

EUROPEAN - AMERICAN NUCLEAR DATA COMMITTEE

SUMMARY RECORD OF THE SEVENTEENTH MEETING
(TECHNICAL SESSIONS)

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Compiled by

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(Scientific Secretary)

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HIGHLIGHTS OF THE SEVENTEENTH EANDC MEETING

The discussion about the future rôle of EANDC, which was initiated by the US delegation at the sixteenth EANDC meeting, was continued. It was generally agreed that EANDC should maintain focus on fission reactor programs, but be aware of applications of nuclear data to other areas and move into those areas as the needs develop. The Committee also agreed to have periodic revisions of its mandates and to present the first revision to the Steering Committee of NEA in 1976. Attention should be paid to overlap in work with INDC.

Furthermore, the Committee members agreed to recommend that the name of the Committee should be changed to "The Nuclear Energy Agency Nuclear Data Committee" (NEANDC).

New facilities and changes of existing facilities for nuclear data measurements were reported and also several plans on the building of heavy ion accelerators.

A large number of nuclear data measurements in progress was reported. The status of work on neutron standard cross sections and discrepancies in important neutron data were reviewed. The IAEA panel for the review of the 2200 m/sec constants for the main fissile isotopes was reported to continue its work with a recent emphasis on the discrepancy between $\bar{\nu}$ and $\bar{\eta}$ values. The US delegation presented a list of 2200 m/sec constants accepted for the fourth edition of the evaluated nuclear data library, ENDF/B released in February, 1974, where some of the errors of the experimental data had been relaxed to eliminate discrepancies. The situation for the ${}^6\text{Li}(n, \alpha)$ cross section was reported to be far from satisfactory in the energy region below 500 keV. A recent measurement by Friesenhahn gave 3.7 b for the peak cross section at 250 keV compared to about 3 b in measurements by Coates et al, Fort and Marquette and Poenitz. Furthermore it was reported that the data by Fort and Marquette may be changed due to a revision in the ${}^6\text{Li}$ content of their Li-glass scintillator. Due to structure in the ${}^{197}\text{Au}(n, \gamma)$ cross section this reaction was recommended not to be

used as a standard unless the neutron energy spectrum was well known. The data for the ^{235}U fission cross section now agree to about $\pm 3\%$, $\pm 3,5\%$ and $\pm 4\%$ in the energy regions 100 keV - 1 MeV, 1 - 3 MeV and 3 - 6 MeV, respectively. In the energy region below 100 keV new measurements are consistent with values 8% lower than ENDF/B III at about 30 keV.

The progress of measurements was discussed in relation to nuclear reactor data request lists. The Committee recommended that local data committees should prepare short lists of the most urgent needs in this field. It was also recommended that national request lists of fission product yield data should be prepared and that the progress reports should include contributions in this area.

A session was devoted to discussion of needs for nuclear data for fusion reactors, safeguards and biomedical applications.

The US delegation expressed regret for being obliged to cancel the proposal of neutron reaction measurements using underground nuclear explosions because of funding problems.

The international cooperation of elastic and inelastic cross section measurements and on computer codes for nuclear model calculations and data analysis was discussed. In both areas a continuous cooperation was recommended.

The current NEA and US activities on data indexing, compiling and evaluation were presented. A specialist meeting on capture cross sections of structural materials (Fe, Cr and Ni) was held in May 1973 at Karlsruhe. The forming of an European Evaluation Working Group with participation from EURATOM countries was going to be discussed at a meeting in Geel on May 7, 1974.

The Committee recommended that the CCDN Evaluation Newsletter should in waiting for the FPND Newsletter from IAEA, include

fission product (decay schemes and yields) evaluations from the OECD area. The release of ENDF/B IV had begun in February 1974.

Proposals of two panel meetings sponsored by EANDC on "fission cross sections" and on "nuclear theory for the calculation of nuclear data" were referred back to local data committees for consideration.

Partly due to the growing interest of isotopic sample loans from the USAEC Research Pool at Oak Ridge for non-neutron nuclear data measurements the present mechanism for handling isotopes requests within the EANDC were reviewed and certain revisions were recommended. The Committee recommended the abolition of the earlier classification of loan requests and that the EANDC chairman in consultation with at least two other members act as referees to USAEC for a request.

The next meeting of EANDC will be held at Harwell on April 7-11, 1975 with a topical discussion on Capture Cross Section Measurements.

LIST OF PARTICIPANTS

1. EANDC Members

V. Benzi, CNEN^x), Bologna, Italy
K.H. Böckhoff, BCMN^{xx}) (Geel, Belgium), Euratom
S. Cierjacks, KFK, Karlsruhe, Germany
R.E. Chrien, BNL, Brookhaven, USA
H. Condé, RIND, Stockholm, Sweden (Scientific Secretary)
W.G. Cross, AECL, Chalk River, Canada
T. Hürlimann, EIR, Würenlingen, Switzerland
H. Jackson, ANL, Argonne, USA
H. Motz, LASL, Los Alamos, USA
P. Ribon, CEA^{xx}), Saclay, France
G.L. Rogosa, USAEC, Washington, USA
J.A.G. Rosén, NEA, OECD
M.G. Sowerby, AERE, Harwell, UK
J. Story, AEE, Winfrith, UK (Chairman)
K. Tsukada, JAERI, Tokai-mura, Japan

2. Observers

R. Block¹⁾, Research Reactor Institute, Kyoto University,
Osaka (permanent adr. Rensselaer Polytechnic
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T. Fuketa, JAERI, Tokai-mura, Japan (Local Secretary)
J. Hirota, JAERI, Tokai-mura, Japan (EACRP Observer)
K. Hisatake²⁾, Tokyo Inst of Techn., Tokyo, Japan
S. Igarasi³⁾, JAERI, Tokai-mura, Japan
A. Michaudon⁴⁾, CEA, Bruyères-le-Châtel, France
J. Royen, NEA, OECD (Secretary)
S. Tanaka⁵⁾, JAERI, Tokai-mura, Japan

x) Unable to attend the meeting

xx) Ad hoc members: K.H. Böckhoff attended in place
of R. Batchelor

P. Ribon attended in place of
R. Joly

1) Attended sessions 3, 4 and 5

2) " " 3, 4 and 5

3) " " 3, 4, 5 and 7

4) Attended all sessions except 1, 6, 11 and 12

5) Attended sessions 3, 4, 5 and 7

1. INTRODUCTORY ITEMS

The committee was first addressed by Mr G Inoue, acting Chairman of JAERI, who expressed a welcome to all participants on behalf of the Japan Atomic Energy Commission. He also stressed the importance of nuclear data in the nuclear reactor field and congratulated the Committee for work done in the field of compilation and in developing international cooperation for establishment of reliable measurements. The Chairman expressed the Committee's thanks to the Japanese Authorities, Mr Inoue and Prof Tsukada for the hospitality of housing the Seventeenth EANDC meeting.

The Chairman announced the death of Dr E Bretscher and recalled the long period he had been active in the Committee.

2. FACILITIES AND MEASUREMENTS

2 a) New facilities

Belgium A bent crystal diffraction spectrometer for high resolution γ -ray studies will be installed under 1974 at the BR 2 high-flux reactor at the Belgium Centre at Mol. Furthermore, a Bi or Fe filtered reactor beam will be set up for γ -ray studies.

At the variable cyclotron of the University of Louvain a new on-line mass separator will be installed about April 1975 for the study of short-lived nuclei far from the stability line.

The electron linac at the University of Gent will be improved. Beam intensity and energy of the modified machine will be close to the present performance of the BCMN linac. A large photo-fission program has been started by Deruytter at this institute.

Canada Cross reported that the operation start of the "TRIUMF" facility, which is a 500 MeV sectorfocussed negative ion cyclotron, was delayed and the schedule was now 1 μ A by September 1974. It will take about one year to work up to full beam intensity which is 100 μ A at 450 MeV.

At the Tandem accelerator at Chalk River, which is mostly used for heavy ion works, a new pelletron chain will be installed by which the terminal voltage can be raised from 13 to 14 MV. Two new ion-sources have been installed, one is a Li charge-exchange source for He and Li and the other is a universal negative ion-source, which provides a high beam of all ions others than He.

The NRU reactor is still shut down. The moderator vessel is changed and the start-up has been delayed due to a shortage of heavy water.

The bremsstrahlung monochromator at the University of Toronto linac has been completed. Preliminary test give a resolution of better than 30 KeV.

CBNM Böckhoff reported that in the frame of the new 4-years-plan, CBNM, Geel has got approval for the modernization of its Linac and Van de Graaff facilities.

The objectives of the Linac modification are to achieve 3 ns bursts of 12 A peak current at an average energy of about 120 MeV as well as to increase the mean beam power at large burst widths to a level of about 12 kW. Envisaged contractor is a successor of CSF which constructed the existing Linac. The order is expected to be placed within the following months and executed 23 months later.

Objective of the modernization of the Van de Graaff facility is to close the neutron energy gaps existing with the present 3 MV machine. A CN type Van de Graaff is envisaged which is upgraded to 7 MV terminal voltage and which is equipped with klystron bunching.

France Michaudon gave information concerning proposals of two new accelerators for the next 5 years plan in France. One proposal was on a heavy ion accelerator consisting of 2 cyclotrons coupled together. The accelerator is supposed to achieve 30 MeV/nucleon for light heavy ions and 6-7 MeV/nucleon for heavier ions, with a beam intensity of 10^{11} - 10^{13} particles per second. No decision concerning the proposal will be taken before 1975. The second proposal is a modification of the synchrocyclotron SATURNE in order to be used for studies in nuclear physics. The machine will accelerate protons with variable energies between 200 MeV and 2 GeV.

At Bruyères-le-Châtel the EN-tandem is being upgraded from 6 to 7 MeV.

Ribon informed that the Saclay 60 MeV electron linac will be closed for nuclear physics and nuclear data measurements within one year.

Germany Cierjacks informed that the heavy ion accelerator at Darmstadt will be completed by the end of 1974. It will accelerate ions up to uranium with an energy of 6 MeV/nucleon.

The isochronous cyclotrone at Karlsruhe has been provided with an external injection system for acceleration of heavy ions as Li and C. A polarized D-source has also been installed.

Japan Tsukada reported that the 12 UD Pelletron is now under construction at the Tsukuba University. Experiments utilizing heavy ions and polarized protons will be started in 1975.

At the National Laboratory for High Energy Physics, a 8-GeV AGS will be completed in the beginning of 1975. A 500-MeV injector will be tested this fall. The possibilities to use the injector as a neutron source are now under discussion.

At the Department of Nuclear Engineering, Tohoku University, the 4.5 MV Dynamitron and its beam transport system are now under construction and will be completed in March 1975. A nanosecond pulsing system is installed at the high voltage terminal giving a pulsed proton beam of 2 nsec durations and 5 mA in the peak. The machine will be used for nuclear data work. neutron physics for reactors, radiation damage, nuclear physics, chemistry etc.

Fuketa handed out an addendum to the Japanese Progress Report (EANDC(J) 30 L) and gave the following comments concerning the JAERI linac.

The performance of the JAERI linac is being continually improved since its first operation in April 1972. A beam intensity of ≥ 900 mA peak with 0.1 μ sec pulse width at ~ 100 MeV has been achieved by an increase of Q-magnets and a prebuncher. Work is in progress on a refinement of the modulator system to increase the pulse repetition rate and an improvement of the injection system to obtain pulses with shorter width and higher peak current.

The neutron generating target has also been continually modified and improved. A target of the same type as the Geel Linac will be tested in near future.

Block reported on facilities at the Kumatori Laboratory of the Kyoto University.

Two iron filters had been set up at the 45 MeV linac for neutron total and capture cross section measurements at 24 KeV. Total cross section measurements with a capability of $\pm 0.2\%$ accuracy had been made on C and Be. The capture measurements were made with a pair of C_6F_6 spectrum averaged detectors to give counting rate proportional with energy.

A multi-core critical assembly reactor (KUCA) is scheduled to be completed in June 74. The facility contains 4 rooms and 3 reactor core frames. Two solid moderator cores and one light water moderator core can be assembled.

Netherlands Böckhoff reported that a new facility for polarized thermal neutrons had been installed at the HFR facility at the Reactor Centrum in Petten. The new facility will give a flux at the sample of $3 \cdot 10^8$ n/cm²,s.

Sweden Condé informed that the 225 cm cyclotron at the Research Institute for Physics, Stockholm had been improved to permit acceleration of heavy ions.

At the tandem accelerator in Uppsala a foil-stripper had been installed. The pulsed neutron facility at this machine, which partly will be used for studies of fast neutron reactions above 5 MeV, was now in operation.

The budget had been allocated for a 6 MeV tandem-pelletron to be installed in late 1974 at the Department of Nuclear Physics, Lund. The research program will include nuclear structure and reaction studies and also neutron physics.

Switzerland Hürlimann reported that the SIN-facility had been operated with a 600 MeV proton-beam. Full intensity of the beam is expected towards the end of 1974. No neutron physics is planned.

The chopper at the research reactor Diorit is operating again.

United Kingdom Sowerby informed that new D's were installed in the Harwell synchrocyclotron to reduce radial oscillations. The pulse width for neutron work was after the modification of the order of 5 ns. A low energy facility (5-13 MeV electrons) has been installed at the Harwell Linac. It will be used for photofission studies, radiation damage studies etc.

On a question by Rogosa, Sowerby informed that a 30 MV tandem accelerator is being planned at Daresbury. Construction will be done in cooperation with HVEC.

United States Rogosa briefly reported some of the highlights concerning new facilities in the United States.

High Energy

The proton synchrotron at the National Accelerator Laboratory has operated successfully for experiments at 400 BeV and is currently operating routinely at 300 BeV, one and a half times its original design energy.

Medium Energy

The Los Alamos Meson Physics Facility has recently operated at primary beam intensity as high as 6 microamperes, providing beams for several simultaneous experiments currently underway. In spring -74, the accelerator will operate at up to 650 MeV beam energy and experiments will be carried out at the 1-10 microampere level. Within a few months the maximum proton energy will be increased to 850 MeV and the full 1 milliampere design beam intensity is expected to be achieved in the fiscal year 1975. In addition to nuclear and subnuclear research studies, applied studies including biomedical, radioisotope and nuclear materials security research will be carried out.

The Bates Electron Accelerator Facility at the Massachusetts Institute of Technology achieved on January 30, 1974 a beam of 406 MeV, slightly in excess of its design energy. The facility will be tuned up and the precision electron scattering program utilizing the new high resolution spectrometer system should be well underway later in the year.

Heavy ions

The FY 1975 Budget Request now before Congress includes a project, "Heavy Ion Accelerator Facilities". The project has two major components. It will provide for improving the capabilities of the super HILAC at the Lawrence Berkeley Laboratory and for converting it into a facility that will be better able to serve the growing variety of user groups from other institutions. The second part of the project

will provide for the establishment of a new 25 MV tandem electrostatic heavy-ion accelerator at the Oak Ridge National Laboratory. The accelerator will operate both in a stand-alone mode and as an injector into the existing Oak Ridge Isochronous Cyclotron. The project cost for both parts is estimated at 19.2 M\$.

Low Energy

A fast neutron time of flight system has been moved from the Nuclear Physics Laboratory at the Wright Patterson Airforce Base to the Triangle Universities Nuclear Laboratory at Duke University. A neutron cross section experimental group has been formed at Duke University. The system has been checked out and the first production runs took place in mid-December when measurements of the $^{12}\text{C}(n, n)$ and $^{12}\text{C}(n, n')$ reaction for neutron energies above 9 MeV were begun.

2 b) Progress reports

Belgium

At the Belgium Centre in Mol the total cross section measurement on Ra is continuing. The measurement was done at the BR2 reactor and the energy range was extended up to 700 eV. Average level spacing of 0.42 eV has been obtained.

Canada Cross referred to some of the work described in EANDC(Can) 47 "L".

At Chalk River cross section measurements of the $^{103}\text{Rh}(n, n')$ $^{103\text{m}}\text{Rh}$ reactions from the threshold to 20 MeV have been completed and submitted for publication. The cross sections for $^{127}\text{I}(n, 2n)-$, $^{93}\text{Nb}(n, 2n)-$ and $^{93}\text{Nb}(n, \alpha)-$ reactions have also been measured.

An attempt has been made to account for the He found in a number of Ni alloys in thermal reactors. The cross sections for the $^{59}\text{Ni}(n,\alpha)$ and $^{58}\text{Co}(n,\alpha)$ -reactions have been measured and found to be not large enough to account for the He-production. Santry has suggested that the He is produced by reactions in Li and/or B.

Search has also been made for ^{26}Al produced by the $^{27}\text{Al}(n,2n)^{26}\text{Al}$ -reaction in reactor installed Al. The work confirms that heavily-irradiated reactor Al contains no useful quantity of ^{26}Al .

CBNM Böckhoff informed that the new 4-years-plan of Euratom started in January 1973. The Central Bureau for Nuclear Measurements in Geel is now headed by Mr De Meulder who is assisted by Mr Batchelor for the scientific part of CBNM's activity. The program of the institute will be also further on aligned with the scope of EANDC.

Research in progress at CBNM comprised:

a) Linac Measurements

- Neutron resonance parameter measurements of ^{91}Zr (0.18 - 14.8 keV); ^{96}Zr (0.3 - 30 keV)-transmission measurements completed for both isotopes of Zr, capture measurements planned; ^{177}Hf (10 - 300 eV) data available (see last ed. BNL 325); ^{237}Np (7 - 250 eV)-analysis in progress; ^{236}U (43 eV - 4.1 keV)-publ. in prep.; ^{238}U -meas. up to 1.8 keV started; ^{242}Pu (below 1.3 keV) - see Nucl. Phys. A 207 (1973) 342.

- Normalization of σ_f for ^{233}U (18.1 - 17.6 eV)-subm. for publ. in Nucl. Sci. Eng. and ^{241}Pu (0.01 - 55 eV)-analysis in progress.

b) Van de Graaff Measurements

- Activation cross sections:
 - $^{197}\text{Au}(n,\gamma)^{198}\text{Au}$ between 0.5 and 2.25 MeV
(Measurements will be extended down to 0.1 MeV)
 - $^{46}\text{Ti}(n,2n)$ and $^{66}\text{Zn}(n,2n)$ between 12 and 20 MeV
(ready for publication)
 - $^{51}\text{V}(n,\alpha)^{48}\text{Sc}$ between 10 and 20 MeV
(paper submitted to Atomkernenergie)
 - ^{235}U fission neutron energy spectrum at $E_N = 0.5$ MeV incident energy. (Published in Nucl. Sc. Eng. 50 (1973) 108.)
 - ^{252}Cf spontaneous fission neutron energy spectrum.
(published in Proceedings of the Kiev Conf. 1973 (in press) and Atomkernenergie 22 (1973)84).
- Reevaluation of the T(p,n), D(d,n) and T(d,n) reactions
(Nuclear Data Tables 11 (7) - (1973), 569).
- Evaluation of the $^7\text{Li}(p,n)^7\text{Be}$ and $^-^7\text{Be}$ reactions for $E_n < 7$ MeV (EANDC - 159 "L").

France Ribon referred to a preprint distributed at the meeting of the France contribution to the 1973 Progress report from EURATOM and highlighted some results.

Measurements made at CEN-Saclay show a linear energy dependence between the total number of neutrons emitted in fission and the total energy of the prompt γ -rays. The measurement was made for 4 different nuclei.

Scattering of monoenergetic gamma-rays in a number of nuclei with $A \geq 60$ show a resonance structure with peaks at 5.5 and 7.3 MeV for many (Ni, Zr, Pb etc) but not for all nuclei (Au, Ta). The effect cannot be explained.

The total cross section of ^{241}Am was measured up to 1 keV. 190 resonances were identified up to 150 eV. Preliminary fission cross section data have also been obtained.

At CEN-Cadarache capture cross section measurements are in progress for 9 nuclei including ^{238}U between 10 and 65 keV. For structural materials and for Au data have been obtained up to 500 keV.

At CEN-Grenoble the disintegration scheme of several fission products has been studied. The yields of fission products are being measured for the spontaneous fission of Cf and fission of ^{232}Th and ^{238}U induced by 14 MeV neutrons.

The yields of Nd-isotopes have been measured for fission in ^{235}U and ^{239}Pu induced by thermal and fast neutrons at CEN-Fontenay-aux-Rose.

Michaudon reported on recent measurements made at the Bruyères-le-Châtel. The $\bar{\nu}$ -value for ^{241}Pu between 1.5 and 14 MeV has been measured to about 1% accuracy. The $\bar{\nu}$ - and E_{γ} -values of resonances in ^{235}U and ^{241}Pu have been measured as a joint effort between Bruyères-le-Châtel and Saclay. The $(n, \gamma f)$ -reaction, as explained earlier $\bar{\nu}$ -results in ^{239}Pu , was also seen in the 4^{-} resonances for ^{235}U , but not for any resonances in ^{241}Pu .

Inelastic neutron scattering studies have been made for ^{12}C between 8 and 15 MeV. Results will go into ENDF/B V. Results from a measurement of gamma-ray production in ^{56}Fe have been sent to Nucl.Phys. for publication.

Germany Cierjacks referred to a draft progress report distributed at the meeting and highlighted some measurements.

Fission cross section measurements of ^{239}Pu in the energy range 0.5 to 1.2 MeV had been made at the 3 MV Van de Graaff at Karlsruhe. Total and capture cross section measurements for a large number of structural materials were reported to be completed. New measurements were made of the capture cross section for ^{238}U and ^{197}Au between 10 keV and 200 keV. The energy dependence of $\bar{\nu}$ for ^{235}U and ^{239}Pu below 1.3 MeV was measured. No structure was observed within 1% accuracy.

At the isochronous cyclotron, Karlsruhe, high resolution measurements have been made of the total cross sections for Fe, Cr and Ni. The energy resolution 0.01 ns/m provided a better definition of the deep minimum. The neutron energy region was 400 keV - 32 MeV. High resolution elastic scattering measurements had been performed at the 190 meters flight path for Ca and C. New measurements for the elements of O, Si, Fe and Pb were planned. Inelastic neutron scattering cross section measurements had been measured for Cr- and Ni-isotopes at the 60 meters flight path giving an energy resolution of 0.03 to 0.04 ns/meter.

At the Nuclear Chemistry Institution in Jülich measurements have been made of (n,x)-cross sections using a Cockroft-Walton accelerator. In particular (n,2n)-, (n,p)- and (n, α)-cross sections have been measured for a large number of nuclides.

Excitation functions have been determined of $^{238}\text{U}(n,2n)$ -reaction in the energy region 13-18 MeV at the Van de Graaff at the University of Hamburg.

At the University of Kiel new measurements have been made with a fast chopper time-of-flight spectrometer. Resonance parameters have been determined for Cd-isotopes and transmission measurements have been made on Hf.

At the University of Munich coherent scattering amplitudes of a large number of compounds have been measured by small angle scattering of neutrons on Christiansen-filters. Precision neutron total cross section measurements have been made on Au and Co in the 40 μeV -5 meV range.

On a question by Story if the effort on heavy ion work was going to mean some reduction in neutron cross section measurements, Cierjacks replied that this will probably not be the case for the near future because of separated budgets for these two research activities.

Japan Fuketa informed about neutron cross section measurements in progress at the JAERI Linac. Transmission measurements on natural uranium were in progress. The measurements were made above 20 eV with an energy resolution of ~ 0.5 nsec/m. Resonances are analyzed up to about 4-5 keV. The total cross section below 100 keV will also be deduced. A special attention has been paid to make precise determination of the background. A measurement with a sample at liquid nitrogen temperature is scheduled for the near future.

Transmission and scattering measurements has been made on W, and was reported in JAERI-M 5624. Transmission areas and scattering yields for about 50 levels below 1255 eV were analysed to obtain resonance parameters. Spins of 13 levels in ^{184}W were confirmed.

Transmission and capture measurements on tantalum are also in progress. A considerable reduction of the background in the capture measurement with a large liquid scintillation detector has been achieved. The analysis on the transmission areas and the capture yields of tantalum resonances by the TACASI Code is about to start.

The construction of a ^{235}U fission chamber is in progress to be used in a research program on fission.

Sweden Condé referred to the Progress report from Sweden of September 1973 (EANDC(OR) 135 "L") and gave some updated information.

In December 1972 a Swedish Nuclear Data Committee was formed. It consists of members representing users and producers of nuclear data within the reactor, shielding, fusion, medical and biological fields. Its main concern is on information and co-ordination of works in the nuclear data field.

At Studsvik the systematic studies of fast neutron scattering has been continued by Holmqvist, Wiedling et al. Up to now 23 elements have been studied in the energy region 1.5 to 8 MeV. Recently the measurements have been extended to forward angles between 10° and 40° .

Systematic studies have also been made by the same group of inelastic neutron scattering, in the energy range 2.0 to 4.5 MeV. 20 elements have been investigated in the mass region 24 to 209.

The study jointly made by groups from the University of Lund and the Tandem Accelerator Laboratory, Uppsala of the reaction mechanism in fast neutron capture has been continued. The measurements have been extended to the giant resonance region above 8 MeV of neutron energy and include studies of light element as Si and S and nuclei with closed neutron shells as Y and Ce. The same group has also made an attempt to solve the discrepancy between 14 MeV neutron capture cross sections measured by activation and gamma-ray spectrum measurements. Preliminary results indicate that earlier activation measurements probably are wrong because they have not been properly corrected for capture of low energy neutrons in the background.

Measurements are also in progress at the Tandem Accelerator Laboratory by a group from the Research Institute of National Defence on gamma-ray production cross section ratios and fission fragment angular distributions.

Austria, Denmark, Norway, Portugal, Switzerland and Turkey Progress reports covering Austria (EANDC(OR) 126 "L"), Portugal (EANDC(OR) 132 "L") and Switzerland (EANDC(OR) 133 "L") together with informations from Denmark, presented at the OR-group meeting at Risö, December 1973 were summarized by Hürlimann. He also gave some informations of the activities in Norway and Turkey.

Austria Inelastic scattering cross sections have been measured for Ag, Sb and I at 390, 760, 960 keV using photo-neutron sources at the Atominstitut in Vienna. At the Institut für Radiumforschung und Kernphysik measurements have been made of the cross section for Ni(n,p)-reaction at 14 MeV using nuclear emulsion techniques. Good agreement was obtained

with existing data. At Seibersdorf studies have been made of the influence of uncertainties in fission product nuclear data on the interpretation of gamma-spectrometric measurements of burned fuel elements.

Denmark Extensive studies have been done at the Tandem Accelerator Laboratory of the Niels Bohr Institute of fission isomers. Recent measurements were made on half-lives in the picosecond region. A 30 psec isomer in ^{236}Pu has been observed.

Norway A measurement of the $^{116}\text{Cd}(n,p)$ -cross section at 14.7 MeV has given the result 2.2 ± 0.5 mb.

Portugal Most of the work is concerned with nuclear spectroscopy and neutron diffraction. The total cross section of nuclear grade graphite has been measured between 1 meV and 200 meV. The power of the swimmingpool reactor is planned to be increased from 1 to 2.5 MW.

Switzerland (n,α) - and (n,T) -reactions in Be at 14 MeV have been studied at Lausanne. The experimental angular distributions do not fit with calculations. Measurements are also made on $^{10}\text{B}(n, \text{charged particle})$ -reactions. At Neuchâtel investigations of elastic scattering on deuterium at 2.45 MeV has been carried out. At the Federal Institute of Technology studies are in progress of neutron break-up of Au and Pb. At Würenlingen the spontaneous fission decay constant of ^{235}U has been measured. They obtained a half-life 10 times higher than reported earlier. Thermal neutron fission yields have been studied especially the yield of ^{150}Pm

Turkey Total cross section measurements have been made of ^{159}Tb in the energy range 0.06 eV-1 eV.

United Kingdom Sowerby referred to the April 1972 - March 1973 UK progress report (EANDC(UK) 151 "L") and gave additional information.

At the National Physical Laboratory all measurements on \bar{v} for Cf-252 are being reassessed to see if any cause can be found for the difference between the values for the old samples 3.695 and new sample 3.72.

Monte Carlo calculations of the Mn bath were being performed - these confirmed that the corrections used by NPL are valid.

As part of the NPL programme of flux measurements proton recoil and associated particle techniques for the (D,D) reaction are being developed. These should significantly improve accuracy for neutrons in the energy range 2 to 6 MeV.

At the Chemistry Division Harwell the most important work has been the investigation of the variation of fission yields with neutron energy for U^{235} . These data and others were discussed at the IAEA Bologna Panel on Fission Product Nuclear Data.

The conclusions were

- 1) Valley and wing yields rise with energy as expected
- 2) Yields on the peaks are constant over the range of neutron spectra expected in fast reactors (within $\pm 4\%$) but fall off above 2 MeV.
- 3) No information on changes in yield of nuclides affected by fine structure.

The production cross section of Cm^{242} resulting from Am^{241} capture in a fast reactor spectrum has been measured. This experiment will be a good check on $Am^{241} \sigma_{n\gamma}$. It also helps improve calculations of Cm^{242} production in fast reactors.

At the Nuclear Physics Division, Harwell measurements have been continued on

- 1) Fission spectrum
- 2) Inelastic scattering of ^{238}U

Both experiments still in progress with no final data to date.

Pearlstein and Moxon's data on U-238 $\sigma_{n\gamma}$ have not been worked on since the progress report was written. The data are important because they, along with the Ryves data make it impossible to get consistency between the measurements of U-238 (n, γ), U-235 (n,f) and the U-238(n, γ)/U-235(n,f) ratio. The measurements of the (n, γ) are all consistent and have been made by activation (U-239 decay) or with large liquid scintillators. The two absolute ratio measurements are based on Np-239 decay. The (n, γ) data are believed to be correct but the situation is far from satisfactory.

Pattenden et al have reported Fe total cross sections obtained with the synchrocyclotron. This work is continuing and is part of the Harwell programme to get good $\sigma_{n\gamma}$ data for the structural materials.

The U-238(n,f)/U-235(n,f) ratio measurements have now been finalised. They agree with the data of Cierjacks et al (EANDC(E) 157) except around 7 MeV where the Karlsruhe data are higher.

Capture cross section measurements have been made for $^{151}, ^{153}\text{Eu}$ in the energy range 1eV-100 keV. Total and capture cross sections have been measured for Hf-isotopes, by Moxon and Uttley.

Lynn had recently made calculations on the $^{238}\text{U}(n, \gamma n')$ reaction to explain excess of low energy neutrons in fast reactors. The results agreed with similar calculations made by Moldauer. The reaction can not contribute significantly to the production of low energy neutrons.

United States Chrien, Jackson and Motz referred to EANDC(US) 186 "U" and high-lighted some recent measurements.

At Aerojet Nuclear Corporation there is an extended examination of the nuclear data required for the reactor core decay heat problem. This is an examination of the nuclear parameters of fission product nuclei, the yields, the half-lives, the average β and γ energies and total decay energies. There have been 338 priority nuclei established for the ENDF/B 4 evaluation effort.

They have also undertaken average cross section measurements for the fission product nuclei in the "Coupled Fast Reactivity Measurements Facility" (CFRMF) which has a spectrum of approximate that of a fast reactor.

Furthermore an evaluation of $\bar{\nu}$ and $\bar{\eta}$ is undertaken by J.R. Smith.

At Brookhaven the 24 keV neutron beam was used to look at neutron capture spectra. At this energy the p- and s-wave capture cross sections are comparable for heavy nuclei. For ^{238}U strong p-wave capture was observed.

An extensive measurement program of fission cross sections is underway at the Livermore Laboratory, including measurements on σ_f for ^{235}U from 3-20 MeV relative to the (n,p) scattering cross section and σ_f for $^{233}, ^{234}, ^{235}, ^{236}, ^{238}\text{U}$ and $^{239}, ^{240}, ^{241}, ^{242}\text{Pu}$ from thermal to 15 MeV.

A new program is in progress at the Phoenix Memorial Laboratory of the University of Michigan covering studies of standard cross sections of primary interest. The facility consists of a low

neutron background laboratory, a Mn-bath neutron source comparator, an equipment for the uniform in-pile activation and routine remote handling of photo-neutron sources. The choice of suitable gamma-ray-emitters is limited to relatively long lived isotopes as ^{24}Na , ^{72}Ga and ^{124}Sb .

The first measurements are made of the absolute σ_f for ^{235}U at 964 and 261 keV, the $^6\text{Li}(n,\alpha)$ cross section at 964 keV and σ_f for ^{239}Pu at 964 keV.

At Argonne measurements will be made of the half-lives of uranium- and plutonium-isotopes (acc. about 0.1-0.2%) in part as in response from the growing need of the safeguards program. The measurements will emphasize the mass spectroscopic techniques. Result is reported for the half-life of ^{235}U .

Another area of growing interest in the Argonne cross section program is low energy charged particle induced cross sections, e.g. of p, d and ^3He -induced reactions of Li. The interest of this kind of measurements comes from the CTR-program and has recently grown because of the high grid laser pulse fusion systems. Exploratory measurements have been done over the last six months.

The fast neutron physics program is continuing but has been broadened to include activation and dosimetry measurements.

On a question by Cierjacks on how much overlap it is between the half-life measurement programmes at Geel and ANL Jackson replied that there will be strong interactions between the programmes: Serious discrepancies exist between measurements using different techniques why the primary effort is to assign different laboratories the same measurement using different techniques and then intercompare all the results. Böckhoff informed that van Inbrucks at Geel got the following preliminary result for ^{233}U : $T_{1/2} = (1.59 \pm 0.01) \cdot 10^5$ years (close to the ANL-value). For ^{239}Pu there is a 1.3% discrepancy between the previous adopted best value and the value of Poetting, Geel, obtained with calorimetric techniques. Concerning ^{241}Pu a

discrepance of 7% exist between results from the ^{241}Pu growth method and mass spectrometric methods. Chrien informed that the Division of Materials Security of AEC is funding a program of half-life measurements at Mound Laboratory for the Pu-isotopes. They claim an accuracy of 0.02% by calorimetric methods.

At Oak Ridge a series of measurements have been done on gamma-ray production cross sections. The measurements have been made at the 47 meter flight path at ORELA within a neutron energy range of 1 to 20 MeV using a NaI-crystal. Measurements have been made on in all 14 elements.

At Los Alamos studies have been made by J.D. Seagrave of the interactions of fast neutrons with the isotopes of H and He.

Measurements have been made of the thermal capture cross sections for ^6Li and ^7Li . Earlier values for thermal radiative capture in some light elements are discrepant, partly due to chemical impurities in the samples that have been used. The cross sections have been measured to an accuracy of better than 10% and are given in the report.

Final values are reported of the fission cross section measurement for ^{235}U between 1 and 6 MeV.

Spin assignment measurements on ^{235}U and ^{237}Np have been made using a polarized beam at ORELA and a polarized target. Result of 65 spin assignments for ^{235}U show a lack of K=0 channel spin compared to Harwell data by Postma and Patten.

Preliminary results exist on a fission neutron spectrum measurement on the spontaneous fission of ^{252}Cf .

Total cross section measurements have been started at the LASL Tandem accelerator using a white neutron source. Measurements have been made on ^{16}O , ^{17}O , ^{18}O and ^{12}C between 1.6 MeV to 18 MeV.

2 c) Research Papers

Research papers submitted since the 16th meeting held in March 1974 are listed in the Appendix.

In addition to the papers already discussed under item 2b (progress reports), Michaudon commented on a paper by Jary, distributed at the Meeting, about calculation of (n, xn) and (n, xnf) cross sections for heavy nuclei by the statistical model.

3. MEASUREMENT REVIEWS AND EVALUATIONS

3 a) Review of thermal neutron data for the main fissile isotopes

As a member of the IAEA panel for the review of the 2200 m/sec constants, Story informed that recent emphasis had been put to the discrepancy between $\bar{\nu}$ and $\bar{\eta}$ -values. Axton had made a thorough review of all $\bar{\nu}$ -data and concluded that the data now are in agreement. This meant that a smaller error could be given to the $\bar{\eta}$ -value deduced from direct measurements of $\bar{\nu}$. This averaged $\bar{\nu}$ -value disagreed in turn with the same value deduced from $\bar{\eta}$ -measurements.

Lemmel at IAEA concluded that one could remove the discrepancy if the Westcott g-factors were allowed to float. Story felt that it was difficult to accept the degree of change needed in the ^{235}U g-factors for the absorption cross section. The present situation had not yet been discussed by the IAEA panel.

Chrien presented the CSEWG position and distributed a written paper giving a list of data adopted for ENDF/B IV.

To anchor ENDF/B IV cross sections properly in the region of thermal neutron energies the normalization and standards sub-committee in CSEWG had to prepare an up to date set of 2200 m/sec-parameters for the principal fissile materials. The sub-committee collaborated with the IAEA-group and used their LS-fitting program. The ENDF/B III Westcott g-factors were adopted. Most members in the sub-committee agreed that few, if any, of experimental measurements had errors of less than 0.5%, and that a number of discrepancies in input data should be eliminated by increasing their uncertainty assignments. An analysis by B Leonard showed that basic inconsistencies among various ways of estimating α could be relieved by increasing to 2% the error assignments for individual direct reactor irradiation measurements of α .

After some discussion the Chairman concluded that an interim solution existed and that IAEA task force on the 2200 m/sec constants will continue.

3 b) Fast neutron fission cross-sections

Sowerby reported that the situation concerning fast neutron fission cross-sections had improved during the last year.

On the whole the data on ^{235}U presented at the IAEA Standards Panel in November 1972 are in good agreement. In the region between 100 keV and 1 MeV the data agree to about $\pm 3\%$. The only set of data which are slightly discrepant is the one by Käppeler which is about 8% higher than the other data below 600 keV.

The new data between 1 and 6 MeV by Hansen et al, Los Alamos have significantly improved the situation at higher energies. The data of Szabo et al (Kiev. Conf. 1973) and Poenitz (IAEA Standards Panel 1972) are lower than the Hansen et al data between 1 and 1.8 MeV by up to 3%. The ^{235}U cross-section is now known to $\pm 3.5\%$ between 1 and 3 MeV and $\pm 4\%$ between 3 and 6 MeV. Between 6 and 15 MeV, except in the vicinity of 14 MeV, no new data have been reported.

Below 100 keV, there has been a long standing discrepancy. At the time of the IAEA Standards Panel meeting there were two provisional inconsistent sets of data from ORNL which did not agree with the other recent data. However, the new preliminary data of Perez et al (ORNL-TM-4390) agree with the data of Gayther et al, Poenitz and Szabo et al and are consistent with values 8% lower than ENDF/B III in the region of 30 keV.

On ^{239}Pu , new data was presented by Szabo et al at the Kiev Conference 1973. Measurements have also been made at Harwell by Gayther et al up to about 1 MeV which agree with the data by Szabo. Most of the knowledge of the ^{239}Pu fission cross-section comes from $^{239}\text{Pu}/^{235}\text{U}$ ratio measurements. New ratio measurements by Poenitz are about 10% discrepant with earlier data.

On ^{238}U new measurements have been made by Cierjacks et al at Karlsruhe (EANDC(E) 157 "U"), by Coates et al at Harwell (EANDC (UK) 151 "L") and by Meadows and Poenitz at ANL (Nucl.Sci. and Eng. 49, 310, 1972). In the region of 2-3 MeV the experimental data agree to about 3%.

Cierjacks mentioned that Käppeler had new data not yet published, on the $^{239}\text{Pu}/^{235}\text{U}$ fission cross section ratio and Condé informed that measurements were in progress at the Tandem Accelerator Laboratory, Uppsala on the $^{238}\text{U}/^{235}\text{U}$ fission cross section ratio between 5 and 11 MeV.

On a question from the Chairman if enough work was done in the fission cross area or if more work was needed, Sowerby replied that the fission cross section of ^{235}U is requested as a standard to 1% and this is not achieved. Motz informed that in the US there was no push for measurements which could meet the 1% accuracy. Jackson reported that measurements were in progress at Livermore on σ_f for ^{235}U . The objective is to reach 2-5% accuracy between 1 keV and 15 MeV.

The Committee agreed to recommend a panel meeting on fission cross section towards the end of 1975. As most of the works are done in the OECD area, NEA should be approached to promote such a meeting.

3 c) Fission neutron spectra

Story opened the discussion by pointing out that it seems to be a general conclusion from all integral works on fast reactors that either the $^{238}\text{U}/^{235}\text{U}$ fission cross section ratio is wrong or the ^{238}U inelastic scattering cross section is wrong or the fission spectrum is wrong.

Sowerby informed about a collaboration between Harwell and Studsvik (Adams and Johansson) to measure the ^{235}U fission neutron spectrum at 0.5 MeV incident neutron energy at the IBIS machine in Harwell. A liquid neutron detector (NE 213) with pulse shape discrimination was used. The flight path was 3 meters and the neutrons were produced by the $^7\text{Li}(p,n)$ -reaction. Energy calibration were made by the $^{11}\text{B}(d,n)$ -reaction up to 16 MeV. This calibration was the most crucial point of the experiment. By using Studsvik efficiency curves one gets T-values between the older Harwell and Studsvik data. The pronounced tail of the earlier Harwell data seems to be disappearing and was believed to be due to some mistake in the energy calibration.

Ribon reported that in the fission cross section measurement of ^{235}U at Cadarache a slight excess of neutrons was found above 5 MeV compared to a Maxwellian spectrum.

Motz informed that the ^{235}U fission neutron spectrum measurement at LASL will be repeated. A measurement of the fission neutron spectrum for ^{252}Cf had been made up 12 MeV of fission neutron energy and there was no indication of a high energy tail.

An information was given by Block that at the Kumatori-laboratory, Dr Kimura had measured the fission neutron spectrum for ^{235}U at thermal energy using threshold detectors.

Condé reported that Johansson et al, Studsvik were measuring the fission neutron spectrum for ^{239}Pu at 0.5 MeV.

Motz remarked that in ENDF/B IV the T-value for ^{235}U was changed to 1.32 MeV which in turn increased the calculated average σ_f for ^{238}U in a fission spectrum to about 290 mb. However the accepted experimental value from the measurement by Leachman and Schmidt is (312 ± 4) mb.

The Chairman concluded that the disagreement between the differential and the integral measurements still exist and more work is needed.

3 d) Specialist evaluation meetings in 1973

Sowerby informed that an EACRP sponsored specialist meeting about Capture Cross Sections of Structural Materials (Fe, Cr and Ni) was held in May 1973 at Karlsruhe.

Ribon gave a summary of the meeting and noted that there are discrepant results between different measurements of capture cross sections for structural materials.

On the experimental side the main problems were the detection of scattered neutrons and background determination. The lead-slowing-down spectrometer measurements and activation measurements are relatively insensitive to scattered neutrons and yield low capture data compared to scintillator tank measurements as e.g. given by RPI.

The high capture cross section data by RPI were supported by a new liquid scintillator measurement reported from Karlsruhe (< 100 keV) and a total-energy-detector measurement reported from Cadarache (70-550 keV, acc. 5%).

From the reactor physics side the capture cross sections for structural materials are requested with 10% accuracy between 1 keV and 1 MeV. According to a report by Barré the new capture cross sections of Cadarache are not possible to accept. If Ni- and Cr-data have to be increased by about 50% compared to the data in the Cadarache data file the Fe capture cross section has to be reduced by a factor of 2. Also the Fe-data given by Moxon below 50 keV were believed to be too high.

Block remarked that in the RPI measurement the background in the minima was 30-40 mb. This background could significantly contribute to the cross section when averaging over a large energy interval.

Cierjacks informed that in the Karlsruhe measurement the minima was about 15-20 mb.

3 e)

Activation detector cross sections

Böckhoff reported that a measurement of the $^{197}\text{Au}(n,\gamma)$ cross section between 0.5 MeV and 2.25 MeV was in progress at Mol (see the EURATOM progress report).

Ribon informed that the EURATOM Dosimetry Working Group had a meeting at Geel in March 1974. A request list consisting of about 14 requests (13 requests of priority 1) was prepared.

Motz informed that there had been established a US program sponsored by the Reactor Research Division of AEC to develop a capability to accurately measure neutron reaction rates for fast reactor fuels and materials development programs, the ILRR program. The initial goal is $\pm 5\%$ in the principal ^{235}U , ^{283}U and ^{239}Pu reactions. A secondary program is on dosimetry problems. Four different US laboratories and the laboratory at Mol, Belgium are involved in the program.

Fuketa informed about the Japanese works on activation detector cross-sections and referred to two papers one by Kimura et al in Jour. of Nucl. En. 27, 741 (1973) and one by Miyasaka and Tanaka in Jour. of Nucl. Sci. and Techn. 10, 574 (1973). Summaries of the two papers were distributed at the meeting. The papers discussed the status on the accuracy of reactor dosimetry cross sections (Threshold reactions).

Cross reported that a measurement of the $\text{Rh}(n,n')$ cross section in the energy region 5-14 MeV was in progress at Chalk River and will be published in the Can. Jour. of Physics. A 50% discrepancy exist above 5 MeV between an evaluation made by IAEA and the Chalk River group.

4. PROGRESS OF MEASUREMENTS IN RELATION TO NUCLEAR REACTOR DATA REQUEST LISTS

4 a) Comments from local data committees

The length and reviews of the request lists were discussed in some detail.

The USNDC request list containing 658 requests was expected to be reviewed annually before sent to WRENDA. Jackson pointed out that data users find status reports much more useful than the comments in the request lists.

The UK list containing 221 requests (incl. eval.) was reported to be reviewed periodically. All priority 1 requests need to have some comments in the list.

In the French list containing 160 requests for reactor data, 3/4 of the requests are new compared to the list 4 years ago. A problem has been observed in that it takes in general longer time to make the experiments than the term during which the request lasts.

On a question by Cierjacks how many requests could be solved by an evaluation Ribon estimated for France 10% and Jackson estimated that very few US-requests could be solved by evaluations.

4 b) Summary of scattering requests in RENDA 1973

Some discussion took place about inelastic scattering in ^{238}U and structural materials. It was concluded that a fair amount of work was going on in US, UK, France and Sweden and that the item could be dropped from the agenda in the future.

5. OTHER NEEDS FOR NUCLEAR DATA

5 a) Fusion reactors

Jackson informed the Committee that USNDC has a subcommittee which discusses the CTR data problems. At the present time the efforts are mainly on evaluations. He referred to appendix F of the minutes from USNDC (EANDC (US) 187 A) and summarized five particular areas where the subcommittee feel there are major data needs:

- 1) ^7Li (n, n') 10-15 MeV
- 2) ^{13}C (n, α) ^{10}Be
- 3) F (n, n')
- 4) Nb gamma-ray production
- 5) Transport of neutrons with energies above 8 MeV through Mn, Cr, Fe, Ni and Pb

The subcommittee had decided to begin an evaluated data-library specifically for CTR-problems. A.B. Smith had made an evaluation of Nb. Within next 12 months there will probably be a statement about requests for measurements.

Rogosa added that the nuclear data needs were still given a low priority within the CTR program.

Motz drew the Committees attention to a paper in Nucl. Sci. and Eng. 53, 304 which gave the cross section sensitivity of the breeding ratio in a fusion reactor blanket.

Tanaka reported that a subcommittee on CTR data problems will be organized within JNDC during the fisical year 74/75. A joint ad-hoc subcommittee will also be formed between JNDC and RCNFR (Research Committee for Nuclear Fusion Reactors). A list of nuclear data needs for fusion reactors will be set up by the ad-hoc joint subcommittee.

Story informed that a separate table had been added to the UK nuclear data request list containing 15 requests connected with CTR problems.

Cierjacks reported that based on some integral measurements to be made at Karlsruhe and Jülich a list had been set up containing data needs for 5 elements.

The Chairman concluded that the situation concerning data requirements for CTR was just in the beginning of being looked at and probably it would last a couple of years before the real needs had been identified.

5 b)

Safeguards

Jackson referred to EANDC(US) 187 "A" and said that the Division of Nuclear Materials Security within AEC had pointed out a need of precise values of the Pu-isotopes half-lives. The needs are for calorimetric assay of Pu-isotopes as a means of non-destructive materials test. Earlier half-life data

were discrepant up 1-2% dependent on the method with which the half-life was determined. The goal is now to determine the half-lives with 0.1-0.2% uncertainties. The Mound lab. and ANL are planning measurements. Coordination will be made with European laboratories.

Story informed that in UK the stand point was that the same data are needed for safeguards and reactor calculations, why no explicit safeguard request list had been prepared.

Motz commented that the US safeguard requests were limited to data needs for the techniques which are applicable for the passive or active interrogation of fuel elements. Some overlap existed with requests from burn-up studies. Next US safeguard request list will probably have fewer requests.

Finally, Cierjacks referred to the German progress report p 15-16 and summarized that the German data needs could be restricted to 2 areas: Q-values and half-lives for calorimetric measurements and burn-up data.

5 c) Biomedical applications

Jackson remarked that the report by Chrien at the 16th EANDC meeting very well covered the situation in this area. The USNDC Biomedical Applications Subcommittee has recognized two major areas of data needs: 1) Production cross sections for radionuclides and 2) level scheme information for absorbed dosage calculations. A problem is that existing compilations of data are not in a useful form for biomedical people, e.g. the failure of including the mean of beta-ray energy in place of the maximum electron energy in beta decay. The Medical Internal Radiation Dose Subcommittee under the Society of Nuclear Medicine in the US prepare decay-schemes tables which are of direct use in the biomedical area (MIRD Pamphlets).

Jackson also presented a compilation by Caswell and Horen of nuclear information for biomedical applications.

Cross pointed out that the important thing in this area is that the presentation of the data is in a digested form for the medical people. Cross also pointed out the needs of neutron cross sections for (n, α) - and (n, p) -reactions in materials of the body above 14 MeV due to proposals to use neutrons from 50 MeV cyclotrons for therapy.

Jackson referred to a statement made at a seminar concerning the requirements and availability of nuclear information in nuclear medicine, Miami, June 1973 that an accuracy of basic nuclear data of only the order of 20% is needed because of the much larger uncertainties in the biological data available. However more accurate data is requested for radionuclide production. Some of these later requests will probably come into the next nuclear data request list from the USNDC.

Condé informed that a preparatory meeting on nuclear data for radionuclide production had been held at Studsvik for the IAEA symposium on nuclear data in science and technology, Paris, March 1973 (see Proceedings).

Cierjacks reported that experimental work was in progress at the Karlsruhe isochronous cyclotron of (d, x) - and $(\alpha, \text{many particle})$ -reactions for medical therapy purposes.

The Chairman concluded that the area was still in an exploratory state.

5 d) Other applications

Tanaka raised the question of the handling of the nuclear data needs for decay-heat or after-heat calculations for reactor fuels.

Story pointed out that there are two different sets of data which can be used in after-heat calculations. One set is based on intergral measurements of the Maienshein- (gamma-rays) and MacNair (β -decay)-types and the other set is based on a summation of the decay data for all fission products.

Motz referred to what had been said under item 3a) and added that new measurements of the "maienshein type" are proposed by Idaho Falls and LASL. At LASL a liquid He calorimetry measurement is planned. The response time for this measurement is of the order of 10 sec.

He also informed that the evaluation of the fission product data for ENDF/B IV was undertaken by a CSEWG-subcommittee.

In the discussion which followed it was concluded that many fission product data were uncertain especially for the shorter lived products and that most of the information in this area was presented at the IAEA Bologna Panel on Fission Product Data.

Jackson informed that USNDC basic science subcommittee had pointed out some important topics among them the photodisintegration of the deuteron (20% discrepancy between theory and experiment around 30 MeV) and the (n, p)-cross section towards which they will focus their attention. Chrien added that the basic science subcommittee has an important function to help to examine the data compilation centre activities in the US at Oak Ridge and Berkeley.

Rogosa mentioned that within the basic science subcommittee it had been proposed that in conjunction with the operation of LAMPF, TRIUMF and SIN to start a compilation effort of data in the medium energy range (compilation of e.g. medium energy p- and n-reaction cross sections and secondary particles).

Cierjacks brought up the problem of (n, α) cross sections leading to He and high temperature defects in structural materials.

Jackson replied that this was a widely discussed subject in the US. It was discussed if the He was produced by (n, α)-reactions in the material or in impurities.

Story informed that integral measurement on (n, α)-reactions in Fe, Mo and Ni was made in Dounray fast neutron some years ago. The results were in agreement with earlier experiment.

Ribon remarked that (n, p)- and (n, α)-cross sections for Fe were priority 1 requests in France.

Planned experiments or experiments in progress were reported by Cierjacks at Karlsruhe and by Michaudon ($^{13}\text{C}(n,n')3\alpha$ at 14 MeV) at Bruyères-le-Châtel.

No further activities in the non-fission reactor field were reported.

6. INTERNATIONAL CO-OPERATION IN NUCLEAR DATA MEASUREMENT AND ANALYSIS

6 a) Neutron reaction measurements using underground nuclear explosions

The Chairman referred to the discussion under item 1 f) "Actions from previous meetings" and asked if there was any further information to be given. Rogosa said that he had no additional information to the report he gave at the 16th INDC in September 1973.

6 b) Elastic and inelastic cross section measurements

The Chairman drew the attention to a report by Fröhner (EANDC(E) 135 "A") in which it was pointed out that in relation to the large number of requests for elastic and inelastic cross section data very few measurements were in progress.

Tanaka said that he agreed with the statement made by A.B. Smith at the last EANDC meeting that the efforts in elastic and inelastic scattering measurements had tapered off at many laboratories. Tanaka gave two reasons for the decrease in the scattering experiments 1) lack of exciting topics related to basic nuclear physics in this field and 2) lack of major improvements in the techniques.

Finally, Tanaka asked for a better collaboration in the scattering field. Instead of having a newsletter which took much time to prepare, Tanaka asked for exchange of more informal informations.

The members agreed that the Committee should encourage the interchange of informal documents in the scattering field. To facilitate the circulation of documents Jackson agreed to set up a list of laboratories which are active in the measurement of elastic and inelastic neutron cross sections.

6 c) Computer codes for nuclear model calculations and data analysis

Rosén outlined the origins of the topic and reminded that A.B. Smith at the 14th EANDC Meeting at ANL brought up the question about compatibilities of computer codes. At the 15th EANDC Meeting the topic was again discussed and Benzi accepted an action to compile a list of computer codes. A first draft of the list was presented at the last EANDC meeting with many gaps which now have been filled in. The final list will be given a wide distribution (U-distribution).

6 d) Other plans and proposals for collaboration, or for meetings

A number of meetings were discussed.

Jackson distributed a note about the 4th Conference on Nuclear Cross Sections and Technology to be held in Washington D.C., 3 - 7 March 1975 and said that the conference is intended to be international and some individuals from outside the US have been asked to be members of the Program Committee.

Ribon proposed a NEA sponsored panel on fission cross sections for ^{232}Th , ^{233}U , ^{235}U , ^{238}U and ^{239}Pu , ^{240}Pu , ^{241}Pu .

Many requests for fission cross sections seem to be fulfilled within a few years, why at that time a panel could be suitable.

All members were asked to discuss the proposal with local data committees and report back at the next EANDC meeting.

Ribon informed about a proposal by IAEA to arrange in late fall 1974 or early 1975 a Consultants Meeting on the use of Nuclear Theory in Neutron Data Evaluation.

Ribon raised the question if EANDC could consider the possibility to sponsor a specialist meeting on a topic of nuclear theory for the calculation of nuclear data not considered by the IAEA panel.

An action was placed on all members to consider the proposal by Ribon for the next meeting.

7. DATA INDEXING, COMPILING AND EVALUATION ACTIVITIES

7 a) Current NEA activities including compilation of integral data

Rosén reported first about the activities at the Computer Program Library at ISPRA and referred to a written status report.

Rosén also reported about the activities of the NEA Neutron Data Compilation Centre at Saclay.

The systematic revision of older data from the CCDN service area had continued. Among new data which were entered into the NEUDADA file Rosén mentioned

- 1) Fission yield library by Crouch
- 2) Capture and fission gamma-ray spectra by Weitkamp et al

Concerning the EXFOR-data the contribution from USSR is increasing but still rather modest; 16 000 data records were received from CDJ last year compared to 260 000 from NNCSC.

The amount of requests for data from CCDN has gone up. New groups of users from industries, universities and hospitals have been recognized.

Rosén announced that a review of the activities at the CCDN had been initiated by NEA. A working document about the proposal will be distributed to the members. Rosén gave a list prepared by Fröhner of possible additional types of data that could be handled by CCDN and asked for comments

After some discussion it was concluded that the proposal was best discussed after the outcome of the IAEA specialist meeting on Nuclear Data for Applications, 29 April-3 May, 1974.

Of the proposed topics for manuals or special-purpose compilations the delegations from US and Canada in consultation with Rosén recommended the following priorities:

- 1) Neutron source reactions
- 2) Quick-orientation list for average cross sections (thermal and fast reactor spectra averaged)

7 b) Current US activities

Chrien read a status report from NNCSC. Rogosa added the information that the responsibility for the US request compilation had been moved from LASL to NNCSC and the responsibility for CINDA was transferred from the Technical Information Centre at Oak Ridge to NNCSC.

Concerning the Oak Ridge Nuclear Data Project Rogosa informed there was no special expansion or contraction planned. The outcome of the IAEA X-centre meeting would tell if a world-wide cooperation was coming in the nuclear decay scheme field. Level diagrams from ORNL data for $45 < A < 200$ was published by Academic Press a few month ago. The Tables of Isotopes project at Berkeley is working with the 7th edition to be published in 1976.

7 c) Organization of co-operation on evaluation in Europe

Ribon informed about an evaluation meeting in Geel recommended by JENDREC on May 7, 1974 where it would be discussed to set up an European Evaluation Working Group with participation from EURATOM countries. The plans are to start some co-operation between a few evaluation groups and later, if feasible, extend the co-operation to several groups maybe also outside the EURATOM.

8. MEETINGS AND CONFERENCES OF INTEREST TO THE EANDC

The Chairman distributed a list of Past and Future Meetings.

9. SPECIAL SAMPLES

Isotope separation

Rogosa outlined the origin of the constraints on the availability of loan samples from the USAEC Research Pool as a response to a letter from Story. In the letter Story had pointed out the need of such an orientation due to the considerable turnover in the membership of the EANDC and due to the growing interest of samples for non-neutron data measurements.

In the discussion which followed Cierjacks asked if samples could be available on loan for fundamental research through bilateral agreements between a laboratory and USAEC. Rogosa responded that EANDC is not the only way of getting loan endorsements. AEC has the authority to set the policy but has not yet decided if isotopes will be given for a wide range of fundamental research. A discussion will take place at the USNDC meeting in September concerning the loan of the stable isotopes for areas extending beyond the neutron cross section measurements.

Condé pointed to the special problems for the smaller countries within the OR-group of EANDC for which the present policy of loan endorsement only to "pure" RENDA measurements has been felt very restrictive.

Fuketa informed that sometimes the delay in time is so long that the experiment is no longer relevant. Rogosa replied that one should not be embarrassed to say that the samples are not needed any more.

The mechanism for handling isotopes requests within the EANDC and the role of the Committee in this matter was discussed and the Subcommittee was asked to come up with a recommendation.

Chrien summarized the report of the Subcommittee on Isotopes.

The Committee adopted after some discussion the Subcommittee report which contained the following recommendations:

- 1) The EANDC avoid responsibility for loan transactions which involve measurements for the purpose of basic nuclear science. These requests should be sent directly to USAEC.
- 2) The abolition of the classification of loan requests (category I, II and III) according to whether or not the requests pertain to requests in WRENDA.

- 3) The Chairman of EANDC selects at least 2 committee members to act as referees for a request. The referees will judge the competence of the experimenter and the soundness of the experiment.
- 4) The critique of the experiment, accompanying the loan requests would enable the responsible US agency to better judge the importance of the request to its National Energy program. Question of waiver of loan fees should be left to USAEC and should not be recommended by EANDC.

10. REPORT OF SUB-COMMITTEE ON STANDARDS AND DISCREPANCIES

Sowerby presented the draft sub-committee report, which discussed the following topics:

- 1) Isotopic standards, half lives of actinides
- 2) $H(n,n)$
- 3) ${}^3\text{He}(n,p)$
- 4) ${}^6\text{Li}(n,\alpha)$
- 5) ${}^{10}\text{B}(n,\alpha)$
- 6) ${}^{197}\text{Au}(n,\gamma)$
- 7) ${}^{235}\text{U}(n,f)$
- 8) Developments in Neutron flux measurement techniques
- 9) Discrepancies

Precise thermal data (including $\bar{\nu}$ for ${}^{252}\text{Cf}$) and fission neutron spectra were not considered as they have been discussed under special items of the Agenda.

About the $H(n,n)$ cross section Cierjacks informed that recent measurements at Karlsruhe and Geel indicate increasing anisotropy between 15 and 30 MeV which also is indicated by theoretical calculations.

Concerning the ${}^3\text{He}(n,p)$ cross section Sowerby pointed out that more work is needed if it is going to be used as a standard.

The situation was reported to be far from satisfactory for the ${}^6\text{Li}(n,\alpha)$ cross section in the energy region below 500 keV. A recent measurement by Friesenhahn gives a value for the peak cross section at 250 keV of 3.7 b in relation to about 3 b

in the measurements of Coates et al, Fort and Marquette and Poenitz. Futhermore, Ribon reported that the value by Fort and Marquette may be changed due to a revision in the ${}^6\text{Li}$ content of their Li glass scintillator. A Li-glass sample will be sent from Cadarache to ANL for comparison of content. Ribon agreed to inform all EANDC members about the new data by Fort and Marquette after the correction of the ${}^6\text{Li}$ content.

Motz informed that Friesenhahn, Intelcom Rad Tech Lab used a LiF layer instead of a Li-glass as have been used by the other groups. The Friesenhahns detector should have a better understood content.

The use of theory to aid in the solving of discrepancies for this nuclei was reported to be a debatable question. However good charged particle data can help the situation and Motz reported on plans at LASL to do (α, T) -scattering measurements in the energy region 11-12 MeV to compare with earlier Cal Tech data, which contain some inconsistencies. Motz agreed to inform EANDC members about the progress of the charged particle measurements.

Sowerby added that the ${}^6\text{Li}(n, \alpha)$ cross section below about 50 keV is still a good standard.

Concerning the ${}^{10}\text{B}(n, \alpha)$ cross section the sub-committee reported that new data by Friesenhahn were in agreement with earlier data and that this cross section is also a good standard to at least 50 keV. Futhermore, the subcommittee recommended that the Friesenhahn flux measurement techniques should be checked by comparison with some methods other than the only one used in the experiment.

For the ${}^{197}\text{Au}(n, \gamma)$ cross section the subcommittee concluded that this reaction should not be a standard unless the energy dependency of the neutron spectrum in the measurement is well known due to the structure in the ${}^{197}\text{Au}(n, \alpha)$ cross section round 24 keV.

For the $^{235}\text{U}(n,f)$ cross section it was referred to the discussion under item 3 c) of the agenda.

Concerning the developments in flux measurement techniques the sub-committee reported about the different techniques developed at different standard laboratories, NBS, NPL, Harwell, Karlsruhe, BIPM, BCMN, NRC, Cadarache, ETL (Tokio), IMM (Leningrad) and PTB (Germany).

The final comments by the subcommittee were :

- 1) Many discrepancies occur because people disseminate data which are not complete.
- 2) For some sets of data there are a number of versions at the data Centres and this can lead to confusion.
- 3) There is a tendency to assume that the most recent data are correct. Evaluators have to be more cautious.
- 4) The report of the 1972 Panel meeting should be made available soon.

The Chairman accepted an action to write to J.J. Schmidt, IAEA about the publication of the Proceedings of the Standard Panel 1972.

Sowerby agreed to circulate the report of the Subcommittee as an EANDC-document.

Sowerby recommended for the future work of the Sub-committee of Standards and Discrepancies that the different items should be

prepared by identified members of the Sub-committee. That member could have comments sent to him beforehand of his particular items (cross-sections) to allow a better base for a discussion within the sub-committee. At the present meeting the following members reported as follows :

H(n,n), $^3\text{He}(n,p)$ - Tsukada

Isotopic standards, half-lives, $^{10}\text{B}(n,\alpha)$ - Böckhoff

$^{197}\text{Au}(n,\gamma)$ - Cierjacks

$^6\text{Li}(n,\alpha)$, $^{235}\text{U}(n,f)$, - Sowerby

List of EANDC documents issued since the sixteenth EANDC Meeting
(November/December 1972)

Committee Papers

- 91"U" Sixth biennial report on the activities of the EANDC; November 1972; W.W. Havens, Jr. and W.G. Cross
- 91"A" Summary record of the sixteenth meeting of the EANDC (Paris, France; 27 Nov.-1 Dec. 1972); compiled by H. Condé
- 92"U" Summary record (technical) of the sixteenth meeting of the EANDC (Paris, France - 27 Nov.-1 Dec. 1972); compiled by H. Condé
- 93"U" Distribution list for EANDC documents; July 1973
Revision 1 - Sept. 1973
Revision 2 - Oct. 1973
Revision 3 - Nov. 1973
Revision 4 - Feb. 1974

Canadian Documents

- (CAN)47"L" Canadian report to the EANDC (Dec. 1972 to Mar. 1974); compiled by W.G. Cross

Euratom Documents

- (E)147"AL" Der totale Wirkungsquerschnitt von ^{10}B zwischen 90 keV und 420 keV; H. Beer, R.R. Spencer and F.H. Fröhner
- (E)151"U" Evaluation of neutron data for ^{235}U ; 1972; E. Schatz
- (E)154"U" $\bar{\nu}$, the average number of emitted neutrons in fission (contributions to the EANDC topical conference held on Nov. 29, 1972 at Saclay, France on the occasion of the 16th meeting of the EANDC); March 1973; edited by P. Ribon
- (E)155"U" $\bar{\nu}$, the average number of fission neutrons (contribution to the topical conference of the 16th EANDC meeting); 1973; P. Ribon
- (E)156"U" The neutron capture in ^{23}Na (RCN-175); September 1972; J. Kopecky, F. Stecher-Rasmussen and K. Abrahams
- (E)157"U" Progress report on nuclear data research in the European Community for the period January 1 to December 31, 1972; submitted by the JENDRPC
Volume I - March 1973
Volume II - May 1973

- (E)158"L" Quelques remarques sur l'évaluation des sections efficaces neutroniques de ^{239}Pu dans le domaine des résonances (Note CEA-N-1638); May 1973; H. Derrien
- (E)159"L" An evaluation for cross sections of the reaction ^7Li (p,n) ^7Be and $^7\text{Be}^*$; 1973; H. Liskien and A. Paulsen

Japanese Documents

- (J)27"AL" Program ELIESE-3; Program for calculation of the nuclear cross sections by using local and non-local optical models and statistical model (JAERI 1224); December 1972; S.I. Igarasi
- (J)28"AL" Evaluation of some fast neutron cross section data (T. Kanda and R. Nakasima)
- (J)29"AL" On the differential cross section for neutron-proton scattering at 14.1 MeV; May 10, 1973; S. Shirato and K. Saitoh
- (J)30"L" Progress report from Japan, July 1972 to June 1973 inclusive; edited by T. Momota
- (J)31"AL" Request list for nuclear data for the development of safeguards techniques; September 1973
- (J)32"AL" Bibliography for thermal neutron scattering (JAERI-M5395); Fourth edition, Sept. 1973; by the Thermalization Group, Japanese Nuclear Data Committee
- (J)33"AL" Neutron scattering from ^{207}Pb (JAERI-M5418); October 1973; Y. Tomita, S. Tanaka and M. Maruyama

U.K. Documents

- (UK)150"L" Fission product chain yields from experiments in reactors and accelerators producing fast neutrons of energies up to 14 MeV (AERE-R-7394); May 1973; E.A.C. Crouch
- (UK)151"L" U.K. Nuclear Data Progress Report, April 1972 - March 1973 (UKNDC(73)P.53); August 1973; edited by M.G. Sowerby
- (UK)152"A" Technical minutes of the 9th meeting of the U.K. Nuclear Data Committee, held at A.E.R.E. Harwell on 22nd June, 1973; B.H. Patrick
- (UK)153"A" U.K. views on the future, scope, outlook and structure of the EANDC; 21 January 1974; J.S. Story and M.G. Sowerby
- (UK)154"AL" Nuclear data requirements for the reactor programme in the United Kingdom (AEEW-M1249); March 1973; A.L. Pope

(UK)155"A" Important nuclear data requirements for the U.K. reactor programme; J.L. Rowlands

(UK)156 -

(UK)157"AL" Estimates of the $(n, \gamma n')$ cross section for ^{238}U (DIDWP(74)/P.33); J.E. Lynn

U.S. Documents

(US)172"AL" Structure studies in light nuclei with neutrons (COO-1717-3); 27 October 1972; R.O. Lane

(US)176"U" Reports to the U.S. Nuclear Data Committee Meeting at National Bureau of Standards, 24-26 October 1972 (USNDC-3); edited by H.E. Jackson

(US)177"L" Status of measurements for the U.S. nuclear energy program, Reports of the USNDC Sub-committees, February 1973 (USNDC-5); edited by H.E. Jackson

(US)178"A" Technical minutes of the USNDC Meeting at National Bureau of Standards, 24-26 October 1972 (USNDC-4 A); compiled by H.E. Jackson

(US)179"U" A review of the total radiation widths of the neutron resonances of ^{238}U ; F. Rahn and W.W. Havens, Jr.

(US)180 "U" Proceedings of the Conference on Particle Accelerators in Radiation Therapy, Los Alamos Scientific Laboratory, 2-5 October 1972 (LA-5180-C)

(US)181"U" Reports to the U.S. Nuclear Data Committee meeting at Oak Ridge National Laboratory on 18-20 June 1973 (USNDC-7); compiled by H.E. Jackson

(US)182"A" Relative and absolute measurements of the fast neutron fission cross section of ^{235}U ; W.P. Poenitz

(US)183"L" Neutron Cross Sections - Volume I: Resonance Parameters (BNL 325, Third Edition, Volume I)

(US)184"A" Technical minutes of the USNDC meeting, 18-20 June 1973, held at Oak Ridge National Laboratory, Oak Ridge, Tennessee (USNDC-8A); compiled by H.E. Jackson

(US)185"A" Stable Isotope Research Pool Inventory, September 1973.

(US)186"U" Reports to the U.S. Nuclear Data Committee Meeting at Argonne National Laboratory, 28-29 November 1973 (USNDC-9); compiled by C.D. Bowman

(US)187"A" Minutes of the USNDC meeting on 28-29 November 1973 at Argonne National Laboratory, Argonne, Illinois (USNDC-10 A); compiled by C.D. Bowman

(US)---"A" Supplement: Recommendations for Implementing Radiotherapy with Negative Pions at LAMPF (LA-5266-MS, Informal Report); May 1973; C. Richman and D.E. Groce

Documents from other OECD countries

- (OR)123 Not assigned
- (OR)126"L" Progress Report to EANDC from Austria-1973; compiled by O.J. Eder
- (OR)127"L" Progress Report to EANDC from Denmark - 1973; not produced
- (OR)128"L" Progress Report to EANDC from Greece - 1973; not produced
- (OR)129"L" Progress Report to EANDC from Iceland - 1973; not produced
- (OR)130"L" Progress Report to EANDC from Ireland - 1973; not produced
- (OR)131"L" Progress Report to EANDC from Norway - 1973; not produced
- (OR)132"L" Progress Report to EANDC from Portugal - 1973; compiled by F. Gama Carvalho
- (OR)133"L" Progress Report to EANDC from Switzerland - 1973; compiled by T. Hürlimann
- (OR)134"L" Progress Report to EANDC from Spain - 1973; not produced
- (OR)135"L" Progress Report on nuclear data activities in Sweden; September 1973 (KDK-2); Swedish Nuclear Data Committee
- (OR)136"L" Progress Report to EANDC from Turkey - 1973; not produced
- (OR)137"AL" The neutron time-of-flight facility at the Uppsala tandem accelerator (TLU 9/73); H. Condé, L.-E. Persson, L.-G. Strömberg, A. Lindholm, G. Lodin, L. Nilsson and C. Nordborg
- (OR)138"A" Summary Record of the Fourteenth Meeting of the EANDC Regional Sub-Committee on Nuclear Data, held at Risø, Denmark, on 6 and 7 Dec. 1973
- (OR)139"A" Requests for neutron data measurements (Sweden)(KDK-3); December 1973; Swedish Nuclear Data Committee.

MEMORANDUM FOR THE RECORD

1. On 10/10/54, the following information was received from the [redacted] office:

2. [redacted] advised that [redacted] had been [redacted] on 10/10/54.

3. [redacted] advised that [redacted] had been [redacted] on 10/10/54.

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20. [redacted] advised that [redacted] had been [redacted] on 10/10/54.