

POINT AND TUBE SOURCES (GAMMA AND ELECTRON EMITTERS)

A wide range of gamma-ray and electron emitting reference sources of different geometries is described in this section. The

single radionuclide point sources or source sets containing up to 9 different radionuclides are used for calibrating gamma-ray spectrometers and gamma counters. Mixed radionuclide, X-ray and conversion electron sources are also available to cover a wide energy range for different detectors. If a modified source of this type is required, please send us your specification using the form at the end of this section.



isotrak™

 Eckert & Ziegler
Nuclitec

3. Point and tube sources (gamma and electron emitters)

3.1 General information

Applications

These gamma reference sources are designed for calibrating and checking gamma-ray spectrometers, gamma counters and electron spectrometers. Typical applications in research, environmental measurements and nuclear medicine include:

- 1) Calibrating high resolution gamma-ray spectrometers
 - Single radionuclides p 51, 53
 - Sets of sources p 51, 53
 - Mixed radionuclide point sources with low self-absorption p 54, 55
- 2) Calibrating NaI spectrometers
 - Single radionuclides p 51, 53
 - Mixed radionuclide point source p 76
- 3) Calibrating NaI counters
 - Tube type sources p 60

The advantages of the sources described are:

- Sealed sources - robust design for cost effective, long, useful life
- Easy to mount in jigs for reproducible measurement conditions
- Choice of capsule dimensions and source activities
- Minimal self-absorption and small active volume - accurate calibrations
- Traceable to national standards laboratories including NIST, NPL, PTB, LPRI

Tolerances

The maximum deviation of the delivered activity from the nominal values stated is $\pm 30\%$, unless stated otherwise.

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).



Traceability

The sources are traceable to standards held by national laboratories such as the Physikalisch-Technische Bundesanstalt (Germany), the National Physical Laboratory (UK), the National Institute of Standards and Technology (USA), the Laboratoire Primaire des Rayonnements Ionisants (France), and many other laboratories world-wide. Further details are given in section 9.1.

Certification

Each source is supplied with a certificate of calibration which states:

- Activity of radionuclide
- Uncertainty
- Reference time and date
- Activity of any gamma-ray emitting impurities detected, expressed as a percentage of the activity of the main radionuclide at the reference time
- Serial number
- ISO classification
- Results and date of leakage test

Quality assurance

The sources are calibrated at Eckert & Ziegler Nuclitec's DKD accredited measurement laboratory at Eckert & Ziegler Nuclitec in Germany. The facility operates a quality management systems which have been independently audited and approved to ISO9001:1994.

ISO classification

The International Organization for Standardization has published a classification of sealed sources based on safety requirements of typical usage. The source types have been tested to ISO2919 which is equivalent to ANSI N542-1977 (see section 9.3). The ISO classification is given for each source type in the following pages.

Useful working life

The useful working life of the sources is usually limited by the half life of the radionuclide. In addition, regular improvements in source design and measurement mean that it is good working practice to renew the sources every 10 years.

Availability

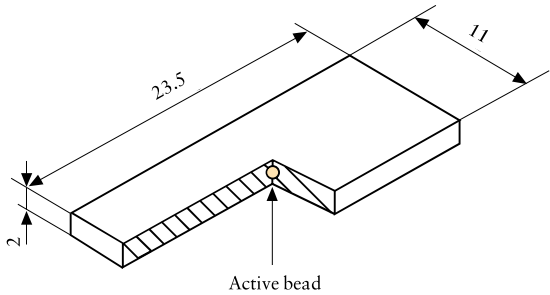
Sources are normally delivered within 6 weeks from receipt of order.

3. Point and tube sources (gamma and electron emitters)

3.2 Rectangular type sources

Construction

The radioactive isotope is absorbed in an ion-exchange bead approximately 1mm in diameter. The bead is fixed inside a solid plastic capsule. The active bead is visible, and located at the geometric centre of the source. The engraving is colour-coded.



Tolerance

The maximum deviation of the delivered activity from the nominal values is -10% to +30% for all radionuclides with the exception of Hg-203 which is -10% to +50%.

Absorption corrections

The effect of absorption and scattering in the source depends on the measurement geometry and the measurement equipment. The table below shows the transmission factor for the main gamma rays emitted. Transmission factors at other energies may be calculated by interpolation. The transmission factor is the fraction of gamma rays produced in the source that will emerge from its surface calculated for narrow beam emission normal to the plane of the source.

ISO classification

C.34343
Drawing: VZ-1240

Energy [keV]	Radionuclide	Transmission factor
60	Am-241	0.970
88	Cd-109	0.981
122	Co-57	0.982
279	Hg-203	0.986
344	Eu-152	0.987
662	Cs-137	0.990
834	Mn-54	0.991
1173	Co-60	0.993
1836	Y-88	0.994

3. Point and tube sources (gamma and electron emitters)

3.2 Rectangular type sources

Ordering information - Single radionuclides

Radionuclide	Nominal activity [kBq]	Overall uncertainty [%]	Product code (DKD certificate)
Am-241	37	3	AMR1122
	370	3	AMR1152
Ba-133	37	3	BDR1122
	370	3	BDR1152
Cd-109	37	4	CUR1122
	370	4	CUR1152
Cs-137	37	3	CDR1122
	370	3	CDR1152
Co-57	37	3	CTR1122
	370	3	CTR1152
Co-60	37	3	CKR1122
	370	3	CKR1152
Eu-152	37	3	EFR1122
	370	3	EFR1152
Hg-203	74	4	MBR1222
	740	4	MBR1252
Mn-54	37	3	MFR1122
	370	3	MFR1152
Na-22	37	3	SKR1122
	370	3	SKR1152
Y-88	37	3	YER1122
	370	3	YER1152



Radionuclide sets

Each set of sources is supplied in a presentation box which also contains a pair of forceps, two positron absorbers, and an adaptor plate. For easy reference, a copy of the calibration information is shown in the lid of the box.

Ordering information - Radionuclide sets

Radionuclide	Nominal activity [kBq]	Product code (DKD certificate)
Set 1, containing:		QCR3110
Am-241	37	(total activity = 370kBq)
Ba-133	37	
Cs-137	37	
Co-57	37	
Co-60	37	
Hg-203	74	
Mn-54	37	
Na-22	37	
Y-88	37	
Set 2, containing		QCR310
Am-241	370	(total activity = 3.7MBq)
Ba-133	370	
Cs-137	370	
Co-57	370	
Co-60	370	
Hg-203	740	
Mn-54	370	
Na-22	370	
Y-88	370	

3. Point and tube sources (gamma and electron emitters)

3.3 Disc type sources



Construction

With the exception of Ra-226, Am-241 and Pb-210 sources, the radioactive isotope is absorbed in an ion-exchange bead approximately 1mm in diameter. The bead is fixed inside a solid plastic capsule 25mm in diameter and 3mm thick. The active bead is visible, and located at the geometric centre of the source.

For Am-241 and Pb-210, the active component is in the form of a ceramic bead.

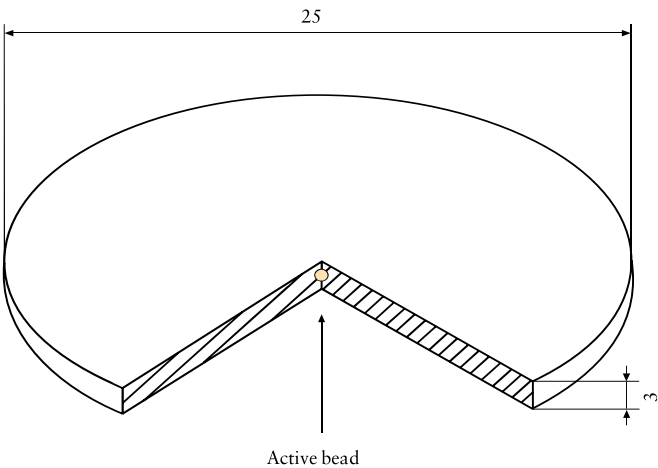
For Ra-226, the ion exchange bead is sealed inside a glass capillary tube before being fixed inside a 6 mm thick plastic disc. This construction (drawing VZ-590) reduces the possibility of release of radon gas from the decay of Ra-226.

Tolerances

The maximum deviation of the delivered activity from the nominal values is -10% to +30% for all radionuclides with the exception of Hg-203 (which is -10% to +50%) and Ra-226 (which is $\pm 30\%$).

ISO classification

C.34313
Drawing: VZ-477
Drawing: VZ-478
(Pb-210, Am-241)



(Note: Ra-226 sources are 6mm thick.)

Absorption corrections

The effect of absorption and scattering in the source depends on the measurement geometry and the measurement equipment. The table shows the transmission factor for the main gamma rays emitted. Transmission factors at other energies may be calculated by interpolation. The transmission factor is the fraction of gamma-rays produced in the source that will emerge from its surface calculated for narrow beam emission normal to the plane of the source.

Energy [keV]	Radionuclide	Transmission factor
47	Pb-210	0.964
60	Am-241	0.958
88	Cd-109	0.970
122	Co-57	0.973
279	Hg-203	0.979
344	Eu-152	0.979
662	Cs-137	0.985
834	Mn-54	0.987
1173	Co-60	0.988
1836	Y-88	0.991

3. Point and tube sources (gamma and electron emitters)

3.3 Disc type sources

Ordering information - Single radionuclides

Radionuclide	Nominal activity [kBq]	Overall uncertainty [%]	Product code (DKD certificate)
Am-241	37	3	AMR8122
	370	3	AMR8152
Ba-133	37	3	BDR8122
	370	3	BDR8152
	3700	3	BDR8252
Cd-109	370	4	CUR8152
Cs-137	37	3	CDR8122
	370	3	CDR8152
	3700	3	CDR8252
Co-57	37	3	CTR8122
	370	3	CTR8152
	3700	3	CTR8252
Co-60	37	3	CKR8122
	370	3	CKR8152
	3700	3	CKR8252
Eu-152	37	3	EFR8122
	370	3	EFR8152
Hg-203	74	4	MBR8222
	740	4	MBR8252
Mn-54	37	3	MFR8122
	370	3	MFR8152
Na-22	37	3	SKR8122
	370	3	SKR8152
	3700	3	SKR8252
Pb-210	200	4	RBR8122
Ra-226	100	3	RARB9480
Y-88	37	3	YER8122
	370	3	YER8152



Radionuclide set

The set contains 8 sources of long-lived radionuclides for calibrating gamma-ray spectrometers from 46keV to 1836keV.

The set of sources is supplied in a presentation box and includes a positron absorber. For easy reference, a copy of the calibration information is shown in the lid of the box.

Ordering information - Radionuclide set

Radionuclide	Nominal activity [kBq]	Product code (DKD-Certificate)
Set comprising:		QCRB9481
Am-241	37	(total activity = 452kBq)
Ba-133	37	
Cs-137	37	
Co-60	37	
Eu-152	37	
Na-22	37	
Pb-210	200	
Ra-226	30	

3. Point and tube sources (gamma and electron emitters)

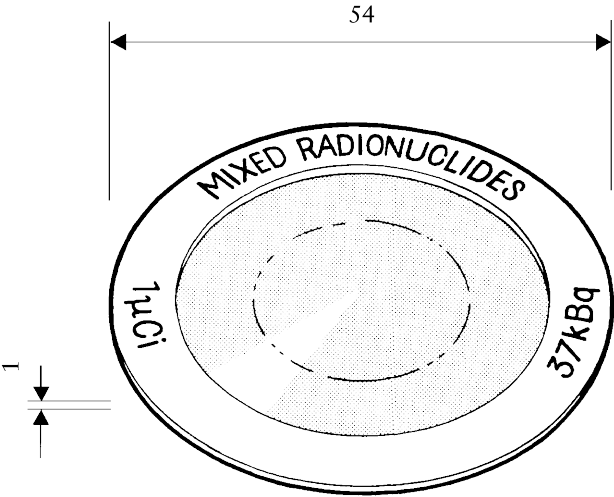
3.4 Mixed radionuclide calibration source for 88 - 1836keV range

Application

The QCD1 source can be used for calibrating high resolution gamma-ray spectrometers where a solid source with minimal self-absorption is required. The energy range covered is 88-1836keV

Certification

The source is supplied with a UKAS certificate of calibration.



Construction

The source is prepared by dispensing an accurately weighed aliquot of mixed radionuclide solution onto a polyester tape 0.06mm thick. The aliquot is dried in an atmosphere of hydrogen sulphide to prevent volatilization of mercury, and then covered with a second layer of tape. The active deposit is approximately 5 mm in diameter. The tape is attached to a 1mm thick aluminium annulus of inner diameter 38mm and outer diameter 54mm. The source is constructed of thin polyester tape to minimise self-absorption of the gamma-rays. The source should be handled carefully by its aluminium ring using rubber-tipped forceps.

Ordering information

Radionuclide	Activity [kBq] [μCi]		Gamma-ray energy [keV]	Overall uncertainty [%]	Product code
The source contains:					QCD1 (total activity 40 kBq)
Cd-109	17	0.5	88	4	
Co-57	1	0.02	122	2.5	
Ce-139	1	0.02	166	2.5	
Hg-203	2	0.05	279	2.5	
Sn-113	3	0.08	392	5	
Sr-85	4	0.1	514	2.5	
Cs-137	3	0.08	662	2.5	
Co-60	3	0.08	1173	1	
			1333	1	
Y-88	6	0.2	898	4	
			1836	4	

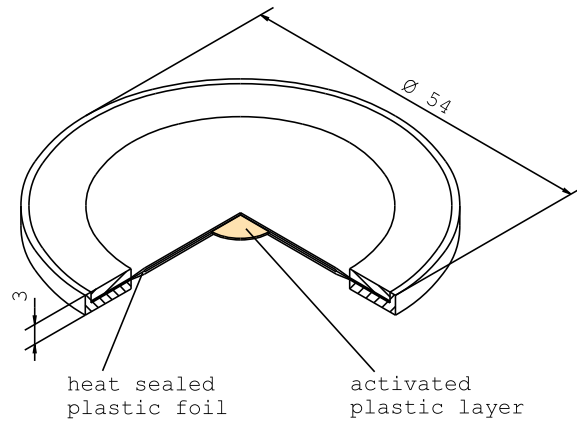
3. Point and tube sources (gamma and electron emitters)

3.5 Mixed radionuclide calibration source for 60-1836keV and 46-136keV ranges

Application

Similar in construction to QCD1, these sources cover the energy ranges 60-1836keV or 46-136keV, where a solid source with minimal self-absorption characteristics is required.

Please ask for other nuclide mixtures.



Construction

The radioactive material is incorporated in a plastic layer, 10mm in diameter and 0.2mm thick. The plastic layer is covered on each side by a paper label, 0.15mm thick, and the assembly is heat sealed between 0.125mm thick plastic foils. The foils are mounted in a ring, 54mm in diameter, 3mm thick (drawing VZ-1159).

Ordering information

Radionuclides	Activity [kBq]	Gamma-ray energy [keV]	Overall uncertainty [%]	Product code (DKD certificate)
Radionuclide mixture NG3 containing:				QCRB1186 (total activity 40kBq)
Am-241	3	60	3	
Cd-109	15.6	88	4	
Co-57	0.6	122	2.5	
Ce-139	0.7	166	2.5	
Hg-203	2.1	279	2.5	
Sn-113	2.8	392	5	
Sr-85	3.8	514	2.5	
Cs-137	2.6	662	2.5	
Co-60	3.0	1173	1	
		1333	1	
Y-88	5.9	898	4	QCRB4136 (total activity 46kBq)
		1836	4	
Radionuclide mixture NG4 containing:				
Pb-210	20	47	5	
Am-241	4	60	3	
Cd-109	20	88	4	
Co-57	2	122	2.5	

3. Point and tube sources (gamma and electron emitters)

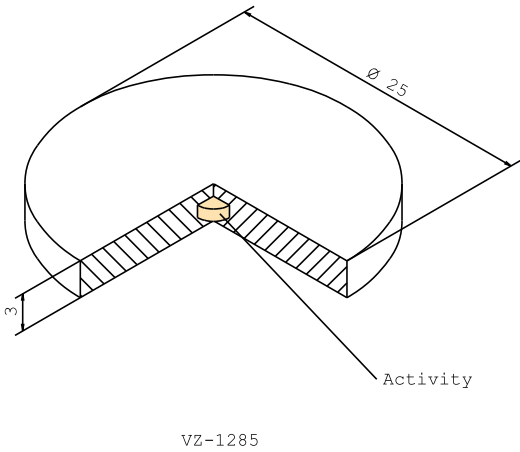
3.6 Source for NaI spectrometers

Application

This source type is used for the energy calibration of NaI spectrometers, or as a check source for Ge-spectrometers.

Construction

The activity of each radionuclide is adsorbed in one ion exchange bead 1mm in diameter. The beads are mounted in a plastic disc 25mm in diameter and 3mm thick (drawing VZ-1285).



Ordering information

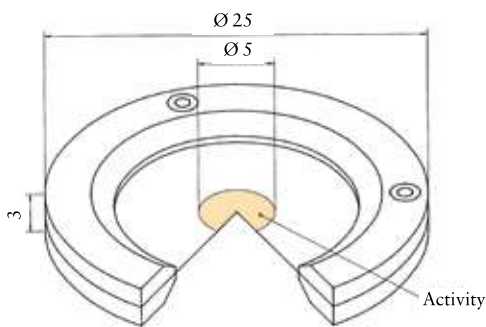
Radionuclide	Nominal activity [kBq]	Product code
Am-241	37	QCRB 5936 (total activity 148kBq)
Co-57	37	
Co-60	37	
Cs-137	37	

3. Point and tube sources (gamma and electron emitters)

3.7 X-ray and low energy photon sources

Application

These sources have been designed to minimise self-absorption of low energy photons, so they are suitable for calibrating X-ray spectrometers such as Si(Li) detectors. For energy calibration only, a more robust source design is used.



Sources for energy and efficiency calibration

Construction

A thin deposit of active material 5mm in diameter is heat sealed between plastic foils. The foils are mounted in an aluminium frame 25mm in diameter, 3mm thick (drawing VZ-1562). The 20 - 37 kBq sources are sealed between foils 0.1mm and 0.015mm thick, with the thinner foil on the engraved side. The 370 kBq sources are sealed between plastic foils 150 µCi thick (drawing VZ-2402).

Ordering information - VZ-1562

Radionuclide	Nominal activity [kBq] (calibrated for activity and emission)	Product code
Am-241 ¹⁾	37	AMRB5937
Ba-133	37	BDRB5938
Cd-109	37	CURB5939
Co-57	37	CTRB4056
Fe-55	37	IERB5941
Nb-93m	20	NHRB9483
Pb-210	37	RBRB9482
Zn-65	37	ZARB5943

¹⁾ Source should be wipe-tested regularly.

Ordering information - VZ-2402

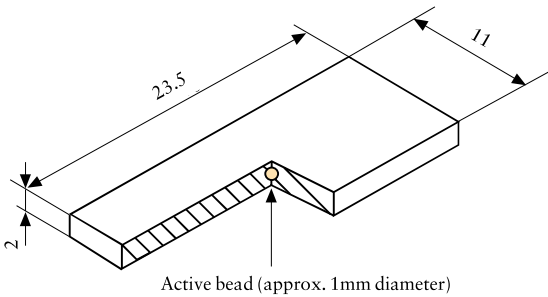
Radionuclide	Nominal activity [kBq] (calibrated for activity)	Product code
Am-241 ¹⁾	37	AMRB9484
Ba-133	370	BDRB7369
Cd-109	370	CURB6235
Co-57	370	CTRB8045
Fe-55	370	IERB6236

¹⁾ Source should be wipe-tested regularly.

Robust source for energy calibration

Construction

The radioactive isotope is absorbed in an ion-exchange bead approximately 1mm in diameter. The bead is fixed inside a solid plastic capsule. The active bead is visible, and located at the geometric centre of the source. This source is uncalibrated and is intended for energy calibration only.



ISO classification

C.34343
Drawing: VZ-1240

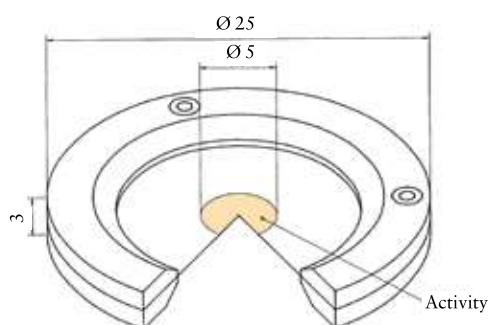
Ordering information

Radionuclide	Nominal activity [MBq] (uncalibrated)	Product code
Fe-55	1.85	IER15510

Application

These sources are intended for calibrating the energy response of magnetic or solid state electron detectors. The calibrated Bi-207 source can also be used to estimate the detection efficiency.

Radionuclides have been chosen that have intense, easily resolvable, electrons from internal conversion.



Construction

A thin deposit of active material is glued between Mylar foils (drawing VZ-486), 0.9mg/cm² thick, or between titanium foils (drawing VZ-392) each 2.4mg/cm² thick. The foils are supported in an aluminium frame 25mm in diameter, 3mm thick. The diameter of the active deposit is approximately 5mm.

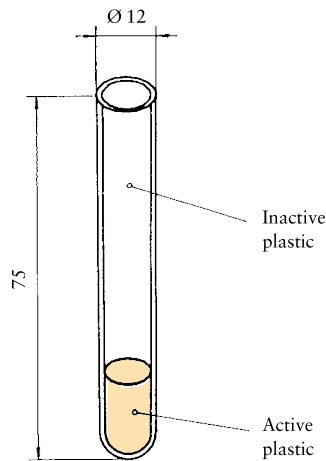
Ordering information

Radio-nuclide	Nominal activity [kBq]	Window material	Calibrated	Product code
Bi-207	37	Titanium	Uncalibrated	BIRB1082
Bi-207	37	Mylar	Uncalibrated	BIRB1083
Bi-207	37	Mylar	Calibrated ¹⁾	BIRB4391
Cs-137	37	Mylar	Uncalibrated	CDRB4630
Cs-137	370	Mylar	Uncalibrated	CDRB4944
Cs-137	370	Titanium	Uncalibrated	CDRB5552
Cd-109	370	Mylar	Uncalibrated	CURB2955

¹⁾ Calibrated for activity

3. Point and tube sources (gamma and electron emitters)

3.9 Tube type sources



Application

Tube type sources are used in the quality control of well-type NaI detectors used in biomedical research and nuclear medicine. For the quality control of multi-well detectors, matched sets of tube sources and multi-finger sources are available. The advantages of using a multi-finger source are:

- Saves time - 1 source for 12 measurements simultaneously
- No half life correction needed (I-129 sources)
- Sealed sources - safer to handle than liquid standards

Construction

The radioactive material is homogeneously incorporated in 1ml or 2ml of resin at the base of a plastic tube, 12mm in diameter and 75mm long. The rest of the tube is filled with inactive resin.

ISO classification

C.23233
Drawing: VZ-1236



Ordering information - single sources

Radionuclide	Nominal activity [kBq]	Overall uncertainty [%]	Product code (DKD certificate)
Am-241	3.7	3	AMRB4541
Ba-133	3.7	3	BDRB4543
Cs-137	3.7	3	CDRB4545
Co-57	3.7	3	CTRB4547
Co-60	3.7	3	CKRB4549
Eu-152	3.7	3	EFRB4551
Na-22	3.7	3	SKRB4555
I-129	3.7	3	ISRB4557
I-125	3.7	3	IMRB5829 ¹⁾

¹⁾ Please allow 12 weeks for delivery of this source from receipt of order.

3. Point and tube sources (gamma and electron emitters)

3.9 Tube type sources

Ordering information - Source set (uncalibrated)

Radionuclide	Nominal activity [kBq]	Product code
Ba-133	3.7	QCR5410
Cs-137	3.7	
Co-57	3.7	
Co-60	3.7	
I-129	3.7	
total activity	18.5	