G48

INTERNATIONAL ATOMIC ENERGY AGENCY
Division of Research and Laboratories
L a b o r a t o r y
Electronics and Measurement Section

Vienna, 1982-01-01

SET OF 8 CALIBRATED GAMMA-EMITTING SOURCES

(EMS-A2)

C E R T I F I C A T E

(A) Activities

The 8 sources constituting the

SET No.: 006

have the activities stated in the table below within the uncertainty limits there quoted.

The reference time is

1 January 1982, 00.00 Universal time

Nuclide	Activity kBq	Statistical error % +)	Systematic error %	Rounded overall uncertainty of the activity % ++)
^{241}Am	370.6	± 0.3	± 0.7	± 1.0
^{57}Co	534.9	± 0.3	± 0.4	± 1.0
^{22}Na	458.2	± 0.3	± 0.6	± 1.0
^{137}Cs	411.0	± 0.3	± 0.6	± 1.0
^{54}Mn	403.7	± 0.3	± 0.5	± 1.0
^{60}Co	346.0	± 0.3	± 0.4	± 1.0
^{133}Ba	416.7	± 0.3	± 1.2	± 1.5
^{152}Eu	400.7	± 0.3	± 1.6	± 2.0

+) Confidence level: 99%

++) (Rounded) sum of statistical and systematic errors.

(B) General Information

Physical Form:

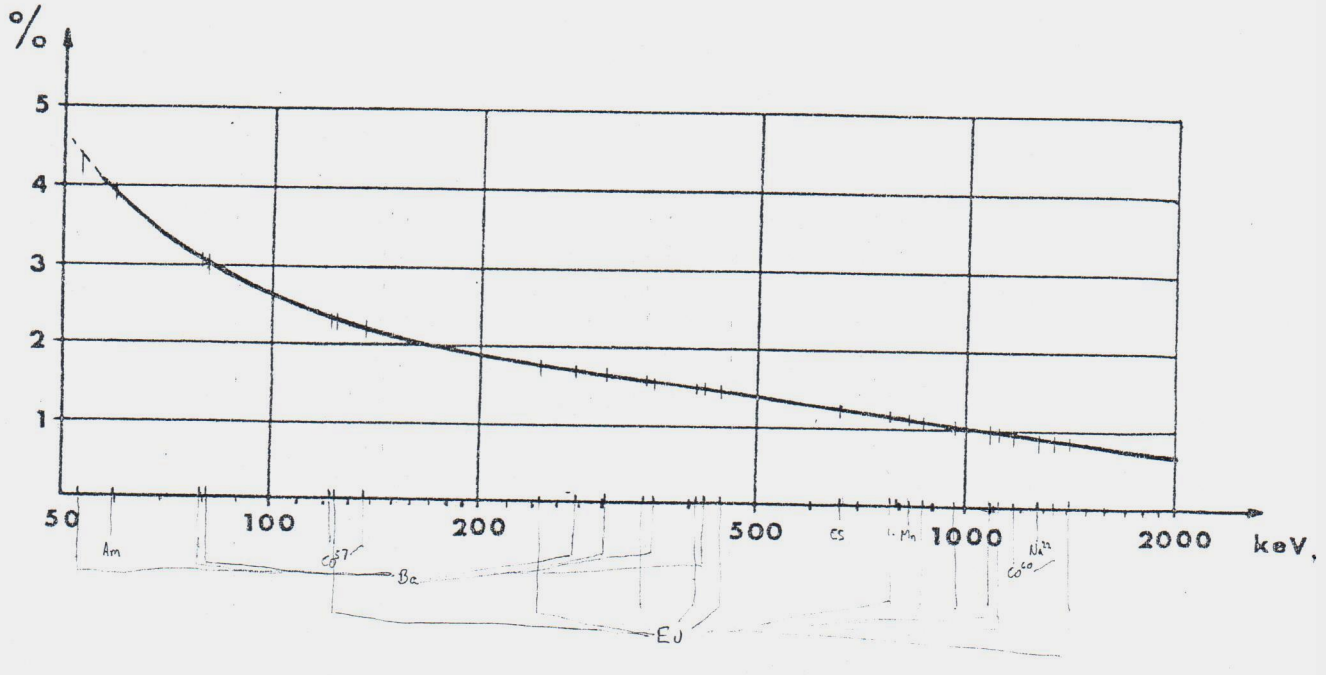
The radioactive material was sealed by heat between two polystyrene discs. This disc was then sandwiched between aluminium foils which were sealed together by cold welding. The sources are therefore expected to remain stable and leakproof for many years.

The thickness of the absorbing material in the direction of the axis is about 0.22 mm polystyrene and 0.52 mm $\pm$ 0.02 mm aluminium.

An inactive specimen of the polystyrene sandwich accompanies the set of sources.

Self-absorption:

The attenuation of full-energy γ-rays along the direction of the axis was found to agree with the theoretical predictions. For the attenuation of the different γ-rays (including scattering), the values of the curve below are recommended thus the number of full-energy γ-rays emitted per second (in the direction of the axis) are reduced by these percentages relative to sources having no self-absorption.



Decay Scheme Assumptions:

A table of values recommended for certain disintegration parameters is attached.

For the calibrations, small changes in the disintegration parameters would not affect the overall uncertainty stated in A).

RECOMMENDED NUCLEAR DATA

(IAEA-Vienna, Nuclear Data Section)

Radio-nuclide	Half-life [d]	Photon energy [keV]	Percentage per disintegration
^{241}Am	$(1.580 \pm 0.002) \cdot 10^5$ (2)	59.537 ± 0.001	36.0 ± 0.3 (1)
^{57}Co	271.77 ± 0.05 (3)	122.063 ± 0.003 136.476 ± 0.003	85.59 ± 0.19 (1) 10.58 ± 0.08 (1)
^{22}Na	950.34 ± 0.13 (3)	511.006 ± 0.002 1274.540 ± 0.020	+) 99.94 ± 0.02 (1)
^{137}Cs	11009 ± 11 (3)	661.645 ± 0.009	84.6 ± 0.5 (1)
^{54}Mn	312.5 ± 0.5 (1)	834.827 ± 0.021	99.9760 ± 0.0002 (1)
^{60}Co	1925.2 ± 0.4 (3)	1173.238 ± 0.004 1332.501 ± 0.005	99.87 ± 0.06 (4) 99.980 ± 0.009 (4)
^{133}Ba	3848.0 ± 1.1 (3)	53.155 ± 0.016 79.621 ± 0.011 80.997 ± 0.005 276.397 ± 0.012 302.851 ± 0.015 356.005 ± 0.017 383.851 ± 0.015	2.20 ± 0.04 (1) 2.61 ± 0.07 (1) 34.0 ± 0.8 (1) 7.10 ± 0.10 (1) 18.33 ± 0.22 (1) 62.3 ± 0.7 (1) 8.92 ± 0.09 (1)
^{152}Eu	4931 ± 15 (1)	121.779 ± 0.003 244.693 ± 0.005 344.272 ± 0.007 411.111 ± 0.011 443.979 ± 0.010 778.890 ± 0.016 867.38 ± 0.03 964.05 ± 0.03 1085.83 ± 0.03 1112.08 ± 0.04 1408.03 ± 0.03	28.37 ± 0.24 (1) 7.51 ± 0.06 (1) 26.58 ± 0.18 (1) 2.234 ± 0.013 (1) 3.121 ± 0.018 (1) 12.96 ± 0.07 (1) 4.16 ± 0.06 (4) 14.62 ± 0.06 (1) 10.16 ± 0.05 (1) 13.56 ± 0.06 (1) 20.58 ± 0.09 (1)

+) not recommended for calibration

References

(1) "Radioaktive Standardsubstanzen PTB" (Stand 1.3.1980 und 1.7.1980)

(2) A. Lorenz, INDC (NDS)-108/N, "Proposed Recommended List of Transactinium Isotope Decay Data", Part I, Half-lives Sep. 1979.

(3) H. Houtermans, "Half-lives of 35 Radionuclides", International Journal of Applied Radiation and Isotopes Vol 31, pp 153-154

(4) M. Despres, J. Morel, G. Malet, "Etudes du spectre du Pu-239, mésure des énergies et des intensités absolues des raies gamma", Note technique LMRI 79/63 (Décembre 1980)

Accuracy as a Function of Time:

The overall uncertainties are expected to grow progressively after the reference date due to uncertainties in half-lives and the effects of impurities.

Radionuclide Purity:

The purity of the radionuclides was checked by a Ge(Li)-γ-spectrometer with a known efficiency curve. The efficiency for the ^{60}Co, 1333 keV-line was about 12% compared with a 3"x3" NaI(Tl) scintillation counter.

The radioactive impurities detected are stated below. The activities of the impurities are given as percentages of the activities of the principal nuclides for the reference date 1982-01-01. The activities of the impurities are not included in the activities of the principal nuclides. The half-lives of the impurities are given in days in the parentheses.

^{54}Mn: 0.2% ^{65}Zn (243.97); 0.05% ^{60}Co (1925.2);
^{57}Co: 0.12% ^{56}Co (77.3); 0.017% ^{58}Co (70.92);
^{133}Ba: < 0.01% ^{65}Zn (243.97); < 0.01% ^{60}Co (1925.2);
^{137}Cs: 0.02% ^{134}Cs (754.5);
^{152}Eu: 1.68% ^{154}Eu (5844);

(C) Calibration

In preparing the sources, the specific activity of a stock solution was measured with a calibrated 4π - ionization chamber. The calibration values of the chamber were weighted means of at least nine values* determined by interregional comparisons of absolutely calibrated sources. From each such stock solution the different sources were aliquoted by gravimetry. The gravimetry itself was checked by an additional γ-comparison. The systematic error is taken as overall uncertainty of the calibration values of the ionization chamber and the overall gravimetric error.

* (with the exception of Eu-152, where only one value was available)

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