheme. There was discussion on whether the exchange should be on all cross sections of the nuclides specified. Kolstad's intention was to exchange data only on those cross sections used as standard reference data although Rae and Schmidt argued that other cross sections were necessary in order to estimate corrections.

Troianov stated that the USSR favoured general exchange of evaluated data and he agreed to Kolstad's proposal as a valuable step. Rae said that the UK would also be pleased to take part. The question of whether other data might be available was raised by Divatia and Kolstad replied that there might be exchange on an ad hoc basis. In general, the US wished to see how exchange in a well-defined area worked before considering further steps.

In general the Committee welcomed the US proposal and Havens was asked to draft a recommendation on the exchange. This is given in Appendix 1.3. Kolstad agreed to inform the Director General (Action 36).

Introducing the problem of formats, Schmidt noted that the proposed USSR Evaluated data file format (INDC(CCP)-13/L) had been discussed at last December's IAEA Consultants Meeting. Ribon and Story had replied to this proposal. It was hoped that Obninsk would develop a format close to those already being used. Ribon's study is given in INDC(FR)-2/L.

Troianov outlined progress at Obninsk. Programs have been written for experimental translation of data from the UK and KEDAK formats, to the Obninsk format (SOKRATOR). Experiments in translation of UKNDL were progressing satisfactorily. Translation from the ENDF/B format is under study and no major difficulties have turned up yet. Ribon questioned whether fully automatic translation was practicable. Rowlands felt that it was certainly possible but that reduction of the number of data points was desirable and this could best be done by hand. (There was some confusion at this point on whether the Obninsk format referred to was the same as that of INDC(CCP)-13/L.)

VIII.D Coordination of Evaluation Activities

Ribon commented that, at the June 1970 London meeting (EANDC/EACRP Joint Sub-committee on Evaluation), the consensus was that the present different priorities in different countries made world-wide coordination of evaluation very difficult. Coordination between OECD countries was a first step. Schmidt suggested that this was an unsatisfactory solution to non-OECD reactor physicists who wanted data as soon as possible. The problem would be considered at the Vienna Panel meeting in August. Schmidt suggested the possible extension of the Evaluation Newsletter to non-OECD countries.

VIII.E IAEA Panel on Neutron Nuclear Data Evaluation, Vienna (August/September 1971)

Referring to Section C.2.c and Appendix D of INDC(NDS)-31/L Schmidt outlined the objectives and organization of the panel meeting and described the Provisional Agenda established at a preparatory meeting in April. There was no further discussion.

MEETINGS AND CONFERENCES

IX. A Reports on Past Meetings

There was no discussion in this session on many of these meetings. All but numbers 3, 10 and 12 are described in INDC(NDS)-31/L.

1. IAEA Panel on Pulsed Neutron Research, Vienna, August 1970.

2. Second International CODATA Conference and Fifth Annual CODATA Meeting, St. Andrews, September 1970.

3. EANDC Symposium on Neutron Standards and Flux Normalization, Argonne, Illinois, October 1970. Discussed in Session IV. A.

4. IAEA Consultants Meeting on Non-Neutron Nuclear Data, Vienna, November 1970. Discussed in Session V. A.

5. IAEA Panel on Contained Peaceful Nuclear Explosions for Industrial Purposes, Vienna, January 1971.

   There was no discussion of nuclear data at this meeting. Kolstad will recommend to the Director General that such data be considered by future panels on this subject.

6. IAEA Consultants Meeting on Capture Gamma Spectroscopy, Vienna, February 1971.

7. Third Conference on Neutron Cross Sections and Technology, Knoxville, Tennessee, March 1971.

   Abstracts were given to the Committee and the Proceedings are expected to be published shortly.

8. Regional Study Group on Low Energy Accelerator Utilization, Rio de Janeiro, March 1971.

   Whetstone's report has been distributed to the Committee. See also Appendix B of INDC(NDS)-31/L. Kolstad agreed to send a copy of the National Academy of Sciences' report on New Uses for Low Energy Accelerators to each Committee member and 10 copies to the Agency (Action 37).

9. Meeting of the IAEA Working Group on Reactor Radiation Measurements, Vienna, April 1971.

   This was discussed in Session IV. B (f). Keddar's report has been distributed to the Committee.

10. IAEA Fusion Conference, Madison, Wisconsin, May 1971.

Schmidt reported briefly on the meeting. No decisive new results were announced but fusion scientists were encouraged by the progress made in several directions. Some promising devices have just started to operate and a feasibility experiment may be expected within 5 to 10 years.

11. International Working Group on Fast Reactors Meeting, Vienna, May 1971. Minutes will be distributed when available. (Action 39).

12. Meeting of Ad Hoc Working Group of UN Agencies on UNISIST, Paris, June 1971.

Schmidt referred to Hjärne's report on UNISIST (INDC(NDS)-38/G) and warned that UNISIST, which covered documentation of the whole area of science, appeared to be attempting too much before individual disciplines were sufficiently organized. So far, it has had no effect on neutron data compilation.

13. Panel on Plutonium Recycling in Thermal Power Reactors, Vienna, June 1971.

Schmidt referred to INDC(NDS)-40/L, which reviews the nuclear characteristics of Pu isotopes in a thermal spectrum. NDS was asked to send the proceedings of this panel (when available) to INDC members (Action 38).

IX. B Future Meetings

1971

Information on some of these is given in INDC(SEC)-14/L, Supplement, and in INDC(NDS)-31/L.

1. CODATA Annual Meeting and Symposium, Washington, July 1971.

CODATA is kept informed of IAEA data activities and includes them in its newsletter. Lack of funds prevents attendance at this meeting of an IAEA representative.

2. Gordon Research Conference on Nuclear Structure Physics, Andover, New Hampshire, July 1971.

3. International Conference on Statistical Properties of Nuclei, Albany, New York, August 1971.

4. IAEA Consultants Meeting on the Status of Prompt Fission Neutron Spectra, Vienna, August 1971

5. IAEA Panel on Neutron Nuclear Data Evaluation, Vienna, August-September 1971.

6. Fourth Geneva Conference on the Peaceful Uses of Atomic Energy, Geneva, September 1971.

7. International Conference on Chemical Nuclear Data, Canterbury, September 1971.

8. Conference for the Establishment of a World Science Information System (UNISIST), Paris, October 1971.

9. Symposium on Ion Sources and Formation of Ion Beams, Brookhaven, October 1971.

10. International Symposium on Targets and Nuclear Research Materials Preparation, Gatlinburg, Tennessee, October 1971.

The Committee expressed its support of this meeting.

11. The Third International Transplutonium Symposium, Argonne, Illinois,

1972

1. IAEA Panel on Standards for Nuclear Data Measurements, place and date to be determined.

This meeting was discussed by the Standards Sub-committee. It may be held in mid-1972, possibly close to the INDC meeting.

2. First Meeting of the International Working Group on Nuclear Structure and Reaction Data, Vienna, January 1972.

Discussed in Session V.B and Appendix 11.

3. IAEA Symposium on Neutron Inelastic Scattering, Grenoble, March 1972.

4. International Seminar on Neutron Data Evaluation, Romania, Summer 1972.

5. International Conference on Study of Nuclear Structure with Neutrons, Balatonfured, Hungary, September, 1972.

The IAEA role in this conference is yet to be decided.

1973

1. Proposed Nuclear Data Section Panels

Possible topics for further meetings in 1973 were discussed. Present NDS commitments preclude a Panel, but a consultants meeting might be possible. High intensity neutron sources, neutron capture gamma ray spectra and fission product data were mentioned as topics. Taschek described two aspects of the first topic - developments in the production of very high fluxes and the use of such fluxes to study radiation damage. An Agency Conference on this topic could not be held until 1975. Taschek and Troianov were asked to explore the possibility of holding a Symposium on High Intensity Neutron Sources at Los Alamos or in the USSR in 1973 (Action 41). On Rowlands' suggestion, NDS was asked to investigate the possibility of a consultants meeting on Fission Product Data (Action 40).

2. Symposium on the Collection, Compiling, Indexing, Evaluation and Distribution of Nuclear (including Neutron) Data. Early 1973.

Discussed in Session V.D.

3. Third IAEA Symposium on the Physics and Chemistry of Fission (probably 1973).

1974

1. Third IAEA Conference on Nuclear Data.

IX. C. Conclusions and Implications of Above Meetings

There was no discussion on this item.

X. TIME, PLACE AND TOPICAL DISCUSSION FOR NEXT MEETING

It was agreed that the next INDC meeting would be held in Vienna, July 17-21, 1972. After very brief consideration of the Topical Discussion for this meeting, it was proposed that each member send suggested topics to Schmidt (Action 42).

Kolstad noted that the Methods of Work (INDC-1/G) required the office of Chairman to pass to the USSR on January 1, 1972. The Executive Secretary is customarily chosen, with the Chairman's approval, from a member state geographically close to that of the

Chairman. Troianov was asked to obtain the name of a USSR representative to serve as Chairman and that of another Committee member to serve as Executive Secretary (Action 43). Schmidt would also take up this matter with the USSR State Committee on Atomic Energy (Action 44).

The Committee expressed its appreciation to the Indian Government and BARC Staff for acting as capable and gracious hosts to the meeting.

TOPICAL CONFERENCE AND LABORATORY VISITS

A Topical Conference on "Neutron Induced Fission" was held after agenda item IV. A. As well as the meeting participants, about 70 scientists from the BARC, the Tata Institute for Fundamental Research (TIFR) and other Indian laboratories attended. The program and abstracts ofthe papers presented are given in Appendix 15. A recording was made and Divatia was prepared to compile the Proceedings and transcribe papers and discussion for which no written text was available (Action 46). Schmidt was asked to enquire about the possibility of having the Proceedings duplicated at the Agency and distributed as an INDC-/U document (Action 47). Condé, Rae and Ribon were asked to check with co-authors on the release of papers for inclusion in the Proceedings (Action 45).

The Committee spent an afternoon visiting various BARC facilities, including the CIRUS and ZERLINA reactors, the Van de Graaff accelerator laboratory, the variable energy cyclotron project and the fuel fabrication plant. Various individual visits to other parts of the Laboratories and to the TIFR were made during and after the week of the meeting.

APPENDIX 1

FORMAL RECOMMENDATIONS OF THE COMMITTEE

1.1 Request List for Safeguards

The INDC recognizes, and agrees with, the procedures proposed by the IAEA (given in INDC(NDS)-31/G, pp 21-23) for the screening, from the Safeguards point of view, of requests for nuclear data needed for the development of Safeguards instruments and techniques, before they are presented to the INDC. In view of the time required for the acquisition of any such data, the INDC recommends that the IAEA take the necessary steps to produce, as soon as possible, an official list of nuclear data requests for Safeguards development purposes.

1.2 Neutron Standard Reference Data

The INDC regards neutron standard reference data as one of the most important areas for the future development of nuclear energy. A good set of neutron standard reference data is essential for significant international cooperation on nuclear technology. Measurements of neutron standard reference data require very specialized talents and efforts. The major equipment necessary for neutron standard reference data measurements are necessarily required at major standard laboratories. The INDC suggests that the Director General encourage the measurement of neutron standard reference data in the member countries.

1.3 Exchange of Evaluated Neutron Standard Reference Data

The INDC is pleased to inform the Director General of the IAEA that arrangements have been made for a free and full exchange of evaluated neutron standard reference data. The isotopes which are used for measurement of neutron standard reference data are ^{1}H, ^{3}He, ^{6}Li, ^{10}B, ^{12}C and ^{235}U. We understand that the Nuclear Data Section of the IAEA is prepared to be responsible for implementing this exchange of evaluated neutron standard reference data.

1.4 Increasing Workload of the Nuclear Data Section

In view of the additional responsibilities that the Agency's Nuclear Data Section is to assume in the near future regarding, e.g. the regular production and operation of the World Request List (WRL) for neutron nuclear measurements and the increasing

exchange of evaluated neutron data, the INDC suggests that the Director General consider providing the Nuclear Data Section with additional staff to cope with the increased workload.

1.5 Non-Neutron Nuclear Data

The INDC supports the action of the IAEA in proposing to form an International Working Group for Compilation, Evaluation and Dissemination of Non-Neutron Nuclear Data which is necessary for various applied nuclear programmes. It is clear that the considerations which INDC will give to this activity cannot take the same level of priority as its responsibilities for neutron data, so fundamental to current nuclear energy programmes. Considerable importance must be attached to formulating the responsibilities of the Working Group. These areas are discussed below in a suggested Frame of Reference which should guide the Working Group in the conduct of its business.

Proposed Term of Reference for the IWGNSRD

1. The International Working Group on the Compilation, Evaluation and Dissemination of Nuclear Structure and Reaction Data will be a continuing group within the frame-work of the International Atomic Energy Agency. It will report to the INDC which shall be the sole channel by which the Working Group may issue documents or otherwise report to the IAEA.

2. Membership

In selecting the members of the Working Group, the Director General will be guided by the following considerations:

a. Each member will be a scientist or expert actively working in the field of compilation and evaluation of nuclear data or having broad responsibilities for programmes in this field.

b. Each member will be appointed by the Director General after consultation with the member's Government. No more than one member will be appointed from any one Member State.

c. Each member may be accompanied by advisers or specialists.

d. As a means of ensuring continuity, members actively engaged in data activities would normally serve on the Working Group for a period of three years.

3. Functions

The main functions of the Working Group will be:

a. To become informed of the needs, requests and priorities for nuclear structure and reaction data needed for applied nuclear energy programmes and other areas of technology both through the INDC and directly from requesting groups.

b. To establish guidelines for the compilation, evaluation and dissemination of nuclear structure and reaction data responsive to known high priority needs of a variety of nuclear energy programmes and other areas of technology.

c. To recommend guidelines for international coordination of compilation and evaluation work in nuclear structure and reaction data of applied interest, to investigate means for providing dissemination of data that will serve the users adequately, to report in detail to INDC the status of, and needs for, such data.

4. Methods of Work

With approval and guidance of INDC, the Working Group will determine its own methods of work, including the establishment of any special groups or subcommittees. It shall keep records of all its meetings and other procedures and provide copies to the INDC.

5. Secretariat

Within the approved budget the Director General will authorise the administrative and secretariat services required by the Working Group including interpretation and translation services, meeting facilities, maintenance of records and distribution of documents. The IAEA would provide all necessary services through its Nuclear Data Section.

6. Meetings

Normally the Working Group will meet once a year. The travel and subsistence expenses of members of the Working Group, as well as of any accompanying advisers and experts, will be borne by their respective Governments or organizations.

7. Relations with other Organizations

The Director General may invite international or regional organizations to be represented at meetings of the Working Group or at particular sessions during such meetings.

APPENDIX 2 - LIST OF ACTIONS ARISING FROM FOURTH INDC MEETING

Number	Page	Action on	Action
1	5	NDS/INDC Secretariat	Issue official edited version of minutes of Third INDC Meeting as INDC document with L distribution.
2	9	NDS/INDC Secretariat	Issue revised Compendium of Committee Regulations as INDC document with limited L distribution.
3	9	NDS/INDC Secretariat	Issue revised page 4 of Methods of Work (INDC(SEC)-10/G) to Committee members.
4	9	Kolstad	Inform Director General of revisions to Methods of Work.
5	11	All members	Submit to NDS Secretariat, by Nov. 1, 1971, requests, comments and indications of interest regarding participation in nuclear data experiments using nuclear explosions.
6	11	NDS/INDC Secretariat	Assemble information of Action 5 and submit draft document to next INDC meeting.
7	11	Taschek	Provide figures on costs of neutron physics experiments with nuclear explosions, discussed during meeting, to Cross and Schmidt in time for inclusion in draft minutes.
8	11	Taschek	Provide members, as soon as possible, with reports giving results from previous experiments using nuclear explosions, and estimated costs of typical experiments, and facilities to be made available to experimenters.
9		Cross Schmidt	Provide members with a list of actions, immediately after the meeting.
10	21	NDS/INDC Secretariat	Publish progress reports of countries in NDS Service Area as INDC(SEC) document, with U distribution, including a list of main institutions and facilities in each country.
11	27	NDS/INDC Secretariat	Send Safeguards Report by Beyster to Committee members when available.
12	27	All members	Urge respective countries to submit any requests for nuclear data for safeguards purposes to the IAEA, Department of Safeguards and Inspection.

Number	Page	Action on	Action
13	28	Schmidt	Send official list of requests on targets and samples to Committee members, as soon as possible.
14	28	All members	Send comments on the requests of Action 13 to the INDC Chairman, within two months of receipt, with copies to the Executive and Scientific Secretaries.
15	31	Taschek	Develop guidelines for ad hoc sub-committee on non-neutron nuclear data, send to sub-committee members for comments and submit a report to next INDC meeting.
16	30	Schmidt	Invite Chairman of ad hoc Non-Neutron Nuclear Data Sub-committee to designate a member, or members, of the sub-committee to take part as observer(s) in the first meeting of the IWGNSRD.
17	32	Troianov	Inform NDS of present status and expected date of issue of revised first EXFOR tape of CJD Obninsk.
18	34	All members	Send information on the status and programs of all non-neutron nuclear data centres in respective countries to INDC members.
19	34	Rae	Investigate the possibility of including fission product yields in the data compilation of the 4 neutron data centres.
20	35	Members Concerned	Ensure that appropriate screening procedures are established in respective member states for neutron nuclear data requests.
21	35	Cindro Divatia Gemmell	Report at next meeting on the screening procedures used for neutron nuclear data requests in their respective countries.
22	36	NDS/INDC Secretariat	Prepare a draft World Request List and issue as INDC (SEC)-G document to INDC participants and EANDC members well in advance of next meeting.
23	36	NDS/INDC Secretariat	Issue Non-EANDC request list as INDC(SEC) document with L distribution.
24	37	Ribon	Find out if the last French request list can be merged with RENDA in time to get into first edition of World Request List.
25	37	NDS/INDC Secretariat	Issue First Edition of World Request List by end of 1972, without referring to local committees, but after prior screening of INDC and EANDC.

Number	Page	Action on	Action
26	37	Havens	Inform EANDC Committee members immediately that all RENDA revisions must reach CCDN by - (exact date for submission w ll be agreed after INDC Meeting in discussions between Havens, Liskien and Rosen from ENEA) in order to be included in First World Request List.
27	38	NDS/INDC Secretariat	Prepare draft request list of nuclear data for fusion reactors, send to members of Fusion Council for commen and screening and submit revised draft to next INDC meet
28	38	Members concerned	Submit requests for nuclear data for fusion reactors by Oct. 1, 1971, to NDS.
29	31	Schmidt Havens	Serve on Program Committee of 1973 Nuclear Data Sympo ium as INDC representatives.
30	31	Troianov	Send the name of a USSR representative to serve on the program committee of the 1973 Nuclear Data Symposium to Schmidt.
31	31	Schmidt	Invite USSR State Committee on Atomic Energy to nomina representative to program committee of the Nuclear Data Symposium.
32	42	Troianov	Send sufficient number of copies of Proceedings of Kiev Conference for G distribution, to NDS, as soon as they are available.
33	42	NDS/INDC Secretariat	Issue proceedings of Kiev Conference as INDC(CCP)-G document.
34	42	NDS/INDC Secretariat	Translate and distribute USSR report on ^{232}Th capture cross sections as INDC(CCP), with L distribution.
35	42	NDS/INDC Secretariat	Distribute Translation of Obninsk reports on Nuclear Dat and Reactor Physics Topics as INDC(CCP) document with L distribution.
36	43	Kolstad	Inform Director General of the recommendations on Stand ard Reference Data and of the arrangements made by IND for exchange of evaluated neutron standard reference data
37	45	Kolstad	Send 10 copies of Fowler's report on the use of low energ accelerators to Agency and one to each Committee memb
38	46	NDS/INDC Secretariat	Send Proceedings of Panel on Pu Recyling to INDC members, when available.

Number	Page	Action on	Action
39	46	NDS/INDC Secretariat	Distribute minutes of May 1971 IWGFR Meeting to INDC members when available.
40	48	NDS/INDC Secretariat	Explore the possibility of holding an IAEA Consultants Meeting on Fission Product Data in 1973.
41	48	Taschek Troianov	Explore the possibility of holding a Symposium on High Intensity Neutron Sources at Los Alamos or in the USSR in 1973.
42	48	All members	Send suggested topics for Topical Conference at next INDC meeting to Schmidt by September 1, 1971.
43	49	Troianov	Obtain name of USSR representative to serve as INDC Chairman, Jan. 1972-Jan. 1974, and name of another committee member to serve as Executive Secretary. Inform Kolstad and Schmidt before end of 1971.
44	49	Schmidt	Write to USSR State Committee on Atomic Energy regarding next INDC Chairman and Executive Secretary.
45	49	Condé Rae Ribon	Check on clearance of respective papers for inclusion in Topical Conference Proceedings and inform Divatia.
46	49	Divatia	Compile proceedings of Topical Conference and send to NDS.
47	49	Schmidt	Investigate feasibility of reproducing proceedings of Topical Conference and issuing as INDC document with U distribution.
48	37	NDS/INDC Secretariat (Lorenz)	Revise Draft Proposal on World Request List and send to Cross in time for inclusion as appendix in draft minutes.
49		Kolstad	Prepare Chairman's biennial report for presentation to next meeting.
	Continuing Actions arising from Third INDC meeting and not Listed above:		
50	6	NDS/INDC Secretariat	Ensure INDC members continue to receive minutes of IWGFR meetings.
51	6	NDS/INDC Secretariat (Hjärne)	Provide information on available targets and foil materials.
52	7	NDS/INDC Secretariat (Hjärne)	Continue to inform INDC members of UNISIST developments likely to affect Data Centres.

APPENDIX 3 - MEMBERSHIP OF SUB-COMMITTEES

A. Standing Sub-committees

Standard Reference Data : Chairman: Aten
Members: Havens, Jankov, Joly, Rae Schmidt.

Discrepancies in Important Nuclear Data and Evaluations:
Chairman: Rowlands
Members: Cierjacks, Joly, Nishimura Schmidt, Taschek, Troianov
Consultant: Goldstein

Nuclear Data For Safeguards:
Chairman: Cierjacks
Members: Divatia, Jankov, Nishimura, Ricabarra, Rowlands, Taschek
Consultant: Byer

B. Ad Hoc Sub-committees

Non-Neutron Nuclear Data:

1. Ad Hoc during 1971 Meeting: Chairman: Taschek
Members: Cierjacks, Divatia, Schmidt, Troianov
Consultant: Havens

2. Ad Hoc until 1972 Meeting: Chairman: Taschek
Members: Aten, Divatia, Joly (Ribon), Rae, Schmidt, Slaus (Cindro), Troianov
Consultant: Havens

APPENDIX 4

Government of India

BHABHA ATOMIC RESEARCH CENTRE

Bombay
Dated 12 July 1971

Welcome address by the Director, BARC, to the participants of the Fourth International Nuclear Data Committee meeting to be held during July 12-16, 1971 at Trombay.

On behalf of the Bhabha Atomic Research Centre, it is a pleasure to welcome you all who have gathered here today for the Fourth International Nuclear Data Committee meeting. We are happy that it has been possible to hold this meeting in Bombay this year. We recall with pleasure an earlier occasion, the International Conference on Neutron Inelastic Scattering held in 1964 when we had a large group of physicists from various countries amongst us. The physics programme at the Bhabha Atomic Research Centre constitutes a very important part of our activity, and we have active groups of physicists working in solid state, fission nuclear reactions, reactor physics and technical physics studies. They, particularly, value this opportunity to meet the members of an expert body such as the International Nuclear Data Committee, and exchange ideas with them.

India has been a member of the International Nuclear Data Committee from the very beginning when it started in 1962 as the International Nuclear Data Scientific Working Group (INDSWG). Since then we have participated with enthusiasm and optimism in the initial difficult period as well as the final smooth progress of this group until it has emerged as an advisory committee to the Director-General, IAEA in the form of the present International Nuclear Data Committee. We have always supported this and other similar efforts at international collaboration.

As soon as our participation in the nuclear data activity began, we initiated through the Nuclear Physics Division, an Indian Nuclear Data Group here in Trombay. This group has been responsible for maintaining a continuing liaison with the INDC, preparing progress reports on nuclear data activities in India, contributing to the CINDA (Card Index Neutron Data) and the DASTAR (Data Storage and Retrieval System), and stimulating interest in nuclear data activity.

Through the INDC and the Nuclear Data Section of the Division of Research and Laboratories of the IAEA, our scientists have benefited in a number of ways by receiving CINDA manuals, progress reports of other laboratories, unevaluated and evaluated data and other useful information. They hope to derive further benefits when the activity of the INDC covers a wider scope, by inclusion of programmes such as procurement of targets and samples required for nuclear data measurements. We also note with

satisfaction that the INDC is interested in nuclear data for fusion research and safeguards and in non-neutron nuclear data for applied science and technology.

A special feature of this meeting appears to be the Topical Conference on "Neutron Induced Fission". This topic is of great interest to us and we all look forward to this conference which, we are sure, will result in many stimulating discussions.

Any country that is interested in a major programme of developing atomic energy for peaceful uses, has necessarily to be interested in nuclear data for these various applications. India's atomic energy programme envisages development of fast reactors and fast breeder reactors; a pulsed fast reactor is under construction; a Reactor Research Centre specially devoted to the development of fast breeder reactors is being planned at Kalpakkam near Madras. In view of these developments, measurement, compilation and evaluation of nuclear data is of primary importance to us at this stage. A major facility for nuclear data measurement, a Variable Energy Cyclotron, is under construction at Calcutta.

We hope you have a fruitful conference and you are able to discuss the various aspects of nuclear data comfortably in these surroundings. We also hope the guests from abroad have a pleasant stay.

INTERNATIONAL ATOMIC ENERGY AGENCY
AGENCE INTERNATIONALE DE L'ENERGIE ATOMIQUE
МЕЖДУНАРОДНОЕ АГЕНТСТВО ПО АТОМНОЙ ЭНЕРГИИ
ORGANISMO INTERNACIONAL DE ENERGIA ATOMICA

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APPENDIX 5

IN REPLY PLEASE REFER TO
PRIERE DE RAPPELER LA RÉFÉRENCE:

DAT/311-Gen-0

13 April 1971

Dear Dr. Kolstad,

Thank you for your letter of 2 April 1971 concerning INDC.

I am pleased to hear that you will stop off at IAEA Headquarters on the way back from India and hope that either I or the Director General will be here at that time.

With regard to the interpretation of paragraph 6 of the INDC Terms of Reference, it appears to me that the implication is clear that the Committee should meet more frequently in Vienna than abroad. I suggest that the introductory sentence of Section IV of the INDC Methods of Work be modified at the forthcoming INDC meeting, so that it reflects more exactly the meaning conveyed in the Terms of Reference.

The list of meeting participants will be sent to you by Dr. Schmidt as soon as the Agency has received a reply to all the INDC nominations. At that time also a list of proposed items for the agenda of the forthcoming INDC Meeting will be forwarded to you.

Sincerely yours,

André Finkelstein
Deputy Director General
Department of Research
and Isotopes

Dr. George A. Kolstad, Chairman
International Nuclear Data Committee
U.S. Atomic Energy Commission
Washington, D.C. 20545, USA

cc: Dr. G.C. Hanna,
AECL

APPENDIX 6

REPORT OF THE INDC SUBCOMMITTEE ON STANDARDS

by

W. W. Havens, Jr.

The report is basically the concluding sessions of the EANDC Conference on Neutron Standards held at Argonne National Laboratory in October 1970. The concluding session gives the reports and recommendations of the working groups of the EANDC Conference.

This concluding session is divided into five parts:

a) $^{1}H(n,n)$ and $^{3}He(n,p)$ cross sections
b) lithium, boron and carbon standard processes
c) fission and capture standards
d) techniques and methods for flux, fluence and cross section measurements
e) special topics primarily associated with fission, standard sources and foils and half-lives.

The report will be brought up to date by 1) E. R. Rae reporting on recent work on light nuclear standards, 2) R. F. Taschek reporting on new fission and capture experiments, 3) H. Condé reporting on recent $\bar{\nu}$ measurements, and 4) W. W. Havens, Jr. attempting to fill in the gaps.

The full proceedings of the EANDC Conference on Neutron Standards is expected to be available for distribution early in August.

Summary of conclusions and recommendations of Working Groups on Neutron Standards and Flux Normalization, 21-23 October 1970 at ANL

$^{1}H(n,n)$

Useful energy range 100 keV to 30 MeV

σ_{nT} known to 1/2 to 1°/o in range 100 keV - 30 MeV. $\sigma(90^{o})/\sigma(180^{o})$ known to ±35°/o for E_n 100 keV - 10 MeV, ±20°/o for E_n 10-15 MeV and ±10°/o for E_n 15-30 MeV. Accuracies sufficient for standards purposes at present time.

$^{3}He(n,p)$

Useful energy range thermal to 10 MeV

$\sigma(n,p)$ known to 0.2°/o at 1 eV, 1°/o at 1 keV, 3°/o at 10 keV and 10°/o above 100 keV.

Recommendations

(1) Theoretical analysis should be attempted based on accurate σ_{nT} measurements as for ^{6}Li.

(2) Accurate measurements of pulse height spectrum in proportional counter to compare $^{1}H(n,n)$ and $^{3}He(n,p)$ cross sections.

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

Useful energy range thermal to 1.7 MeV

$\sigma(n,\alpha)$ known to ±0.5°/o at thermal, ±1°/o to 10 keV, ±2°/o to 100 keV from theoretical fit (spread in experimental results ±8°/o). 100 keV - 1.7 MeV, accuracy is ±5-15°/o.

Recommendations

(1) Repeat of σ_{nT} measurements 100 eV to 2 MeV to confirm data used in theoretical fit.

(2) Direct measurements 100 eV - 2 MeV of $\sigma(n,\alpha)$ with variety of flux measuring techniques to confirm shape of cross section around 247 keV resonance.

(3) Further measurements of angular distribution of reaction products.

(4) Study of inverse reaction.

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

Useful energy range thermal to 200 keV

$\sigma(n,\alpha)$ known to ±0.5°/o at thermal, ±1°/o at 1 keV, ±2°/o at 10 keV, ±3°/o at 100 keV and ±5°/o at 200 keV. $\sigma(n,\alpha\,\gamma)$ similarly known below 100 keV.

Recommendations

(1) Further σ_{nT} measurements needed in range 200-300 keV.

(2) Confirmation of low energy scattering measurements is desirable.

(3) Direct measurements of $^{10}B(n,\alpha)$ and $^{10}B(n,\alpha\,\gamma)$ should be made with a variety of flux measuring techniques.

$^{12}C(n,n)$

Useful energy range thermal to 1.5 MeV

σ_{nT} known to $\pm 0.5^{o}/o$ in eV range, and to $\pm 1^{o}/o$ from 0.5 to 1.5 MeV. In intermediate range, there are discrepancies of $2^{o}/o$ between "precision" measurements, but cross section is probably known to $\pm 1^{o}/o$. Angular distribution of scattered neutrons is isotropic (in C.M. system) at 100 keV and can be calculated to $\pm 10^{o}/o$ up to 1.5 MeV. These accuracies are sufficient for present standards purposes.

$^{235}U(n,f)$

Cross section known to $\pm 1^{o}/o$ at thermal, $\pm 3^{o}/o$ to 1 keV, ± 6-$8^{o}/o$, 1 to 30 keV, $\pm 5^{o}/o$, 30 to 400 keV, $^{+4}_{-7}$ $^{o}/o$, 400-1500 keV and $\pm 7^{o}/o$ above 1.5 MeV. These accuracies were felt by the Working Group to be rather optimistic.

Recommendations

(1) Ratio measurements should be reported as such.

(2) Fission foil exchange should be implemented.

(3) Recording of fragment spectrum data should be available at all energies.

(4) A 144 keV Si neutron beam should be put in operation.

(5) For monoenergetic spot checks, a study should be made of the incident flux spectrum, and two different methods having comparable precision should be employed.

Capture standards These were considered only briefly and the following recommendations (made by Carlson in his review) were stated:

(1) Absolute cross sections of ^{197}Au are badly needed above 300-400 keV.

(2) While at the moment ^{197}Au appears to be the best standard, careful study of capture in some of the recently available rare earths is fully warranted. Some of these have cross sections a factor of two higher than that of Au.

(3) ^{181}Ta should be carefully studied as it has the potential of a good capture standard.

General recommendation applying to all above cross sections. Since all these cross sections are energy dependent, associated with their use must be convenient energy standards. Suitable standards may be the resonances in Fe and Al.

Flux measurement Although the crosssections discussed above can be used to obtain absolute flux measurements, they are frequently used only in a

relative manner, for example in association with white source time of flight spectrometers. There are three absolute methods of flux determination, suitable for use with monoenergetic beams. These are:-

(1) Manganese bath (thermal to 2 MeV)

(2) Associated activity method with $^{7}Li(p,n)$ from 30 keV - 600 keV, $^{51}V(p,n)$ up to 600 keV, and $^{57}Fe(p,n)$ up to 1.3 MeV.

(3) Associated particle method with T(p,n) and D(d,n) reactions from 0.1 to 2.5 MeV and T(d,n) near 14 MeV.

Recommendations

(1) Improved knowledge of decay schemes and angular distributions relating to (2) above.

(2) Application of pulse shape discrimination where the H(n,n) interaction is used in proton recoil devices.

(3) The use of at least two different flux measuring methods in each laboratory.

(4) Flux intercomparisons between laboratories at specific energies using stable and simple transfer instrument - ^{235}U and ^{238}U fission chambers according to the energy. Initial comparison should be between Van de Graaffs, other low energy accelerators and filtered beams.

(5) Possible transfer instruments for white-source time-of-flight systems should be investigated.

(6) Study should be made of possible transfer instruments which could be used with all sources.

Recommendations concerning improvements in experimental techniques used with monoenergetic D.C. sources

(7) Development of high power targets - e.g. for Dynamitrons.

(8) Use of shielding and collimation to improve signal to background and quality of neutron beams.

(9) Proper self shielding and multiple scattering corrections.

(10) Improved knowledge of neutron producing reactions (see recommendation (1) above).

(11) Standardisation of samples and detectors to improve intercomparison between laboratories and to minimise sample preparation costs.

Special Topics This section is concerned mainly with discrepancies in the fission neutron spectrum and $\bar{\nu}$ which more properly relate to the Discrepancies Sub-Committee.

APPENDIX 7

STATUS OF FAST FISSION CROSS SECTIONS

M. Moore (LASL)

The fission cross section of ^{235}U remains as the major problem in fast neutron measurements. Since it is used as the standard, it occupies the pivotal position for the discussion of other existing discrepancies. While the accuracy of existing data on the ^{235}U fast fission cross section does not approach the requested 1-2%, recent evaluations indicate that 4-5% accuracy may currently obtain below 150 keV. This represents substantial progress over the last year, and measurements currently underway are expected to yield significant additional improvements within the next year.

The scope of the present survey is the consideration of those requests in RENDA which involve the measurement of fission cross sections in the neutron energy range above 10 keV. Requests for measurements of $\bar{\nu}$ or other quantities of interest such as delayed neutron and gamma yields, fission yields, or elastic and inelastic scattering are not included. The major emphasis is placed on those requests carrying a priority 1 designation in RENDA. These include (1) the fission cross section of ^{235}U and ^{239}Pu, and the fission ratios, to a requested accuracy of 1%, and (2) ratios of the fission cross section of ^{238}U to that of ^{235}U, and of radiative capture of fast neutrons by ^{238}U, again to accuracies approaching 1%.

A. Fast fission cross sections of ^{235}U and ^{239}Pu

A year ago, at the Helsinki conference on Nuclear Data for Reactors, two comprehensive reviews were made on the status of fast fission cross sections, by Davey[1] and Poenitz.[2] As might be expected, these reviewers took two different points of view, but the recommendations made by Davey could not be disputed: additional measurements are needed for ^{235}U. They should be measured relative to the (n,p) scattering cross section, they should have precision of ~2%, and they should be made over a wide enough energy region to avoid questions of non-overlapping data.

The status of the ^{235}U fission cross section was reconsidered at the EANDC Standards Symposium in October 1970, and preliminary results

of a few measurements undertaken to resolve the problem were reported. However, it was not until the 1971 Knoxville conference on Neutron Cross Sections and Technology that the situation began to show signs of improvement. Two experimental papers were accepted for presentation, by Szabo et al[3] and by Käppeler and Fröhner,[4] and a review was made by Byer and Konshin[5] which included the preliminary results of a simultaneous evaluation of ^{235}U fission, ^{239}Pu fission, ^{238}U capture, and the ratios of ^{239}Pu fission and ^{238}U capture to ^{235}U fission. Further experimental work was reported by deSaussure et al[6] on ^{235}U fission and capture at the Boston meeting of the American Nuclear Society.

In their review of ^{239}Pu fission cross sections, Byer and Konshin treated the ^{239}Pu and ratio measurements separately and deduced the ^{235}U cross sections from these, attempting to arrive at a consistent set of ^{239}Pu, ratio, and ^{235}U fission cross section curves in a simultaneous fashion. They concluded that between 30 and 150 keV, this procedure yields such a consistent set: the ratio data of Pfletschinger, the ^{239}Pu data of Szabo et al and White et al, and the ^{235}U data of Lemley et al, Szabo et al, Poenitz, Knoll and Poenitz, and White (except for the 40 keV point of White) define a set in which the product of any two of the curves will yield the third, to within about 4-5%.

In this connection, the recent preliminary results by deSaussure et al also deserve mention. These data show remarkably good agreement with the best set of recent data in the resonance region, as considered by James; they lie roughly half way between the Lemley et al results and Davey's evaluation at 10 keV; and they show good agreement with the Davey evaluation at 100 keV (about 5% higher than the Lemley et al and Szabo et al results).

Byer and Konshin concluded that between 150 keV and 1 MeV, the situation is considerably worse: it is not possible to arrive at a consistent set of ^{239}Pu fission, ratio, and ^{235}U fission curves utilizing the Poenitz results without requiring adjustments exceeding 15%. Disregarding the Poenitz results leads to substantial improvement. The recent Szabo et al data lie about as far below Davey's evaluation as the older Allen and Ferguson data lie above (3-4% below 500 keV). The ^{235}U curve based on ^{239}Pu fission and ratio measurements, deduced by Byer and Konshin, also lies within these limits.

Above 1 MeV the Byer and Konshin curve is about 5% higher than the revised Smith, Henkel, and Nobles results. Measurements of ^{235}U fission above 2 MeV in progress at LASL by Smith, Barton, and Koontz[7] are expected to help resolve this point.

The existence of structure in the ^{235}U fission cross section, persisting to energies well above 100 keV, is now well established. The most recent and highest resolution measurements were reported by Bowman and Sidhu[8] at the Knoxville conference. The most distinctive peaks in the fission cross section also appear in the total cross section of ^{235}U, as measured by Böckhoff and Dufrasne at Geel. Statistical tests comparing structure in the fission and total cross sections in detail have not yet been made, but it seems clear that the major part of the structure can be attributed to Porter-Thomas fluctuations rather than to the effects of the second well in the fission barrier. It is generally accepted that the structure does not resolve the discrepancy of the Poenitz ^{235}U measurements below 1 MeV.

B. Fission and capture of ^{238}U

Two recent evaluations have been carried out of the ^{238}U capture cross section, by Byer and Konshin, and by Pitterle.[10] Both followed the same procedure: using the best known value at 30 keV as a normalization point, the curve was obtained by renormalizing the discrepant sets of data which spanned this energy region. The two evaluations appear to agree to within ~5% at all energies above 10 keV, the Byer and Konshin results being slightly lower because of the influence of the data reported by Friesenhahn et al[11] (not considered by Pitterle). Both curves are somewhat lower than the earlier evaluations by Davey and Pitterle below 25 keV. Preliminary measurements by deSaussure et al[12] are also a few percent lower than the earlier Davey and Pitterle evaluations below 30 keV.

The reevaluation of the ^{238}U fission cross section by Pitterle[10] was done on the basis of the ^{238}U-^{235}U fission ratio measurements of Smith et al as revised by Hansen. Pitterle noted that the evaluated fission ratios appear to be accurate to 2-5% over the entire region of interest, and suggests that the discrepancy of 5-10% between the evaluated ^{238}U fission cross section he obtained and integral measurements can be attributed to an underestimation of the ^{235}U fission cross section above 2 MeV, which

was used as a reference. Again, one might hope that the Smith, Barton, and Koontz measurement of the ^{235}U fission cross section will be able to resolve this question.

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APPENDIX 8

From: J. J. Schmidt, Head
Nuclear Data Section

10 June 1971

To: INDC Members

Subject: Report from the Chairman of the INDC Subcommittee on Discrepancies in Important Nuclear Data and Evaluations by J. J. Schmidt, IAEA, Nuclear Data Section.

So far there were no discussions within the INDC Subcommittee on Discrepancies in Important Nuclear Data and Evaluations between the two INDC meetings. The reason for this is that it has been felt that those discussions should be based, at least in part, on the results and conclusions of various reviews on topics of relevance to the subcommittee which the Nuclear Data Section has performed and is still performing in the period between the last and the present INDC meeting. As far as it is possible at the present time this report will summarize briefly the main conclusions from these reviews and will cover some additional relevant topics as a basis for future discussions and recommendations of the Subcommittee.

1. Alpha-^{239}Pu

In response to the recommendation of the Specialists Meeting on alpha-^{239}Pu in Studsvik, Sweden, in June 1970, Dr. Sowerby from Harwell and Dr. Konshin from the Nuclear Data Section performed a thorough review of the available alpha measurements on ^{239}Pu in the energy region from about 0.1 keV to MeV in close consultation with the experimental groups involved, i.e. Farrell at Los Alamos, Gwin et al. at Oak Ridge, Czirr at Livermore, Sukhoruchkin et al. in Moscow and Ryabov et al. at Dubna. This review is prepared for publication in the IAEA Atomic Energy Review during summer this year. It comprises a thorough discussion of each available experiment. Particular emphasis is put on the consideration of systematic errors and assignment of appropriate weighting factors to the individual data sets before averaging them. Weighted averages of the experimental results will then be derived, which will represent the best estimate of all the experimental groups involved on the basis of the presently available information, and which will therefore be recommended for general use in fast reactor design and other relevant nuclear applications. It is anticipated that the presently achievable confidence levels of these recommended data will be of the order of $\pm$ 10 to 15% which simultaneously characterizes the confidence level achievable with the presently available experimental techniques.

In view of this and, as long as no definitely much more accurate measurements discrepant from these recommended values become available, no further specialists meetings on this subject seem to be justified.

2. Fast ^{239}Pu fission and ^{238} capture

An extensive review of the available information on these two subjects is presently being carried out by Drs. Byer and Konshin from the NDS. The review covers cross sections for ^{239}Pu fission and ^{238}U capture as well as the ratios of these cross sections to the ^{235}U fission cross section in the energy range between 1 keV and about 15 MeV. It is one of the main purposes of this review, and in this respect it differs from preceding similar evaluations, to make a clear separation between absolute and relative measurements for both quantities independent from the ^{235}U fission cross section and those measurements made relative to the ^{235}U fission cross section.

All the elements are considered in similar detail as in the alpha-^{239}Pu review, regarding the experimental method and errors. A weighted least squares orthogonal fitting programme is used in order to derive best curves through the available experimental data and yields uncertainties corresponding to a 95% statistical confidence level at each energy point. In this way recommended curves are derived for the ^{239}Pu fission and ^{238}U capture cross section data, independent of $\sigma_f(^{235}U)$, and to the cross section ratios ^{239}Pu fission/^{235}U fission and ^{238}U capture/235 fission. Then ^{235}U fission cross sections are derived from the ^{239}Pu fission and ^{239}Pu/^{235}U fission ratio curves as well as from the ^{238}U capture and ^{238}U capture/^{235}U fission ratio curves.

The preliminary results of this review indicate, aside from a number of minor inconsistencies, that there appears to be a fundamental discrepancy which is so far not understood: the ^{235}U fission cross section derived from the Pu data supports the higher ^{235}U fission cross section values as defined by the measurements of White, Leroy, Käppeler and others, whereas those derived from the ^{238}U capture data support the lower Poenitz $\sigma_f(^{235}U)$ values. The Poenitz values seem also to be supported by gold capture and gold capture/^{235}U fission ratio measurements. This discrepancy needs certainly further clarification and the following conclusions and recommendations are provisionally drawn subject to final confirmation of the above mentioned results.

(a) Check measurements would be needed for the ratio gold capture/^{239}Pu fission; no such data have been measured so far.

(b) It appears highly desirable that a thorough review be performed on the available fission cross section measurements on ^{235}U. NDS is prepared to do this review starting in the fall of this year.

(c) It is recommended that the Second IAEA Standard Panel planned for 1972 places further emphasis on the ^{235}U σ_f problem including those cross sections and cross section ratios, as mentioned above, relevant to a solution of the ^{235}U fission problem. The two surveys by Drs. Byer and Konshin on ^{239}Pu fission and ^{238}U capture cross sections, enlarged by additional experimental data available at the time, and the mentioned ^{235}U fission review could serve as a basis for the

relevant discussions at this panel.

3. Prompt fission neutron spectrum

In view of the still persisting well known discrepancies between microscopic and integral fission spectrum determinations, and in response to wishes expressed at EANDC and INDC meetings, the NDS is going to convene a meeting of experts in Vienna, 25-27 August 1971, primarily to review the present status of microscopic fission spectrum measurements and to confront microscopic and integral results for the fission spectrum in order to obtain a solution of the existing discrepancies.

For this meeting NDS is currently preparing a review of the existing measurements. The preliminary indication is, that the most recent measurements as e.g. performed at Argonne and Karlsruhe confirm the hitherto accepted older Los Alamos measurements and confirm also that the average energy of the prompt neutrons emitted in ^{235}U fission by thermal neutrons lies slightly below 2.0 MeV.

This certainly contradicts the conclusions from integral threshold reaction cross section measurements and from integral measurements (e.g. fission cross section ratios) in fast critical assemblies. If the meeting is going to confirm this preliminary conclusion, then other reasons will have to be found in order to explain the integral results. One possible reasons might be that the ^{235}U fission cross section values above 1 MeV used in the normalization of many of the relevant threshold reaction cross sections have been assumed too low. Whether this is a valid argument or not can only be decided when results from the new Los Alamos precision measurement of $\sigma_f(^{235}U)$ in this energy range have become available. Further details regarding the agenda of the fission spectrum meeting can be found in section C.2.b. of the progress report of NDS to the forthcoming INDC meeting (INDC(NDS)-31/L).

4. $\bar{\nu}$ values

A preliminary review of $\bar{\nu}$ values for the main fissile isotopes was prepared and submitted to the IAEA consultants meeting on $\bar{\nu}$ values at Studsvik, Sweden, in June 1970. Upon the recommendation of this meeting the review was brought up to date with respect to fertile and fissile nuclides and enlarged so as to cover also the current status of thermal and spontaneous $\bar{\nu}$ values and a number of transactinium nuclides built up during reactor burn-up. Apart from deviations from the linear increase in the lower MeV range, which were particularly discussed at the Studsvik meeting (see INDC(NDS)-25/L) and which is still not fully understood, in view of the fact that the statistically best measurement of Boldeman does not show such a deviation, the accuracy of the presently recommended $\bar{\nu}$ values does strongly depend upon the confidence level with which the ^{252}Cf standard is known.

The Cf standard problem will certainly be dealt with in more detail in the report on the Standards Subcommittee. For completeness I would

like to mention here, that the recent investigations of the so-called "French effect" (by this is meant the dependence of the prompt pulse detection efficiency on the multiplicity of the number of neutrons detected per fission, as reported first by Soleilhac at the Studsvik meeting) particularly by Signarbieux et al. did not show as great an effect as one would have expected.

According to his results corrections for the "French effect" would amount only to a fraction of a percent and could therefore still not explain the total discrepancy of about 2% between liquid scintillator and manganese bath measurements.

The fact that reactor group constant sets based on the current available data from the ENDF/B, UK and KEDAK evaluated nuclear files are underestimating k_{eff} for Pu criticals and overestimating k_{eff} for ^{235}U criticals by the order of 1 and more percent, seems to justify the major efforts going on and planned to clarify the Cf problem.

Regarding the well known discrepancy between the results on the variation of $\bar{\nu}$ through resonances of ^{235}U and ^{239}Pu between RPI (Weinstein et al.) and Dubna (Ryabov et al.), more recent work by Weston et al. from Oak Ridge has failed to resolve this discrepancy; preliminary results, however, indicated that the resonance spin dependence is small, lying someway in between the contradictory results of Weinstein and Ryabov.

5. keV neutron capture in structure materials

Nothing new has become known to me on this topic. In view of the fact that Harwell (Moxon et al.) has devoted considerable efforts to the clarification of the earlier discrepancies, it is suggested that Dr. Rae, member of the discrepancies subcommittee, report briefly on the present situation at the INDC meeting.

6. Neutron data for reactor radiation dosimetry

According to recent discussions at the meeting of the IAEA Working Group for Reactor Radiation Measurements in Vienna, 19-21 April 1971, it appears that there are a number of discrepancies and gaps in the available experimental information regarding data commonly used in the reactor radiation dosimetry. Furthermore, different evaluated data sets are used in various laboratories and at present no reference set of nuclear data has found general acceptance. The data concerned are:

- (n,p), (n,α) and (n,2n) cross sections (mostly threshold reactions)
- (n,γ) and (n,f) cross sections
- thermal capture cross sections
- activation resonance integrals
- half lives of radioactive product nuclei.

In order to clarify the situation, the working group proposed as a first

step that the NDS prepare a status report on those neutron cross section data and distribute it 3 months before the next meeting of the working group; this meeting is scheduled for the second half of 1972.

This status report should give a broad survey (not a thorough evaluation) of the existing and used experimental and evaluated data and should serve as a basis for the preparation of recommendations and the establishment of priorities for further experimental and evaluation work. Simultaneously this report certainly will serve as a review of the dosimetry data requests in the current request lists. On a longer time scale the Working Group recommends to ENEA to take appropriate steps in order to arrive at internationally acceptable reference values for the nuclear data involved.

The Working Group took the data problems in reactor dosimetry rather seriously because of the close relationship to proposed international standardizations of reactor flux and fluence measurements.

7. IAEA Panel on Neutron Nuclear Data Evaluation

Between 30 August and 3 September 1971, the IAEA will convene a Panel on Neutron Nuclear Data Evaluation. The main objectives of this panel are to review the methods, quality and present status of neutron nuclear data evaluation as well as to examine the basic requirements and problems associated with establishing and exchanging computer-based evaluated neutron data libraries. A total of 15 countries and 2 international organizations (ENEA/EURATOM) with major nuclear data programmes will send participants to this panel.

The provisional agenda for the panel is attached to this report. Accordingly it is foreseen, that on two days in the middle of the panel, five parallel working groups discuss problems connected with the agenda items 2, 3, 4, 5.I and 5.II. The subgroups will prepare reports on their discussions, conclusions and recommendations and submit these to a one-day plenary session for discussion, amendments and final adoption by the full panel.

The panel will start with a plenary session dealing with a review of evaluation activities and needs in IAEA member states. A survey report for this introductory session will be prepared by the NDS. The concluding session on the last day is planned to deal with international cooperation in evaluation, improvement in the exchange of evaluated data etc. (agenda item 6).

I would not like to comment in detail on the background of the provisional agenda; this has been prepared in a two-day preparatory meeting in Vienna in the beginning of April, in which Benzi, Hinkelmann, Ribon and Story participated. I may draw the attention only to the fact that the handling of discrepant experimental data, problems of data analysis and interpretation, discussion of systematic errors and similar problems related to the objectives of the subcommittee, will find major emphasis at the panel.

APPENDIX 9

DRAFT REPORT OF THE SUBCOMMITTEE ON NUCLEAR DATA FOR SAFEGUARDS

Following the establishment of the Safeguards Subcommittee as a standing committee of INDC during its regular meeting of 22-26 June 1970, it was attempted to pursue certain tasks which the subcommittee had considered important. The obviously urgent tasks were as follows:

1) The establishment of priorities for Safeguards nuclear data and of acceptable criteria to use in setting the priorities.

2) The establishment of a Safeguards nuclear data request list broadly useful for a variety of measurers and users.

3) To consider how the broad scope of the nuclear data required can be fitted into existing requesting procedures and how the compilation of the data is to be accomplished.

Further questions arose but appeared to refer to problems which would arise at a later stage and were therefore not under immediate consideration. Such questions, included the problems of funding, of broadening participation in applicable programs, and of finding a way to include Safeguards into Renda. See INDC minutes for the Formal Recommendations.

In response to Memorandum INDC (NDS)/SC.3/1 from T. A. Byer to members of the Subcommittee, the United States groups involved in Safeguards have taken certain actions as will be described below. Addendum 2 of INDC(NDS)21G already described the initial nuclear data requests from the USSR in the area of Safeguards work.

In the USA the AEC Office of Safeguards and Material Management responded to a request from the Division of Research concerning participation in the nuclear data aspects of Safeguards by making formal presentations to the nuclear cross sections advisory committee in December of 1970. Priorities originally used by the LASL group and transmitted to the Nuclear Data Section in October of 1970 were modified to satisfy a broader cross section of Safeguards laboratories and appear in a USA document submitted for this meeting, i.e., INDC (USA) 33G. This document reviews the present status of this problem in the USA and contains a comprehensive request list.

There is thus now at hand a fairly representative list of requests from several countries and institutions together with a much better understanding of priorities, problem areas and methods of approach. These should allow the Agency to compile a Safeguards Nuclear Data Request List which hopefully can be incorporated in Renda in due time.

APPENDIX 10

FINAL RECOMMENDATION FROM THE INDC

(Forwarded to the Director General, IAEA, January 22, 1971)

Recommended Policy and Procedures for the Handling of Requests for Targets and Samples for Nuclear Data Measurements

A. Policy for Evaluation of Requests

The requests may be classified into three categories as follows:

Category A: Requests for targets and samples needed for nuclear data measurements corresponding to priorities 1 and 2 in the current carefully examined and approved neutron data measurement request lists (e.g. RENDA) and to first priority data requests (as defined below) for the scientific and technical development in areas such as safeguards and nuclear fusion.

Category B: Requests for targets and samples needed for nuclear data measurements corresponding to lower priority requests in the request lists and subject areas mentioned in Category A, and to less urgent data needs for applied nuclear purposes.

Category C: Requests for targets and samples needed for nuclear data measurements not covered by Categories A and B.

Requests in Category A, and in exceptional cases also in Category B, should be considered for direct funding or other applicable support by the IAEA. Requests in Category C, and normally also in Category B, should not be considered for direct funding.

For inclusion in Category A there can also be considered other subject areas in the general field of peaceful uses of nuclear energy of vital interest to the program of the IAEA. The inclusion of high priority requests for data for such a subject field in Category A can be made by the IAEA contingent upon the recommendation of an advisory body. Appropriate priorities explicitly defined and vouched for by such an advisory body as well as the careful examination and approval of the data requests by the same or other advisory bodies will be a prerequisite for the inclusion.

All requests will be considered and carefully evaluated by the INDC. Regarding those requests which cannot be funded or otherwise supported directly by the IAEA, suggestions may be given by INDC members to the requestors as to other possible methods for the procurement of targets and samples. The IAEA should assist the requestors in this procurement by correspondence, if necessary.

B. Procedure for Evaluation of Requests

In order to be considered by the INDC, requests for targets and samples should be submitted formally through the cognizant Government authority to the IAEA. The Nuclear Data Section of the IAEA is asked to take the appropriate steps to ensure this and to keep the INDC members informed.

The requests should be categorized and compiled by the Nuclear Data Section and sent to the members of the INDC by the Scientific Secretary. This should be done on a quarterly or half-yearly basis, depending on the number of requests.

The members of the INDC should convey their comments to the Chairman of INDC within a period of two months and send copies to the Executive and Scientific Secretaries of the INDC.

The Scientific Secretary should prepare a summary report, including draft recommendations, and circulate it to the INDC members, after consultation with outside experts, if necessary.

The Chairman of the INDC will submit those recommendations, on which, in his opinion, a consensus has been reached, to the Director General of the IAEA. Other cases should be taken up at the following INDC meeting.

APPENDIX 11a

ANNEX I

UNIVERSITY OF CALIFORNIA

LAWRENCE RADIATION LABORATORY
BERKELEY, CALIFORNIA 94720

December 4, 1968

Dr. Henry Seligman
Department of Research and Isotopes
International Atomic Energy Agency
Kaertnerring 11
A-1010
Vienna 1, Austria

Dear Dr. Seligman:

For some time we have felt that it would be desirable to have a means for closer communication and liason among the major worldwide groups who compile data on Nuclear Level Schemes and Radioisotopes. The need for such liason and cooperation is becoming daily more evident as the "data explosion" continues, increasing the difficulty for each of the groups to keep up with the data in its area of activity.

We are aware of the interest that has developed in IAEA in the nuclear information field and we believe that the IAEA would provide an ideal mileau for such international liason and cooperation as is needed in the nuclear data field.

We have, therefore, prepared the enclosed proposal for the creation of an IAEA Committee on Compilations of Nuclear Level and Radioisotope Data, which we wish to submit for consideration by IAEA. This proposal has the approval and encouragement of Chairman G. T. Seaborg of the United States Atomic Energy Commission, and its International Division (Dr. A. S. Friedman) and Technical Information Division (Dr. E. Brunenkant) have also given their full support to this effort. We have been in close touch with our colleagues in the Nuclear Data Group at Oak Ridge as this idea developed, and they wish to participate fully in the Committee's functions. Dr. L. K. Peker and Professor B. S. Dzhelepov of Leningrad (who direct the major nuclear data compiling effort in the Soviet Union) have warmly supported the idea of an international liason group in verbal discussions held at Dubna in July 1968 with Dr. Lederer of our group, and a copy of this proposal is being sent to them as well as to Professor Endt in Utrecht.

We hope that IAEA can treat this as a formal proposal, to be acted on in the near future. If, however, it is necessary for us to follow a different procedure in this regard, please advise me as to how to proceed.

Dr. Henry Seligman -2- December 4, 1968
Vienna 1, Austria

With thanks for your help, and with best wishes,

Sincerely yours,

Jack M. Hollander

JMH:sac
Enclosures (3)
cc: Dr. E. Brunenkant
Prof. B. S. Dzhelepov
Dr. S. Eklund
Prof. P. M. Endt
Dr. A. S. Friedman
Dr. L. K. Peker
Dr. G. T. Seaborg
Dr. A. H. Snell

INDC Conclusions and Recommendation of June 1969

7.(b) Hollandar's Proposal

Annex I contains the proposal of Hollander, suggesting a way in which the Agency can act to coordinate some of the world's scattered Nuclear Data Compilations which are exclusive of Neutron Cross Sections. The Committee noted that the "... proposal to establish international cooperation in the compilation of data on radioactive isotopes and nuclear levels constitutes a constructive step towards recognition of the importance of this activity within the framework of the IAEA. ... that such nuclear data compilations constitute an important resource for many applied activities (e.g. medicine, engineering biology, agriculture) especially in developing countries ... that in order to provide a sound basis for establishment of IAEA policies to promote cross fertilization among different kinds of nuclear data compilation activities, meetings and/or symposia should be held at an early date." The Fourth Recommendation was passed accordingly.

4th RECOMMENDATION

The Committee recommends that the IAEA plan to sponsor a small symposium no later than 1973 on the collection, compilation, indexing, evaluation and distribution of nuclear data, especially other than neutron data but also including neutron data.

INDC Remarks of June 1970

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 October 1970 (probable consultants: Hollander, Peker, Siegbahn). A meeting between the IAEA (Grinberg and some others) and Euratom (Spernol, 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 field could be compared.

APPENDIX 11d

Copy

INTERNATIONAL ATOMIC ENERGY AGENCY
AGENCE INTERNATIONALE DE L'ENERGIE ATOMIQUE
МЕЖДУНАРОДНОЕ АГЕНТСТВО ПО АТОМНОЙ ЭНЕРГИИ
ORGANISMO INTERNACIONAL DE ENERGIA ATOMICA

KÄRNTNER RING 11, P.O. BOX 590, A-1011 VIENNA, AUSTRIA

TELEPHONE: 52 45 11
52 45 25
TELEX: 01-2645
CABLE: INATOM VIENNA

IN REPLY PLEASE REFER TO
PRIÈRE DE RAPPELER LA RÉFÉRENCE

14 June 1971

V B

Sir,

I have the honour to inform you that in November 1970, the Secretariat of this Agency convened a group of consultants to review the status of the compilation of data on nuclear structure. This was done in response to a number of proposals that the Secretariat had received in recent years.

The conclusions and recommendations of the consultants are contained in the enclosed report INDC NDS-30 which is at present available in English only. Pursuant to the main recommendation of the consultants, the Secretariat plans to proceed further with the establishment of an international working group on the compilation, evaluation and dissemination of nuclear structure and reaction data. The first meeting of the working group will be held at the Agency's Headquarters from 24 to 28 January 1972 and, if the results of this meeting confirm the consultants' recommendation, the group will be formally established.

The main purpose of the proposed group on nuclear structure data will be to advise the Director General about the Agency's programmes in this subject and to promote the development and exchange of relevant technical information. The members of the group will therefore serve in their personal capacity but they will be appointed after consultation with the governments concerned.

I should accordingly be grateful if your Government would nominate a scientist working with this subject and familiar with the relevant programmes in your country who might be designated as a member of the group. If your Government so wishes he may be accompanied by additional experts from your country. It is foreseen that the Agency will provide facilities for an annual meeting of the group but will not defray the travel and subsistence expences of members of the group or of additional experts designated by governments.

LHjärne/er

cl.: Drs. Herzberg
Finkelstein
Fischer
(on draft)

cc each Mission
Office of the D.G.
Registry (2)

The situation in the sector of nuclear physics data with which the group will deal is causing considerable concern. The severe backlog of work in compiling data on nuclear structure is having far-reaching consequences in many applications of the peaceful uses of atomic energy. To ensure that participants are as well prepared as possible for the meeting, this letter is being sent well in advance of the date of the meeting.

A draft agenda for the first meeting and draft terms of reference for the group are also enclosed. I should be grateful if the Secretariat could be informed as soon as possible of the name of the expert whom your Government would recommend as a member of the group and the names of any additional experts whom it may wish to send to the group's meetings.

Accept, Sir, the assurances of my highest consideration.

Enclosure:
List of Governments invited

Sigvard Eklund
Director General

List of Governments invited:

The Resident Representatives of

Australia
Brazil
Canada
France
Germany, Fed. Rep. of
Hungary
India
Israel
Japan
Netherlands
Romania
Sweden
United Kingdom
USA
USSR

APPENDIX 11e

First Meeting of the International Working Group
on the Compilation, Evaluation and Dissemination
of Nuclear Structure and Reaction Data

24 - 28 January 1972

PROVISIONAL AGENDA

1. Opening and announcements

2. Organization, terms of reference and title of the Working Group.

3. Needs in the user communities
   a) Status of surveys of needs; kind, depth and form of the needed information; first results and conclusions
   b) Priorities; particularly high priority needs.

4. Compilation of experimental data
   a) Current status of compilation activities including scope and depth of compiled data and related information; level of computer use, available staff and funds, etc.
   b) Feasibility of extending the collaboration on the collection of data and related information from experimentalists
   c) Needs for agreements on formats for exchange of compiled data and related information and possible ways of implementation

5. Evaluation
   a) Current status of evaluation work, including manpower, equipment and funds available for the purpose. Special attention should be given to those phases of the evaluation works, which are the greatest "mechanical" obstacles, and which are potential fields of improvements in a cooperative effort.
   b) Evaluation methods, criteria and documentation.
   c) Feasibility of compatible computer formats and files for evaluated data.

6. Recommendation to authors, editors and journal reviewers regarding requirements on content of publications on nuclear physics experiments.

7. Dissemination; optimization of information transfer between nuclear data centres and users.

8. Feasibility of a "Non-neutron CINDA".

9. A program for longer-term (meaning at least a couple of years) activities of the Working Group, to take full account of the recommendations of the Nov. 1970 Consultants Meeting as revised at this meeting.

10. Summary of actions and recommendations

APPENDIX 11f

TERMS OF REFERENCE

INTERNATIONAL WORKING GROUP ON THE COMPILATION, EVALUATION AND DISSEMINATION OF NUCLEAR STRUCTURE AND REACTION DATA

1. The International Working Group on the compilation, evaluation and dissemination of nuclear structure and reaction data will be a continuing group within the framework of the International Atomic Energy Agency. It will advise the Director General of the IAEA on the Agency's programme relating to nuclear structure data.

2. MEMBERS

In selecting the members of the Working Group, the Director General will be guided by the following considerations:

a. Each member will be a scientist or expert actively working in the field of compilation and evaluation of nuclear data or having broad responsibilities for programmes in this field.

b. Each member will be appointed by the Director General after consultation with the member's Government.

c. Each member may be accompanied by advisers or specialists.

d. As a means of ensuring continuity, members actively engaged in data activities would normally serve on the Working Group for a period of at least three years.

3. FUNCTIONS

The main functions of the Working Group will be:

a. To establish guidelines for the compilation, evaluation and dissemination of nuclear structure and reaction data.

b. To review comprehensively the status of, and needs for, nuclear structure and reaction data and to establish guidelines for international coordination of compilation and evaluation work and to investigate means for providing dissemination of data that will adequately serve the users.

4. METHODS OF WORK

Except as otherwise herein stated, the Working Group will determine its own methods of work, including preparation of its Agenda, establishment of special groups, keeping of records and other procedures.

5. SECRETARIAT

Within the approved budget the Director General will provide the administrative and secretariat services required by the Working Group including interpretation and translation services, meeting facilities, maintenance of records and distribution of documents. The IAEA would provide the services of a scientific secretary.

6. MEETINGS

The Working Group would normally meet once a year. The travel and subsistence expenses of members of the Working Group as well as of any accompanying advisers and experts will be borne by their respective Governments or organizations.

7. RELATIONS WITH OTHER ORGANIZATIONS

The Director General may invite international or regional organizations to be represented at meetings of the Working Group or at particular sessions during such meetings.

APPENDIX 11g

June 23, 1971

Dr. Sigvard Eklund
Director General
International Atomic Energy Agency
Karntner Ring 11
Vienna A-1010, Austria

Dear Dr. Eklund:

I would like to express to you my personal appreciation for your understanding of the needs and purposes of the International Nuclear Data Committee (INDC) in arranging to hold its fourth meeting in Bombay. I realize that meetings such as this, away from Vienna, present special problems to the Agency and pursuant to Dr. Finkelstein's letter of April 13, 1971, the Committee will reconsider that portion of its "Methods of Work" dealing with the frequency of meetings away from Vienna.

I plan to return to the United States via Vienna, and, if convenient to you, would plan to report to you briefly on the meeting on Wednesday, July 21. I would hope to see Dr. Finkelstein on the 21st also. If it is more convenient for you, I could come in to see you during the afternoon of the 20th, but that would be immediately on arrival from an all-night flight from India and I may not be functioning too well.

One of the matters I would discuss with you concerns the establishment of an International Working Group on the Compilation, Evaluation and Dissemination of Nuclear Structure and Reaction Data. Although the recommendations of the November 23-25 Consultants Meeting on this subject are to be considered by the INDC at its meeting in Bombay, I understand from NDS Memo No. 144, page 14, that you have already approved the establishment of such a working group. My concern is twofold: (a) that the judgment of the INDC in this matter might be impaired by premature approval by the Agency of a consultants group recommendations (INDC-NDS-30), and (b) that the Agency may be proliferating independent international committees (i.e. the activities

of the proposed working group comprise a subset of the responsibilities of the INDC). I suspect that the problem can be resolved by somehow bringing the working group under the cognizance of the INDC (perhaps they could become a subcommittee).

I am looking forward to the INDC meeting in Bombay and to meeting with you on the 21st (or the 20th).

Best personal regards,

Sincerely,

George A. Kolstad
Chairman, International Nuclear
Data Committee

Enclosure:
Cy of ltr, Finkelstein to Kolstad, 4/13/71

cc: A. Finkelstein, IAEA, wo/encl.
W. C. Cross, AECL, w/encl.
J. J. Schmidt, IAEA, w/encl.

bcc: W. W. Havens, Columbia Univ., wo/encl.
R. F. Taschek, LASL, wo/encl.
E. Brady, NBS, w/encl.
G. C. Hanna, AECL, wo/encl.
A. Labowitz, U.S. Mission, IAEA, wo/encl - w/note: "Dear Al: Enclosed is a copy of my itinerary along with a copy of my letter to Eklund. Hope you will be around on the 20th and 21st. Do you have any insight on why the Agency would go ahead with the working group without checking it out with the INDC?" also enclosed cy of NDS Memo No. 144.
W. Yeomans, DIA

DRAFT APPROVED BY W. YEOMANS, IA, 6/22/71

OFFICE ▶	R:ADPM					
SURNAME ▶	GAKolstad/jel					
DATE ▶	6/23/71					

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APPENDIX 11h

2 July 1971

Dear Dr. Kolstad,

In the absence of Dr. Åklund let me briefly reply to your letter of 23 June 1971. I appreciate very much your coming to Vienna after the INDC Meeting; unfortunately Dr. Åklund will not be in Vienna at that time nor shall I, but I think all matters of concern can be taken up between you and Dr. Schmidt.

The matter of the International Working Group on Nuclear Structure Data figures at a prominent place in the agenda of the Fourth INDC Meeting. I would only like to emphasize that this is a working group of experts in nuclear structure data compilation and evaluation which, as other working groups of the Agency, receives no funding from the Agency and which is supposed to report its deliberations and conclusions to INDC.

With best regards.

Yours sincerely,

A. Finkelstein
Deputy Director General
Department of Research
and Isotopes

Dr. George A. Kolstad
Chairman, INDC
USAEC
Washington, D.C. 20545
USA

NO CLEARANCE

cc: Mr. Lorens
Reg. (2)

JJSchmidt/emk

APPENDIX 12

RESPONSIBILITIES AND AREAS OF WORK OF AD HOC SUBCOMMITTEE ON NON-NEUTRON NUCLEAR DATA

1. To identify the major areas of Science and Technology having possible needs for non-neutron nuclear data.
2. To prepare a list of types of users and requestors in these major areas of interest.
3. To establish suitable criteria for determining priorities for compilation and evaluation of nuclear data of particular nuclides.
4. To identify individuals and/or organizations who will provide request lists with approved priorities assigned.
5. To provide, for INDC, Working Group and NDS use, a list of nuclides for compilation and evaluation.
6. To establish that nuclides agreed upon for evaluation may have all the appropriate nuclear quantities compiled and evaluated, even though only one or a few parameters are requested.
7. To identify person or persons to attend first IAEA Working Group meeting on nuclear structure compilation to represent INDC.
8. To recommend to INDC a uniform method for interacting with relevant working groups.
9. To identify person or persons to act as consultants to the ad hoc subcommittee.

Symposium on the Collection, Compilation, Evaluation and Distribution of Applied Nuclear Data

I. Nuclear Data Needs for Applied Programs.

- A. Fission Nuclear Reactors
- B. Thermonuclear Energy Systems
- C. Nuclear Safeguards
- D. Geophysical Applications
- E. Medical Applications
- F. Activation Analysis
- G. Tracer Studies

II. Collection and Compilation of Nuclear Data.

- A. Collection and Compilation of Nuclear Data for Fission Reactors
- B. Collection and Compilation of Nuclear Data on Light Nuclei
- C. Collection and Compilation of the Data for the Nuclear Data Sheets

III. Evaluation of Nuclear Data.

- A. For Fission Reactors
- B. Nuclear Reaction Data
- C. Decay Schemes
- D. Computer Aids for Nuclear Data Evaluation
- E. Arranging the Data in a usable, convenient machine recoverable format
- F. Bottle necks in Nuclear Data Evaluation

IV. Cooperative Efforts in Nuclear Data Compilation and Evaluation.

- A. The International Nuclear Data System
- B. The Regional Neutron Cross Section Centers
- C. Similarities and Differences between Neutron Data Compilation and Level and Decay Scheme Data
- D. Possible Formats for Compilation of all types of Nuclear Data

V. Dissemination of Nuclear Data.

- A. Research Journal Publications
- B. Nuclear Data Reviews
- C. Nuclear Data Center Services
- D. Possible Improvements in Dissemination of Nuclear Data
- E. CINDA and the Need for a Comparable Index for Non-Neutron Nuclear Data

APPENDIX 14

WORLD REQUEST LIST AND RENDA STATUS - PROPOSAL FOR MERGING

by

A. Lorenz

Nuclear Data Section (NDS), IAEA

As stated in the communication from the EANDC Chairman, W. W. Havens Jr., to the INDC Chairman, G. A. Kolstad, dated 10 November 1970, the EANDC Committee has recommended at its October 1970 meeting that the non-EANDC request list for neutron nuclear data measurements (which has been compiled by the NDS for the INDC) be combined with RENDA, to form one world-wide request compilation.

In addition to this major policy decision, the EANDC also recommended that:

1. The world request list be produced by the IAEA,

2. The combined request list be a joint cooperative effort between IAEA and ENEA,

3. The responsibility for the detailed review of the world request list be passed from the EANDC to the INDC.

Further recommendations with regard to scope and distribution of the world request list (WRL) were also made.

The actual implication of this recommendation is that the major responsibility for the coordination, compilation and production of the WRL passes from the EANDC Secretariat (ENEA) and CCDN to the INDC Secretariat, i.e. IAEA/NDS.

Inasmuch as both ENEA and IAEA, i.e. their respective nuclear data centres, are directly affected by this decision, the NDS, in full agreement and cooperation with the CCDN, is proposing the following to serve as the basis of the WRL operation.

In general, all efforts will be made to set up the WRL operation on the basis of the RENDA/EANDC Request List and on the past experience gained by the CCDN/ENEA operation of that system. Also, inasmuch as the operation of the WRL involves the four regional nuclear data areas as defined in the international nuclear data

exchange operation EXFOR, it would be efficient and expedient to organize the WRL operation within that same framework.

The following five points proposal of the WRL operation outlined below should be considered:

1. Input: All new submissions for the WRL would be submitted to the INDC members well in advance of their yearly meeting, through the INDC Secretariat (NDS). These new submissions, originating from the four regional nuclear data areas, should be screened by the local data committees charged with this responsibility, prior to submission to the INDC Secretariat (NDS).

2. Reviewing: The new WRL submissions together with the existing compilation of the WRL would be reviewed by INDC. After review, the INDC would submit its comments and any additional relevant information to the INDC Secretariat (NDS), who will merge the reviewed information (review reports) and distribute copies of the review reports and regional retrievals from the WRL file to the four data centres. It would then be the responsibility of the four data centres to submit these reviews to the regional local data committees charged with the WRL responsibility for final approval.

3. Channels of communication: In order to simplify this operation and to improve the flow of information, all WRL input, both new, reviewed and approved, should be channelled to and from the INDC Secretariat through the existing four data centres. The INDC Secretariat should not have to communicate with regional local data committees or individuals. All WRL information submitted from the data centres to the INDC Secretariat should be in a computerized form either in the form of punched cards or magnetic tape. These transmissions from the four data centres to the INDC Secretariat would only be needed twice between WRL publications: firstly to communicate new entries prior to the INDC meeting and secondly to communicate the revisions following the INDC review and local committee review.

4. Processing: The computer processing, that is collation, merging, retrieval, of the WRL information as well as the updating of the WRL file shall be performed by the INDC Secretariat (NDS), with any needed assistance provided by the CCDN (ENEA). In conjunction with this assignment of responsibility, the ENEA/CCDN will hand over all existing request list (RENDA) computer programmes to the IAEA/NDS.

In order to alleviate the transfer of the WRL operation from CCDN to NDS, it has been agreed between CCDN and NDS that during the first year of this system's implementation, the CCDN will perform the necessary computer operations for the WRL, performing the needed merge and sort operations, providing selected retrievals and producing the updated file on tape for publication. Full transfer of the WRL computer processing from CCDN to NDS would be effectuated in the course of 1972.

5. Publication: The INDC Secretariat (IAEA/NDS) shall be responsible for the production of a periodically updated WRL document which shall be submitted to the INDC at its yearly meeting. At the same time the INDC Secretariat shall distribute the WRL document to recipients designated by the INDC. (This would presumably correspond to the existing INDC/U distribution including the present RENDA (EANDC) distribution). As part of its responsibility, the NDS shall also provide request upon any needed retrieval from the WRL file.

APPENDIX 15

TOPICAL CONFERENCE ON "NEUTRON INDUCED FISSION" TO BE HELD DURING THE FOURTH INDC MEETING

Date : Wednesday, July 14, 1971

Place : Modular Laboratories, 'B' Block Auditorium, BARC, Trombay, Bombay-85

PROGRAMME

	SESSION 1 (12.00 Noon - 1.15 p.m.)	Speaker
1.1	Excitation Energy Dependence of Shell Effects in Nuclear Fission	S. S. Kapoor (25 min.) BARC, Bombay
1.2	Report of work on Nuclear Spectroscopy of Highly Deformed Th^{231} by J. E. Lynn J. D. James	E. R. Rae (15 min.) AERE. Harwell
1.3	Did Superheavy Nuclei Exist in our Solar System	N. Bhandari (15 min.) TIFR, Bombay
	Discussion	(20 min.)

LUNCH

	SESSION 2 (2.30 p m. - 3.45 p.m.)	
2.1	Mass Distribution in Fission and Some Related Phenomena	W. W. Havens (25 min.) Columbia University, N. Y.
2.2	Theory of Mass and Charge Distribution in Fission	V. S. Ramamurthy (15 min.) BARC, Trombay
2.3	Distribution of the total Fission Width	N. Ullah (15 min.) TIFR, Bombay
	Discussion	(20 min.)

TEA

SESSION 3 (4.15 p.m. - 5.45 p.m.)		Speaker
3.1	Prompt Radiations Emitted in Low Energy Fission	D. M. Nadkarni (15 min.) BARC, Trombay
3.2	Recent Studies on Prompt Neutron and Gamma Rays from Fission	A. Conde (15 min.) RIND, Stockholm Sweden
3.3	Radiations Emitted in Fission	P. Ribon (15 min.) Saclay, France
3.4	Fission Barrier Heights, Energy Release, and Fragment Energy Partition Processes from the Viewpoints of the Nuclear Structural Models	A. Chatterjee (15 min.) SINP, Calcutta
	Discussion	(20 min.)
	Concluding Remarks	R. Ramanna BARC, Bombay

EXCITATION ENERGY DEPENDENCE OF SHELL EFFECTS IN NUCLEAR FISSION

S. S. Kapoor

Bhabha Atomic Research Centre, Trombay, Bombay-85

It is now well known that the inclusion of ground state shell effects in the liquid drop model deformation energy of nuclei in the actinide region produces a pronounced double-humped fission barrier, which is responsible for a number of interesting experimentally observed phenomena in low energy fission. Theoretical investigations of the excitation energy dependence of the shell effects have been carried out by our group, which have shown that the nuclear shell effects on the fission data disappear rapidly with excitation energy. These investigations have brought out certain new effects which are important for the analysis and interpretation of the fragment anisotropies, fission excitation functions and other fission data at medium excitation energies and these will be discussed in this talk. The implication of the rapid washing out of the shell effects on the production probability of super-heavy nuclei will also be discussed.

REPORT ON WORK ON NUCLEAR SPECTROSCOPY OF HIGHLY DEFORMED Th-231

J. E. Lynn and G. D. James
A. E. R. E., Harwell, UK

and

L. G. Earwaker
University of Birmingham, Birmingham, UK

A measurement of the neutron-induced fission cross section of Th-230 has been made in the neutron energy range 680 keV to 1.4 MeV with a neutron energy resolution of 5 keV. At selected energies near a prominent resonance at 715 keV, the angular distribution of fission products with respect to the neutron beam has been measured with neutron energy resolution of about 18 keV. The results obtained are interpreted in terms of a β-vibration in the secondary fission potential barrier minimum and enable a direct estimate of the effective moment of inertia of the Th-231 nucleus in its shape isomeric state to be obtained.

DID SUPERHEAVY NUCLEI EXIST IN OUR SOLAR SYSTEM?

Narendra Bhandari

Tata Institute of Fundamental Research, Bombay-5

A systematic analysis of fossil tracks in a variety of primitive material from our solar system show an abundance of tracks characteristic of fragments released in the fission of predicted superheavy elements with $Z > 110$. These tracks cannot be attributed to other known sources like heavy nuclei of cosmic ray of fission of plutonium, uranium and other lighter elements. The evidence is found in three achondritic meteorites (Norton county, Nakhla and Moore county), one stony iron meteorite (steinbach) and certain grains from the lunar dust and can be taken to indicate that superheavy elements were extant at the time of formation of planetary bodies in our Solar System. The near absence of these tracks in younger lunar and terrestrial rocks and terrestrial ores suggest that at least some superheavy nuclei have a half life of 10^7-10^8 years and are now extinct.

From the data available so far the chemical nature of the superheavy elements cannot be ascertained. However their association with the lunar and achondritic meteorites, which are chemically differentiated and depleted in volatiles, does not preclude the possibility that they belong to superactinide group.

MASS DISTRIBUTION IN FISSION AND SOME RELATED PHENOMENA

J. Felvinci, E. Melkonian, W. W. Havens Jr.
Columbia University, New York, USA

This paper primarily discusses the experiments performed at Columbia University on the several types of mass distribution, the variation of the mass distribution with the mass of the fissioning nucleus, with its degree of excitation and with its spin state. Results of experiments performed elsewhere are included where necessary to illuminate the subject. Also discussed is a further elaboration of the mass distribution as a function of the kinetic energies of the fission fragments as well as a more detailed account of the emission of neutrons from the fragments. The possibility is raised that the mass distributions may be related more to the K quantum number of the transition state than to the spin of the fissioning nucleus.

Finally, a very recent experiment looked for an isomeric state of ^{236}U in fission induced by resonance energy neutrons in a ^{235}U target. The neutron energies ranged from a few hundredths of an eV to 3 keV. The time interval was observed between the detection of a gamma ray

and the fission fragment. The resolution of the system was 3.4 nsec. The results are consistent with an isomeric state with a half life of 7 ± 1 nsec. The previously observed 66-130 nsec state is indicated but the statistics are not good enough to draw any conclusion about the life time of this state. The ratio of delayed to prompt fission appears to be quite large.

THEORY OF MASS AND CHARGE DISTRIBUTIONS IN FISSION

V. S. Ramamurthy

Bhabha Atomic Research Centre, Trombay, Bombay-85

A theoretical analysis of the fragment mass and charge distributions in the fission of heavy nuclei is presented. It is shown that the asymmetric mass division in low energy fission of heavy nuclei arises simply from the requirement that at the instant of scission, the temperatures and the chemical potentials of the nascent fragments tend to be equal. The finite width of the observed mass distribution arises as a result of the statistical width around the most probable division. Assuming that the fission process is adiabatic with respect to the collective degrees of freedom of elongation (fragment separation) and rotation, the nascent fragments are shown to interact through the exchange of a relatively small number of nucleons near the Fermi energy, while the remaining nucleons form inert cores of the nascent fragments. The probability for a nucleon exchange in any nascent fragment Configuration depends on the structure of the single particle energy levels in the nascent fragments and their occupancies and are therefore shell dependent. The final mass and charge distributions are evaluated from the nuclear exchange probabilities by treating the process, as a stochastic process. At high excitation energies, due to the random population of many single particle levels, the shell effects on the transfer probabilities disappear and the mass division tends to be symmetric.

DISTRIBUTION OF THE TOTAL FISSION WIDTH

Nazakat Ullah

Tata Institute of Fundamental Research, Bombay-5

Earlier we [1] had given an expression for the distribution of the total fission width using R-matrix theory of nuclear reactions. This expression does not take into account the effects due to unitarity, which

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1. Nazakat Ullah, Nucl. Phys. A93 522 (1967).

have been shown to play a prominent role in the phenomenon of average cross section. In the present paper, we consider the effects of unitarity on the fissioning widths.

PROMPT RADIATION EMITTED IN LOW ENERGY FISSION

D. M. Nadkarni

Bhabha Atomic Research Centre, Trombay, Bombay-85

The present paper briefly reviews some of the recent investigations carried out at Trombay on prompt radiations emitted in the neutron induced fission of ^{235}U and spontaneous fission of ^{252}Cf. Earlier investigations dealt with the energy spectrum and angular distribution of neutrons and γ-rays with respect to the fragment direction in thermal neutron fission of ^{235}U. During the last few years using high resolution Si(Li) spectrometer, extensive studies of K X-rays emitted in fission, such as the yields, the average emission times and the multiplicities of K X-rays emitted from fragments of specified atomic numbers, have been carried out. Studies of several aspects of long range charged particle emission in fission have been made such as the dependence of their yield and energy spectrum on the excitation energy of the fissioning nucleus, the angular anisotropy of these long range charged particles and their associated fission fragments with respect to incident 3 MeV neutron direction, and the correlation of the energy of these long range charged particles and their angles of emission. The yield and energy spectrum of K X-rays and X-rays emitted in binary and ternary fission of ^{252}Cf have also been determined. Investigations on isomeric transitions from ^{252}Cf fission fragments using a high resolution Ge(Li) γ-ray spectrometer are currently in progress.

RECENT STUDIES ON PROMPT NEUTRON AND GAMMA RAYS FROM FISSION

H. Condé

Research Institute of National Defence, Stockholm, Sweden.

A review is given of some recent experimental results of $\bar{\nu}$ values i.e. the average number of prompt neutrons emitted in fission and also of the energy spectra of the fission neutrons. Special attention is given to the energy dependence of $\bar{\nu}$ for the neutron induced fission of ^{235}U.

Furthermore, a summary is given of an experimental study by ALBINSSON (1971) of prompt gamma rays in the thermal neutron fission of ^{235}U. The study concerns the energy and yield of the gamma decay as a function of fragment mass and time after fission.

RADIATIONS EMITTED IN FISSION

P. Ribon

Saclay, France

We briefly examine the properties of the various particles which are emitted during or after the fission process. Their emission can occur at three different stages:

1. At the scission time. These are mostly alpha particles and other light particles. The results for these emissions are numerous and coherent and allow one to obtain information on the scission configuration. On the contrary, neutron emission is not well enough known.

2. By the fission fragments. These de-excite mainly by neutron emission but, due to their high spin values ($I \sim 15$), gamma-ray emission is expected to compete with the neutron emission. However, some very recent results give lower spin values ($I \sim 7$).

3. By the fission products. The delayed neutron precursors are now quite well known, and the interest is turning more and more toward their energy spectra. The calculations which have been made to fit the previously measured spectra do not describe the structure of the most recent results.

FISSION BARRIER HEIGHTS, ENERGY RELEASE AND FRAGMENT ENERGY PARTITION PROCESSES FROM THE VIEWPOINTS OF THE NUCLEAR STRUCTURAL MODELS

A. Chatterjee

Calcutta University and Saha Institute of Nuclear Physics, Calcutta

The work in the Sahaa Institute on the above aspects is briefly reviewed. Several attempts of semi-empirical nature have given valuable information mainly on the charge distributions, charge yields, and scission point fragment deformations. Structureless Fermi gas models have been applied in the past to infer the properties at the scission point and effects on fragment excitation energies. A working model combining the collective potential energy surface concept and a microscopic structure-sensitive form of a Fermi gas model developed since 1966 is described; the model has aimed mainly to study (i) the systematics of one-humped barrier

heights and energy releases in different fissioning nuclei, (ii) partitions of fission energies in the fragment structures into their kinetic and excitation energies, (iii) prompt fragment γ-de-excitation processes, and (iv) excitation energy dependence. Detailed microscopic comparisons with experiments on different nuclei from different reaction channels leading to fission, in the mass range $226 \leq A \leq 256$ whenever such experiments exist, have been made. The agreement in most cases has been satisfactory.

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

DEPARTMENT OF PHYSICS

Program Nuclear Physics Laboratories 538 West 120th Street

November 10, 1970

Dr. George A. Kolstad
Chairman
International Nuclear Data Committee
U.S. Atomic Energy Commission
Washington, D. C. 20545

Dear George:

At the meeting of the EANDC at the Argonne National Laboratory, October 26-29, 1970, the Committee voted unanimously to combine the non-EANDC Request List for Neutron Nuclear Data Measurements with RENDA to form one world-wide request compilation. The Committee also considered several questions and problems which may arise as a result of the combination of these two request lists and recommends the following:

1. The combined world request list should be prepared and screened as in the past, by local data committees charged with this responsibility. The world request list should be produced by the IAEA. The Committee suggest that the combined request list be a joint cooperative effort between IAEA and ENEA.

2. Responsibility for the detailed review of the world request list should pass from the EANDC to the INDC. Provision should be retained for computer retrieval of a specialized request list to facilitate reviews by local data committees and task groups as in the past. Some changes in format, permitting requests to be combined, should be considered.

3. The present distribution to EANDC countries should be retained.

4. The extension of the request list to include the data required for nuclear safeguards, fusion reactors, and medical applications appears to be in order. However, extreme caution should be used in introducing these requests, since unrestricted introduction of these requests will expand the request list so much that it will become useless.

5. The Committee has recognized that requests for evaluations are also of interest. The proper way of formalizing requests for evaluations, however, remains to be determined.

The EANDC wishes the INDC the best of luck in the preparation and distribution of a world-wide request list and hopes that the combined list will be a more useful document than the present request list.

Sincerely yours,

W. W. Havens, Jr.
Chairman, EANDC

WWH:ss
cc: G. C. Hanna
R. Joly

heights and energy releases in different fissioning nuclei, (ii) partitions of fission energies in the fragment structures into their kinetic and excitation energies, (iii) prompt fragment γ-de-excitation processes, and (iv) excitation energy dependence. Detailed microscopic comparisons with experiments on different nuclei from different reaction channels leading to fission, in the mass range $226 \leq A \leq 256$ whenever such experiments exist, have been made. The agreement in most cases has been satisfactory.

APPENDIX 17

PROGRESS REPORTS SUBMITTED TO THE FOURTH INDC MEETING

Argentina	INDC(ARG)-1/G	
Australia	INDC(AUL)-15/G	(received after meeting)
Austria	INDC(AUS)-2/G	(received after meeting) EANDC(OR)-105
Belgium	INDC(BLG)-1/G	
Brazil	INDC(BZL)-3/G	
Bulgaria	INDC(BUL)-2/G	
Canada	INDC(CAN)-9/G	EANDC(CAN)-44L
ENEA	INDC(ENE)-4/G	
Finland	INDC(SF)-2/G	
Hungary	INDC(HUN)-3/G	
India	INDC(IND)-13/G	BARC-553
Iran	INDC(IRN)-1/G	
Japan	INDC(JAP)-10/U	EANDC(J)-22L
Korea	INDC(KOR)-1/G	
Netherlands	INDC(NED)-2/G	
Poland	INDC(POL)-4/G	No. 1318/I/PL
Portugal	INDC(PRT)-1/G	(received after meeting)
Rumania	INDC(RUM)-2/G	
Republic of South Africa	INDC(SAF)-3/G	
Sweden	INDC(SWD)-3/G	EANDC(OR)-111L
Switzerland	INDC(SWT)-2/G	EANDC(OR)-112L
Turkey	INDC(TUK)-2/G	
UK	INDC(UK)-12/G	EANDC(UK)-134AL
Uruguay	INDC(URU)-1/G	
USA	INDC(USA)-25/U	EANDC(US)-150U
	INDC(USA)-30/U	EANDC(US)-156U (received after meeting)
USSR	INDC(CCP)-15/G	
Yugoslavia	INDC(YUG)-2/G	

A complete list of INDC documents received by the Secretariat up to November 1971 is given in INDC(SEC)-19/U.

APPENDIX 18 Organization of Nuclear Data Activities in the U.S.A.

The Nuclear Cross Sections Advisory Committee (NCSAC) is presently composed of 20 members with M.S. Moore as Chairman. The work of the NCSAC is largely carried out by disciplinary subcommittees chaired by NCSAC members and composed of outside experts. The subcommittees and their chairmen are: Isotopes (H. Newson, Duke), Standards (H.H. Landon, NBS), Information (H. Goldstein, Columbia), Elastic and Inelastic Scattering (A.B. Smith, ANL), Gamma Ray Production and Capture (H.E. Jackson, ANL), Sample Configurations (ad hoc: A.B. Smith, ANL and R.C. Block, RPI), Fission (C.D. Bowman, LRL), Resonance Parameters (R.C. Block, RPI), Thermal Cross Sections and Radioactive Samples (R.M. Brugger, INC), Fast Neutron Reaction Cross Sections and Thresholds (H. Alter, AI), Total Cross Sections (M.H. Kalos, CIMS), Medium Energy Cross Sections (G.C. Phillips, Rice).

The NCSAC meets about twice a year and the next meeting will be held during the first week in December. Before each meeting, reports are made of recent measurements and progress of active work. These are collected and issued after each meeting in the document "Reports to the AEC Nuclear Cross Sections Advisory Committee", which receives EANDC and INDC distribution.

According to the Terms of Reference, the responsibilities of NCSAC (almost identical to those of EANDC) include: 1. Measurements 2. Equipment and Techniques 3. Research Materials 4. Compilation of Nuclear Data 5. Nomenclature 6. Technical Meetings 7. Review of Proposals 8. Liaison with other US Committees and Agencies 9. Liaison with International Committees.

The NCSAC is responsible for issuing and revising the US Request List, most of which is incorporated into RENDA. The US list undergoes continuous revision, and a revised version is usually issued yearly. The disciplinary subcommittees of NCSAC have just completed a comprehensive review of it, and a document summarizing their recommendations is in preparation. Recommendations are due at each NCSAC meeting from the Isotopes subcommittee concerning the program of Research Materials Collection of separated isotopes produced by the calutrons at Oak Ridge National Laboratory. At the last NCSAC meeting a recommendation was made concerning the disposition of excessively activated sample material.

The NCSAC has also taken an active part in the compilation and dissemination of nuclear data. The efforts of this committee, among others, resulted in the establishment of the NNCSC at Brookhaven National Laboratory in 1966, and two members of NCSAC serve on the NNCSC Steering Committee. Members of NCSAC also participate actively in the work carried out by the NNCSC's Cross Section Evaluation Working Group.

Topical conferences and other technical meetings are organized or sponsored by NCSAC whenever the need arises, and each NCSAC meeting includes an open technical session with invited speakers.

The Advisory Committee on Reactor Physics* (ACRP) meets about three times a year as required. Members, appointed yearly, represent fourteen national laboratories and industrial undertakings. Requests for measurements required for reactor programmes are presented to the ACRP and are screened by appropriate working parties; the ACRP is also consulted by the NCSAC

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* Information from informal statement at EANDC meeting by F. Maienschein

regarding the removal of apparently satisfied requests. Two other areas of prime concern to the ACRP are calculational methods and the interpretation of integral experiments, including experiments on shielding

The Cross Section Evaluation Group* (CSEWG) holds two meetings per year. It comprises representatives from some twenty institutions funded to carry out evaluation work and some data measurers in an advisory capacity. The main responsibility of CSEWG is the ENDF/B library, which is being improved by an iterative process involving "benchmark" data testing, and the committee's work naturally leads it into the field of standards, documentation, and methods of evaluation.

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*Information from informal statement at EANDC Meeting by S. Pearlstein

APPENDIX 19

OFFICE MEMORANDUM

TO Members of INDC DATE: August 31, 1971

FROM R. F. Taschek

SUBJECT: COSTS OF DOING NEUTRON PHYSICS EXPERIMENTS ON AN UNDERGROUND NUCLEAR DETONATION. ACTION 7

SYMBOL: ADR

The possibility of doing neutron physics experiments on "open" underground nuclear detonations raises the question of costs to experimenters who might be interested in participating in such a program.

Although no precise answer can be given to this still very general question, enough experience has been developed in previous physics shots so that a reasonably good guide has been developed by Ben Diven who has been in charge of part of this program. In what follows most of the costs have been converted to scientific man years which need to be applied since the monetary costs in the various countries cannot really be normalized. It is assumed for want of other information that there will be no assessed costs for the nuclear explosive and installed apparatus; namely this will be done much like an outside "user" participating in an approved experiment at a large accelerator. Similarly there may be guidance, service help, and collaboration with LASL scientists. The comments below are mostly Diven's:

The cost of doing an experiment with a nuclear explosive is high. Most experiments that are worth doing are very difficult ones and use exotic samples that may require some degree of remote handling and care in radiation safety practices. Measurements extend over many decades in neutron energy and proper analysis of the data may require extensive computation. It is felt that for the kind of experiments done so far a minimum effort for any experimental group would be about two man years.

The effort required to do a cross-section experiment on a nuclear explosion will be estimated in two ways. One is based on LASL experience on Shot 8 and the other on U.K. experience on Pommard.

Certain detailed information on Physics 8 is available. The equivalent of 12 scientific staff participants in two groups at the LASL worked two years in preparation for the shot and in the data analysis which followed. This 24 man-year effort produced 24 experiments, of which most have been published or are in preparation for publication. The experiments were:

TO: Members of INDC DATE: August 31, 1971

Fission	Capture
^{243}Am	^{197}Au
^{249}Bk	^{238}U
$^{249,252}Cf$	$^{244,246}Cm$
$^{243,244,245,246,247,248}Cm$	^{239}Pu
^{253}Es	Other: Neutron polarization by transmission through LMN polarized proton crystal at 1°K.
^{237}Np	
$^{239,242,244}Pu$	
$^{234,236,238}U$	

Next, consider the U.K. experiments on Pommard. They performed four very complex experiments. Two of their measurements were capture-to-fission ratios (^{239}Pu and ^{241}Pu) and one was the (n,p) cross section of ^{7}Be which provided a difficult sample problem. They used five physicist man years and three electronics technician man years. It would probably have been wiser for them to have done somewhat easier experiments for their early try and to have relied on LASL equipment design rather than develop all of their own in which case their manpower requirements would have been considerably reduced.

From the above, a good estimate would indicate that two staff member years per experiment may be a reasonable effort for an average cross-section measurement with a nuclear explosion. If the sample is very difficult to prepare and handle, the cost would be correspondingly higher.

The possibility of requests for trivial experiments exists. People with certain special interests may wish to "put a mouse in the beam." Possibly some useful, but near-zero-effort experiments would be suggested. One example might be calibration of threshold detectors in a well-known flux. One should probably expect some such experiments and, if kept within reason, they should be permitted.

In the discussion above there is no specific reference to hardware costs, primarily because these will vary from experiment to experiment and will be best known by the experimenter himself. It seems likely that the method of data recording, whether by fast photography of oscilloscope traces or recording on magnetic disks, have already been worked out by LASL and there is probably enough such apparatus available for as many experiments as can be done at any one time. Likewise there may be enough support and service facilities housed in trailers available for nearly all possible programs. If specific experiments are proposed the LASL staff can help in establishing what is needed.

Action 8 -- A selected list of reports giving results of previous neutron experiments underground nuclear detonations is being sent to you.

R. F. Taschek

R. F. Taschek
Assistant Director for Research