NEANDC 125 "U"

NUCLEAR ENERGY AGENCY NUCLEAR DATA COMMITTEE

S U M M A R Y R E C O R D

OF THE

TWENTY-FIRST MEETING

(Technical Sessions)

CBNM, Geel (Belgium)

24th-28th September 1979

Compiled by

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(Scientific Secretary)

OECD NUCLEAR ENERGY AGENCY
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TECHNICAL SESSIONS

Participants in the 21st Meeting were as follows :

For Canada :
Dr. W.G. Cross
Atomic Energy of Canada Ltd.
Chalk River

For Japan :
Dr. K. Tsukada
Japan Atomic Energy Research Institute
Tokai-Mura

For the United States of America :

Dr. R.E. Chrien (Chairman)
Brookhaven National Laboratory

Dr. S.L. Whetstone
U.S. Department of Energy

Dr. H.T. Motz
Los Alamos Scientific Laboratory

Dr. F.G. Perey
Oak Ridge National Laboratory

For the countries of the European Communities and the European Commission acting together :

Dr. K. Böckhoff (Local Secretary)
Central Bureau for Nuclear Measurements
Geel, Belgium

Dr. C. Coceva (Scientific Secretary)
Comitato Nazionale per l'Energia Nucleare
Bologna, Italy

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Dr. E. Fort
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Cadarache, France

Dr. A. Michaudon (Vice-Chairman)
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Dr. M.G. Sowerby
United Kingdom Atomic Energy Authority
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Winfrith

For the other OECD countries acting together :

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Stockholm, Sweden

Dr. H. Vonach
Inst. für Radiumforschung und
Kernphysik
Vienna, Austria

Nuclear Energy Agency:

Dr. N. Tubbs

Dr. P.D. Johnston (Secretary)

Observers

The following observerswere present at different times during the meeting:

K. Budtz-Jørgensen (CBNM Euratom)

J. Debrue (NEACRP observer)

H. Liskien (CBNM Euratom)

M. Moore (Los Alamos, USA)

G. Rohr (CBNM Euratom)

B. Rose (CBNM Euratom)

J.J. Schmidt (IAEA-NDS, Vienna)

E. Wattecamps (CBNM Euratom)

H. Weigmann (CBNM Euratom)

1. Isotopes

The procedures for obtaining samples of enriched isotopes are unchanged: those repofted in the minutes of the 20th NEANDC meeting continue to be valid.
The following report "US DOE separated stable and heavy element isotope production" is submitted to the Committee by Whetstone.

US DOE Separated Stable and Heavy Element Isotope Production

1. "Contained" Calutrons have been reactivated and are being run to produce enriched Pu-242 (Goals: ∿150 g. 99.9% and ∿ 100 g 95%). A (very) small amount of Pu-244 (∿15%) is also obtained. Calutrons will run until about December 1979; product ready by about March.

2. Operation will revert back to the production of stable isotopes. During the first 6-8 months of 1980, Tl-203 and Tl-205 will be separated (the Tl-203 is used for the production of Tl-201 for medical usage).

3. A new management plan is being developed by the Oak Ridge Operations Office.

4. It has been decided that the establishment of Heavy Element Isotope Loan Pool is too costly to consider at this time. A computer-based inventory system is being set up, however, that will include not only heavy element materials on hand at ORNL, but also those held at other DOE sites. The system is expected to become fully operational in 1981.

5. The production of Th-230, Th-229 and Pa-231 at the Mound Facility is being suspended for lack of customers. The production of U-234 is being continued.

6. The price of Am-241 has been increased from $600/g to $800/g.

Qaim and Cierjacks express their general satisfaction with the procurement of enriched isotopes, except for delays, sometimes very long, between request and delivery. Cross says that under this respect the situation should improve, since the regulations on resistence to nuclear weapons proliferation are now established. Also, with the new organization, bureaucratic work should be greatly reduced, leading to a better service.
Qaim informs that it is possible to obtain some enriched isotopes also from Israel.

2. National Progress Reports

The following progress reports for the year 1979 are distributed:
- Energy Research Centre, Petten, Netherlands
- Japanese progress report (draft)
- Canadian progress report to the NEANDC, NEANDC(Can)-51/L
- Bureau of Nuclear Data Evaluation, Department of fast breeders, C.E.N. Cadarache, France

Cierjacks illustrates the project for an intense spallation neutron source, now at the stage of a feasibility study to be concluded within June 1981. Although the configuration of the source is not yet fixed, it will probably consist of a proton linear accelerator with Alvarez structure, with an energy perhaps of 600 MeV and a peak intensity around 100 mA, having a 10% duty cycle. Also the possibility of adding a storage ring is being considered. The target system, with cooling, beam tubes, etc., is the other main part of the source which is being studied, with the help of experiments carried out at the SIN of Villigen (Switzerland). Such an intense source is needed mostly for solid state physics, in view also of the shut down of three experimental reactors in Germany, i.e. those of Munich, Karlsruhe and Jülich. It is found that a neutron source based on an accelerator, from many points of view, is more convenient than a reactor. It is expected to obtain a thermal neutron flux at the beam tubes of about 6.10^{14} n/(cm^2 s) . Besides solid state physics, other interests are in the field of radiation damage, pion physics, neutron cross-sections.

It is also important that the accelerator is in the class of machines useful for studies of electro-nuclear breeding.
Qaim informs us about the compilation of a gamma-ray catalog by U. Reus, W. Westmeier and I. Warnecke GSI Report 79-2 (Darmstadt), and a table of alpha-rays (emitters, intensities, energies, half-lives, etc.) by W. Westmeier and R. Esterlund, Marburg University.
Motz says that the storage ring to be added to the WNR facility at Los Alamos will need about 3 years to be completed.
Chrien informs us that at Brookhaven the Tristan mass separator is being installed: it will be devoted to delayed neutron studies and nuclear spectroscopy of fission fragments. The high flux reactor will be upgraded to reach neutron fluxes (at the experimental beam-tubes) comparable to those of the Grenoble reactor. Chrien points out that the measurement of the capture cross-section of ^{232}Th at low energy has given significantly higher values than ENDF/B IV. A precise measurement of the total cross-section at the 24.37 keV minimum in ^{56}Fe was performed. The angular distributions of the emitted alphas in the $^{10}B(n,\alpha)$ and $^{6}Li(n,\alpha)$ reactions were measured and compared with the predictions of the R-matrix calculations of G. Hale. Michaudon describes the work performed at Bruyères-le-Châtel during 1979. In cooperation with LASL and ORNL high resolution fission cross section measurements were performed on ^{231}Pa at the ORELA machine in the range 5 keV-12 MeV. Absolute fission cross sections were determined for ^{235}U at 4.45 MeV and at 10 MeV, and for ^{241}Am at 14.6 MeV. Measurements were made of the kinetic energy and angular anisotropy of fragments from fission of ^{238}U and ^{230}Th induced by fast neutrons. Fast neutron scattering measurements were performed on ^{232}Th, ^{233}U, ^{238}U and ^{242}Pu. The average number of prompt neutrons emitted per fission was determined as a function of incident neutron energy up to 15 MeV for ^{235}U and ^{237}Np. Yields and angular distributions were obtained for neutrons emitted by bombarding a Be target with deuterons at energies of 8 and 11.5 MeV. Capture cross sections were measured in Gd, Rb, Ta, Ce, Cs for neutron energies between 0.5 and 3 MeV. Michaudon informs the committee on the following calculations and evaluations of nuclear data: capture cross sections (10 keV$\leq E_n \leq$3 MeV) of the gadolinium isotopes 155, 156, 157, 158 and 160. Optical model calculation of the even isotopes of ytterbium, 172, 174 and 176.

Cross-sections of ^{241}Pu (in co-operation with LASL).
Cross-sections of ^{85}Rb and ^{87}Rb (in cooperation with BNL).
(n,p) and (n,α) cross sections of the tungsten isotopes 182, 183, 184 and 186.
Fort describes briefly the evaluation work performed at Cadarache. An unofficial paper is presented, which describes the codes FISINGA and SI2N developed for neutron data evaluation.
Also the evaluation works on ^{237}Np, ^{241}Am and natural Nickel are described.
In addition to the presentation of the 1978 progress report for U.K., Sowerby says that the installation of the new linear accelerator is now completed and the whole commissioning will be finished in Nov. 1979.
Progress in Japan is illustrated by Tsukada, by presenting the July '78-June '79 progress report. Special mention is made of the fast neutron facility using the ion beam from the JAERI 20 MV tandem accelerator and of the compilation of the version two of the Japanese evaluated nuclear data library (JENDL-2).
The Canadian progress report from April 1978 to September 1979 is presented by Cross. In particular he gives some information on measurements of yields of ^{233}U and ^{239}Pu obtained by bombarding spallation targets with high energy protons (up to 500 MeV) at TRIUMF. The measured production of fissile materials and neutron leakage are compared with calculations, using nuclear cascade and evaporative model and neutron transport, for different target geometries. Discrepancies as large as 40% are found for large geometries (40 cm diameter, 30 cm long target). Cross mentions also the compilation of energies and intensities of prompt gamma rays from neutron capture, available from A. Lone upon request.
The activities of the CBNM at Geel are briefly illustrated by Böckhoff. In particular he reports on the status of the fission cross section measurements of ^{241}Am, performed using both the Van de Graaff and the Linac: the work is not yet concluded. A large effort at Geel is put into the resonance parameter determination for the isotopes ^{54}Fe, ^{56}Fe, ^{57}Fe, ^{50}Cr, ^{52}Cr, ^{53}Cr, ^{104}Pd, ^{105}Pd, ^{106}Pd, ^{108}Pd, ^{110}Pd and into the cross-section measurement of the $^{54}Fe(n,\alpha)$, $^{54}Fe(n,p)$ and $Ni(n,\alpha)$ reactions.
Vonach mentions the measurements carried out in Vienna of the secondary neutron spectra emitted for 14.1 MeV incident neutron energy. Such measurements were performed for 17 elements with 5-10% accuracy for the secondary neutron energy range 0.25-6 MeV.
The Swedish activities are outlined by Condé. Among other things, he

mentions the progress in the conversion of the synchrocyclotron of the Uppsala University to a sector focused cyclotron and the delayed neutron facility at Studsvik. As a consequence of the neutron elastic scattering measurements carried out at Studsvik, he points out that the fast neutron elastic cross-section of Bi could be used as a secondary standard, with a possible application in fission-fusion devices.

Motz refers about the work done at Los Alamos 1) to improve the theoretical models for the representation of fission neutron spectra 2) on chemical analysis by thermal neutron induced gamma-ray spectrometry 3) on measurements and calculations of the decay heat of ^{235}U, ^{233}U and ^{239}Pu.

3. Meetings

Harmonization of NEA-sponsored meetings with those organized by IAEA-NDS is discussed. J.J. Schmidt presents a list of meetings planned for the next three years. Such a list is reproduced in Appendix 1.

As regards the specialists' meetings already decided at the 20th NEANDC meeting, Chrien reads a letter by A.Smith on the meeting on fast neutron capture cross-sections of important fissile and fertile isotopes, to be held in Argonne, October 1980. He says that it is important that the subject of this meeting is interpreted as fast capture cross sections, with emphasis on fissile and fertile isotopes and not so much on resonance parameters and thermal cross sections.

Coceva confirms that the Bologna meeting on cross sections of fission product nuclei will take place in the days 12-14 December, 1979.

An extensive discussion is carried out on the series of international conferences on nuclear data for applications, to be held after the 1981 European conference. Chrien says that no Knoxville-type meeting will be organized in 1982 in the U.S., and proposes to extend the period between these regional conferences to four years, with a phase difference of two years between the European and the U.S. series. Everybody agrees that a three years cycle is too short. For the next European conference, several possible places are proposed, among them Vienna, by Vonach, but there it could take place only late in the year. It is preferred to endorse the suggestion that the CBNM organize the conference, possibly in Antwerp, with the co-sponsorship of NEA.

Other detailed news on meetings to be sponsored by NEA or of general interest for NEANDC are given in the report of the subcommittee on

meetings. Besides that, the Committee is reminded of the symposium on neutron cross sections from 10-50 MeV, to be held on May 10-14, 1980 at Brookhaven: such a meeting will be devoted to the data needs for the Fusion Materials Irradiation Test Facility.

It is also recommended that committee members disseminate information about the consultants meeting on neutron source properties, which will take place in Debrecen on March 17-21, 1980 under the sponsorship of IAEA-NDS.

4. Technical Discussions

i) Reference-mass Standards

A proposal is discussed to set up a national (U.S.) ^{235}U fissile-foil reference-mass standard. Such a proposal, advanced by A. Smith at Argonne, is motivated by the need of increasing the accuracy of fast fission cross section of common actinides up to the required 1-2%. To this end, cross section measurers need reference foils with ^{235}U mass known within 0.3%. The National Bureau of Standards has already begun to work on this project. It is planned to extend an inter-laboratory comparison with other national laboratories, in particular with Western Europe via the CBNM, Geel. This activity is commented on favourably, and a proposal is advanced by Liskien (CBNM observer) to link this intercomparison with the one of neutron flux measurements, which should start in 1980.

ii) Actinide Cross-sections

The NEANDC specialist meeting on nuclear data of plutonium and americium isotopes for reactor applications,which had been decided upon at the 20th meeting, was held at Brookhaven on November 20-21, 1978 and the proceedings have just been published (BNL 50991, NEANDC L-116). A summary by R. Chrien was distributed in April 1979. Chrien reads the final recommendations, which can be found at p. 377-378 of the above report. In the discussion, it is stressed that any effort in developping detectors and instrumentation to cope with highly active materials should be encouraged (see contributions by Budtz-Jørgensen and by Dabbs in the proceedings). J.J. Schmidt reports on the second IAEA advisory group meeting on transactinium isotope nuclear data, which was held in Cadarache on May 2-5, 1979. The proceedings, now in draft form, will be published as INDC(NDS)-106/LN report. Schmidt summarizes the recommendations of the

working group, stressing the needs of fission cross-section data in the subthreshold region and of capture cross-section measurements for Np, Pu, Am and Cm isotopes. Evidence is given by Fort to the substantial experimental improvements and to the evaluation efforts since the prvious 1975 meeting. It is also true that the requirements are now more stringent. Fort points out that in many requests the required accuracy corresponds to two standard deviations, while f.i. for U.K. requirements it is one standard deviation. An action is put on the Chairman to recommended also to INDC and NEACRP a consistent use of errors, or confidence limits, in all request lists.
M. Moore illustrates a method by means of which the results of accurate measurements on some easily available actinides, such as ^{235}U, ^{239}Pu and ^{238}U, can be used to evaluate the corresponding data of nuclei having four nucleons more, like ^{242}Pu. This method could be used to set some constraints to the usual optical model calculations of cross sections for nuclei where experimental data are not available. A paper on this subject is to be presented at the Knoxville conference.
J.J. Schmidt deems it useful a comparison work of different recent evaluations of actinide nuclear data, such as those performed at Cadarache, Bologna and Harwell.
Böckhoff reads a letter of Chabrillac on the work of Tellier et al. in which a substantial improvement is obtained in resolving the discrepancy between the values of the effective capture integral in ^{238}U as obtained from differential data and from integral experiments. This work was published as CEA-N-2078, NEANDC(E)206"L".

iii) Decay Heat

Motz informs us that no new measurement was performed in the U.S. since the last meeting. Previous work done at Los Alamos is now published: LA-6713 on ^{235}U and LA-7452 on ^{233}U and ^{239}Pu, both by J. Yarnell and P. Benot. Fission product gamma spectra for ^{233}U, ^{235}U, and ^{239}Pu have been published in LA-7620 by E.T. Jurney et al.
A comparison between calculations based on version IV and version V of ENDF-B shows very little variation ; in particular the 10% discrepancy between calculated and measured values for Pu is unchanged.
The ANS decay power standards are now available.
Information on file development in U.K. is given by Rowlands: revised data by Tobias are now available. The effect of isomeric states of fission products was calculated by M.F. James (AAEW): taking into

account this effect implied a decay-heat variation of about 2% within 1 hour from shutdown.

In the discussion on the Pu discrepancy, Motz reports the opinion of England, according to whom the difference may be due to the decay of light fragments, which are present in the case of ^{239}Pu and not in ^{235}U. Motz is inclined to attribute the difference to incorrect fission yields. Cross reminds us that the results of a work by W.H. Walker (AECL 6528) support the idea that the discrepancy is due to a wrong estimate of the heat from beta rays.

Condé points out that measurements of ^{235}U fission fragments decay are going on at the Studsvik facility, where they plan also to measure the decay of ^{239}Pu fission fragments as a whole, i.e. not mass-separated.

iv) Nuclear Data Needs for Fast Reactor Shielding

For the U.S., Perey reports the information given by R. Roussin, Chairman of the shielding subcommittee of CSEWG. U.S. requirements in this field are in the process of being completely re-assessed. In this process, the formulation of needs is delayed by specificities of shielding design. At present there is no request for new data for shielding.

Rowlands says that a preliminary review of U.K. requirements was given in the paper of J. Butler presented at the Harwell (1978) conference. There is a need for sensitivity studies and for benchmark experiments in order to define the requirements. Rowlands stresses the difficulty of applying the results of benchmark experiments to practical cases, due to the complicated geometry of shielding design. There is a need for error files having particularly accurate covariance data. Such problems will be discussed also at the next NEACRP meeting.

v) Data for Fusion Systems

Perey distributes and illustrates documents issued by the Office of Fusion Energy (OFE) and by the Office of Basic Energy Sciences (OBES) concerning the needs of the U.S magnetic fusion energy program and the work being carried out or planned to meet such requirements. Requested neutron cross sections generally cover the 0-40 MeV interval.

Priority 1 requirements are:

1) for the fusion materials development program (including data for the FMIT facility, dosimetry and material damage calculations);

2) for the next generation of D-T reactor designs, and
3) nuclear physics data to support operation of experimental devices or for design studies of experiments.

Perey says that fusion reaction experiments on exotic fuels are going on at Argonne and that at Ohio University a triplet quadrupole spectrometer is in operation for (n,Z) reactions.
Work going on for anticipated needs is not reported in the distributed documents; f.i. the work carried out at Princeton for the interpretation of diagnostic data, such as T+T cross sections.
Motz presents the work done at Los Alamos, in particular the efforts to measure D+D, and later D+T and T+T cross sections at the low-energy end down to 10 keV, with the help of a specially designed windowless cryogenic target.
Qaim points out that at the last Interlab seminar data were presented by C. Uttley (see also the 1978-1979 U.K. nuclear data progress report) showing a cross section for $^{7}Li(n,n'\alpha t)$ lower by 20% than the ENDF-B/IV estimate in the range 5-15 MeV. This might have some implications on T breeding. However these are still preliminary results which must be checked again.
Tsukada reminds us that there is a 30-50% discrepancy between the Russian measurements of T+T cross section and those performed at Los Alamos: according to Jurney, at least part of the difference could be due to gas occluded in the window or in the supports of the target.
J.J. Schmidt reports briefly on the Advisory Group meeting on nuclear data for fusion research and technology which was held in Vienna in December 1978. The proceedings of this meeting were published in the INDC-NDS-101-LF report. Schmidt confirms that nuclear data requirements are quite extensive, the largest part of them being in the field of the data for damage studies. In Schmidt's opinion a significant contribution could come from developing countries by means of measurements with 14 MeV neutrons, specifically for total cross sections, and n-emission cross sections as a function of angle.

vi) Data for Alternate Fuel Cycles and Electro-nuclear Breeding

Chrien presents a pilot project for a Fast Mixed Spectrum Reactor (FMSR) which is being carried out at Brookhaven. This new reactor concept would have excellent non-proliferation characteristics, good uranium utilization and would require no fuel reprocessing since it would operate on a once-through-and-store fuel cycle. The cost of the

electric power obtainable from FMSR should be equivalent to that of conventional fast breeders. After the first core, consisting of moderately enriched uranium, the new fuel consists only of natural or depleted Uranium. Fuel would remain in the reactor a very long time , about 17 years, reaching a burnup of 13-15%. A first feasibility study was presented by Fischer and Cerbone in the report BNL 50976 (January 1979).

Nuclear data needs for this project are summarized, for fission product cross-sections , in a table given by D. Mathews and distributed to the members.

Fort reminds us that at the TND Cadarache meeting (May 1979) it was concluded that " .. New reactor concepts under consideration will put added emphasis on long burn up and on hard spectrum fast reactor systems. Sensitivity analysis in these cases should reveal heightened requirement for data on higher actinides and on cross sections above 100 keV. ... "

Qaim points out the importance of measuring the cross sections of materials present as impurities, for reactions leading to gas production: f.i. the reaction $^{40}Ca(n,\alpha)^{37}Ar$ with the attendant problem of Ar diffusion at temperatures higher than 300°C. Also a reaction which is of great concern in fuel management is $^{12}C(n,p)^{12}B$ because of the unknown cross section of ^{12}B. Another important reaction mentioned by Qaim is $^{14}N(n,p)^{14}C$.

About electro-nuclear breeding, Cross underlines the fact that for important materials (Au, for instance) not enough data are known of the (n,2n), (n,3n), (n, 4n) reactions, in the range 20÷40 MeV.

A discussion takes place on the reliability of calculations of cross sections of the (n,kn) processes, which does not seem to be satisfactory. Experimental problems of spectrum unfolding with threshold detectors are discussed by Cierjacks.

On the same subject of electro-nuclear breeding, Chrien presents a pilot study being performed at Brookhaven (see BNL 50838) of a light water reactor fuel enricher/regenerator. The idea is to produce fissile material in light water fuel elements surrounding a spallation target producing about 10^{20} neutrons/sec. This may be obtained from a 1.5 GeV proton linear accelerator with an average current of 0.3 A. It is estimated that fertile material in excess of 1 ton per year could be produced. In comparison with the once-through light water reactor fuel cycle, this new concept could allow a higher amount of

energy, by a factor of 3, extracted from natural Uranium, a lower separative work by a factor of about 4 and a reduced volume of the spent fuel to be stored by a factor 2. An important feature is that one could stretch the use of light water reactors beyond the limits set by ^{235}U resources.
Debrue summarizes the current views on the Thorium cycle. It appears that no large experimental effort is going on on this fuel cycle.

vii) Dosimetry Requirements

Problems related to the creation of a dosimetry data library are reviewed by Perey. Since activation cross sections are always measured as ratios to known data, great importance is given to the quality of standard data in this field.
Perey points out that much of the basic data are inconsistent; hence the need for new highly accurate measurements and better evaluations, which should always take into account the method of measurement. Evaluations are complicated by the high degree of correlation among data found in the literature and by the difficulty in tracing the standard on which the data are based; for this reason many data are not usable.
Liskien points out the very severe organization problems in this field, since in principle all evaluations should be carried out simultaneously; he says that the possibility of absorbing new data is practically very limited. Perey, however, maintains that the requirements cannot be satisfied only by better evaluations and that new measurements are needed; it is possible to introduce new results in old information, without re-evaluating everything if the correlation file is properly done.
It is reminded that the 3rd Symposium on Reactor Dosimetry will take place at Ispra, Italy, October 1-5, 1979.

viii) Evaluation of Average Level Spacings

Fort shows that there is a great demand for having a sure basis for the evaluation of average level spacings from measurements of neutron resonances. He reports that largely different results, sometimes by a factor of 2, may be obtained by applying different evaluation methods. Fort suggests that a procedure or an exercise is proposed to a number of laboratories to compare these different methods and

to assess their applicability: such a proposal should be presented at the forthcoming NEANDC Specialists' Meeting on Fission Product Cross Sections. The results of the comparison should then be examined in a workshop to be organized by the NEA. The Committee agrees with Fort's views and the Chairman is charged to write a letter to Coceva suggesting to discuss at the Bologna meeting practical ways to compare different methods of extracting average level spacings.

ix) Intercomparison of Nuclear Model Codes

A number of comparisons of different nuclear model codes has been organized in the U.S. by a subcommittee of CSEWG chaired by A. Prince (BNL). It was proposed to extend this intercomparison work to Europe and Japan with the help of the NEA. Johnston explains the way this intercomparison should be performed and illustrates the document NEANDC 118 "L".

It is stressed that each code should be run by its originator and that only the results should be given to the coordinator for further processing.

The Committee comments favourably on this initiative, also because it is an occasion of discussions and meetings on a specific problem, leading to an improvement of the contacts between nuclear physicists and evaluators all over the world.

Chrien suggests that this extension of the comparison should be discussed among interested people at the forthcoming Knoxville Conference: the results of this discussion should form a starting point for the co-operation work.

x) Biomedical Needs

Qaim says that, in this field, non neutron data are becoming more and more important. Up to now few isotopes have been of common use, such as ^{99}Tc and ^{131}I, which can be produced in reactors: for these there is no need of data. It is however necessary to have better data for cyclotron-produced isotopes. The interest is now concentrating on neutron deficient isotopes decaying with short half-lives by positron emission or electron capture, for example ^{201}Tl or ^{123}I. For radioisotope production, one must consider also the impurities which are formed because they might disturb, for example producing some damage in the organs. For these impurities many decay data and decay schemes are known, but there is a need for some of them, such as ^{74}Br

and ^{75}Br. Qaim underlines the importance of nuclear data for exact calculations of the purity of the resulting sample; in some cases the purity can be improved by a careful design of the irradiation facility, to minimize competing reactions.
Cross points out that information on production of positron emitters is not likely to be easily available: because of the short half-life and of the need of producing the radioisotopes on the spot, there is a large market for accelerators and great commercial interests behind that.
Tsukada illustrates the progress made in Japan and also in Sweden, in the production of light radio-isotopes with low-energy electron linear accelerators, by means of photo-reactions induced by bremsstrahlung radiation.
Condé informs us about the photo-production of radioisotopes at Lund, using a microtron.
About neutron therapy, the state of the art was assessed at the Harwell Conference: data are needed in the 20-50 MeV region.
For pion therapy, Motz reports that an accelerator development program (PIGMI) has received support in the U.S.
Rose says that people is becoming interested in a new method of radio-therapy based on the Auger effect. At Jülich some investigation on this subject is carried out by the medical institute. In the U.S. the MIRD Committee is currently looking after this possibility. It is reminded that the MEDLIST program (Oak Ridge) deals with this effect.
Nuclear data needs in medicine and biology were summarized at the 1978 Panel on reference nuclear data and published in the proceedings, BNL-NCS-51023.
It is also reminded that a meeting on neutron therapy and radioisotope production will be held by IAEA in Vienna on October 6-10, 1981.
Schmidt says that the NDS of IAEA should like that some experts of nuclear data participate in this meeting in order to advise the users in the formulation of their data requirements.

xi) Techniques for Measuring (n, charged particle) Reactions

The current programs in the U.S. for measurement of (n,charged-particle) reactions are those at the Lawrence Livermore Laboratory and Ohio University, both using magnetic quadrupole spectrometers, and a new effort is planned at the ORELA linear accelerator (Oak Ridge).
An experimental program for the measurement of gas production reactions is being carried out at Rockwell International (USA) by a group led by H. Farrar. The Helium produced is measured with a high-sensitivity gas

mass spectrometer; absolute results are attained by adding a known amount of ^{3}He spike to the collected gas sample.
A similar technique has been initiated at Jülich, for neutrons produced by deutron break-up on a Be target. Radiochemical techniques for selecting different charged reaction products are also used.
Such techniques will be treated in one of the monographs to be published under the auspices of NEANDC.
Böckhoff expresses his intention of initiating some measurements of (n,p) and (n,α) cross sections at the linac time-of-flight facility of CBNM, Geel;he anticipates that a difficult aspect of this kind of measurements will be given by the radiation damage of the solid state detectors.
Some papers dealing with these techniques are presented at the topical conference during this meeting. (See Section 5).

xii) Data for Thermal Reactors

The status is well represented by the proceedings of the Electrical Power Research Institute (EPRI) symposium on "Nuclear Data Problems for Thermal Reactor Applications" EPRI NP-1098. The summary (section 1 of the proceedings) is distributed to the committee members.

5. Topical Meeting on "Progress in Neutron Data of Structural Materials for Fast Reactors since the NEANDC/NEACRP Specialists' Meeting at CBNM, Geel , December 1977"

This one-morning conference takes place according to the programme given in Appendix 2.
The general discussion at the end of the meeting is summarized in Appendix 3 by F. Fröhner.
In the afternoon, B. Rose presents CBNM's activities, in the frame of the Energy and the Joint Research Centre General Directorates. A general description of the CBNM can be found in the May 1978 issue of "Europhysics News".
After Rose's exposition, a visit to all CBNM facilities was organized for the Committee members.

6. Neutron and Related Nuclear Data Compilations and Evaluations

i) Request Lists

Schmidt reports on the compilation of the new WRENDA 79/80 request list. The compilation is completed and is ready for printing.

The total length of the list is increased, since there were about 500 items deleted and a larger number of new requests. Current interest is shifted towards fusion problems, for which the number of requests have increased drastically.
Both Tubbs and Perey have the impression that in many cases the requests are advanced without having a clear picture of the status of the requested data. All requests should be critically reviewed by some knowledgeable people.
Michaudon says that, in some cases, the requests show that the existence of measured data was ignored. Probably, in these cases, what are really lacking are evaluations and not measurements.
Perey says that requestors should keep in mind the recommendations of the Vienna meeting on data for fusion.
Fort points out that information on the correlations might change the requested accuracy. Difficulty arises because, in general, evaluated data have no accuracy stated. Fort adds that in the case of structural materials, French requirements have taken due account of the results of integral measurements.
In the discussion on the ways to improve the procedures for the formation of request lists, the opinion emerges that a two-step approach should be followed, similar to the one in use for the U.K. request list, in which the draft list prepared by data users is critically reviewed by subcommittees including, besides users, also measurers and evaluators. The most recent U.K. request list (AEEW-M 1712, 1977) is distributed to the committee members. An action is put on the Chairman and all members to encourage the application of the U.K. procedures in all OECD countries.
Chrien suggests that WRENDA should list the requests for evaluations separately from the requests for measurements.
Michaudon points out that the experimental programs of the various laboratories do not seem often to take the requests in due account; however Böckhoff observes that sometimes, in order to set up a new measurement, a very long time is needed, e.g. for the procurement of separated isotopes, etc.

ii) NEA Data Bank Activities

Tubbs reports on the work of the Data Bank, after the merging of CCDN and CPL: great benefit has been drawn from this operation and the work marks a clear improvement. The conversion of nuclear data from the NEUDADA format to EXFOR has proceded according to schedule and now

there is more power to compile data in EXFOR format than ever. The conversion work into EXFOR will be completed in Spring 1980. The PDP 11/70 computer is working now with 5 terminals, but since they are not enough, 3 more will be installed.
Advantage has been taken from the clearing-up work associated with the conversion to the new computer, to put more order in the information system and increase the productivity.
Johnston illustrates some problems concerning the classification and manipulation of data in EXFOR format: a new computation format for experimental neutron data(resonance parameters)has been adopted and is presented in NNDEN/26. The number of compilations has increased from approximately 100 per year in the past, to 200 per year.

iii) IAEA/NDS activities

Schmidt distributes tables showing some statistical data on the requests received and fulfilled by NDS in 1978 and 1979. Schmidt points out the trend to increase the number of compilations and exchanges of charged particle nuclear data.
However, the data received from some laboratories are not yet in EXFOR format: Schmidt suggests that these laboratories should be solicited to convert their formats to EXFOR.
As for photonuclear data, Schmidt observes that there is a non-negligible push, spurred by very recent developments. For instance, a new centre for photo-nuclear data has been set up in Moscow.
The work is proceeding of the Nuclear Structure and Decay Data (NSDD) network, 2/3 of the total effort being carried out in the U.S. and 1/3 elsewhere.
The next meeting of the NSDD network will be held in Vienna in April, 1980.
CINDA archival volume, covering references up to the end of 1976 was published early in 1979. Also an updated volume, called CINDA 79, was published, covering the years 1977 and 1978. A supplement of CINDA 79 will appear very soon, in the fall of 1979.
The publication of CINDU, information of nuclear data libraries available from NDS, will be dropped in the future and replaced by a Nuclear Data Newsletter and by publications of a documentation series on IAEA/NDS nuclear data services. As suggested at the Reactor Dosimetry Nuclear Data Meeting (Vienna,November 1978),an International Reactor Dosimetry File(IRDF)will be

compiled with the last evaluated data on current important neutron dosimetry reactions for reactors, together with their covariance matrices.
The compilation of a complementary benchmark file was also recommended at the same meeting.
Both files are currently under production and will hopefully be ready at the end of 1979.
Schmidt ends his exposition by illustrating briefly the meetings organized by the NDS (see Appendix 1).

iv) CSEWG Activities

Chrien distributes and comments a document on CSEWG activities, prepared by B. Magurno.
Of particular interest the description of the status of ENDF/B-V and of the mechanisms to control and test the evaluated data. The work of the CSEWG Normalization and Standards Subcommittee, which is preparing a report on Neutron Standard Reference, is of importance for the NEANDC Subcommittee on Standards and Discrepancies. The intention is to share the files of the two subcommittees on a regular basis.
Chrien highlights also CSEWG activities in the fields of data compilations (particularly the new edition of BNL-325), meetings, and publications.
Of particular interest the EPRI Symposium on "Nuclear Data Problems for Thermal Reactors", held at Brookhaven, May 22-24, 1978 (proceedings published in the report EPRI NP-1098), the "Fission Spectrum Workshop", held at Brookhaven, October 23, 1978 (proceedings published in the report LA-7739-C) and the forthcoming Symposium on "Neutron Cross-Sections from 10-50 MeV", which will take place at Brookhaven on May 12-14, 1980 and which will be organized by M. Baht.

v) A-chain Evaluations

Cross reviews the status of the various contributions to "mass-chain" evaluations. There are now 72 chains for which an evaluation work is going on; 45 chains, which were evaluated in 1975, are not included in the current work, so that the goal of having each chain reviewed on a 4-year cycle will not be attained.
U.S. contributions to the international effort in "mass-chain" evaluations is summarized in Magurno's paper.
The U.S. work, which is now centralized in the Nuclear Data Project at Oak Ridge, will be transferred in approximately one year to Brookhaven.
In the discussion, the desirability emerges of having a common list of half lives of radioactive isotopes, to be officially used on an

international basis. This problem was already discussed at the last INDC meeting. The ideal source for this list should be the ENSDF (Evaluated Nuclear Structure Data File). Whetstone says that it is planned to produce a "Radioactivity Handbook" at the Lawrence Berkeley Laboratory using data from the ENSDF. The first edition of this handbook should be published early in 1983. A partial list, concerning commercially available radioisotopes, updated to 1978, is available from Chalk River.

vi) Exchange of Evaluated Nuclear Data Files between NEA Member Countries

The discussion is centered on the completion of the ENDF/B-V nuclear data file and on the decision by the DOE to limit the distribution of the general purpose files and derived multigroup application files to U.S. and AECL (Chalk River) users, except for the auxiliary files for Standards, Actinides, Dosimetry and Fission Products (see NNDC newsletter n. 79-2).

Also, concern is expressed by the NEA Secretariat on the trend to limit the availability through the Data Bank of some important programs and, instead, to resort to bilateral agreements for the exchange of such programs.

In order to give rise to a more relaxed attitude in the release of data files and programs for the benefit of all NEA countries, it is decided that all members should forward to their national authorities the agreed statement. Such a statement, obtained from a draft prepared by Rowlands, is a warm appeal "to find a balance of contributions acceptable to all parties" so that a freer exchange of information may take place between all NEA member countries.

Such a statement will be forwarded also to the NEACRP through Fort, NEANDC observer.

NDS MEETINGS PLANNED FOR 1980

Date	Duration	Location	Type of Meeting	Title	Responsible Staff
January 28-February 22	4 weeks	ICTP Trieste, Italy	Training Course	Advances in Nuclear Theory for Applications	J.J. Schmidt, N. DayDay
April 14-18*	5 days	Utrecht,* Holland	Advisory Group	Nuclear Structure and Decay Data	A. Lorenz
March 17-21	5 days	Debrecen, Hungary	Consultants	Neutron Source Properties	K. Okamoto
May 19-22	4 days	Paris, France	Technical Committee	Atomic and Molecular (A+M) Data for Fusion	K. Katsonis
May 23-24	2 days	Paris, France	Consultants	A+M Data Centre Network	Head of A+M Data Unit
June 12-13	2 days	Vienna, Austria	Research Co-ordination	Intercomparison of Actinide Neutron Nuclear Data Evaluations	H.D. Lemmel
June 12-13	2 days	Vienna, Austria	Research Co-ordination	Measurement and Evaluation of Transactinium Isotope Nuclear Decay Data	A. Lorenz
June 16-20	5 days	Vienna, Austria	Technical Committee	11th Meeting of the International Nuclear Data Committee (INDC)	J.J. Schmidt, A. Lorenz
October 6-10*	5 days	Vienna, Austria	Consultants	Biomedical Nuclear Data	A. Lorenz
November 24-28*	5 days	Brookhaven, USA	Consultants	Fifth Annual Nuclear Reaction Data Centre Meeting	H.D. Lemmel

* Tentative

NDS Meetings planned for 1981

Type of Meeting	Title
Conference (possible IAEA Cooperation)	Nuclear Data for Reactors and other Applications (OECD-NEA)
Technical Committee	12th Meeting of INDC (Fall in Vienna)
Advisory Group	Nuclear Data for Radiation Damage and Dosimetry (May 1981)
Advisory Group	Nuclear Data for Alternate Fuel Cycles
Consultants'	Uranium and Plutonium Resonance Parameters
Consultants'	Sixth Annual Meeting of the Nuclear Reaction Data Centres (Fall in Vienna)
Consultants'	Meeting of the Atomic and Molecular (A+M) Data Centre Network
Research Coordination	Intercomparison of Actinide Neutron Nuclear Data Evaluations
Research Coordination	Measurement and Evaluation of Transactinium Isotope Nuclear Decay Data
Research Coordination *	14 MeV Nuclear Data Measurements for Fusion
Research Coordination *	A+M Data Evaluation

* New project to be organized in 1980.

NDS Meetings planned for 1982

Type of Meeting	Title
Conference (possible IAEA Cooperation)	Nuclear Data for Technology (USA)
Training Course	Nuclear Physics for Applications
Advisory Group	Biomedical Nuclear Data
Advisory Group	Meeting of the Nuclear Structure and Decay Data Network
Consultants'	Seventh Annual Meeting of the Nuclear Reaction Data Centres (USSR)
Consultants'	U-235 Fast-fission Cross Sections
Consultants'	Meeting of the Atomic and Molecular (A+M) Data Centre Network
Research Coordination	Intercomparison of Actinide Neutron Nuclear Data Evaluations
Research Coordination	Measurement and Evaluation of Transactinium Isotope Nuclear Decay Data
Research Coordination	14 MeV Nuclear Data Measurements for Fusion
Research Coordination	A+M Data Evaluation

Commission of the European Communities

JOINT RESEARCH CENTRE

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APPENDIX 2

Topical Discussion

at the occasion of the 21st NEANDC Meeting
on 26th September, 1979 at CBNM Geel

Progress in Neutron Data of Structural Materials
for Fast Reactors since the NEANDC/NEACRP Specialist
Meeting at CBNM, Geel in December 1977

Conference Room in the Main Building of CBNM

PROGRAMME

Session A Chairman: D.B. Gayther

8.30 - 8.50 : Measurement of (n, charged particle) reaction cross sections of structural materials for fast reactors.
S.M. Qaim and R. Wölfe

8.50 - 9.00 : Determination of cross sections for the neutron induced helium production on Cr, Fe, Ni and ^{54}Fe.
A. Paulsen, H. Liskien, F. Arnotte, R. Widera

9.00 - 9.45 : Contributions from the USA

9.45-10.00 : High resolution cross section measurements of structural materials.
A. Brusegan, F. Corvi, G. Rohr, R. Shelley, T. van der Veen, E. Cornelis, C. Jungmann, L. Mewissen, F. Poortmans

10.00-10.10 : Recent work on structural material cross sections at Karlsruhe.
F. Fröhner, K. Wisshak, F. Käppeler

10.10-10.30 : Coffee break

Session B Chairman: F. Fröhner

10.30-10.45 : Capture cross sections of structural materials measured with the Harwell large liquid scintillator.
D.B. Gayther, B. Thom, M.C. Moxon, J.E. Jolly

10.45-11.20 : Transmisssion measurements on the Harwell Synchrocyclotron.
G.D. James and D.B. Syme, presented by M.C. Moxon

Comparison of computer programmes used to obtain resonance parameters from capture data.
M.C. Moxon

11.20-11.50 : Progress in neutron cross section measurements and evaluations concerning structural materials in Japan.
K. Tsukada

11.50-12.10 : Evaluation of neutron cross sections for some corrosion products of stainless steel.
H. Gruppelaar, H.A.J. van der Kamp

12.10-12.30 : Measurements of structural material capture to ^{235}U fission rate ratios in intermediate and fast spectra.
P. Azzoni et al.

12.30-12.50 : General discussions.

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APPENDIX 3

Brief Resumé of the Free Discussion

F. H. Fröhner

After the last presentation there was about half an hour of free discussion and comments.

The examples of discrepant resonance parameter sets shown by F. Perry for ^{60}Ni+n and by F. Fröhner for ^{58}Fe+n had caused some concern. After some discussion, however, it was concluded that for ^{60}Ni agreement between Harwell and ORNL was satisfactory for the majority of levels and that the effect of the remaining discrepancies was probably tolerable for practical purposes such as group constant calculation. The discrepancies for ^{58}Fe looked more serious. With respect to the quite different effective radii for potential scattering it was said that the formal separation between potential scattering and resonance contribution is not unique but depends on the channel radius chosen, on the number and range of explicitly treated resonances including negative levels and on the formal treatment of all other ("distant") levels. Variations of the effective radius can be compensated to some extent by variations of the resonance widths. The final criterion, apart from data uncertainties due to background subtraction, sample impurities etc., can only be the goodness of fit. The proper perspective was established by the remark that ^{58}Fe was important for astrophysics but not for reactor technology. Nevertheless the ^{58}Fe discrepancies should be taken as a warning by resonance analysts and users of resonance parameters that transmission analysis is not as umproblematic as is often assumed.

A question whether it was really necessary to parametrize high-resolution data was answered in the affirmative. The main reasons given were the need for resonance parameters in the reduction of capture (or other reactions) yield data and the bad errors in

self-shielded group constants caused by the inevitable energy shifts and different resolution effects in tabulated experimental data from different experiments. These can only be eliminated by generating the various cross sections needed (σ_n, σ_γ) from a consistent set of resonance parameters.

The discussion than turned to a discussion of the 1.15 keV level of ^{56}Fe+n. It was concluded that finally, after clarification of normalization problems at Geel and of dead-time effects at Harwell, the Geel transmission measurements and the Harwell capture measurements gave values of Γ_γ and of Γ that agreed within error bars. In contrast to this the 27.7 keV level of ^{56}Fe+n was still a matter of concern. The new Karlsruhe capture measurement with time-of-flight discrimination against capture of scattered neutrons outside the sample was reported to give much better accuracy ($\sim$ 6%) for Γ_γ than all previous experiments. Unfortunately the most recent Harwell figures and new data from Lucas Height are 30-40% lower, although with larger errors.

The last point discussed concerned multiple-photon detection in total-energy detectors. There seem to be conflicting theoretical results for the proper weighting functions but F. Corvi presented new experimental results indicating that the corrections for multiple events are quite small (few percent) for the C_6D_6 tank at Geel.