International Atomic Energy Agency

INDC(NDS)-89/G+Sp.

INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

Minutes of the IAEA Consultants Meeting on the Evaluation of Actinide Neutron Cross Sections Vienna, 13-14 December 1976 and Discussions of the Programme at the 9th INDC Meeting Vienna, 16-20 May 1977

compiled by

R. Lessler
Nuclear Data Section
International Atomic Energy Agency

July 1977

IAEA NUCLEAR DATA SECTION, KÄRNTNER RING 11, A-1010 VIENNA

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Introduction

This meeting was convened in response to a recommendation by the IAEA Advisory Group Meeting on Transactinium Isotope Nuclear Data (TND) which was held at Karlsruhe, Fed. Rep. of Germany, 3-7 November 1975. That meeting recommended that "... an internationally coordinated effort be implemented and pursued during the next ten years so as to improve the status of transactinium neutron nuclear data required for nuclear technology". It suggested specifically that "this international effort should comprise a coordinated programme for the evaluation of transactinium isotope neutron nuclear data".

The objective of the meeting was to investigate the feasibility of a coordinated programme for the evaluation of actinide neutron cross sections. The meeting was attended by representatives from France, Federal Republic of Germany, India, Israel, Japan, Romania and U.K. These countries, together with the U.S.S.R. and Italy form the potential candidates for participation in such a coordinated programme.

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Consultants' Meeting

on the

Evaluation of Actinide Neutron Cross Sections

Vienna, 13-14 December 1976, IAEA Headquarters,
Meeting Room 'E'.

AGENDA

Monday, 13 December:

10:00 a.m.

1. Opening of the meeting.
2. Adoption of the agenda.
3. Review of conclusions from TND meeting (Karlsruhe, November 1975).
4. Present TND evaluations programmes in various countries.

Tuesday, 14 December:

5. TND evaluations to be performed by participant group during 1977-1979. Format of complete evaluation.
6. TND evaluations for the period 1980-1986 (tentative list).
7. Discussion of methods of research results reporting and coordination.
8. Tentative schedule for future group meetings.
9. Summary of the meeting.

Prof. S. Yiftah has agreed to chair the meeting.

Consultants' Meeting on the Evaluation
of Actinide Neutron Cross Sections
13-14 December 1976

LIST OF PARTICIPANTS

S. Yiftah (Chairman)	Soreq Nuclear Research Centre Atomic Energy Commission Yavane 70600, Israel	Israel
J. Salvy	Centre d'Etudes de Bruyères-le-Chatel B.P. no. 61 F-92120 Montrouge	France
H. Kuesters	Institut fuer Neutronenphysik und Reaktortechnik Postfach 3640 D-7500 Karlsruhe	Germany, Fed. Rep.
M.K. Mehta	Bhabha Atomic Research Centre Trombay, Bombay 400 085 India	India
T. Fuketa	Division of Physics Japan Atomic Energy Research Inst. Tokai-Mura, Naka-Gun Ibaraki-Ken 319-11 Japan	Japan
G. Vasiliu	Institute for Atomic Physics P.O. Box 5206 Bucharest-Magurele Romania	Romania
G.D. James	Nuclear Physics Div., Bldg. 7.21 Atomic Energy Research Establishment Harwell, Didcot, Oxon, OX 11 ORA U.K.	United Kingdom

IAEA, NDS

R.M. Lessler - Scientific Secretary
J.J. Schmidt
A. Lorenz, part-time
K. Okamoto, part-time
M. Vlasov, part-time

IAEA, Contracts Administration

P. Cate, for contract discussion

I. MINUTES OF THE IAEA CONSULTANTS' MEETING ON THE EVALUATION OF ACTINIDE NEUTRON CROSS SECTIONS, VIENNA, 13-14 DECEMBER 1976

1. Summary

The meeting first reviewed the recommendations of the Karlsruhe Advisory Group. Then each of the participants outlined the national programme for actinide neutron data evaluations intended by his country for the periods 1977-79 and 1980-86. These programmes so far reveal a strong overlap for several actinides, while some other actinides of almost equal importance are not covered at all at least in the initial period 1977-79. The meeting, while agreeing in principle on the usefulness of a coordinated evaluation programme, suggested therefore that in order to reduce multiplication of work and to cover a larger range of nuclides, first bilateral cooperative agreements be sought between the countries concerned before a multilateral evaluation programme be started and supported by the IAEA. The deadline for reaching bilateral agreements was fixed at 31 March 1977.

2. Detail

2.1. Review of previous recommendations

The meeting participants reviewed the recommendations issued by the IAEA Advisory Group Meeting on Transactinium Isotope Nuclear Data held at Karlsruhe, 3-7 November 1975, and published in the Proceedings of this meeting, IAEA-186, Vol.1, pages 3-5, regarding an internationally coordinated effort designed to improve the status of transactinium isotope neutron nuclear data required for nuclear technology. They took note in particular of the recommendation for a coordinated programme for the evaluation of transactinium isotope neutron nuclear data and suggested that such a programme include nuclear theory computations of actinide cross sections. This should be discussed further e.g. at the Course on Nuclear Theory for Applications to be held in 1978 at the International Centre for Theoretical Physics in Trieste.

The participants agreed that a coordinated programme should include two or more independent evaluations by different laboratories (Karlsruhe recommendation 1.4). Regarding Karlsruhe recommendations 1.5b and 1.6 it was suggested that analyses and comparisons of the available TND evaluations as well as TND sensitivity studies should also be included among the topics of the next specialists' meeting on TND. In this context it was noted that the NEACRP is planning a general survey of sensitivity studies at its next meeting.

Regarding the actinide Newsletter, Karlsruhe recommendation 2, it was recommended that IAEA/NDS contact Dr. S. Raman of ORNL and find out about its status.

The participants observed that Karlsruhe recommendation 3 regarding the analytical results on irradiated fuel is useful and should be pursued. Benchmarks for a simple analysis of the growth and decay of actinide nuclides in LWRs and LMFBRs would be useful for testing evaluations and should be made available to the group.

2.2. Conclusions and recommendations

The meeting concluded that a complete evaluation of neutron nuclear data for one isotope should cover all occuring neutron reactions for thermal neutron energies, resolved and unresolved neutron resonances, and fast neutron energies and include

1. a full list of references;
2. a description of the evaluation methods used;
3. a discussion of the uncertainties of the evaluated data; and
4. a comparison with other recent and/or widely available evaluations.

The consultants emphasized that the required accuracies vary with the application. The first source of references for the required accuracies should be the report IAEA-186 in which special attention was given to accuracy. Since accuracies were not in general considered as carefully for WRENDA, the accuracies listed in WRENDA 76/77 (INDC(SEC)-55/URSF) should only be used when they are not available in IAEA-186.

The consultants agreed in principle on the usefulness of a coordinated evaluation programme and recommended that for such a programme to be successful the IAEA should devote more effort and funds for this purpose and in particular should

1. conclude research contracts and agreements with the participants in the programme;
2. provide experimental and evaluated data available at the IAEA in the format in which they were received;
3. sponsor research coordination meetings between the programme participants; and
4. distribute the results of evaluations performed as part of the coordinated programme.

The following 14 nuclei were identified as being the most important:

^{241}Am, ^{242m}Am, ^{243}Am, ^{242}Cm, ^{244}Cm, ^{245}Cm, ^{246}Cm, ^{247}Cm, ^{248}Cm, ^{249}Bk, ^{249}Cf, ^{250}Cf, ^{251}Cf, and ^{252}Cf.

Appendices 1 and 2 contain the planned evaluation programmes per individual country for the periods 1977-79 and 1980-86. It is seen that a number of countries intend to do evaluations on the same nuclides, whereas no evaluations are intended for other nuclides of almost equal importance. The consultants emphasized the benefit that could arise from bilateral agreements whereby two countries would agree to share the evaluation of selected nuclides. In this way duplication could be reduced and the number of nuclides evaluated on a given time scale could be doubled. The consultants urged the countries involved to reach such bilateral agreements before the IAEA starts a multilateral cooperative programme. It should be noted that the programmes listed for 1980-1986 are very tentative and will undoubtedly be revised in the future.

It was agreed that a statement of every country's intention for participation in a coordinated evaluation programme with changes to the proposed list (thereby implying results of bilateral agreements) be sent to the IAEA by 31 March 1977. IAEA/NDS will include these statements in the corrected minutes of this meeting and distribute them as an INDC report. In due course after March 77 the IAEA will be expected to conclude research contracts and agreements respectively with the programme participants. Each of the participating groups should then inform the others every six months about the progress of its work.

Provided that a coordinated research programme on the evaluation of actinide neutron cross sections can be worked out in the first months of 1977, it was agreed that the next meeting on this subject be held in January 1978. (At the INDC meeting this was changed to May 1978).

Intended Actinide Neutron Cross Section Evaluation Programmes

A. Programme by country

Country	Ready to be released 1977	Programme for 1977-1979	Tentative Programme for 1980-1986	Remarks
France	^{231}Th*, ^{233}Th*, ^{236}Pu*, ^{238}Pu* ^{240}Pu*, ^{242}Pu*, ^{244}Pu*	^{241}Am to ^{243}Am, ^{242}Cm ^{244}Cm, ^{243}Cm, ^{245}Cm ^{236}Pu, ^{237}Pu*, ^{238}Pu, ^{242}Pu, ^{237}Np, ^{239}Np, ^{232}U, ^{237}U*, ^{239}U*		
Germany Fed. Rep.	Documentation of KEDAK-III	^{241}Am, ^{242m}Am, ^{243}Am, ^{244}Cm	KEDAK-IV	Committed (77/79)
India		^{232}Th*, ^{233}Pa*, ^{233}Th*	^{231}Th, $^{231,232}Pa$, ^{233}U	
Israel	^{237}Np	^{240}Pu, ^{241}Pu, ^{242}Pu ^{241}Am*, ^{243}Am*, ^{244}Cm	^{242m}Am, $^{245,246,247,248}Cm$	$^{240,241,242}Pu$, $^{241,243}Am$ in co-operation with Karlsruhe
Italy	$^{243,244}Pu$*, ^{242}Am*, $^{246,248}Cm$*, ^{249}Bk*	^{245}Pu*, ^{244}Am*, $^{249,250}Cm$* $^{250,253,254}Cf$*, ^{253}Es*		
Japan	^{241}Am, ^{241}Pu, JENDL-I	^{243}Am, ^{244}Cm JENDL-II	JENDL-III	
Romania		^{232}Th (for 77/8), ^{233}U*, ^{231}Pa*, ^{232}Pa*, ^{233}Pa*		
U.K.	^{241}Am, ^{242m}Am, ^{243}Am	^{239}Np, ^{242}Cm, ^{242}Am (?), ^{243}Cm (?)	$^{243,245,246,247,248}Cm$	
U.S.S.R.	^{238}Pu*, ^{243}Am*, ^{244}Cm*, ^{240}Pu (all released during 1976)	^{241}Pu, ^{242}Pu		

* Partial Evaluation

B. Programme by Isotope

Element	Isotope	Ready to be released 1977	Programme for 1977-1979	Tentative Programme for 1980-1986
Thorium	231	France*		India
	232		India*, Romania	
	233	France*	India*	
Protactinium	231		Romania*	India
	232		Romania*	India
	233		India*, Romania*	
Uranium	232		France	
	233		Romania*	India
	237		France*	
	239		France*	
Neptunium	237	Israel	France	
	238			
	239		U.K., France	
Plutonium	236		France	
	237	France*	France*	
	238	USSR **, France*	France	
	239			
	240	USSR ***, France*	Israel	
	241	Japan	Israel, USSR	
	242	France*	Israel, USSR, France	
	243	Italy*		
	244	France*, Italy*		
	245		Italy*	
Americium	241	Japan, U.K.	France, Germany, Israel*	
	242	Italy*	France,	
	242m	U.K.	France, Germany	Israel
	243	U.S.S.R.**, U.K.	France, Germ., Israel*, Japan	
	244		Italy*	
Curium	242		France, U.K.	
	243		France	U.K.
	244	U.S.S.R.**	France, U.K., Germany, Japan, Israel	
	245		France	U.K., Israel
	246	Italy*		U.K., Israel
	247			U.K., Israel
	248	Italy*		U.K., Israel
	249		Italy*	
	250		Italy*	
Berkelium	249	Italy*		
Californium	250		Italy*	
	253		Italy*	
	254		Italy*	
Einsteinium	253		Italy*	
Files		JENDL-I KEDAK-III docum.	JENDL-II	JENDL-III KEDAK-IV

* Partial evaluation

** Partial evaluation released during 1976

*** Full evaluation released during 1976

Appendix 2

Details of intended TND evaluation programmes

A. FRANCE

TENTATIVE PROGRAMME 1977-79

NOTE: 1) The actinide evaluations to be decided will depend on various factors (manpower, other nuclei, opportunities, availability of data for fitting calculations, ...) and on an approximate list of priorities (column 1 below).

2) Except for any work in progress (PR) or planned to be started shortly (ST), the following programme (which concerns several evaluation groups) is very tentative and established only for the first phase 1977-1979.

Target	complete eval.	F(1)	O.M. calc.(2) ($\gtrsim$ 10 keV)	S.M. calc.(3) ($\gtrsim$ 10 keV)	S.M. calc.(3) ($\gtrsim$ 1 MeV)	Accuracies(4)
^{242}Cm	x					TND(FR)
^{244}Cm	x					TND(FR)
^{241}Am	x	x	x	x		TND(FR)
^{242m}Am	x					TND(FR)
^{243}Am	x					TND(FR)
^{236}Pu	ST	x	PR		ST	TND(FR)
^{237}Pu		x			PR	NS
^{238}Pu	ST	x	PR	x	ST	TND(FR)
^{240}Pu		x	PR	x	ST	NS
^{242}Pu		x	PR	x	ST	NS
^{244}Pu		x	PR	x	ST	NS
^{237}Np	ST	x			x	TND(FR)
^{239}Np	ST					TND(FR)
^{232}U	ST	x	ST	x	x	NS
^{237}U		x	ST	x		NS
^{239}U		x	ST	x		NS
^{231}Th		x			PR	NS
^{233}Th		x			PR	NS

(1) F: fast neutron calculations (see following columns; eval. and calc. can be independent or not)
(2) Optical model calculations (coupled channel model)
(3) Statistical model calculations
(4) TND(FR) = TND Karlsruhe (fast reactors) IAEA-186, Vol.I, p.18
NS = not specified
x = intended

B. FEDERAL REPUBLIC OF GERMANY

1. Present work

- Intercomparison of 1-group data, used in various laboratories, for actinide build-up and decay
- Calculation of the influence of various data sets in a typical fast reactor spectrum (to be released middle of 1977)
- Important Nuclei in the Fuel Cycle Chains for LWRs and FBRs (no special report, will be included in other publications)
- Full documentation of evaluations (including recent modifications) for $^{238,240,241,242}Pu$ on KEDAK-3 (in cooperation with Yiftah); Documentation is in reproduction stage.

2. Work planned for 1977/1979

- Full evaluation of (to 15 MeV) $^{241,243}Am$ and ^{244}Cm (1. Priority) ^{242m}Am (2. Priority)
- Included will be: half-lives, branching ^{241}Am to ^{242g}Am and ^{242m}Am; ^{242g}Am to ^{242}Pu and ^{242}Cm
- Furtheron investigation of spontaneous fission rates from Pu and Cu isotopes
- (α,n) process for Cm and Pu isotopes (and ^{241}Am)
- Test of data and comparison with integral experiments, if available.

Target: Fuel cycle analysis for LWRs and FBRs (during operation: ^{241}Am and Cm - spont. fission in reloading and shut down events: reactivity, subcriticality. After discharge: Nuclide concentration and activity inventory for reprocess. and waste.

Accuracy requested: Not finally fixed, but estimated to be about 10 - 20 % for ^{241}Am (capture) and about 30 % for the other nuclei.

3. Cooperation Arrangements

- With Prof. Yiftah for ^{237}Np, ^{238}Pu (completed), ^{240}Pu, ^{241}Pu, ^{242}Pu (third phase) and for ^{241}Am, ^{243}Am (fast region) (contract with GfK-Karlsruhe).
- exchange desirable with UK (Harwell), Japan (JAERI), France

4. 1980-1986

Programme not yet decided.

C. INDIA

1. Previous work

No previous evaluation done. Newcomers in the game.

2. Programme for 1977-1979 and co-operation arrangement for different energy regions

Our experience and expertise is in the area of theoretical calculations using the statistical model, local, non-local and deformed optical models for elastic, inelastic and total cross sections; capture cross sections using statistical model, contribution due to direct, collective and cascade processes. With the statistical model and appropriate level density formulae (n,2n), (n,3n) cross sections could also be calculated.

Keeping in mind our own interests in the thorium fuel cycle, we originally proposed to do a partial evaluation in terms of types of cross sections as well as energy regions for ^{233}Th, ^{232}Th and ^{233}Pa. In general accuracy requirements seem to be 20 %. The TND proceedings are not much help as the U-Th cycle is not included for fast reactor programmes.

While only ^{232}Th (n,2n) and ^{231}Pa and ^{232}Pa for (n,γ) are listed in the thermal reactor fuel cycle applications with accuracies of 20 % and 10 % respective, an evaluation for ^{233}Pu (n,γ) is specifically recommended (Recommendation V-3, Vol.1 IAEA-186 p.12). The (n,γ) cross sections for Th and Pa are again mentioned in the fast reactor data status (Recommendation III-1 theoretical, p.20). The (n,2n) and (n,3n) cross sections on ^{232}Th again figure in the waste management and isotope applications requirement (Table 5, p.26) with 50 % accuracies. Similarly half life and decay data for ^{232}Th are required with 5 % accuracies (Table 6).

In view of the information given at this meeting about evaluation of ^{232}Th and ^{233}Pa in JENDL-1 and Th in Romania, the situation now is quite different from what we had submitted earlier. We will have to look first at these evaluations in detail before deciding the magnitude of the effort required. However as we have not done any evaluation so far it would be worthwhile to collaborate with Romania on the part of the thorium evaluation that they have not done as well as the part they have done to train ourselves in the techniques of evaluation. A detailed discussion with the Romanian team and a personnel exchange may be necessary before a specific programme can be formulated. The offer from Bruyères-le-Châtel to provide computer codes and to help in theoretical calculations with optical and statistical models can be utilized. A properly formulated research contract from IAEA would help in setting priorities and forming a scheduled programme.

3. A detailed study of the data status for specific nuclides involved in the Th-U cycle may be carried out during the initial part of the second phase of the programme. The tentative second phase programme then would include a data status study and evaluation for other nuclides. If the results of the first phase are encouraging and as our own fast breeder programme crystallizes during the present decade, we may be able to take responsibility for evaluations for a larger number of nuclides.

D. ISRAEL

1. Completed recent evaluations

To be released: 1977
^{237}Np full evaluation

2. Programme for 1977-1979

Full evaluation (third time) of:
^{240}Pu, ^{241}Pu, ^{242}Pu for KEDAK file.

Partial fast energy calculations of
^{241}Am, ^{243}Am for intercomparison purposes with Karlsruhe.

Partial data of ^{237}U needed for (n,2n) spectra of ^{238}U.

Full evaluation of ^{244}Cm.

Required accuracies for fast reactors (percent)

	σ_f	$\sigma_{n,\gamma}$	$\bar{\upsilon}$
^{240}Pu	2	5	
^{241}Pu	1.5	8	
^{242}Pu	4	8	
^{241}Am	15	5	10
^{243}Am	30	10	25
^{244}Cm	50	50	

3. Tentative programme for second phase (1980-1986)

Full Evaluation of: ^{242m}Am; ^{245}Cm; ^{246}Cm; ^{247}Cm; ^{248}Cm

4. Cooperative Arrangements:

with Karlsruhe. See above.

E. ITALY

(Telex from E. Menapace, Comitato Nazionale per l'Energia Nucleare, Bologna, Italy, 4 January 1977)

1. No evaluations released recently.

2. The programme 1977-79 concerns the evaluation or revision of thermal and resonance cross sections and related quantities (for sensitivity studies and thermal reactor calculations) for $^{243,244,245}Pu$; $^{242,244}Am$; $^{246,248,249,250}Cm$; ^{249}Bk; $^{250,253,254}Cf$; ^{253}Es (the evaluations for $^{243,244}Pu$; ^{242}Am; $^{246,248}Cm$; ^{249}Bk could be released in 1977) and moreover theoretical investigation for the calculation of fission cross section and $\bar{\upsilon}$ application to sensitivity studies and reactor calculations in the fast region.

3. The last mentioned activity will continue in the period 1980-86 according to the requests of fast reactor programme.

F. JAPAN

1. Evaluation or compilation work recently completed:

All of these are compiled in JENDL-1, and will be released in early 1977.

Nuclides	full or partial evaluation	written report
^{232}Th	rather full evaluation. Adoption from many individual experiments and evaluations, but not from the large files.	at least in the JENDL-1 documents.
^{233}Pa	partial. Adoption of Drake and Nichols, GA-7462 (1967). But calculated total, elastic, inelastic, (n,2n) and (n,3n) above 1 keV.	in the JENDL-1 documents.
^{234}U	partial. Fission cross sections above 215 ev were taken from Drake & Nichols (GA-8135, 1967), and Jary (CEA-R-4647, 1975). The energy distribution of secondary neutrons, $\bar{\upsilon}$, fission yield and fission spectrum were taken from ENDF/B-IV.	in the JENDL-1 documents.
^{235}U	partial = above 82 eV including unresolved resonance parameters. Below 82 eV, ENDF/B-IV was adopted. The energy distribution of inelastic neutrons to continuum and the fission yield were taken from ENDF/B-IV.	in the JENDL-1 documents.
^{238}U	partial = above 4 keV including unresolved resonance parameters. Below 4 keV, ENDF/B-IV was adopted.	in the JENDL-1 documents.
^{239}Np	full, except energy dist. of inelastic neutrons to continuum, $\bar{\upsilon}$, fission yield, and fission spectrum were taken from ENDF/B-IV.	in the JENDL-1 documents.
^{239}Pu	partial Thermal c.s., capture above 5.5 MeV, energy dist. of inelastic neutrons to continuum, fission yield and fission spectrum were taken from ENDF/B-IV.	in the JENDL-1 documents.
^{240}Pu	partial = above 3.91 keV including unresolved resonance parameters. Below 3.91 keV, energy dist. of inelastic neutrons to continuum, $\bar{\upsilon}$, fission yield and fission spectrum were taken from ENDF/B-IV.	in the JENDL-1 documents.
^{241}Pu	full, except energy dist. of inelastic neutrons to continuum, $\bar{\upsilon}$, fission yield and fission spectrum were taken from ENDF/B-IV.	in the JENDL-1 documents and to be published in J. Nucl. Sci. Technol. in early 1977.

Nuclides	full or partial evaluation	written report
^{241}Am	full, except energy dist. of inelastic neutrons to continuum, $\bar{\upsilon}$, fission yield and fission spectrum were taken from ENDF/B-IV.	in the JENDL-1 documents and for $\geq$1 keV to be published in J. Nucl. Sci. Technol., $\lesssim$ev range published in JAERI-M in Japanese.

2. Programme for 1977-1979:

○ ^{241}Am full evaluation, but re-evaluation of the above.
higher priority
[Requirements]

A. Thermal reactors (fuel cycle Applications)
(n,γ) for ^{242g}Am production: 10 % (core design)
30 % (fuel discharge)
20 % (transport)
(n,γ) for ^{242m}Am production: 50 % (core design)

B. Fast reactor
(n,γ) - 5 %
fission - 15 %
$\bar{\upsilon}$ - 10 %

C. Waste management and isotope applications
(n,γ) branching ratios - 10 %

The following isotopes will probably be included in JENDL-2 in addition to the isotopes in JENDL-1.

^{233}U at least full compilation
[Requirements]

A. (n,2n) - 30 % (fresh fuel)

B. none

C. (n,2n) - 10 % (fuel handling)

^{236}U at least full compilation
[Requirements]

A. (n,γ) - 4 % (core design)

B. none

C. none

^{237}Np at least full compilation
[Requirements]

A. (n,γ) - 10 % (core design)
50 % (fresh fuel)

B. (n,γ) - 30 %
fission - 50 %
(n,2n) - 50 %
$\bar{\upsilon}$ - 50 %

C. (n,2n) - 10 % (radioisotope power sources)
(γ,n)

^{238}Pu at least full compilation
[Requirement]

A. (n,γ) - 30 %

B. (n,γ) - 20 %
fission - 7 %
$\bar{\upsilon}$ - 4 %

C. $(n,3n)$ - 50 % (fuel handling)
(n,f) - 20 % (actinide recycling)

^{242}Pu at least full compilation
[Requirement]

A. (n,γ) - 5 % (core design)
50 % (decay heat)
30 % (fuel discharge)
20 % (transport)

B. none

C. (n,γ) - 30 % (actinide recycle)

^{242}Am at least full compilation
[Requirement]

A. $^{242m}(n,\gamma)$ - 50 % (core design)
$^{242m}(n,f)$ - 30 % (core design)

B. $^{242m}(n,\gamma)$ - 50 %
$^{242m}(n,f)$ - 15 %
$\bar{\upsilon}$ - 10 %

C. $^{242g}(n,\gamma)$ - 50 % (actinide recycling)
$^{242g}(n,f)$
^{242g} total
$^{242m}(n,\gamma)$ - 20 % (actinide recycling)
$^{242m}(n,f)$
^{242m} total

o ^{243}Am full evaluation
higher priority
[Requirement]

A. (n,γ) - 10 % (core design)

B. (n,γ) - 10 %
fission - 30 %
$\bar{\upsilon}$ - 25 %

C. (n,γ) - 50 % (actinide recycling)
$(n,2n)$ - (radioisotope power sources)

^{242}Cm at least full compilation
[Requirement]

A. (n,γ) - 50 %

B. (n,γ) - 50 %
fission - 25 %
$\bar{\upsilon}$ - 15 %

C. (n,γ) - 20 % (thermal)
(n,γ) - 30 % (fast)
(n,f) - 20 %
total - 20 %

o ^{244}Cm full evaluation
higher priority
[Requirement]

A. (n,γ) - 50 %

B. (n,γ) - 50 %
fission - 50 %

C. (n,γ) - 30 %
(n,f) - 20 %

^{246}Cm at least full compilation
[Requirement]

A. none

B. none

C. (n,γ) - 10 % (thermal, resonance neutrons)
(n,γ) - factor 2 (fast neutrons)

^{250}Cf at least full compilation
[Requirement]

A. none

B. none

C. (n,γ) - 10 % (thermal neutrons)
(n,f) - 10 % (resonance neutrons)

^{252}Cf at least full compilation
[Requirement]

A. none

B. none

C. none

3. Tentative Program for 1980 - 1986:

JENDL-3 might include more TND, but re-evaluation of the previously compiled data might become more important.

4. Cooperative arrangement to share the energy regions is not yet planned.

5. [Note] For three nuclides which are marked by o in the above, ^{241}Am, ^{243}Am and ^{244}Cm, we would like to contribute to the international evaluation effort with first priority.

G. ROMANIA

Proposals: to do

^{232}Th - full evaluation (1977/78)

^{233}U - partial evaluations (1978/79)

$^{231,232,233}Pa$ - partial evaluations (1978/79)

The purpose: power reactor calculations

Proposals for cooperation: with European or other data centres, and particularly with B.A.R.C. Trombay, India.
(Perhaps 1-2 persons from our group could work for several months in such a center, using part of the money received for a research contract).

H. UNITED KINGDOM

1. Completed evaluations

A report on the evaluation of data for ^{241}Am, ^{242m}Am and ^{243}Am will be published early in 1977. The work covers the reactions (n,γ), (n,f), (n,n'), (n,2n) and (n,3n) for thermal, resonance and fast energies, $t_{1/2}$ and branching ratios, information on neutron spectra and secondary energy laws. Angular distributions are not included.

2. Proposed Programme for 1977-1979

This programme will entail work similar to the above on ^{239}Np, ^{242}Cm and ^{244}Cm.

3. Tentative programme for 1980-1986

Work on the remaining Cm isotopes.

4. Accuracies

The requested accuracies for ^{239}Np and the Cm isotopes, taken from the Karlsruhe TND report, are given in Table 1.

5. Cooperative arrangements

Cooperative arrangements to share work by bilateral agreements are not ruled out.

Table 1

Requested accuracies

Element	Priority	nγ	nf	(n,2n)	(n,abs)	Γ	$\bar{\upsilon}$
^{239}Np	1	20 % fast	50 % fast	50 %	100 %		fast 50 %
^{242}Cm	2	50 % thermal 20 % resonance 50 % fast	 20 % therm + res 25 % fast				15 %
^{243}Cm	3	30 % {thermal / resonance / fast}	20 % fast 50 % thermal			15 %	
^{244}Cm	2	50 % thermal 50 % fast 30 % fast	50 % fast 20 % fast				
^{245}Cm	3	50 % fast	50 % thermal				
^{246}Cm	3	10 % therm + res 200 % fast					
^{247}Cm	3	30 % thermal	5-10 % therm. res. 10 % fast				
^{248}Cm	3	50 % thermal					

I. USSR

(Telex from L.N. Usachev, Fiziko-Energeticheskij Institute, Obninsk, U.S.S.R., 16 December 1976)

Urgently:we are ready to make our contribution to international cooperation in evaluation of actinide neutron cross sections by evaluating ^{241}Pu and ^{242}Pu. The evaluations are supposed to be completed during 1977.

II. DISCUSSIONS OF THE PROGRAMME AT THE 9TH INDC MEETING, VIENNA, 16-20 MAY 1977

The INDC discussed the planned IAEA programme on evaluations of actinide neutron nuclear data during its May meeting. The INDC meeting participants plus Kuesters (FRG), Barré (France) and Campbell (UK) attended these discussions.

In addition to the discussions at the INDC meeting a working session was convened during the INDC meeting among the programme participants for discussions of the appended working paper, and procedures for the initiation of the programme.

On the basis of discussions of the appended paper the following title was approved for the programme: "Coordinated IAEA programme on the intercomparison of evaluations of actinide neutron nuclear data", and instructions were worked out regarding the research contracts or agreements to be concluded by the programme participants with the Agency.

The INDC agreed on the usefulness of a "Coordinated IAEA programme on the intercomparison of evaluations of actinide neutron nuclear data" and recommended that for such a programme to be successful the IAEA should

1. conclude research contracts or agreements with the participants in the programme;

2. sponsor research coordination meetings between the programme participants at appropriate intervals;

3. in cooperation with other data centres provide to the participants in the programme experimental and evaluated data in the format in which they were received; agreement to standardize data in ENDF-B format would be desirable.

4. distribute and correlate the results of evaluations performed as part of the coordinated programme; and

5. inform the INDC members on the progress of the programme including status reports and plans for meetings.

Working Paper

Plans for Cooperation in the Evaluation of Actinide Neutron Nuclear Data

The following comments on the status of the IAEA's plans for a programme on actinide neutron data evaluation were derived from correspondence and discussions with the interested laboratories.

Nine countries are definitely interested in the evaluation of actinide neutron cross sections, i.e. France, FRG, India, Israel, Italy, Japan, Romania, UK and the USSR. For many of these countries, actinide evaluations are closely linked to their national reactor projects. For these countries the evaluation of Am, Cm and higher Pu-isotopes forms a high priority in their national reactor programme. However, in view of the complexity of the actinide evaluation task, they wish to emphasize the exchange and intercomparison of evaluation methods and their results. They are interested in a full exchange of actinide data and desire that by about 1980 a full actinide evaluated data file be built up, for at least the important isotopes. Other countries such as Romania and India are interested in and have partially agreed to share evaluation work on Th cycle nuclides. So far these countries have not had much experience in evaluation and they are interested in a free exchange of information and data. Within the framework of the build up to their own nuclear data libraries, they are interested in learning evaluation procedures and hope to benefit from an Agency supported exchange and from intercomparison with the more developed countries.

Therefore the following cooperative scheme is suggested: The ten countries interested in actinide evaluation are asked to join in an Agency supported "Coordinated Programme on the Intercomparison of Evaluations of Actinide Neutron Nuclear Data". The goal of this programme should be to establish in about 2-3 years a first version of an evaluated actinide neutron nuclear data file. If such a programme is agreed upon it will probably be supported by the Agency in the following way: The participating developed countries will sign IAEA research agreements (without Agency financial support except to attend coordination meetings). Some of the developing countries will apply for IAEA research contracts (with limited Agency financial support). Starting with the ninth month, the contracting countries will be obligated to submit reports every 6 months on the progress of their work. All countries will have to ask for annual renewal of the contracts or agreements. Furthermore the Agency will convene all participants in coordination meetings as the need occurs (normally annually) which would review the results and guide the future direction of the work. It is suggested that, in addition to these meetings the evaluated results be reviewed mutually by the participants and by the last evaluators of the given evaluation.

If this suggested programme is adopted, the Agency will try to make sure that this effort produces a uniform data file with schedules and common rules for the participating groups.

The following instructions were given at the session for research contracts and research agreements:

1) Use title in working paper: "Coordinated Programme on the Intercomparison of Evaluations of Actinide Neutron Nuclear Data".

2) Put in detail: isotopes to be evaluated, and cross sections, energies, theoretical calculations, etc. in the evaluation and dates of evaluation.

3) Signed proposals for Research Contracts and Research Agreements due next month (by 30 June 77) as needed to have programme approved in July by IAEA.

4) Date programme commences: 1 August 1977.

5) The Head of institute should sign and return all copies to R. Lessler, NDS. When programme is approved by the IAEA a copy will be sent back to you.

6) The IAEA will make a detailed list of evaluations to be done by the various participants and send it to all participants so each participant will know what evaluations are scheduled.

7) Programme participants will meet together at IAEA about May 1978.