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EUROPEAN-AMERICAN NUCLEAR DATA COMMITTEE

TECHNICAL MINUTES OF THE FOURTEENTH MEETING OF THE COMMITTEE

Argonne National Laboratory, USA, 26-29 October 1970

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TABLE OF CONTENTS

	<u>Page</u>
<u>Highlights of the Fourteenth EANDC Meeting</u>	1
<u>List of Participants</u>	3
1. <u>Introductory Items</u>	4
2. <u>Reports on Facilities and Measurements</u>	4
a. New Facilities	
b. Progress Reports	
c. Research Papers	
d. New Results on the Standardization of the Fission Cross-Section of U-235	
e. The Prompt Fission Neutron Spectra of U-235 and Pu-239	
f. The Neutron Energy Spectrum of Cf-252	
3. <u>EANDC Symposium on Standards</u>	8
a. Redefinition of the Meaning of a Standard Cross Section	
b. Standards for Light Nuclei	
c. Fission and Capture Standards	
d. Flux Measurements	
e. Special Topics	
f. A Code of Practice for the Statement of Accuracy	
4. <u>Nuclear Data for Safeguards, Fusion and Medical Applications</u>	12
5. <u>Conferences</u>	12
a. Helsinki Conference on Nuclear Data for Reactors	
b. Studsvik Panels on $\bar{\nu}$ and α for Pu-239	
c. CODATA Conference, 7 - 12 September 1970	
d. 3rd Conference on Neutron Cross-Sections and Technology, 15 - 17 March 1971	
e. Conference on the Statistical Properties of Nuclei, Albany, New York, 23 - 27 August 1971	
f. Additional Conferences	
6. <u>Request List</u>	14
a. Discussion of New Request List RENDA (EANDC-85 U)	
i $\bar{\nu}$ Requests	
ii Moderators	
iii Thermal Capture Cross-Sections	
iv Resonance Parameters for Non-Fissile Elements	

v	Resonance Parameters for the Fissile Elements	
vi	Fast Fission Data	
vii	Fast Neutron Capture	
viii	Elastic and Inelastic Neutron Scattering	
ix	Threshold Reactions	
b.	World Wide Request List	
c.	EACRP Recommendations for Including Evaluations	
7.	<u>Data Indexing, Compiling and Evaluation</u>	17
a.	Current ENEA Activities	
b.	Current IAEA Activities	
c.	Current US Activities	
d.	Publication of CINDA	
e.	Other National and International Activities in Indexing and Compiling	
8.	<u>Time, Place and Topical Discussion for the Next EANDC Meeting</u>	22
APPENDIX	List of Documents issued since the 13th Meeting	23

HIGHLIGHTS OF THE FOURTEENTH EANDC MEETING

Reference Cross Sections and Flux Measurements

The Fourteenth Meeting of the EANDC, which followed a three-day EANDC symposium on standards, reviewed the status of reference cross sections and flux measurements. The hydrogen cross section was judged to be adequately known, and that of carbon to be satisfactory between 0.5 and 1.5 MeV, but it was recommended that NBS extend the measurements on carbon down to ~ 1 keV. Knowledge of the Li-6 and B-10 cross sections has improved considerably in recent years, but further work on their total cross sections was thought desirable, notably (i) a repeat measurement, at Geel, for Li-6 from as low an energy as possible to 0.5 MeV, and (ii) an attempt, at KFK, to resolve the ANL/AERE discrepancy for B-10 between 200 and 300 keV. A subcommittee is to report on the best way to establish the (n, α) cross section of Li-6 up to 100 keV.

The status of the U-235 fission cross section remains unsatisfactory. At thermal energies the new measurement by Deruytter indicates that the IAEA least squares fit value may be too low by ~ 3 b. At higher energies the best available data agree to about $\pm 3\%$ up to ~ 1 keV but above this energy the situation deteriorates. Large fluctuations in the cross section persisting up to several tens of kilovolts have been confirmed in several laboratories, and these may be responsible for some of the difficulties. Several recommendations for improving the situation were put forward.

Condé et al have recently measured the magnitude of the "Soleilhac effect" in the FOA liquid-scintillator tank and found that the value of \bar{v} (Cf-252) obtained with this apparatus should be reduced by 0.6%. Diven has evaluated the effect for the LASL tank and found it to be less than 0.1%. Thus the discrepancy between the high liquid-scintillator results and the low manganese-bath and boron-pile results remains unexplained.

Reference cross sections for capture were briefly reviewed. Gold may still be the best, though better data are needed above ~ 350 keV, but other nuclides with higher cross sections should be studied.

Regarding flux measurements, it was recommended that whenever possible more than one method be used. The EANDC also encouraged the international fast-neutron flux intercomparison being organized by the BIPM, and recognized the usefulness of flat detectors with a fast time response such as the AERE boron-vaseline sphere.

Progress Reports and Research Papers

Preliminary reports were presented on new measurements of the capture cross sections of U-238, at ORNL and Columbia, and of Pu-240 at RPI. For both nuclides there are discrepancies with older data and the EANDC endorsed a request for the loan of a Pu-240 sample to AERE which will be used to check the normalization of their earlier measurements.

Measurements at ORNL on the variation of \bar{v} from resonance to resonance in Pu-239 fission indicate that the effect is small, i.e. intermediate between

the contradictory results of Ryabov and of Weinstein and Block. The energy variation of \bar{v} (Pu-239) in the MeV range has been more accurately determined as the result of experimental and evaluation work at AWRE.

Extensive attempts in both the UK and the US have failed to produce the 0.3y isomer of Pu-241 previously reported by Nisle at INC, and it is now generally accepted that it does not exist.

Smith reported that recent ANL work on the total and scattering cross sections of U-238 up to 1.8 MeV has considerably reduced previous discrepancies. He also reported on the status of the energy spectrum of the neutrons from U-235 and Pu-239 fission; while recognizing that integral measurements indicate a harder spectrum he believed that the microscopic data should still be accepted and presented new experimental results from ANL that supported this view. Aten presented new data on the spectrum of neutrons from Cf-252 fission.

Recommendations

EANDC members presented detailed and careful reviews of the current Request List for Neutron Data Measurements; their individual reports will be given an L distribution and brought to the attention of local data committees. The EANDC agreed that their requests should be merged with those from non-OECD countries in a World-Wide Request List produced under the responsibility of the IAEA.

TECHNICAL MINUTES OF THE FOURTEENTH MEETING OF THE COMMITTEE

Argonne National Laboratory U.S.A.

26 - 29 October 1970

List of Participants

EANDC Members :

W.W. Havens, Jr., Columbia University, U.S.A. (Chairman)
A.H.W. Aten, Jr., Euratom, Geel, Belgium
R. Batchelor, AWRE, Aldermaston, U.K.
H. Condé, Stockholm, Sweden
E.H. Fröhner, Karlsruhe, Germany
G.C. Hanna, Chalk River, Canada (Executive Secretary)
*T. Hürlimann, EIR, Würenlingen, Switzerland
R. Joly, CEA Saclay, France (Corresponding Secretary)
G.A. Kolstad, USAEC, Washington D.C. U.S.A.
M.S. Moore, Los Alamos, U.S.A.
M. Nève de Mévergnies, Mol, Belgium
W.T. Potter, ENEA, Paris, France
E.R. Rae, Harwell, U.K.
A.B. Smith, Argonne, U.S.A.
J. Story, AEE, Winfrith, U.K.
K. Tsukada, JAERI, Japan

*Did not attend

Observers:

A.J. Deruytter, Euratom, Geel, Belgium
H.E. Jackson, Argonne, U.S.A. (Local Secretary)
K.F. Lauer, Euratom, Geel, Belgium
F. Maienschein, Oak Ridge, U.S.A. (EACRP Observer)
S. Pearlstein, NNCSC, Brookhaven, U.S.A.
J.J. Schmidt, IAEA, Vienna, Austria

1. INTRODUCTORY ITEMS

The Minutes of the 13th Meeting, EANDC-83, were accepted, as was the Draft Version of the Fifth Biennial Report of the Activities of the EANDC by P. Weinzierl and M. Nève de Mévergnies.

2. REPORTS ON FACILITIES AND MEASUREMENTS

2(a) New Facilities

The following new facilities and changes were mentioned:

Belgium At the Universiteit Leuven the isotope separator (EANDC-84, B1) is now operating. The variable energy cyclotron at the Université de Louvain is progressing on schedule (completion date: late 1971).

Canada The calandria of the NRU reactor is to be replaced which will result in improved experimental facilities. High-gradient tubes for the Chalk River MP Tandem have been ordered; the maximum terminal voltage should increase from 10 MV to at least 13 MV.

France The new 4 MV Van de Graaff at Limeil is being tested and experiments are being started. The addition of a fourth section to the Saclay linac and the modifications to the existing three sections have resulted in an improvement of a factor of 2 - 2.5 in the intensity, e.g. at a pulse length of 20 nsec a current of about 3A (\sim 8 kW mean power) has been available since November 1969.

Germany At Karlsruhe the new 190 m flight path on the isochronous cyclotron is in operation, and the 3 MV pulsed Van de Graaff will have its RF ion source replaced by a Duoplasmatron - 1 nsec pulses will be available at two stations in December. At the Technical University, Darmstadt, design details of the new heavy ion accelerator are being discussed. Vonach is planning neutron evaporation studies with the Munich Tandem Accelerator.

Japan The KN-4000 type 4 MV Van de Graaff at the Tokyo Institute of Technology has been working since September 1969, and the new Van de Graaff at Kyushu University, in operation since April 1970, has reached 7.5 MV. A new electron linac for JAERI has been authorized (80 MeV \times 600 mA) and is expected to be operating early in 1972. Three AVF cyclotrons have been approved: (i) National Institute of Radiological Science (60 MeV p's, 1973), (ii) Institute of Nuclear Study, Tokyo University (25 MeV p's, 1973), and (iii) Research Centre of Nuclear Physics, Osaka University (70 MeV p's, 1974).

Netherlands The fast neutron oscillator facility STEK at Petten came into operation in 1969. It works well but the neutron spectrum has not yet been established; resonance detectors and proton recoil techniques are being used and a time-of-flight facility is under construction.

Sweden and Denmark The EN Tandem at the University of Uppsala commenced operation in October 1970 and a klystron bunching system will be installed in December 1970. The Uppsala synchro-cyclotron is to be rebuilt as a sector-focused cyclotron to accelerate protons (90 MeV) and heavy ions up to C-12. A Super-FN Tandem is to be installed at Risø in the spring of 1971 and the old EN Tandem will go to Aarhus in 1972.

United Kingdom The possibility of a very large tandem accelerator (>20 MV terminal voltage) for Daresbury appears to be more promising. The AERE tandem will be used for some neutron work in the near future. The AERE linac now has a tantalum window on the mercury cooled booster target which overcomes problems of thermal stress for pulse lengths $> \frac{1}{4}$ μ sec. The 100 MeV electron linac at the University of Glasgow (2 ns pulses 25 m flight path) is to be used for some neutron inelastic scattering measurements. The NPL is still planning to set up the Boron Pile.

United States At ANL the Tandem Dynamitron is operating very well (9 MeV, 100 μ A on target) and a nanosecond pulsing system for the 4 MV single-ended Dynamitron has been installed (\sim 2 mA peak at 1 nsec FWHM). At BNL the double tandem facility is now operational (3 μ A of 30.5 MeV p's). The Columbia University Nevis cyclotron will be converted to a high duty factor AVF cyclotron by mid 1971, and beam intensities should increase by a factor of at least ten. The 100 MeV Livermore electron linac was accepted on 30 September 1970; it provides electron pulses of 5 nsec to 3 μ sec duration at a repetition frequency of 0 to 1300 pps with a maximum power of 50 kW (see EANDC-83 for further details). Neutron targets are ready for use and the neutron time-of-flight facilities are essentially complete. The 30 MeV LRL Cyclograaff should be in full operation by July 1971. The LASL meson physics facility (LAMPF) remains on schedule with an 800 MeV proton beam in the switchyard scheduled for July 1972. The University of Maryland isochronous cyclotron has produced external beams of 100 MeV protons and 140 MeV alpha particles. The 400 MeV electron linac at MIT should be complete by early 1972; a low energy beam is expected early next year. The ORNL electron linac ORELA was accepted in August 1969 and performance has been satisfactory except for some electron gun difficulties. Three klystrons have operated for more than 3500 hrs without failure, and one was replaced at 3000 hrs.

2(b) Progress Reports

Reviewing briefly the contents of their progress reports, several EANDC members referred generally to the Helsinki Conference and the EANDC Standards Symposium as providing more recent information. Further additional information and comments were:

Canada Story asked Hanna to explore the possibility of Santry (section 1 of (Can)-42 L) making a comparison of the S-32(n,p) cross section (see section 1(a) of (Can)-38 L) with U-235(n,f), and Batchelor indicated that White's fission chamber might be available. Hanna mentioned that the values for the energy released in fission calculated by Walker and Milton (section 11 of (Can)-42 L) are in close agreement with the James (AEEW) values.

Euratom Fröhner reported that the radiation widths obtained from the KFK capture measurements on iron and nickel ((E)-127 U, p 54) agree well with those obtained by Stieglitz at RPI. Deruytter mentioned the measurements at Geel ((E)-127 U, p 235) and Columbia ((US)-143 U) of the kinetic-energy release in Pu-240 spontaneous fission and in thermal-neutron induced Pu-239 fission; the results are completely contradictory. He is to discuss this with Melkonian, and Aten and Havens will report at the next EANDC meeting. Nève mentioned an offer from the Adlers (University of Illinois) to analyze Geel linac scattering data on U-235, and on Np-237 when available and Smith offered the services of ANL; the EANDC considered that such Adler-Adler analyses would be useful.

United Kingdom Updating (UK)-120 AL, Batchelor reported that the nuclear data effort at AWRE is now equally divided between experimental work (measurements of $(n,2n)$ and $(n,3n)$ cross sections) and evaluation. Evaluations of $\bar{v}(E)$ for Pu-239((UK)-125) and carbon cross sections have been completed. Reports on fast neutron scattering by the boron isotopes and molybdenum will be issued shortly. Rae also referred to an increase in evaluation work, and mentioned an experiment being set up on the 100 m flight path of the Harwell linac to carry out $(\bar{v}\sigma_f)$ measurements. NPL are to make an activation measurement of the U-238(n, γ) cross section between 0.1 and 1.5 MeV.

Rae referred to the negative results of a Harwell search for the 0.3 y Pu-241 isomer (see CN-26/107) and Moore mentioned that several groups in the US have tried hard to find any evidence for its existence; presumably it does not exist.

United States Moore supplemented (US)-143 U by referring to recent ORNL work, on U-238(n, γ) which shows some discrepancies with GGA data, and on the variation of \bar{v} for Pu-239 fission in the resonance region which has failed to resolve the current discrepancy, preliminary results indicating that the effect is small i.e. intermediate between the contradictory results of Block and Ryabov.

Results from RPI on Pu-240(n, γ) show 30% discrepancies with data from Harwell and Geel. Commenting on this Rae mentioned his request for a Pu-240 sample (item 4e below) to check the Harwell normalization, which would also affect the Geel results; Deruytter however believed that a renormalization could only explain part of the discrepancy.

Measurements at Columbia on U-238(n, γ) in the resonance region have been completed and are being analyzed. A preliminary examination of resonances at 930, 950 and 1020 eV suggests agreement with the Geel results rather than those of Glass.

2(c) Research Papers

Comments on research papers not considered under other agenda items were:

(E)-126 AL (Pu-240) This assessment does not include the information from (UK)-103 and will therefore be redone, taking account of Soleilhac's \bar{v} results.

(E)-130 AL (U-235) For the 8 resonances that were also investigated by Cowan et al (Phys Rev 130 2380 1963) spin assignments agree in only 5 cases; it therefore appears that the mass distribution is not solely determined by J.

(UK)-121 AL (Pu-239) These (deliberately) low-energy-resolution measurements show that a linear dependence of \bar{v} on energy is adequate in practice. A minor disagreement with Soleilhac has not been resolved.

(US)-145 A (σ_s and σ_T for U-238) Smith reported that this work, the result of action 21 of the 13th meeting, disposes of the "bump" above 1 MeV but noted that the revision of ENDF/B averages the older data and evaluations

with the new information from ANL. He also mentioned a recent paper by Okrent et al in Nuclear Applications and Technology, 9 454 (1970).

2(d) New Results on the Standardization of the Fission Cross Section of U-235

Discussion of this topic was deferred to item 3(c).

2(e) The Prompt Fission Neutron Spectrum of U-235 and Pu-239

Smith referred briefly to (US)-139 L and (US)-147 A and presented some preliminary results from time-of-flight work, in progress at ANL, on the fission of U-235 and Pu-239 induced by neutrons in the energy range 100 - 450 keV. The fission neutron spectrum data so far processed, for the range 0.3 to 1.6 MeV, are well fitted by a "Maxwellian" distribution ($\sqrt{E} \exp(-E/T)$, $T = 2\bar{E}/3$) of mean energy 2.0 MeV (and not by one of 2.4 MeV, the mean energy proposed by W.N. McElroy). Smith said he was not planning to undertake measurements on Cf-252.

Batchelor asked whether the proportional counters developed by E. Bennett at ANL (EANDC Standards Symposium, Session IV, Paper 4) could be used to measure fission neutron spectra, especially for the low energy range. Smith thought their sensitivities might be too low, unless a very intense source of Cf-252 were available.

Story referred to the discrepancy between the calculated and measured values for the fission cross section of U-238 averaged over a fission spectrum, which had been emphasized by J.A. Grundl at the EANDC standards symposium (Session VI, Paper A.1.). This discrepancy suggests that the fission neutron spectrum is harder than the Watt-Cranberg spectrum with $\bar{E} \approx 1.95$ MeV. Story pointed out that fast reactor physics measurements generally support a harder fission spectrum, unless one is prepared to reduce the U-235 fission cross section considerably in the range from about 50 keV to 1.5 MeV.

Schmidt mentioned IAEA plans for a confrontation next summer between experimenters of the micro and macro persuasions. The Nuclear Data Section in Vienna will help by compiling all the differential data and by re-evaluating the cross sections of threshold reactions.

Condé referred to recent measurements at Studsvik reported to the Helsinki Conference (CN-26/57) on the fission of U-238 induced by neutrons of 1.35 and 2.02 MeV. In each case the data fitted a Maxwellian distribution of temperature 1.29 MeV.

2(f) The Neutron Energy Spectrum of Cf-252

Aten circulated a preliminary report, based on a thesis by H. Pauw (University of Amsterdam, 1970), describing integral measurements on the spectrum of neutrons from a Cf-252 source in a scatter-free arrangement. Seven activation reactions gave good agreement with a $\sqrt{E} \exp(-E/T)$ spectrum with $T = 1.39$ MeV, except for the Au (n, γ) reaction which indicated a lower energy (by a factor of 0.7) for the part of the spectrum below 1.5 MeV. On the other

hand the Au (n,2n) reaction rate, the calculated value of which is very sensitive to the value assumed for T, also indicated $T = 1.39 \pm \sim 0.02$ MeV for the high-energy part (> 10 MeV) of the spectrum.

Schmidt referred to work at Karlsruhe by Werle (INR-4/70/25) which indicated a value of $T = 1.4$ MeV for the region above 1 MeV but an excess of neutrons, similar to that found by Meadows, in the low energy region.

3. EANDC SYMPOSIUM ON STANDARDS

The Committee considered that the "EANDC Symposium on Neutron Standards and Flux Normalization", held at ANL the previous week (21 - 23 October), had been a great success, and the Committee expressed its appreciation to the organizers for the interesting programme and the excellent local arrangements. The Proceedings are being published by the DTIE of the USAEC. Because most EANDC members had attended the symposium discussions during the Committee meeting were relatively brief (see items 3b, c, d and e below). At the close of the meeting it was decided that the Subcommittee on Standards should continue its work.

3(a) Redefinition of the Meaning of a Standard Cross Section

The Chairman drew attention to the different meanings attached to the word "standard", e.g. by the NBS where it denotes something regularly useful to industry, and by the EACRP who use it to refer to such cross sections as those of cobalt and manganese which are frequently employed in activation measurements in reactor physics. Aten mentioned the concept of the completely arbitrary standard, such as the metre.

Story suggested "reference cross section" as a preferable term, and Moore mentioned the inclusion of the words "flux normalization" in the title of the recent symposium, which had arisen from some internal US problems with "standards" not being considered as the business of the AEC. The Chairman believed that although the EANDC knew what was meant it might be well to move towards using the terms reference cross section and flux normalization.

3(b) Standards for Light Nuclei

Batchelor opened the discussion on light nuclei. The thermal cross sections are well enough known, as is the hydrogen cross section over the whole energy range of interest. Knowledge of the He-3 cross section could be improved but there is some question of its practical usefulness.

Rae spoke on the Li-6 (n, α) cross section and pointed out that our present knowledge relies heavily on Uttley and Diment's measurements of σ_T and that the status of σ_s is not altogether satisfactory. After some discussion the EANDC formally recommended that Geel should make a new measurement of σ_T for Li-6 from thermal energies to 0.5 MeV. The EANDC also set up a subcommittee (Smith, Rae and Aten) to report, by January 1971, on the best way of establishing the (n, α) cross section below 100 keV. All members were asked to send suggestions to the subcommittee.

Rae noted the discrepancy between the ANL and AERE measurements of the total cross section of B-10 between 200 and 300 keV, and the Committee recommended that Karlsruhe attempt to resolve it. Measurements of the (n,α) and (n,α') cross sections were in hand at Harwell.

The EANDC also recommended that NBS measure the total cross section of carbon down to 1 keV, strongly supported the present AERE programme of measurements on reference cross sections and looked forward with interest to the results that will be obtained using the flat boron-vaseline detector.

3(c) Fission and Capture Standards

Moore presented a summary of the situation, and there was further discussion by the Committee.

3(c)i Fission Cross Sections

U-235 is still considered as the reference fission cross section, though Joly suggested that the fluctuations of σ_f for U-233 in the region around 10 keV should be examined to see if they were, unexpectedly, smaller than for U-235.

There are still problems with the fission cross section of U-235, even at thermal energy; the new value for the half life of U-234 has introduced a discrepancy between Deruytter's recent very accurate measurement and the output value from the IAEA least squares fit, which now needs revising (it may be too high by $\sim 3b$). At higher energies the best available data (from Geel, Oak Ridge, and Saclay) agree to $\pm 3\%$ up to 1 keV, but it is still considered desirable for white-source measurements to be extended down to the thermal region. From 1 to 30 keV the situation remains unsatisfactory; the two sets of data covering this region (AERE and LASL) do not match the Geel, Oak Ridge and Saclay data at 1 keV. At the standards symposium Poenitz had summarized the status of the data above 30 keV but the discrepancies are so serious that his suggested changes and estimated accuracies were not generally accepted.

Deruytter recommended a fission foil exchange programme, but, recalling earlier abortive attempts, EANDC recommended only that measurers avail themselves of the special facilities available at Geel. However they strongly supported Deruytter's other suggestion, that all measurers record and publish their fission fragment pulse height spectra at all energies.

The Committee recognized the care that is necessary in the construction of Sb - Be sources and the interpretation of measurements made with them. They also recommended that a 144 keV beam obtained using a silicon filter be put in operation. It was also agreed that whenever possible flux measurements should be made using two independent techniques of comparable precision.

Moore informed the Committee of work planned or in progress on U-235 fission; it includes:

- a. AERE $\overline{\sigma}_f$ will be measured to several hundred keV using the linac and a fast neutron detector.

- b. ANL Poenitz will repeat work with his grey neutron detector to determine the shape between 20 keV and 1.5 MeV. He will again normalize to the Knoll and Poenitz value at 30 keV and will use the V(p,n) reaction at higher energies with a measurement of the associated activity.
- c. Cadarache Leroy plans to study the fission cross section of U-235 below 100 keV using thinner foils and improved techniques to reduce scattering corrections. He will also remeasure B-10(n, α) below 100 keV as a check.
- d. Columbia University Melkonian has data up to a few keV; analysis is under way.
- e. KFK Käppeler will extend the energy range from 300 keV to 1.2 MeV, using a gas scintillator for fission and a recoil proton telescope for the flux monitor. He will try to reduce the background in the telescope by minimizing the scattering materials, and by using a solid state detector with a different material for the surface barrier.
- f. LASL Barton et al plan measurements over the region 2 - 20 MeV relative to H(n,p).
- g. LRL Bowman will repeat his studies of fluctuations with ten times better resolution.
- h. ORNL Peelle intends to measure over the energy range 100 keV to 1 MeV using ORELA. Measurements will be made relative to H(n,p).
- i. Univ. of Michigan Knoll is making fission cross section measurements using photoneutron sources.

3(c) ii $\bar{\nu}$

Condé et al have recently measured the magnitude of the "Soleilhac effect" in the FOA liquid-scintillator tank and found that the value of $\bar{\nu}$ (Cf-252) obtained with this apparatus should be reduced by 0.6%. Diven has evaluated the effect for the LASL tank and found it to be less than 0.1%. Thus the discrepancy between the high liquid-scintillator results and the low manganese-bath and boron-pile results remains unexplained. The EANDC supported the recommendations of the Working Group at the standards symposium that Soleilhac (Bruyères le Chatel) and J.R. Smith (INC) be asked to undertake measurements of $\bar{\nu}$ for Cf-252.

3(c) iii Capture Cross Sections

Capture standards were considered only briefly. Specific recommendations made by Carlson in his review at the EANDC standards symposium were:

- a. The absolute cross sections of Au-197 are badly needed above 300 - 400 keV.

- b. While at the moment Au-197 appears to be the best standard, careful study of capture in some of the recently available rare earths is fully warranted. Some of these have cross sections a factor of two higher than that of Au.
- c. Ta-181 should be carefully studied as it has the potential of a good capture standard.

3(d) Flux Measurements

Fröhner opened the discussion of flux measurements by referring to the usefulness of the manganese bath technique for accurate absolute determinations, to $\sim 1/2\%$, from thermal energies up to several MeV. With manganese replaced by vanadium, as De Volpi had stressed at the standards symposium, measurements can be made more rapidly because of the shorter cycle time. Fröhner also mentioned the importance of the associated particle and associated activity techniques.

Relative measurements, e.g. of the flux shape in white-spectrum measurements, are still hampered by the lack of a reliable method of bridging the energy gap between the region of reliable $1/v$ detectors and the region where the $H(n,p)$ cross section can be used, though it is not a trivial matter to design a reliable proton-recoil detector system. Fröhner recommended further work on He-3 since the Li-6 and B-10 cross sections are less accurately known than one would wish. However, he agreed with Rae that the AERE boron-vaseline detector should be very valuable in bridging the energy gap.

Joly mentioned the plans of a BIPM group headed by Caswell (NBS) to compare fast neutron flux measurements at various Standards Laboratories by means of a suitable transfer instrument. Many experts consider that this will not be a straightforward operation (e.g. because of background problems) but it could perhaps lead to the discovery of unknown sources of errors. Joly agreed to draft a letter for the Chairman to send to Caswell encouraging him.

3(e) Special Topics

Hanna, who had been asked to report on the Special Topics session of the standards symposium, said that most of the items had already been dealt with.

3(f) A Code of Practice for the Statement of Accuracy

Story commented briefly on the report ((UK)-128 AL) by Campion et al. He was interested in the comments of experimenters, but he believed the report had some fundamental defects from the point of view of an evaluator in that it did not come to grips with the "user's" need to treat both random and systematic effects symmetrically. Rae thought Campion's main reason for having the report circulated was the uncertain significance of the accuracies requested in RENDA -- whether they were standard deviations or not. Story replied that the old UK request list had always included such a statement.

4. NUCLEAR DATA FOR SAFEGUARDS, FUSION, AND MEDICAL APPLICATIONS

The discussion was concerned essentially with how data requests for Safeguards, Fusion, and Medical Applications should be entered into the Request List, and it was agreed that establishing priorities would be difficult. There was no consensus on whether they should be flagged in the Request List, e.g. by S, F and M, and all decisions were left to local data committees. In any event the Request List is expected to become the responsibility of IAEA (see agenda item 6b).

Moore agreed to look into the question of distributing US reports on Safeguards Research to the EANDC.

5. CONFERENCES

5(a) Helsinki Conference on Nuclear Data for Reactors

Schmidt referred to the Report on the Helsinki Conference published in Atomic Energy Review 8 (3) 711 (1970), and to the advance copies of the Panel Discussion which had been circulated to conference participants. A report by Hjärne (INDC(NDS)-26/L) analyzed the results of the Questionnaire on the conference. The Conference Proceedings, comprising two volumes each of 800 pages, were expected to be available at the end of 1970.

Commenting very briefly on the conference Schmidt noted that evaluation activities had increased but he thought there were still too many uncoordinated individual efforts. The cooperation of experimenters would be necessary in arriving at internationally accepted evaluations.

5(b) Studsvik Panels on $\bar{\nu}$ and α (Pu-239)

The Chairman complimented Schmidt on the organization of the two Studsvik meetings, which had saved valuable time at the Helsinki conference itself. The conclusions and recommendations of the panels (strictly "experts meetings") are being distributed by the IAEA as INDC(NDS)-25/L; the Chairman asked that all EANDC members be included in this L distribution.

Condé reviewed the $\bar{\nu}$ meeting briefly and noted particularly the recommendations that:

- i fresh measurements are urgently required for $\bar{\nu}$ in the resonance region, to resolve the present almost complete lack of agreement between the experiments of Ryabov and Weinstein (see also item 2b (US) above,
- ii additional experiments are required to complement the interesting $\bar{\nu}$ results for Cf and Cm found by Russian workers (CN-26/90),
- iii further measurements are required below 200 keV for $\bar{\nu}_p(E_n)$ for U-235 and Pu-239, as well as more measurements in general for Pu-240 and Pu-241,
- iv measurements on delayed fission gamma rays are still required, particularly for Cf-252, and

- v a better theoretical approach is required to the energy dependence of \bar{v} to provide a guide to what we might expect.

Schmidt summarized the conclusions of the meeting on α (Pu-239). The problem was not yet solved -- in the energy range 0.1 - 30 keV accuracies are generally not better than 10 - 15% and some discrepancies are larger than this. The possible reasons for these discrepancies were discussed at Studsvik, and the IAEA was following this up with a thorough review, by Sowerby (AERE) and Konshin (IAEA), which will be sent to all experimental groups for comment. Schmidt referred specifically to the following conclusions from the Studsvik meeting:

- i each experimenter should provide the IAEA with the cross section values, capture and fission resonance areas and half widths, that were used in the normalization of the measurements,
- ii there should be a closer investigation of possible systematic deviations between measurements of α that depend on \bar{v} and those that do not (because of the variation of \bar{v} from resonance to resonance in the resolved region, which is still not well established),
- iii the influence of geometrical self shielding and multiple scattering should be investigated more thoroughly by experiment and theory,
- iv it is desirable to perform new measurements for energies above 10 keV using new methods,
- v the possibility of checking the α results obtained by time-of-flight methods by measurements with filtered neutron beams should be explored more thoroughly.

5(c) CODATA Conference

Schmidt had attended this conference (St. Andrews, 7 - 12 September 1970) and an accompanying meeting of the CODATA Committee; a report by Schmidt and Hjärne is being issued as an INDC document. The main aim of CODATA is to establish interdisciplinary coordination but Schmidt felt that there had been too many fragmented status reports on individual fields at the conference, though there had been an interesting session on computer demonstrations. He regretted the lack of discussion at the committee meeting of future activities, but noted the past achievement of CODATA in having produced an International Compendium of Data Projects, which is to be updated in a greatly expanded second edition. CODATA had always regarded the coordination achieved in the neutron data field as a model to be followed, and they were not intending to enter the non-neutron nuclear data field, where attempts at coordination were being planned by the IAEA.

5(d) Third Conference on Neutron Cross Sections and Technology

The Chairman noted that a further announcement regarding this conference (Knoxville, Tennessee, 15 - 17 March 1971) was to be sent out shortly.

H.H. Landon (NBS) will be reporting on the EANDC standards symposium. It is hoped that participation from outside the US will be on the same scale as at the previous (Washington) conferences.

5(e) Conference on the Statistical Properties of Nuclei

The Chairman provided up to date information on this conference which is to be held at the State University of New York at Albany, 23 - 27 August 1971. The preliminary program comprises:

1. Introductory Session
2. Analysis of Experimental Resonance Reaction Data
3. and
4. Statistics of Resonance Parameters (Parts I and II)
5. Nuclear Level Density
6. Properties of Averaged Resonance Parameters
7. Decay of the Compound Nucleus
8. Limitations of the Compound Nucleus
9. Round Table Discussion of Selected Topics : Conclusion

5(f) Additional Conferences

The following conferences were mentioned:

- i International Symposium on Special Research Materials for Nuclear Measurements, Gatlinburg, Tennessee, 5 - 8 October 1971

Kobisk (Oak Ridge) and Lauer are members of the organizing committee, and the proceedings will be published by the USAEC. EANDC agreed to help sponsor this conference.

- ii International Conference on Multiply Charged Heavy Ion Sources and Accelerating Systems, Gatlinburg, Tennessee 22 - 27 October 1971

Kolstad is a member of the organizing committee. Sponsored by IUPAP, APS and the European Physical Society.

- iii IAEA Panel on Evaluation Methods, almost definite, for the summer of 1971, 30 - 40 people. The fission neutron energy spectrum may be discussed at a satellite meeting (see also agenda item 2e).

6. REQUEST LIST

6(a) Discussion of the New Request List (EANDC-85 U)

Following the decisions taken at the 13th meeting (EANDC-83 U, p 38) a series of reports commenting on the requests listed in RENDA had been written by EANDC members. In most cases these reports, some of them in draft form, were distributed at the meeting and immediately discussed by the Committee. Brief accounts of the discussions are given below (6a(i) - 6a(ix)). Moore noted that the RENDA retrievals had omitted requests for gamma ray production cross sections and that some 50 items had therefore not been covered.

The Committee then considered how best to promulgate the information contained in the individual reports. It was decided not to combine them into a single document, as had been done in 1967 (EANDC-76 U), but to ask all authors to issue their individual reports as L-distribution documents so that local data committees, especially, could study them. Authors were urged to convert draft reports into final form as soon as possible.

6 (a) i \bar{v} Requests

Condé spoke to (OR)-102 L. Regarding $\bar{v}(E)$ for Pu-239 Batchelor mentioned the recent evaluation by Mather and Bampton ((UK)-125 and Fröhner asked about the unusual behaviour observed by Nesterov et al (CN-26/74) who found $\bar{v}(\text{Pu-239})$ more or less constant up to 1 MeV. Condé noted that these authors considered their Pu-239 results to be only preliminary; they did not agree with other measurements and Condé did not believe them. Rae contended that there were many low data points in the region of 0.25 MeV, and mentioned that unexpected behaviour in this region could be due to the onset of p wave fission, which is known to be characterized by a different fragment mass distribution.

6 (a) ii Moderators

Story spoke to (UK)-129, and mentioned that a large fraction of the requests do not specify a "purpose". He also noted that many Priority I requests make no reference to any work in progress; UK practice is to start work themselves on Priority I items unless they are known to be receiving adequate attention elsewhere. There is only one request for thermal scattering law data remaining in EANDC-85 (No. 1370 for BeO) and Story believed it was possible that the requesters might be satisfied by the work of Schroeder, JUL-61ORG(1969), which had come to his attention after writing (UK)-129. Story noted that J-18 AL gave a good summary of thermal scattering data, including comparisons of theory and experiment, but did not explore the question of what reactor designers wanted and whether existing data were adequate.

6(a) iii Thermal Capture Cross Sections

Hanna gave a brief summary of (Can)-43, and there was no discussion.

6(a) iv Resonance Parameters for Non-Fissile Elements

Rae presented (UK)-131. The Chairman mentioned the desirability of a group approach to certain requests, e.g. those for data on separated isotopes of Zr and Hf, in order to ensure coordination of activities at different laboratories and the production of the best possible data. Regarding fission products, Aten referred to the German fast reactor program which required integral measurements immediately for initial design and differential measurements at a later stage. Rae observed that most requests for differential data on fission products would probably be met by improving our knowledge of the statistics for stable

nuclei rather than by direct measurements on the fission products themselves. Nève mentioned Mol/Geel plans for measurements of σ_S , and of σ_γ at higher energies, for U-238, and Moore added that Columbia had data for σ_T and σ_γ ; DeSaussure was also active at ORNL.

6(a) v Resonance Parameters for Fissile Elements

Joly spoke to (E)-134 which included all heavy elements and therefore partially overlapped (UK)-131. There was general agreement that satisfying all these requests would be extremely difficult, and widespread discrepancies were noted in reported values of resonance parameters, but it was not clear whether these were due primarily to the experimental data themselves (including the treatment of background) or to the methods of analysis. Moore referred to the plans to compare independent analyses of a fictitious data set (to be prepared by Lynn at AERE) but Joly pointed out that the analysis of raw transmission data from samples of different thickness would not be involved, and Story was generally sceptical of the usefulness of this approach. Havens emphasized the difficulties of baseline subtraction, and said that the data from different laboratories always agreed better than the analyses, though Joly cited Pu-240 as a clear example of discrepant data. Story thought any parameterization of the data was acceptable, provided that no one tried to use it as "statistical" information. Havens concluded the discussion by referring to the article on Fourier Analysis in the 1910 Edition of the Encyclopaedia Britannica which claimed that five parameters would give an acceptable fit to the profile of any human face.

6 (a) vi Fast Fission Data

Moore presented (US)-148. The problem is essentially σ_f for U-235 since the ratio measurements are relatively reliable. He referred to the discussion at the EANDC standards symposium (see agenda item 3c) and particularly to independent absolute measurements used in the U-235 evaluation by Poenitz. These support the lower U-235 fission cross section values and should not be completely discounted.

6'(a) vii Fast Neutron Capture

Fröhner spoke to (E)-135 and noted that the highest accuracy so far achieved was about $\pm 5\%$, for Au; requests for 1 or 2% accuracy must therefore be considered quite unrealistic at the present time.

6 (a) viii Elastic and Inelastic Neutron Scattering

Smith presented (US)-149. Some 200 requests had been examined (25 of them priority 1) and 151 explicit remarks added. These predated the EANDC standards symposium, and Smith believed that the NBS request for 0.5% for H should be reconsidered. Aten considered a 1% accuracy for C to be unobtainable but Rae and Smith claimed that the total scattering was known to be better than 1% between 0.5 and 1.5 MeV.

6 (a) ix Threshold Reactions

Aten presented a preliminary version of (E)-136. He believed that many requests could be combined, e.g. data at 14.6 MeV should be considered as satisfying a 14 MeV request. There were two types of requests,

the first for fast reactor design, and the second for activation detectors used in flux and spectrum measurements. Aten recommended the setting up of a "sufficient set" of activation detectors; far too many are being used at present.

(b) World Wide Request List

Schmidt opened the discussion and noted that the INDC had recommended at its June 1970 meeting that the EANDC and non-EANDC lists be combined, if EANDC agreed. IAEA would collect the non-EANDC requests and send them to CCDN who would merge them. Schmidt referred to the screening procedures in non-EANDC countries which are being improved with IAEA help.

The Committee agreed to the combining of all requests into a World Wide Request List, noting that the mechanics of preparing it would be no more difficult than for the present list, and that computer retrievals for review purposes would still be available.

(c) EACRP Recommendations for Including Evaluations

The Committee was unable to reach a consensus but agreed that all members would ask their local data committees to produce lists of requests for evaluations and distribute them as EANDC documents before June 1971. The Committee would then reopen the discussion at its next meeting.

7. DATA INDEXING, COMPILING AND EVALUATION

7(a) Current ENEA Activities (November 1969 - October 1970)

The CCDN activities were reported by Potter as follows:

i General

No new activities have been taken up by the CCDN and its activities continue to fall under the four headings: Experimental Data, CINDA, Evaluated Data, and RENDA. A total number of 230 requests (predominantly for experimental data) were answered in the period November 1969 to October 1970. The average delay has been cut down to about 5 days unless additional contacts with authors or other data centres are found to be indispensable. An average of one request in eight came to CCDN from NDS and originated from laboratories outside the CCDN area of responsibility, mainly from the USSR.

ii Experimental Data

About 100,000 data points were added to the NEUDADA file, an increase partly compensated by correction work which has led to the deletion of many duplicates. Appointment of liaison officers for countries or individual laboratories well-known as data producers has been found essential for a quick improvement of the file content, and the CCDN will continue to invite such liaison officers. At present the total file contains about 1,150,000 data points. The last index was published in October 1969 as CCDN-NW 11.

In view of the EXFOR agreement between the NNCSC, CCDN, NDS and CJD, which became effective 1 July 1970 the file was split into two subfiles: the Internal Subfile contains all the data compiled from laboratories in the CCDN area of responsibility, and the External Subfile contains the rest. Conversion programmes between NEUDADA and EXFOR in both directions were implemented, and one exchange tape with about 45,000 records was produced, while another tape containing about 15,000 was received from the NNCSC. Recent re-organization within the CCDN provides not only for the fulfillment of the EXFOR agreement but also for work on the backlog. Highest priority is being given to those data sets published during the period October 1968 - July 1970 when data exchange between the CCDN and the NNCSC was temporarily halted. The CCDN has been represented at all "four centre" meetings; discussions on data exchange were held with the NNCSC and the NDS, but cooperation has not been helped by the absence of the CJD (Obninsk) representatives from both the meetings held this year.

iii CINDA

The CCDN has continued to prepare entries for its service area, to carry out computer operations on behalf of the three centres on the European continent and to send exchange tapes to the DTIE. The total number of records is at present 68,000. Agreements between the CCDN and the NDS ensure that the next cumulative edition of CINDA in its old form or by automatic phototype setting, can be published by IAEA early in 1971.

iv Evaluated Data

The CCDN continued to distribute on request information from ENDF/B, UKNDL and KEDAK in the original formats to users in its area of responsibility. (Requests from the NDS for special DFN's of the UKNDL are only answered with the explicit approval of C.G. Campbell). Recently revised versions of all three files were received. Results of V. Benzi's evaluation work on radiative capture cross sections for nuclei with $32 \leq Z \leq 66$ were published in CCDN-NW 10 in December 1969. This file is available in ENDF/B and UKNDL formats. An updated reference list of evaluation work is in press and will be published in November as CCDN-NW 12 replacing CCDN-NW 9 dated March 1969.

v RENDA

An updated version of the EANDC requests for neutron data measurements was published in February 1970 as document EANDC-85 U. Special care was taken to harmonize comments and laboratory abbreviations. USAEC and UKAEA have computerized the compilation of national requests but unfortunately not in a format which can be used directly by the RENDA system. UK requests were split clearly into requests for experiments and evaluation. The latter were not included in EANDC-85 U (see discussions at the 5th meeting of the EANDC-EACRP Joint Sub-Committee for Evaluations). Steps have been taken to ensure a rapid combination of the existing EANDC file with the supplementary IAEA file, if the EANDC were to recommend such an action.

Potter also reported that an ENEA committee chaired by Dr. Kowarski was examining the ENEA's information activities in depth. It would be reviewing the position of the CCDN and the Computer Programme Library at Ispra, and also how its conclusions might relate to the EANDC and the EACRP. Accordingly these committees were each being invited to send a representative to the next meeting

of the Kowarski committee in Paris 7 - 8 December 1970. The EANDC decided provisionally to ask Story to represent them, though it was understood that C.G. Campbell (also from Winfrith) would be the EACRP representative.

7(b) Current IAEA Activities

Schmidt reported informally as follows:

i Four-Centre Meeting, Paris, October 1970

Although the Obhinsk representatives did not attend this meeting, so that no official agreements were reached, there was important progress on EXFOR coding, and on a compilers' manual LEXFOR which specifies the physics basis of EXFOR. Regarding a Data Index, it was suggested that CINDA should so indicate whenever data are available in a data file at one of the Centres.

ii Compilation

December 1970 is to be devoted to a crash programme of entering new data and converting older entries from DASTAR to EXFOR format.

iii Activities arising out of the Studsvik and Helsinki Meetings

(The IAEA plans concerning $\bar{\nu}$ and α are outlined in agenda items 2e and 6b) T.A. Byer has assembled data on fission cross section measurements for U-235 and Pu-239 and is writing a review.

iv Request List

The non-OECD request list will be updated; a small USSR delegation is expected to visit Vienna in December 1970 and letters have been sent to other requesters. A proposal from Byer on requests for safeguards data, especially on priority definitions and screening procedures, has been approved by a majority of the INDC's Standing Subcommittee on Safeguards Data and appropriate steps should soon be taken to obtain official submissions. Most of the Safeguards requests are expected to be for non-neutron data and to go into a separate Request List. There are no plans yet for assembling a list of requests for evaluations.

v Targets and Samples

An INDC subcommittee has made some progress towards setting up procedures; Hjärne has visited Geel and Schmidt will be visiting Oak Ridge.

7 (c) Current US Activities

Pearlstein presented the following report on NNCSC activities:

i Experimental Data

At a Four-Centre meeting held in Moscow in November 1969 an exchange format (EXFOR) was devised for the transmission of experimental data between Centres. After a trial exchange of tapes, formal transmission of data began 1 July 1970. At the recent Four-Centre meeting in Paris the NNCSC transmission

was examined in detail. No serious problems in the transmission of experimental data have been noted so far.

Trial transmissions of data from experimenters in a format approximating EXFOR are under way at USAEC laboratories. These procedures will minimize the time required for the generation of author proofs and the entry of data into the files.

The compilation BNL-400, "Angular Distributions in Neutron-Induced Reactions, Volume I, Z = 1 to 20" has been issued. Volume II is in press. Computerized techniques were used in preparation of the material for publication. These techniques will reduce the costs and time required for future publications.

ii Evaluated Data

Version II of the ENDF/B library has been distributed. An intensive effort to test the data in benchmark calculations is being performed by the Cross Section Evaluation Working Group, a cooperative effort among several laboratories. An ENDF Formats and Procedures Manual will be issued soon.

Programming has been started on a physics checking code, PSYCHE, for ENDF data. The code will use a library of basic data, such as masses, spin, decay properties, etc., to check input data. In addition statistical properties and spectrum averages will be calculated from the data file for comparison with experimental values such as strength functions, resonance integrals, fission and Maxwellian spectrum averages, etc.

Increasing attention is being given to nuclear model codes for use in evaluation studies. The NNCSC is attempting to assist studies that will determine the availability, code size, programming language, capabilities, and documentation of useful codes. (The report on the 8 October 1970 meeting of the CSEWG task force on nuclear model codes was distributed to the EANDC meeting.)

iii General

A bi-monthly newsletter has been issued since January 1970 describing the latest additions to the experimental data files.

Interactive graphic equipment is scheduled for delivery in December 1970.

7 (d) Publication of CINDA

Moore presented the following report on CINDA:

i Publication of CINDA-71

At the last EANDC meeting, a recommendation was made to split CINDA into two volumes, one containing earlier entries which would require only infrequent revision, the other containing cumulatively the most recent entries and which would appear annually as in the past. Details of the recommendation were not settled at the meeting, and during the next several months these details were discussed by correspondence by the EANDC ad hoc CINDA subcommittee members.

At the meeting of the EANDC-EACRP Joint Subcommittee on Evaluation in London, June 1970, and again at the EACRP meeting in Richland, July 1970, publication plans for CINDA-71 were discussed. At that time, it appeared that the recommendation to split CINDA into two volumes would not be implemented for CINDA-71, and perhaps not for the subsequent few editions, because of the use of a new format which will effectively reduce the size of the volume.

ii Summary of US CINDA Entries over the past Year

The following information was supplied by Laurence T. Whitehead of the Division of Technical Information Extension at Oak Ridge, concerning CINDA activity over the past year.

Total Entries in CINDA	76,783	12 October 1970
US	27,259	
Saclay	49,524	
Within last year, added	17,127	
US	4,564	
Saclay	12,563	
Reports - for last year		
US	2,543	
Saclay	1,898	

The entries made in the last year by Saclay included cleanup of older literature. Coverage was extended from 1955-1970 to 1950-1970. US Report literature coverage was extended back through the declassified reports as far back as 1944. This work is continuing.

Schmidt added that the IAEA was rather confident that computer controlled composition would be feasible, and that only one volume would be required in 1971. However, he agreed with Moore that CINDA would have to be split some time (there was a 20% increase in the past year).

7(e) Other National and International Activities in Indexing and Compiling

All members were asked to include news of indexing and compilation activities in their progress reports.

Rae mentioned a recent compilation of fission product yields by J.G. Cuninghame of the Chemistry Division at Harwell; the data are on magnetic tape. Rae suggested that anyone interested in the data should write to Cuninghame.

8. TIME, PLACE, AND TOPICAL DISCUSSION FOR THE NEXT EANDC MEETING

It was agreed to follow the established pattern and hold the next meeting in an OR-group country. Condé submitted two proposals, the Laboratório de Física e Engenharia Nucleares, Sacavem, Portugal, or the Danish Atomic Energy Commission Research Establishment, Risø. He suggested that if the meeting were in Portugal the Topical Discussion might be on the Capture Cross Sections of Fission Products, though this was not directly related to the Portuguese programme, and that V. Benzi should be invited to attend. If the meeting were at Risø a suitable subject would be The Impact of Nuclear and Fission Theory on Nuclear Data. Other suggested topics were Research Programmes with Small Reactors (for Portugal) and Low Energy Inelastic Scattering and Reactor Physics (Risø).

It was decided to hold the next meeting on 11 - 15 October 1971 at a place to be decided by the OR-group, possibly with the help of the Chairman. It was also agreed that consideration should be given to meeting for one day of the week at the ENEA Headquarters in Paris.

APPENDIX

LIST OF EANDC DOCUMENTS ISSUED SINCE THE
13th EANDC MEETING IN BOURNEMOUTH (October 1969)

(a) Committee Papers EANDC-X

- 82-U Distribution List of EANDC documents
83-A Complete Minutes of the Thirteenth Meeting of
 the Committee
83-U Technical Minutes of the Thirteenth Meeting
 of the Committee
84-U Isotope Separation Facilities
85-U RENDA Compilation of EANDC Requests for
 Neutron Data Measurements

(b) Canadian Documents - EANDC(Can)-X

- (Can)42-L Progress Report, September 1969-September 1970, comp. by G.C. Hann
(Can)43-L Review of the 1970 EANDC Request List - Thermal
 Neutron Capture Cross Sections and Capture
 Resonance Integrals, by G.C. Hanna

(c) Euratom Documents - EANDC(E)-X

- (E)124-U Neutron Nuclear Data Compilation and Evaluation
 - Past, Present and Future, by J.J. Schmidt
(E)125-U Evaluated Microscopic Neutron Cross Sections and
 26 Group Constants for Cd, by H. Bachmann et al
(E)126-AL Examen critique des sections efficaces neutroniques
 du ²⁴⁰Pu, by J.P. L'Hériteau and P. Ribon
(E)127-U Progress Report on Nuclear Data Research in the
 Euratom Community, January 1 to December 31 1969
(E)128
not assigned
(E)129-AL Measurement of the ²³⁵U Fission Cross Section in
 the Resonance Region and Discussion of the Normal-
 ization Differences, by A.J. Deruytter and C. Wagemans
(E)130-AL Scattering Cross Section of ²³⁵U below 100 eV,
 Determination of Γ_n and J of Resonances, by F. Poortmans,
 H. Ceulemans, E. Migneco and J. Theobald
(E)131-AL Measurement and Normalization of the ²³⁹Pu Fission
 Cross Section in the Low Resonance Region, by
 A.J. Deruytter, C. Wagemans and G. Penning

(E)132
not assigned

- (E)133-AL The Half Life of ^{234}U , by P. DeBievre et al
- (E)134-L Some Comments on Requests in RENDA-70 for Heavy Element Resonance Parameters, by R. Joly
- (E)135-L Review of RENDA Requests for Fast Neutron Capture Measurements, by F.H. Fröhner
- (E)136-L Remarks on RENDA Requests for Threshold Cross Sections, by A.H.W. Aten

(d) Japanese Documents EANDC(J)-X

- (J)16-AL Bibliography for Thermal Neutron Scattering (2nd Edition) July 1969
- (J)17-AL Average Level Spacings and the Nuclear Level Density Parameter, August 1969
- (J)18-AL Evaluation of Thermal Neutron Scattering Cross Sections for Reactor Moderators (Summary Report) September 1969
- (J)19-L Progress Report, August 1969 - June 1970, by T. Momota
- (J)20-AL Japanese List of Requests for Measurements September 1970

(e) Documents from other OECD Countries EANDC(OR)-X

- (OR)93-L Progress Report from Switzerland, June 1970, edited by T. Hürliman
- (OR)94-L Progress Report to EANDC from Austria, January 1970, edited by P. Weinzierl
- (OR)95-L Progress Report from Denmark, August 1970, edited by H. Bjerrum Møller and C.J. Christensen
- (OR)96-L Progress Report from Sapin, September 1970, edited by F. Verdager
- (OR)97, 98, 100 Assigned to Progress Reports which have not been produced
- (OR)99-L Progress Report on Nuclear Data Research from Sweden, August 1970, edited by H. Condé
- (OR)101-L Progress Report from Portugal, August 1970, edited by F. Gama Carvalho

(e) Documents from Other OECD Countries EANDC(OR)-X (continued)

- (OR)102-L Review of $\bar{\nu}$ Requests in RENDA, 1970, by H. Condé
- (OR)103-AL Neutron Capture Cross Sections in F, Mg, Al, Si, P and S from 20 to 80 keV, by G. Nyström
B. Lundberg and I. Bergqvist

(f) U.K. Documents EANDC(UK)-X

- (UK)118-AL The Half-lives of ^{198}Au and ^{148}Pm , by M.J. Cabell
and M. Wilkins
- (UK)119-AL Structure in the Fission Cross-section of ^{235}U , by
B.H. Patrick, M.G. Sowerby and M.G. Schomberg
- (UK)120-AL U.K. Nuclear Data Progress Report Mid 1968, by
E.R. Rae
- (UK)121-AL Measurements of $\bar{\nu}_p$ for ^{239}Pu between 40 keV and
1.2 MeV, by D.S. Mather, P.F. Bampton, G. James and P.J. Nind
- (UK)122-AL The Ratio of the $^6\text{Li}(n,\alpha)$ to $^{10}\text{B}(n,\alpha)$ Cross-
section from 10 eV to 80 keV and recommended
values of the $^{10}\text{B}(n,\alpha)$ Cross-section, by
M.G. Sowerby, B.H. Patrick, C.A. Uttley and K.M. Diment
- (UK)123-AL The EANDC-EACRP Joint Sub-Committee for Evaluations
- Report of the 5th Meeting in London, 10-12 June 1970,
by B.H. Patrick
- (UK)124-AL An Activation Technique for the Absolute Calibration
of a Long Counter, by J.M. Adams, A.T.G. Ferguson and
C.D. McKenzie
- (UK)125-AL Evaluation of $\bar{\nu}$ for ^{239}Pu , by D.S. Mather and
P.F. Bampton
- (UK)126-AL Elastic and Inelastic Scattering of Neutrons in the Energy
Range 1.0-5.0 MeV by Natural Mo, by R.E. Coles and D. Porter
- (UK)127-AL Evaluation of Cross-sections and Angular Distribution for
Total Elastic and Inelastic Neutron Scattering from Carbon
in the Energy Range 1 eV-15 MeV, by D. Porter and K. Wyld
- (UK)128-AL A Code of Practice for the Statement of Accuracy,
by P.J. Champion, J.E. Burns and A. Williams
- (UK)129-A On the Requests in RENDA for Nuclear Data for
Moderators (draft), by J.S. Story

(f) U.K. Documents EANDC(UK)-X (continued)

(UK)130-AL Concerning the Half-life of ^{144}Ce , by M.J. Cabell and M. Wilkins

(UK)131-A On the Requests in RENDA for Nuclear Data for Resonance Parameters of Non-fissile Materials, by E. Rae

(g) Documents from the United States EANDC(US)-X

(US)133-A Compilation of Requests for Nuclear Cross Section Measurements (draft version, November 1969), by L. Stewart, H.T. Motz and M.S. Moore

(US)134-A Nuclear Physics Studies with Fast Neutrons: A Survey, by J.C. Hopkins

(US)135-A Comparison of Calculations with Integral Experiments for Plutonium and Uranium Critical Assemblies, by C.C. Cremer, R.E. Hunter, J.-J.H. Berlijn and D.R. Worlton

(US)136-A Neutron Fission Cross Sections for ^{231}Th , ^{233}Th , ^{235}U , ^{237}U , ^{239}U , ^{241}Pu , and ^{243}Pu from 0.5 - 2.25 MeV using (t,pf) Reactions, by J.D. Cramer and H.C. Britt

(US)137-A Status of the ^{10}B Absorption Cross Section, by L. Stewart

(US)138-U Angular Distributions in Neutron-induced Reactions, Volume 1, Z=1 to 20 - BNL 400

(US)139-L Remarks on the Neutron-induced Fission Spectrum, by C.R. Lubitz and L. Stewart

(US)140-A Fission Cross Sections of ^{237}Np from Pommard, by W.K. Brown, D.R. Dixon and D.M. Drake

(US)141-A Neutron Flux Determination in Time-of-Flight Cross-Section Measurements using Underground Nuclear Explosions, by W.K. Brown, P.A. Seeger and M.G. Silbert

(US)142-A An Evaluation of ^{235}U Neutron Cross Section Data for Energies above 15 keV, by H. Alter and C. Dunford

(US)143-U Reports to AEC Nuclear Cross Sections Advisory Committee, Argonne National Laboratory, May 20-22, 1970, compiled by R.E. Chrien

(US)144-L Stable Isotope Cross Section and Heavy Element Research Pool Inventory, May 1970

(f) Documents from the United States EANDC(US)-X (continued)

- (US)145-A Fast Neutron Total and Scattering Cross Sections
of ^{238}U , by P. Lambropoulos
- (US)146-A Safeguard Papers from ANS/AIF Winter Meeting -
November 1968, February 20, 1970
- (US)147-A Some Remarks on Prompt Fission Neutron Spectra,
May 1970, by A.B. Smith
- (US)148-L Fast Fission Requests in RENDA, October 1970,
by M.S. Moore
- (US)149-L Review of Requests for Neutron Scattering Cross
Sections, October 1970, by A.B. Smith

