International Atomic Energy Agency

INDC-35/U

INDC

INTERNATIONAL NUCLEAR DATA COMMITTEE

MINUTES

OF THE ELEVENTH INDC MEETING

Vienna, 16-20 June 1980

Compiled by

S. Yiftah
Soreq Nuclear Research Centre
Yavne, Israel

Aided by

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May 1981

IAEA NUCLEAR DATA SECTION, WAGRAMERSTRASSE 5, A-1400 VIENNA

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INDC - 35/U

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(Executive Secretary)

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Yavne, Israel

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Summary, conclusions and recommendations

The International Nuclear Data Committee met at IAEA Headquarters, Vienna, for its eleventh meeting, on 16-20 June 1980. The meeting was attended by 13 committee members, 7 advisors and 15 observers from 15 countries and 3 international organizations.

The Committee reviewed the nuclear data activities of the IAEA, in Member States and in Nuclear Data Centres during the 18 months since its last meeting in Bucharest, October 1978. The committee also discussed critically the nuclear data programmes for the next 18 months.

The INDC noted the three high-priority areas in the Agency's overall programme (safeguards, nuclear safety and assistance to developing countries) together with the implication of phasing out or reducing in scope low-priority areas because of the constraints of a near-zero growth in the Agency's budget.

The official Minutes include summaries of the discussions of the agenda items, full reports of subcommittees, list of actions, together with lists of participants and subcommittees membership. The main conclusions and recommendations of the eleventh INDC meeting follow:

1) The INDC noted that, with the building and operation of more than 200 power reactors all over the world, there occurred a shift and change of emphasis from nuclear data for reactor design to nuclear data for safety, the nuclear fuel cycle and nuclear waste management.

2) The INDC noted the growing interest of developing countries in introducing nuclear power and technology and the resultant growing services requested from the Agency, including nuclear data and nuclear education services.

3) The INDC noted the recommendations of the Scientific Advisory Committee that the Agency's nuclear data programme, budget and manpower should be maintained at the present level. The detailed NDS programme should reflect the major needs of the high-priority areas of the Agency's overall programme.
4) The INDC commends the NDS for formulating in detail the "Project of international cooperation for training of nuclear scientists in developing countries", using the expertise available in the nuclear data field, involving a close cooperation between research institutes in developing and developed countries. It finds that this project can be a focus and a channel through which the Agency can fulfill part of its role in assisting developing countries to form the infrastructure and manpower necessary for using nuclear energy. The INDC recommends that the IAEA take the necessary steps for the implementation of this important project.

The INDC recommends to start this project at a modest level of organizational effort, and to take into account the needs of developing countries and the equipment which is already at their disposal.

The INDC recommends that NDS work in close cooperation with the other units of the IAEA in order to implement this project.
5) The INDC reviewed carefully the impact of the 1978 and 1980 Nuclear Theory for Applications Courses held at the ICTP Trieste, under the joint sponsorship with the Nuclear Data Section, and recommends the holding of a third Course in 1982 at the ICTP Trieste. The Committee urges the Nuclear Data Section to explore all possible avenues for obtaining the necessary funds, including ICTP and the Agency's Technical Assistance funds.

Detailed conclusions, recommendations and actions arising from the eleventh INDC meeting are included in the body of the minutes.

Actions arising from the 11th INDC Meeting

No	Session	Person	Action
1	III.B.	J.J. Schmidt	Policy recommendations made by specialist technical meetings should be sent to INDC participants for comments before IAEA takes action on them
2	IV.C.	J.J. Schmidt	Prepare evaluation of after-effect and impact of 1980 Trieste course and distribute to INDC participants
3	V.A.	J.J. Schmidt	Include in the introduction of the next WRENDA edition a note indicating that the accuracies appearing in the list correspond to 1 σ error except where noted otherwise
4	V.A.	All members	Ensure that national WRENDA requests are properly reviewed
5	V.A.	J.J. Schmidt	Distribute Standards & Discrepancies Subcommittees reports to WRENDA requesters
6	V.B.	S. Yiftah	Include summaries of two CRP June 1980 meetings in INDC proceedings
7	VIII.A.	All Subcommittees Chairmen	Provide final Subcommittee Reports for official minutes within 30 days after 11-th INDC meeting
8	VIII.B.	A. Smith	Approach Macklin to ensure that he officially informs appropriate people or publishes his renormalised Th-232 capture data

9	VIII.B.	Frohner	Include specific references about factor-of-two discrepancy for Am-241 fission resonance integral
10	VIII.B.	J.J. Schmidt	Clarify whether requests in WRENDA 79/80 for Np-237 (n,2n) are for total (n,2n), for part leading to Np-236m, or for part leading to Pu-236 (see INDC(UK)-33/G, p43)
11	VIII.C.	All members	Inform WRENDA contributors that standard accuracy requirements should be stated with 1 σ error. State explicitly if otherwise
12	VIII.C.	All members	Inform WRENDA contributors to state explicitly in comments section if average value of cross section in a typical spectrum is required
13	VIII.C.	All members	Inform WRENDA contributors to state explicitly energy resolution requirements or covariance assumptions, if any
14	VIII.C.	J.J. Schmidt	Review, in consultation with Safeguards experts, requirements and uses of nuclear data in analysis of safeguards measurements and issue report
15	VIII.C.	All participants	Comment and up-date list of sources suitable for radiation damage measurements given in INDC/P (80)-14
16	VIII.C.	All participants	Propose to NDS appropriate topics and speakers for meeting on nuclear data requirements for radiation damage predictions and selected safety-related topics
17	VIII.C.	All participants	Encourage sensitivity studies needed to assess nuclear data requirements for topics of previous action

18	VIII.C.	J.J. Schmidt	Ensure that adopted actinide evaluations arising from TND evaluations CRP are complete, include uncertainty estimates and are of attested quality
19	VIII.C.	J.J. Schmidt	Ensure that choice of data items for study within CRP on Actinide Decay Data relates to well-defined justified and documented needs. Recommended values should include uncertainties and be supported by appropriate documentation
20	VIII.C.	J.J. Schmidt	Ensure that evaluation documentation and intercomparisons are available well in advance of CRP Meetings
21	VII.C.	J.J. Schmidt	Continue important work of the two TND CRP's on Evaluations and Decay Data and inform INDC members on developments
22	VIII.D.	J.J. Schmidt	Ensure that members of subcommittee B are informed about the outcome of INTOR workshops as far as they are relevant to nuclear data and material choice
23	VIII.D.	J.J. Schmidt	Put evaluated file formats for double differential data on the agenda of the next NRDC meeting
24	VIII.E.	J.J. Schmidt	Inform INDC members of outcome of Interregional Project implementation discussions
25	VIII.E.	A. Smith	Dispatch new version of Report on NDS programme for comments to members of subcommittee, chairman, scientific secretary and executive secretary

26	X.A.	S. Yiftah	Dispatch corrected version of Actions for comments of INDC participants
27	X.C.	J.J. Schmidt	Inform INDC members of final date of next INDC meeting as soon as possible

I. Introductory items

Prof. H. Kakihana (Deputy Director General, Dept. of Research and Isotopes, IAEA) welcomed the participants to the INDC meeting, and outlined the objectives of the INDC. He informed the Committee about the current priority areas of IAEA and the recent review of the Agency's nuclear data programme by the IAEA Scientific Advisory Committee, and outlined current changes in this programme towards the Agency's priority areas, in particular towards increased support of developing countries.

II. Committee business-I

A. List of participants and attendance of observers

Dr. Michaudon read the list of participants and observers (see App. 1) and the list of subcommittee chairmen (see App.2).

B. Adoption of agenda

The tentative agenda was revised and approved.

C. Report from past INDC chairman

The outgoing chairman, Dr. Cross, presented a report for the years 1977-1979 (INDC-33/LN). The report considers the trends in applications of nuclear data, the progress in international collaboration, atomic and molecular data for fusion, and other topics.

D. Review of actions arising from the 10th INDC Meeting

The 37 actions arising from the previous meeting (see INDC-31/L, App. XII.A) were reviewed. A working paper (J.J. Schmidt, INDC/P(80)-19) addressed the question of "Shortcomings of center files and dissemination" (action no. 5). A list of samples loaned out (action no. 12) is to be found in INDC/P(80)-12. A list of intense neutron sources for use in radiation damage (action no.30) was prepared (INDC/P(80)-14).

E. Changes in membership and chairmanship of the INDC subcommittees

The compositions of the different subcommittees were revised and are given in App. 2. Dr. Froehner will stay as chairman of the Discrepancies Subcommittee until the end of the present meeting. Dr. Smith resigned as head of the Standards Subcommittee effective at the completion of the 1980 file document.

F. Scope and agenda of the INDC subcommittees

Dr. Michaudon summarized the scope of the four standing subcommittees: A (fission reactor nuclear data); B (other nuclear data); Standards; and Discrepancies; and the two ad-hoc subcommittees: Future NDS Programme and Meetings, and Interregional Project (which includes also the Trieste courses, as well as fellowships).

G. Loss of the barn

Dr. Michaudon mentioned that, together with Dr. Liskien, he recommended to BIPM (Bureau International des Poids et Mesures) to maintain the barn as a unit of cross-section for nuclear reactions. A similar action was made to Euratom through the Advisory Committee for Management of Programmes (CBMN). Apparently the barn is temporarily saved but INDC should continue to follow up any possible evolution of the use of the barn.

III. IAEA nuclear data programme

A. Recommendations from the Scientific Advisory Committee (SAC) to IAEA concerning the future IAEA nuclear data programme

Dr. Schmidt called attention to the appropriate working papers INDC/P(80)-10 and-11, and to INDC(NDS)-111, and informed the Committee in detail about the results of the recent review of the NDS programme by SAC in January 1980. SAC concluded that NDS should be maintained at its present level, but certain activities should be phased out or reduced. SAC advised against initiating new nuclear data activities on alternative fuel cycles (Th-U) and advanced reactor designs. As a consequence, further large meetings on fission product nuclear data will not be organized (except smaller consultants meetings such as the one on delayed neutron data held in March 1979). No fission product nuclear data evaluation will be done by NDS, but the edition of the annual progress report on fission product nuclear data will be continued. The evaluation of reactor dosimetry data by NDS has been phased out. INDC concurred with SAC that nuclear data for radiation damage and safety assessment are important and should be continued. Evaluation of thermal reactor data has been terminated. The review of nuclear data for reactor design will in future be restricted to items of key interest to all IAEA Member States. In this context a Consultants Meeting on U and Pu isotopes resonance parameters (related to reactor safety) is recommended to be held in 1981. The activity relating to the NDS library of evaluated actinide neutron cross sections and the international reactor dosimetry file should be continued.

B. Review of the recommendations to the IAEA from the 10th INDC meeting

All recommendations of the 10th INDC meeting were implemented or taken into serious consideration.

C. Summary of recommendations concerning nuclear data from past IAEA/NDS and other meetings.

Dr. Schmidt called attention to working paper INDC/P(80)-10, which presents a summary of recommendations from past IAEA meetings together with their state of implementation.

D. Presentation of NDS activities (including A+M data for fusion)

This sub-topic covered present and future activities (see INDC/P(80)-11) as well as a discussion about the manpower and the cost of various aspects of the program.

Drs. Smith and Ferguson complained that the inter-regional project was not announced sufficiently in advance. Dr. Schmidt answered that no funding was required for 1980 and that the project was to start in 1981.

A copy of CIAMDA, the new Computer Index of Atomic and Molecular Data for fusion produced by the NDS Atomic and Molecular Data Unit, was circulated.

IV. IAEA/NDS nuclear data services and support of research in developing countries

A. IAEA/NDS nuclear data services to developing countries

In order to improve these services NDS has replaced the CINDU report by a Nuclear Data Newsletter, and a documentation report series. Dr. Lemmel explained that the EXFOR file is 90% complete and CINDA is assumed complete.

Dr. Schmidt elaborated on paper INDC/P(80)-12, which summarizes the overall programme status of targets and samples supplied by the IAEA/NDS to developing countries for nuclear data measurements.

Concerning the topic of research contracts, Dr. Smith raised the question of how the quality of the research contract work is assessed. Dr. Kapoor said one index would be the related publications which appear in refereed journals.

The subject of fellowships was referred to the Interregional Project subcommittee.

B. Planned IAEA/NDS Interregional Technical Assistance Project for Training of Nuclear Scientists from Developing Countries, using the expertise available in the nuclear data field.

Dr. Schmidt referred to the relevant papers: INDC/P(80)-4,-5 and -24. The main emphasis should be in the training of developing nations in nuclear techniques, with secondary emphasis on data production. A likely subject would be 14 MeV neutron cross sections and related techniques, because of the availability of IAEA-supported 14 MeV neutron generators in many developing countries. Dr. Cross commented that most 14 MeV requests which are still maintained are difficult to meet.

C. Joint IAEA/NDS - ICTP Trieste Courses on Nuclear Theory for Applications

Reports on the 1978 and 1980 Trieste courses are to be found in INDC/P(80)-13 and -3, respectively. It was concluded that an evaluation of the impact of the 1980 course was necessary (see action no. 2).

V. Coordinating activities

A. WRENDA 79/80 and future WRENDA publications

A WRENDA input guide designed to help requestors in the preparation of revised and new requests for WRENDA 81/82 is presented in INDC/P(80)-7. In the discussion, the following 3 actions were formulated. To include a note in WRENDA specifying 1 standard deviation accuracies, except where noted otherwise (action no. 3).

To ensure that national WRENDA requests are properly reviewed (action no. 4). To distribute Standards and Discrepancies Subcommittees reports to requesters (action no. 5).

B. IAEA/NDS Coordinated Research Programmes

Continuation of the two Coordinated Research Programmes (CRP) on actinide nuclear data by two further years until the end of 1982 was endorsed by the Committee (see also actions 6 and 18-21). The Proceedings of the two CRP Meetings on Actinide Nuclear Data (June 1980) are included in the INDC minutes (action 6).

C. Nuclear data for radiation damage and nuclear safety

A memorandum on the REAL-80 project (interlaboratory comparison of radiation damage estimates) was distributed: INDC/P(80)-9. Dr. C. Ertek (Seibersdorf Lab.) summarized the status report on REAL-80, which is to be found in INDC/P(80)-17.

A draft list of intense neutron sources for radiation damage studies was distributed: INDC/P(80)-14.

A review of the ^{103}Rh(n,n') cross section was distributed: INDC/P(80)-15.

D. Nuclear data for safeguards

NDS plans were endorsed to conduct a review of the requirements and uses of nuclear data in the analysis of safeguards measurements, as a first step towards establishing an international consistent nuclear data file for safeguards (see action 14). A meeting on safeguards nuclear data was deferred pending the outcome of this review.

Another topic discussed was: the nuclear data implications of the IAEA safeguards project for an international measurement system for nuclear materials. A presentation was made by S. Deron, head of the Safeguards Analytical Lab of the IAEA, Seibersdorf Laboratories (INDC/P(80)-8). Dr. Deron was requested by the IAEA/NDS to supply in due time a list of needed nuclear data for the project.

E. Standards

The topics of "international exchange of standard reference U-235 fission foils" and of "fission cross section transfer instruments" were discussed.

The Committee strongly urged NDS to implement the exchange and mass comparison between US and USSR fission foils in order to remove the remaining uncertainties in fission foil mass standards. Such a comparison was felt to be essential before holding the recommended Consultants Meeting on precision ^{235}U fission cross sections (see Appendix 5).

F. International Nuclear Fuel Cycle Evaluation (INFCE) study and its consequences for nuclear data, if any

A summary on INFCE was presented by Mr. Skjoldebrand from the IAEA Division of Nuclear Power. The discussion did not reveal any new implications to nuclear data.

G. Extension of NEANDC/NEA-DB projects to non-OECD countries

Dr. J. Rosen informed on two NEA Data Bank projects, in which also a few scientists from non-OECD countries participate:

1) Nuclear model code comparisons;
2) Comparison of methods for the determination of average resonance parameters.

VI. Nuclear data centres

A. Status reports and future activities of nuclear reaction data centres and groups

The following topics were covered: neutron data, charged particle nuclear data, and photonuclear data. Dr. Smith mentioned that a new issue of BNL-325 (resonance parameters) was going to press.

B. Status of mass chain data evaluation (NSDD network)

Dr. Lorenz mentioned that the work of 16 evaluation groups and 2 data centers is coordinated by NDS, in cooperation with BNL. Meetings are held every 2 years. There are 3 specific objectives:

1) Coordination and acceptance of new evaluation groups.
2) Maintenance and improvement of standards and rules that govern evaluations.
3) Review of computerised file development.

VII. Progress reports

Short statements were made by the different participants on the status of nuclear data evaluation in their respective countries. The points touched included:

1) Additions to submitted progress reports
2) Activities in countries not represented on INDC
3) New or projected large experimental facilities

VIII. Reports of technical, policy and ad-hoc subcommittees

The subcommittee reports are to be found as follows: A-App. 3; B-App.4; Standards-App. 5; Discrepancies-App.6; Meetings and Future NDS Program-App. 7; Interregional Project-App. 8.

IX. Meetings

A list of meetings planned by NDS for the period 1980-2 was distributed (A. Lorenz, INDC/P(80)-16).

Dr. Yankov will inform NDS and INDC members on the USSR decision concerning a major Neutron Physics Conference after the 1980 Kiev Conference.

A 1-week Conference will be held at Cambridge in 1982, honouring the 50th anniversary of the discovery of the neutron.

An International Conference on Neutron Physics and Nuclear Data will take place in Antwerp (Sept. 82) with a scope similar to that of the 1978 Harwell Conference.

X. Committee business - II

A review was made of the actions, conclusions and recommendations of the present meeting. A tentative date was fixed for the next (12th) INDC meeting (it now stands at: 5-9 October 1981).

APPENDIX 1

List of Participants

I. Members and advisors

Canada	Dr. W.G. Cross	
France	Dr. H. Derrien*	
	Prof. A. Michaudon	Chairman
Germany (G.D.R.)	Prof. D. Seeliger	
Germany (F.R.G.)	Dr. F. Froehner	
India	Dr. S.S. Kapoor	
	Dr. M.K. Mehta*	
Israel	Dr. M. Caner*	
	Prof. S. Yiftah	Executive Secretary
Italy	Dr. E. Menapace	
Japan	Dr. K. Harada	
Sweden	Dr. H. Condé	
U.S.S.R.	Dr. B.D. Kuzminov*	
	Dr. G.B. Yankov	
United Kingdom	Dr. A.T.G. Ferguson	
	Dr. J.L. Rowlands*	
U.S.A.	Dr. H.T. Motz*	
	Dr. A.B. Smith	
IAEA	Dr. A. Lorenz*	Local Secretary
	Dr. J.J. Schmidt	Scientific Secretary

* Advisors

II. Observers

Austria	Prof. H.K. Vonach	
Hungary	Prof. J. Csikai	
Israel	Dr. Y. Gur	part time
Romania	Dr. S.N. Rapeanu	
CEC/BCMN Geel, Belgium	Dr. H. Liskien	
OECD/NEA, Paris, France	Dr. J. Rosén	
IAEA	Dr. R. Skjöldebrand	part time
	Dr. S. Deron	"
	Dr. D. Cullen	"
	Dr. N. Dayday	"
	Dr. N. Kocherov	"
	Dr. M. Lammer	"
	Dr. M.D. Lemmel	"
	Dr. K. Okamoto	"
	Dr. O. Schwerer	"

III. Absent members

Australia	W. Gemmell

APPENDIX 2

Membership of INDC Subcommittees

June 1980

Subcommittee A

Rowlands (Chairman)
Fröhner
Rapeanu
Schmidt
Kuzminov
Motz
Menapace
Kapoor
Condé
Derrien
Lemmel
Kocherov
Yiftah
Caner
Gur

Subcommittee B

Liskien (Chairman)
Cross
Ferguson
Yankov
Mehta
Seeliger
Harada
Csikai
Lorenz
Okamoto
Lammer

Standards Subcommittee

Lorenz
Lemmel
Yankov
Rapeanu
Condé
Ferguson
Liskien
Seeliger
Csikai
Kapoor
Gur
Schmidt
Smith (Chairman)
Vonach

Discrepancies Subcommittee

Fröhner (Chairman)
Mehta
Derrien
Rowlands
Schmidt
Harada
Caner
Kuzminov
Schwerer
Okamoto
Menapace
Motz
Cross

Future of NDS Programme + Meetings

Schmidt
Lorenz
Kuzminov
Kapoor
Rowlands
Rosen
Yiftah
Fröhner
Smith (Chairman)

Interregional Project

Michaudon
Mehta
Schmidt
Csikai
Ferguson
Motz
Cross
Yankov
Condé
Dayday
Cullen
Menapace
Harada
Seeliger (Chairman)
Gur

Report of INDC Subcommittee A

The subcommittee is concerned with nuclear data for fission reactor applications. Nuclear data requirements and status are considered and recommendations are made to the INDC.

Members:

M Caner
H Condé
H Derrien
C Ertek
F Froehner
M Gur
S Kapoor
N Kocherov
B Kuzminov
M Lammer
A Lorenz
E Menapace
A Michaudon
H Motz
S Rapeanu
J Schmidt
S Yiftah
J Rowlands (Chairman)

Report of Subcommittee A

1 Assignment of uncertainties in nuclear data

1.1 WRENDA

It was noted that the INDC has proposed that the accuracy requirements given in WRENDA should be interpreted as 1σ requirements unless the status comments for the item state the alternative definition used.

In some cases requesters might be able to qualify the accuracy requirements. For example, if the requirement is for the quoted accuracy in the average value in a reactor spectrum this should be stated. Other information about energy resolution requirements, or covariance assumptions, should also be included if it can be expressed briefly.

1.2 Evaluations

It was agreed that an essential requirement of an evaluation is an estimate of the uncertainties in the evaluated cross sections. As a minimum the uncertainties in the thermal Maxwellian, the resonance region and a fast reactor spectrum average, should be given. Uncertainties in fission spectrum averages would also be valuable. Alternatively, sufficient information should be given for these to be derived. For the most important reactions covariance files are desirable.

1.3 Measurements

It was noted that the representation of uncertainties in measured data is to be a topic at the next Nuclear Reaction Data Centres Meeting.

2 Safeguards, fuel handling, reprocessing and waste management

2.1 Nuclear data for the transactinium isotopes

The requirements and the status of the data were reviewed by Dr Menapace and Dr Gur and their assessments are given in an Appendix to the report.

2.2 Co-ordinated Research Programme (CRP) on the Intercomparison of Evaluations of Actinide Neutron Nuclear Data

There are marked differences between the accuracies requested for secondary actinide cross sections by different countries, ranging typically from ± 10% to ± 30%. Nevertheless, there is general agreement on the need for good quality evaluations for a large number of secondary actinide isotopes and continuation of the CRP on evaluation of actinide neutron nuclear data is supported. The Nuclear Data Section is asked to ensure that adopted evaluations are complete and of attested quality and include uncertainty estimates. The Nuclear Data Section is also asked to try to ensure that evaluation documentation and intercomparisons are available well in advance of CRP meetings.

2.3 Nuclear data requirements for Safeguards applications

Dr M Lammer summarised the transactinium isotope decay data (TDD) requirements for safeguards. The requirements arise for the following applications:

1) Active interrogation technique, where the unknown sample is measured against a standard of known composition. TDD are required for

   a) initial analysis of the standard;

   b) determination of changes in the composition of the standard due to activation during measurements, as well as from spontaneous fission neutrons within the sample, and radioactive decay;

2) Direct measurement of decay γ-rays for verification purposes (fresh or spent fuel)

3) Calorimetric measurements of spent fuel decay power (not yet routinely used).

The requirements have been reviewed by Dr Fuketa (1978 Harwell Conference), Dr Lemley (November 1978 Brookhaven Meeting, BNL 50991) and at the Second IAEA Advisory Group Meeting on TND, Cadarache, (1979) (INDC(NDS)-106). There are differences in views about the need for improved actinide decay data although some requirements are generally agreed, for example improved accuracy for the Pu241 half-life.

A need for a reference set of nuclear data with well justified uncertainty estimates has been expressed by several safeguards experts. As a first step towards this goal it is recommended that the Nuclear Data Section review the requirements and uses of nuclear data in the analysis of safeguards measurements, in consultation with safeguards experts, and issue a report detailing these.

2.4 The Co-ordinated Research Programme on the Measurement and Evaluation of Transactinium Isotope Nuclear Decay Data

There is a need for more accurate decay data, and for recommended reference sets of data, for applications such as safeguards. Continuation of the CRP on TND Decay Data is supported. The Nuclear Data Section is asked to ensure that the reasons for the choice of data items for study are documented and, preferably, have the support of National Nuclear Data Committees. It is considered important that documentation is produced to support the choice of recommended values, and the associated uncertainties, and that these are well validated.

It was reported that the CRP is endeavouring to correlate its work as closely as possible with the International Nuclear Structure Data Evaluation effort but differences in the objectives and timescales prevent complete integration.

2.5 TND Meetings

It was agreed that it would be appropriate to hold a 3rd TND Meeting in 1983 (4 years after the 2nd Meeting in Cadarache). This is the earliest date considered to be appropriate but it is expected that much new data will be available then.

3 Radiation damage, nuclear safety and dosimetry

3.1 Radiation damage

Dr Ertek described the REAL 80 project. This intercomparison of damage rate calculations, using specified data for cross sections, reaction rates and spectra, together with associated uncertainty estimates, is primarily a test of methods, although some information on the effects of the cross section uncertainties could be derived. However, further studies are needed to identify the nuclear data relevant to the prediction of radiation damage effects. These data could include scattering recoil cross sections, (n,γ) nuclear recoil cross sections, helium formation by (n,α) reactions and hydrogen generation by (n,p) reactions. Materials and circuit activation, associated with operation and decommissioning of reactors might also be included as an extension of a study of materials damage nuclear data requirements. The temperatures of reactor components are important factors determining the irradiation damage and so the nuclear data required to predict energy deposition should also be considered in such a study. The components of this include the energy released in fission, (including the gamma spectra), nuclear recoil, (n,γ)reactions and associated gamma spectra, gamma ray absorption and the energy released in charged particle reactions (such as $B10(n,\alpha)$ in control elements).

3.2 Dosimetry

Dosimetry plays an essential role in correlating irradiation damage effects. The production of the International Dosimetry File, co-ordinated by NDS, is an important contribution to this aspect of improving irradiation damage data and methodology.

The status of the dosimetry reaction Rh103(n,n')Rh103m was described by Dr Kocherov (INDC/P(80)15). There is a 25% difference between one measurement and an evaluation in the energy range 6-12 MeV, the requested accuracy being 5%. Further differential and integral measurements were considered to be needed. It is possible that Dr Helm (Karlsruhe) could make an integral measurement. However,this would not be sensitive to data above 6 MeV.

Dr Ertek reported that the Seibersdorf laboratory had provided palladium sources and rhodium foils to laboratories participating in an international callaborative exercise investigating the standardisation of neutron flux measurements. The recent ASTM-Euratom meeting and the International Working Group on Reliability of Reactor Pressure Components have requested a new exercise, both to enable difficulties which some laboratories encountered in the earlier exercise to be resolved and for other laboratories to participate (in particular, in the USA). The Seibersdorf laboratory has agreed to provide the sources and foils. One result of this exercise could be integral measurements of the Rh(n,n') cross section in different spectra suitable for data checking.

The subcommittee asked Dr Froehner if the Discrepancies Subcommittee could include this Rh(n,n') reaction in their list of reactions to be reviewed.

3.3 Sources for radiation damage measurements

Members of the INDC were asked to comment on and up-date the list of sources suitable for radiation damage measurements given in INDC/P(80)14. (Dr Motz has provided an accelerator technology bibliography).

3.4 Safety

Aspects of reactor safety which require accurate nuclear data for their demonstration were considered. The aspects include:

(i) Doppler effects (U and Pu resonance parameters). A NDS Consultants Meeting on U and Pu resonance parameters is planned for 1981.

(ii) Sodium voiding reactivity effects.

(iii) Thermal reactor temperature coefficients (variation of eta values with energy in the thermal region)

(v) Criticality aspects of transporting, reprocessing and storage of fuel.

It was noted that the NEACRP is collaborating in an assessment of the status of criticality methodology.

(vi) Energy deposition and decay heating.

(vii) Induced radioactivity of irradiated materials.

(viii) Irradiation damage of components.

(ix) Control element design.

3.5 Meeting on nuclear data for radiation damage and selected safety topics

It was considered timely to convene a meeting to review the nuclear data requirements relating to radiation damage predictions and also to selected safety related topics. The NDS was asked to consider an appropriate combination of topics which would be suitable for such a meeting. Members were asked to write to Dr Schmidt proposing appropriate topics and speakers who could survey the requirements and status of the data.

4 Shielding nuclear data

Requirements have been reviewed by J Butler (1978 Harwell Conference) and M Salvatores (1979). The NEA is organising a series of meetings relating to nuclear data for shielding, the next meeting being "Specialists Meeting on Nuclear Data and Benchmarks for Reactor Shielding" October 1980. It was proposed to await the outcome of the NEA sponsored programme of meetings before initiating an IAEA activity. It was noted that there is also to be a Topical Meeting on Advances in Reactor Physics and Shielding, in the USA.

5 Fission product nuclear data

5.1 NDS reports series on progress in fission product nuclear data

The subcommittee were pleased to note that although a number of areas of work in NDS had been terminated because of the need to devote effort to new areas it has been possible for NDS to continue production of the series of FPND Progress Reports. These progress reports are considered to be a very valuable contribution to international collaboration on measurement and evaluation of fission product nuclear data.

5.2 NEANDC sponsored meeting on fission product capture cross sections held at Bologna

Dr Menapace summarised the main conclusions and recommendations of the meeting:

(i) higher quality resolved resonance parameters are required for long-lived unstable nuclides such as Tc99, Pd107, Sm151, Pm147, Cs135 and Ru103.

(ii) average total cross section measurements are required in the energy range 5 to 100 KeV for S_o and S_1 strength function determination;

(iii) the uncertainties estimated for mean level spacings were as follows:

for the 20 most important nuclides ± 5% uncertainty; for 4 nuclides ± 10%; for the remainder the uncertainty estimates were larger;

(iv) concerning the determination of average capture widths, there are still not enough individual resonance Γ_γ values for many nuclides and, moreover, separate values for $l = 0$ and $l = 1$ are needed;

(v) from the resolved resonance parameters of the 20 most important FP nuclides, S_o has been determined typically to about ± 30% with smaller (∿ ± 10%) uncertainties in favourable cases (eg Rh103, I127); S_1 values determined from resolved resonances are quite uncertain and it is more reliable to determine these from average σ_T data and, when the average spacing is small, average capture cross section data in the few KeV - 100 KeV energy range;

(vi) further developments of microscopic theories and macroscopic systematics are recommended for average spacing and radiative width determination.

5.3 NEANDC/NEA-DB project on comparison of methods for the determination of average resonance parameters

Dr Derrien described the project:

The proposals for an intercomparison of methods concerns mainly the determination of the mean level spacing (D_{obs}) and the neutron strength functions (mainly S_o) from the resolved resonances parameters. It has already been discussed at the Bologna FP capture cross section meeting. Different methods are used to obtain these average parameters: maximum likelihood, missing level estimator, least squares fitting of the experimental distributions, etc, the main problem being the estimation of the number of missed levels. Unfortunately, it happens that the same methods applied by different authors on the same set of data can give very different results. These difficulties of finding accurate average parameter values have arisen several times in the evaluation of fission product cross sections and occur also for the actinide nuclei, such as U235, U238, Np237 and Pu239, for which there are apparently good sets of experimental resonance parameters.

In collaboration with OECD/NEA-DB an international intercomparison of methods has been organised by E Fort (Cadarache) and P Ribon (Saclay). The project can be summarised as follows:

1 a set of resonance parameters is generated as follows:

energy levels from a gaussian orthogonal ensemble by diagonalizing a symmetric random matrix; neutron widths and capture widths from Porter-Thomas and χ^2 distribution;

2 this set of resonance parameters is used to calculate a total cross section in the usual experimental conditions with typical statistical fluctuations;

3 the total cross section is analysed.by the shape analysis method and another set of resonance parameters is obtained which should be different from the original one because it contains the experimental and analysis effects;

4 the new set of resonance parameters is sent to evaluators who are participating in the exercise, and analysed by them;

5 the results will be compared and discussed in a final report.

Participation by non-OECD countries is invited and some have already agreed to take part. Those wishing to participate should contact Dr J J Schmidt, NDS.

5.4 Delayed neutron data

Dr Condé summarised the conclusions of the March 1979 Consultants Meeting on Delayed Neutron Properties.

For nuclear reactor applications the highest accuracy requirements for delayed neutron data are for measurement and interpretation of reactivity effects. Requirements also arise for the detection of fuel cladding failure.

Sensitivity studies have been undertaken which give the data accuracies needed to achieve a certain uncertainty in the effective delayed neutron fraction ($\bar{\beta}$). The major source of uncertainty is in the absolute delayed neutron yields.

The different applications require data of different accuracies; the requirements for $\bar{\beta}$ have been assessed as follows for the different applications:

Design	± 5%
Power reactor operation	± 3%
Critical experiment operation and interpretation	± 3%
Dynamics	±10%
Safety	±10%

The accuracy in the total delayed neutron yields in the more significant fissionable isotopes required to achieve an accuracy of ± 3% in $\tilde{\beta}$ is estimated to be 1.5 to 2%. The Consultants Meeting on Delayed Neutron Data concluded that this accuracy appears to be obtainable in the near future following completion of some additional measurements, the resolution of discrepancies and more detailed intercomparisons and evaluations.

The status of the data has improved in recent years and there are now no large uncertainties or discrepancies. There could be some additional requirements for Safeguards applications. The data on yields from individual precursors is now sufficiently good for total delayed neutron yields to be derived to useful accuracies (for example to an accuracy of $\sim$ 4 - 5% for U235).

A second Consultants Meeting might be appropriate in a few years time.

5.5 Fission product yields

The need for a Consultants Meeting on fission product yields was discussed. It was considered that the FPND Progress Report, and the Meetings on Physics and Chemistry of Fission provide a framework for the exchange of information and it was thought that the few experts working in this field are already in correspondence.

Appendix

The required and achieved accuracies of transactinium isotope cross section data

The following tables and remarks attempt to summarise the requirements and status of transactinium isotope cross section data contained in the review papers presented at the Second IAEA Advisory Group Meeting on Transactinium Isotope Nuclear Data (May, 1979) and the discussions at the CRP Meetings.

In general, the requirements presented in references (1) and (2) depend on both irradiation and cooling times. The capture cross sections have a much greater impact on the calculated arisings than fission cross sections. However, the Pu241 fission cross section is of higher importance in calculations of Am241 and Am242 production for long irradiation periods in fast reactors (2).

Table 1 gives the requirements and status of the cross section data relating to the U-Pu fuel cycle based on references (3), (4), (5), (6), (7) and (8) and Table 2 gives the requirements for the U-Th fuel cycle based on references (3), (5) and (7). (Requirements for the principal actinides, U235, U238 and Pu239 are not included.) Table 3 reproduces the requirements and achieved accuracies given in Reference (6). These requirements are for the prediction of fast reactor fuel activity and decay heat emission. Reference (2) summarises the main requirements for thermal reactors. These are for the thermal capture cross sections of Pu241, Am241, Cm242 and Cm245 and the capture resonance integrals of Pu240, 241 and 242, Am241 and 243 and Cm244.

TABLE 1

Cross section data required for the U-Pu fuel cycle

Isotope	Reaction	Typical Required Accuracy (percent)	Achieved Accuracy (percent)
U236	(n, γ)	10	25
Np237	(n, γ)	10	25
Np237	(n,2n)	15 (Fast)	100*
Pu236	(n, γ)	50 (Thermal)	50*
Pu238	(n, γ)	10 (Thermal)	
		20 (Fast)	50
Pu238	(n,f)	7 (Fast)	20
Pu240	(n, γ)	1 (Thermal)	
		5 (Fast)	
Pu240	(n,f)	2 (Fast)	
Pu241	(n, γ)	3 (Thermal)	
		8 (Fast)	20
Pu241	(n,f)	2 - 5	5
Pu242	(n, γ)	5 - 15	10
Pu242	(n,f)	4	5 - 10
Pu243	(n, γ)	10 - 50	50
Pu243	(n,f)	10 - 50	50
Am241	(n, γ)	5 - 10	15
Am241	(n, γ)m		20
Am241	(n,f)	10 - 20	10 - 15
Am242	(n, γ)	5 - 30	30
Am242	(n,f)	10 - 30	30
Am242m	(n, γ)	20	30
Am243	(n, γ)	10 (Thermal)	
		20 - 30 (Fast)	25
Am243	(n,f)	10 (Thermal)	10
		10 (Fast)	10
Cm242	(n, γ)	20 (Thermal)	50
		50 (Fast)	50

Isotope	Reaction	Typical Required Accuracy (percent)	Achieved Accuracy (percent)
Cm242	(n,f)	10 - 25	30 - 50
Cm243	(n, γ)	5 - 20	
Cm243	(n,f)	10 - 30	30
Cm244	(n, γ)	10 - 30	50
Cm244	(n,f)	5 - 30	20
Cm245	(n, γ)	10 - 20	
Cm245	(n,f)	5 - 20	
Cm246	(n, γ)	10 - 20	
Cm246	(n,f)	10 - 20	
Cm247	(n, γ)	10 - 20	
Cm247	(n,f)	5 - 20	
Cm248	(n, γ)	10 - 20	
Cm248	(n,f)	20	

TABLE 2

Cross-section data required for the Th-U cycle

Isotope	Reaction	Energy Range	Requested Accuracy (See Note 1) (Percent)	Achieved Accuracy (Percent)
Th232	(n,tot)	60eV-100KeV	2	
Th232	(n, γ)	1 eV-20eV	2	
Th232	(n, γ)	20eV-1MeV	3 - 5	5 - 10
		1MeV-4MeV	10	5 - 10
Th232	(n,2n)	Thresh-10MeV	10	
Th232	(n,f)	Thresh-20MeV	3 - 5	4 - 10
Pa233	(n, γ)	20eV-15MeV	10	
U232	(n, γ)	Thermal	50	
U233 (see Note 2)	(n, γ)	1mV-.5eV	1	
U233	(n, γ)	.5eV-2eV	2	
		.1KeV-1.5MeV	5 - 10	
U233	(n,f)	1mV-100eV	1	3 - 5
		100eV-10MeV	3	
U234	(n, γ)	Thermal	5	

Note 1

The requested precisions for Th232 and U233 are close to those of the isotopes playing similar roles in the U-Pu cycle, ie U_{233} corresponds to U235.

Note 2

In addition, for U233:

α is required with 2 - 8% precision (1eV-1KeV)
η is required with 0.4% precision (1mV-1eV)
ν (prompt) required with 0.25% precision (1eV-30eV)
1% precision (30eV-1KeV)
2% precision (1KeV-30KeV)

Table 3

Higher Actinide Nuclear Data Requirements
for Fast Reactors

Nuclear Data Requirements of Highest Priority

Quantity	Present Accuracy (%)	New Required Accuracy (%)	Purpose
Np-237 σ_{n2n}	100	25	Production of Pu-236
Am-241 $\sigma^{g}_{n\gamma}$	20	8 10	Total heat generation Total neutron production
Am-243 $\sigma_{n\gamma}$	25	10	Total neutron production
Cm-242 spontaneous fission branching ratio	10	5	Total neutron production
(α,n) yield	30	10*	Total neutron production

References

1 H Küsters - NEACRP-A-345 (1978)

2 A Gandini et al - 1977 ISPRA meeting

3 H Kouts - Second Advisory Group Meeting on Transactinium Isotope Nuclear Data, Cadarache (1979)

4 L N Usachev et al - NEACRP-A-335 (1978)

5 J Bouchard - Second Advisory Group Meeting on Transactinium Isotope Nuclear Data, Cadarache (1979)

6 B H Patrick and M G Sowerby - INDC-UK-37/G (1980)

7 Report of the Working Group on Neutron Reaction TND.
Second Advisory Group Meeting on Transactinium Isotope Nuclear Data, Cadarache, (1979).

8 Specialists Meeting on Nuclear Data of Pu and Am isotopes for reactor applications. Brookhaven (1978).

Report of Subcommittee B

1. Fusion

The field was reviewed by an Advisory Group meeting on "Nuclear Data for Fusion Reactor Technology" convened by IAEA/NDS in December 1978 (INDC(NDS)-101/LF and IAEA-TECDOC-223). While the most important reaction types and their most important respective energy regions could be identified, there is still a wide range of materials under discussion, due to different conceptional designs and still open options within a specific design. In this respect the subcommittee suggests that future data taking is more guided by the INTOR project and asks to be informed about the outcome of relevant INTOR workshops. Concerning nuclear data, two fields have obtained special attention since the above-mentioned Advisory Group Meeting: tritium breeding from ^{7}Li, and FMIT.

Integral experiments conducted at Karlsruhe and Los Alamos indicated that the presently used ^{7}Li(n,n't)^{4}He could be too high. Recent differential data taken in the 5-14 MeV range by the activation method (tritium assay by liquid scintillation) in Harwell have yielded values 26 % lower than ENDF/B-IV. This has prompted three further activities

- at Argonne activation data (gas- and liquid scintillation counting) at 6.9, 7.9 and 8.9 MeV were determined. Assuming the cross section is flat, the average value is (362 $\pm$ 19)mb, thus $\sim$ 16 % lower than ENDF/B-IV.
- at Geel the direct detection method was applied at 6, 7, 8, 9 and 10 MeV. With the exception of the 8 MeV point, preliminary results are $\sim$ 20 % lower than ENDF/B-IV.
- activation data (gas extraction and counting with anticoincidence shield) are taken in cooperation between Geel and Jülich. At present there is only a preliminary value at 5.2 MeV.

Both laboratories, Harwell and Argonne, have checked the reliability of their activation results by redetermining the well-known ^{6}Li(n,t)^{4}He thermal cross section. In this connection Dr. A.T.G. Ferguson reported on difficulties which were due to inhomogeneities of sample material (the ^{6}Li/^{7}Li ratio was not constant).

It should be pointed out that at present data evaluation for the tritium production cross section is also based on results derived from neutron scattering experiments which are of limited accuracy. If this is constructed from the total cross section and the elastic scattering cross section (incl. 478 keV level) one deals with a difference of two nearly equal numbers. If the inelastic scattering cross section (excl. 478 keV level) is determined, then extrapolation in angle and energy are important corrections. However, the secondary neutron energy spectrum by itself is important for the calculation of breeding factors. Recently data have been taken at Los Alamos by Lisowski et al. for primary neutrons of 6 and 10 MeV. Data taking at 7 and 8 MeV is going on at University Dresden by D. Seeliger and coworkers. Note should be taken that presently available formats of evaluation files (ENDF/B, UKNDL) cannot handle the resulting double differential data.

Nuclear data requirements for the design and use of intense neutron sources based on Li(d,n) or Be(d,n) for example the American Fusion Materials Irradiation Test facility (FMIT) and the present status of these data were reviewed very recently (May 1980) at the Symposium on "Neutron Cross Sections from 10-50 MeV" in Brookhaven. Although the meeting showed significant progress in both experiment and theory, it was clear that the full requirement for design has not been met and it was probable that those for interpretation of its experiments might be substantially late. In his introductory remarks Dr. A.B. Smith stated:

"Three years hence data for the use of this facility must be available. With current plans, data impacting on the choice of ETF design must be in hand within the coming four years. These are short time scales that largely preclude major and comprehensive goal-oriented data efforts. Reliance is, and will continue to be, largely placed upon underlying and long term competence. That faith may be misplaced as that general capability, particularly in experimental areas, is being seriously eroded. With present trends, it is doubtful that future needs, yet unspecified, can be met."

2. Nuclear Data Needs for Analysis

The use of nuclear techniques for analysis can be divided into two main classes: bulk analysis for which neutron interactions are almost exclusively used and surface analysis for which charged particle beams are employed.

In the field of surface analysis, it was accepted that there was no indication of any departure from the predominant use of standards in the quantitative interpretation of analytical results. There was a considerable need however for cross-sections in the preliminary phase of feasibility study. One contribution to this is the compilation of charged particle differential cross-sections by R.A. Jarjis which covers the energy range below about 30 MeV and elements from Hydrogen to Copper. This has received a preliminary distribution to the INDC and about 100 people known to be working in this field. A rather closely related topic is charged particle activation for surface analysis. In this field there was a growing interest in the use of heavy ion reactions at comparatively low energies to study the composition of the first 1-2 μm of the surface as well as providing activity to permit wear and corrosion studies and new measurements are needed.

The use of neutrons for bulk analysis of materials was seen to be a growing activity. In the geological field there have been important reviews by Sanders at the Harwell Conf. and by Senftle at the Knoxville meeting. At the latter Michealis has also looked at the special case of underwater mineral exploration which is of increasing importance. There was also a valuable review of oil well logging, the field in which nuclear techniques were first extensively applied.

It was clear that as these field became increasingly sophisticated their awareness of the need for nuclear data was increasing. One of the most urgent requirements was for better measurements of spectra of portable (α,n) sources where variations of over 10 % were reported. Improved quality control is clearly required.

The main neutron data requirement is for γ-ray production cross-sections. There is a consensus view that data on the principal rock matrix materials is adequate as most are reactor shielding materials but for more extended mineral exploitation Michealis suggests that cross-sections accurate to about 5 % will be needed for a wide range of metals in addition to those of nuclear energy interest.

3. Bio-Medical Applications

a) Radio-Therapy with Neutrons

Recent developments in neutron radio therapy and the resulting needs for nuclear data were reviewed by Cross at the Harwell Conference, by Broerse at the Knoxville Conference and by Tsukada at the Debrecen meeting on Neutron Source Properties. The data requirements remain much as they were at the last INDC meeting, the most important being data for

- KERMA calculations in tissue (primarily cross sections for $^{12}C(n,n'3\alpha)$, $^{16}O(n,\alpha)$, $^{16}O(n,p)$ and possibly $^{16}O(n,n'4\alpha)$)
- neutron transport calculations in tissue and in shielding
- dosimetry and spectral measurements with activation detectors.

The energy range extends up to about 50 MeV. Many of the data for dosimetry and neutron transport are also required for material damage research - since the last INDC meeting, there has been some progress (at Davis, California) in measuring neutron cross sections for reactions emitting charged particles from oxygen and carbon. Calculations of cross sections of tissue elements, at energies up to 50 MeV, are continuing at Harwell.

There are some recent Los Alamos data on $^{197}Au(n,xn)$ cross sections relevant to neutron spectrum and dosimetry measurements at energies up to 30 MeV.

A meeting on KERMA-factors and Interaction Cross Sections for Neutron dosimetry will be held at the Physikalisch-Technische Bundesanstalt (PTB) in Braunschweig, FRG on October 2/3, 1980.

b) In vivo Activation Analysis

There were papers at the Knoxville conference (by Cohn) and Debrecen Neutron Source Meeting (by Mill and Harvey) on the use of filtered neutron beams for analysis of Ca, Cd and other elements in the body, but no needs for new data were identified.

4. Nuclear Incineration

This topic was touched upon by Küsters in his paper at the Harwell Conference where he pointed out the difficult chemical problems associated with separation of Am and Cm isotopes from the Lanthanides and the likely additional radiation hazards that might arise. The matter was very fully discussed at the Second Technical Meeting on the Nuclear Transmutation of Actinides at Ispra, April 1980 when economics and a very detailed hazard analysis were considered as well as the chemical and nuclear problems. This meeting concluded that: Chemical separation of the higher actinides was feasible based on currently identified technology that has been experimentally tested some up to full scale operation. Other long lived isotopes such as Technetium and Iodine which are major fission product contributers to the overall hazard can also be partitioned. The transmutation of actinides appeared feasible in either thermal or fast reactors. Though transmutation of Technetium appeared feasible, that of iodine did not. Thus nuclear incineration was concluded to be technically feasible.

BUT on the other hand the cost of actinide partitioning seemed relatively high and there were substantial short term health hazards in the process, whereas the long term benefits seemed very small. The short term risks were estimated to exceed the long term benefits integrated over a million years. There was no indication that the use of more advanced devices for transmutation would alter these conclusions since they derive largely from a more thorough estimate of risks arising from the deposited material. The sub-committee proposed that in the light of these conclusions this topic would not be considered further.

5. Nuclear Data Needs for the Thorium Cycle

The sub-committee accepted the view of the SAC that widespread development of the Thorium/U^{233} cycle was unlikely in the forseeable future. It therefore proposed that it would not consider data requirements for this cycle at the present time.

6. Recommendations regarding pertinent future meetings

a) Nuclear data for fusion: a sequel to the Meeting on Nuclear Data for Fusion, convened by the IAEA in 1978, is recommended to be held in 1983/84. That meeting could review the 10-50 MeV data which would have been generated in anticipation of the operation of FMIT and other material testing facilities.

b) Biomedical Nuclear Data: it is suggested that IAEA hold a small exploratory meeting of experts in 1981 to investigate the status of nuclear data for the production of radio-isotopes, and to decide on the need to convene a larger meeting on this topic in 1982. The topic of this meeting should be limited to charged particle production of radio-isotopes for use in medicine; both standard (commercial) isotope production as well as small quantity production of short-lived isotopes in hospitals should be taken into account.

c) Low energy photon data: the subcommittee recommended to defer any decision on this topic until the next INDC meeting.

7. Updating Responsibilities for the next INDC meeting were assigned as follows:

fusion data needs	(Liskien, CBNM Geel)
data needs for analysis	(Ferguson, AERE Harwell)
data needs in bio-medicine	(Cross, AECL Chalk River)

INDC members are asked to forward relevant material to the appropriate person.

Cross
Csikai
Ferguson
Harada
Liskien (chairman)
Mehta
Seeliger
Yankov

Lammer)
Lorenz) (ex officio)
Okamoto)

INDC STANDARDS SUBCOMMITTEE

Report to the INDC, 11th Meeting, 16-20 June, 1980.

I. Subcommittee Topical Agenda

A. Define membership and adopted agenda

B. Review technical content and establish responsibilities

C. Consideration of additions to technical content

D. Special technical problem areas

E. Numerical tabulations and presentations

F. Distribution and coordination policies

G. Correlation with other IAEA/NDS Activities

H. Meetings

I. Discussion of ENDF-300

J. Recommendations

K. Chairperson

II. Subcommittee membership and attendance

A. Lorenz (NDS)*
H. Lemmel (NDS)*
G. Yankov (SUSSR)
S. Rapeanu (ROM)*
H. Conde' (SWE)
A. Ferguson (UK)
H. Liskien (EEC)
D. Seeliger (DDR)
J. Csikai (HUN)*
S. Kapoor (IND)
Y. Gur (IA)*
J. Schmidt (NDS)*
H. Vonach (AUS)*
A. Smith (US) - Chairman

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* = observer-attendees for this meeting.

III. Narrative report of the Subcommittee

This section of the report is a narrative version of the topical statement presented to the full Committee on June 20. In addition, remarks relevant to discussions before the full Committee are included. The contents have been approved by the Subcommittee participants and this report is hereby submitted as a formal record of the Subcommittee proceedings.

A. Membership and agenda

The Subcommittee membership and participation was established in the introductory session of the full Committee with the result given in Title-II, above.

A draft agenda was distributed to all INDC members prior to the meeting. This draft, with some modification, was adopted for subsequent Subcommittee discussions. It is topically outlined in Title-II, above.

B. Review of previous technical content and definition of continuing responsibilities

The scope of the activity and the available time precluded in-depth technical reviews during the meeting. Moreover, any single meeting will not encompass the requisite wide spectrum of specialists in these highly technical areas. Therefore, the Subcommittee; 1) reviewed the continued suitability of previously established technical titles, 2) assigned responsibility for their continued review, and 3) commented on relevant contemporary work. These matters are outlined by technical title below.

1. H(n;n)

This is the primary standard and will remain in the file. The responsibility for updating is with the UK (Ferguson-Uttley). Subcommittee comments were as follows:

a. The Drosg results have been revised removing the previously noted discrepancy (see ENDF-300).

b. New polarized-proton measurements being set up at the Indiana University cyclotron may contribute to the understanding of the underlying reaction mechanism.

c. The numerical content of the file should be taken directly from Hopkins and Breit (Nucl. Data. A9 137 1971) rather than converted from the point values given in ENDF-V.

d. The numerical file should be extended to at least 40 MeV so as to be useful for work associated with higher-energy damage-study facilities (e.g. FMIT).

e. New high-energy total-cross-section measurements extending to ~200 MeV were reported at the BNL Sym. on Neutron Cross Sections from 10-50 MeV (Lisowski et al.).

2. ^{6}Li(n;alpha)

This basic standard will remain in the file. The responsibility for updating is with the US (Smith). It is proposed to replace the present review with that of ENDF-300 (G. Hale). Subcommittee comments were as follows:

a. Recent NBS results for the reaction ratio ^{10}B/^{7}Li are not consistent with ENDF-V at low energies.

b. An ANL measurement and R-matrix interpretation are in good agreement with ENDF-V. (ANL/NDM-52).

c. Gayther (UK) has new measured values up to 0.8 MeV (AERE-R-8556).

d. Triton angular distributions have been measured at CBNM from 10-300 keV (Knitter+Budtz-Jorgensen). These results do not clearly differentiate between a resonance-reaction mechanism and the deuteron exchange process (Weigmann+Manakos, Z. Phys. A289 383 1979).

e. Inverse reaction studies corresponding to neutron energies between 0.2 and 3.5 MeV are underway at Uppsala University (Conde'+).

f. An analytical expression of the ^{6}Li and of the ^{10}B (n;alapha) reactions has been derived at Obninsk. The perscription agrees with ENDF-V values to 0.5% up to 0.9 MeV and could be useful in calculational usage.

g. Inconsistencies in the ^{6}Li, ^{10}B and ^{235}U ENDF-V evaluations and associated correlated errors were noted.

3. ^{10}B(n;alpha$_0$) and (n;alpha$_1$)

These two reactions remain very useful standards and will be retained. The review responsibility is with CBNM (Liskien/Wattecamps). Comments by the Subcommittee were:

a. Recent low energy discrepancies in ratio values are reported from the NBS (see DOE-NDC (US) status report, in press).

b. New NBS measurements using both gas and solid boron detectors are consistent; in particular, not supporting the molecular effects previously reported (see DOE-NDC (US) status report).

4. C(n;n) scattering

This remains a useful scattering standard and will be retained. The review responsibility is with the US (Smith). The revisions to the past statement are expected to be minor. It was noted that:

a. ^{13}C results at Ohio Univ. and ANL clarify the perturbations from this minor isotope (DOE-NDC status report).

b. A new ANL total cross section result verifies ENDF-V below 1.0 MeV to within 0.5% (DOE-NDC status report).

c. There was some comment as to the desirability of extending the reference energy range above the present 2.0 MeV limit but no conclusions were reached.

5. ^{197}Au(n,gamma)

This reference standard will be retained in the file. The review responsibility is with the US (Smith). It is planned to use the corresponding contents of ENDF-300. Comments made by the Subcommittee were:

a. Measurements are underway in the range 1-10 MeV at Lund Univ. (Bergqvist et al.).

b. New USSR results relative to H(n;n) over the energy range 0.35-1.5 MeV were reported. The manuscript is in Russian and is being translated by the NDS.

The full Committee discussion noted that the half-life of the residual ^{198}Au activity as given in the document submitted in the discussion of Title III-B-11, below, was probably not the best and should be updated.

6. ^{235}u(n;f)

This is the basic fission-cross-section standard and will be retained in the file. The review responsibility is with the USSR (Yankov). The review will be prepared directly following the 5th Kiev conference in order to include the latest results. The associated matter of fissile-foil comparison is discussed below.

7. ^{252}Cf nu-bar

This parameter remains in the file as the basic nu-bar standard. Review responsibility is transferred from NDS to the US. The Subcommittee chairman was instructed to approach J. Smith (INEL) to serve as reviewer. Comments before the Subcommittee were:

a. ORNL tank results give 3.783 ± 0.010 (ORNL/TM-6805).

b. J. R. Smith (INEL) is remeasuring using a bath. That work will also address perturbations due to sulfer-cross-section uncertainties. The results are "tending" toward a value near 3.77 (DOE-NDC status report, in press).

c. Jurney (LASL) has a new thermal cross section for sulfer.

d. Axton (UK-NPL) may be reviewing the status of his past work but that could not be verified.

e. It was stated that Boldeman (AUS) is obtaining new nu-bar values. Lemmel (NDS) is attempting to obtain details.

8. ^{252}Cf prompt fission neutron spectrum

This spectrum is recognized as the basic fission-spectrum standard and it finds wide application in calibration procedures. Therefore it will be retained in the file. The responsibility for review is jointly shared by the NDS (Lemmel) and USSR (Yankov). The work carried out in the USSR (Blinov-Leningrad) under a NDS research contract is directly relative to this problem. Indeed, an invited paper at recent Debrecen meeting by Blinov summarized the contemporary status and made recommendations for future work. In that review it was stated that the contemporary knowledge indicates a Maxwellian shape with a temperature of 1.42 MeV. Other comments were:

a. Boldeman (Lucas Hieghts) reports that the most reliable of his six measurements gives a Maxwellian temperature of T = 1.426 MeV (the average of his results gives T = 1.424 ± 0.013 MeV). Analysis of the low-energy portion of the spectrum continues (Trans. Am. Nucl. Soc., 32, 733).

b. Relative measurements of fission spectra have been reported including ^{252}Cf (Smith et al., ANL/NDM-49). These correlate spectra from the fission of prominent actinides with that of ^{252}Cf.

9. Actinide Half-lives

These values remain of key importance and are retained in the file. The responsibility for updating is with the NDS (Lorenz). The update shall be consistent with the results of the TND-CRP work in so far as possible and shall include ^{234}U. Generally, the isotopes of the previous issue of the file shall be addressed. Comments defined a new value for ^{234}U from the USSR of 2.459 ± 0.007 (10^5) y. That new result is consistent with the 1978 IAEA value given in the previous issue of the file.

10. Thermal Constants

This title was considered important and will be retained in the same scope as in the previous file. However, the review responsibility will be changed from NDS which no longer desires the responsibility. The Subcommittee chairman will approach the National Nuclear Data Center (US) with the objective of obtaining agreement to take the responsibility for review concurrent with the periodic preparation of BNL-325, Vol.-1. If that objective can be achieved the reviewer will be S. Mughabghab. Discussion (Lemmel) suggested that the outstanding problem in this area is the uranium cross section values obtained in thermal column measurements, primarily at AECL. These were said to have a wide impact on the uncertainties of the uranium thermal constants.

11. Gamma-ray Standards

These shall be retained in the file. The responsibility for updating is with the NDS, assisted by CEA (Lorenz + Michaudon). Where applicable, the energy scales will be consistent with the IUPAP Commission on Atomic Masses and Fundamental Constants (see R. Helmer, P. Van Assche and C. Van der Leun, to be pub. in Atomic Data and Nucl. Data Tables). Half-lives and absolute intensities should be consistent with ENSDF where possible. It was noted in Committee comments that some of the values cited in the above were probably not the best (e.g. half-life of ^{198}Au). Care should be taken to assure the best quality and toward that end the CEA will review the compilation before it is included in the file.

12. X-ray Standards

The previous version of the file contained this topic by title only. The Subcommittee chairman noted that there had been no interest expressed in the topic during the past 18 months. Therefore, it was concluded that this title should be removed from the file.

13. Neutron flux measurements

This item was discussed in some detail. It was decided to change its context from the broad-scope comments of the previous distribution to specific remarks relevant to the flux intercomparisons under BPIM auspices. A summary describing BPIM-program accomplishment to this time was presented (Michaudon). Also underway are programs in the areas of fission-transfer instruments and neutron-indium interactions (particularly the In(n;n') reaction). The fission transfer instrument is nearing final completion in the UK and a summary statement was provided (Ferguson). The In(n;n') intercomparison is under way and described by a CBNM paper (Liskien). All three of these reports will be edited and incorporated in the next edition of the file under a single topic.

14. Energy Standards

These shall be retained in the file. The update responsibility is with the UK (Ferguson-James). The Subcommittee comments were as follows:

a. Selected standard resonances are given in ENDF-300 with error matrices. They are only relevant to particular experimental sets.

b. It was pointed out that there may be a need for a well defined list of calibration reactions for use at mono-energetic accelerators (p-n, p-gamma, etc.) but no recommendation was made.

15. ^{27}Al(n;alpha)

This remains an important reference cross section and is retained in the file. The review responsibility is with H. Vonach. The previous review pointed out that the ENDF-V evaluation stems from a very old data base and can be much improved with new information. After some discussion, it was concluded that the recent evaluation of Vonach et al. is much superior to ENDF-V in this particular area and should be used for the numerical tabulation. In so doing the numerical content of the file becomes international in origin.

16. ^{237}Np(fission-product-yields)

At this and the previous meeting there were discussions of the validity of this reaction as a standard. It was concluded that the title should be dropped from the file in the present form of fission-product-yields. However, the $^{237}Np(n;f)$ cross section does have some advantages as a standard. It has a lower threshold than ^{238}U and is much freer of structure in the few MeV range. Therefore $^{237}Np(n;f)$ should be highlighted as potentially a very good standard. Good relative shapes have been reported over very wide energy ranges (e.g. Carlson and Patrick, NBS) and if these can be normalized with a few very careful absolute values this fission cross section can be very useful. In Committee discussions it was pointed out (Derrien) that French work is underway with the objective of providing precise absolute ^{237}Np fission cross sections in the few MeV range.

In view of the above remarks the $^{237}Np(n;f)$ cross section should be carefully reviewed in the near future when the results of work now in progress are available.

C. Consideration of Additional Technical Content for the File

1. Numerical tabulation of ^{252}Cf prompt-fission-neutron spectra

It was pointed out that this spectrum is the basic fission neutron spectrum and is widely used for calibration purposes. Thus the file could well contain appropriate numerical values for practical use. There was no clear reference as ENDF-V apparently does not contain the ^{252}Cf fission-neutron spectrum. Alternatives may be available from Boldeman, Blinov or Grundl and Eisenhauer. It was recommended that H. Lemmel and A. Smith select a well documented numerical file for inclusion in the numerical tabulations. (Chairman's Note: Since the meeting Boldeman has provided numerical data extending from 0.8 - 14.0 MeV. The results are consistent with a Maxwellian form and will be used in the first attempt to construct a reference file.)

2. $^{238}U(n;f)$

The wide use of the $^{238}U(n;f)$ cross section as a practical reference standard was discussed. It was concluded that the common usage is such as to warrant inclusion of this cross section in the technical content of the file. The responsibility for review is with the US (Smith). The corresponding numerical values will be taken from the ENDF-V dosimetry file. It was pointed out that there will very likely be a small (1-2%) correction in the ENDF-V numerical values in the immediate vicinity of 2.5 MeV.

3. Safeguards Standards

There was some discussion of safeguards standards. It was concluded that the situation at present was either nebulous or covered by Title III-B-9, above. Thus no specific safeguards-oriented items should be introduced at this time. The situation will be reviewed at the next meeting.

4. Monoenergetic, accelerator-based, neutron sources

It was pointed out that this type of source is, at times, used as a standard for flux determinations and, frequently, for various instrument calibrations. Various aspects of both uses were discussed in some detail at the Debrecen meeting and it was recommended that the properties of these basic sources be compiled at the data centers. There have been some comprehensive evaluations of these source reactions (e.g. Liskien and Paulsen, Atomic Data and Nucle. Data Tables, 15 57 1975) but they are generally five or more years old and there has been considerable improvement in the knowledge of these reactions since that time. It was felt that guidelines should be set forth including some references to good evaluations and statements as to the availability of the data at the centers. Perhaps comprehensive tabulations could be provided at a later date if such become available in the literature. The responsibility for incorporating some guidelines in the file is with the US (Smith) and NDS (Lemmel).

D. Special Problems

1. Standard ^{235}U fission foils

An extensive fission-foil comparison was carried out within the US (ANL/NDM-48). Subsequently, the NBS remeasured its basic standard foil. The result, combined with those previously reported (ANL/NDM-48), led to the conclusions that the US ^{235}U standard-foil system is known to an accuracy of about 0.6% (the justification is outlined in the US-DOE-NDC status report, in press). Some comparisons between the NBS and CBNM foil masses were consistent with the above accuracy estimate but the comparisons were to lesser precisions. It was concluded (NBS) that the US system was sufficiently known to meet the goal of 1% accuracies in the ^{235}U fission cross section. Therefore, the NBS proposes to give its attention to implementing the wide use of the standard through the provision of secondary "user" reference foils accurately tracable to the primary foil.

The situation beyond the US is more uncertain and, in particular, it is not clear that the US results are consistent with the precise standards used in the USSR as reported at the Knoxville conference. At that conference it was proposed to exchange US and USSR reference foils in a precise-comparison program. The NDS has been approached with the objective of implementing such a comparison. The details of progress toward that end were not clear. However, the Subcommittee strongly encouraged NDS steps toward implementing the comparisons of US, USSR, etc. mass scales. Indeed, it was felt that definitive comparisons of the reference foil systems in the USSR, US, etc. were essential before holding the proposed specialists meeting on precision ^{235}U fission cross sections (see meeting discussion below).

E. Numerical tabulations and presentations

H. Liskien distributed a working document to the Subcommittee consisting of:

a. A revised numerical presentation of the ENDF-V standard file. The readability was much improved over that in INDC-30/L and the interpolation rules were clearly specified. In addition, the uncertainties were expressed in a "people readable" formats including the covariance matrices. The latter had been reviewed by F. Perey.

b. A clear summary statement of regions of applicability including a simple graphical representation.

c. Some guidelines as to particular measurement applications.

The Subcommittee concluded that this new numerical formulation was a very much of an improvement and should be used in place of the tables in INDC-30/L. There was some discussion as to whether these improved tables should receive a separate distribution or be a part of the re-issue of the entire file. The latter course was chosen as it would encourage the user to look beyond the simple numerical listings thus leading to a better understanding and, possibly, to encouraging work on the standards themselves. However, for those who only want a numerical value, the numerical tabulations in the next issue of the complete file will be placed at the front of the document where they are readily available.

F. Distribution and coordination policies

1. INDC/NEANDC coordination

This is a joint effort of the two Committees and ways of improving coordination were discussed. Up to the present time the major contribution has been made by the INDC. It was felt that the next distribution of the file (schedules below) should be under INDC auspices. Thereafter the lead responsibility should be taken by the two Committees in alternate cycles or some other mechanism found for sharing the burden between the two Committees. This matter of coordination should be brought to the attention of the incoming NEANDC chairman by his INDC counterpart.

2. Distribution of the file documentation

The distribution of the previous document (INDC-30/L) appeared to be very comprehensive. However, every effort should be made to get the file in as wide a use as possible and toward that end the Subcommittee chairman will write a letter to all centers encouraging them to distribute the document to all relevant parties in their areas of responsibilities.

3. Distribution schedules

All reviewers are asked to provide their updated or new contributions to the Subcommittee chairman by 15 September. An exception is ^{235}U(n;f) which will be deferred a few weeks in order to take advantage of new information becoming available at the 5th Kiev conference. The Subcommittee chairman will then attempt to assembly camera-ready copy for the NDS by November 1980. It was pointed out that the NDS had done an excellent job of reproducing and distributing the previous version of the file.

G. Correlation with other IAEA/NDS Activities

It was noted that the file makes explicit use of the results of the CRP in the TND area and that NDS research contracts make major contributions to several technical topics (e.g. ^{252}Cf fission-neutron spectrum). Furthermore, some of the technical titles are particularly relevant to the proposed 14 MeV inter-regional program (e.g. ^{238}U(n;f) and ^{27}Al(n;alpha) cross sections are key standards near 14 MeV.

H. Meetings

The Subcommittee again endorsed a small specialists meeting dealing with fast-neutron precise-fission-cross-sections of ^{235}U. However, it was felt that an essential factor was the resolution of uncertainties in fissile-foil mass standards and that the meeting should not be held until those issues are resolved. It was hoped that the foil exchange and comparison of III-D-1 (above) would be completed in a timely manner making possible this meeting in 1982. If there is extensive delay in the foil intercomparisons this specialists meeting should be combined with the larger advisory group meeting, below.

The Subcommittee has long recommended an advisory group meeting on standard reference data at approximately 7-year intervals. That recommendation stands and implies such a meeting in 1984.

I. ENDF-300

The document ENDF-300, "Standard Reference and Other Important Data" (by CSEWG-US) was presented to the Subcommittee. In the Subcommittee context, it is essentially the evaluator's documentation of the ENDF-V standard file. It differs from the INDC/NEANDC standard file in that it does not include user-oriented numerical information (i.e. tabular cross sections with uncertainties) and in that it is a statement of the respective evaluators and not a critical review. There are also some differences in scope. However, ENDF-300 is a very useful document and relevant to Subcommittee responsibilities. The Subcommittee's documented file should avoid undue redundancy with ENDF-300 and maintain a different character and objective.

J. Recommendations, responsibilities and actions

These are highlighted throughout the above as underlined statements.

K. Chairperson

The Subcommittee chairman, A. Smith, requested that he be replaced at the coming (12th) INDC meeting. Fresh leadership should always be sought. The Subcommittee concurred. The INDC should reflect upon the appointment of the next Subcommittee chairperson.

A. B. Smith, Subcommittee Chairman
Argonne National Laboratory
June 26, 1980
Revised 1/24/81

Report of the Discrepancy Subcommittee to the 11th INDC Meeting

F. H. Fröhner, M. K. Mehta, H. Derrien, J. L. Rowlands,
K. Harada, M. Caner, B. D. Kuzminov, O. Schwerer,
K. Okamoto, W. G. Cross, E. Menapace, H. T. Motz, J.J. Schmidt

The subcommittee had to consider two compilations of contributions to the Discrepancy File

- the "INDC Discrepancy File 1979" compiled by F. H. Fröhner, INDC-32/L
- the more recent "Review of Important Nuclear Data Discrepancies" compiled by M. G. Sowerby, NEANDC 124 A, INDC(UK)-33/G, May 1980.

The latter document was written under NEANDC auspices and submitted to the INDC for review at the present meeting under the new agreement reached at the last NEANDC meeting in September 1979 according to which the NEANDC and INDC Discrepancy Subcommittees would co-operate and maintain a common Discrepancy File. An updated file was now to be prepared by the INDC Discrepancy Subcommittee. It is to be made available for scrutiny to the NEANDC at its next meeting.

The two working documents contained, for a part of the discrepancy list, the same entries. In general the discussion by the INDC subcommittee followed the sequence of entries in Sowerby's compilation since it is more recent and somewhat more complete. For each item the changes and amendments formulated by the INDC subcommittee are summarised briefly in what follows.

1. The ^{7}Li(n,n'αt) cross section

This item was delegated to subcommittee B as relevant to fusion research.

2. Capture Cross Sections for Cr, Fe, Ni

The two working documents contained two different entries. F. H. Fröhner, in the 1979 compilation, emphasized the new possibility to measure s-wave capture free of the effect of quasi-prompt capture of resonance-scattered neutrons in the vicinity of the sample. This effect is now recognized as the main cause for the very discrepant (factor of 2) results obtained in conventional time-of-flight measurements. Wisshak and Käppeler demonstrated for the notorious 27.7 keV resonance of ^{56}Fe how the effect can be eliminated by using, along with quasimonoenergetic incident neutrons from a pulsed electrostatic accelerator, a short primary flight path and a long secondary flight path which causes complete time separation between the (Moxon-Rae) detector signals due to capture photons and those due to scattered neutrons. The systematic errors could thus be reduced to about 6%. The second recent major improvement is the use of the high-resolution scattering measurements to determine the level spins for p- and d-wave resonances which are needed for the calculation of good self-shielding factors. This approach was used by F. Perey (ORNL) and by Schouky and Cierjacks (KFK) for ^{56}Fe. The recommendations are to apply both new techniques to other important structural materials, in particular ^{58}Ni and ^{60}Ni.

The review by G. Rohr and F. Corvi is written more from the viewpoint of linac users. These authors recommend normalization not with the black-sample technique based on resonances of Ag or Au at few eV but e.g. with the 1.15 keV resonance of ^{56}Fe+n or the 1.63 keV resonance of ^{52}Cr+n, for which more accurate resonance parameters are requested. Other recommendations are more conventional: low neutron sensitivity, well known capture detector efficiency up to 10 MeV photon energy, total and capture cross sections to be measured in parallel for reliable reduction of capture yields to capture yields to capture cross sections, attention to possible non-isotropy of scattering in multiple-scattering calculations, and also of capture-photon angular distributions.

With these improvements it appears possible to establish the capture cross sections of the main structural materials with about 10% accuracy within the next few years up to 300 keV.

3. The $^{63}Cu(n,\alpha)^{60}Co$ Reaction

For this dosimetry cross section measured averages over a ^{235}U fission neutron spectrum were ≈ 40% higher than the same average calculated from microscopic cross sections and the known ^{235}U fission neutron spectrum. New microscopic data measured by Winkler et al. at ANL, averaged in the same way, give $\langle\sigma\rangle = 0.507 \pm 0.049$ mb in good agreement with the value $\langle\sigma\rangle = 0.534 \pm 0.015$ mb obtained from the integral data. It seems therefore justified to strike this item from the Discrepancy File.

4. The $^{93}Nb(n,n')^{93m}Nb$ Reaction

The two entries considered, one by J. J. Schmidt and a more recent one by H. Vonach, complement each other. J. J. Schmidt recommends one or two additional measurements of the half-life since it is affected by almost 10% uncertainty. Vonach gives a status report, concluding that statistical-model calculations seem to be at least as accurate as data available in early 1980. During the discussions he added the following information.

(1) The evaluations by Strohmaier, Tagesen and Vonach mentioned in his review, is based on model calculations. It will be published in Physics Data soon.

(2) A rather accurate measurement of the $^{93}Nb(n,n')^{93}Nb$ activation cross section has recently been performed at 14.3 MeV Ryves et al. at NPL. The preliminary result, σ = 35mb, is in excellent agreement with the evaluation of Strohmaier et al.

(3) Inclusion of the final value will allow to reduce the uncertainties of the evaluated cross section, which now range from 20-50%, to about 10-20%.

(4) An activation measurement reported by W. Taylor in the most recent UK progress report, UKNDC(80) p.96, gave $\sigma = 0.155 \pm 0.045$b lower than the prediction of Strohmaier et al. but still within uncertainty limits.

(5) The discrepancies in the range 0.8-3 MeV remain unresolved. New measurements are urgently needed there.

5. Fast Neutron Capture in ^{232}Th

Two reviews, from M. K. Mehta and H. M. Jain and from W. P. Poenitz and A. B. Smith, were discussed. An updated summary by M. K. Mehta follows:

Major discrepancies have existed between the measurements of Macklin and Halperin (Nucl. Sci. Eng. 64 (1977) 849) and other recent measurements of Poenitz and Smith (ANL-NDM-42, 1978) and Lindner et al. (Nucl. Sc. and Eng. 59 (1976) 381) with deviations of as much as 10 to 15%. Macklin has recently renormalised his data using new standard values (private communication to Mehta 1980) which reduces this discrepancy considerably.

The scatter between various measurements up to 1 MeV is still between 5 to 10% i.e. the 3 to 5% accuracy requirements indicated in WRENDA are not satisfied. Between 1 and 4 MeV the Lindner and Miskel (PR 128 (1962) 2717) measurements agree within experimental errors and are well within the 10% accuracy requirement.

There are no measurements above 4 MeV except for one by Perkin et al. (Proc. Phys. Soc. 79 (1958) 505) at 14.5 MeV. There is a need for new measurements in this energy region to provide a basis for a proper evaluation.

Ref. (1) M. K. Mehta and H. M. Jain
Review Paper B6 (b). Second Advisory Group Meeting on Transactinium Isotope Nuclear Data, CEN-Cadarache 1979.*

(2) W. Poentiz and A. B. Smith
NEANDC 124 A, INDC(UK)-33/G, (1980) p. 15

6. Fast Neutron Fission of ^{232}Th

Again two reviews, by M. K. Mehta and H. M. Jain and by A. B. Smith, were discussed. A summary by M. K. Mehta follows:

Recent measurements by Meadows (B. A. P. S. 24 (1979) 875) and Nordborg et al. (Proc. Int. Conf. on Neutron Phys. Nucl. Data ..., Harwell 1978) are reported after completion of the ENDF-B/V evaluation. Earlier extensive measurements of Behrens et al. (UCID-17442, 1977), together with these recent measurements relative to the $^{235}U(n,f)$ cross section and agree with each other except for the region 8-10 MeV.

Absolute measurements of the cross section have been reported by a number of authors, but they are all older measurements and are all lower than the ratio data by up to 15%. This discrepancy could mainly be ascribed to the use of different reference cross section values which were not standardised.

The ENDF-B/V evaluation quotes accuracies varying between 4 and 10% from threshold to 20 MeV. This is larger than the requested accuracies of 3-5%. There is some ground for more accurate measurement around 14 MeV because the 14 MeV values, which are used to fix the normalisation of various sets, exhibit large scatter.

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* Proceedings published as IAEA report IAEA-TECDOC-232

Ref. (1) M. K. Mehta and H. M. Jain
Review Paper B6 (b). Second Advisory Group Meeting on Transactinium Isotope Data, CEN-Cadarache 1979.

(2) A. B. Smith, NEANDC 124 A, INDC(UK)-33/G, (1980) p. 18

7. Fission Cross Section and Fission Cross Section Ratios for U-233

The status has not changed since the data were reviewed by Patrick (Proc. of Int. Conf. on Neutron Physics and Nucl. Data - Harwell - 1978). Reviews by Mehta and Jain (Second Adv. Gr. Meeting on Transactinium Isotope Nucl. Data - -Cadarache - 1979) and by Fort (NEANDC 124 A, INDC(UK)-33/G, p.21, 1980) come essentially to the same conclusions as Patrick. There is a significant discrepancy between absolute values and those extracted from ratio measurements using ENDF-B/V ^{235}U standard cross section, especially between 0.1 and 1.0 MeV. The ratio measurements agree within 3 to 5% with each other when renormalised with respect to the same standard cross section (ENDF-B/V ^{235}U fission cross section). The quality of data suggests an overall accuracy of no better than 3% when a proper evaluation is carried out. This does not quite meet the required and requested accuracies and new measurements are recommended.

8. The ^{235}U Fission Cross Section

This cross section was discussed by the Standards Subcommittee.

9. $^{238}U(n,\gamma)$ Cross Sections below 100 keV and ^{238}U Resonance Parameters

Reviews by H. Derrien and by G. de Saussure were discussed. The following additional remarks can be made:

The last extensive evaluation of U^{238} resonance parameters has been done by G. de Saussure et al. for ENDF/B-V. They have considered the recent measurements and reanalysed the old data. The most significant changes are a reduction by about 15% of the capture widths for the first three s-wave resonances and an increase of 10 to 20% of the s-wave strength function above 1.5 kev. These changes have considerably reduced the discrepancy between the measured and calculated U^{238} capture rate in thermal critical lattices. It is not clear that the remaining part of the discrepancy is due to the inaccuracy in the resolved resonance parameters.

Since the ENDF/B-V evaluation, the results of a very recent transmission measurement performed at HARWELL have been published, giving the resonance parameters up to 520 eV. These results are in agreement with the evaluation by de Saussure et al.

According to H. Tellier (Division of thermal reactors, Saclay) the calculated temperature coefficient is not satisfactory. That could be due to the shape of the thermal cross section. There seems to be no measurement of the cross section shape at thermal energy. It is possible that the shape deviates from the 1/v law and that could explain all remaining discrepancies. In this case, a measurement of the total or the capture cross section in a sufficiently wide energy range around 0.0253 ev should be recommended.

Unresolved region

The difficulties of measuring the U^{238} capture cross section in the energy range 1 to 100 kev suggest that new approaches and better techniques should be used.

Concerning the use of unresolved resonance parameters to predict resonance self-shielding and Doppler effect, it is not evident that the technique used in ENDF/B is adequate. Extending the measurement in the resolved region up to 10 kev should be useful to test the validity of this technique. Such measurements of the capture cross section are planned at ORNL. Experience at Obninsk is that self-shielding factors are underpredicted by $\approx$ 10% with available average parameters as was reported at the 1980 Kiev Conference.

10. Inelastic Neutron Scattering from ^{238}U

The review of A. B. Smith was part of both compilations. The work by R. Winters, ORNL, mentioned there is now finalised, the cross section in the second Fe window at 85 keV is found to σ = 358mv, in good agreement with ENDF/B-V and a recent level-statistical calculation by Fröhner. Above 200 keV the situation remains less satisfactory, experimental results always being higher than model calculations.

11. $^{237}Np(n,2n)$ cross section

This is a new entry in the NEANDC compilation. B. H. Patrick's review was adopted with the additional remark that the two data points by Nishi given by Patrick are superseded, the new values being about 30% lower. It is also desirable that NDS clarify whether the requests in WRENDA 79/80 are, in fact, for the cross section for production of ^{236}Pu as assumed by Patrick.

12. ^{239}Pu Decay Power Discrepancy

This is a new entry in the NEANDC compilation by J. R. England and P. G. Young. The following comments were made:

a) Although the measured Pu-decay power with a calorimeter is larger than calculated, it is still well below the decay power of ^{235}U. No safety questions have therefore arisen.

b) Nevertheless, a discrepancy of about 10% exists between measurement and calculation.

c) There is, at present, a possibility that this discrepancy is due to fission product decay energies available for these calculations. These are mostly not measured but taken from systematics.

d) It may well be that NDS and LDC's could contribute to this by by some combination of analysis of existing data and/or acquisition of spectral decay data which might clarify the data base.

13. ^{241}Am fission cross section

Discussion of the review by A. Michaudon, H. Derrien and G. Grenier and of the evaluations recently performed at Cadarache, Bologna and Karlsruhe showed that the factor-of-ten discrepancy between the bomb shot data of Seeger et al. and the lower results of Shpak in the region below 100 keV can be considered as cleared up. The latest measurements by Knitter and Budtz-Jørgensen, Hage et al. and Wisshak et al. give values even lower than Shpak, in good agreement with level-statistical calculations based on average resonance parameters. The main discrepancy can thus be considered as removed.

There remains a discrepancy, afflicting the lower end of the resolved-resonance region. The measured fission resonance integral is about twice as high as the value calculated from resonance parameters. Likely causes are wrong fission widths for the first two resonances although it is hard to believe that these are wrong by about a factor of two.

14. ^{235}U and ^{239}Pu Resonance Parameters

H. Derriens' review is discussed in both compilations. It was concluded that the polarization data of Moore, Keyworth et al. have removed most discrepancies for ^{235}U, in particular with respect to Γ_γ. For the resonances which are now known to be singlet, an average of Γ_γ = 36.5 meV is obtained in excellent agreement with Moore's calculated value $\Gamma_\gamma = 35 \pm 2$ meV. Derrien recommends reanalysis of existing resonance data with the new information on resonance positions and spins. After this mop-up operation it seems possible to strike ^{235}U resonance parameters from the Discrepancy File.

For ^{239}Pu the situation is still highly unsatisfactory and ways should be explored to polarize Pu samples although it is understood that the alpha decay heat is an obstacle.

15. $^{103}Rh(n,n')^{103m}Rh$

This item is new on the list. The motivation is given in N. Kocherov's working paper INDC/P(80)-15. As $^{93}Nb(n,n')$ this reaction has a low threshold and can be used as a dosimetry cross section in damage studies but with the relatively short half life of 56 min. There are, in addition, three priority 1 requests in WRENDA 79/80. The discrepancy exists for energies above 5 MeV where evaluations by Lapenas et al. and from the UK based on experimental work by Butler and Santry (UKNDL DFN 94 A) differ from an evaluation by Vonach et al. by 30%. This is correlated with the neutron source reactions used in measurements (D(d,n) vs. T(p,n), the former data disregarded by Vonach as unreliable). Helm at KFK has been asked to make an integral measurement in the SNEAK facility.

Report of Ad-hoc Subcommittee on Meetings and Future NDS Program*

11^{th} INDC Meeting, Vienna, June 16-20, 1980.

Preface

This Subcommittee was charged with considering: 1) the NDS-associated program of meetings including general meeting policies and specific recommendations as to content and scheduling, and 2) the broad and general aspects of the future NDS program. This report to the Committee consists of three parts. Section I deals with the broad aspects of the future NDS program. Section II suggests some general guidelines for NDS meetings. Section III outlines a suggested meeting schedule derived from discussions within this Subcommittee, in other Subcommittees and within the Committee generally.

I. Future NDS Program

It is a time of changing and/or uncertain nuclear-energy policies in many areas of the world. This is reflected in the broad guidance recently given the NDS which primarily focuses on safeguards, nuclear safety, and assistance to developing countries.[a] This guidance should certainly receive the most serious of consideration while at the same time the health of the underlying nuclear-data capability must be maintained and new initiatives pursued when the need arises.

The present NDS program has relevance to safeguard needs (e.g. actinide half-lives) and further contributions may very well emerge as a result of NDS studies now planned (e.g. an international safeguards nuclear-data file). However, regional experience suggests that safeguard programs are primarily institutional and instrumental in nature with relatively modest requirements for nuclear data (e.g. instrumental calibration samples, etc.).

The importance of nuclear safety, particularly as publically perceived, cannot be overestimated. Nuclear data, both microscopic and macroscopic, play a key role in safety aspects of the nuclear-energy cycle including; for example, criticality in transport and processing, safety computations and their validation, and the assay of radiation damage. Precise nuclear data are essential to the international acceptance of technical safety assessments and thus to the acceptance of overall system safety. The NDS program has long been responsive to safety needs (e.g. the provision of fission-product, delayed neutron, etc. data) and is being further strengthened in

*References: INDC(NDS)-111, P(80)-22, P(80)-11 and summaries of specialist- and advisory-group meetings.

[a] See introductory remarks to the Committee by H. Kakihana, Deputy Director General of the Department of Research and Isotopes of the IAEA.

areas relevant to safety issues (e.g. increased emphasis on damage-related data). The latter trends should continue and be enhanced. NDS efforts toward that end are strongly encouraged and should benefit from a close association with other IAEA nuclear-safety-related programs.

Training provided to developing-country personnel through the ICTP courses on theory and evaluation has been well received and another in this series of courses is encouraged.[b] Toward that end independent sources of support should be sought. An outgrowth of the ICTP courses has been the proposed "Project of international cooperation for training of nuclear scientists in developing countries using expertise available in the nuclear data field" oriented toward the needs of developing countries. The objective is the establishment of a degree of technical expertise that is both widely applicable and self sustaining on the long term. It is recommended that this project be implemented at an initial conservative level with particular attention to existing capability and need within the respective developing countries. Fellowships will be a particularly effective aspect of this project and it is essential that the selection of personnel and institutions participating in these fellowships be such as to provide maximum benefit to the developing country while at the same time being realistically correlated with the host-country program. Advantage should be taken of the experience of the IAEA technical assistance and fellowship offices and of the Physics Section in implementing this project.

It has long been evident that there are serious shortcomings in basic physics understanding with broad and detrimental impact on nuclear programs. Furthermore, basic understanding is essential to a useful, attractive and productive data effort. The NDS is encouraged to identify areas of basic deficiencies and improve understanding by sponsoring appropriate meetings, publications, etc. involving the best available basic and applied talent. An example of such an initiative is the proposed specialist's meeting on theory and application of level densities involving a wide range of basic theoretical concepts having a strong impact on applied data. Such endeavors can benefit from cooperation with the Physics Section.

Data compilation activities are running smoothly and are responsive to need. Increased efficiency has released professional resources for new endeavors and that trend should be further encouraged. Properly, evaluation efforts are at a very modest level. Particularly to be avoided are long-term evaluation commitments that are inconsistent with Section capability.

The target-and-samples program, already modest, is understood to be subject to further reduction. The latter seems a contradiction in the context of increased assistance to developing countries. "Seed" monies in this area are wise. They should not be confused with major support.

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[b]Detailed statements dealing with the content of this paragraph are found in the report of the Ad-hoc Subcommittee on Inter-regional Project, Trieste Course and Fellowships.

Continued attention should be given to the quality of the program, particularly where associated with activities outside the Section (e.g training courses, CRP (Coordinated Research Programs) efforts, research contracts, assistance to developing countries and technical meetings). Peer review should result in guidance, increased quality, and improved training. Consideration could be given to publications as, for example, derived from ICTP courses, that ultimately would amount to a definitive contemporary reference series of particular value in developing areas.

II. Guidelines for Technical Meetings

Technical meetings have been and will continue to remain one of the most valued aspects of the IAEA/NDS program. The Subcommittee considered mechanisms to further enhance their value. From these considerations emerged the following suggested guidelines for technical meetings.

1. Where at all possible, the INDC shall be made aware of technical-meeting intent, content and schedule an appropriate period of time prior to the meeting.

2. Meeting invitations should always be made through proper official channels. Parallel and informal personal communications may also be appropriate.

3. An organizing committee or working group shall be established for each technical meeting with responsibilities for:

   A. Guiding detailed program scope.

   B. Suggesting invited and contributed participation.

   C. Proposing chairpersons.

4. Written guidelines should be established addressing meeting procedural matters such as:

   A. Detailed specification of written manuscripts.

   B. Publication policies applicable to classes of meetings.

   C. Responsibilities of chairpersons and local organizing groups.

5. Announcements of meeting scope and schedule should be such as to assure wide publicity.

III. Meeting Schedule

The following narrative outline was prepared from INDC(NDS)-11, P(80)-22, the reports of various subcommittees and from the discussions of this ad-hoc subcommittee. An event calendar is given in the attachment.

A. Major regional conferences

These major data conferences are supported by region or country and held in cooperation with the IAEA. The present three-year cycle extends through '80 with a US conference (Knoxville) in '79 and the 5th Kiev conference in '80. It was learned shortly after the 11th INDC meeting that the conference proposed for '81 at Antwerp has been deferred until '82 (private communication to the Subcommittee chairman)[a]. Thus the three year cycle will terminate in '80. The US will consider a conference in '84 but not at the 3-year intervals as the field is not changing sufficiently fast to warrant a meeting in the U.S. less than 2 years following a major NEA meeting. At the Committee discussion it was stated that the USSR has no fixed plans beyond '80. It is recommended that the NDS continue to keep track of these meetings, to cooperate with them as in the past and to properly relate them to its reference area. However, the NDS should undertake no such major conference itself.

B. Symposia

1. Physics and Chemistry of Fission

Meetings of this type have been held on a 5-6 year cycle and the last one was in '79. This implies a similar meeting in '84-'85. It seems likely that the content will increasingly deal with heavy-ion processes. These meetings are under Physics Section auspices and not a direct NDS responsibility. However, the technical content is relevant to NDS-INDC interests and a good correlation should be established with the sponsoring Physics Section.

2. Nuclear Data for Energy, Status and Perspective

The Subcommittee continues to concur with the NDS proposal for a symposium addressing the broad aspects of the contemporary and future status of nuclear data for nuclear energy (see Appendix XI-C, INDC-31/L). The previously proposed date of approximately '85 remains valid as it will be a time for decision in both fission and fusion contexts.

C. Seminars and Schools

1. ICTP Training Courses on Theory and Evaluation

The second of these courses has just been completed and a third is planned for '82. Partial support can be expected but there remain questions as to the rest of the funding. In any case, support of these courses should not compromise other aspects of the NDS meeting schedule.

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[a]Now a formal NEANDC announcement.

The nature of the course may change to reflect needs and the progress of the inter-regional project for training scientists in developing countries. A companion workshop on methodology of evaluation has been proposed to the ICTP for '81. Whether or not these ICTP associated activities will continue on a 2-year cycle will depend upon their continued value as determined by contemporary review, support and program directions.

D. Advisory Group Meetings*

1. Basic and Applied Nuclear Level Densities

This meeting was the outcome of suggestions made at the recent CRP meeting on the comparison of actinide evaluations. The content should extend from the best contemporary basic understanding to the application. Shortcomings in basic knowledge were felt to be critical in many applied contexts. Planning should include detailed consultations with the Physics Section and with the basic research community at large. The suggested date is '82-'83, possibly in association with the above Antwerp Conference. The meeting should be of first rate professional stature from the point of view of both basic and applied interests.

2. Radiation Damage and Safety

The emphasis should be on material effects including safety implications (e.g. vessel damage). The content should include both microscopic and integral nuclear data. The meeting is scheduled for '81.

3. Bio-medical Nuclear Data

Recommended by Subcommittee B at this and the previous meeting (INDC-31/L) and scheduled for '82. The meeting and its content will be guided by the smaller consultant's meeting scheduled for '81 (see below) but the anticipated focus will be on isotope production.

4. NSDD Meeting

These on-going meetings are essential to the success of the nuclear structure and decay data effort and are pursued on a 2-year cycle. Following this cycle the coming schedule is for meetings in '82 and '84.

5. Nuclear Data for Fusion

This meeting was recommended by the Advisory Group of '78 and by Subcommittee B. The Subcommittee emphasized the importance of the 10-50 MeV energy range as relevant to fusion-damage measurements (e.g. work at the FMIT). The meeting is scheduled for the '83-'84 period.

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*The Subcommittee recognizes that scheduling, support and other considerations may result in interchanging Advisory, Consultant's and Specialist's meetings while retaining the same technical content. Such options should be open to the NDS.

6. Standard Reference Data

The Standards Subcommittee continues to recommend this broad-scope meeting on approximately a 7-year cycle. This implies a '84-'85 date. It is related to the consultants meeting on precision $^{235}U(n,f)$ cross sections outlined below.

7. TND Meeting

The previous TND Advisory Group Meeting and Subcommittee A supported this type of meeting on approximately a 4-year cycle. This implies a schedule of '83-'84 which should correspond to the summing up of the CRP-TND work.

8. Not supported

Several other Advisory Group meetings were considered and not supported. Specifically, an autonomous safety meeting was not recommended. Relevant topics could be considered under titles D-2 and 7, above. A shielding-data-oriented meeting was not supported. The NEA plans a shielding benchmark meeting in '80 and there is a relevant meeting in the US under ANS auspices in the same year.

E. Technical Committee Meetings

1. INDC (International Nuclear Data Committee)

The Committee meets at 18-month intervals in correlation with the NEANDC. This implies meetings in '81, '83 and '84. The next meeting is tentatively scheduled for 21-25 September '81, in Vienna.

F. Consultant's and Specialist's Meetings

1. Bio-medical Nuclear Data

Subcommittee B continues to recommend this meeting. It should be of an exploratory nature with emphasis on the charged-particle production of radio-isotopes. The proposed date is spring '81. The meeting should determine whether or not the larger Advisory Group meeting on the subject (see above) is warranted and, if so, what its scope should be.

2. U and Pu Resonance parameters

At the past and present INDC meeting, Subcommittee A endorsed this meeting (see INDC 31/L). It is scheduled for '81.

3. NRDC Meetings

These were felt to be essential to the proper function of the international system of Nuclear Reaction Data Centers and should certainly continue on the annual cycle. The INDC expressed concern for fiscal and policy decisions that inhibited proper NDS attendance at these essential meetings. Of particular concern was a limitation to a single NDS attendee.

4. A+M Network Meetings

This proposed sequence of annual meetings is not now an explicit concern of the INDC. However, it may impact upon the overall meeting budget of the NDS. A+M activities should not have a detrimental impact on the nuclear data effort.

5. ^{235}U Fast Fission Cross Sections

The Standards Subcommittee recommended this meeting at both the present and past INDC meetings (see INDC-31/L). It is tentatively scheduled for '82. However, it is contingent upon the successful east-west intercomparison of precise U-235 reference foils before the meeting. If that intercomparison is unduely delayed this specialist's meeting should be combined with the broader Advisory Group meeting recommended above. If held, attendance should be limited (e.g. to 6-10 specialists).

6. Sensitivity and Uncertainty Analysis

Such a meeting was suggested by the fusion-data Advisory Group meeting of '78. It was not clear whether the scope was limited to sensitivity analysis of fusion systems or encompassed the more general matters of sensitivity and uncertainty analysis. The topic was discussed in both Subcommittees A and B and before the main Committee. It was concluded that the forthcoming NRDC meeting should discuss this technical area in the broad context. Pending the outcome of that discussion no explicit meeting is scheduled.

7. Not Endorsed Meetings

A safeguards-oriented meeting was deferred pending a review of relevant data needs by the NDS. The previously proposed low-energy photon meeting (see INDC-31/L) was deferred. Subcommittee A did not endorse a fission-product meeting at this time.

8. ICTP Workshop on the Methodology of Evaluation

This workshop was proposed by the NDS for '81 and it was to be supported from sources outside the NDS budget. Such support appears unlikely therefore the meeting will probably not occur.

G. CRP (Coordinated Research Project) Meetings

There are two series of these: 1) comparisons of actinide evaluations and 2) actinide decay data. Both meet on a yearly basis through '82. It was questioned as to whether or not such a fixed annual schedule was desirable. An alternative of meetings scheduled in accord with accomplishment rather than on fixed schedule was suggested. In any event, careful preparation for these meetings is essential and their timely value is widely recognized.

It was noted that a CRP on A+M data is being considered. That is not an INDC responsibility but there should not be any detrimental impact on the nuclear-data program.

H. Some Other Relevant Meetings

1. ANS Topical Conference on Reactor Physics and Shielding, Sun Valley, Idaho 9/'80.

2. NEA Conference on Nuclear Data and Benchmarks for Reactor Shielding, 10/'80.

3. NEA Symposium on Fast Neutron Capture, ANL late '81 or early '82.

4. Conference commemorating the 50th anniversary of the discovery of the neutron, Cambridge, '81.

IV. Subcommittee Membership

J. Schmidt
A. Lorenz
B. Kuzminov
S. Kapoor
J. Rowlands
S. Yiftah
J. Rosen
F. Froehner
A. Smith, Chrm.

ATTACHMENT 1.

	'78	'79	'80	'81	'82	'83	'84
Major Conf.	Harwell 9/78	Knoxville 10/79	5-Kiev 9/80		Antwerp JRC-CBNM	Kiev(?)	US(?)
Symposia		Phy. + Chem. Fission					Phy+Chem of Fission Nucl. Data for Nucl. Energy
Seminars and Schools	ICTP Theor. 1/78		ICTP Theor. 2/80		ICTP Theor.		
Advisory Groups	NSDD Meeting Nucl. Data for Fusion Dosimetry Data	TND Meeting	NSDD Meeting A+M Data	Radiation Damage and Safety 12/10/81	Basic and Applied Nucl. Level Densities Bio-Med. Nucl. Data NSDD Meeting	Nucl. Data TND Meeting	Standard Ref. Data NSDD Meeting for Fusion
Technical Committees	INDC 10/78		INDC 6/80	INDC 5/10/'81 IFRC(A+M) 1/81		INDC	INDC
Consultants and Specialists Meetings	NRDC Meeting	NRDC Meeting Delayed Neutron Data	NRDC Meeting A+M Network Neut. Sources	U + Pu Res. Parameters NRD Meeting A+M Network Bio-Med Nucl. Data early '81	NRDC Meeting A+M Network U-235(nf)	NRDC Meeting A+M Network	NRDC Meeting A+M Network
CRP Meetings	TND Eval. TND Decay	TND Eval. TND Decay	TND Eval. TND Decay	TND Eval. TND Decay A+M(?)	TND Eval. TND Decay A+M(?)		

Report of the Interregional Project Subcommittee

Conclusions and Recommendations on the planned Interregional Project in the field of nuclear data

Summary

The INDC supports the proposal for a "Project of interregional cooperation for training of nuclear scientists in developing countries, using the expertise available in the nuclear data field" and strongly recommends that the IAEA take the necessary steps for its implementation.

The INDC recommends to start the project at a modest level of organizational effort, and to take into account the needs of developing countries and the equipment which is already at their disposal.

The INDC recommends that NDS works in close co-operation with the other units of the IAEA in order to implement this project.

Full detailed conclusions and recommendations are given below.

1. General Recommendations

The proposal of the IAEA Nuclear Data Section (NDS) for an "Interregional Project for Training in Basic Techniques for the Generation of Nuclear Data required for the Development and Applications of Nuclear Science and Technology" has been discussed with high interest by the Committee.

The basic idea of this proposal - to support the developing countries by training of scientists and technical assistance using techniques and methods developed in the nuclear data field on the one hand and measurement of needed nuclear data on the other hand is supported by the INDC. It is in agreement with the priorities of the IAEA overall programme.

For making more transparent the main objectives of this project, it is proposed to change the title into the following:

> "Project of interregional co-operation for training of nuclear scientists in developing countries, using the expertise available in the nuclear data field".

It is recommended by the Committee, that the further preparation of this project should be carried out by IAEA/NDS in close co-operation with the IAEA technical assistance programme as well as with the IAEA fellowships programme and other IAEA sections interested or involved in the training of scientists in developing countries.

The members of the Committee suggest also to start with operation of the project at a low level of organizational effort, i.e. with a comparatively small number of participating laboratories in developing and developed countries on the basis of well-defined scientific programmes, which in most cases could be fixed in bilateral agreements.

2. Activities of the project

A careful identification of the specific needs in the interested developing countries is necessary. The activities of the project should basically conform to these needs (particularly training needs) of the developing countries and the basic equipment which is already at their disposal. It could include the following: measurements of microscopic neutron nuclear data with a degree of sophistication appropriate to the laboratory concerned, as well as applications of the same expertise in such areas as

(i) Development and applications of neutron sources;

(ii) Development and calculations of radiation detector systems and associated nuclear instrumentation;

(iii) Measurement of macroscopic cross-sections and integral experiments and their interpretation, e.g. in terms of group cross-sections;

(iv) Theory of neutron-nucleus interactions, the development of codes and their use in calculations of neutron cross-sections;

(v) Use of neutron sources, accelerators, detectors, etc., developed for nuclear data measurements in areas of applications of interest to developing countries.

3. Organization and Methods of Work

The Committee considers that, in general, the most effective means of furthering the aims of this inter-regional project would be the provision of fellowships, to enable scientists from developing countries to work in host laboratories. The host laboratory could be in either a developed or developing country.

Although the Committee believes that sending an expert to a developing country is, as a rule, less cost-effective than a fellowship programme, it may be desirable in some circumstances. An example would be assistance in the completion and initial operation of an accelerator in the developing country. In such instances, the services of the expert should be available for a sufficient time to justify the travel costs.

In suitable cases the inclusion of reasonable funds for targets, samples or equipment should be foreseen.

Because of the expected diverse nature of the scientific work carried out at any one time under this project, the expenses of regular annual coordination meetings of all participants would not be justified. In circumstances where several participating laboratories had a close similarity of technical interests, timely meetings of the visiting and host scientists from these laboratories could be worthwhile, particularly if organized on a regional basis. Attendance of visiting participants at a suitably-planned ICTP course could also be valuable. In this event, the overwhelming emphasis should be on the course, rather than on presentation of results by the participants.

In the selection of specific projects to be supported

1. the primary consideration should be the value of the technical training provided and its applicability to the needs of the developing country, rather than the importance of the scientific results produced,

2. preference should be given to projects that could reasonably be expected to lead to a continuing scientific programme in the developing country, with minimal external assistance, and to result in the training of additional technical personnel,

3. projects that can be completed within a relatively short (2 to 4 years) term should be preferred,

4. the work carried out in a host laboratory should also be of benefit to that laboratory.

Under this inter-regional project, a given programme could be initiated for example

1. as a result of an informal, technical agreement between a laboratory in a developing country and a prospective assisting laboratory. A request for funds to cover a specific proposal would then be made to the IAEA by the developing country;

2. by the request of a developing country to the IAEA for training or other technical assistance to meet a stated need. If the IAEA approves the proposal, it would attempt to make arrangements with a suitable host laboratory or technical expert.

In either case there would be an agreement between the IAEA and both the developing country and the country providing assistance.

The INDC would be willing to assist in judging the technical aspects of specific proposals.

The IAEA would monitor the progress of fellowship projects through periodic reports, submitted by the visiting scientist and reviewed by the host laboratory. Outside experts, some from the INDC, might be asked to assist in judging the continuing value of individual projects.

4. Financing of Interregional Project

The Nuclear Data Section should investigate all possible sources of funding the project, both within and outside the IAEA.

Conclusion and Recommendation on Trieste Courses

The Committee discussed the impact of the courses held in 1978 and 1980 at ICTP-Trieste under the joint sponsorship with NDS on Nuclear Theory Applications. The general opinion of the Committee was that the courses have made a very good contribution especially in bringing together pure and applied nuclear physicists - especially from developing countries - and in providing them appropriate exposure to basic theory as well as to the methodology of nuclear data processing and evaluation for their use in nuclear energy related applications. It was commented that the way the courses have evolved, they have become rather unique in their treatment of basic neutron physics and its application, in the sense that at present such a course coverage would draw participation even from developed countries. Thus these courses serve a very special need interlinking basic nuclear (neutron) physics with its application to the field of nuclear data.

An outline of the proposed programme for the next (third) course in this series to be held in 1982 was described. The broad categories would include recent developments in the detailed understanding of reaction mechanisms, dynamics of nuclear fission and methodology of data processing and evaluation.* The coverage would include some repetition of material from earlier courses and a more exhaustive treatment of relevant areas including new material. The committee agreed with this broad framework and noted that the detailed programme of the course would be worked out by Dr. Schmidt in consultation with the concerned organizers during the next year.

The committee noted that although the first course in 1978 was partly funded through the regular budget of the NDS, it was no longer possible to do so. The Committee recorded with gratitude that the second course in 1980 was funded by the Technical Assistance Programme of the Agency.

Recommendations

Realizing the importance of these courses, the impact they have made on the participants from the developing countries, and the interest the ICTP has indicated in them, the Committee strongly recommends the continuation of these courses, especially the holding of the Third Course in 1982 at ICTP-Trieste. Noting that the necessary funding should not be through the regular budget of the NDS, the Committee urges the NDS to explore all possible other avenues for obtaining the necessary funds. Effort may be made to impress the ICTP with the need for providing a major part of the funds (if not all) and other sources like the Technical Assistance Programme of the IAEA may be persuaded to contribute to the necessary funds again for the Trieste Course.

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* The committee was informed that a suggestion has been made to the ICTP to hold a workshop on the methodology of nuclear data evaluation as part of their nuclear physics programme for 1981 to be fully funded by ICTP. It was noted that the detailed programme of the Third Course should take this into account in case the workshop cannot be held at ICTP in 1981.

APPENDIX 9

Summary on the Coordinated Research Project (CRP) on the Intercomparison of Evaluations of Actinide Neutron Nuclear Data

H.D. Lemmel

The Third Research Coordination Meeting of this Project took place in Vienna, 12-13 June 1980. For the 2nd Meeting in Aix-en-Provence, 30 April-1 May, 1979, see the Summary Report INDC(NDS)-104. An Abstract is also included in INDC(NDS)-111 pages 7 + 8.

Since then, Cadarache and Stuttgart became new participants of the CRP, which includes now 6 participants from West Europe plus 5 from India, Israel, Japan, Romania, USSR.

The evaluations performed by the participants were included on a tape "INDL/A" (IAEA Nuclear Data Library for Actinides). The present contents of this tape is attached. It is available from NDS(or the other neutron data centers) together with a summary documentation "IAEA-NDS-12".

The work of the participants is part of their national programs. The purpose of the CRP is to stimulate critical intercomparison of the evaluations and scientific information exchange among participants, and to feed the results into a common file.

Whereas at the Aix-Meeting in 1979 guidelines for the methodology of intercomparison were designed, the Vienna Meeting 1980 was devoted very much to details of intercomparison, in particular concerning nuclear theory and statistical parameters.

The meeting was chaired by F. Fröhner. Aside from discussing the status reports presented by the participants, I would like to mention the following topics of discussion.

1. C. Lagrange: On the usefulness of coupled channel calculations for actinide nuclei.

This paper was presented by J. Salvy. It demonstrates on several examples that noticeably better results can be obtained from deformed optical model calculations as compared to spherical optical model calculations. For the heavier actinides deformed optical model calculations appear therefore to be preferable, although the computer time involved is often considered prohibitively large. On the other hand, a work by U. Fischer, Karlsruhe (report KFK-2907, Feb. 1980) was available which claims that the spherical optical model is still satisfactory for U and Pu isotopes.

2. M.K. Mehta reported on calculations of (n,2n) and (n,3n) cross-sections based on statistical models. Above the (n,3n) threshold the Pearlstein theory (1965) underestimates the (n,2n) cross-section and overestimates the (n,3n) cross section. Various calculations performed since then were reviewed and their merits discussed.

3. B.H. Patrick presented a summary of the document NEANDC(UK)-174A= INDC(UK)-34: An assessment of the accuracy requirements on higher actinide nuclear data for fast reactors, by B.H. Patrick and M.G. Sowerby. This paper considers for a specific fast reactor spectrum the production of six actinide isotopes, the α heat and total heat, the spontaneous fission rate, the (α,n) yield and the total neutron yield. It was found that the calculation of these data suffers mainly from the uncertainties in

Np-237 (n,2n)
Am-241 (n,γ) Am-242g
Am-243 (n,γ)
(α,n) cross-sections
Pu-241 half-life

The accuracy of fission cross sections was considered sufficient for this calculation. Similar calculations for other configurations may indicate insufficient accuracies also for other data. Among others, Dr. Bobkov stressed the need for more accurate U-234 (n,3n) data. Although Patrick's calculation was made with one group only, it was considered important and similar calculations should be encouraged, possibly with more groups.

4. H. Derrien intercompared the average resonance parameters for Am-241 as assumed in Cadarache, Bologna, Harwell and Karsruhe, Similarly, the Pu-242 parameters assumed at Minsk and Karlsruhe were compared. It was concluded that the knowledge of level densities and in particular their variation over large energy ranges presents a problem, and better theories are required.

5. N. Kocherov presented a compilation of integral actinide cross-section measurements in facilities of which the spectrum was sufficiently well described, such that these measurements can be used as bench-mark tests for the actinide evaluations. Participants were encouraged to perform corresponding calculations to test their evaluations. The fact that for each facility the spectrum is described in a different group structure, will create some technical problems. Another limitation is, that none of these spectra was confirmed by experiment but only by calculation resp. evaluation.

Extract from the document IAEA-NDS-12 documenting the contents of the tape INDL/A.

The tape contains four files:

A. Complete evaluations

File 1: ENDF/B format

2024	94-Pu-241 94-Pu-242*	Minsk
5161	94-Pu-242	Bruyeres-le-Chatel
9543	95-Am-243	JAERI
9642	96-Cm-242	JAERI
9644	96-Cm-244	JAERI
9645	96-Cm-245	JAERI
9999	90-Th-232 91-Pa-233*	Romania
	95-Am-241* 93-Np-237*	Cadarache

File 2: UKNDL format

1009A	95-Am-241	Harwell

File 3: KEDAK format

1	96-Cm-244 96-Cm-246*	Soreq

B. Partial evaluations, resolved resonance region

File 4: ENDF/B format

9441	94-Pu-241	Bologna
9442	94-Pu-242	Bologna
9541	95-Am-241	Bologna
9543	95-Am-243	Bologna
9642	96-Cm-242	Bologna

*Finished, tape expected

APPENDIX 10

Report on the Third IAEA Coordinated Research Meeting on the Measurement and Evaluation of Transactinium Isotope Nuclear Decay Data

The third meeting of the participants in the IAEA Coordinated Research Programme (CRP) on the Measurement and Evaluation of Transactinium Isotope Nuclear Decay Data was convened on 12-13 June 1980, at IAEA Headquarters in Vienna.

The meeting reviewed the "Requirements and Status of Transactinium Isotope Decay Data" which were defined at the Second IAEA Advisory Group Meeting on Transactinium Isotope Nuclear Data, at Cadarache, 2-5 May 1979. This review resulted in the identification of thirty isotopes for which the accuracies of either the half-life, or the gamma and/or alpha (I_γ and I_α) intensities were not satisfied; the isotopes for which the accuracies of the half-lives had not yet been achieved are: Th 229, Np 236, Pu 241, Cm 242 and Cm 246.

The meeting reviewed also the "Proposed Recommended List of Transactinium Isotope Decay Data. Part I. Half-lives (September 1979 Edition), published in INDC(NDS)-108/N, and revised the half-life values of the following isotopes: Th 230, U 232, Pu 240, Am 242m, Cm 243, Cm 245 and Es 253. The revised listing of transactinium isotope half-lives (June 1980 Edition) which will be published as INDC(NDS)-108/N Rev. 1., will also include half-life values for a number of additional isotopes, including actinide decay products.

The CRP also started the review of the status and recent measurements of the I_α and I_γ values and their uncertainties, for a few selected isotopes for which the I_α and I_γ accuracies had not yet been achieved.

APPENDIX 11

List of NDS working papers distributed at this meeting;INDC/P(80)-series

1. Information on Final INFCE Publications
   J.J. Schmidt (31 March 1980)
2. Preliminary Report on the Advisory Group Meeting on Nuclear Structure and Decay Data, Vienna, 21-25 April 1980
   A. Lorenz (6 May 1980)
3. Report on the Interregional Advanced Training Course on Applications of Nuclear Theory to Nuclear Data Calculations for Reactor Design, International Centre for Theoretical Physics (ICTP), Trieste, 28 January - 22 February 1980
   J.J. Schmidt and M.K. Mehta (16 May 1980)
4. Proposal for an IAEA/NDS Interregional Project for Training in Basic Techniques for the Generation of Nuclear Data Required for the Development and Applications of Nuclear Science and Technology
   J.J. Schmidt (16 May 1980)
5. Proposal for an IAEA-sponsored Interregional Project for Training in Basic Techniques for the Generation of Nuclear Data Required for the Development and Applications of Nuclear Science and Technology
   J.J. Schmidt (2 June 1980)
6. Brief summary of nuclear data requests (except for fission reactors) contained in WRENDA 79/80
   J.J. Schmidt (16 May 1980)
7. WRENDA Input Guide
   J.J. Schmidt (20 May 1980)
8. Nuclear data for safeguards
   J.J. Schmidt (10 June 1980)

9. REAL-80 Project - Interlaboratory comparison of radiation damage (displacement per atom) estimates
   J.J. Schmidt (2 June 1980)

10. Summary of Recommendations from Past IAEA Meetings
    J.J. Schmidt (3 June 1980)

11. The IAEA nuclear data programme, with particular consideration of the 1981-1982 period
    A. Lorenz and J.J. Schmidt (6 June 1980)

12. Targets and Samples
    J.J. Schmidt (12 June 1980)

13. Winter Courses on Nuclear Physics and Reactors -
    Part I: Course on Nuclear Theory for Applications, organized jointly by the IAEA Nuclear Data Section, the International Centre for Theoretical Physics (ICTP) and the Centro di Calcolo, Bologna, Italy, and held at the ICTP in Trieste, 17 January - 10 February 1978
    J.J. Schmidt (3 June 1980)

14. Draft list of intense neutron sources for radiation damage studies
    K. Okamoto and J.J. Schmidt (9 June 1980)

15. ^{103}Rh(n,n')^{103m}Rh Cross-Section
    N. Kocherov (10 June 1980)

16. NDS Meetings: 1980, 1981, 1982
    A. Lorenz (30 May 1980)

17. Status Report on the REAL-80 Project of the 3rd ASTM Euraton Meeting
    C. Ertek and J.J. Schmidt (13 June 1980)

18. Nuclear Data for Safeguards
    A. Lorenz (10 June 1980)

19. Shortcomings of center files and dissemination
    J.J. Schmidt (10 June 1980)

20. Summary Conclusions and Recommendations from the IAEA Consultants' Meeting on Neutron Source Properties, Debrecen, Hungary, 17-21 March 1980

    K. Okamoto and J.J. Schmidt (10 June 1980)

21. Consultants Meeting on Delayed Neutron Properties, Vienna, 26-30 March 1979

    O. Schwerer and J.J. Schmidt (10 June 1980)

22. Possible future Meetings

    J.J. Schmidt (11 June 1980)

23. Gamma-ray Energy Calibration Standards

    A. Lorenz (12 June 1980)

24. Ad-hoc Subcommittee on the proposed Interregional Project

    J.J. Schmidt (16 June 1980)

25. Half-lives of commercial and biomedical isotopes

    W.G. Cross and J.S. Merritt (1980)

26. Report on the Third Coordinated Research Meeting on the Measurement and Evaluation of Transactinium Isotope Nuclear Decay Data. (18 June 1980).

27. Summary on the Coordinated Research Project (CRP) on the Intercomparison of Evaluations of Actinide Neutron Nuclear Data

    H.D. Lemmel (17 June 1980).

28. EXFOR Data Transmission Statistics (17 June 1980).