RADIOACTIVE SOLUTIONS AND GASES

This section contains detailed information about radioactive reference solutions. Low activity solutions manufactured by the National Physical Laboratory in the UK are also part of the Isotrak product range. Mixed radionuclide solutions recommended by national standards laboratories (NIST-USA or PTB-Germany) used for calibrating gamma-ray spectrometers, are also shown. If the required solution is not shown, please specify your requirements using the form at the end of this section.

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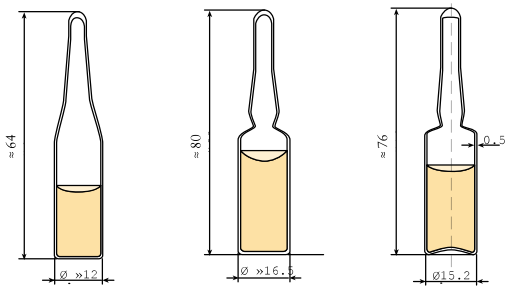
6. Radioactive solutions and gases

6.1 General information

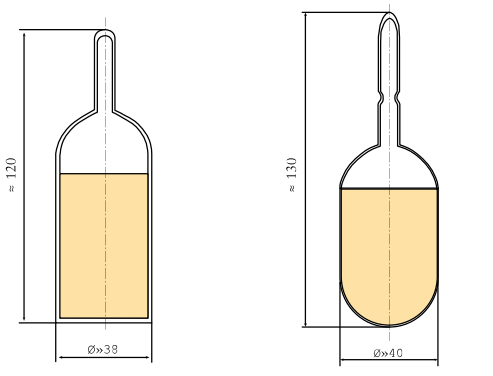
Applications

Eckert & Ziegler Nuclitec GmbH is pleased to offer one of the world's widest ranges of radioactive solutions, for applications in environmental monitoring, health physics, nuclear medicine, research and development, and geology. We also offer a custom preparation service; if the radionuclide or chemical form you require is not shown, Eckert & Ziegler Nuclitec GmbH will try to assist you (see p 117).

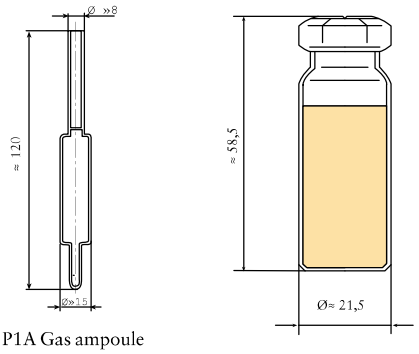
Ampoule sizes



1ml ampoule | 5ml ampoule | 5ml PTB ampoule



50ml flat-bottomed ampoule | 50ml round-bottomed ampoule



P1A Gas ampoule

For environmental monitoring

Mixed nuclide solutions for gamma-ray spectrometry	p 91
Heavy element tracer solutions	p 107
Ultra-low activity solutions	p 112
NPL Intercomparison samples for quality assurance	p 112
Single radionuclides for calibrating beta counters, NaI detectors etc.	p 99ff

For health physics

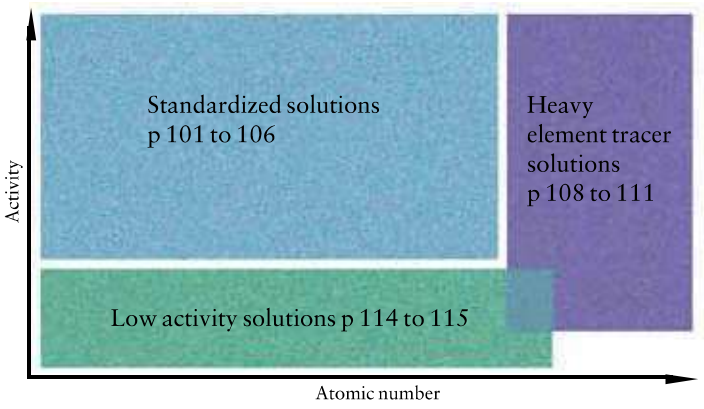
Single nuclides for preparing planchets or filter paper standards	p 101 - 106
Kr-85	p 103

For research and development

Radionuclides for nuclear decay scheme studies	p 101 - 115
Heavy elements for testing chemical separation procedures	p 108 - 111

For geology

Heavy elements for testing the transport of radioisotopes through materials, or for dating	p 108 - 111



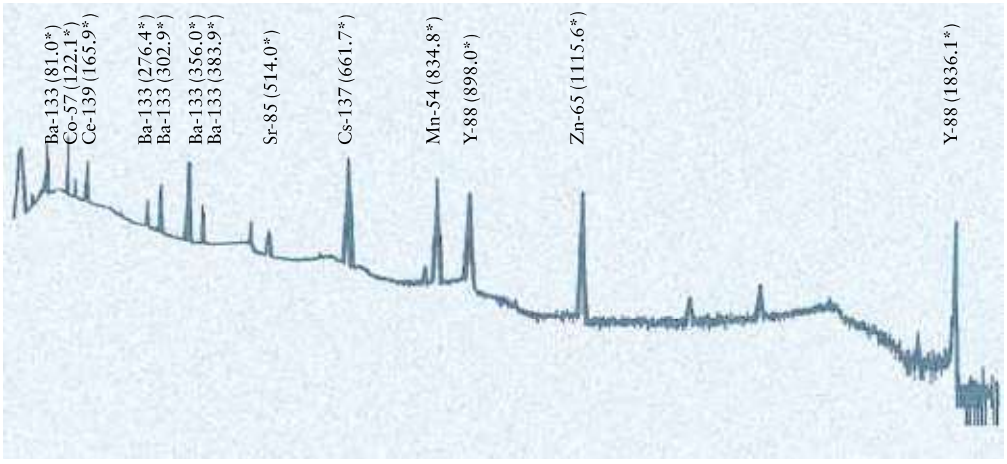
6.2 Mixed nuclide standardized solutions

Description

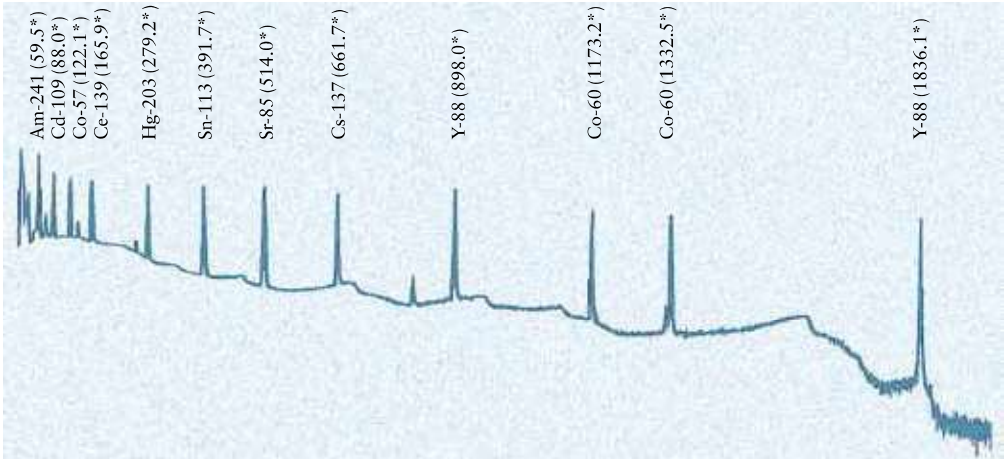
Eckert & Ziegler Nuclitec GmbH offers seven different mixtures of radionuclides for calibrating high resolution gamma-ray spectrometers. The radionuclides are recommended by NIST (USA) and PTB (Germany) and cover the energy range 46-1836keV. The solutions are calibrated in our UKAS or DKD accredited measurement laboratories and are traceable to national standards world-wide, including the USA, France, Germany and the UK. To make the calibration process as easy as possible, each solution is supplied with a certificate of calibration which matches the format of gamma-ray spectrometry software packages. Inactive diluents are available so that the solutions can be diluted to any volume. Typical gamma-ray spectra from the different mixtures are shown on the next page. The seven mixtures can be used for the energy ranges shown in the table.

Mixture	Energy range [keV]	Nuclides	Mixture recommended by	Notes
NG1	80-1836	Ba-133,Co-57,Ce-139,Sr-85, Cs-137,Mn-54,Zn-65,Y-88	PTB	The half lives of the component radio-nuclides are relatively long (shortest is 65 days, Sr-85). At close source-detector distances, summation effects become important.
NG2	88-1836	Cd-109,Co-57,Ce-139,Hg-203, Sn-113,Sr-85,Cs-137,Co-60,Y-88	NIST	The shortest half life is 47 days (Hg-203). The Hg should be precipitated as a sulphide if the solution is dried, to avoid loss of the radioactivity. Summation effects are less important than for NG1.
NG3	60-1836	Am-241, Cd-109,Co-57,Ce-139, Hg-203,Sn-113,Sr-85,Cs-137, Co-60,Y-88	NIST (modified)	As NG2, but extends the calibration down to 60keV.
NG4	46-136	Pb-210,Am-241,Cd-109,Co-57	PTB	Intended for low energy calibration only (46-136keV).
NG5	88-1836	Cd-109,Co-57,Ce-139,Cr-51, Sn-113,Sr-85,Cs-137,Co-60,Y-88	NIST (modified)	The shortest half life is 28 days (Cr-51). Preparation of solid standards is easier than for NG2 and NG3, as the Cr-51 replaces the Hg-203.
NG6	60-1836	Am-241,Cd-109,Co-57,Ce-139, Cr-51,Sn-113,Sr-85,Cs-137, Co-60,Y-88	NIST (modified)	As NG5, but extends the calibration down to 60keV.
NG7	60-1836	Am-241,Cd-109,Co-57,Ce-139, Hg-203,Sn-113,Sr-85,Cs-137, Mn-54,Co-60,Zn-65,Y-88	NIST (modified)	As NG3, but with Mn-54 and Zn-65 for high accuracy calibration.

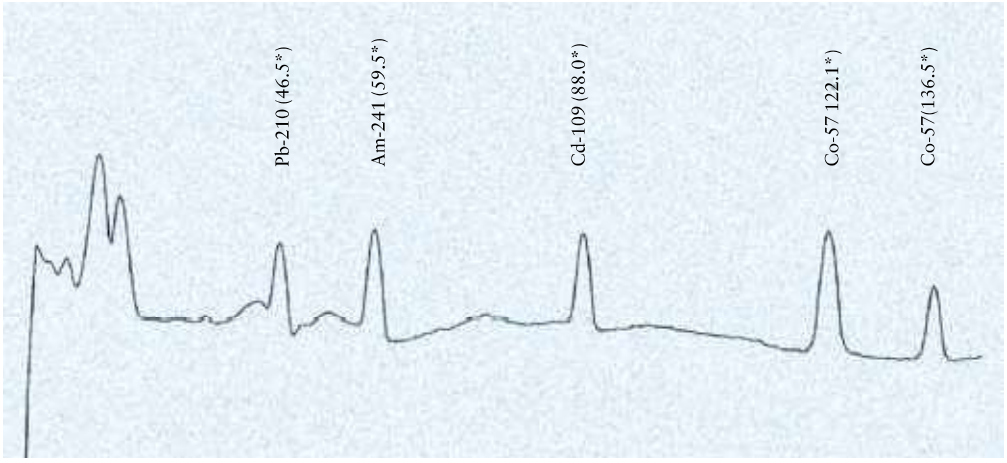
6.2 Mixed nuclide standardized solutions



A typical gamma spectrum for the NG1 radionuclide mixture



A typical gamma spectrum for the NG3 radionuclide mixture



A typical gamma spectrum for the NG4 radionuclide mixture

6.2 Mixed nuclide standardized solutions

Certification

Each standard is provided with a UKAS or a DKD certificate of calibration. The following information is given on each certificate:

- Reference time of measurement
- Gamma rays emitted per second per gram of solution
- Mass of solution
- Uncertainties
- Gamma-ray emitting impurities detected
- Chemical composition of solution
- Current best estimate of the half life of the component radionuclides

Chemical composition

The chemical composition of the solutions is shown in the tables. The solutions also contain non-radioactive carrier element to minimise adsorption of the radioactive material onto the surface of the ampoule. Normally the carrier concentration is 25µg/ml of each inactive element.

Measurement

To ensure the highest accuracy and consistency possible, each radionuclide in the mixture is individually assayed. The mixed solution is prepared by gravimetric dispensing and then checked by high resolution gamma-ray spectrometry.

Radionuclidic purity

For high sensitivity, gamma-ray emitting impurities are determined by high resolution gamma-ray spectroscopy of each individual radionuclide in the mixture. Some radionuclides are also checked by radiochemical analysis. The final mixture is then checked for cross-contamination.
In addition to the principal gamma rays shown on the certificate of calibration, several low intensity photopeaks may be observed in the spectrum. The most significant are shown below.

Spectrum notes

Energy [keV]	Origin
1325	Escape peak from 1836keV peak of Y-88
814	Double escape peak from 1836keV peak of Y-88
511	Annihilation radiation from positron decay of Y-88 (may not be resolved from the 514keV peak from Sr-85)
225	From decay of Sn-113
136	From decay of Co-57
80-90	X-rays from decay of Hg-203
2506	Sum peak from the decay of Co-60 (1173+1333keV)
2734	From decay of Y-88
In mix NG1	
161	From decay of Ba-133
223	From decay of Ba-133
437	Sum peak from Ba-133 (356+81keV)
511	Annihilation radiation from positron decay of Y-88 and Zn-65

6.2 Mixed nuclide standardized solutions

Storage/dispensing

The solutions are chemically stable in the original ampoules and the storage time is limited by the half lives of the radionuclides. The relative activities of the radionuclides in the mixtures have been adjusted so that the relative intensities of the peaks in the gamma-spectrum are optimum one month after the reference date.
So that the radionuclides are not preferentially adsorbed on the walls of any vessels used, the solutions should be diluted using an inactive diluent (p 98) and acid of the molarity shown on the measurement certificate. The solutions may be diluted to any volume, provided that the correct carrier concentration is maintained using additional ampoules of diluent if necessary. Any diluents used must not contain anions which would cause precipitation (for example, sulphate ions in the case of Ba-133, or chloride ions for Pb-210).
Care must be taken if the solutions are dried for preparing solid sources. If the solution contains a volatile compound such as mercury, the metal should be precipitated as a sulphide to minimise loss of the radioactive material and dispersion of the radioactivity into the working place.

Quality assurance

Products are manufactured in accordance with a quality management system which has been approved to meet the requirements of BS EN ISO/IEC 17025:2000.

Traceability

Standardized solutions are traceable to standards held by national laboratories such as the National Physical Laboratory (UK), the National Institute of Standards and Technology (USA), the Laboratoire National Henri Bequerel (France) and many other national laboratories world-wide. Further details are given in section 9.1.

Uncertainties

The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95% (see section 9.2).

Tolerances

The activities at the reference time stated on the certificate will be within 10% of the nominal activities given in the table.

Availability

The solutions are produced at regular intervals and are available throughout the year. However, for the solution to be useful for the longest time possible, please place orders in the months shown in the table.

6.2 Mixed nuclide standardized solutions

Ordering information

Product code	Energy range [keV]	Radio-nuclides	Nominal activity [kBq]	[µCi]	Chemical form	Nominal volume [ml]	For fresh material, place order...	for delivery
QCYB41	80-1836	Mixture NG1:			20µg/g of each	2.0		
		Ba-133	6	0.16	element			
		Co-57	6	0.16	in 0.5M HCl		by end December	January
		Ce-139	6	0.16			by end March	April
		Sr-85	30	0.81			by end June	July
		Cs-137	12	0.32			by end September	October
		Mn-54	12	0.32				
		Zn-65	30	0.81				
		Y-88	30	0.81				
		total activity: 132kBq (3.6µCi)						
QCYB40	46-136	Mixture NG4:			20µg/g of each	2.0		
		Pb-210	20	0.5	element			
		Am-241	4	0.1	(except Am) in		by end December	January
		Cd-109	20	0.5	0.5M HNO_3		by end June	July
		Co-57	2	0.1				
		total activity: 46kBq (1.2µCi)						

6.2 Mixed nuclide standardized solutions

Inactive diluents provide an accurate and stable means of diluting the mixed radionuclide solutions. The correct use of the inactive diluents avoids problems of preferential adsorption of the radioactive species on the walls of the container.
To dilute a mixed nuclide solution, choose the diluent to match the solution from the list below. Mix the diluent, mixed radionuclide solution and correct acid to the volume needed. The maximum possible volume is shown in the table; if a larger volume is needed, use additional ampoules of diluent.

Ordering information - Inactive diluents

For use with	Product code of diluent to order	Acid to use	Maximum volume per ampoule of diluent [1)]	Composition
QCYB41	NQB2393	0.5M HCl	1000 ml	5ml of 0.5M HCl 4mg/ml of Ba ,Co, Ce, Sr, Cs, Mn, Zn & Y
QCYB40	NQB2392	0.5M HNO_3	1000 ml	5ml of 0.5M HNO_3 4mg/ml of Pb, Cd & Co