EUROPEAN-AMERICAN NUCLEAR DATA COMMITTEE

TECHNICAL MINUTES OF THE FIFTEENTH MEETING OF THE COMMITTEE

Lisbon, Portugal

11-15 October, 1971

Compiled by

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(Executive Secretary)

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HIGHLIGHTS OF THE FIFTEENTH EANDC MEETING

Following INDC approval of merging RENDA with the non-OECD request list, the EANDC approved the schedule for the first World Request List for Nuclear Data (WRENDA). A draft, produced by the CCDN and IAEA in cooperation, will be reviewed by individual Committee members before June 1972 and the first edition will be published by the IAEA by the end of the year. A preliminary review of requests was made at the meeting. Subsequent editions will be reviewed only by the INDC. Requests for Safeguards and Fusion data will be in separate documents but the production schedule is undecided.

The need for an international list of evaluation requests was debated but a decision was deferred until next year. Specialists meetings, and an evaluation newsletter with wider circulation, were proposed as possible alternatives for promoting international coordination in evaluation. Resulting from a joint EACRP-EANDC subcommittee meeting, two such specialists meetings were planned for 1972. Following a proposal of the EACRP, the EANDC agreed to abolish the joint subcommittee, but suggested that both committees consider sponsoring further specialists meetings.

Committee members were asked to determine the interest in their countries in participating in nuclear experiments at an underground nuclear explosion in 1975, now under consideration by the USAEC. The decision to hold this, or to invite international participation, may depend on the degree of interest expressed.

The status of cross sections and related data used for standards, summarized in the published proceedings of last year's symposium at ANL, was reviewed.

A subcommittee, reporting on ways of improving measurements on $\underline{^{6}Li(n,\alpha)}$, recommended that "direct" measurements be supplemented by shell-transmission and $\sigma_{tot} - \sigma_{scatt}$ measurements. Discrepancies between Li-glass scintillator results from Harwell and Cadarache remain, and a recent experiment has confused attempts to explain them by scintillator thickness effects. However, theoretical fits are now thought to be valid to about 1% below the resonance and perhaps 5% above it.

A review of the <u>fission cross sections of ^{235}U and ^{239}Pu and</u> their measured ratio has been written by Byer and Konshin. Up to 150 keV, results are now consistent to about 5% but agreement is poorer at higher energies. New experiments were reported at Knoxville and others are in progress. ^{235}U remains the major problem. Recent evaluations of the capture cross section of ^{238}U have been made by Byer and Konshin and by Pitterle. At all energies above 10 keV these appear to agree within about 5%. Nevertheless, there are serious discrepancies between both old and recent results that are not understood. A critical review of measurements of α for ^{239}Pu, by *Sowerby and Konshin*, *will be published early in 1972.* A total uncertainty of 10-15% is expected, over the energy range 0.1 keV to 1 MeV.

Suggested explanations for discrepancies among $^{197}Au(n,\gamma)$ cross section measurements included the possible effect of a cross section fluctuation near the energy used for normalization, the use of ^{235}U for flux standardization and underestimation of room-scattered thermals. Several members urged retention of Au as a standard, despite present discordant results.

Several recent experiments on the "French effect" show that it can account for only part of the differences between ^{252}Cf $\bar{\nu}$ values obtained with liquid scintillators and with a Mn bath. The differences are now smaller than before, following a new Mn bath experiment by Axton and a 0.6% revision of Condé's scintillator value. An updated IAEA review will be published.

At an IAEA consultants meeting on the spectrum of prompt fission neutrons, proponents of integral and of microscopic measurements failed to resolve their differences, although the nature and extent of the differences are better appreciated. Previous experiments were criticized and new measurements planned. A review of microscopic measurements, as well as a new measurement by A. B. Smith, support old Los Alamos data. It was accepted that a Maxwellian shape is inadequate, particularly at and below the peak of the spectrum.

SUMMARY RECORD OF THE FIFTEENTH EANDC MEETING

LIST OF PARTICIPANTS

1. EANDC Members

A.H.W. Aten, Jr., Euratom, Geel, Belgium
R.E. Chrien, BNL, Brookhaven, USA
H. Condé, RIND, Stockholm, Sweden
W.G. Cross, AECL, Chalk River, Canada (Executive Secretary)
F.H. Fröhner, KFK, Karlsruhe, Germany [a]
W.W. Havens, Jr., Columbia University, New York, USA (Chairman)
T. Hürlimann, EIR, Würenlingen, Switzerland
G.A. Kolstad†, USAEC, Washington, USA
M. Nève de Mévergnies, Mol, Belgium
M.S. Moore*, LASL, Los Alamos, USA
P. Ribon*, CEA, Saclay, France
J.A.G. Rosén***, ENEA, Paris
J.L. Rowlands*, AERE, Winfrith, UK
M.G. Sowerby*, AERE, Harwell, UK
J. Story, AERE, Winfrith, UK
K. Tsukada, JAERI, Japan

2. Observers

F. Gama Carvalho, LFEN, Sacavém, Portugal (Local Secretary)
H.W. Küsters**, KFK, Karlsruhe, Germany (EACRP Observer)
W.T. Potter, ENEA, Paris
J.J. Schmidt††, IAEA, Vienna

* Ad hoc members: P. Ribon attended in place of R. Joly
M.S. Moore attended in place of A.B. Smith

† Unable to attend meeting

** Attended Session IIIb and subsequent sessions

†† Attended all sessions except I, IV and IX

*** Attended Sessions I-IV, Vd and VIII.

[a] Now at CCDN, Saclay, France.

I INTRODUCTORY ITEMS

The Committee was welcomed by Commander Soeire de Brito, President of the Jumta de Energia Nuclear, who described briefly the present programme and plans for nuclear energy in Portugal.

After correction of minor typographical errors, the Minutes of the Fourteenth Meeting were adopted as published in EANDC 87 "A".

II. REPORTS ON FACILITIES AND MEASUREMENTS

II (a) New Facilities

Belgium. A variable energy cyclotron, nowunder construction at the University of Louvain, is expected to give an external beam early in 1972. It will be used for charged particle and fission experiments. A new target constructed for the Geel linac, similar to the ORELA target, is expected to give improved gamma flash suppression.

Canada. A new beam tube to be installed in the Tandem Van de Graaff in December is expected to give 5 μA of protons, of at least 26 MeV. A new moderator tank for the NRU reactor, to be possibly installed in 1972, will have improved beam tube facilities. The NRX tank was changed early this year without serious difficulties.

France. A 4 MV Van de Graaff is now operating at Limeil. The high flux reactor at Grenoble has attained criticality but is not yet at full power. A neutron capture cross section facility at Cadarache will be tested in November.

Germany. The isochronous cyclotron at Karlsruhe has been modified to give a higher repetition rate and higher power, and is expected to be in use for neutron measurements by the end of 1971. Limited efforts to develop at 1-GeV superconducting Linac have begun.

Japan. A 120-MeV electron linac is under construction and scheduled to be tested early in 1972. Its main purpose is for neutron cross section measurements. A 4-detector, time-of-flight, neutron spectrometer, with flight paths up to 8 metres, is being built for use with the JAERI Van de Graaff.

Netherlands. A decision has been taken to build a 300-MeV electron linac which may be used for electron scattering, medical applications, neutron physics and as a meson factory.

Sweden. A crossed-field analyzer has been added to the Studsvik Van de Graaff, which is used half time for neutron physics. A pulsed source for the Tandem at the National Accelerator Laboratory at Uppsala, to be used for time-of-flight neutron experiments, has been tested.

United Kingdom. At Harwell, the 150-MeV synchrocyclotron is being reactivated for nuclear data measurements. The useful neutron output is similar to the booster-linac combination, but the resolution (~ 0.05 nsec/m) is much better. Facilities for obtaining a low-energy (5 to 15 MeV) beam from the linac, to be used for photonuclear work, have been approved.

U.S.A. The Brookhaven Linac Isotope Producer (see EANDC(US) 150U) is now operating at half its rated output. Its primary use will be production of neutron deficient tracers for biomedical purposes, hopefully starting in 1972, but a large yield of neutrons of up to 100 MeV will also be available. A brief description was distributed.

The Argonne Tandem-Dynamitron fast neutron generator has been modified to operate as either a tandem (8 MeV, 50 μA) or single ended accelerator (4 MeV, 1 mA), to provide a pulsed-neutron source. A ten-detector neutron spectrometer, with flight paths up to 7 metres, is being built. A 4 MV Dynamitron at Argonne and the Brookhaven Double Tandem Van de Graaff (30 MeV, 2μA) have operated well over the last year, mainly on charged particle and heavy ion research.

Completion of the Nevis synchrocyclotron's conversion to a spiral, sector-focused machine, is expected in April 1972. The expected average extracted beam is 10 to 40 μA of 550-MeV protons. Neutron work may start in the latter half of 1972.

A new 100-MeV electron linac at Livermore has met or exceeded all specifications except as a positron accelerator, and is now on a 24-hour/day schedule. Neutron experiments, with flight paths up to 256 metres, have begun. A new cyclograaff at Livermore, which can produce 27-MeV protons, obtained a beam in late spring 1971 and is expected to be fully operational this fall.

At Los Alamos, a 230-MeV proton beam was obtained from the LAMPF in mid-summer. A full energy beam is expected by mid-1972 and experiments may start in January 1973. Among other uses, there are plans for neutron time-of-flight spectrometry.

The schedule of the 400-MeV electron linac at MIT calls for 100-MeV beam tests in October 1971 and 400-MeV tests in the spring of 1973. Operation of the Oak Ridge electron linac (ORELA) continues on a 24-hour/day basis, with impro ved electron gun experience. A 200 m flight path has been built and a 90 m path is under construction.

II (b) Progress Reports and Activities of Local Data Committees

There was a brief discussion of the proper content of progress reports. Havens felt that having up-to-date results was more important than completeness and questioned the inclusion of published data. The problem of deadlines for contributions was particularly acute for composite reports like that of Euratom. Some of the reports submitted included work of marginal interest to the Committee. It was agreed some years ago that, in general, neutron experiments directed to the study of solid state properties should be excluded.

Belgium. Nève referred to work at Mol and Louvain, described in EANDC(E) 140U, mentioning particularly measurements on ^{237}Np (Knoxville Conference Proceedings, p.667) and of fission product yields of delayed neutron precursors (Radiochim. Acta 16, 47, 1971).

Canada. Referring to EANDC(Can)-44L, Cross drew attention to completion of the ^{234}U half-life measurements, with results in good agreement with recent values from Geel and Argonne, and the work of Walker on fission product yields for thermal fission of ^{239}Pu, ^{241}Pu and ^{233}U. Aten urged that figures on these yields be made available as soon as possible and this was generally supported.

France. Ribon described mainly work that was more recent than that reported in EANDC(E)-140U. At Saclay, measurements on the fission cross section of ^{233}U and ^{241}Pu in the resonance region are nearly finished. Future emphasis will be on capture cross sections. Results on fission of ^{239}Pu accompanied by α-emission should soon be published. Measurements on neutron multiplicity for ^{239}Pu show fluctuations from one resonance to another that are not correlated with spin. It is not yet clear how these compare with results from RPI and Oak Ridge, in which somewhat different quantities were measured. Experiments to look for low-energy gamma emission preceding fission in ^{235}U have just started. Determination of strength function variations with A, from average total cross section measurements, and their interpretation, were described at the Albany Conference.

At Cadarache, fission cross section measurements of ^{235}U and ^{239}Pu have been extended from 1 to 3 MeV. New measurements on the $^{6}Li(n,\alpha)$ cross section, from 150 to 260 keV, made with 1 and 3-mm thick scintillators, agree with earlier thick-scintillator results and confuse the attempt to explain differences between Harwell and Cadarache results on the basis of scintillator thickness. Measurement of the fission neutron spectrum from ^{235}U, for 30-keV incident neutrons, began recently.

At Fontenay-aux-Roses, the measured yield of ^{148}Nd (to $\pm$ 2% absolute accuracy), in thermal and fast fission of ^{235}U and fast fission of ^{239}Pu, confirms earlier results. For ^{235}U the yield (2.40 $\pm$ 0.2) is higher than the accepted value. ^{148}Nd is considered a good fission indicator, particularly as the yield varies slowly with energy.

At Bruyères-le-Châtel, work has started on $\bar{\nu}$ for ^{240}Pu up to 14 MeV and on the (n, 2n) and (n,3n) cross sections of various fissile materials.

Germany. Referring to EANDC(E)-140U, Fröhner mentioned work at Munich on high accuracy measurements of the total cross sections of Bi, Pb, Si, C, SiO_2 and D_2O, at 130 eV. (Story noted that the C value was about 1% higher than needed to match age measurements.) Fast fission factors for Be and BeO, and the resonance integral of Hf, were determined at Jülich. Measurement of the total cross sections of gross fission products, from 1 to 30 eV, is continuing at Kiel.

At Karlsruhe, in addition to the work described in EANDC(E)-140U, high resolution transmission measurements, from 10 to 300 keV, were made for ^{10}B, Cr isotopes, ^{54}Fe, ^{62}Ni and ^{64}Ni, in preparation for capture measurements. Comparison of the ^{235}U fission cross section with the hydrogen cross section (Käppeler and Fröhner) has been delayed by uncertainties in the composition of the hydrogenous radiator, but measurements at about 20 energies are now being repeated. Bandl's values of α for ^{235}U and ^{239}Pu, from 8 to 60 keV have been renormalized slightly and will be included shortly in a KFK report. High resolution (n,n'γ) measurements (Cierjacks) will be continued near the end of the year and extended to fission cross sections, from 0.5 to 6 MeV or higher. Earlier measurements on sub-threshold fission in ^{238}U may also be repeated. Calculations by Nix and by Strutinsky indicated that this might be expected. The University of Tübingen plans to collaborate with KFK to look for fission isomers of short half lives.

Euratom (Geel). Aten, referring to EANDC(E)-140U, drew attention to measurements of the $^{6}Li(n,\alpha)$ cross section for thermal neutrons, the ^{234}U half life, total cross sections of ^{237}Np and ^{235}U in the resonance region, fission cross sections of ^{233}U and ^{241}Pu, sub-threshold fission of ^{241}Am and to the normalization of fission cross section measurements from different laboratories, using carefully selected energy intervals. A report on precise measurements of neutron fluxes is now being prepared.

On behalf of Liskien and Paulsen, Aten asked whether they should concentrate their efforts on a new compilation of threshold reaction data or on the angular distributions of neutrons from commonly used charged-particle reactions. While opinion was divided, the majority of the Committee preferred threshold reaction data and some members requested that this be in tabular as well as graphical form.

For ^{239}Pu, the average energy of fission neutrons (measured above 1 MeV) was found to vary more rapidly with incident neutron energies up to 5 MeV, than is indicated by Terrell's expression. There was no disagreement for ^{238}U and ^{235}U. More neutrons were apparently observed between 0.5 and 1 MeV than would be expected for a Maxwellian distribution fitted at higher energies.

Netherlands. Aten mentioned the fission measurements of aligned nuclei, done in collaboration with Harwell. The STEK coupled fast-thermal facility for fission product measurements is now working steadily and its energy spectrum has been measured. A measurement of the ^{252}Cf energy spectrum with activation detectors has been submitted for publication

Italy. As there was no member from Italy, Cross read the report given by Benzi to the INDC meeting in July. Most of this work is described in EANDC(E)-140U.

Portugal. This work is described in EANDC(OR) 109 L. There was no discussion.

Sweden. Condé referred to EANDC(OR)-111L. At Studsvik, systematic studies of differential cross sections for fast neutron elastic scattering have continued. These cover measurements on 20 elements at 8 MeV and on V, Cr, Fe and Ni at several energies between 1.8 and 8 MeV. Inelastic cross sections were measured for about 20 elements from 2 to 4.5 MeV. Time-of-flight measurements of fission neutron spectra from ^{235}U and ^{238}U, for incident neutron energies up to 2 MeV, give Maxwellian distributions with temperatures between 1.27 and 1.30 MeV. However, recent discordant results are described in Agenda item III(d). An experiment to measure fast neutron capture cross sections has started but, so far, only elements with large cross sections have been measured, because of intensity limitations. Qualitative agreement with a semi-direct theory was obtained for fast neutron capture gamma-ray spectrum measurements on Pb isotopes (Bergqvist et al, University of Lund).
At the Research Institute of National Defence, gamma rays from inelastic scattering of 4 to 8 MeV neutrons from O and N were measured. The cross section for O was lower than earlier measurements (by Bonner) by a factor of 2. Values of $\bar{\nu}$ for neutron-induced and spontaneous fission of ^{236}U have been measured, with special attention to the threshold region. Within 1.5%, no correlation was

found between structure in the energy dependence of $\bar{\nu}$ and in the fission cross section. The fission cross section and the angular distribution of fission fragments were measured for ^{232}Th and ^{231}Pa, in the threshold region, and some structure was found.

Denmark. Condé referred to EANDC(OR)-106L which describes various theoretical and experimental aspects of the fission process that have been studied at the Niels Bohr Institute. At Risø, minor revisions to the neutron half life results give a value 10.64 ± 0.15 min.

Switzerland. Work described in EANDC(OR)-112L was outlined by Hürlimann. Cross sections and angular distributions were measured for (n,p) and (n,α) reactions produced in ^{19}F, ^{29}Si, ^{32}S and ^{40}Ca by 5.8-MeV neutrons. For 14-MeV neutrons on ^{9}Be, (n,α) and (n,t) angular distributions were measured at Lausanne and ^{10}B measurements have started. At Würenlingen, the thermal capture cross section and resonance integral for ^{18}O were measured, the latter being unexpectedly large. Multiple scattering corrections to capture cross sections measured with a Moxon-Rae detector have been derived. At Basel, blocking effects have been observed in fission induced by 14-MeV neutrons.

Austria. Hürlimann referred to EANDC(OR)-105L. At the Vienna Atominstitut, activation cross sections were measured at 5 energies between 24 and 974 keV for ^{197}Au, ^{165}Ho, ^{164}Dy and ^{152}Sm. The (γ,n) cross sections of Be and D were measured at several energies. At the Institut für Radiumforschung und Kernphysik, measurements with 14-MeV neutrons include excitation of first 2+ states of 19 even-even nuclei, (n,p) and (n,α) spectra and angular distributions, gamma spectra following capture and (n,p) cross sections. At Seibersdorf, thermal capture cross sections will be measured for high purity separated isotopes from the mass separator. At Story's suggestion, Hürlimann agreed to draw Weinzierl's attention to the importance of trying to measure resonance integrals for these samples.

Japan. Referring to EANDC(J)-22L, Tsukada reported on elastic and inelastic scattering of 1.5 to 3.5-MeV neutrons from La, Pr, Er and Bi at JAERI. Coupled-channel calculations fit these results better than spherical OM calculations. Analysis of the scattering cross section of Fe for 1.5 to 2.5-MeV neutrons was reported at the Albany Conference. Inelastic scattering from ^{133}Cs led to energies and assignments of several levels. Other work is described in EANDC(J)-22L.

The nuclear data committee has evaluated the C total cross section up to 2 MeV, analyzed total cross sections of nuclei with $33 < Z < 73$ over the range 100 keV to 15 MeV, to study systematics in optical model parameters, and compiled elastic and inelastic cross sections for Pu, Na and O. Other compilations are in progress. A Fortran version of NEUDADA (NESTOR) has been prepared for data storage and retrieval.

United Kingdom. Sowerby mentioned some work described in EANDC(UK)-134AL. The first data reported from the new Glasgow linac is for inelastic scattering from ^{27}Al. Measurements at the National Physical Laboratory include a number of thermal capture cross sections, $\bar{\nu}$ for ^{252}Cf (3.72) measured with a new sample, and the capture cross section of ^{238}U at 156, 470, 560 and 620 keV. The latter will eventually be related to a V bath measurement. Most of the work at Aldermaston has been published or is in EANDC reports.

Recent work at Harwell, not described in EANDC(UK)-134AL, included:

- ^{238}U inelastic scattering for 1 to 2.4-MeV neutrons.
- measurement of the ^{235}U fission neutron spectrum.
- measurements to explain differences between ^{240}Pu capture cross sections obtained at Harwell, Geel and RPI. These suggest that Harwell's original average Γ_γ should be increased to about 27 meV.
- measurements of $\bar{\nu}\,\sigma_f$ for ^{240}Pu up to higher energies than measured at Geel.
- calibration of a "black detector" against a long counter, which confirmed the calculated efficiency.
- $^6Li(n,\alpha)$ cross section measurements made relative to the black detector, using thin scintillators.
- $^{10}B(n,\alpha\gamma)$ cross sections which, up to 100 keV, agreed with those derived from total and scattering measurements.
- relative measurements of $\bar{\nu}\,\sigma_f$ for ^{235}U, from a few hundred eV to 1 MeV. Up to 300 keV, these agree with results of a simultaneous evaluation of σ_f for ^{235}U, ^{238}U, ^{239}Pu and σ_{capt} for ^{238}U. At higher energies these measurements fall below the evaluation.

U.S.A. Chrien referred to EANDC(US)-150U and EANDC(US)-156U. At Argonne, $^{235}U/^{239}Pu$ fission cross section ratio measurements by Poenitz failed to confirm the structure above 1 MeV reported by Savin. (There was brief discussion on the hazards of normalizing such measurements near 30 keV.) Measurements of the fission cross section ratios of ^{238}U and ^{235}U from 2 to 5 MeV gave results 6% higher than usually accepted values, closer to integral measurements. Time-of-flight measurements of the fission neutron spectrum of ^{235}U and ^{239}Pu (A.B. Smith) confirm earlier microscopic measurements but not integral results (EANDC(USA)-153L). Use of a Ge(Li) detector for fast neutrons was shown to have advantages of stability, good efficiency and insensitivity to low energy neutrons. Photoneutron spectra, measured near threshold for ^{53}Cr, ^{57}Fe and ^{61}Ni, were reported at the Albany Conference.

At Brookhaven, gamma spectra following p-wave neutron capture in ^{92}Mo and ^{98}Mo can be explained on the basis of single-particle neutron motion. Measurement of spin assignments for resonances in ^{235}U, using high energy gamma transitions, gives an unexpectedly low ratio of spin 3 to spin 4 fission widths. Capture gamma spectra in ^{237}Np, measured at low neutron energies, yield the binding energy of ^{238}Np.

At Gulf Radiation Technology, statistical model analysis of heavy element capture cross sections, over the 1 to 1000 keV region, gives good agreement with measured results. A high precision measurement of the $^{10}B(n,\alpha_0)$ and $^{10}B(n,\alpha_1)$ cross sections, up to 1 MeV, is in progress. At Oak Ridge, capture cross sections were measured, using the total energy technique, for about 40 nuclides. A binding energy for ^{239}Pu, about 5 keV higher than that given by Motz, was obtained. Measurement of the capture cross section of ^{207}Pb does not confirm the large direct capture component in the 41-keV resonance suggested by Livermore photoneutron results. Inelastic scattering cross sections of ^{7}Li, C, Na, Si and Fe, measured using a carbon fluoride scintillator, were presented at Knoxville. Measurement of α for ^{239}Pu, from 0.02 eV to 400 keV, gave good agreement with Gwin's previous work.

At RPI, resonance parameters for ^{240}Pu were reported at Knoxville. KeV capture results in V, Cr and Ni showed a very high correlation between neutron and total radiation widths for even-even targets which, in view of threshold photoneutron measurements, is difficult to explain theoretically.

A coupled fast reactivity facility at Aerojet Nuclear is being used to measure average cross sections, by both activation and reactivity measurements, of stable and radioactive fission products. Structure in the ^{235}U fission cross section in the keV region, has been measured by Bowman at Livermore with very high resolution (0.15 nsec/m). At Lockheed, an evaluation of the ^{197}Au capture cross section has been made, from 10 to 5400 keV. At Los Alamos, Moore has measured resonance fission in the sub-barrier resonances of ^{252}Cf. Measurements of J and K of levels in ^{236}U and ^{238}Np, using polarized neutrons and polarized targets, are planned for next year at the ORELA. Calculations on the detection of ^{238}U capture resonances with a large scintillator show that some "p-wave" resonances reported earlier result from scattering effects.

Neutron spectroscopy at Columbia has been concentrated on measurement of resonance parameters in rare earth elements. Level spacings show remarkably good agreement with Dyson-Mehta theory. Parameters for ^{238}U have been measured up to 5 keV for Γ_n and 2.35 keV for Γ_γ and the energy variation agrees fairly well with that found at Geel. The wide variations in Γ_γ noted by Glass were not observed. Fission cross sections of ^{233}U and ^{235}U have been measured from low energies to 40 keV and are being fitted with multi-level theory. Gamma spectra and multipolarities from radiative capture in ^{235}U were measured in the resonance region. A 7-nsec isomer has apparently been observed in ^{236}U.

There was concern and discussion on the lack of information on Fe radiation widths. Measurements are underway or planned at Harwell, Karlsruhe and Cadarache. The possibility of a meeting on this topic was briefly considered but no action was planned by the Committee at this time.

In connection with new activities of local data committees, Havens commended the recent involvement of many US non-committee members as consultants in reviewing various measurement programmes. There was no further discussion.

Other Countries. A report was received from Turkey (EANDC(OR)-113L) and a letter from Greece. Rosén had been informed that no nuclear data measurements were being done at present in Norway.

II (c) EANDC Research Papers

Comments on papers not discussed under other Agenda items are given below.

UK-132AL "Evaluation of $\bar{\nu}$ for ^{235}U" (Mather, Bampton). There was some discussion on whether further measurements were needed to resolve the question of low energy structure. An experiment is being considered at Oak Ridge.

UK-133AL "Activation Measurements of the Cross Section of $^{147}Pm(n,\gamma)^{148g}Pm$ for reactor neutrons" (Cabell). Both Cabell and Walker (EANDC(Can)-44L) obtained cross sections lower than most older values.

UK-135AL "An isomeric state of ^{241}Pu" (Cabell, Wilkins). No state was observed. The half-life measured (15.16 y) is longer than usually found, but is supported by recent work of Whitehead and Sherwood (14.91 y).

UK-136AL "Evaluation of $\bar{\nu}$ for ^{238}U" (Mather, Bampton). The significance of a 3-line fit, which arises from the energy dependence of the data of Soleilhac et al, was questioned.

US-151A "Evaluated nuclear data for H in ENDF/B-II format" (Stewart, La Bauve, Young). The deviation from isotropic scattering begins at a lower energy than expected.

US-160A "Recommendation for the preparation of modular size metallic isotope samples for neutron cross section measurements" (Block, Smith). This proposal is under consideration by the USAEC. There is argument in the US about the best size. Criticisms from Geel were that the optimum size varied with Z, and that stacking thin samples gave greater thickness inhomogeneities and more chance of surface oxidation. Coating the samples would complicate construction of a mosaic.

OR-104 "Gamma rays from inelastic scattering in oxygen" (Lundberg, Strömberg, Condé). Results disagree with Hall and Bonner (1959) but agree with Dickens and Perey (1970).

E-118U "Evaluation of fast critical experiments using recent methods and data"(Kiefhaber, Schmidt). The purpose was to use differences between observed and calculated properties of various critical assemblies to suggest possible deficiencies of data.

Aten described a survey by Zijp (RCN-71-083) on the effective cross sections used in different laboratories for the commonest threshold and resonance detectors in typical reactor spectra. The wide variations observed indicated the need for discussion. An ad hoc subcommittee (Chairman, Aten; members, Hürlimann, Nève; Observer, Schmidt) was set up to propose recommendations on discrepancies in detector cross sections.

III MEASUREMENTS, REVIEWS AND EVALUATIONS

III(a) Subcommittee on Standards and Discrepancies

This item was discussed by the whole Committee as no sub-committee meeting was held during the year.

H(n, n). There is a new precision measurement by A. B. Smith and others, at 2.534 MeV. While Wilson's summary at the 1970 Argonne Standards symposium indicated that the low energy parameters were "in good shape", a recent Munich measurement of the coherent scattering length suggests a discrepancy in the singlet effective range that Wilson regards as serious. Equipment is available at Brookhaven for further measurements.

$^{6}Li(n,\alpha)$. Recent measurements at Harwell and Cadarache, and the difficulties of reconciling the results, were mentioned in the UK and French progress reports. Moore understood that Uttley's R-matrix calculation of this cross section, partly reported at Knoxville, was thought to be valid to about 1% below the resonance and perhaps 5% above. Ribon mentioned a similar analysis by Fort, which also gave a good fit to both the total (n,α) cross section and angular distributions up to 520 keV. Ribon wished to make a direct comparison of the two theories. Sowerby and Ribon agreed to urge Uttley and Fort, respectively, to complete their calculations on $^{6}Li(n,\alpha)$ and issue EANDC reports as soon as possible (Actions 9 and 10).

$^{10}B(n,\alpha)$ and $^{10}B(n,\alpha\gamma)$. Havens drew attention to recent papers by Lane and others (Physical Review C, 4, 377 (1971)) and by A. B. Smith and others (Physical Review C, 4, 1061 (1971)) on determination of the R-matrix parameters and their use in calculating the differential cross sections for these two reactions.

^{12}C. The recent Munich value for the low energy total cross section (4.74 ± 0.007 barns) agrees with Uttley and Diment's evaluation. It is about 1% above the Japanese evaluation (EANDC(J)-22L) or the value n eeded to match age measurements.

$^{23}Na(n,\gamma)$. Goldstein had outlined (EANDC(US)-157A) the discrepancies among 3 measurements of Γ_γ for the 2.85-keV resonance. Chrien thought that these probably arose from the difficulties of measuring Γ_γ's in the presence of large Γ_n's. Interference with a negative energy resonance was likely necessary to reconcile the thermal cross section and resonance Γ_γ. Neither the Harwell nor Brookhaven gamma spectrum measurements were considered particularly reliable.

Fe. Goldstein had noted (EANDC(US)-157A) discrepancies between measurements of the total cross section minima and those calculated from resonance parameters. Fröhner suggested that these might result from neglect of various corrections (e.g. Doppler broadening) in the calculations.

Moxon is continuing evaluation of keV capture in Fe and Ni. Story suggested that about half the resonances observed in these elements by Hockenbury et al should be attributed to d-wave excitation, contrary to Hockenbury's assessment.

$^{197}Au(n,\gamma)$. Havens commented that the agreement among many measurements of this cross section was much worse than the accuracies claimed. Goldstein, in EANDC(US)-157A, quoted "adjustment factors" up to 25%, to bring different data into agreement. Suggested explanations discussed were (1) underestimation of the importance of room-scattered thermal neutrons and (2) the frequent use of the ^{235}U fission cross section for flux standardization. Sowerby said that separation of Au results, into those measured relative to ^{235}U and others, gave better agreement within each set. Grench had obtained reasonable agreement by suitable normalization of results obtained since 1959 (EANDC(US)-156U) and the Harwell simultaneous evaluation gives good agreement with Grench between 100 and 800 keV.

KFK data on both the total and capture cross sections show a strong fluctuation just in the region (20-24 keV) often used for normalizing different experiments. Fröhner agreed to inform the Karlsruhe group of the importance of this fluctuation and to ask them to estimate its effect on normalization procedures (Action 11). Errors caused by the Al and Ti containers of Sb-Be sources were mentioned by Aten, who urged that ^{197}Au should not be abandoned as a standard just because of imperfect measurements. Several other members supported the retention of ^{197}Au.

$^{238}U(n,\gamma)$. Recent papers are by Poenitz (1970 Nuclear Standards Symposium), Fricke et al (Knoxville), Silver et al (Knoxville) and de Saussure (EANDC(US)-150U). There are now 3 time-of-flight measurements (Harwell, Oak Ridge, Gulf Radiation Technology), all normalized on the 6 eV resonance. Sowerby outlined the discrepancies among them: they agreed in shape only over limited ranges. Havens considered recent Columbia data unreliable because of large backgrounds. (See also III(c))

Discussion on ^{235}U fission cross section discrepancies was deferred to Agenda item III(b).

^{239}Pu. Aten reported that the technique of normalizing results from different laboratories over a carefully chosen energy interval (previously used with success for ^{235}U) had been extended to ^{239}Pu, and reduced the apparent differences in $^{239}Pu/^{235}U$ ratios. The interval chosen varies from one nuclide to another. Fröhner suggested, as an alternative, using a cumulative resonance integral for normalization.

α ^{239}Pu. Moore mentioned that this quantity, over the energy range 100 eV to 100 keV, is still considered a high priority item in the USA. Sowerby and Konshin are writing a review of the data available up to the Knoxville Conference (including Bandl's measurement). Schmidt suggested that it would be worthwhile to delay publication (in the IAEA Atomic Energy Review) in order to include Gwin's recent measurement and six others from the USSR.

$\bar{\nu}$ ^{252}Cf. Earlier results have divided into two groups (scintillators; Mn baths and boron pile) about 2.5% apart. New Mn bath measurements by De Volpi (3.736) and Axton (3.72), as well as small corrections to scintillator values, reduce the difference apparently to something like two standard deviations. The Committee agreed that the measured values were converging but were undecided whether or not a real discrepancy existed between them. Values of $\bar{\nu}$ ^{252}Cf, derived by De Volpi from direct measurements (3.731 ± 0.008) and by Steen from thermal ^{233}U measurements and the author's proposed revision of g-values (3.774 ± 0.014) were presented at the Knoxville Conference. Story questioned the validity of the g-values given in the 1969 IAEA review. A new review of 2200 m/sec data is planned for 1972.

$^{240}Pu(n,\gamma)$. Cross sections from RPI are at least 20% higher than those from Geel and Harwell. Harwell has recently renormalized upward (see III(b)) and Sowerby suggested that the Geel results might contain the same error. Aten agreed to examine the Geel normalization and inform the Committee.

The Committee considered all the items in Goldstein's "Check List of Neutron Cross Section Discrepancies". There was no discussion on items not mentioned above or covered under other Agenda items.

III(b) Recent work on the ^{235}U Fission Cross Section

This item was discussed under III(c).

III(c) Status of Fast Fission Cross Sections and ^{238}U Capture

These two items were considered together. Moore first described recent experiments on cross section ratios. Poenitz measurements on fission cross section ratios in ^{235}U, ^{238}U and ^{239}Pu and Käppeler and Fröhner's measurement of σ_f (235) relative to the (n, p) cross section have already been mentioned in the US and German progress reports. A second comparison of σ_f (235) to the (n, p) cross section, over 1 to 28 MeV, is underway at Los Alamos (K. Smith). Some concern was expressed over the possible non-stoichiometric composition of the hydrogen radiator. Moore also referred to Bowman's ^{235}U relative cross section values and measurements of $\bar{\nu}\ \sigma_f$ (235), from 100 keV to 1 MeV, at Harwell.

^{235}U still remains the major problem, although Moore felt that, below 150 keV, the situation was better than last year. In a review (to be published in the IAEA Atomic Energy Review) Byer and Konshin were able to get consistency to 4 or 5% among data on $^{235}U(n, f)$, $^{239}Pu\ (n, f)$ and $^{238}U(n, \gamma)$ in this energy range. Schmidt warned that some of the preliminary conclusions that Byer and Konshin reported at Knoxville might be altered. There was discussion but no general agreement on how well the cross sections were known between 150 keV and 1 MeV. Above 1 MeV, serious discrepancies exist and the hope is that these will be resolved by the Los Alamos experiment mentioned above. Grundl has remeasured the ratio σ_f (238)/ σ_f (235) in a ^{235}U fission spectrum, obtaining a value 6% higher than predicted by microscopic data.

For ^{238}U capture, there are recent evaluations by Konshin and Byer and by Pitterle. Both curves, which were normalized in the region around 30 keV, are lower than the older Davey and Pitterle evaluations, with de Saussure's latest measurements falling between the old and new evaluations. Above 2 MeV, a new 6% discrepancy has been created by the recent measurements of Meadows and Poenitz (EANDC(US)-156U) on the $^{238}U/^{235}U$ fission ratio. Other new data were discussed under Agenda item III(a). See also EANDC(US)-163A.

The Committee decided not to take any action. Sowerby was asked to write a 1-page report on the Sowerby-Patrick-Mather simultaneous evaluation of ^{235}U, ^{238}U and ^{239}Pu fission and ^{238}U capture cross sections, and distribute it to Committee members.

III(d) The Prompt Fission Neutron Spectrum of ^{235}U and ^{239}Pu

Schmidt reported on the IAEA Consultants meeting on the Status of Prompt Neutron Spectra, held in August and attended by experts on both microscopic and integral measurements. Hjärne's preliminary draft of recommendations was distributed to the Committee.

It was generally accepted that a Maxwellian shape did not fit the whole spectrum, the main disagreement occurring at and below the maximum. A paper by Soloviev on the theoretical shape of the prompt fission spectrum will be issued as an INDC report, but some EANDC members questioned the validity of his approach. Possible structure in the spectrum below the maximum was disputed. No preferred values of T were recommended. Recent preliminary results by Holmqvist et al, on the spectrum from 0.5 MeV neutron fission of ^{235}U, show closer agreement with a Watt distribution than with a Maxwellian.

Further measurements on the spectrum from both ^{235}U and ^{252}Cf, with pointwise tabulation of the results, were recommended. Criticisms of existing measurements included inadequate separation of direct fission neutrons and scattered neutrons (in both microscopic and integral measurements), gamma sensitivity of neutron detectors and inadequate investigation of the detector's energy dependence.

The Consultants meeting also recommended new measurements (to 2 or 3%) of average fission cross sections of ^{235}U and ^{238}U in spectra from ^{252}Cf and the thermal fission of ^{235}U. The accuracies of Grundl's and Fabry's integral measurements were felt to be less than claimed, because of back-scattering. Grundl and Fabry have started new measurements at the National Bureau of Standards. Moore noted that attempts to calculate room-scattering for the integral measurements of Leachman et al were being considered.

The distribution for the complete report of this meeting has not been decided. However Schmidt agreed to issue a summary report to the Committee as soon as possible.

An IAEA review, prepared for the Consultants meeting, confirmed older Los Alamos microscopic spectral measurements, giving an average energy slightly below 2 MeV. A recent measurement by A.B. Smith (EANDC(USA)-153L) gave a similar result.

III(e) Recent work on 2200 m/sec Fissile Isotope Constants

Schmidt pointed out the apparent discrepancy between Deruytter's recent measurement of the ^{235}U thermal fission cross section (587.9 ± 3.4 b) and the value given by Hanna et al in the 1969 IAEA review (580.2 ± 1.8). Adoption of the new half life for ^{234}U (Geel, Argonne, Chalk River) may reduce this difference by about 2 barns. Deruytter's value for ^{239}Pu (742.5 ± 3.7 b) on the other hand, agrees with the IAEA review, as does a recent measurement by Petrascu et al (741.0 ± 7.0).

A revision of the IAEA review of 2200m/sec fission constants is planned by the Agency for 1972.

III(f) Recent Work on the "French Effect" in Liquid Scintillator $\bar{\nu}$ Measurements

Ribon reported that both recently published work of Signarbieux et al (Nuclear Inst. and Methods) and work in progress at Bruyères-le-Châtel conclude that the effect is too small to account for the whole discrepancy between scintillator and Mn bath measurements of $\bar{\nu}$. Boldeman and Axton are at present measuring $\bar{\nu}$ ^{252}Cf. Soleilhac plans further measurements in about a year, after instrumental effects have been investigated.

III(g) Report of the Joint EANDC-EACRP Subcommittee on Evaluations

1. The Evaluation Newsletter

Ribon reported that this now goes to more than 100 people in all OECD countries, EACRP members having recently been added to the distribution list. Havens commended the Newsletter as a valuable means of distributing information and urged members to keep Ribon informed of current evaluation activities.

2. Subcommittee Report

This report had been distributed and will be given an EANDC number*. The subcommittee met in August, just before the IAEA panel on neutron nuclear data evaluation. They discussed the possibilities for inter-European coordination in evaluation efforts and how this could be furthered by small meetings of specialists. Two meetings were proposed for 1972 - one at Harwell in January to consider the present status of evaluations of fissile nuclides and a second at Ispra or Bologna in mid-year, to discuss conversion programmes for evaluated data.

* EANDC- 88A; EACRP-A 176.

III(h) Discrepancies in Detector Cross Sections

Aten reported on a meeting of the ad hoc Subcommittee on Discrepancies in Detector Cross sections. The first problem considered was the selection of suitable detector reactions which required further cross section measurements. This topic will be discussed in June 1972 by an IAEA working group on reactor radiation measurements and the results will be reported to the INDC. The NDS will prepare a status report before the meeting, after consultation with Zijp and Maas. The Subcommittee decided to take no further action on this problem until after the working group meeting.

Two other problems were the use of different decay schemes by experimenters measuring cross sections, and the use of different average cross sections for flux measurements. The Subcommittee declined to recommend any conventions on such matters but urged that authors publish all pertinent data on the decay schemes and average cross sections used. It appeared premature to specify a convention on the shapes of fast neutron spectra.

Aten asked if there were interest in neutron activation detectors that would operate at high temperatures ($>$ 1000°C). Work was proceeding at Geel on Mg-Al-Co oxide ceramics and on high temperature alloys. Rowlands suggested that this question be referred to the EACRP and Küsters agreed to do this.

IV THE EANDC REVIEW OF REQUESTS

For the benefit of new members, Havens described the normal reviewing procedure. Comments made at an EANDC meeting were taken by members to the local data committees who would modify requests as they considered necessary. The present review was intended just as last minute corrections to be given directly to the CCDN and IAEA.

(i) $\bar{\nu}$ Requests (Condé). The comments of EANDC(OR)-102L are still valid. Only one low accuracy request (956) has been fulfilled. However, Boldeman's very recent measurements have not yet been taken into account.

(ii) Moderator Requests (Story). There is little change since EANDC(UK)-129L. Few of the 59 requests (even those of Priority I) include any indication that work is in progress or planned to meet them. Story reiterated his conviction that Priority I requests should either state that measurements are planned or explain why they are not.

(iii) Thermal Capture Cross Sections (Cross). Of the 90 requests not listed as "satisfied" or "probably satisfied" in EANDC(Can)-43L, (of which nearly half are Priority I) only about 2 appear to have been satisfied since. Most are from the USA, Canada and Japan. Moore commented that the thermal part of the Savannah River requests on cross sections related to ^{252}Cf production had more or less been satisfied, although data up to 1 keV are still required.

Aten asked why many requests still appeared in RENDA marked "withdrawn". The apparent practice has been to retain a request for one edition, after it has been met. Story suggested that these be put in a special table with separate notation for requests that had been met and those withdrawn for other reasons.

Cross noted that the information in the new Danish request list was incomplete and Condé agreed to discuss this with the originators before submission to CCDN.

(iv) Resonance Parameters for $Z < 90$ (Chrien). Chrien had prepared a detailed summary of new information pertinent to these requests. This was distributed to the Committee. In commenting on these, he questioned why partial gamma radiation widths for some of the rare earths had been requested.

(v) Resonance Parameters for $Z \geq 90$ (Joly, Ribon). A report (EANDC(E)-139AL) was distributed. Most of these requests have not been fulfilled in the last year, even at very low energy, except for ^{239}Pu. Ribon commented that when several parameters are asked for, the request should explain to which information the accuracy figure applies - e.g. to a particular parameter, to an average valve, to a function of parameters such as ($g\ \Gamma_n, \Gamma_\gamma/\Gamma$) etc.

Moore expressed the opinion that present resonance parameters for most fissile nuclides are virtually meaningless, since the non-uniqueness of multi-level fits prevented significant extrapolation to the unresolved region. (This might not apply to ^{239}Pu and ^{241}Pu.) There was mixed reaction to this opinion and some discussion. There is growing evidence that spins and K values are the important parameters to measure.

(vi) Fast Fission Data (Moore). A few modifications were needed to update EANDC(US)-163A. Moore agreed to make these and issue it with L distribution by October 31, 1971.

(vii) Fast Neutron Capture (Fröhner). While most of EANDC(E)-135AL still applies, Fröhner felt that recent results on ^{197}Au and ^{238}U capture should be incorporated. He agreed to make these modifications and send the amended report to the CCDN and IAEA before October 31, 1971. It would then be given an L distribution.

(viii) Elastic and Inelastic Scattering. A report to the NCSAC by its scattering subcommittee (A.B. Smith, Chairman) was reproduced and distributed to Committee members.

(ix) Threshold Reactions (Aten). Aten reported that EANDC(E)-137L was up to date except for the recent list of Swedish requests. Aten agreed to issue an addendum covering recent requests to the CCDN and IAEA before October 31, 1971.

There was general discussion on the treatment of "withdrawn" requests. Those "withdrawn" in RENDA'70 would completely disappear from WRENDA'72. On suggestions from Schmidt and Fröhner it was agreed that items withdrawn in the latest request lists would be printed only as a separate list of request numbers in WRENDA, although they would remain in the computer file and could be retrieved for anyone needing them.

Aten remarked that many of the comments in present request lists were made out of date by data in CINDA'71, but it was generally felt impractical to amend these before the October 31 deadline. Rowlands suggested that only comments on planned experiments were useful to potential measurers, who could get information on completed experiments from CINDA.

V. INTERNATIONAL COOPERATION IN THE MEASUREMENT OF NUCLEAR DATA

V(a) Neutron Measurements using Underground Nuclear Explosions

This matter had been discussed at the last meeting. Moore said that, while USAEC plans were still uncertain, an explosion ("Physics 10") possibly open to international participation had been suggested for 1975. The tentative proposal was that the whole cost of the explosion would be borne by the USAEC. The Los Alamos laboratory could probably provide facilities for data recording, all other equipment being supplied by the participants. Various degrees of collaboration with Los Alamos groups might be considered. Taschek had discussed possible costs to participating groups at the last INDC meeting and Moore agreed to send this information to members who did not already have it. A minimum effort of two scientist-years was suggested and considerably more was likely.

Whether or not Physics 10 is held may depend on the degree of interest expressed by foreign laboratories. The IAEA had agreed to coordinate such expressions of interest from different countries. All members were asked to consult with appropriate groups in their countries and inform Schmidt of their interest before the end of 1971. No binding commitments were required at this stage, but specific proposals would be more valuable than general indications of approval. Moore hoped that some novel experiments would be suggested.

If plans for Physics 10 go ahead, expected participants might be invited as observers to a Physics 9 underground explosion in 1973.

V(b) Elastic and Inelastic Cross Section Measurements

Chrien mentioned a collaborative experiment by the Argonne laboratory and a South African group on fast neutron scattering from Ti. Evaluations were also made.

V(c) Computer Codes for Nuclear Model Calculations

This item was discussed last year. A. B. Smith had remarked on the difficulties of running codes on different computers and the different results often obtained when this was done. At the IAEA panel on Neutron Nuclear Data Evaluations in August 1971, a number of specific recommendations had been made. Rosén felt that some of these were unrealistically ambitious and described the high cost to a laboratory of producing, debugging, testing and documenting a programme. The total cost of about $35 per Fortran statement amazed several members but Rosén said it could be supported by many instances. To check out a "finished" program obtained from another centre, at the Ispra CPL, costs between one and two thousand dollars. Because of these high costs, the ENEA program library at Ispra must be very selective in collecting programs for subsequent distribution.

To assist this selection, Rosén wished to obtain opinions on programs from the users. He suggested that members send in a brief description (following the ENEA program abstract format) of up to 10 nuclear model codes which had been found particularly useful and had potentially wide interest and this was agreed to. Story warned that the more useful a code was, the more likely it was to be under continual revision. Rosén agreed to send each member the name of the data centre liason officer in his establishment.

V(d) Recommendations of Other Areas of International Cooperation on Nuclear Data Measurements

As an example of existing collaboration, Nève mentioned that the Grenoble reactor could be used by scientists from countries other than France and Germany. A Belgian group had recently been asked to collaborate on a physics experiment. Chrien commented on collaboration on level-scheme determinations among Brookhaven, Risø, Munich and Argonne.

International intercomparison of flux measurements had been discussed at the 1970 Argonne Standards Symposium. A meeting had been considered for early 1972 but EANDC members had no information on it. The Chairman agreed to find out about this meeting from Caswell and inform the members.

Aten reported that the fission foil exchange programme, sponsored by BCMN and started about a year ago, had progressed very slowly because of delays in returning foils.

V(e) Capture Gamma Ray Newsletter

Information on experiments in progress or being planned at 25 laboratories is compiled by Earle and Lone at Chalk River and distributed every six months. Chrien cited this as a valuable example of international cooperation.

VI. NON NEUTRON NUCLEAR DATA

VI(a) Safeguards

The only Safeguards request list available was from the US (EANDC(US)-159A) which Moore described. About half the requests, from Gulf Radiation Technology, are for yields of prompt and delayed neutrons and delayed gammas, stimulated by photon interrogation. The remainder, from Los Alamos and Brookhaven, are for yields from neutron interrogation. Aten suggested that, for some of the requests, the energy range was unnecessarily wide (e.g. 0 to 14 MeV) and that it would be preferable to specify a few selected energies - e.g. 3 and 14 MeV in the case of neutrons. Moore noted that scattering in large hydrogenous samples degraded the energy of the interrogating beam, so that data over some energy range were required.

It was generally agreed that some conventions on interrogating procedures were both possible and desirable, in order to reduce the data needed. Members were asked to discuss with their local committees possible improvements in Safeguards request lists.

Aten expressed the hope that data committees in other countries would submit Safeguards request lists before the next EANDC meeting. Schmidt quoted an action on INDC members to urge their committees to submit lists.

Schmidt described the procedures agreed on by the INDC and within the IAEA for handling Safeguards requests. These requests will not appear in WRENDA'72 but in a separate document. Aten noted that some techniques are common to Safeguards and to normal fuel inventory control, leading to duplication in the lists. There was some feeling against the INDC decision to have Safeguards and fusion requests in separate lists from reactor requests. Schmidt explained that this was unavoidable if the time schedule for the WRENDA'72 was to be met, since many of the fusion and Safeguards requests had not yet been submitted. A more permanent difficulty in combining the lists is the different priority systems for Safeguards and reactors. Havens read from the minutes of the INDC 1971 meeting, in which the expectation was expressed that computer retrieval of any desired category would reduce the problems of having requests distributed among three separate documents.

VI(b) Fusion

Fusion request lists were available from Euratom (EANDC(E)-141A) and from the US (EANDC(US)-162A). Story said that the UK list was very similar to the US list. Nève commented that EANDC(E)-141A had been prepared for Euratom's Advisory Group on Fast Reactor Technology. It differed in only a few respects from the US list. Cross sections for threshold reactions were requested at several energies (rather than only at 14 MeV) and could be interpolated by means of theory. No priorities were assigned because application of the data appeared to be remote. A German fusion request list, to go to the IAEA at the end of October, was being prepared by Cierjacks, who was in close touch with Nève.

Story presented a summary of available data on ^{12}C (given in Appendix 5) based mainly on experiments at Lausanne. There are US requests, not in US-162A, for data on inelastic scattering from ^{12}C.

VI(c) Medical and Other Applications

Havens raised the question whether the EANDC should be involved in such a broad field. Cross suggested that, despite the great variety of medical applications, the amount of nuclear data required primarily for these applications was not large. The most extensive unsatisfied needs were some decay schemes, and cross sections of biological elements and of reactions used for flux measurements, the latter being common to reactor requirements. Schmidt remarked that a meeting to discuss these matters would be held in 1972. There was no discussion of industrial applications.

VII. SAMPLES

The Chairman reported that he had acted on all requests during the year. When no opinion had been received within a reasonable time from many of the members, action was taken on the basis of existing replies. Tsurada and Aten remarked that their requests were progressing satisfactorily and there appeared to be no other pending requests.

VIII DATA INDEXING AND COMPILATION: THE DATA CENTRES

VIII(a) Current ENEA Activities

Rosén announced that Fröhner would replace Liskien as head of CCDN. CCDN had continued to prepare entries for the service area and exchange tapes with DTIE. The CINDA system is being reprogrammed for faster access and linked with the NEUDADA library. Numerous retrieval requests have been met. EXFOR exchange is operating steadily. Only complete libraries of evaluated data are collected and distributed at present but computer programmes are being acquired for processing and retrieval of specific data. Evaluated data is sent only within the service area and the recipient agrees not to retransmit it. A written report was distributed to Committee members (Appendix 4).

There was some discussion on the need to distribute partial files of evaluated data but no specific conclusions were reached.

VIII(b) Current IAEA Activities

Schmidt spoke to INDC(NDS)-31L. CINDA'71 and its first supplement had been issued; a second supplement would be published in early 1972. The CINDU data index has been maintained. About half the DASTAR entries of experimental data have been converted to the EXFOR format. A Four-Centre meeting in October will consider future trends and developments of the centres, CINDA and EXFOR, among other things. A compilers manual (LEXFOR) has been prepared.

Several reviews on fission and capture cross sections were referred to in Session III. A report on $\bar{\nu}$ data for all isotopes with $230 \leq A \leq 252$ is finished. A review on thermal data for Pu isotopes was prepared for panel meetings. A status report on reactions used for reactor fluence measurements will be finished in mid-1972. A survey of evaluation needs and activities in member states was made for the Evaluation Panel in August. Data needs for fusion reactors are being collected from the major fusion research centres. A list of requests for Safeguards is being assembled.

A working group meeting in 1972 on non-neutron nuclear data is described under Agenda item X(a). This group will be concerned with level schemes, charged particle reactions and other data of importance to Safeguards and fusion programmes and possibly to radioisotope applications.

Replying to Rowlands questions, Schmidt described the situation on nuclear data in the USSR. Groups at Obninsk and Minsk are eager to produce data files but have been delayed by hardware and software computer problems. Some evaluated data on inelastic scattering has been received from Nicolaev. A ^{238}U file is in preparation. One cannot predict how much data can be expected from the USSR in the near future. Nicolaev's recent request list does not indicate experiments in progress or planned.

Rosén raised the question of why EXFOR did not adhere to the ISO standards. Future communication between the 4-centres and other data centres might require a more widely accepted format, although the translation problems appeared to be fairly straightforward. Schmidt mentioned some of the advantages of EXFOR, as compared with all-embracing schemes like INIS, and said that the question would probably be considered at the next 4-centre meeting.

VIII(c) Current U.S. Activities

Chrien read Pearlstein's report on the activities of the NNCSC (Appendix 3), mentioning procedures for correcting the SCISRS library, the ENDF/B-III library and installation of an interactive graphic system at the NNCSC.

At the US data centre meeting in September, nine experts reviewed the functions and programmes of each data centre and discussed compilation of data for the GE chart, Hollander's Table of Isotopes, the ORNL Nuclear Data Project, McGowan's charged particle reaction file, Heath's catalogue of gamma spectra and Fuller's photonuclear data evaluation. Among non-official recommendations, the meeting

- urged that all journals adopt a keyword system
- deplored suppression of tabular data by some journals and encouraged wider use of the National Auxiliary Publication microcard service
- endorsed further publication of the GE chart
- suggested that a standardized system be used in scanning and referencing journals
- encouraged increasing use of computer data files.

A new, more portable edition of the Table of Isotopes is in progress and a new edition of BNL-325 is being planned which will include mainly resonance parameters. Members were encouraged to send suggestions on BNL-325 immediately to Goldberg.

Moore reported that a recent arrangement between the DTIE and NNCSC will provide listings of SCISRS content to CINDA by about January 1972. Entry of ancient data into CINDA should also be completed by January.

Chrien described the Feshbach crash program to bring nuclear data compilation up to date by the fall of 1974. Some funds are available but the program has not actually started.

VIII(d) Other National and International Activities in Indexing and Compiling

Schmidt reported that a small group from Euratom countries was meeting in October to consider decay schemes of radioactive isotopes used in medicine. They will do prototype evaluations on 5 particularly important isotopes to develop rules for further work.

IX RELATIONS AMONG DATA CENTRES

Schmidt remarked that, apart from very extensive correspondence, the main interactions among the centres occur at Four-Centre meetings. He outlined the Agenda of the October meeting at Brookhaven which included future policies and coordination, interaction with data requesters, possible extension of the scope of EXFOR data, the Evaluation Newsletter, relations between the centres and WRENDA, links to INIS and UNISIST, manuals and dictionaries and CINDA.

Rowlands suggested that an INDC meeting might be a more useful place than a 4-centre meeting to discuss the Evaluation Newsletter or collaboration on evaluation, since 4-centre delegates did not represent the evaluators in OECD countries. He urged that any world-wide extension should not be allowed to reduce the effectiveness of present collaboration among a limited number of countries. Ribon noted that the recommendation of the Vienna Evaluation Panel (Agenda item X(a)) can imply publishing a second newsletter on a wide scale, rather than extending the circulation of the present Evaluation Newsletter.

X. MEETINGS AND CONFERENCES

X(a) Reports on Past Meetings

Brief reports were given on the following meetings.

1. IAEA Consultants Meeting on Non-Neutron Nuclear Data, Vienna, November 1970.

   Schmidt referred to INDC(NDS)-30 for details. The main recommendation of the meeting was that a Working Group on Nuclear Structure and Reaction Data (IWGNSRD) be formed, and its technical terms of reference were proposed. This recommendation was accepted by the Agency, who arranged a working group meeting for March 1972, and the INDC approved this action. A primary objective is to identify the important non-neutron data needs of applied nuclear energy programmes.

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

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

4. Third International Conference on Neutron Cross Sections and Technology, Knoxville, March 1971.

5. IAEA Regional Study Group Meeting on Low Energy Accelerator Utilization, Rio de Janeiro, March 1971.

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

7. IAEA Fusion Conference, Madison, May 1971.

8. IAEA International Working Group on Fast Reactors Meeting, Vienna, May 1971.

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

10. IAEA Panel on Plutonium Recycling in Thermal Reactors, Vienna, June 1971.

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

12. International Conference on the Statistical Properties of Nuclei, Albany, August 1971.

    Havens reported that there was nothing startlingly new. The most interesting papers were on non-statistical properties.

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

    This was discussed under Agenda item III(d).

14. IAEA Panel on Nuclear Data Evaluation, August/September 1971, Vienna.

    A preliminary report, giving the Agenda, a list of papers submitted, and recommendations of the meeting, was distributed to members. Schmidt discussed the recommendations. The Agency was asked to arrange for a study of multigroup constants and their discrepancies and to list available nuclear model codes and arrange for tests of their reliability and accuracy. The Panel commended the exchange of evaluated data and the investigation of a common format for their transmission. It suggested that the Agency explore the problems of a world-wide equivalent of the Evaluation Newsletter and possibly discuss this question with the INDC.

Schmidt felt that recommendation of a particular format for evaluated data exchange was premature at the moment. Most of the necessary translation programmes between the 4 widely used formats already exist. The topic will be discussed at the next 4-centre meeting.

A vital condition for the extension of the Evaluation Newsletter was felt to be that the present speed of collecting and distributing up-to-date information be maintained. Rowlands argued that extension of the Newsletter was not worthwhile until there was free exchange of evaluated data. Schmidt felt that the existence of a world-wide Newsletter might stimulate such exchange.

Proceedings of the Panel will be published early in 1972.

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

Final values for new measurements of the ^{234}U half life were presented.

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

17. Third International Symposium on Targets and Nuclear Research Materials Preparation, Gatlinburg, October 1971.

Moore reported that the Proceedings were already available and outlined many of the subjects discussed - enrichment factors, high dispersion instruments, electro-deposition, casting and vaporization techniques.

X(b) Future Meetings

1971

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

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

3. International Symposium on Heavy Ion Research, Gatlinburg, October 1971.

1972

1. IAEA Panel on Standards for Nuclear Data Measurements, November 1972.

2. International Working Group on Nuclear Structure and Reaction Data, Vienna, March 1972.

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

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

5. International Conference on the Study of Nuclear Structure with Neutrons, Budapest, Hungary, July 1972.

1973

No NDS Panels are planned for 1973.

1. IAEA Symposium on the Collection, Compilation, Indexing, Evaluation and Distribution of Nuclear (including Neutron) Data, probably March 1973, possibly France.

   A program committee, now being formed, will meet in March 1972.

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

1974

1. Third IAEA Conference on Nuclear Data.

TOPICAL DISCUSSION AND VISIT TO SACAVÉM

A Topical Discussion on the subject "Research Programmes with Small Reactors" was held at the Laboratório de Física e Engenharia Nucleares (LFEN), Sacavém, on October 13. It was attended by meeting participants and scientists from the LFEN staff and from the University of Lisbon. The director of LFEN, Dr. Carlos Cacho welcomed the delegates and outlined the organization and facilities of the Sacavém Laboratory, The Chairman (Havens) described briefly the history of topical conferences at EANDC meetings. The following papers were presented:

- A Research Program for Small Reactors, A.H.W. Aten
- Slow Neutron Physics Research, H. Rauch (Atominstitut der Öesterreichischen Hochschulen, Vienna)
- U.S. Research Programs with Small Reactors, M. Moore
- Use of BR1-reactor at Mol in the Field of Nuclear Data, P. del Marmol, A. Fabry and M. Nève de Mévergnies
- Research Work with the Portuguese Research Reactor and Survey of Research Programs with Small Reactors in EANDC OR-countries, F. Gama Carvalho
- Research Program with Small Reactors in Spain, J. Montes Ponce de León.

Participants visited the Van de Graaff, reactor and other laboratories at Sacavém and had individual discussions with scientists there.

Report of Ad hoc Subcommittee on Establishing
The $^{6}Li(n,\alpha)$ Cross Section

1. Although the exact wording of the EANDC minutes appears to require that the $^{6}Li(n,\alpha)$ cross section should be measured more accurately (or at least be remeasured) between about 1 keV and 100 keV, it seems more reasonable to ask for data through the resonance. This would mean measurements up to 0.5 MeV, but since recent measurements of Clements and Rickard show there are discrepancies of up to a factor 2 above 1 MeV and this energy range is also important, one might as well consider measurements up to 1.7 MeV or even higher.

Dr. A. B. Smith has strongly advocated that the $^{6}Li(n,\alpha)$ cross section should be determined as the difference between σ_T and σ_{sc}. This only seems to be a promising method at the low energies (e.g. below ~400 keV) where σ_{sc} is not very much greater than $\sigma_{n\alpha}$. If this suggestion is followed it is evident that the main problem will be the determination of σ_{sc}. The values of σ_T seem to be reasonably well established but there is a case for making an additional measurement covering the eV to MeV energy range to confirm the data of Uttley. The energy range around 1 to 2 MeV is not particularly well known because this is the region of minimum cross section and the samples used to obtain the available data have been too thin.

Whether or not a "greasy ball" (Boron-Vaseline sphere) would be useful for the scattering measurement, as suggested by A. B. Smith seems doubtful. Its efficiency for detecting neutrons scattered in different directions is by no means constant. One of the main points to consider will be to decide what will be the most suitable neutron detector for this purpose. (The use of ^{3}He detectors has been suggested, but the question should be studied with great care). If an accuracy of 1-2°/o is required in $\sigma_{n\alpha}$ then similar or greater accuracy is required in the measurement of σ_{sc}. Since the scattering from ^{6}Li is not isotropic in the energy range we are considering it appears that this will not be easy to achieve. In measuring σ_{sc} it will probably be convenient to use carbon as a standard scattering material. Apart from this Smith's suggestion to measure both ^{7}Li and ^{6}Li should certainly be followed at least up to 0.48 MeV because the ^{7}Li scattering and total cross sections are effectively identical in this energy range. However, if the measurements for ^{7}Li are correct it does not follow that those for ^{6}Li are also good because the corrections for absorption of scattered neutrons are more important in the latter case. To make corrections for this and for multiple scattering it will be necessary to use a Monte Carlo programme. It might be possible to make measurements on a series of samples of different size and different isotopic composition and hence extrapolate to zero sample size and 100°/o ^{6}Li composition but these extrapolations are difficult to do accurately. They could however be used as a check on the Monte Carlo calculation.

2. The shell transmission method should by no means be neglected as it provides a method of obtaining $\sigma_{n\alpha}$ independent of neutron flux measurements. One can not hope to obtain quite the same accuracy as with the σ-difference method but if say ±4°/o accuracy were obtained it would provide a very welcome check on the other data.

The shell transmission method is based on the fact that, if a neutron source is placed in a spherical shell, the fraction of neutrons absorbed is given by one minus the integrated transmission of the shell. It makes the computation of the results easier if a point neutron source is used and the detector is mounted a long way from the shell so that its efficiency does not need to be independent of direction. Of course the positions of the source and detector can be interchanged so that a non isotropic source can be used with a small isotropic detector. The major corrections that have to be made to the measured transmission arise from imperfections of the source or detector inside the shell (e.g. not isotropic and/or not small compared to the cavity size) and from the effects of multiple scattering in the shell. The effects of the multiple scattering can be made smaller by using a thin shell but under these conditions it is difficult to measure the transmission accurately. Therefore, before commencing a high accuracy measurement of this type, it is obviously important to do accurate calculations using a sophisticated Monte Carlo programme which can take into account all the experimental conditions. The experiment can then be designed to give results which are as insensitive as possible to the assumptions made during the analysis of the results. Experiments could be performed using Van de Graaff accelerators, Linacs and photoneutron sources and each of these have their advantages and disadvantages. There do, however, appear to be significant advantages in using a pulsed neutron source.

The shells required would not cause too many difficulties as they can be made at CBMN. The thickness would only be constant to 2-3°/o but the average thickness would be well known.

3. An alternative method is to count directly the α-particle and/or triton using a thin ^{6}Li foil or scintillator. This type of experiment is being performed on a linac by Coates et al using a thin ^{6}Li glass scintillator and the "greasy ball" for flux measurements. The upper limit in energy with which the thin scintillator can be used is 1-2 MeV because of γ-rays produced by inelastic scattering in the scintillator. At higher energies, therefore, it would appear that thin ^{6}Li layers would be the basis of the best detector system. These must

be mounted in a counter system which produces little background by scattering. The measurement of neutron flux to high accuracy is a major problem in this type of experiment but in principle accuracies in the range 2-5°/o should be possible. Measurements appear to be feasible on both Linacs and electrostatic generators up to energies of several MeV.

4. It will probably be useful to consider the possibility of obtaining valuable information from the inverse reaction. This problem will require a special study both concerning the accuracy and reliability attainable and the selection of a suitable laboratory to perform the measurements.

5. The problem will likely be solved only when agreement between results with several methods is obtained and that such scope probably indicates a co-operative effort between several institutions or at least between several independent groups at the same institution.

APPENDIX 2

COMMISSION DES COMMUNAUTES EUROPEENNES

DIRECTORAT-GENERAL

CENTRE COMMUN DE RECHERCHE

BUREAU CENTRAL DE MESURES NUCLEAIRES

RECEIVED OCT 26 1971 W. W. HAVENS Jr.

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Prof. W.W. HAVENS, Jr.
Chairman EANDC
Division of Nuclear Science and Engineering
Columbia University
741 Sw. Mudd Building
520 West 120th Street
NEW YORK, N.Y. 10027
U.S.A.

GEEL, October 21, 1971

Dear Professor Havens,

The committee ad hoc created by the EANDC on 12.10.71 to report on "Discrepancies on Detector Cross Sections" (members: Aten, Nève de Mévergnies and Hürlimann, J.J. Schmidt also present at the discussion) has already given its conclusions orally during the meeting at Lisbon. Even so I feel that it may be good to put these conclusions in writing to make sure that I have correctly reported the opinion of the members.

1. It was learned that the Nuclear Data Group of the IAEA has a working group on cross-section values and resonance integrals and on the selection of suitable detectors for thermal, intermediate and fast neutron flux densities. This working group is preparing a meeting in the course of June 1972. In this meeting a report will be produced which will be submitted to the INDC-meeting in July 1972. It was felt by your committee ad hoc that this report might go far to resolve present uncertainties in cross-section values of detector cross sections and resonance integrals and to make helpful suggestions for the selection of the most useful activation detectors. In as far as experimental data are at present insufficient the IAEA working group will be able to make suggestions for measurements which should be undertaken. At the time of the next INDC this report will then be available for consideration. To avoid double work your committee ad hoc has suggested that nothing will be done on behalf of the EANDC until the report of the Agency working group will be available.

2. To deal with the uncertainties in flux density measurements due to differences in the decay schemes adopted for the products of the nuclear reactions involved (e. g. the number of gamma-rays per decay of $^{115}In^{m}$) the committee ad hoc decided to suggest that EANDC urge authors to mention in their publications all pertinent information concerning the decay schemes involved. (This seemed to be a more acceptable solution than the introduction of arbitrary conventions for insufficiently well-known decay schemes.)

3. To deal with uncertainties in flux density measurements for fast (fission spectrum) neutrons due to differences in the assumption of the shape of the fission spectrum and of the cross section curves, the committee ad hoc decided to suggest that EANDC urge authors to indicate in their publications the values used for the average cross section for fast neutrons of their detector reaction.

4. In view of the intensive discussions going on at present concerning the shape of the fission spectrum the ad hoc committee considered that it would be premature to suggest a convention for a fission flux spectrum to relate average cross sections to flux density above defined energy limits (thresholds).

I hope I have managed to report our conclusions with a fair accuracy. The discussion in the full EANDC was somewhat rapid, but if any corrections should be made I hope the members of the committee ad hoc will provide them.

With kind regards,

A. H. W. ATEN

Copies :
Mr. Nève de Mévergnies
Mr. Hürlimann
Mr. J. J. Schmidt

Current Status of National Neutron Cross Section Center Compilation and Evaluation Activity Report to the EANDC October 1971

S. Pearlstein

Procedures for correcting the computerized experimental data library, CSISRS, have been developed. New data are fairly well screened through the use of "Author proofs". Older data are presently being scanned for errors using graphical and other automated techniques that include a rough comparison of data with limits based on BNL-325 eye guides.

A preliminary third version of the Evaluated Nuclear Data File (ENDF/B-III) has been distributed to the Cross Section Evaluating Working Group. It contains 50% more evaluations than ENDF/B-II largely due to the inclusion of files for individual fission product nuclides. The new library also contains photon production and interaction data for several nuclides. The neutron data has been processed through a preliminary version of PSYCHE, a physics checking code. A review of these preliminary data and the approval of data for wide distribution will take place at a CSEWG meeting December 1-2, 1971.

A meeting of the heads of U. S. Centers active in compiling low energy physics data took place at Brookhaven National Laboratory on September 23-24, 1971. Represented were the Nuclear Data Project, Table of Isotopes, Energy Levels of Light Nuclei, Chart of the Nuclides, Charged Particle Information Center, Photonuclear Data Center, Gamma Ray Spectrum Catalogue, and the National Neutron Cross Section Center. Plans are underway to exchange basic information among the Centers, develop a unified dialogue with Journals publishing nuclear data, and meet on a regular basis for the discussion of mutual problems.

With the delivery of a random vector generator in August 1971, hardware was completed for the NNCSC interactive graphics system. The simultaneous display of experimental and evaluated data is now possible. Interactive tools similar to the AI-IBM SCORE system for the manipulation of data are being adapted or are under development.

REPORT OF THE CCDN TO THE EANDC

November 1970 - October 1971

1. INTRODUCTION

During the period under review the CCDN has continued to disseminate information on literature, experimental data, evaluated data and requests for measurements in the field of neutronics. There have been no new activities.

2. CINDA

The CCDN has continued to prepare entries for its service area, to carry out computer operations on behalf of the three European centres and to send exchange tapes to DTIE. The reprogramming of the CINDA system is also in progress, and it is hoped that by the time CINDA 72 is published the new programmes will be in operation. The main object of the work is:

- to have the system running under direct access in order to speed up all the operations;

- to include a regular link with the NEUDADA library to make CINDA the International Data Index.

3. EXPERIMENTAL DATA

Besides answering requests for retrievals, the experimental data group is developing two main activities:

- the implementation of the experimental data exchange between the four centres under EXFOR. Concerning the despatch of EXFOR tapes up to the present, the situation is summarised in the attached table A. In addition to those mentioned, three are now in preparation at the CCDN and will be sent off in the near future;

- the systematic correction of the "Internal" file (containing data stemming from the CCDN area of responsibility) of the NEUDADA library on a laboratory/country basis.

The appointment of liaison officers has continued. Up to now data from Austria, Denmark, Finland, Greece, Norway, Spain, Sweden, Switzerland, Turkey and CBNM Geel have passed this procedure. The correction of Japanese data is under way: Dr. Igarasi from JAERI is helping the CCDN in this task. It is foreseen that the correction of data from Belgium, the Netherlands and Italy will follow.

4. EVALUATED DATA

CCDN's activities in this field continued to be restricted to the collection and distribution of evaluated nuclear data libraries. The present situation is summarised in table B attached. The programmes for the edition and retrievals of the libraries are in course of implementation.

5. RENDA

In accordance with the proposals made at the 14th meeting of the EANDC, the responsibility for producing the next edition of RENDA has been turned over to the INDC. A four-centre co-operation will be worked out in which the NDS will care for the publication of the list and will operate the computer system. The next issue, however, will be based on the following agreement: CCDN will prepare entries from areas 1 and 2, and NDS those from areas 3 and 4. The computer operations will be executed by CCDN at Saclay, while the publication will be the task of NDS.

TABLE A

EXFOR tapes already despatched

Originating centre	Tape No.	No. of subworks	No. of records
NNCSC (Brookhaven)	1001	99	13,060
	1002	196	13,720
	1003	67	18,090
	Total	362	45,870
CCDN (Saclay)	2001	228	45,124
	2002	9	40,546
	2003	7	35,955
	2004	12	22,890
	2005	733	22,616
	Total	989	167,131
NDS (Vienna)	3001 } 3002 }	preliminary tapes	
	3003	330	7,108
	3004	297	6,543
	Total	627	13,751
CJD (Obninsk)	-	-	-

TABLE B

Evaluated nuclear data libraries

Library	Format	Library	Format
UKNDL	U.K.	$32 \leq Z \leq 66$	
KEDAK	KEDAK	$(\sigma n, \gamma)$	
ENDF/B	ENDF/B	18 Fission Products (Benzi)	U.K. & ENDF/B
Pu^{239}		$(\sigma n, \gamma)$	
Pu^{240} (Ribon)	U.K.	$(\sigma n, 2n)$	
Pu^{241}		Cu (Benzi)	U.K.
188 Fission products (Cook)	U.K.	Cu (Haeggblom)	A.E.

^{12}C (n,n), (n,n') AND (n,n')3α REACTIONS AT 14.5 MeV

$\sigma_{n,n}$ = 785 $\pm$ 35 mb

$\sigma_{n,n'}$ = 221 $\pm$ 15 mb, through the 4.44-MeV level only

$\sigma_{n,n'3\alpha}$ = 8.5 $\pm$ 2 mb, via $^{12*}C$ 7.65-MeV level

= 62.5 $\pm$ 5 mb, via $^{12*}C$ 9.64-MeV level

= 13.5 $\pm$ 3 mb, via $^{12*}C$ 10.84-MeV level

= $3.5^{+3}_{-1.5}$ mb, via $^{12*}C$ 11.83-MeV level

~ 4.2 mb, via $^{12*}C$ 12.71-MeV level

= 98 $\pm$ 15 mb to a broad continuum which can be roughly apportioned as follows:

i) 37 $\pm$ 27 mb to the very broad $^{12*}C$ 10.3-MeV level ($\Gamma \sim$ 2 MeV)

ii) 50 mb via $^{12*}C(n,\alpha)$ $^{9*}Be$ 2.43-MeV level

iii) 11 mb via $^{12}C(n, ^5He)$ ^8Be and $^{12*}C(n,\alpha)$ $^{9*}Be$ states above 2.43 MeV.

The $^{12*}C$ 11.83-MeV level decays to the 2.9-MeV level of ^8Be, and not at all to the ^8Be ground state. The $^{12*}C$ 12.7-MeV level also decays principally through the 2.9-MeV level of ^8Be.

See Grin et al. Helv. Phys. Acta 42, 990 (1969)
Phys. Letters 25B, 387 (1967)
Mösner et al. Nucl. Phys. 75, 113 (1966).

FRDP, Winfrith
September 1971.

J. S. Story

APPENDIX 6

LIST OF EANDC DOCUMENTS ISSUED SINCE THE FOURTEENTH EANDC MEETING (October 1970)

Committee Papers

86L Fifth Biennial Report of the Activities of EANDC (P. Weinzierl and M. Nève de Mévergnies)

87A Complete Minutes of the Fourteenth Meeting of the Committee (G.C. Hanna)

87U Technical Minutes of the Fourteenth Meeting of the Committee (G.C. Hanna)

Canadian Documents

(Can)44L Canadian Progress Report, September 1970 to September 1971 (W.G. Cross)

(Can)45L Canadian List of Requests for Measurement, October 1971 (W.G. Cross)

Euratom Documents

(E)118U Evaluation of Fast Critical Experiments using Recent Methods and Data (E. Kiefhaber and J.J. Schmidt)

(E)128U Microscopic Neutron Nuclear Data and 5-group Cross Sections for the Actinides ^{231}Pa, ^{232}U, ^{234}U, ^{236}U, ^{237}U, ^{237}Np, ^{238}Np, ^{236}Pu, ^{238}Pu, ^{241}Am and ^{242}Cm (B. Hinkelmann)

(E)137L Remarks on Renda Requests for Threshold Cross Sections (A.H.W. Aten Jr.)

(E)138AL Evaluation des Données Neutroniques de ^{239}Pu (P. Ribon and G. Le Coq)

(E)139AL Some Comments on Requests in RENDA-70 for Heavy Element Resonance Parameters (R. Joly and P. Ribon)

(E)140U Progress Report on Nuclear Data Research in the Euratom Community, Jan-Dec. 1970

(E)141A A List of Nuclear Data Requests for Fusion Reactor Technology (M. Nève de Mévergnies and A. Paulsen)

(E)142L Propriétés des Niveaux Induits par les Neutrons de Résonance dans les Isotopes Stables de Néodyme (H. Tellier)

Japanese Documents

(J)21AL	Japanese List of Requests for Evaluation, May 1971.
(J)22L	Progress Report, July 1970 to June 1971 (T. Momota)
(J)23AL	Japanese List of Requests for Measurement, September 1971.

Documents from other OECD Countries

(OR)104AL	Gamma Rays from Inelastic Neutron Scattering in Oxygen (B. Lundberg, L.G. Strömberg and H. Condé)
(OR)105L	Progress Report to EANDC from Austria, August 1971 (P. Weinzierl)
(OR)106L	Progress Report to EANDC from Denmark, August 1971 (H.B. Møller)
(OR)107L	Not issued (Greece)
(OR)108L	Prompt $\bar{\nu}$ in Spontaneous and Neutron Induced Fission of ^{236}U and the Half Life for Spontaneous Fission (H. Condé and M. Holmberg)
(OR)109L	Progress Report to EANDC from Portugal, August 1971 (F. Gama Carvalho)
(OR)110L	Not issued (Spain)
(OR)111L	Progress Report on Neutron Physics Research in Sweden, August 1971 (H. Condé and T. Wiedling)
(OR)112L	Progress Report to EANDC from Switzerland, June 1971 (T. Hürlimann)
(OR)113L	Nuclear Data Activities at the Çekmece Nuclear Research and Training Center - Turkey, January-September 1971 (Ç. Ertek)

U.K. Documents

(UK)129L	On the Requests in RENDA for Nuclear Data for Moderators (final version) (J.S. Story)

(UK)132AL Evaluation of $\bar{\nu}$ for ^{235}U (AWRE 0 55/71) (D. S. Mather and P. F. Bampton)

(UK)133AL Activation Measurements of the Cross Section of the Reaction $^{147}Pm(n,\gamma)^{148g}Pm$ for Reactor Neutrons (M. J. Cabell) (published in J. Inorg. Nuc. Chem. 32 3433 (1970))

(UK)134AL UK Nuclear Data Progress Report, Mid 1969-Mid 1970 (E. R. Rae)

(UK)135AL An Isomeric State of ^{241}Pu ? (M. J. Cabell and M. Wilkins) (published in J. Inorg. Nuc. Chem 33 903 (1971))

(UK)136AL Evaluation of $\bar{\nu}$ for ^{238}U (AWRE 0 44/71) (D. S. Mather and P. F. Bampton).

US Documents

(US)150U Reports to NCSAC Livermore Meeting December 1970 (R. E. Chrien)

(US)151A Evaluated Nuclear Data for Hydrogen in the ENDF/B format (L. Stewart, R. J. LaBauve and P. G. Young)

(US)152A Nuclear Fusion Resonance Reactions of Possible CTR Interest (J. R. McNally)

(US)153L Note on the Prompt-Fission Neutron Spectra of ^{235}U and ^{239}Pu (A. B. Smith)

(US)154

(US)155AL Survey of Research Reactors 1970 (NBS Comm. on Nuclear Science)

(US)156U Reports to NCSAC Durham Meeting, May 1971 (R. E. Chrien)

(US)157A Check List of Neutron Cross Section Discrepancies, May 1971 (H. Goldstein, H. Alter and M. H. Kalos)

(US)158A Survey of Man power and Facilities to meet the needs of the US Applied Nuclear Energy Program, May 1971.

(US)159A Report of the NCSAC Ad hoc Subcommittee on Safeguards, April 1971.

(US)160A Recommendation for the Preparation of Modular Size Metallic Isotope Samples for Neutron Cross Section Measurements (R. C. Block and A. B. Smith)

(US)161AL	US Research with Small Reactors, August 1971 (M. S. Moore)
(US)162A	Cross Section Requirements for Fusion Reactors, July 1971
(US)163A	Status of Fast Fission Cross Sections, September 1971 (M. S. Moore)