



International Atomic Energy Agency

INDC(NDS)-108/N

INDC

INTERNATIONAL NUCLEAR DATA COMMITTEE

Proposed Recommended List
of Transactinium Isotope Decay Data
Part I. Half-lives (September 1979 Edition)

A. Lorenz, editor

Compiled by Members of the IAEA
Coordinated Research Programme on the
Measurement and Evaluation of Transactinium
Isotope Decay Data

September 1979

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

Produced by the IAEA in Austria

September 1979

79-9815

Proposed Recommended List
of Transactinium Isotope Decay Data
Part I. Half-lives (September 1979 Edition)

A. Lorenz, editor

Compiled by Members of the IAEA
Coordinated Research Programme on the
Measurement and Evaluation of Transactinium
Isotope Decay Data

September 1979

Abstract

A proposed list of recommended values of transactinium isotope half-lives and branching fractions, compiled by members of the IAEA Coordinated Research Programme on the Measurement and Evaluation of Transactinium Isotope Decay Data is presented.

Introduction

The objective of the IAEA Coordinated Research Programme (CRP) on the Measurement and Evaluation of Transactinium Isotope Nuclear Decay Data, is to arrive at a consistent set of transactinium isotope decay data and their uncertainties (including half-lives, branching fractions and gamma-ray and alpha emission spectra) which would satisfy the requirements identified by the community of data users.

In this context, the participants in this CRP have initiated this task by preparing the enclosed list of half-lives and branching fractions for the more important transactinium nuclides. An extension to this list, including data for the minor actinides and heavy element isotopes produced by the decay of the major actinides, is in preparation.

In its present form, the enclosed list should be regarded as containing tentatively proposed values. The group recognizes that considerable expertise in the area of half-life measurement and evaluation exists within research groups not directly involved in the preparation of this list. Consequently, this group wishes to elicit as wide a range of comments and criticism as possible on this list of proposed values.

To avoid any misunderstanding regarding the purpose of these tabulations the members of this CRP have prepared the following statements:

"It appears that some confusion has arisen over the purpose of the recommended list of half lives proposed after the last Coordinated Research Programme meeting on Measurement and Evaluation of Transactinium Isotope Decay Data. The listing has been seen by some people as a definitive evaluation which is being recommended for international acceptance. The members of this group would like to make it clear that the intention of producing this list was as a current statement of the status of half life values for the transactinium nuclides. These values together with the uncertainties associated with them are then available to other experts such as evaluators and measurers of data, who are not represented on the CRP. From this and subsequent listings and the comments received, the CRP hopes to be able to assess and monitor the progress being made in the field of transactinium isotope decay data. These listings should eventually serve as the initial part of an international reference list of transactinium isotope nuclear decay data".

This group has also started an initial review of alpha and gamma-ray emission spectra for the major transactinium isotopes, for their eventual inclusion in the final compilation. The initial proposed list of these values is to be published in INDC(NDS)-109/N, and will be submitted subsequently for "open refereeing" in the same manner as the list included in this report.

The members of this Coordinated Research Programme and those who participated in the critical review of the data are listed in Appendix 1.

Table Content

The list of decay data included in this report is the result of a critical appraisal of the current status of transactinium isotope half-lives and branching fractions. The data compiled in this list have been drawn from the following existing decay data files:

- ENSDF, the Evaluated Nuclear Structure and Decay Data File. Compiled by the Nuclear Data Project at Oak Ridge,
- the Actinide data file of the Idaho National Engineering Laboratory (INEL) which serves as the source file for the decay data part of the ENDF/B compilation,
- the UK Chemical Nuclear Data Committee Heavy Element Decay Data File, compiled at the AEE Winfrith laboratory.

Whenever warranted, the data have been supplemented or superseded by the latest known measured and/or evaluated values. For completion, the basic list compiled by the group was supplemented by data (marked by an asterisk in the Table) obtained from the Seventh Edition (1979) of the Table of Isotopes.

In ascribing uncertainties to the recommended half-life values, the group adopted the following criteria:

- the total uncertainty be defined as "1 sigma random error plus 1/3 the linear sum of the systematic errors based on a statistical confidence level of 68.3 %", and that
- the total uncertainty be in no case lower than 0.1 %.

Proposed Recommended List of Transactinium Isotope Decay Data. Part I: Half-lives.

SP = Spontaneous Fission, EC = Electron Capture, IT = Isomeric Transition

Nuclide	Total half-life	Decay Mode	Branching Fraction	Partial half-life
Th 228	$(1.913 \pm .002) \text{ y}$	α	1	-
Th 230	$(7.7 \pm .3) \cdot 10^4 \text{ y}$	α	1	-
"	"	SF		$(1.5 \pm 1.5) \cdot 10^{17} \text{ y} *$
Th 232	$(1.405 \pm .006) \cdot 10^{10} \text{ y}$	α	1	-
"	"	SF		$>1 \times 10^{21} \text{ y} *$
Pa 231	$(3.276 \pm .011) \cdot 10^4 \text{ y}$	α	1	-
"	"	SF		$\geq 1.1 \times 10^{16} \text{ y} *$
Pa 232	$(1.31 \pm .02) \text{ d}$	β^-	1	-
Pa 233	$(2.70 \pm .01) \cdot 10^1 \text{ d}$	β^-	1	-
U 232	$(7.2 \pm .1) \cdot 10^1 \text{ y}$	α	1	-
"	"	SF	$(0.9 \pm 0.7) \cdot 10^{-12}$	$(8.0 \pm 6.2) \cdot 10^{13} \text{ y}$
U 233	$(1.592 \pm .002) \cdot 10^5 \text{ y}$	α	1	-
"	"	SF	$(1.3 \pm 0.3) \cdot 10^{-12}$	$(1.22 \pm 0.28) \cdot 10^{17} \text{ y}$
U 234	$(2.446 \pm .007) \cdot 10^5 \text{ y}$	α	1	-
"	"	SF	$(1.2 \pm 0.6) \cdot 10^{-11}$	$(2.04 \pm 1.02) \cdot 10^{16} \text{ y}$
U 235	$(7.038 \pm .007) \cdot 10^8 \text{ y}$	α	1	-
"	"	SF	$(2 \pm 1) \cdot 10^{-9}$	$(3.5 \pm 0.9) \cdot 10^{17} \text{ y} *$
U 236	$(2.342 \pm .004) \cdot 10^7 \text{ y}$	α	1	-
"	"	SF	$(1.2 \pm 0.6) \cdot 10^{-9}$	$(2.0 \pm 1.0) \cdot 10^{16} \text{ y}$
U 237	$(6.75 \pm .01) \text{ d}$	β^-	1	-
U 238	$(4.468 \pm .004) \cdot 10^9 \text{ y}$	α	1	-
"	"	SF	$(5.45 \pm 0.06) \cdot 10^{-7}$	$(8.20 \pm 0.09) \cdot 10^{15} \text{ y}$
U 239	$(2.350 \pm .005) \cdot 10^1 \text{ m}$	β^-	1	-
Np 236	$(1.15 \pm .12) \cdot 10^5 \text{ y}$	β^-	0.089 ± 0.020	
"	"	EC	0.911 ± 0.020	
Np 236m	$(2.25 \pm .04) \cdot 10^1 \text{ h}$	β^-	0.48 ± 0.01	
"	"	EC	0.52 ± 0.01	
Np 237	$(2.14 \pm .01) \cdot 10^6 \text{ y}$	α	1	$>(1 \times 10^{18}) \text{ y} *$
"	"	SF		
Np 238	$(2.117 \pm .002) \text{ d}$	β^-	1	-
Np 239	$(2.354 \pm .006) \text{ d}$	β^-	1	-
Pu 236	$(2.851 \pm .008) \text{ y}$	α	1	-
"	"	SF	$(8.1 \pm 2.3) \cdot 10^{-10}$	$(3.52 \pm 1.00) \cdot 10^9 \text{ y} *$
Pu 237	$(4.54 \pm .02) \cdot 10^1 \text{ d}$	EC	$> 0.99 *$	
"	"	α	$< 0.000033 *$	
Pu 238	$(8.774 \pm .009) \cdot 10^1 \text{ y}$	α	1	-
"	"	SF	$(1.84 \pm 0.05) \cdot 10^{-9}$	$(4.77 \pm 0.13) \cdot 10^{10} \text{ y}$

Nuclide	Total half-life	Decay Mode	Branching Fraction	Partial half-life
Pu 239	$(2.411 \pm .003) \cdot 10^4$ y	α	1	-
"	"	SF	$(4.4 \pm 0.4) \cdot 10^{-12}$	$(5.5 \pm 0.5) \cdot 10^{15}$ y
Pu 240	$(6.55 \pm .02) \cdot 10^3$ y	α	1	-
"	"	SF	$(5.0 \pm 0.2) \cdot 10^{-8}$	$(1.31 \pm 0.05) \cdot 10^{11}$ y
Pu 241	$(1.47 \pm .04) \cdot 10^1$ y	β^-	> 0.99 *	
"	"	α	$(2.45 \pm .08) \cdot 10^{-5}$ *	
Pu 242	$(3.76 \pm .02) \cdot 10^5$ y	α	1	-
"	"	SF	$(5.50 \pm 0.06) \cdot 10^{-6}$	$(6.842 \pm 0.075) \cdot 10^{10}$ y
Pu 244	$(8.2 \pm .1) \cdot 10^7$ y	α	1	-
"	"	SF	$(1.25 \pm 0.06) \cdot 10^{-3}$	$(6.56 \pm 0.32) \cdot 10^{10}$ y
Am 241	$(4.326 \pm .006) \cdot 10^2$ y	α	1	-
"	"	SF	$(4.1 \pm 0.1) \cdot 10^{-12}$	$(1.06 \pm 0.03) \cdot 10^{14}$ y
Am 242	$(1.601 \pm .002) \cdot 10^1$ h	β^-	0.827 ± 0.003 *	
"	"	EC	0.173 ± 0.003 *	
Am 242m	$(1.52 \pm .07) \cdot 10^2$ y	IT	> 0.99 *	
"	"	α	$(4.76 \pm 0.14) \cdot 10^{-3}$ *	
"	"	SF	$(1.6 \pm 0.6) \cdot 10^{-10}$	$(9.5 \pm 3.6) \cdot 10^{11}$ y
Am 243	$(7.38 \pm .04) \cdot 10^3$ y	α	1	-
"	"	SF	$(2.2 \pm 0.2) \cdot 10^{-10}$	$(3.35 \pm 0.31) \cdot 10^{13}$ y
Cm 242	$(1.628 \pm .004) \cdot 10^2$ d	α	1	-
"	"	SF	$(6.8 \pm 0.6) \cdot 10^{-6}$	$(6.6 \pm 0.6) \cdot 10^6$ y
Cm 244	$(1.811 \pm .002) \cdot 10^1$ y	α	1	-
"	"	SF	$(1.347 \pm 0.002) \cdot 10^{-6}$	$(1.344 \pm 0.002) \cdot 10^7$ y
Cm 246	$(4.73 \pm .10) \cdot 10^3$ y	α	> 0.99	-
"	"	SF	$(2.614 \pm 0.005) \cdot 10^{-4}$	$(1.809 \pm 0.038) \cdot 10^7$ y
Cm 248	$(3.397 \pm .032) \cdot 10^5$ y	α	0.9174 ± 0.0003 *	$(3.703 \pm 0.035) \cdot 10^5$ y *
"	"	SF	$(8.26 \pm 0.03) \cdot 10^{-2}$	$(4.112 \pm 0.041) \cdot 10^6$ y
Bk 249	$(3.20 \pm .06) \cdot 10^2$ d	β^-	> 0.99 *	~ 323 days *
"	"	α	$(1.45 \pm 0.08) \cdot 10^{-5}$ *	$(6.04 \pm 0.35) \cdot 10^4$ y *
"	"	SF	$(4.7 \pm 0.2) \cdot 10^{-10}$	$(1.86 \pm 0.10) \cdot 10^9$ y
Cf 249	$(3.506 \pm .021) \cdot 10^2$ y	α	1	-
"	"	SF	$(5.02 \pm 0.10) \cdot 10^{-9}$	$(6.98 \pm 0.14) \cdot 10^{10}$ y
Cf 250	$(1.308 \pm .009) \cdot 10^1$ y	α	1	-
"	"	SF	$(7.7 \pm 0.3) \cdot 10^{-4}$	$(1.70 \pm 0.07) \cdot 10^4$ y
Cf 252	$(2.64 \pm .01)$ y	α	0.96908 ± 0.00008 *	$(2.72 \pm .01)$ y *
"	"	SF	$(3.092 \pm 0.008) \cdot 10^{-2}$	$(8.538 \pm 0.039) \cdot 10^1$ y
Es 253	$(2.047 \pm .002) \cdot 10^1$ d	α	1	-
"	"	SF	$(8.7 \pm 0.3) \cdot 10^{-8}$	$(6.44 \pm 0.22) \cdot 10^5$ y

Footnote: data marked by an asterisk were obtained from the Table of Isotopes (1979) Seventh Edition.

PARTICIPANTS IN THE REVIEW OF THE DATA

Appendix 1

Participants in the Coordinated Research Programme are indicated by an asterisk.

Debertin, K.	Physikalisch Technische Bundes- anstalt Abteilung 6 Bundesallee 100 D-3300 Braunschweig Fed. Rep. of Germany
Ewbank, B.	Nuclear Data Project Oak Ridge National Laboratory P. O. Box X Oak Ridge, Tennessee 37830 U.S.A.
* Fudge, A.J.	Actinide Analysis Group Chemistry Division Building 220 AERE Harwell, Didcot OX11 0RA U.K.
Kulakov, V.	Institut Atomnoi Energii I.V. Kurchatova 46 Ulitsa Kurchatova Moscow D-182 USSR
Lorenz, A. (project officer)	Nuclear Data Section IAEA, Vienna
* Malet, G.	Laboratoire de Metrologie des Rayonnements Ionisants CEN-Saclay B.P. No. 2 F-91190 Gif-sur-Yvette France
Nichols, A.L.	Technology Branch, Bldg. 08/A50 AEE Winfrith Dorchester, Dorset DT11 8DH U.K.
* Reich, C.W.	Idaho National Engineering Laboratory EG & G Idaho, Inc. Idaho Falls, Idaho U.S.A.
* Umezawa, H.	Division of Chemistry JAERI Tokai-Mura, Naka-Gun Ibaraki Ken 319-11 Japan
* Vaninbrouckx, R.	Central Bureau for Nuclear Measurements Steenweg naar Retie B-2440 Geel Belgium