International Atomic Energy Agency

INDC(NDS)-106/LN

INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

Second IAEA Advisory Group Meeting

on

Transactinium Isotope Nuclear Data

CEN Cadarache, France, 2-5 May 1979

SUMMARY REPORT

Edited by A. Lorenz

Nuclear Data Section
International Atomic Energy Agency

September 1979

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

Reproduced by the IAEA in Austria
September 1979
79-7936

INDC(NDS)-106/LN

Second IAEA Advisory Group Meeting

on

Transactinium Isotope Nuclear Data

CEN Cadarache, France, 2-5 May 1979

SUMMARY REPORT

Edited by A. Lorenz

Nuclear Data Section
International Atomic Energy Agency

September 1979

Abstract

The Second Advisory Group Meeting on Transactinium Isotope Nuclear Data was convened by the IAEA Nuclear Data Section at the CEA Centre d'Etudes Nucléaires at Cadarache, France, from 2-5 May 1979. The meeting was attended by 37 representatives from 10 Member States and 2 international organizations.

The main objectives of this meeting were to assess the transactinium nuclear data (TND) requirements for nuclear fission reactors and fuel cycles, with emphasis on new trends in nuclear technology, and to review the status of the required TND in the light of new measurements, calculations and evaluations.

Table of Contents

I. SUMMARY OF THE MEETING

A. Introduction

The Second Advisory Group Meeting on Transactinium Isotope Nuclear Data (TND) was convened by the IAEA Nuclear Data Section as a sequel to the first TND meeting held at the Kernforschungszentrum Karlsruhe in November 1975. This meeting was held at the CEA Centre d'Etudes Nucléaires at Cadarache, France, from 2-5 May 1979. The meeting was attended by 37 scientists from 10 Member States and 2 international organizations. The list of participants is given in Appendix 1.

The participants of the first TND meeting in 1975 recognized that transactinium isotopes were becoming more and more important in nuclear technology, and that the knowledge of nuclear data required to evaluate the effects of transactinium isotopes in nuclear technology was not satisfactory. Recommendations of that meeting led to the formation of two IAEA-sponsored coordinated research programmes: one on the intercomparison of evaluations of transactinium isotope neutron nuclear data, the other on the measurement and evaluations of transactinium isotope decay data. In addition to the topics considered at the 1975 TND meeting, the last three years have seen a growing emphasis on alternate fuel cycles aiming at improved safety of nuclear fuel cycles and at increased viability of nuclear materials safeguards. This meeting was convened in order to review these developments, to appraise the progress made by the Agency's coordinated research programmes since the last meeting, and to review the status of the international efforts in the field of transactinium isotope nuclear data.

B. Objectives

The meeting brought together producers of TND, responsible for their measurement and evaluation, with users of TND concerned with their applications, to achieve the following objectives:

- summarize the TND requirements for nuclear reactors and fuel cycles including new trends in nuclear technology;
- review the status of the required TND in the light of new measurements, calculations and evaluations, including reports on coordinated research programmes and recent meetings;
- formulate specific technical recommendations for future activities and their coordination.

C. Proceedings

To meet the objectives, the meeting was organized around two sets of invited review papers (see Appendix 2) covering the data requirements in the first session (Session A), and the data status in the second session (Session B). The review papers presented

during the first part of the meeting formed the basis for discussions and preparations of the conclusions and recommendations which were formulated by two separate working groups during the second part of the meeting. The discussion of the working group reports and the adoption of the conclusions and recommendations by the plenary meeting took place during the third and last part of the meeting. The Adopted Meeting Agenda is given in Appendix 3.

The meeting was opened by the Scientific Secretary A. Lorenz, and a welcoming address on behalf of the French CEA was given by M. Gajac, Deputy Director of the Department of Fast Reactors of the CEN at Cadarache.

The review papers, prepared specifically for the meeting, are planned to be published as a separate IAEA report. The translations of the Soviet reports which were contributed to the meeting are published as a separate report INDC(CCP)-135/LN. Other contributed papers (listed in Appendix 4), which were presented at the meeting, are not included in the proceedings of this meeting, and can be requested directly from the authors. The general recommendations and the reports of the two working groups are included as Parts II and III of this report.

II. GENERAL RECOMMENDATIONS

1. On the Endorsement of the two Coordinated Research Programmes (CRP's) on TND

The meeting expressed its satisfaction on the progress made by the Agency's two Coordinated Research Programmes on the Intercomparison of Transactinium Neutron Data Evaluations and on the Measurement of Transactinium Isotope Nuclear Decay Data during the initial period of their activities. The meeting strongly recommended that the activities of both programmes be continued in order to satisfy the needs for improved evaluations and measurements of transactinium nuclear data to meet the stated requirements.

2. On the CRP on the Intercomparison of Neutron Data Evaluations

The meeting adopted and endorsed the conclusions and recommendations which resulted from the 30 April - 1 May 1979 meeting of the Coordinated Research Project on the Intercomparison of Transactinium Neutron Data Evaluations, and recommended that the IAEA take all the necessary actions to implement these recommendations as well as the proposed timetable for future work.

3. On TND Measurements

The meeting recommended that the requests for data and accuracies should be justified with an indication of the main use of the data and specifically that requests be detailed with indication of the accuracies requested for each energy range. Sensitivity coefficient analysis should be performed over the full range of requirements. The importance of correlation of errors must be taken into account in such studies.

In those cases where only one measurement of an important data component exists, it is almost as important to undertake confirmatory measurements as it is to get new measurements where as yet none exist. It is urged that experimental programmes be oriented to providing these measurements as checks on existing unique data sets. Examples are the fission cross section of Pu-238 across the threshold, and the cross sections of the even isotopes of curium, where the only data in existence are those measured in underground nuclear explosions.

Considering that the activity of measurers is sometime more strongly determined by the availability of samples than by the expressed needs, it is suggested that IAEA endorse the initiative taken by NEANDC in this matter, namely

- to make easily available samples of highest purity including at least the isotopes on the Priority 1 list, and

- to encourage different laboratories to perform measurements of the same quantities using common samples.

4. On the TND Newsletter

Much useful TND information on measurements, evaluations and computer calculations in progress has become available as a result of the publication of the TND Newsletter by Dr. S. Raman of the Oak Ridge National Laboratory. The meeting welcomed the publication of the first and second issues of this newsletter and strongly recommended that it be continued to be published on an annual or bi-annual basis. The meeting also urged that scientists contributing to the general TND effort send in their contributions for inclusion in the TND Newsletter.

5. On future TND Meetings

The meeting recommended to the IAEA that meetings on Transactinium Isotope Nuclear Data be held every four years.

III. CONCLUSIONS AND RECOMMENDATIONS OF WORKING GROUPS

A. Report of the Working Group on Neutron Reaction Data of Transactinium Isotopes

Bobkov, Yu.
Budtz-Jorgensen, C.
Bouchard, J. (Chairman)
Derrien, H.
Fort, E.
Gur, Y.S.
Igarasi, S.
Knitter, H.H.
Kouts, H.
Kuroi, H.
Mattes, M.
Mehta, M.K.
Menapace, E.
Patrick, B.H.
Philis, C.
Salvy, J.
Sandberg, H.
Tellier, H.
Yiftah, S.

1. Introduction

The Working Group has considered the evolution of requirements and status of transactinium isotope neutron data since the Karlsruhe meeting.

The following introductory remarks have to be made regarding the considerations given by this meeting:

- The review papers of Session A cover the requirements for existing reactors and alternate fuel cycles. Other sources of possible requirements have not been considered except those already identified at the Karlsruhe meeting.

- No recent review of the status of data was available for some isotopes. So it has not been possible to generate complete conclusions as to the present situation of all transactinium neutron data for which there are requirements.

2. Requirements

The Working Group has considered the changes in the requirements of data for reactor applications since the time of the 1975 meeting. Two general remarks concerning the quoted values of required accuracies are as follows:

- All required accuracies for neutron reaction data recommended at this time are expressed as two standard deviations of the required quantities. This means that the range corresponding to the mean value, plus or minus the quoted accuracy, must have a confidence level of 95 %. The Working Group cannot be sure that all the values listed in the reports generated at the 1975 TND meeting were based on this definition.

- When the "required accuracy" is quoted as 50 % it means that approximate values are sufficient.

For thermal reactor applications some changes in the data requirements have been identified and are summarized in Table I. One concludes that:

- these changes are relatively small compared to the existing requirements, and that

- most of these changes arise from the consideration of uranium and plutonium recycles in LWR's, which technology is not yet currently used.

For fast breeder reactors some modifications in the data requirements are listed in Table II. These concern mainly $(n,2n)$ reactions and are related to better knowledge of ^{236}Pu and ^{238}Pu build-up. 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.

Sensitivity analyses should be performed so that the needs can be developed. In the meantime, it is evident that effort should begin to provide capture cross sections of actinides above 100 KeV, where little experimental data currently exist.

3. Status of Actinide Evaluation Since 1975

The 1975 TND meeting focused its attention on the need for full evaluations of transactinium isotopes.

In the last four years, a relatively large amount of work has been done within the IAEA CRP*, the U.S., Japan and elsewhere, which has resulted in approximately doubling the number of full evaluations. The Table III identifies the isotopes for which full evaluations exist (as listed in CINDA 76/77 including supplement 5), and the 20 isotopes for which full evaluations have been performed for ENDF/B-V. Also listed are the isotopes for which no evaluations are known to exist.

Evaluation programmes proposed by the IAEA CRP** will maintain the momentum already established for at least the next few years. Because of the effort over the last few years, several evaluations exist for the same nuclide. Comparison of different evaluations shows the existence of some discrepancies, analysis of which is recommended in order to improve their quality and consistency.

---

* IAEA Coordinated Research Programme on the Intercomparison of Evaluations of Actinide Neutron Nuclear Data

** Second Coordinated Research Meeting on the Intercomparison of Evaluations of Actinide Neutron Nuclear Data, Summary Report. INDC(NDS)-104/L, July 1979.

4. Change in the Status of Experimental Neutron Cross Sections of Transactinium Isotopes

The Working Group made the following observations regarding the status of experimental neutron cross sections of transactinium isotopes:

1. Although there was no review of the status of experimental data of the nine isotopes relevant to the Th-U fuel cycle at the 1975 TND meeting, it can be said that the status of their experimental data base has changed considerably in the last five years. As a number of evaluations for these isotopes are underway, it may not yet be the right time to decide whether the status of data is totally satisfactory or not. The isotopes concerned in this context are Th-228, Th-230, Th-232, Pa-233, U-232, U-233 and U-234.

2. The status of cross sections of the other isotopes of Th, Pa, U and Np (except for those mentioned under 1 above) was not reviewed at this meeting. It is recommended that they be the subject of a status review at the next TND meeting.

3. For Pu-240, several fission cross section measurements have been made during this period, covering the energy range 1 kev to 20 Mev. Additional measurements are required in the subthreshold region, where structure has been observed in recent experiments. New capture and total cross section measurements have also been made in the important range from 10 keV to 375 keV. The data base in the fast reactor region has been improved by these results.

4. For Pu-242, recent measurements of fission, capture and total cross sections have yielded improved data in the energy ranges from 0.4 to 10 MeV, from 10 to 250 keV and from 10 to 375 keV respectively.

5. Also for the Am-241 isotope, improved measurements have been made of $\sigma(n,f)$ in the range of 100 eV to 5.3 MeV, and for $\sigma(n,\gamma)$ from 10 to 250 keV. Knowledge of the fission cross section in the subthreshold region is considerably improved.

6. For Am-242m, there is only one recently reported measurement, namely of $\sigma(n,f)$ in the energy range of 0.01 eV to 20 MeV.

7. For the curium isotopes, several new cross section measurements have been made at thermal energies since 1975. At other energies, fission cross section measurements are known for Cm-245 between 0.01 and 35 eV.

8. For the isotopes above Cm, several thermal cross section values were reported since 1975. At other energies only a total cross section measurement has been made for Bk-249 and Cf-249 using the same samples. The energy range covered was 0.005 eV to 1 keV.

5. Specific Recommendations for Measurements

The recommendations of the 1975 TND meeting concerning the priorities for measurements were reviewed with the following result:

1. Because of recent differential and integral experiments on Am-241, it seems that data on this isotope no longer includes major discrepancies.

2. Isotopes for which data are still needed with priority are:

	Np-237	Pu-240	Pu-241	Pu-242	Am-242	AM-243	Cm-242	Cm-244
Capture	X	X	X	X	X	X	X	X
Fission			X				X	

3. For the isotopes mentioned above, the requested accuracies are those expressed in the review papers A1 and A2 presented at this meeting.

Table I

Required TND Accuracies for Thermal Reactors - Changes since 1975 TND Meeting

Isotope	$E_n = 0.0253$ eV				Resonance Integral			
	$\sigma(n,\gamma)$		$\sigma(n,f)$		$I(n,\gamma)$		$I(n,f)$	
	1975	1979	1975	1979	1975	1979	1975	1979
Th-230	-	50%	-	-	-	50%	-	-
Np-237	100%	10%	-	-	10%	10%	-	-
Pu-236	100%	50%	-	-	100%	50%	-	-
Pu-238	30%	10%	50%	-	50%	20%	-	-
Am-242m	50%	20%	30%	10%	50%	50%	30%	20%
Cm-242	50%	20%	-	-	50%	20%	-	-
Cm-244	50%	20%	-	-	50%	20%	-	-

Table II

Required TND Accuracies for Fast Reactors - Changes since 1975 TND Meeting

Isotope	Reaction	Energy Range	Required Accuracy	
			1975	1979
Np-237	(n,γ)	0.5 - 100 Kev	30%	15%
Np-237	(n,2n)	above threshold	50%	15%
U-238	(n,2n)	above threshold	20%	10%

Table III

Evaluation Status of Transactinium Isotopes

Element	Evaluations of Isotopes Reported in CINDA 76/77	Evaluations of Isotopes included in ENDF/B-V	Isotopes with T 1/2 > 1 day for which no evaluation is known (partial or complete)
Thorium	232	232	227, 228, 229, 230, 231, 234
Protactinium	231, 233	233	229, 230, 232
Uranium	232, 233, 234, 235, 236, 237, 238	233, 234, 235, 236, 238	230, 231
Neptunium	237, 238, 239	237	234, 235, 236
Plutonium	236, 237, 238, 239, 240, 241, 242, 244	238, 239, 240 241, 242	246
Americium	241, 242, 243	241, 242m, 243	240
Curium	241, 242, 243, 244, 245, 246, 247, 248	243, 244, 245, 246	240, 250
Berkelium	249	-	245, 246, 247 248
Californium	249, 250, 251 252, 253	-	246, 248, 254
Einsteinium	253	-	251, 252, 254 255
Fermium	-	-	252, 253, 257
Mendelevium	-	-	258

B. Report of the Working Group on the Status and Needs for Nuclear Decay Data of Transactinium Isotopes

Bambynek, W.	Landayro, P.A.
Blachot, J.	Malet, G.
Debertin, K.	Nichols, A.L. (Chairman)
Duchemin, B.	Reich, C.W. (Secretary)
Ewbank, W B.	Robin, M.
Fudge, A.J. (Secretary)	Umezawa, H.
Glover, K.M.	Vaninbroukx, R.
Kulakov, V.	

1. Introduction

This Working Group considered decay-data requirements for nuclear technology, including in-core reactor physics needs and various aspects of the nuclear fuel cycle, comprising irradiated fuel handling, fuel reprocessing and recycling, shielding, waste management and safeguards. The Group also took notice of the relevance of certain of these data in non-reactor related areas. The primary objective of this Working Group was to define the requirements and review the status of transactinium isotope decay data; the results of this exercise are listed in Tables I and II of this report.

The make-up of this Working Group was considerably broader than that of the group which met at the 1975 TND meeting. This fact, together with developments in nuclear technology which have taken place since that meeting, has made it possible to redefine the decay-data needs somewhat more clearly than was possible at that time. The Working Group recognized, however, that much remains to be done in the establishment of effective communication with the users of decay data and that, consequently, the decay-data needs identified in Tables I and II are not necessarily complete.

2. The Coordinated Research Programme on the Measurement of Transactinium Isotope Nuclear Decay Data (Decay Data CRP)

Members of the Decay Data CRP have prepared lists reviewing the present status of transactinium isotope decay data in order to determine whether existing requests for nuclear data have been met. In their present form these lists should be regarded as containing only tentatively proposed values. It is recognized that considerable expertise in the area of half-life measurement and evaluation exists within research groups not directly involved in the preparation of these lists. Consequently, the CRP members must elicit as wide a range of comment and criticism of these values as possible. From these comments the Decay Data CRP should decide whether or not requested nuclear data needs have been met to the required accuracy. The updating of this status list should be carried out annually

in coordination with the measurers of decay data, until it is considered that these needs have been met by the participants of the next IAEA Advisory Group meeting on Transactinium Isotope Nuclear Data.

The status of the measurement activity carried out within the scope of the Decay Data CRP was reviewed by this Working Group. It was concluded that significant progress has been made since the first meeting of the Decay Data CRP one year ago:

- Measurements of the Pu-239 half-life with precisions of the order of 0.1 % now exist*, which well satisfy the accuracy requirements for this important quantity;

- Measurements of absolute-intensity values for the γ-rays from the decay of Pa-233, Pu-238, Pu-239 and Am-241, and L-X-ray intensities from Pu-238 decay have been completed;

- Half-life measurements of Pu-240, Pu-241 and Cm-242 are in progress;

- Measurements of α-transition intensities of Pu-238, Pu-239, Pu-240, and Pu-242, half-life, α- and γ-intensity measurements for Np-237, and γ-intensity measurements for Pu-238, Pu-239 and Pu-240 are being planned and will begin soon.

3. Evaluated Decay Data Files

A number of evaluated nuclear structure and decay data files of comparable quality are available, in particular the Evaluated Nuclear Structure Data File (ENSDF), which is an international nuclear structure data file representing the evaluated status of measured data. It is noted that ENSDF does not include certain decay parameters (for example, $\bar{\upsilon}$ and the associated energy released from spontaneous fission). There are also a number of applications in which the measured data alone (and hence ENSDF) are insufficient to solve specific problems. In such instances the ENSDF data have to be supplemented with data from other sources and with estimates of parameters that are as yet unmeasured. Noted examples of this type of file include the US ENDF/B file, the French file and the UKCNDC (Chemical Nuclear Data Committee) file. It is recommended that the maintenance of these files containing supplementary data be encouraged, so that desired and necessary comprehensive calculations can be made. Standard formats need to be adopted to facilitate the intercomparison of these supplementary and estimated data. In addition, it was also concluded that the widest possible dissemination of new evaluations and calculations of specific nuclear decay data be encouraged.

---

* See the general comment of Table I

Table I

Requirements and Status of Transactinium Isotope Decay Data

General Comment on uncertainties: for the alpha, gamma and x-ray intensities, the required and achieved accuracies apply to the selected major transitions only. The stated uncertainties are intended to correspond to 1σ confidence levels; the Working Group questions the validity of any presently stated uncertainties of less than 0.1 % for half-lives and 0.5 % for other quantities.

NUCLIDE	DATA TYPE	REQUIRED ACCURACY	ACHIEVED ACCURACY	NEEDS AND COMMENTS
Th-228	$T_{\frac{1}{2}}$	1%	0.1%	Decay Chain Calculations
	I_γ	2%(a)		
Th-229	$T_{\frac{1}{2}}$	1%	2%	Mass Determination in U-233 Chain
	I_γ	2%(a)		
Th-230	$T_{\frac{1}{2}}$	1%	4%	Marine Dating
Th-233	$T_{\frac{1}{2}}$	1%	0.5%	Decay Heat
	I_β	2%	UNKNOWN	
	I_γ	2%	UNKNOWN	
Pa-231	$T_{\frac{1}{2}}$	1%	0.3%	Non-Destructive Assay (N.D.A.)
	I_α	2%	2-5%	
	I_γ	2%	5-10%	
Pa-233	$T_{\frac{1}{2}}$	0.5%	0.4%	Thorium Cycle and N.D.A.
	I_γ	0.5%	1%	
U-232	$T_{\frac{1}{2}}$	1%	2%	Shielding Calculations, Mass Determination and N.D.A.
	I_α	2%	1%	
	I_γ	2%	5-10%	
U-233	$T_{\frac{1}{2}}$	0.5%	0.2%	Thorium Cycle Studies
	I_α	1%	1%	
	I_γ	1%	10%	
U-234	$T_{\frac{1}{2}}$	0.3%	0.3%	Thorium Cycle and N.D.A.
	I_α	1%	4%	
	I_γ	2%	10%	
U-235	$T_{\frac{1}{2}}$	0.5%	0.1%	Mass Determination and N.D.A.
	I_α	1%	5-10%	
	I_γ	1%	UNKNOWN	
U-236	$T_{\frac{1}{2}}$	0.5%	0.2%	Mass Determination and N.D.A.
	I_α	3%	5-10%	
	I_γ	1%	5-10%	
U-238	$T_{\frac{1}{2}}$	0.5%	0.1%	Mass Determination and N.D.A.
	$T_{\frac{1}{2}}$ (S.F.)	2%	1 - 2 %	Geochronology
	I_α	1%	5-20%	Mass Determination and N.D.A.
	I_γ	1%	15%	Mass Determination and N.D.A.

Table I
(continued)

U-239	$T_{\frac{1}{2}}$	1%	0.2%	Decay Heat
	I_β	2%	(b)	
	I_γ	2%	10%	
Np-236	$T_{\frac{1}{2}}$	5%	10%	U-232 Production
	Branching Ratio	5%	2%	
Np-236m	$T_{\frac{1}{2}}$	5%	2%	
	Branching Ratio	5%	2%	
Np-237	$T_{\frac{1}{2}}$	0.5%	0.5%	Mass Determination for Neutron Flux Monitoring
	I_α	1%	20%	
	I_γ	0.5%	10%	
Np-238	$T_{\frac{1}{2}}$	1%	0.1%	Activation Analysis of Np-237 and Am-242m Determination
	I_γ	2%	10%	
Np-239	$T_{\frac{1}{2}}$	1%	0.3%	Decay Heat
	I_β	2%	(b)	
	I_γ	1%	2%	
Pu-236	$T_{\frac{1}{2}}$	1%	0.3%	Fuel Analysis
	I_α	2%	2%	
	I_γ	2%	30%	
Pu-238	$T_{\frac{1}{2}}$	0.5%	0.1%	Mass Analysis and N.D.A.
	SF Branching Ratio	2%	3%	
	I_α	1%	1-2%	
	I_γ	1%	2-5%	
	L-x-Rays	2%	3%	Standards Calibration and Health Physics
Pu-239	$T_{\frac{1}{2}}$	0.5%	0.1%	Mass Analysis and N.D.A.
	I_α	1%	1-2%	
	I_γ	1%	2-5%	
	L-x-Rays	5%	3%	
Pu-240	$T_{\frac{1}{2}}$	0.5%	0.1%	Mass Analysis and N.D.A.
	SF Branching Ratio	2%	4%	Health Physics
	I_α	1%	1-4%	
	I_γ	1%	2-5%	
	L-x-Rays	5%	3%	
Pu-241	$T_{\frac{1}{2}}$ TOTAL.	0.5%	3%	Mass Analysis and N.D.A.
	$T_{\frac{1}{2}}$ ALPHA.	1%	2%	
	I_γ	1%	2-5%	

Table I
(continued)

Pu-242	$T_{\frac{1}{2}}$	1%	0.6%	Mass Analysis and N.D.A.
	SF Branching Ratio	5%	1%	
	Lα	5%	4-6%	
	Iγ	5%	UNKNOWN	
Am-241	$T_{\frac{1}{2}}$	0.2%	0.1%	N.D.A. and Detector Calibration Standard
	I_γ	1%	2-5%	
	L-x-Rays	2%	3%	
Am-242	$T_{\frac{1}{2}}$	1%	0.1%	Actinide Transmutation Studies
	SF Branching Ratio	1%	1%	
Am-242m	$T_{\frac{1}{2}}$	1%	5%	Americium Mass Assay
	SF Branching Ratio	2%	3%	
Am-243	$T_{\frac{1}{2}}$	1%	0.5%	Americium Mass Assay and Neutron Capture Studies
	I_α	2%	UNKNOWN	
	I_γ	1%	5-10%	
Cm-242	$T_{\frac{1}{2}}$	0.2%	0.3%	Safeguards and N.D.A.
	SF Branching Ratio	3%	10%	Fuel Assay
Cm-243	$T_{\frac{1}{2}}$	1%	1%	Fuel Assay
	I_α	2%	2-10%	
	I_γ	2%	3-10%	
Cm-244	$T_{\frac{1}{2}}$	1%	0.1%	Mass Assay
	SF Branching Ratio	3%	0.2%	
	I_γ	1%	10%	
	L-x-Rays	5%	3%	Health Physics
Cm-245	$T_{\frac{1}{2}}$	1%	1%	
	I_α	2%	0.5-5%	Fuel Assay
	I_γ	2%	UNKNOWN	
Cm-246	$T_{\frac{1}{2}}$	1%	2%	
	I_α	2%	1-5%	Fuel Assay
	I_γ	2%	UNKNOWN	
Cf-252	$T_{\frac{1}{2}}$	0.2%	0.4%	N.D.A.
	SF Branching Ratio	1%	0.3%	

Footnotes:

(a) The listed requirements represent those for the more prominent (or useful) transitions from all the members of the decay chain of these isotopes. These data at present are of uneven quality, with accuracies of 0.1% claimed for some transitions and 5-10% or greater for others. A careful measurement of spectra of the decay chains, in secular equilibrium, headed by these isotopes would be most useful.

(b) The beta intensities (I_β) are inferred from the gamma intensities (I_γ) and hence have similar precisions.

Table II

Requirements For Prompt Neutrons Per Fission ($\bar{\nu}$) From Spontaneous Fission

NUCLIDE	REQUIRED ACCURACY	COMMENTS
U -233	0.25-2 %	Thorium cycle
U -238	2 %	Non-destructive Fuel Assay (N.D.F.A.)
Pu-238	2 %	N.D.F.A.
Pu-240	2 %	N.D.F.A.
Pu-242	5 %	N.D.F.A.
Cm-242	3 %	N.D.F.A.
Cm-244	3 %	N.D.F.A.
Cf-252	0.3 %	Neutron Standard

Footnote: Data are also required on the distribution of prompt neutrons and the average prompt neutron energy.

Table II

Requirements For Prompt Neutrons Per Fission ($\bar{\nu}$) From Spontaneous Fission

NUCLIDE	REQUIRED ACCURACY	COMMENTS
U -233	0.25-2 %	Thorium cycle
U -238	2 %	Non-destructive Fuel Assay (N.D.F.A.)
Pu-238	2 %	N.D.F.A.
Pu-240	2 %	N.D.F.A.
Pu-242	5 %	N.D.F.A.
Cm-242	3 %	N.D.F.A.
Cm-244	3 %	N.D.F.A.
Cf-252	0.3 %	Neutron Standard

Footnote: Data are also required on the distribution of prompt neutrons and the average prompt neutron energy.

PARTICIPANTS LIST

Appendix 1

MEMBER STATES

FRANCE

- BLACHOT, DR. J.
CENTRE D'ETUDES NUCLEAIRES
DE GRENOBLE
CEDEX NO.85
F-38041 GRENOBLE GARE

- BOUCHARD, DR. J.
CENTRE D'ETUDES NUCLEAIRES
DE CADARACHE
C.E.A.
B.P. NO. 1
F-13115 SAINT-PAUL-LEZ-DURANCE

- DERRIEN, M. HERVE
DEDR/DRNR/SEDC/SPNR
CEN-CADARACHE
B.P. NO. 1
F-13115 SAINT-PAUL-LEZ-DURANCE

- DUCHEMIN, DR. B.
CENTRE D'ETUDES NUCLEAIRES
DE CADARACHE
C.E.A.
B.P. NO. 1
F-13115 SAINT-PAUL-LEZ-DURANCE

- FORT, DR. E.
CENTRE D'ETUDES NUCLEAIRES
DE CADARACHE
C.E.A.
BP. NO. 1
F-13115 SAINT-PAUL-LEZ-DURANCE

- HAMMER, DR. PH.
DRNR/SEDE
B.P. NO. 1
F-13115 ST. PAUL-LEZ-DURANCE
FRANCE

- MALET, DR. G.
LABORATORIE DE METROLOGIE
DES RAYONNEMENTS IONISANTS
B.P. NO. 2
F-91190 GIF-SUR-YVETTE

- PHILIS, DR. M.
SERVICE DE PHYSIQUE NUCLEAIRE
CENTRE D ETUDES DE
BRUYERES-LE-CHATEL
B.P. NO. 561
F-92542 MONTROUGE CEDEX

- ROBIN, DR. M.
CENTRE D'ETUDES NUCLEAIRES
DE CADARACHE
C.E.A.
B.P. NO. 1
F-13115 SAINT-PAUL-LEZ-DURANCE

- SALVY, DR. J.
CENTRE D'ETUDES DE
BRUYERES-LE-CHATEL
B.P. NO. 61
F-92120 MONTROUGE, FRANCE

- TELLIER, DR. H.
CENTRE D'ETUDES NUCLEAIRES
DE SACLAY
B.P. NO. 2
F-91190 GIF SUR YVETTE

GERMANY, FED.REP.

- DEBERTIN, DR. K.
PHYSIKALISCH TECHNISCHE
BUNDESANSTALT
ABTEILUNG 6
BUNDESALLEE 100
D-3300 BRAUNSCHWEIG

- MATTES, DR. M.
INSTITUT FUER KERNENERGETIK
DER UNIVERSITAET STUTTGART
PFAFFENWALDRING 31
D-7 STUTTGART 80

INDIA

- MEHTA, DR. M.K.
HEAD,
NUCLEAR PHYSICS DIVISION
BHABHA ATOMIC RESEARCH CENTRE
BOMBAY 400 085
INDIA

PARTICIPANTS LIST

MEMBER STATES

ISRAEL

- GUR, DR. Y.
SOREQ NUCLEAR RESEARCH CENTRE
ATOMIC ENERGY COMMISSION
YAVNE 70600, ISRAEL

- YIFTAH, PROF. S.
SOREQ NUCLEAR RESEARCH CENTRE
ATOMIC ENERGY COMMISSION
YAVNE 70600, ISRAEL

ITALY

- LANDAYRO, DR. P.A.
DIVISION PHYSIQUE DES REACTEURS
DU C.N.E.N. DE ROME
VIALE REGINA MARGHERITA 125
I-00198 ROMA

- MENAPACE, DR. E.
CENTRO DI CALCOLO DEL C.N.E.N.
VIA MAZZINI 2
I-40136 BOLOGNA

JAPAN

- IGARASI, DR. SIN-ITI
DIVISION OF PHYSICS
JAPAN ATOMIC ENERGY RESEARCH
INSTITUTE
TOKAI-MURA, NAKA-GUN
IBARAKI-KEN 319-11, JAPAN

- KUROI, DR. H.
DEPARTMENT OF NUCLEAR
ENGINEERING
JAERI
TOKAI-MURA, NAKA-GUN
IBARAKI-KEN 319-11, JAPAN

- UMEZAWA, DR. H.
DIVISION OF CHEMISTRY
JAPAN ATOMIC ENERGY
RESEARCH INSTITUTE
TOKAI-MURA, NAKA-GUN
IBARAKI KEN 319-11, JAPAN

ROMANIA

- VASILIU, DR. G. *
HEAD OF LABORATORY
INST. OF NUCLEAR POWER REACTORS
P.O. BOX 5204
BUCHAREST-MAGURELE 7000
ROMANIA

SWEDEN

- SANDBERG, MR. H.
CHALMERS UNIV. OF TECHNOLOGY
DEPT. OF REACTOR PHYSICS
S-41296 GOETEBORG
SWEDEN

UNION OF SOV.SOCIAL.REPUBLICS

- BOBKOV, DR. YU.G.
FIZIKO-ENERGETICHESKIJ INSTITUT
OBNINSK ,KALUGA REGION, U.S.S.R.

- KULAKOV, DR. V.
INSTITUT ATOMNOI ENERGII
I.V. KURCHATOVA
46 ULITSA KURCHATOVA
MOSCOW D-182, U.S.S.R.

UNITED KINGDOM

- FUDGE, DR. A.J.
U.K. A.E.A., B.220
ATOMIC ENERGY RESEARCH
ESTABLISHMENT
HARWELL, DIDCOT, OXON. OX11 ORA
U.K.

- GLOVER, MRS. K.M.
U.K. A.E.A., B.220
ATOMIC ENERGY RESEARCH
ESTABLISHMENT
HARWELL, DIDCOT, OXON. OX11 ORA
U.K.

- NICHOLS, DR. A.L.
TECHNOLOGY BRANCH, BLDG. 08/A50
AEE WINFRITH
DORCHESTER
DORSET DT11 8DH
UNITED KINGDOM

- PATRICK, DR. B.H.
NUCLEAR PHYSICS DIV., BLDG. 418
ATOMIC ENERGY RESEARCH
ESTABLISHMENT
HARWELL,DIDCOT,OXON. OX11 ORA
UNITED KINGDOM

* could not attend the meeting

PARTICIPANTS LIST

MEMBER STATES

UNITED STATES OF AMERICA

- EWBANK, MR. BRUCE
  NUCLEAR DATA PROJECT
  OAK RIDGE NATIONAL LABORATORY
  P.O. BOX X
  OAK RIDGE, TENNESSEE 37830
  U.S.A.

- KOUTS, DR. HERBERT
  BLDG. 197
  DEPARTMENT OF NUCLEAR ENERGY
  BROOKHAVEN NATIONAL LABORATORY
  UPTON, NEW YORK 11973
  U.S.A.

- REICH, DR. C.W.
  E.G. & G. IDAHO, INC.
  P.C. BOX 1625
  IDAHO FALLS, IDAHO 83401
  U.S.A.

PARTICIPANTS LIST

INTERNATIONAL BODIES

CEC-GEEL

- BAMBYNEK, DR. W.
  BUREAU CENTRAL DE MESURES
  NUCLEAIRES
  STEENWEG NAAR RETIE
  B-2440 GEEL

- BUDTZ-JORGENSEN, DR. C.
  BUREAU CENTRAL DE MESURES
  NUCLEAIRES
  STEENWEG NAAR RETIE
  B-2440 GEEL

- KNITTER, MR. H.H.
  BUREAU CENTRAL DE MESURES
  NUCLEAIRES
  STEENWEG NAAR RETIE
  B-2440 GEEL

- VANINBROUKX, DR. R.
  BUREAU CENTRAL DE MESURES
  NUCLEAIRES
  STEENWEG NAAR RETIE
  B-2440 GEEL

IAEA-NDS

- LEMMEL, DR. H.D.
  NUCLEAR DATA SECTION
  IAEA

- LORENZ, MR. A.
  NUCLEAR DATA SECTION
  IAEA

N.E.A.-DATA BANK

- GRYNTAKIS, DR. E.
  NEA DATA BANK
  B.P. 9
  BATIMENT 45
  F-91190 GIF-SUR-YVETTE

Appendix 2

LIST OF REVIEW PAPERS

A. Survey of TND Requirements

1. Comprehensive review of TND requirements for U- and U/Pu-fuelled thermal and fast reactors, and their associated fuel cycles. (J. Bouchard)

2. Comprehensive review of TND requirements for alternate fuel cycles, including the Th/U fuel cycle, accelerator breeding of nuclear fuel, and transmutation and incineration of actinide waste. (H. Kouts)

B. Status of Transactinium Isotope Nuclear Data

1. Report on the IAEA Coordinated Research Programme on the measurement and evaluation of transactinium isotope nuclear decay data. (C.W. Reich)

2. Current status of evaluated heavy element decay data for reactor calculations: problems and anomalies. (A.L. Nichols and M.F. James)

3. Status of TND in the evaluated nuclear structure data file (ENSDF). (B. Ewbank)

4. Report on the IAEA Coordinated Research Programme on the intercomparison of evaluations of actinide neutron nuclear data. (S. Yiftah)

5. Report on the November 1978 NEANDC-sponsored workshop on the cross-sections of the heavier plutonium and americium isotopes, complemented by the status and accuracy of experimental neutron cross-section data for elements higher than americium. (H.H. Knitter)

6. Status and accuracy of neutron data for the important isotopes relevant to the 232Th-233U fuel cycle (including Th-231, 232, 233, U-232, 233, 234, Pa-231, 232 and 233).

   a) in the thermal and resonance energy region. (G. Vasiliu)

   b) in the fast energy region. (M.K. Mehta)

7. Present status, critical comparison and assessment of different evaluations and files of neutron cross-section data for selected actinides. (S. Igarasi, et al)

8. Comparative study of different nuclear model calculations of actinide neutron data. (V. Konshin)

Appendix 3

ADOPTED MEETING AGENDA

Wednesday

Introductory Items

- Opening and announcements
- Opening speeches
- Collection and distribution of papers

Presentation of Part A Papers

Chairman: S. Yiftah

Wednesday and Thursday

Presentation of Part B Papers

Chairman: M.K. Mehta

- Cadarache Laboratory visits
- Initial meeting of working groups

Friday

Full day meeting of working groups

- Working group on Neutron Reaction Data of Transactinium Isotopes:
  Chairman: J. Bouchard

- Working group on the Status and Needs for Nuclear Decay Data of Transactinium Isotopes:
  Chairman: A.L. Nichols

Saturday

Plenary session for the discussion and final approval of conclusions and recommendations of the working groups. Chairman: A. Lorenz

Appendix 4

LIST OF CONTRIBUTED PAPERS PRESENTED AT THE MEETING

1. TND Requirement for Actinide Incineration as Waste Disposal Alternative. (H. Kuroi, H. Mitani, T. Mukaiyama and K. Koyama)

2. Evaluation des Paramètres de Resonance de Np 237. (H. Derrien)

3. Evaluation Complète de Am241 entre E_{th} et 6 MeV. Cohérence entre les Données Microscopiques et Intégrals. (E. Fort)

4. Cm 244 Neutron Data Evaluation. (M. Caner and S. Yiftah)

5. On the Methodology of the Intercomparison of TND Evaluations. (S. Yiftah, M. Caner, Y. Gur) (This report has been published as INDC(ISL)-3/GH)

6. Status Report on Swedish Compilation Work. (H. Sandberg)