isotrak

RADIOACTIVE SOLUTIONS AND GASES

Updated section

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RADIOACTIVE SOLUTIONS AND GASES

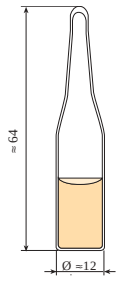
This section contains detailed information about radioactive reference solutions. Low activity solutions manufactured by the National Physical Laboratory in the UK are also part of the Isotrak product range.
Mixed radionuclide solutions recommended by national standards laboratories (NIST-USA or PTB-Germany) 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.

6.1 General information

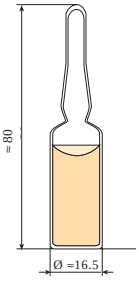
Applications

AEA Technology QSA 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, AEA Technology QSA will try to assist you (see p 31).

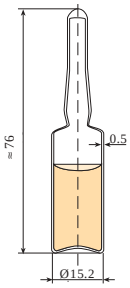
Ampoule sizes



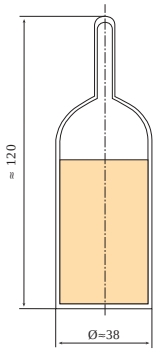
1ml ampoule



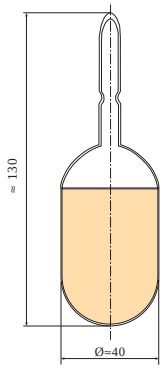
5ml ampoule



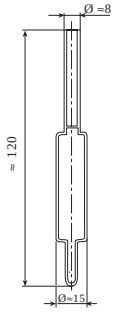
5ml PTB ampoule



50ml flat-bottomed ampoule



50ml round-bottomed ampoule



P1A Gas ampoule

For environmental monitoring

Mixed nuclide solutions for gamma-ray spectrometry	p 5
Heavy element tracer solutions	p 21
Ultra-low activity solutions	p 26
NPL Intercomparison samples for quality assurance	p 26
Single radionuclides for calibrating beta counters, NaI detectors etc.	p 13ff

For health physics

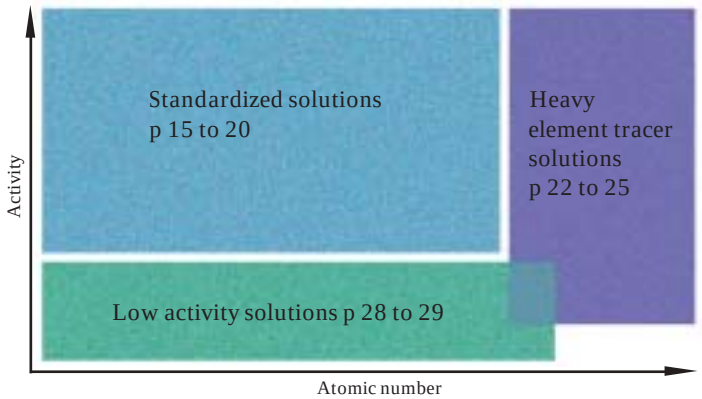
Single nuclides for preparing planchets or filter paper standards	p 15 - 20
Kr-85 and Xe-133 gas standards	p 17, 20

For research and development

Radionuclides for nuclear decay scheme studies	p 15 - 29
Heavy elements for testing chemical separation procedures	p 22 - 25

For geology

Heavy elements for testing the transport of radioisotopes through materials, or for dating	p 22 - 25



6.2 Mixed nuclide standardized solutions

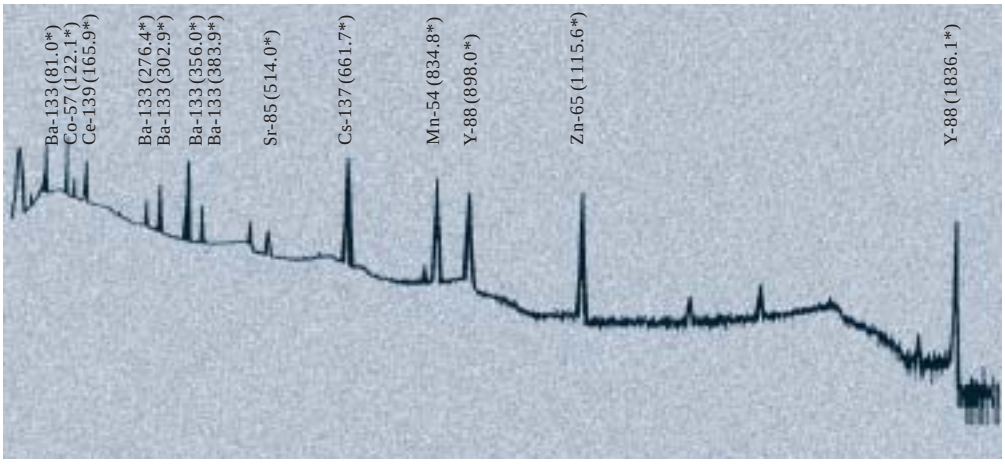
Description

AEA Technology QSA 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.

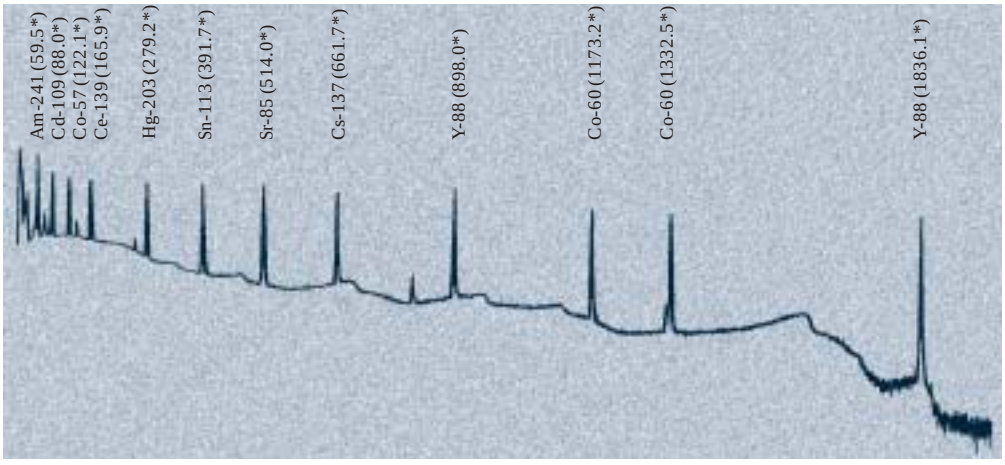
new

6.2 Mixed nuclide standardized solutions



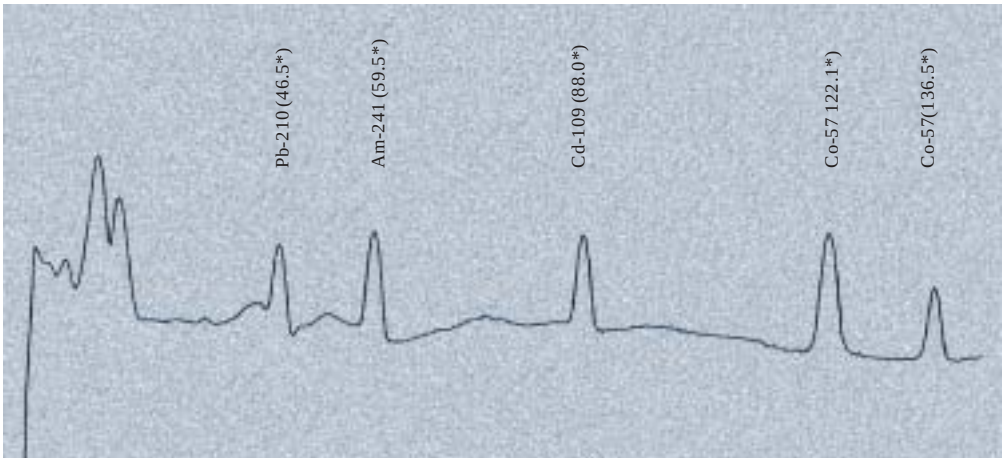
A typical gamma spectrum for the NG1 radionuclide mixture

*) keV



A typical gamma spectrum for the NG3 radionuclide mixture

*) keV



A typical gamma spectrum for the NG4 radionuclide mixture

*) keV

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.

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.

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.

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

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 Becquerel (France) and many other national laboratories world-wide. Further details are given in section 9.1.

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 12) 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.

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)						
QCY44	88-1836	Mixture NG2:			25µg/g of each	5.0	by mid December	March
		Cd-109	78	2.1	element		by mid March	June
		Co-57	3	0.1	in 4M HCl		by mid June	September
		Ce-139	4	0.1			by mid September	December
		Hg-203	11	0.3				
		Sn-113	14	0.4				
		Sr-85	18	0.5				
		Cs-137	13	0.4				
		Co-60	15	0.4				
		Y-88	29	0.8				
		total activity: 185kBq (5.1µCi)						
QCY46	88-1836	Mixture NG2:			25µg/g of each	50	by mid December	March
		Cd-109	78	2.1	element		by mid March	June
		Co-57	3	0.1	in 4M HCl		by mid June	September
		Ce-139	4	0.1			by mid September	December
		Hg-203	11	0.3				
		Sn-113	14	0.4				
		Sr-85	18	0.5				
		Cs-137	13	0.4				
		Co-60	15	0.4				
		Y-88	29	0.8				
		total activity: 185kBq (5.1µCi)						

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
QCY48	60-1836	Mixture NG3:			25µg/g (except	5.0	by mid December	March
		Am-241	17	0.5	Am) of each		by mid March	June
		Cd-109	78	2.1	element in		by mid June	September
		Co-57	3	0.1	4M HCl		by mid September	December
		Ce-139	4	0.1				
		Hg-203	11	0.3				
		Sn-113	14	0.4				
		Sr-85	18	0.5				
		Cs-137	13	0.4				
		Co-60	15	0.4				
		Y-88	29	0.8				
		total activity: 202kBq (5.6µCi)						
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)						
QCY54	88-1836	Mixture NG5:			25µg/g of each	5.0	by mid December	March
		Cd-109	85	2.3	element in		by mid March	June
		Co-57	3	0.09	4M HCl		by mid June	September
		Ce-139	4	0.11			by mid September	December
		Cr-51	152	4.1				
		Sn-113	15	0.42				
		Sr-85	20	0.53				
		Cs-137	14	0.38				
		Co-60	17	0.45				
		Y-88	33	0.88				
		total activity: 343kBq (9.3µCi)						

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
QCY56	88-1836	Mixture NG5:			25µg/g of each element in 4M HCl	50	by mid December by mid March by mid June by mid September	March June September December
		Cd-109	85	2.3				
		Co-57	3	0.09				
		Ce-139	4	0.11				
		Cr-51	152	4.1				
		Sn-113	15	0.42				
		Sr-85	20	0.53				
		Cs-137	14	0.38				
		Co-60	17	0.45				
		Y-88	33	0.88				
		total activity: 343kBq (9.3µCi)						
QCY58	60-1836	Mixture NG6:			25µg/g of each element (except Am) in 4M HCl	5.0	by mid December by mid March by mid June by mid September	March June September December
		Am-241	17	0.45				
		Cd-109	85	2.3				
		Co-57	3	0.09				
		Ce-139	4	0.11				
		Cr-51	152	4.1				
		Sn-113	15	0.42				
		Sr-85	20	0.53				
		Cs-137	14	0.38				
		Co-60	17	0.45				
		Y-88	33	0.88				
		total activity: 360kBq (9.7µCi)						
QCYK8163	60-1836	Mixture NG7:			25µg/g of each element (except Am) in 4M HCl	5.0	by mid June	September
		Am-241	17	0.45				
		Cd-109	78	2.1				
		Co-57	3	0.09				
		Ce-139	4	0.11				
		Hg-203	11	0.3				
		Sn-113	14	0.4				
		Sr-85	18	0.5				
		Cs-137	13	0.35				
		Mn-54	14	0.38				
		Co-60	15	0.4				
		Zn-65	30	0.81				
		Y-88	29	0.8				
		total activity: 246kBq (6.6µCi)						

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
QCY44	N440	4M HCl	50 ml	5ml of 4M HCl 0.225mg/ml of Cd, Cs, Co, Ce, Hg ,Sr, Sn & Y
QCY44	N441	4M HCl	500 ml	50ml of 4M HCl 0.225mg/ml of Cd, Cs, Co, Ce, Hg, Sr, Sn & Y
QCY46	N440	4M HCl	100 ml	5ml of 4M HCl 0.225mg/ml of Cd, Cs, Co, Ce, Hg, Sr, Sn & Y
QCY46	N441	4M HCl	500 ml	50ml of 4M HCl 0.225mg/ml of Cd, Cs, Co, Ce, Hg, Sr, Sn & Y
QCY48	N440	4M HCl	50 ml	5ml of 4M HCl 0.225mg/ml of Cd, Cs, Co, Ce, Hg,Sr,Sn & Y
QCY48	N441	4M HCl	500 ml	50ml of 4M HCl 0.225mg/ml of Cd, Cs, Co, Ce, Hg,Sr,Sn & Y
QCYB40	NQB2392	0.5M HNO_3	1000 ml	5ml of 0.5M HNO_3 4mg/ml of Pb, Cd & Co
QCY54	N540	4M HCl	50 ml	5ml of 4M HCl 0.225mg/ml of Cd, Cs, Co, Ce, Cr, Sr, Sn & Y
QCY54	N541	4M HCl	500 ml	50ml of 4M HCl 0.225mg/ml of Cd, Cs, Co, Ce, Cr, Sr, Sn & Y
QCY56	N540	4M HCl	100 ml	5ml of 4M HCl 0.225mg/ml of Cd, Cs, Co, Ce, Cr, Sr, Sn & Y
QCY56	N541	4M HCl	500 ml	50ml of 4M HCl 0.225mg/ml of Cd, Cs, Co, Ce, Cr ,Sr, Sn & Y
QCY58	N540	4M HCl	50 ml	5 ml of 4M HCl 0.225mg/ml of Cd, Cs, Co, Ce, Cr, Sr, Sn & Y
QCY58	N541	4M HCl	500 ml	50ml of 4M HCl 0.225mg/ml of Cd, Cs, Co, Ce, Cr, Sr, Sn & Y
QCYK8163	NK8192	4M HCl	500 ml	50ml of 4M HCl 0.225mg/ml of Cd, Cs, Co, Ce, Hg, Sr, Sn, Y, Mn & Zn

[1] The solutions can in principle be diluted to any volume using additional ampoules of inactive diluent.

6.3 Standardized solutions

Description

A wide range of single radionuclides in solution is available with activity concentrations ranging from 4kBq/g to 4MBq/g.
The solutions are supplied in flame-sealed glass ampoules to ensure that none of the solution evaporates during transport or storage.
Solutions designed for calibrating radionuclide calibrators in nuclear medicine departments are supplied in vials, identical to the vials used for radiopharmaceuticals. There is a small risk of evaporation from vials, so the certificate of calibration states the total activity of the radionuclide rather than the radioactive concentration. These solutions are not suitable for sub-division.

Chemical composition

The chemical composition of the solutions is shown on pages 15 to 20. Most of the solutions also contain non-radioactive carrier elements to minimise adsorption of the radioactive material onto the surface of the ampoule. Normally the carrier concentration is 100µg/ml of the inactive element.

Measurement

Two methods are used to calibrate standardized solutions. Both are traceable to national standards.

1) Direct calibration
High accuracy standardized solutions are assayed by coincidence counting techniques. The techniques are similar to those used at national standards laboratories. Directly calibrated solutions are identified by the letter 'Z' as the third letter of the product code.

2) Indirect calibration
These solutions are assayed on a highly stable transfer instrument, which has been calibrated continuously for more than 30 years using standards from each batch of directly calibrated solutions. Indirectly calibrated solutions are identified by the letter 'Y' as the third letter of the product code.

Directly calibrated solutions offer the very high accuracy needed for some applications.

Certification

A UKAS certificate of calibration is provided for every solution. The certificate states:

- Radionuclide
- Reference time and date of measurement
- Radioactivity concentration (activity per gram of solution) and/or total activity
- Mass of solution (for directly calibrated solutions in flame-sealed ampoules only, and excluding carbon-14 and tritium)
- Measurement method
- Uncertainty
- Radionuclidic purity
- Chemical composition and carrier concentration (for solutions supplied in flame-sealed ampoules only)
- Current best estimate of the half life of the radionuclide

The Certificate of Calibration is normally packed with the ampoule; for radionuclides with a half life less than 5 days, an abbreviated report is used and the Certificate is despatched separately by post shortly afterwards.

6.3 Standardized solutions

Radionuclidic purity

The radioactive solutions are prepared from carefully specified raw materials, and chemically purified where appropriate. Radionuclidic purity is measured by detailed radiochemical analysis of the solution and by spectroscopic techniques. Some solutions may be checked by high resolution gamma- or X-ray spectrometry alone. The activity of any impurities detected are expressed as a percentage of the main radionuclide at the reference time. Full information is given on the certificate of calibration.

Storage/dispensing

In normal laboratory conditions, the solutions are expected to be chemically stable in the original ampoules for at least 2 years from the date of despatch of the solution. The solutions are designed to be redispensed by the user from the ampoule to other containers using normal radiochemical dispensing techniques. The solutions may be diluted, but in order to maintain chemical stability, the diluent should have the same chemical composition and contain the same concentration of non-radioactive carrier as the standardized solution.
If a solution is used for preparing a solid source, care should be exercised to ensure that volatile compounds (such as antimony, mercury or tin) are not lost from the source during evaporation to dryness. Precipitation is usually satisfactory but it is advisable to check that no radioactivity is lost during the procedure.

Tolerances

Solutions are dispensed so that the activity at the reference time falls within the range -20% to +40% of the nominal activity stated on pages 15 to 20. Wider variations can occur for short lived nuclides but such variations do not normally affect the usefulness of standards produced from the solutions.

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

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 Becquerel (France) and many other national laboratories world-wide. Further details are given in section 9.1.

UKAS CALIBRATION
CALIBRATION NO.0146

Quality assurance

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

Availability

The availability of the different radionuclides is shown on pages 15 to 20. Radionuclides held in stock are normally despatched within one week of receipt of order.

6.3 Standardized solutions

Ordering information

Radionuclide, half life, description of solution	Measurement uncertainty	For fresh material, place order …	for delivery	Nominal activity		Nominal volume	Product code
Americium-241 433y Americium in 0.5M HCl	±0.5%	from stock		200kBq 20kBq	54µCi 0.54µCi	5ml 5ml	AMZ44 AMZ24
Americium in 0.5M HNO_3	±0.5%	from stock		200kBq 20kBq	5.4µCi 0.54µCi	5ml 5ml	AMZ440 AMZ240
Antimony-125 (+Te-125m not necessarily in equilibrium) 2.73y Antimony in 0.5M HCl containing 1mg tartaric acid	±1.7%	please enquire		4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	ACZ72 ACZ64 ACZ44
Barium-133 10.52y Barium in 0.1M HCl	±2%	fom stock		4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	BDZ72 BDZ64 BDZ44
Cadmium-109 (+ Ag-109m in equilibrium) 1.27y Cadmium in 0.1M HCl	±1.4%	mid Sept.	Dec.	4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	CUZ72 CUZ64 CUZ44
Caesium-134 2.06y Caesium in 0.1M HCl	±0.9%	mid March	May	4MBq 2MBq 200kBq 20kBq	108µCi 54µCi 5.4µCi 0.54µCi	1ml 5ml 5ml 5ml	CCZ72 CCZ64 CCZ44 CCZ24
Caesium-137 (+Ba-137m in equilibrium) 30.0y Caesium in 0.1 M HCl	±1.4%	from stock		4MBq 2MBq 200kBq 20kBq	108µCi 54µCi 5.4µCi 0.54µCi	1ml 5ml 5ml 5ml	CDZ72 CDZ64 CDZ44 CDZ24
Calcium-45 163d Calcium in 0.1M HCl	±1.4%	mid Feb. mid Aug.	April Oct.	2MBq 200kBq	54µCi 5.4µCi	5ml 5ml	CEZ64 CEZ44
Carbon-14 5730y Sodium carbonate in water (5mg/ml) Solution contains 1mg formaldehyde/ml	±1.7%	from stock		2MBq 200kBq	54µCi 5.4µCi	5ml 5ml	CFZ64 CFZ44
Glucose in water (1mg/ml) Solution contains 1mg formaldehyde /ml	±1%	from stock		2MBq 200kBq	54µCi 5.4µCi	5ml 5ml	CFZ640 CFZ440

Solutions of C-14 are not individually weighed but are dispensed within the range 5.0g±0.2g

6.3 Standardized solutions

Ordering information

Radionuclide, half life, description of solution	Measurement uncertainty	For fresh material, place order …	for delivery	Nominal activity		Nominal volume	Product code
Cerium-139	±2%	beginning		4MBq	108µCi	1ml	CXZ72
137.6d		Sept.	Dec.	2MBq	54µCi	5ml	CXZ64
Cerium in 0.1M HCl				200kBq	5.4µCi	5ml	CXZ44
	±3.4%	beginning		4MBq	108µCi	1ml	CXY72
		Sept.	Dec.	2MBq	54µCi	5ml	CXY64
				200kBq	5.4µCi	5ml	CXY44
Cerium-141	±0.7%	beginning		4MBq	108µCi	1ml	CGZ72
32.5d		July	Sept.	2MBq	54µCi	5ml	CGZ64
Cerium in 0.1M HCl				200kBq	5.4µCi	5ml	CGZ44
Chlorine-36	±1.4%	from stock		200kBq	5.4µCi	5ml	CIZ44
3.02×10^5 y							
Sodium chloride in water containing 1mg formaldehyde/ml							
Chromium-51	±1%	mid Dec.	March	4MBq	108µCi	1ml	CJZ72
27.7d		mid June	Sept.	2MBq	54µCi	5ml	CJZ64
Sodium chromate in dilute NH_4OH(pH 7-8)				200kBq	5.4µCi	5ml	CJZ44
	±3.4%	mid Dec.	March	4MBq	108µCi	1ml	CJY72
		mid June	Sept.	2MBq	54µCi	5ml	CJY64
				200kBq	5.4µCi	5ml	CJY44
Cobalt-57	±1%	from stock		4MBq	108µCi	1ml	CTZ72
271.4d				2MBq	54µCi	5ml	CTZ64
Cobalt in 0.1M HCl				200kBq	5.4µCi	5ml	CTZ44
Cobalt-58	±1%	mid Oct.	Dec.	4MBq	108µCi	1ml	CRZ72
78.8d				2MBq	54µCi	5ml	CRZ64
Cobalt in 0.1M HCl				200kBq	5.4µCi	5ml	CRZ44
	±2.0%	mid Oct.	Dec.	4MBq	108µCi	1ml	CRY72
				2MBq	54µCi	5ml	CRY64
				200kBq	5.4µCi	5ml	CRY44
Cobalt-60	±0.5%	from stock		4MBq	108µCi	1ml	CKZ72
5.27y				2MBq	54µCi	5ml	CKZ64
Cobalt in 0.1M HCl				200kBq	5.4µCi	5ml	CKZ44
				20kBq	0.54µCi	5ml	CKZ24
Europium-152	±2.7%	from stock		4MBq	108µCi	1ml	EFY72
13.3y				2MBq	54µCi	5ml	EFY64
Europium in 0.1M HCl				200kBq	5.4µCi	5ml	EFY44
Gallium-67	±5.4%	please enquire		4MBq	108µCi	1ml	GJY72
3.26d				2MBq	54µCi	5ml	GJY64
Gallium in 0.1M HCl				200kBq	5.4µCi	5ml	GJY44

6.3 Standardized solutions

Ordering information

Radionuclide, half life, description of solution	Measurement uncertainty	For fresh material, place order …	for delivery	Nominal activity		Nominal volume	Product code
Hydrogen-3 (tritium) 12.33y Tritiated water Solutions of H-3 are not individually weighed but are dispensed within the range 5.0g±0.2g	±2%	from stock		2MBq 200kBq	54µCi 5.4µCi	5ml 5ml	TRY64 TRY44
Indium-111 2.83d Indium in 0.1M HCl	±3.4%	please enquire		4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	INY72 INY64 INY44
Iodine-125 60.1d Sodium iodide in 200µg/ml sodium thiosulphate solution containing 1mg formaldehyde/ml	±1%	mid Dec. mid March mid June mid Sept.	Feb. May Aug. Nov.	4MBq 2MBq 200kBq 20kBq	108µCi 54µCi 5.4µCi 0.54µCi	1ml 5ml 5ml 5ml	IMZ72 IMZ64 IMZ44 IMZ24
Iodine-129 15.7x10^{6}y Sodium iodide in 15mg/ml sodium sulphite solution containing sodium chloride and 1mg formaldehyde/ml	±1%	please enquire		200kBq 20kBq	5.4µCi 0.54µCi	5ml 5ml	ISZ44 ISZ24
Iodine-131 8.04d Sodium iodide in 200µg/ml sodium thiosulphate solution containing 1mg formaldehyde/ml	±0.6% ±1.4%	mid April mid Oct. mid Jan. mid April mid July mid Oct.	May Nov. Feb. May Aug. Nov.	20MBq 4MBq 2MBq 200kBq 20kBq 4MBq 2MBq 200kBq 20kBq	540µCi 108µCi 54µCi 5.4µCi 0.54µCi 108µCi 54µCi 5.4µCi 0.54µCi	5ml 1ml 5ml 5ml 5ml 1ml 5ml 5ml 5ml	IBZ84 IBZ72 IBZ64 IBZ44 IBZ24 IBY72 IBY64 IBY44 IBY24
Iron-55 2.7y Iron in 0.1M HNO_3	±2.7% (on rate of production of K X-rays)	from stock		4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	IEZ72 IEZ64 IEZ44
Iron-59 45.1d Iron in 0.1M HCl	±0.7% ±1.4%	beginning June beg. Feb. beg. June	Aug. April Aug.	4MBq 2MBq 200kBq 4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi 108µCi 54µCi 5.4µCi	1ml 5ml 5ml 1ml 5ml 5ml	IFZ72 IFZ64 IFZ44 IFY72 IFY64 IFY44
Krypton-85 10.72y Gas in P1A ampoule	±5.4% ±6.7%	please enquire please enquire		400MBq 200MBq 40MBq 4MBq	10.8mCi 5.4mCi 1.08mCi 108µCi		KAY1239 KAY1139 KAY939 KAY739

6.3 Standardized solutions

Ordering information

Radionuclide, half life, description of solution	Measurement uncertainty	For fresh material, place order …	for delivery	Nominal activity		Nominal volume	Product code
Lead-210 22.3y Lead/bismuth in 0.5M HNO_3	±1.7%	from stock		200kBq 20kBq	5.4µCi 0.54µCi	5ml 5ml	RBZB44 RBZB24
Manganese-54 312.5d Manganese in 0.1M HCl	±0.9%	mid May	Aug.	4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	MFZ72 MFZ64 MFZ44
Mercury-203 46.6d Mercury in 0.1M HCl	±0.6%	mid Dec. mid June	March Sept.	4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	MBZ72 MBZ64 MBZ44
	±1.5%	mid Dec. mid June	March Sept.	4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	MBY72 MBY64 MBY44
Molybdenum-99 (+Tc-99m in equilibrium) 2.75d Ammonium molybdate in 0.01M NH_4OH	±2.4%	please enquire		4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	MCZ72 MCZ64 MCZ44
	±4%	please enquire		4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	MCY72 MCY64 MCY44
Neptunium-237 $2.14x10^6$y Neptunium in 0.1M HCl (1.4mg ^{237}Np/µCi)	±1%	please enquire		200kBq 20kBq	5.4µCi 0.54µCi	5ml 5ml	NGZ44 NGZ24
Nickel-63 100.0y Nickel in 0.1M HCl	±1.7%	from stock		2MBq 200kBq	54µCi 5.4µCi	5ml 5ml	NBZ64 NBZ44
Phosphorus-32 14.3d Sodium orthophosphate in water containing 1mg formaldehyde/ml	±1.7%	mid Jan. mid May mid Sept.	March July Nov.	20MBq 2MBq 200kBq	540µCi 54µCi 5.4µCi	5ml 5ml 5ml	PBZ840 PBZ640 PBZ440
Plutonium-238 87.7y Plutonium in 0.5M HNO_3	±1%	please enquire		20kBq	0.54µCi	5ml	PPZ24
Promethium-147 2.62y Neodymium + trace of promethium in 0.1M HCl	±1.4%	from stock		2MBq 200kBq	54µCi 5.4µCi	5ml 5ml	PHZ64 PHZ44

6.3 Standardized solutions

Ordering information

Radionuclide, half life, description of solution	Measurement uncertainty	For fresh material, place order …	for delivery	Nominal activity		Nominal volume	Product code
Radium-226 1600y Radium in 0.5M HCl	±2.7%	from stock		200kBq 20kBq	5.4µCi 0.54µCi	5ml 5ml	RAY44 RAY24
Ruthenium-103 39.4d Ruthenium in 1M HCl	±1.4%	beginning Feb.	 April	4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	RIZ72 RIZ6 RIZ44
	±2.7%	beginning Feb.	 April	4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	RIY72 RIY64 RIY44
Ruthenium-106 1.01y Ruthenium in 1M HCl	±1.4%	mid June	August	4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	RKZ72 RKZ64 RKZ44
Selenium-75 119.8d Sodium selenite in water containing 1mg formaldehyde/ml	±3%	mid April	June	4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	SCZ72 SCZ64 SCZ44
Sodium-22 2.60y Sodium in 0.1M HCl	±0.6%	from stock		4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	SKZ72 SKZ64 SKZ44
Strontium-85 64.84d Strontium in 0.1M HCl	±1.4%	mid Nov. mid May	March Sept.	4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	SOZ72 SOZ64 SOZ44
	±2.4%	mid Nov. mid May	March Sept.	4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	SOY72 SOY64 SOY44
Strontium-89 50.5d Strontium in 0.1M HCl	±1%	mid Feb. mid July	April Sept.	2MBq 200kBq 20kBq	54µCi 5.4µCi 0.54µCi	5ml 5ml 5ml	SMZ64 SMZ44 SMZ24
Strontium-90 29.12y Strontium/yttrium in 0.1M HCl	±1%	from stock		2MBq 200kBq 20kBq 2kBq	54µCi 5.4µCi 0.54µCi 0.05µCi	5ml 5ml 5ml 5ml	SIZ64 SIZ44 SIZ24 SIZ04
Sulphur-35 87.5d Lithium sulphate in 0.01M HCl containing 1mg formaldehyde/ml	±1.4%	mid Jan. mid July	March Sept.	2MBq 200kBq	54µCi 5.4µCi	5ml 5ml	SJZ64 SJZ44

6.3 Standardized solutions

Ordering information

Radionuclide, half life, description of solution	Measurement uncertainty	For fresh material, place order …	for delivery	Nominal activity		Nominal volume	Product code
Technetium-99 212860y Ammonium pertechnetate in 0.01M NH_4OH	±1%	from stock		2MBq 200kBq	54µCi 5.4µCi	5ml 5ml	TCZ64 TCZ44
Technetium-99m 6.02h Carrrier free in saline in 0.01M NH_4OH	±6%	UK only please enquire		4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	TKY72 TKY64 TKY44
Thallium-201 3.04d Thallium in 0.1M HCl	±3.4%	please enquire		4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	TDY72 TDY64 TDY44
Tin-113 115.1d Tin in 4M HCl	±3.4%	mid Sept.	Dec.	4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	TFY72 TFY64 TFY44
Tritium - see Hydrogen-3							
Xenon-133 5.25d Gas in P1A ampoules	±6.7%	please enquire		400MBq 200MBq 40MBq	10.8mCi 5.4mCi 1.08mCi		XAY1239 XAY1139 XAY939
Yttrium-88 106.6d Yttrium in 0.1M HCl	±1%	mid Dec. mid June	March Sept.	4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	YEZ72 YEZ64 YEZ44
	±1.9%	mid Dec. mid June	March Sept.	4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	YEY72 YEY64 YEY44
Yttrium-90 2.67d Yttrium in 0.1M HCl	±1%	mid March mid Aug.	April Sept.	2MBq 200kBq	54µCi 5.4µCi	5ml 5ml	YAZ64 YAZ44
Zinc-65 244.3d Zinc in 0.1M HCl	±1.4%	mid May	Aug.	4MBq 2MBq 200kBq	108µCi 54µCi 5.4µCi	1ml 5ml 5ml	ZAZ72 ZAZ64 ZAZ44

6.4 Heavy element tracer solutions

Description

Heavy element tracer solutions are ultra-pure and carrier free for the best, most accurate, analyses possible. The solutions are supplied in flame-sealed glass ampoules or plastic vials.

Advantages of tracer solutions
- High purity - minimal interference with the nuclide being traced
- Carrier free - for preparing high resolution alpha sources
- Cost effective - many analyses from one ampoule

Chemical composition

The chemical composition of the solutions is shown in the table.

Measurement

The activities of the radionuclides are determined by alpha counting using low solid angle or 2-π proportional counters. These counters are calibrated using absolute standards which have been measured by defined solid angle alpha counting.

Certification

Each solution is supplied with a certificate of calibration which states:
- Radioactivity concentration of nuclide
- Mass and volume of solution
- Total activity
- Reference time and date
- Uncertainties
- Chemical form
- Radionuclidic purity

Radionuclidic purity

Impurities are assayed by high resolution gamma-ray spectrometry, alpha-ray spectrometry and by mass spectrometry as appropriate. Full information is given on the certificate of calibration.

6.4 Heavy element tracer solutions

Storage and dispensing

In normal laboratory conditions, the solutions are expected to be chemically stable in the original ampoules for at least 2 years from the date of despatch of the solution. The solutions are designed to be redispensed by the user from the ampoule to other containers using normal radiochemical dispensing techniques.

Tolerances

The activities and radioactivity concentration present are detailed in the table below at the reference date for the measurement. Products may be replaced by a similar product at short notice.

Quality assurance

The solutions are dispensed in a source manufacturing facility which has been independently audited and approved to ISO9001:1994.

Licensing

An export license may be needed for these solutions. Please contact your local AEA Technology QSA office, who will help you with the formalities.

Availability

The solutions are despatched within 2 weeks of receipt of export license if required.

Ordering information

Radio-nuclide	Chemical form	Impurities/Comments	Mass of solution [g]	Concentration [Bq/g]	Total activity [Bq]	Reference date [d/m/y]	Mass of element [µg]	Product code
Ac-227	2M HNO_3	Daughters at Equilibrium	5.4	1355	$7.3x10^3$	12/5/93	0.0028	AFP10010
Ac-227	2M HNO_3	Daughters at Equilibrium	5.4	50430	$2.7x10^5$	11/5/93	0.10	AFP10020
Am-241	2M HNO_3	Am-241 99.9+%	5.4	397	$2.1x10^3$	20/6/91	0.016	AMP10010
Am-241	2M HNO_3	Am-241 99.9+%	5.4	3673	$2.0x10^4$	6/6/91	0.16	AMP10020
Am-241	2M HNO_3	Am-241 99.9+%	5.4	37200	$2.0x10^5$	20/7/88	1.6	AMP10030
Am-241	2M HNO_3	Am-241 99.9+%	5.4	471100	$2.5x10^6$	6/1/87	20	AMP10040
Am-241	3M HNO_3	Am-241 99.9+%	2.2	1488000	$3.3x10^6$	23/8/90	26	AMP10050
Am-243	2M HNO_3	Am-243 99.97% Am-241 0.03%	5.4	452.5	$2.43x10^3$	30/4/97	0.33	ATP10010
Am-243	2M HNO_3	Am-243 99.97% Am-241 0.07%	5.4	1744	$9.4x10^3$	30/4/97	1.3	ATP10020

6.4 Heavy element tracer solutions

Ordering information

Radio-nuclide	Chemical form	Impurities/Comments	Mass of solution [g]	Concentration [Bq/g]	Total activity [Bq]	Reference date [d/m/y]	Mass of element [µg]	Product code
Am-243	2M HNO_3	Am-243 99.5%, Am-241 0.5%	5.4	4560	$2.5x10^4$	9/10/92	3.3	ATP10030
Am-243	2M HNO_3	Am-243 99.39%, Am-241 0.61%	5.4	31150	$1.7x10^5$	20/3/96	23	ATP10040
Am-243	2M HNO_3	Am-243 99.46%, Am-241 0.51%, Cm-244 ~0.004%, Cm-242<0.03%	1.1	737500	$7.9x10^5$	13/3/97	106	ATP10050
Cf-252	2M HNO_3		5.4	20.4	$1.0x10^2$	19/12/95	0.0000057	CVP10010
Cf-252	2M HNO_3		5.4	188	$1.02x10^3$	22/12/95	0.000053	CVP10020
Cm-244	2M HNO_3	Cm-244 99.98%, Pu-239+240<0.015%	5.4	191	$1.0x10^3$	15/4/97	0.00034	CLP10010
Cm-244	2M HNO_3	Cm-244 99.98%, Pu-239+240<0.015%	5.4	5503	$3.0x10^4$	17/4/97	0.0099	CLP10020
Cm-244	2M HNO_3	Cm-244 99.98%, Pu-239+240<0.015%	5.4	21050	$1.1x10^5$	16/4/97	0.038	CLP10030
Cm-244	2M HNO_3	Cm-244 99.98%, Pu-239+240<0.015%	5.4	39220	$2.1x10^5$	16/4/97	0.070	CLP10040
Nb-93m	1M HNO_3/HF	Nb94 0.32%	2.0	6220	$1.3x10^4$	1/1/90	0.00144	NJP10010
Nb-93m	1M HNO_3/HF	Nb94 0.32%	2.0	622500	$1.2x10^6$	1/1/90	0.14	NJP10020
Np-237	2M HNO_3	Np-237 99.99% Pu+Am 0.01%	5.4	310	$1.7x10^3$	11/11/99	64	NGP10010
Np-237	2M HNO3	Np-237 99.99%, Pu+Am 0.01%	5.4	2560	$1.4x10^4$	20/5/92	525	NGP10020
Np-237	2M HNO_3	Np-237 99.99%, Pu+Am 0.01%	5.4	33230	$1.8x10^5$	21/10/99	6850	NGP10030
Pb-210	2M HNO_3	Po-210 at equilibrium	5.4	235	$1.3x10^3$	26/4/93	0.00044	RBP10010
Pb-210	2M HNO_3	Po-210 at equilibrium	5.4	5360	$2.9x10^4$	23/4/93	0.010	RBP10020
Pb-210	2M HNO_3	Po-210 at equilibrium	5.4	172000	$9.3x10^5$	22/4/93	0.33	RBP10030
Pb-210	2M HNO_3	Po-210 at equilibrium	5.4	1060000	$5.7x10^6$	23/4/93	2.0	RBP10040
Pb-210	2M HNO_3	Po-210 at equilibrium	5.4	4750000	$2.6x10^7$	23/4/93	9.0	RBP10050
Po-208	1M HCl	Po-208 98.02% Po-209 1.92%	5.1	70.5	$3.6x10^2$	17/05/99	0.000016	PMP10010
Po-208	2M HNO_3	Po-208 98.31% Po-209 1.69%	5.4	68.8	$3.7x10^2$	23/11/99	0.000017	PMP10020
Po-208	2M HNO_3	Po-208 99.2%, Po-209 0.8%	5.4	2254	$1.2x10^4$	16/10/95	0.00055	PMP10030
Po-208	1M HCl	Po-208 99.4% Po-209-0.6% Po-210<0.01%	5.1	4974	$2.6x10^4$	18/3/93	0.0012	PMP10040
Po-208	2M HNO_3	Po-208 99.2% Po-209 0.8%	5.5	36500	$2.0x10^5$	27/9/95	0.0091	PMP10060

6.4 Heavy element tracer solutions

Ordering information

Radio-nuclide	Chemical form	Impurities/Comments	Mass of solution [g]	Concentration [Bq/g]	Total activity [Bq]	Reference date [d/m/y]	Mass of element [µg]	Product code
Po-209	2MHNO_3	Po-209 99.7%, Po-208 0.2%, Po-210 0.1%	5.4	5.04	$2.7x10^1$	22/3/96	0.000044	PQP10010
Pu-236	2M HNO_3		5.4	10.2	54.8	6/3/03	$2.8x10^{-6}$	PXP10005
Pu-236			please enquire					PXP10010
Pu-238	2M HNO_3	Pu-238 >99.9%	5.4	70.3	$3.8x10^2$	8/2/90	0.00059	PPP10010
Pu-238	2M HNO_3	Pu-238 >99.9%	5.4	4034	$2.2x10^4$	9/12/97	0.037	PPP10020
Pu-238	2M HNO_3	Pu-238 >99.9%	5.4	42660	$2.3x10^5$	4/4/00	0.36	PPP10030
Pu-239	2M HNO_3	Pu-239+240 99.87%, Pu-238+Am-241 0.13%	5.3	64.1	$3.4x10^2$	23/5/89	0.15	PIP10020
Pu-239	8M HNO_3	Pu-239+240 99.87%, Pu-238+Am-241 0.13%	6.3	157	$9.8x10^2$	12/2/88	0.5	PIP10030
Pu-239	2M HNO_3	Pu-239+240 99.88%, Pu-238+Am-241 0.12%	5.3	3946	$2.1x10^4$	11/3/96	9.5	PIP10050
Pu-239	2M HNO_3	Pu-239+240 99.90%, Pu-238+Am-241 0.10%	5.4	20955	$1.1x10^5$	28/6/95	49.5	PIP10060
Pu-240	2M HNO_3	Pu-239+240 99.33%, Pu-238+Am-241 0.67%	5.4	21500	$1.2x10^5$	23/11/99	14	PJP10010
Pu-240	2M HNO_3	Pu-239+240 99.94%, Pu-238+Am-241 0.06%	5.4	47890	$2.6x10^5$	20/9/88	31	PJP10020
Pu-241	1M HNO_3		5.2	976	$5.1x10^3$	24/1/90	0.0013	PKP10010
Pu-241	1M HNO_3		5.2	80800	$4.2x10^5$	24/1/90	0.11	PKP10030
Pu-242	1.4M HNO_3	Pu-242 99.98%	5.3	9.9	$5.3x10^1$	27/3/02	0.36	PRP10010
Pu-242	1.4M HNO_3	Pu-242 99.98%	5.3	1009	$5.4x10^3$	5/2/02	36.5	PRP10020
Ra-226	1M HCl	Plus daughters	5.1	37.5	$1.9x10^2$	15/1/98	0.0053	RAP10010
Ra-226	1M HCl	Plus daughters	5.1	368	$9x10^3$	30/9/99	0.052	RAP10020
Ra-226	1M HCl	Plus daughters	5.1	3706	$1.9x10^4$	5/2/98	0.52	RAP10040
Ra-226	1M HCl	Plus daughters	5.2	38900	$2.0x10^5$	14/4/93	5.5	RAP10060
Ra-226	1M HCl	Plus daughters	5.1	79500	$4.1x10^5$	15/11/91	11	RAP10070
Th-228		please enquire						
Th-229	2M HNO_3	Th-228<0.05%	5.4	9.95	$5.3x10^1$	17/1/97	0.0068	TPP10020
Th-229	2M HNO_3	Th-228<0.05%	5.4	49.5	$2.6x10^2$	13/1/97	0.034	TPP10030
Th-229	2M HNO_3	Th-228<0.05%	5.4	240	$1.3x10^3$	10/1/97	0.16	TPP10040
Th-230	2M HNO_3	Th-230 98%, Ra-226 + daughters 2%	5.4	70.3	$3.8x10^2$	2/7/91	0.50	TZP10010
Th-230	2M HNO_3	Th-230 98%, Ra-226 + daughters 2%	5.4	624	$3.4x10^3$	27/6/91	4.4	TZP10020
Th-230	2M HNO_3	Th-230 98%, Ra-226 + duaghters 2%	5.5	7030	$3.8x10^4$	28/6/91	50	TZP10030

6.4 Heavy element tracer solutions

Ordering information

Radio-nuclide	Chemical form	Impurities/Comments	Mass of solution [g]	Concentration [Bq/g]	Total activity [Bq]	Reference date [d/m/y]	Mass of element [µg]	Product code
U-232	2M HNO_3	Th-228 in equilibrium	5.4	0.563	$3x10^{0}$	19/1/00	0.0000040	UDP10010
U-232	2M HNO_3	Th-228 in equilibrium	5.4	6.01	$3.2x10^{1}$	12/6/90	0.000039	UDP10020
U-232	2M HNO_3	Th-228 in equilibrium	5.4	66.8	$3.6x10^{2}$	1/4/99	0.00044	UDP10030
U-232	2M HNO_3	Th-228 removed 2/2/00	5.4	6739	$3.6x10^{4}$	1/3/00	0.044	UDP10050
U-233	2M HNO_3	U-233 99.28%, U-232 0.52%	5.4	69.1	$3.7x10^{2}$	28/11/95	1.0	UBP10010
U-233	2M HNO_3	U-233 99.7% U-232 0.3%	5.4	231	$1.2x10^{3}$	2/6/94	3.5	UBP10020
U-234	2M HNO_3	U-234 93.3%, U-232 6.15%, U-232 daughters 0.55%	5.39	202.6	$1.1x10^{3}$	3/6/93	4.75	UEP10010
U-234	2M HNO_3	U-234 93.3%, U-232 6.15%, U-232 daughters 0.55%	5.39	1966	$1.1x10^{4}$	3/6/93	46.1	UEP10020
U-235	8M HNO_3	U-234 96.3%, U235+U-236 3.2%, U-238 0.20%, daughters 0.3%	6.7	624	$4.2x10^{3}$	4/2/93	2070	UCP10010
U-235	8M HNO_3	U-234 96.9%, U-235+U-236 2.3%, U-238 0.20%, daughters 0.6%	6.3	774	$4.9x10^{3}$	3/2/93	1720	UCP10020
U-236	2M HNO_3	U-236 99.99%, U-234<0.01%	5.4	7.23	$3.9x10^{1}$	2/3/92	16	UFP10010
U-236	2M HNO_3	U-236 99.99%, U-234<0.01%	5.4	73.9	$4.0x10^{2}$	1/5/96	165	UFP10030

6.5 NPL standards for environmental measurements

Courtesy of National Physical Laboratory [1)]

Chemical composition

The chemical composition of the solutions is shown below. Most of the solutions contain a non-radioactive carrier element to minimise adsorption of the radioactive material onto the surface of the ampoule.

Measurement

The activities of the radionuclides are measured using instruments calibrated by UK primary radioactivity standards.

Dispensing

The solutions are designed to be redispensed by the user from the ampoule to other containers using normal radiochemical dispensing techniques.

Description

The National Physical Laboratory's (NPL) range of very low activity standards have been developed specifically for environmental measurements. The range includes a mixed nuclide standard for gamma-ray spectrometry and single nuclide solutions.

The advantages of these very low activity standards are:
- Easier to handle
- Minimal sample preparation
- Lower risk of cross-contamination
- Lower risk of contaminating instruments
- Suitable for laboratories where regulations restrict the quantities of radioactive materials stored

The NPL is the UK's national standards laboratory and has maintained the UK's primary radioactivity standards for more than ninety years.

Certification

Each solution is provided with an NPL certificate of calibration which states:
- Unique source identifier
- Measurement technique
- Solution description
- Reference date
- Calibration date
- Radioactivity concentration, total activity or gamma-ray production rate
- Uncertainty in radioactivity concentration, total activity or gamma-ray production rate
- Radionuclidic purity
- Solution mass
- Current recommended half-life
- Photon emission probabilities where appropriate
- Supporting information where necessary

Radionuclidic purity

The radionuclidic purity is measured by detailed radiochemical analysis of the solution and by spectroscopic techniques. Some solutions may be checked by high resolution gamma- or X-ray spectrometry alone. The activities of any impurities detected are expressed as a percentage of the activity of the main radionuclide at the reference time. Full information is given on the certificate of calibration.

Tolerances

Solutions are dispensed so that the activity at the reference time is typically within ±10% of the nominal activity stated in the table (pages 28 - 29).

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6.5 NPL standards for environmental measurements

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 solutions are directly traceable to UK absolute primary radioactivity standards. NPL regularly participates in validation and calibration exercises with other national standards laboratories organised under the auspices of the International Bureau for Weights and Measures (BIPM). Via this route and the Mutual Recognition Arrangement, traceability to NPL is accepted as attributing traceability to other national standards laboratories in many other countries, eg. NIST (USA), LNHB (France) and PTB (Germany).

Quality assurance

NPL Management Ltd has been approved by Lloyds Register Quality Assurance Ltd for certification to ISO9001:2000.
The provision of NPL's environmental standards has been accredited by UKAS to ISO17025:1999.

Regulations/licensing

An export licence may be needed for these solutions. Please contact your local AEA Technology QSA office, who will help you with the formalities.

Availability (lead time)

The solutions are despatched within two weeks of receipt of order, or within two weeks of receipt of export license if required.

Courtesy of National Physical Laboratory[1)]

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6.5 NPL standards for environmental measurements

Ordering information - Solutions

Radio-nuclide	Chemical form & carrier concentration	Radioactive concentration [Bq/g]	(nCi/g)	Total activity [Bq]	(nCi)	Nominal mass [g]	Product code
Am-241	4M HCl	10	(0.27)	100	(2.7)	10	AMP21301
Am-243	1M HNO_3	1	(0.027)	10	(0.27)	10	ATP21800
		0.15	(0.004)	0.45	(0.01)	3	ATP21810
C-14	5mg/g Na_2CO_3 + 1mg/g HCHO in water	100	(2.7)	1000	(27)	10	CFP21902
C-14		2000	(54)	20000	(540)	10	CFP21903
Cm-244	1M HNO_3	20000	(540)	20000	(540)	1	CLP22514
		1000	(27)	1000	(27)	1	CLP22513
		20000	(540)	200000	(5400)	10	CLP22504
		1000	(27)	10000	(270)	10	CLP22503
		50	(1.3)	500	(13)	10	CLP22501
		2.5	(0.07)	25	(0.7)	10	CLP22500
Cs-134	0.1mg/g Cs in 0.1M HCl	10	(0.27)	100	(2.7)	10	CCP20501
Cs-137	0.1mg/g Cs in 0.1M HCl	10	(0.27)	100	(2.7)	10	CDP20301
Eu-152	0.1mg/g Eu in 0.1M HCl	100	(2.7)	1000	(27)	10	EFP20903
Fe-55	0.1 mg/g Fe in 0.1M HNO_3	300	(8.1)	300	(8.1)	1	IEP22912
		300	(8.1)	3000	(81)	10	IEP22902
H-3	H_2O	10	(0.27)	100	(2.7)	10	TRP23001
I-129	0.06mg/g NaI + 1.5mg/g Na_2SO_3 in 0.001M NaOH	100	(2.7)	1000	(27)	10	ISP21402
Np-237	0.08mg/g $H_2C_2O_4$ in 5M HCl	10000	(270)	10000	(270)	1	NGP22114
		10000	(270)	100000	(2700)	10	NGP22104
		100	(2.7)	1000	(27)	10	NGP22102
		1	(0.027)	10	(0.27)	10	NGP22100
Pb-210	0.05 mg/g each of Pb & Bi in 1.2M HNO_3	1000	(27)	10000	(270)	10	RBP22203
		40	(1.08)	400	(10.8)	10	RBP22201
		1	(0.027)	10	(0.27)	10	RBP22200
Pu-239	1M HNO_3	20000	(540)	20000	(540)	1	PIP22414
		1000	(27)	1000	(27)	1	PIP22413
		20000	(540)	200000	(5400)	10	PIP22404
		1000	(27)	10000	(270)	10	PIP22403
		50	(1.3)	500	(13)	10	PIP22401
		2.5	(0.07)	25	(0.7)	10	PIP22400
Pu-242	2M HNO_3	1	(0.027)	10	(0.27)	10	PRP21500
		0.3	(0.008)	0.9	(0.02)	3	PRP21510

6.5 NPL standards for environmental measurements

Radio-nuclide	Chemical form & carrier concentration	Radioactive concentration [Bq/g]	(nCi/g)	Total activity [Bq]	(nCi)	Nominal mass [g]	Product code
Sr-90	0.02mg/g Sr, 0.02mg/g Y in 0.1M HCl	40	(1.1)	400	(11)	10	SIP20102
		100	(2.7)	1000	(27)	10	SIP20103
Tc-99	0.1M NH_4OH	0.6	(0.02)	6	(0.16)	10	TCP21110
		100	(2.7)	1000	(27)	10	TCP21102
Th-229	2M HNO_3	10	(0.27)	100	(2.7)	10	TPP22601
		1	(0.027)	10	(0.27)	10	TPP22600
		0.3	(0.008)	0.9	(0.02)	3	TPP22610
		0.3	(0.008)	3	(0.08)	10	TPP22620
U-232	2M HNO_3	1	(0.027)	10	(0.27)	10	UDP22000
U-232		100	(2.7)	1000	(27)	10	UDP22002
U-232		0.3	(0.008)	0.9	(0.02)	3	UDP22010
U-238	2M HNO_3	100	(2.7)	1000	(27)	10	UAP22802
		10	(0.27)	100	(2.7)	10	UAP22801
Mixed: Am-241 Cd-109 Co-57 Ce-139 Hg-203 Sn-113 Sr-85 Cs-137 Co-60 Y-88	In 4M HCl: 0.025mg/g of Cd, Co, Ce, Hg, Sn, Sr, Cs, Y	600	(16)	6000	(160)	10	QCP20803
		6000	(160)	60000	(1600)	10	QCP20804

6.6 Custom preparation service

If the radioactive solution required is not shown in this catalogue, AEA Technology QSA will try to assist you.

Please photocopy the form on the next page, fill in the details as far as possible, and fax the form to your local AEA Technology QSA office.

Alternatively, contact us by Email on:

isotrak@aeat.com

or visit our Internet site on the World Wide Web at:

http://www.isotrak.de
http://www.aeat-qsa.com

We will reply via your local AEA Technology QSA office.

Request for custom radioactive solution

FAX - BACK FORM

To: **Your local AEA Technology QSA office for forwarding to Isotrak Technical Service**

From:

Name: _____

Institute/company _____

Address: _____

_____

_____

Country: _____

Tel: _____

Fax: _____

Email: _____

Date: _____

Nuclide(s) required: _____

Chemical form (eg. in 0.1M HCl) _____

Total activity: _____ __Bq or _____ __Ci

Total volume: _____ ml

_____

Date required by: _____

_____

Any special requirement: _____

Our technical experts may be able to recommend an alternative radionuclide. If you wish, please tell us your application: _____

_____

_____

_____

_____

_____

_____

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