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INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

Third Meeting of the Coordinated Research Project on the Intercomparison of Evaluations of Actinide Neutron Nuclear Data

Vienna, 12 - 13 June 1980

SUMMARY REPORT

H. D. Lemmel
Nuclear Data Section
International Atomic Energy Agency

August 1980

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

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Actinide Evaluations Vienna 1980

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SUMMARY REPORT

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Abstract

The third Research Coordination Meeting of the participants in the IAEA Coordinated Research Programme on the Intercomparison of Evaluations of Actinide Neutron Nuclear Data was convened by the IAEA Nuclear Data Section on 12-13 June 1980 in Vienna.

The meeting participants presented reports on the status of their work, on completed evaluations, on intercomparisons of evaluations, and on specific topics on related nuclear theory and required data accuracies. An IAEA Nuclear Data Library for Actinides (INDL/A) has been started.

Contents

Third Research Coordination Meeting
for the coordinated research project on the
Intercomparison of Evaluations of Actinide Neutron Nuclear Data

Vienna International Centre
12 - 13 June 1980

Meeting Room: Tower A, floor 24, room 11
Opening: Thursday, 12 June, 9:30 hours

Agenda

A. 1. Opening, Election of Chairman, Adoption of Agenda

2. Brief reports by participants:
   - activities completed and being done
   - special problems encountered
   - plans for the future

B. Topical discussions

1. Coupled channel calculations

2. Statistical models for (n,2n) and (n,3n) cross-sections

3. Accuracy requirements

4. Intercomparison of average resonance parameters

5. Integral actinide cross-section measurements

C. Conclusions; date of next meeting

Meeting Participants

FRANCE

H. Derrien *	DEDR/DRNR/SEDC/SPNR C.E.N. - Cadarache B.P. No. 1 F-13115 Saint-Paul-Les-Durance
A. Michaudon	Centre d'Etudes de Limeil B.P. No. 27 F-94190 Villeneuve St. Georges
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GERMANY, Federal Republic of

F. Fröhner *	Institut für Neutronenphysik und Reaktortechnik Kernforschungszentrum Karlsruhe Postfach 3640 D-7500 Karlsruhe
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INDIA

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E. Menapace *	Centro di Calcolo del C.N.E.N. Via Mazzini 2 I-40138 Bologna

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SWEDEN

H. Condé	National Defense Research Institute Avdelning 2 S-104 50 Stockholm 80

U.S.S.R.

Yu.G. Bobkov	Fiziko-Energeticheskij Institute Obninsk, Kaluga Region

UNITED KINGDOM

B.H. Patrick *	Nuclear Physics Div., Bldg. 418 Atomic Energy Research Establishment Harwell, Didcot, Oxon., OX11 ORA

U.S.A.

A.B. Smith	Applied Physics Division Argonne National Laboratory 9700 South Cass Avenue Argonne, Illinois 60439

IAEA Staff Members

N. Kocherov
H.D. Lemmel (Scientific Secretary)
J.J. Schmidt

* The participants of the Coordinated Research Project resp. their co-workers or alternates are marked with an asterisk.

Participants of the CRP who were not present:

V.A. Kon'shin (Mr. Bobkov reported about his work)	Luikov Heat and Mass Transfer Institute BSSR Academy of Sciences Minsk, USSR
G. Vasiliu (He sent data evaluation reports through Mr. Răpeanu who came for another meeting)	Institute of Nuclear Power Reactors P.O. Box MG4. 7000 Bucharest-Magurele Romania

Third Research Coordination Meeting
for the coordinated research project on the
Intercomparison of Evaluations of Actinide Neutron Nuclear Data

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12 - 13 June 1980

List of papers distributed at the Meeting
(The sequence of numbering is incidental)

1. Tentative Agenda

2. INDC(NDS)-104: Summary of last meeting in Aix-en-Provence

3. N. Kocherov:
Status of NDS Compilation of integral cross section and benchmark neutron spectrum data as of June 1980

4. IAEA-NDS-12: INDL/A, Contents and documentation

5. Present status of Transactinium Nuclear Data for JENDL-2

6. S. Igarasi and T. Nakagawa:
Evaluation of Neutron Nuclear Data for Cm-242

7. S. Igarasi and T. Nakagawa:
Summary of evaluated data for Cm-242

8. S. Igarasi and T. Nakagawa:
Evaluation of Neutron Nuclear Data for Cm-245

9. S. Igarasi and T. Nakagawa:
Summary of evaluated data for Cm-245

10. V.A. Konshin:
Applications of the nuclear theory to the computation of neutron cross-sections for actinide isotopes

11. G. Vasiliu et al.:
Nuclear Data Evaluation for Th-232
INDC(RUM)-10

12. A.I. Voropaev et al.:
Group Neutron Fission and Radiative-Capture Cross-Sections for Transactinides. Report INDC(CCP)-149, June 1980.

13. V.A. Konshin et al.:
Evaluation of the ^{235}U Fission Cross-Section in the Energy Range 0.1 keV - 20 MeV

14. J.E. Lynn, B.H. Patrick, M.G. Sowerby, E.M. Bowey:
Progress Report from the UK up to the end of May 1980

15. M.K. Mehta:
Status Report No. 3, India

16. S.B. Garg:
Some comments on Romanian evaluation of Th-232
("Working Paper-1")

17. M.K. Mehta et al.:
Preliminary report on comparison of techniques used for
(n,2n) and (n,3n) cross-sections

18. M. Caner, Y. Bartal, S. Yiftah:
Cm-246 Neutron Data Evaluation. Report IA-1358

19. Ju.G. Bobkov, I.N. Makasova:
Comparison of group constants for Pu-241 and Pu-242

20. Ch. Lagrange:
On the usefulness of coupled channel calculations for
actinide nuclei

21. Centre d'Etudes de Bruyères-le-Châtel:
Progress Report on Actinide Nuclear Data Evaluation Works,
April 1979 - March 1980

22. V.A. Konshin et al.:
Evaluation of Nuclear Data for Pu-241. Report INDC(CCP)-142

23. CNEN-Bologna:
Activity report May 1979 - May 1980

24. CEN-Cadarache:
Survey of the nuclear data activities, 9 June 1980

25. W.P. Poenitz, J.F. Whalen, A.B. Smith:
Total neutron cross-sections of heavy nuclei

26. M. Holmberg:
Angular distributions of the fission fragments of Th-232
(incident neutron energy 1.6 - 1.8 MeV)

27. M. Holmberg and L.E. Persson:
The fission cross-section and some angular distribution of
the fission fragments of Pa-231

28. B.H. Patrick, M.G. Sowerby:
An assessment of the accuracy requirements on higher actinide
nuclear data for fast reactors. NEANDC(UK)-174=INDC(UK)-34

29. G. Vasiliu et al.:
Nuclear data evaluation for Pa-233. Being reproduced as
report INDC(ROM)-12

30. U. Fischer:
Use of optical model to evaluate fast neutron cross-sections
for transactinide nuclei. Report KfK-2907, Feb. 1980

31. Swedish Nuclear Data Committee - Actinide Nuclear Data
Working Group:
Compilation of Actinide Neutron Nuclear Data. Report KIK-35

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

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

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

The evaluations performed by the participants were included on a tape "INDL/A" (IAEA Nuclear Data Library for Actinides). The present contents of this tape is documented in the report "IAEA-NDS-12" (see Appendix).

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

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

The participants presented progress-reports on their work, reports and intercomparisons of evaluations completed, as well as papers on specific topics, in particular about the application of nuclear theory. See the list of papers on page 9. These papers are not appended to this summary report but are available from the IAEA Nuclear Data Section upon request.

A summary of finished and planned evaluations and intercomparisons of actinide neutron nuclear data is given on page 23.

Some of the discussions that took place at the meeting are summarized in the following:

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

2. M.K. Mehta reported on calculations of (n,2n) and (n,3n) cross-sections based on statistical models. Above the (n,3n) threshold the Pearlstein theory (1965) underestimates the (n,2n) cross-section and overestimates

the (n,3n) cross section. Various calculations performed since then were reviewed and their merits discussed.

3. B.H. Patrick presented a summary of the document NEANDC(UK)-174 = INDC(UK)-34: An assessment of the accuracy requirements on higher actinide nuclear data for fast reactors, by B. H. Patrick and M. G. Sowerby. This paper considers a typical fuel element in a plutonium fuelled fast reactor, irradiated to a specific burn-up in a standard spectrum, followed by various cooling periods up to a maximum of 10 years. The paper assesses the adequacy of the nuclear data needed for fast reactor calculations of the arisings of minor actinides, the α-heat, the total heat, the spontaneous fission rate, the (α,n) yield and the total neutron yield. It was found that the achievable accuracy in the calculation of the following quantities (Pu-236 production, α-heat, total heat and total neutron output) falls short of that currently required; if requested accuracies are to be obtained, the most important nuclear data which need to be improved are

Np-237 (n,2n)
Am-241 (n,γ) Am-242g
Am-243 (n,γ)
(α,n) yields
Cm-242 spontaneous fission branching ratio.

The accuracy of fission cross-sections appears to be sufficient at present for such calculations. It was stressed that the study applied to specific conditions and changes in these could lead to different conclusions. Although the calculations were made with one energy group only, they were considered important and similar calculations should be encouraged, possibly with more groups and for other reactor types.

Dr. Bobkov noted that a similar sensitivity study in the USSR gave results which generally agreed quite well with those of Patrick and Sowerby, any differences being mainly due to the uncertainties assigned to the input nuclear data (principally in the (n,2n) reactions). He also pointed out that for uranium fuelled fast reactors, the production of U-232 is very sensitive to the U-234 (n,3n) cross-section.

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

Mr. Fröhner emphasized the importance of more accurate knowledge of the average level densities and their dependence over large energy ranges. A specialists meeting on this topic seems to be desirable.

5. N. Kocherov presented a compilation of integral actinide cross-section measurements in facilities of which the spectrum was sufficiently well described, such that these measurements can be used as bench-mark tests for the actinides evaluations. Participants were

encouraged to perform corresponding calculations to test their evaluations. The fact that for each facility the spectrum is described in a different group structure, will create some technical problems. Another limitation is, that none of these spectra was confirmed by experiment but only by calculation resp. evaluation.

6. H. Condé, as an observer from the Swedish Nuclear Data Committee, presented the report KDK-35 containing a voluminous numerical and graphical Compilation of Actinide Neutron Nuclear Data. This was considered as a most valuable contribution upon which the CRP participants can base future intercomparison work. It was recommended that this Swedish compilation work should possibly continue.

7. A. B. Smith, as an observer from the US, reported about some problems encountered in the field of actinides evaluations in the frame of ENDF/B-5. He referred in particular to the reports

ANL/NDM-32 by Poenitz et al about U-238;
ANL/NDM-35 by Meadows et al about Th-232;
a paper to be published in Nucl. Sci. Eng. by Poenitz about total neutron cross-sections of heavy nuclei;
BNL-325 resonance-parameters with a new edition being in print, and being also available on tape.

8. The need for critical intercomparison of different evaluations on the same nuclide was stressed again. Guidelines for the intercomparison were discussed and laid down at the previous CRP Meeting at Aix; see report INDC(NDS)-104. As not all of the evaluations are produced in ENDF/B format, there are some technical difficulties encountered. It was therefore highly appreciated that Mrs. Mattes from the University of Stuttgart joined the CRP with the intention of concentrating on intercomparison, format conversions and related problems.

On the following pages some of the topics discussed are presented in greater detail.

Plenary Session on Am-241

Summary by H. Derrien

The status of the neutron cross section evaluation of Am-241 has been reported by Bologna, Cadarache, Karlsruhe and Harwell. A general agreement has been found between the 4 evaluations, which constitute a test for the validity of methods for evaluation. The following points were specially discussed.

(1) In the thermal region, Cadarache evaluation relies on the capture cross-section of Weston et al. which seems to be in agreement with the absorption cross-section calculated from the Saclay experimental total cross-sections, although Fröhner pointed out that for the large resonances the $2g\Gamma_n$ from Weston are on average 4% larger than those from Saclay. In consequence, the capture thermal value recommended by Cadarache is slightly smaller than the one proposed in the other evaluations.

(2) The discrepancy in the fission cross-sections (mainly due to the large values obtained in the Seeger data from bomb shot experiment) is definitely removed. Each evaluation agrees in assuming a very small cross-section in the region from 10 keV to 100 keV, which is consistent with the results of the recent fission cross-section measurements performed at Geel and Karlsruhe, and confirmed by the integral measurements performed at Cadarache.

(3) One point has not been solved: it is the disagreement between the measured and the calculated fission integral. New fission cross-section measurement at the very low energy region should be useful. However, very high resolution measurements have been performed at Oak Ridge recently, which are not still analysed and which should give the right answer.

(4) Bryan Patrick pointed out that the branching ratio in the capture to the ground and metastable states should be better known, particularly in the fast neutron region.

Optical Model Calculations

Recommendation and Summary by J. Salvy

The usefulness of deformed optical model (DOM) calculations has been emphasized for actinide evaluations (see the contribution of Ch. Lagrange (BRC) at this meeting). In order to avoid making prohibitively expensive coupled channel calculations it has been proposed by Ch. Lagrange to use extrapolations from the results (including the transmission coefficients needed for statistical model calculations) of well adapted DOM calculations associated to a limited number of even-even nuclei (presently proposed nuclei: ^{232}Th, ^{234}U, ^{238}U, ^{240}Pu, ^{242}Pu, ^{248}Cm). This possibility is due to the smooth trends of the deformation parameters as a function of the mass number in the actinide region.

Such a procedure is to be encouraged and it is greatly recommended to help testing it.

Concerning DOM calculations for odd-mass actinides, the study of the adequacy of the "fictitious even-even nuclei" method proposed by BRC (in cooperation with LASL) is to be encouraged because it could lead to an impressive reduction of computer time (by a factor of 10 to 50 depending on the ground-state spin value).

Calculations with spherical optical potentials remain of interest but in a limited frame and in cases where enough data exist. In particular their adequacy for extrapolations to nuclei for which no experimental data exist is doubtful.

Required and Achieved Accuracies of Actinide Cross Section Data

Summary by E. Menapace

In general the needed accuracies as resulting from the reference papers, is a function of both irradiation and cooling time (1),(2). Moreover, the capture cross sections have much higher impact upon the computed accumulation of actinides than fission cross sections. There is however a slight increase in the sensitivity of computed Am-241 and Am-242 production to the Pu-241 σ_f for long irradiation time in LMFBR (2).

For comparison of the needs with the status of the art of measurements and evaluations, the following list can be deduced for U-Pu cycle (3),(4),(5),(6),(7),(8), and U-Th cycle (3),(5),(7) (the major actinides, i.e. U_{235}, U_{238} and Pu_{239} are not considered in this list):

Table 1. Cross section data concerning U-Pu cycle

Isotope	Reaction	Typical Required Accuracy (%)	Achieved Accuracy (%)
U_{236}	(n,γ)	10	25
Np_{237}	(n,γ)	10	25
Np_{237}	(n,2n)	15 (Fast	100
Pu_{236}	(n,γ)	50 (Thermal)	50
Pu_{238}	(n,γ)	10 (Thermal)	
Pu_{238}	(n,γ)	20 (Fast)	50
Pu_{238}	(n,f)	7 (Fast)	20
Pu_{240}	(n,γ)	1 (Thermal)	
		5 (Fast)	
Pu_{240}	(n,f)	2 (Fast)	
Pu_{241}	(n,γ)	3 (Thermal)	
Pu_{241}	(n,γ)	8 (Fast)	20
Pu_{241}	(n,f)	2-5	5
Pu_{242}	(n,γ)	5-15	10
Pu_{242}	(n,f)	4	5-10

Table 1. (cont'd)

Isotope	Reaction	Typical Required Accuracy (%)	Achieved Accuracy (%)
Pu_{243}	(n,γ)	10–50	50
Pu_{243}	(n,f)	10–50	50
Am_{241}	(n,γ)	5–10	15
Am_{241}	(n,γ)m	5–10	20
Am_{241}	(n,f)	10–20	10–15
Am_{242}	(n,γ)	5–30	30
Am_{242m}	(n,f)	10–30	30
Am_{242}	(n,γ)	20	30
Am_{243}	(n,γ)	10 (Thermal)	
Am_{243}	(n,γ)	20–30 (Fast)	25
Am_{243}	(n,f)	10 (Thermal)	10
Am_{243}	(n,f)	10	10
Cm_{242}	(n,γ)	20 (Thermal)	50
Cm_{242}	(n,γ)	50 (Fast)	50
Cm_{242}	(n,f)	10–25	30–50
Cm_{243}	(n,γ)	5–20	
Cm_{243}	(n,f)	10–30	30
Cm_{244}	(n,γ)	10–30	50
Cm_{244}	(n,f)	5–30	20
Cm_{245}	(n,γ)	10–20	
Cm_{245}	(n,f)	5–20	
Cm_{246}	(n,γ)	10–20	
Cm_{246}	(n,f)	10–20	
Cm_{247}	(n,γ)	10–20	
Cm_{247}	(n,f)	5–20	
Cm_{248}	(n,γ)	10–20	
Cm_{248}	(n,f)	20	

Table 2. Cross section data concerning Th-U cycle

isotope	reaction	energy range	percent requested accuracy (see Note 1)
Th_{232}	(n,tot)	60eV-100keV	2
"	(n,γ)	1eV-20eV	2
"	"	20eV-5keV	5
"	"	5keV-10MeV	5-10
"	(n,2n)	Thresh-10MeV	10
Pa_{233}	(n,γ)	20eV-15MeV	10
U_{232}	(n,γ)	Thermal	50
U_{233} (see Note 2)	(n,γ)	1mV-.5eV	1
"	"	.5eV-2eV	2
"	"	.1keV-1.5MeV	5-10
U_{233}	(n,f)	1mV-100eV	1
"	"	100eV-10MeV	5
U_{234}	(n,γ)	Thermal	5

In a paper submitted to the third CRP Meeting on Evaluation of Actinides the data, of main interest, for actinide production, α-decay heat, total heat generation, spontaneous fission neutrons, (α,n) neutrons and total neutron production for reactivity and shielding calculation purposes, are given (**compare page 12 item 3**).

For thermal reactor needs data of main importance are (see ref.[2]) capture thermal cross sections of Pu_{241}, Am_{241}, $Cm_{242,245}$ and capture resonance integrals of $Pu_{240,241,242}$, $Am_{241,243}$, Cm_{244}.

Note 1. The requested precisions for Th_{232} and U_{233} are close to that of the isotopes placing similar role (in U-Pu cycle), i.e. U_{233} and U_{235}.

Note 2. In addition, for U_{233}:

α is required with 2-8% precision (1eV-1keV)
η is required with .4% precision (1mV-1eV)
ν (prompt) is required with .25% precision (1eV-30eV)
1% " (30eV-1keV)
2% " (1keV-30keV)

References

1) H. Küsters et al., NEACRP-A-345
2) A. Gandini et al., Proc. of the 1977 ISPRA Meeting, page 379
3) H. Kouts, Proc. of the 2nd AGM on TND, Cadarache 1979
4) L.N. Usachev et al., Obninsk Report referred to NEACRP-A-335 (1979)
5) J. Bouchard, Proc. of the 2nd AGM on TND, Cadarache 1979
6) B.H. Patrick and M.G. Sowerby, INDC(UK)-34/G
7) Report of the Working Group on Neutron Reaction TND, 2nd AGM Meeting, Cadarache 1979
8) Proc. of the Specialist Meeting on Nuclear Data of Pu and Am Isotopes, Brookhaven 1978

Subgroup on Np-237

Summary by H. Derrien and M. Caner

We compared the 1977 evaluation of Caner et al. (1) with the evaluation of Derrien and Fort.

In the thermal range the σ_γ of Derrien is higher by about 10% than that of Caner et al.; the former value is based in a renormalization (x1.07) of the $\bar{\sigma}_\gamma$ of Weston to the $\bar{\sigma}_A$ calculated from the Saclay σ_T measurements.

The resonance data are in good agreement. In the higher energy region, the 1979 Mewissen resonance data have a lower energy resolution than the Plattard data which consitute the backbone of the resonance parameters recommended in Ref. 1.

In the fast energy range, the calculated capture curve of Ref. 1 seems to agree with the data of Weston in the keV range. With respect to σ_f both evaluations are essentially in agreement. The values of Plattard (1973) in the range from 5 keV to 40 keV are not to be used (according to Plattard).

The shape of the fission cross-sections from the first threshold up to 7 MeV is well defined. If an accuracy of better than 5% is required on the absolute cross-section, then a new measurement should be recommended in the 1-2 MeV region. In the second plateau large discrepancies exist both in shape and in the values of the cross-sections and new measurements are needed.

The (n,2n) cross-section recommended by Cadarache is 2 to 3 times larger than that recommended in ENDF/B-V. There is close agreement between the Cadarache and Soreq (n,2n) curves. The (n,2n) cross section seems to be reasonably well known, particularly the branch leading to the contaminant ^{236}Pu. A similar conclusion was reached in Ref. 2, p.8 (concerning the ^{236}Pu branch).

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1. M. Caner, S. Wechsler and S. Yiftah, IA-1346 (1977)

2. B.H. Patrick and M.G. Sowerby, INDC(UK)-34/G (1980)

Status of NDS Compilation of integral cross-section and benchmark neutron spectrum data as of June 1980

According to the recommendation of the meeting of the participants of this CRP in Aix-en-Provence in May 1979 NDS has started a compilation of data on integral cross-section measurements for actinide nuclides of interest to the participants. NDS has also approached several specialists with requests for the information about the neutron spectra of the benchmark facilities in which these measurements were made. The present status of this compilation is summarized in Table 1.

From 11 benchmark neutron spectra listed in the table three were obtained by evaluation and 8 by calculation. The information about the last spectrum is expected soon. Two evaluations of ^{235}U fission neutron spectra are included in the table. The evaluation by NBS (item 6) was based on different types of measurements and has uncertainties quoted. The ENDF/B-V evaluation (item 7) was based only on recent time-of-flight measurements and does not quote uncertainties. There are some differences between the results of these evaluations. According to recent information from C. Eisenhauer the ENDF/B-V version gives a somewhat better agreement with integral measurements but there was no decision yet which of the two would be selected as a standard in the US.

The two spectra for Zebra are also slightly different but this is due to the difference in sample containers used in these two cases.

The formats of spectrum data presentation range from 26 groups to 620 groups which might cause difficulties in practical application. The best way out of this from our point of view is to use a code which reduces or expands the number of groups to the required format.

The references to documentation of data in the Table are presented below:

List of references

1. D.W. Sweet, Report AEEW-R 1090, Winfrith, U.K., 1977
2. R.A.P. Wiltshire et al., Report AERE-R 7363, Harwell, U.K., 1973
3. F. Helm, Private communication, 1980, sent to the participants in the Memo dated 24.03.80
4. Report KFK 1273/4
5. W. Scholtyssek, Report KFK 2361
6. Compendium of Benchmark and Test Region Neutron Fields for Pressure Vessel Surveillance, NBS Special Publication
7. W. Mannhart, Private communication
8. C. Eisenhauer, Private communication
9. R. Chawla et al., Ann. of Nucl. Energy, V.6, p. 585-589, 1979
10. K. Gmur, Private communication information promised.

Table 1. Benchmark Neutron Spectra and Integral Cross-sections of Actinide Nuclides Measured in them

	Name of the facility and reference to spectrum documentation	Number of groups	Origin of the spectrum	Type of data measured	Nuclides
1.	Zebra (U.K.) [1]	37	calc.	$\sigma_i^f/\sigma^f{}_{239Pu}$	$^{240,241,242}Pu$ $^{241,243}Am$ ^{244}Cm
2.	Zebra (U.K.) [2]	37	calc.	$\sigma^{Prod}_{242Cm}/\sigma^f{}_{239Pu}$ σ^{Prod}_{242Cm}(abs)	^{242}Cm (production from ^{241}Am)
3.	SNEAK 9B (F.R.G.) [3]	26	calc.	$\sigma_i^f/\sigma^f{}_{235U}$	$^{240,241}Pu$, ^{241}Am } [4]
4.	SNEAK 9C-2 (F.R.G.) [3]	26	calc.	$\sigma_i^f/\sigma^f{}_{235U}$ $\sigma_i^f/\sigma^f{}_{239Pu}$	$^{240,241}Pu$, ^{241}Am } [5]
5.	^{252}Cf Spontaneous Fission Neutron Field	45	eval.	σ^f_{abs} $\sigma^f/\sigma^f{}_{239Pu}$ $\sigma^f/\sigma^f{}_{235U}$	^{240}Np, ^{237}Np } [6] ^{237}Np [7]
6.	^{235}U Spontaneous Fission Neutron Spectrum [8]	620	NBS eval.		
7.	^{235}U Spontaneous Fission Neutron Spectrum [8]	620	ENDF/B-V eval.		
8.	Big-10, U.S.A. [8]	620	calc.	$\sigma_i^f/\sigma^f{}_{239Pu}$	^{233}U, ^{237}Np } [6]
9.	CFRMF, U.S.A. [8]	620	calc.	$\sigma_i^f/\sigma^f{}_{239Pu}$	^{233}U, ^{232}Th, ^{237}Np, ^{240}Pu } [6]
10.	ISNF, U.S.A. [8]	620	calc.	$\sigma_i^f/\sigma^f{}_{239Pu}$	^{237}Np [6]
11.	ΣΣ, U.S.A. [8]	620	calc.		
12.	PROTEUS, Würenlingen, Switzerland [10]	Spectrum information forthcoming		$\sigma^c/\sigma^f{}_{239Pu}$ $\sigma^f/\sigma^f{}_{239Pu}$	^{232}Th, ^{233}U [10] ^{237}Np [9]

Finished and planned actinide evaluations

Country resp. Institute	Evaluations finished by June 1980	Evaluations in progress by June 1980	Evaluations planned by 1981	Evaluations planned after 1981
France Bruyères-le-Châtel		Pu-241 242!?	Pa-231 Th-232	
France Cadarache	Am-241 Np-237	Pu-238	Np-239	
Germany, Fed. Rep. Karlsruhe	Am-241 Cm-244	Am-242, 243		
Germany, Fed. Rep. Stuttgart			intercomparisons	
India B.A.R.C.	Th-232 (total,elastic n2n,n3n; capture above 50 keV	Th-232 (fission) Th-233 Pa-233	Pa-231, 232	Th-231 U-232, 233, 234
Israel Soreq	Cm-246		Cm-248	Pu-242
Italy Bologna	resolved res. region: Pu-241, 242 Am-241, 243, Cm-242 res.+ unres.res.region: Cm-245 to 248	Cm-245 extended up to 15 MeV	Cm-242, 243 0-15 MeV Cm-246 to 248 above 10 keV	Tentatively: Am-243, Cm-244 0-15 MeV depending on new measurements underway

Finished and planned actinide evaluations (cont'd)

Country resp. Institute	Evaluations finished by June 1980	Evaluations in progress by June 1980	Evaluations planned by 1981	Evaluations planned after 1981
Japan JAERI, JNDC	Many (see separate page)	Am-242m, 242g	Pa-231, 233, 234 U-232 Am-241, 243 Cm-243, 244, 245	
Romania Pitesti	Th-232 Pa-233	U-233	Pa-231	
U.K. Harwell	Am-241	Am-243	Am-242m	Cm-242, 244 and 245 to 248 Np-239
U.S.S.R. Minsk	Pu-239 to 242	Am-241	Cm-249 ? Am-249 ? Am-249 4 ?	

Note: Not all of the evaluations finished are already available on tape.

Program of Evaluation Work on TND in Japan

year	nuclides
By 1977	Th-232, Pa-233, U-234, -235, -238, Np-239, Pu-239, -240, 241, Am-241 (these data are stored in JENDL-1.)
1978/1979	Th-228, -230, -232, -233, -234 U -233, -235, -236, -238, Np-237, Pu-236, -238, -239, -240, -241, Am243, Cm-242, -244, -245
In Progress (1980)	Am-242m, -242g
Planned* 1980/1981	Pa-231, -233, -234 U-232, Am-241, -243, Cm-243, -244, -245

*) Japanese Evaluated Nuclear Data Library version-2 (JENDL-2) will be completed by the end of March, 1981. The data evaluated by that time will be stored in JENDL-2.

Date of next meeting

The date of the Fourth Meeting of the CRP was tentatively fixed to 17/18 September 1981 in Geel, preceding the International Nuclear Data Conference in Antwerp 21-25 September.

However, soon after, NDS heard that this Conference was postponed. Therefore, date and place of the Fourth CRP Meeting is uncertain again. Tentatively NDS has scheduled it for 17/18 September 1981 in Vienna.

IAEA-NDS-12
Rev. 1
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INTERNATIONAL ATOMIC ENERGY AGENCY

NUCLEAR DATA SERVICES

DOCUMENTATION SERIES OF THE IAEA NUCLEAR DATA SECTION

I N D L / A

IAEA Nuclear Data Library for

Evaluated Neutron Reaction Data of Actinides

Contents and Documentation

This Library contains evaluations performed by participants of the IAEA Coordinated Research Project on the Intercomparison of Evaluations of Actinide Neutron Nuclear Data.

The tape contains four files:

A. Complete evaluations

File 1: ENDF/B format

2024	94-Pu-241	Minsk
2025	94-Pu-242	Minsk
5161	94-Pu-242	Bruyère-le-Châtel
8888	91-Pa-233	Romania
9543	95-Am-243	JAERI
9642	96-Cm-242	JAERI
9644	96-Cm-244	JAERI
9645	96-Cm-245	JAERI
9999	90-Th-232	Romania

File 2: UKNDL format

1009A	95-Am-241	Harwell

File 3: KEDAK format

1	96-Cm-244	Soreq

B. Partial evaluations, resolved resonance region

File 4: ENDF/B format

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

File 1: Complete evaluations in ENDF/B format

Documentation of format: BNL-NCS-50496, October 1975

Note: Not all of the evaluations follow the ENDF/B rules strictly. For example, resonance parameters and cross-section data are sometimes both included. Caution is therefore required before applying ENDF/B computer programs.

Accession-number 2024 94-Pu-241

2554 records, date of release 79/5, received Nov. 1979, corr. 80/3

Authors: V.A. Konshin, G.V. Entsipov, E.Sh. Sukhovitskij, L.A. Bakhanov, A.B. Klepatskij, G.B. Morogovskij, Ju.V. Porodzinskij

Minsk, USSR, 1979

Complete documentation: Report INDC(CCP)-142, translation by IAEA January 1980.

Title: Evaluation of Nuclear Data for Pu-241 in Neutron Energy Range from 0.001 eV to 15 MeV.

Accession-number 2025 94-Pu-242

1688 records, date of release 79/5

Authors: G.V. Antsipov, L.A.Bakhanovich, A.B. Klepatskij, V.A. Kon'shin, V.M. Maslov, G.B. Morogovskij, Ju.V. Porodzinskij, E.Sh. Sukhovitskij, V.A. Zenevich

Minsk, USSR, 1979

Complete documentation: Report INDC(CCP)-150, translation by IAEA July 1980. (A.K. Krasin, editor)

Title: Evaluation of Nuclear Data for Pu-242 in the 10^{-5}eV - 15MeV Neutron Energy Region

Accession-number 5161 94-Pu-242

1165 records, date of release 79/3

Authors: J. Jary, Ch. Lagrange, C. Philis, J. Salvy

Bruyères-le-Châtel, France, 1979

Summary of evaluation: NEANDC(E)-203 = INDC(FR)-32, February 1979

Title: Compte rendu de travaux sur l'évaluation de données nucléaires rélatives aux actinides (Pu-240, Pu-242, Th-232)

CEA-N-2084, June 1979

Accession-number 8888 91-Pa-233

990 records, date of release 80/5

Authors: G.Vasiliu, S.Mateescu, S.Rapeanu, V.Avrigeanu, M.Ciodaru, N.Dragan, T.Stadnicov, O.Bujoreanu

Institute for Nuclear Power Reactors, Pitesti, Romania, 1980

Complete documentation: Report INDC(ROM)-12, July 1980

Title: Nuclear data evaluation for Pa-233.

Accession-number 9543 95-Am-243

2635 records, date of release 78/10

Authors: T. Fuketa, S. Igarasi, T. Asami, Y. Kikuchi, T. Nakagawa

Nuclear Data Center, JAERI, Tokai, Japan, 1979

Evaluation of Neutron Data on Am-243 and Cm-244

Unnumbered report for the IAEA research agreement No.2073/CF, Feb. 1979
Original report JAERI-M-7174 (1977), in Japanese.

Accession-number 9642 96-Cm-242

737 records, received 79/11

Authors: S. Igarasi et al.

Nuclear Data Center, JAERI, Tokai, Japan, 1980

Progress-Report NEANDC(J)-61 p. 60, September 1979
Original report JAERI-M-8342 (1979), in Japanese.

Accession-number 9644 96-Cm-244

2544 records, date of release 78/10

JAERI 1979

Same documentation as acc.nr. 9543 above.

This is a revision of the earlier evaluation published as JAERI-M-7574 June 1977.
(Original report JAERI-M-7175 (1977), in Japanese.)

Accession-number 9645 96-Cm-245

2625 records, received 79/11

Authors: S. Igarasi, T. Nakagawa

Nuclear Data Center, JAERI, TOKAI, Japan, 1978

Unnumbered report.
Original report JAERI-M-7733 (1978), in Japanese.

Note: Xerox copies of the "unnumbered reports" are available from the IAEA Nuclear Data Section upon request.

Accession-number 9999 90-Th-232

1761 records, date of release 79/2, revised 80/4

Authors: G. Vasiliu, S. Mateescu, D. Gheorghe, M. Ciodaru, E. Badescu, N. Dragan, O. Bujoreanu, C. Craciun, L. Pintiliescu, M. Zaharcu, D. Popescu, T. Statnicov, V. Avrigeanu

Institute for Nuclear Power Reactors, Pitesti, Romania, 1980

Complete documentation: INDC(RUM)-10, May 1980. A Summary of the evaluation is included on tape.

Note: Due to technical difficulties the two Romanian evaluations of Th-232 and Pa-233 and the USSR evaluation of Pu-242 are not yet available on the Sept.1980 version of the INDL/A tape. Listings of the data are included in the respective reports.

File 2: Complete evaluations in UKNDL format

Documentation of format: AWRE/O-70/63, 1963
(Note: In the case of a 4-digit accession-number its first digit is dropped in the record identification field of each record.)

Accession-number 1009^{B} 95-Am-241

4205 records, date of release 79/3 , revised 1980

Authors: J.E. Lynn, B.H. Patrick, M.G. Sowerby, E.M. Bowey

Nuclear Physics Division, AERE, Harwell, U.K.

Complete documentation: AERE-R-8528

Note: Version A contained some small errors in resolved resonance parameters above 50 eV. The corrections were included in a revised report to be published in "Progress in Nuclear Energy".

File 3: Complete evaluations in KEDAK format

Documentation of format: KFK-880, 1968

Accession-number 1 96-Cm-244

2166 records, date of release 79/3. The file is dated 9/11/79 which is the date of conversion from internal KEDAK to standard KEDAK, received at NDS 80/1.

Authors: M. Caner, S. Yiftah

Soreq Nuclear Research Centre, Israel

Curium-244 Neutron Data Evaluation

IA-1353, March 1979

File 4: Partial evaluations (resolved resonance region) in ENDF/B format

Documentation of format: BNL-NCS-50496, October 1975
(Note: The number of records is for all nuclides somewhat larger than originally announced due to the "1451" section added by NDS.)

Accession-number 9441 94-Pu-241

149 records, released 79/5

Authors: E. Menapace, M. Motta, A. Ventury

Centro di Calcolo del CNEN, Bologna, Italy

Evaluation of Pu-241 cross-sections in the resonance region.

Unnumbered report, February 1979

Accession-number 9442 94-Pu-242

89 records, released 79/5

Authors: E. Menapace, M. Motta, A. Ventura

Pu-242 evaluation in resolved resonance region

Unnumbered report, February 1979

See also: Meeting on nuclear data of higher Pu and Am isotopes, Brookhaven, November 1978

Accession-number 9541 95-Am-241

248 records, released 79/5

Authors: G. Maino, E. Menapace, M. Motta, A. Ventura

Am-241 neutron cross sections in the resonance region

Unnumbered report, February 1979

Accession-number 9543 95-Am-243

234 records, preliminary data released 79/5

Author: E. Menapace

Bologna

Not documented.

Accession-number 9642 96-Cm-242

38 records, released 79/5

Authors: E. Menapace, M. Motta, A. Ventura, A. Montaguti

Evaluation of Cm-242 in the resonance region

Unnumbered report, February 1979

Note: Xerox copies of the "unnumbered reports" are available upon request from the IAEA Nuclear Data Section.