RADQUAL
An International Isotopes Company

Calibration Sources & Radioactive Standards

Catalog of Sources

LEA
Authorized Distributor

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Contact: U.S. & Canadian Customers

Sales, Quotes, Questions

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about us

About RadQual/LEA

RadQual imports and distributes LEA products throughout the United States and Canada.

RadQual is a wholly owned subsidiary of International Isotopes, Inc. and manufactures and distributes calibration and reference sources for the nuclear medicine industry. LEA, a wholly owned subsidiary of Orano, produces sources for control and calibration of equipment in the fields of radiation protection and metrology.

LEA's calibration and reference sources are measured according to ISO 17025:2017 under COFRAC[1] accreditation, which provides the same traceability to SI[2] as the National Institute of Standards and Technology (NIST). LEA products include a wide range of calibration sources, and LEA has provided tens of thousands of these radioactive sources in France and abroad over the past 20 years.

LEA is France's leading manufacturer and distributor of calibration sources and standards. As a laboratory accredited by COFRAC[1] for the measurement of ionizing radiations, LEA provides high-quality sources for control and calibration of equipment in the fields of radiation protection and metrology. Located in the South of France, LEA has manufactured and sold tens of thousands of radioactive sources in France and abroad. LEA is subsidiary of the Orano group. Orano transforms nuclear materials so that they can be used to support the development of society, first and foremost, in the field of energy. The Group offers products and services with high added value throughout the entire nuclear fuel cycle, from raw materials to waste treatment, contributing to the production of low-carbon electricity

[1] COFRAC is France's accreditation body in the field of calibration of ionizing radiation. LEA's scope of accreditation N°2-6386 is available on www.cofrac.fr or upon request.
[2] SI : International System of Units

Contact: Ordering/Quotes

To place orders, request quotes or more information, U.S. and Canadian customers can email sales@radqual.com or call 208.524.5300 during regular business hours.

For additional information, visit radqual.com or www.orano.group/lea.

α and β solid sources

Handling Precautions

Alpha and beta sources are considered as sealed sources, with an ISO2919 classification of C11111 or higher.

However, precautions must be taken so that the active surface is not in contact with any other material. LEA recommends handling these sources with tweezers to avoid leaving grease on the surface of the source, which would degrade the spectrum and risk contaminating the user.

We recommend storing these sources in their original packaging, away from dust and more generally away from the ambient air. It is therefore not recommended cleaning these sources and scrubbing the active area to check for contamination, to avoid damaging and tearing off part of the active surface.

By respecting these precautions for use, the recommended working life of our alpha and beta sources is 10 years.

EAS point α sources

Technical Information

Alpha point sources (EAS) are in the form of a stainless steel disk, unmounted (Type C or D) or sealed on an aluminum ring (Type A or B), at the center of which the radionuclides are electroplated.

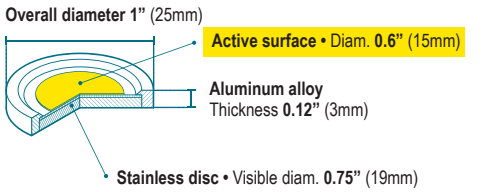
Radiological characteristics of the sources are measured with a calibrated grid cell detector.

Production Range

Catalog References	Custom/On Request
Active Diameter	
15 mm • 0.6 in	From 5 to 75 mm From 0.2 to 2.9 in
External Diameter	
25 mm • 1 in	From 25 to 90 mm From 1 to 3.5 in
30 mm • 1.2 in	
38 mm • 1.5 in	
Activity	
300 Bq • 0.008 µCi	From 10 to 8000 Bq From 0.0003 to 0.2 µCi
800 Bq • 0.02 µCi	
3000 Bq • 0.08 µCi	
Radionuclide	
^{241}Am	

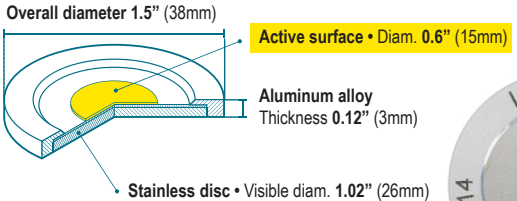
Standard geometries

Type A



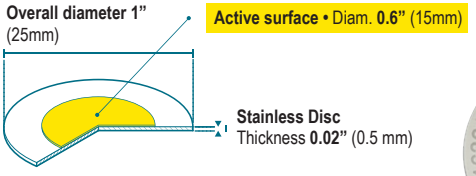
The distance between the active part and the height of the ring is .03".

Type B

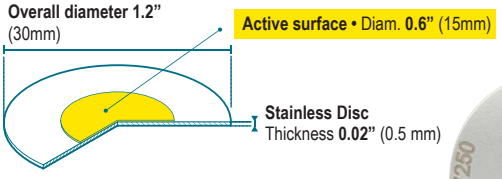


The distance between the active part and the height of the ring is .03".

Type C



Type D



Reference/Product No.

Radionuclide	2π sr alpha flux		k=2 measurement uncertainty	Equivalent activity	Reference
	Under COFRAC* accreditation				
^{241}Am	150	$\alpha.s^{-1}$	≤ 1.5%	300 Bq • 0.008 µCi	**Am241 EAS [Type] 20**
	1500	$\alpha.s^{-1}$	≤ 1.5%	3000 Bq • 0.08 µCi	**Am241 EAS [Type] 30**

Standard manufacturing tolerance: ± 30%

IAEA Category: 5 • ISO2919 Classification: C11111

*Scope N°2-6386 available at www.cofrac.fr or upon request.

How to compose reference:
Replace **[Type]** with the letter **A**, **B**, **C** or **D** according to the required geometry.
For example: **Am241 EAS C 20**

EBS point β sources

Technical Information

Radionuclides are deposited between two hot-sealed polyester foils (approximately 75µm thick each). Each face of the source is gold vacuum-coated for optimum measurement efficiency. They are then mounted in a steel ring.

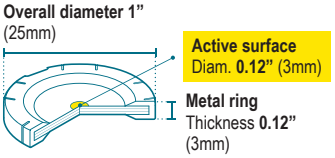
Radiological characteristics of the sources are measured with a calibrated gas flow proportional counter.

Production Range

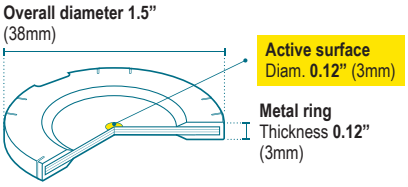
Catalog References	Custom/On Request
Active Diameter	
3 mm • 0.12 in	From 3 to 30 mm From 0.12 to 1.2 in
30 mm • 1.2 in	
External Diameter	
25 mm • 1 in	From 25 to 60 mm From 1 to 2.4 in
38 mm • 1.5 in	
50 mm • 2 in	
Activity	
80 Bq • 0.002 µCi	From 50 to 4 kBq From 0.001 to 8.1 µCi
3000 Bq • 0.08 µCi	
Radionuclide	
^{22}Na, ^{36}Cl, ^{60}Co, ^{90}Sr/ ^{90}Y, ^{137}Cs/ ^{137m}Ba, ^{147}Pm, ^{204}Tl, ^{89}Sr, ^{134}Cs, ^{99}Tc	^{32}P, ^{35}S, ^{63}Ni, ^{129}I

Standard geometries

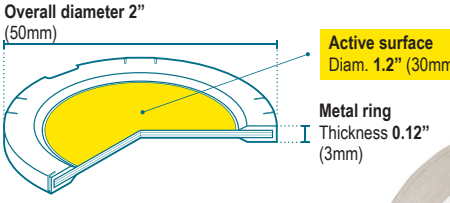
Type A



Type B



Type C



Reference/Product No.

Radionuclide	4π sr beta flux		k=2 measurement uncertainty	Equivalent activity	Reference
	Under COFRAC* accreditation				
^{36}Cl	80	$\beta.s^{-1}$	≤ 1.5%	80 Bq • 0.002 µCi	**Cl36 EBS [Type] 20**
	3000	$\beta.s^{-1}$	≤ 1.5%	3000 Bq • 0.08 µCi	**Cl36 EBS [Type] 30**
^{60}Co	80	$\beta.s^{-1}$	≤ 1.5%	80 Bq • 0.002 µCi	**Co60 EBS [Type] 20**
	3000	$\beta.s^{-1}$	≤ 1.5%	3000 Bq • 0.08 µCi	**Co60 EBS [Type] 30**
^{134}Cs	80	$\beta.s^{-1}$	≤ 1.5%	80 Bq • 0.002 µCi	**Cs134 EBS [Type] 20**
	3000	$\beta.s^{-1}$	≤ 1.5%	3000 Bq • 0.08 µCi	**Cs134 EBS [Type] 30**
^{137}Cs	80	$\beta.s^{-1}$	≤ 1.5%	80 Bq • 0.002 µCi	**Cs137 EBS [Type] 20**
	3000	$\beta.s^{-1}$	≤ 1.5%	3000 Bq • 0.08 µCi	**Cs137 EAS [Type] 30**
^{22}Na	80	$\beta.s^{-1}$	≤ 1.5%	80 Bq • 0.002 µCi	**Na22 EBS [Type] 20**
	3000	$\beta.s^{-1}$	≤ 1.5%	3000 Bq • 0.08 µCi	**Na22 EBS [Type] 30**
^{147}Pm	80	$\beta.s^{-1}$	≤ 1.5%	80 Bq • 0.002 µCi	**Pm147 EBS [Type] 20**
	3000	$\beta.s^{-1}$	≤ 1.5%	3000 Bq • 0.08 µCi	**Pm147 EBS [Type] 30**
^{89}Sr	80	$\beta.s^{-1}$	≤ 1.5%	80 Bq • 0.002 µCi	**Sr89 EBS [Type] 20**
	3000	$\beta.s^{-1}$	≤ 1.5%	3000 Bq • 0.08 µCi	**Sr89 EBS [Type] 30**
^{90}Sr + ^{90}Y	80	$\beta.s^{-1}$	≤ 1.5%	80 Bq • 0.002 µCi	**Sr90 EBS [Type] 20**
	3000	$\beta.s^{-1}$	≤ 1.5%	3000 Bq • 0.08 µCi	**Sr90 EBS [Type] 30**
^{204}Tl	80	$\beta.s^{-1}$	≤ 1.5%	80 Bq • 0.002 µCi	**Tl204 EBS [Type] 20**
	3000	$\beta.s^{-1}$	≤ 1.5%	3000 Bq • 0.08 µCi	**Tl204 EBS [Type] 30**
^{99}Tc	80	$\beta.s^{-1}$	≤ 1.5%	80 Bq • 0.002 µCi	**Tc99 EBS [Type] 20**
	3000	$\beta.s^{-1}$	≤ 1.5%	3000 Bq • 0.08 µCi	**Tc99 EBS [Type] 30**

Standard manufacturing tolerance: ± 30%
IAEA Category: 5 • ISO2919 Classification: C11111
*Scope N°2-6386 available at www.cofrac.fr or upon request.

How to compose reference:
Replace **[Type]** with the letter **A**, **B**, or **C** according to the required geometry.
For example: **Tl204 EBS A 30**

Kits Available

EBS A and EBS B sources are also available in kit form. Radionuclides supplied are ^{147}Pm, ^{134}Cs, ^{137}Cs, ^{90}Sr+^{90}Y, ^{204}Tl and ^{22}Na with an activity of 0.002 µCi (80 Bq) or 0.08 µCi (3000 Bq). Other activities of EBS sources are available on request.

ESA wide area α and β sources • Discs

Technical Information

The radionuclides are deposited on a 0.01 in (0.3 mm) thick aluminum substrate (anodized surface), fixed on a stainless steel support of thickness 0.1 in (2.6 mm) ensuring the rigidity of the assembly.

The radiological characteristics (emergent flux) of the sources are measured with a calibrated absolute proportional 2π sr counter.

NOTE: The size of a calibration source should suit the size of the detector to be controlled or calibrated. It is recommended **NOT** to use wide area sources to control detectors of a significantly different size from the detector itself. LEA does not provide any guarantee on results for other uses than those recommended.

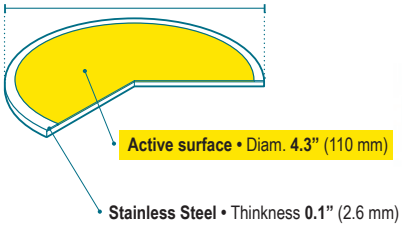
Production Range

	Catalog References	Custom/On Request
Active Diameter		
α & β	15 mm • 0.6 in	From 15 to 160 mm From 0.6 to 6.3 in
	36 mm • 1.4 in	
	44 mm • 1.7 in	
	110 mm • 4.3 in	
External Diameter		
α & β	30 mm • 1.2 in	From 20 to 170 mm From 0.8 to 6.7 in
	47 mm • 1.9 in	
	50 mm • 2 in	
	120 mm • 4.7 in	
Activity		
α	400 Bq • 0.01 µCi	From 100 to 2000 Bq From 0.003 to 0.05 µCi
β	4000 Bq • 0.11 µCi	From 500 to 8000 Bq From 0.014 to 0.22 µCi
Radionuclide		
α	^{241}Am	
β	^{14}C, ^{60}Co, ^{90}Sr, ^{137}Cs, ^{147}Pm	^{32}P, ^{35}S, ^{89}Sr, ^{129}I

Standard geometries

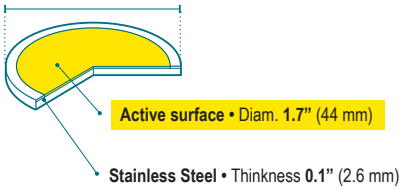
Type K

Overall diameter 4.7" (120mm)



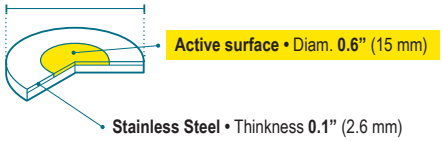
Type L

Overall diameter 2" (50mm)



Type M

Overall diameter 1" (30mm)



Type N

Overall diameter 1.9" (47mm)

Reference/Product No.

	Radionuclide	2π sr alpha flux 2π sr beta flux		k=2 measurement uncertainty	Equivalent activity	Reference
		Under COFRAC* accreditation				
α	^{241}Am	200	$\alpha.s^{-1}$	≤ 6%	400 Bq • 0.01 µCi	**Am241 ESA [Type] 20**
β	^{14}C	1500	$\beta.s^{-1}$	≤ 6%	4000 Bq • 0.11 µCi	**C14 ESA [Type] 20**
	^{60}Co	1900	$\beta.s^{-1}$	≤ 6%	4000 Bq • 0.11 µCi	**Co60 ESA [Type] 20**
	^{137}Cs	2400	$\beta.s^{-1}$	≤ 6%	4000 Bq • 0.11 µCi	**Cs137 ESA [Type] 20**
	^{147}Pm	1900	$\beta.s^{-1}$	≤ 6%	4000 Bq • 0.11 µCi	**Pm147 ESA [Type] 20**
	^{90}Sr + ^{90}Y	2500	$\beta.s^{-1}$	≤ 6%	4000 Bq • 0.11 µCi	**Sr90 ESA [Type] 20**

Standard manufacturing tolerance: ± 30%

IAEA Category: 5 • ISO2919 Classification: C11111

*Scope N°2-6386 available at www.cofrac.fr or upon request.

How to compose reference:
Replace **[Type]** with the letter **K**, **L**, **M** or **N** according to the required geometry.
For example: **Sr90 ESA K 20**

ESA wide area α and β sources • Planchets

Technical Information

The radionuclides are deposited on a 0.01 in (0.3 mm) thick aluminum substrate (anodized surface), fixed on a stainless steel support of thickness 0.1 in (2.6 mm) ensuring the rigidity of the assembly.

The radiological characteristics (emergent flux) of the sources are measured with a calibrated absolute proportional 2π sr counter.

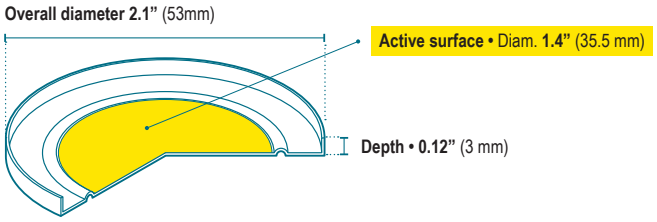
NOTE: The size of a calibration source should suit the size of the detector to be controlled or calibrated. It is recommended **NOT** to use wide area sources to control detectors of a significantly different size from the detector itself. LEA does not provide any guarantee on results for other uses than those recommended.

Production Range

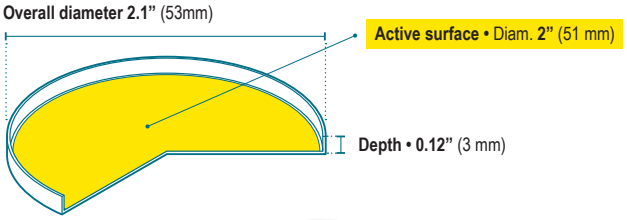
	Catalog References	Custom/On Request
Active Diameter		
α & β	35.5 mm • 1.4 in	From 15 to 160 mm From 0.6 to 6.3 in
	51 mm • 2 in	
External Diameter		
α & β	53 mm • 2.1 in	From 20 to 170 mm From 0.8 to 6.7 in
Activity		
α	400 Bq • 0.01 µCi	From 100 to 2000 Bq From 0.003 to 0.05 µCi
β	4000 Bq • 0.11 µCi	From 500 to 8000 Bq From 0.014 to 0.22 µCi
Radionuclide		
α	^{241}Am	
β	^{14}C, ^{60}Co, ^{90}Sr, ^{137}Cs, ^{147}Pm	^{32}P, ^{35}S, ^{89}Sr, ^{129}I

Standard geometries

Type I



Type J



Reference/Product No.

	Radionuclide	2π sr alpha flux 2π sr beta flux		k=2 measurement uncertainty	Equivalent activity	Reference
		Under COFRAC* accreditation				
α	^{241}Am	200	$\alpha.s^{-1}$	≤ 6%	400 Bq • 0.01 µCi	**Am241 ESA [Type] 20**
β	^{14}C	1500	$\beta.s^{-1}$	≤ 6%	4000 Bq • 0.11 µCi	**C14 ESA [Type] 20**
	^{60}Co	1900	$\beta.s^{-1}$	≤ 6%	4000 Bq • 0.11 µCi	**Co60 ESA [Type] 20**
	^{137}Cs	2400	$\beta.s^{-1}$	≤ 6%	4000 Bq • 0.11 µCi	**Cs137 ESA [Type] 20**
	^{147}Pm	1900	$\beta.s^{-1}$	≤ 6%	4000 Bq • 0.11 µCi	**Pm147 ESA [Type] 20**
	^{90}Sr + ^{90}Y	2500	$\beta.s^{-1}$	≤ 6%	4000 Bq • 0.11 µCi	**Sr90 ESA [Type] 20**

Standard manufacturing tolerance: ± 30%

IAEA Category: 5 • ISO2919 Classification: C11111

*Scope N°2-6386 available at www.cofrac.fr or upon request.

How to compose reference:
Replace **[Type]** with the letter **I** or **J** according to the required geometry.
For example: **Sr90 ESA J 20**

ESA wide area α and β sources • Rectangular and Square

Technical Information

The radionuclides are deposited on a 0.01 in (0.3 mm) thick aluminum substrate (anodized surface), fixed on a stainless steel support of thickness 0.1 in (3 mm) ensuring the rigidity of the assembly.

The radiological characteristics (emergent flux) of the sources are measured with a calibrated absolute proportional 2π sr counter.

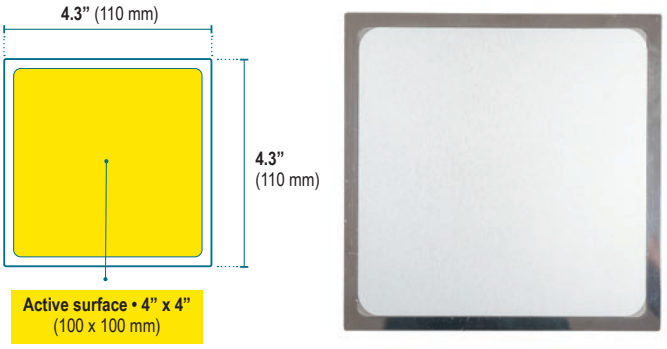
NOTE: The size of a calibration source should suit the size of the detector to be controlled or calibrated. It is recommended **NOT** to use wide area sources to control detectors of a significantly different size from the detector itself. LEA does not provide any guarantee on results for other uses than those recommended.

Production Range

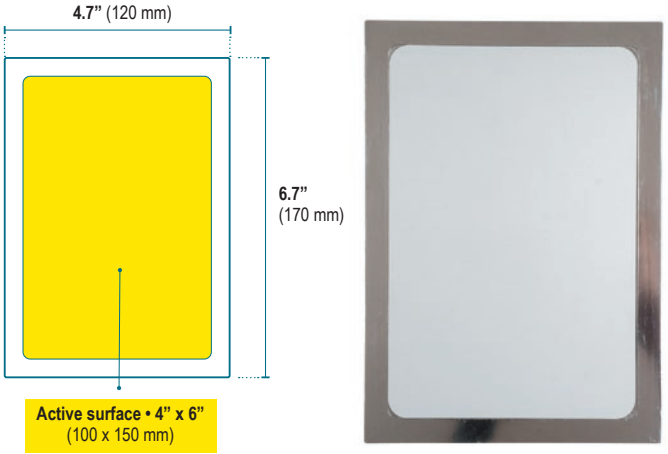
	Catalog References	Custom/On Request
Active Diameter		
α & β	100 x 100 mm 4 x 4 in	From 20 x 20 mm to 150 x 150 mm From 0.8 to 0.8 in to 6 x 6 in
	100 x 150 mm 4 x 6 in	
External Diameter		
α & β	110 x 110 mm 4.3 x 4.3 in	From 26 x 26 mm to 170 x 170 mm From 1 to 1 in to 6.7 x 6.7 in
	120 x 170 mm 4.7 x 6.7 in	
Activity		
α	400 Bq • 0.01 µCi	From 100 to 2000 Bq From 0.003 to 0.05 µCi
β	4000 Bq • 0.11 µCi	From 500 to 8000 Bq From 0.014 to 0.22 µCi
Radionuclide		
α	^{241}Am	
β	^{14}C, ^{60}Co, ^{90}Sr, ^{137}Cs, ^{147}Pm	^{32}P, ^{35}S, ^{63}Ni, ^{89}Sr, ^{99}Tc, ^{129}I

Standard geometries

Type E



Type F



Reference/Product No.

	Radionuclide	2π sr alpha flux 2π sr beta flux		k=2 measurement uncertainty	Equivalent activity	Reference
		Under COFRAC* accreditation				
α	^{241}Am	200	$\alpha.s^{-1}$	≤ 6%	400 Bq • 0.01 µCi	**Am241 ESA [Type] 20**
β	^{14}C	1500	$\beta.s^{-1}$	≤ 6%	4000 Bq • 0.11 µCi	**C14 ESA [Type] 20**
	^{60}Co	1900	$\beta.s^{-1}$	≤ 6%	4000 Bq • 0.11 µCi	**Co60 ESA [Type] 20**
	^{137}Cs	2400	$\beta.s^{-1}$	≤ 6%	4000 Bq • 0.11 µCi	**Cs137 ESA [Type] 20**
	^{147}Pm	1900	$\beta.s^{-1}$	≤ 6%	4000 Bq • 0.11 µCi	**Pm147 ESA [Type] 20**
	^{90}Sr + ^{90}Y	2500	$\beta.s^{-1}$	≤ 6%	4000 Bq • 0.11 µCi	**Sr90 ESA [Type] 20**

Standard manufacturing tolerance: ± 30%
IAEA Category: 5 • ISO2919 Classification: C11111
*Scope N°2-6386 available at www.cofrac.fr or upon request.

How to compose reference:
Replace **[Type]** with the letter **E** or **F** according to the required geometry.
For example: **Sr90 ESA E 20**

x and γ solid sources

EDC γ sources in charcoal filter cartridges

Technical Information

Our active charcoal can be impregnated in two ways:

- Surface impregnation, a radioactive disk is placed in contact with one of the inside surfaces of the housing to simulate surface contamination (E geometry)
- Pore volume impregnation, the activated charcoal is homogeneously impregnated (D geometry)

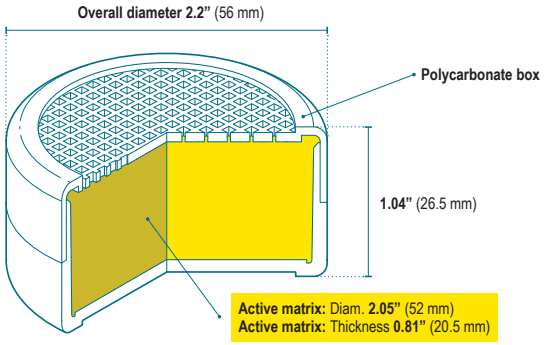
Source activity is measured with calibrated NaI scintillators or HPGe semi-conductors.

Production Range

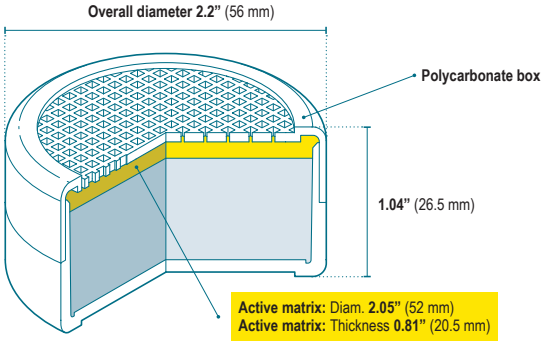
Catalog References	Custom/On Request
Container	
Cartridge of useful volume 2.68 in^3	From 3 to 50 mm From 0.12 to 2 in
Activity	
4 kBq • 0.1 µCi	From 1 to 1000 kBq From 0.03 to 27 µCi
Radionuclide	
^{133}Ba, ^{137}Cs, ^{152}Eu Mix 12ML01	^{51}Cr, ^{54}Mn, ^{57}Co, ^{60}Co, ^{65}Zn, ^{85}Sr, ^{88}Y, ^{109}Cd, ^{113}Sn, ^{134}Cs, ^{139}Ce, ^{241}Am(Non-exhaustive list)

Standard geometries

Type D



Type E



Reference/Product No.

Radionuclide	Activity	k=2 measurement uncertainty	Reference
^{133}Ba	4 kBq • 0.11 µCi	≤ 5%	**Ba133 EDC D 10**
	4 kBq • 0.11 µCi	≤ 5%	**Ba133 EDC E 10**
^{137}Cs	4 kBq • 0.11 µCi	≤ 7%	**Cs137 EDC D 10**
	4 kBq • 0.11 µCi	≤ 8%	**Cs137 EDC E 10**
^{152}Eu	4 kBq • 0.11 µCi	≤ 5%	**Eu152 EDC D 10**
	4 kBq • 0.11 µCi	≤ 5%	**Eu152 EDC E 10**
12ML01*	18.5 kBq • 0.5 µCi	[6% ; 8%]	**12ML01 EDC D 11**
	18.5 kBq • 0.5 µCi	[6% ; 8%]	**12ML01 EDC E 11**

Standard manufacturing tolerance: ± 30% | IAEA Category: 5 | ISO2919 Classification: C11111

* The 12ML01 mixture – ^{241}Am, ^{109}Cd, ^{139}Ce, ^{57}Co, ^{60}Co, ^{51}Cr, ^{137}Cs, ^{113}Sn, ^{54}Mn, ^{65}Zn, ^{85}Sr, ^{88}Y – generates around 15 peaks over an energy range from 60 keV to 1836 keV. The quantity of each radionuclide is chosen so that the counting rates of the main peak of each radionuclide are the same order of magnitude. See appendices for additional information on the 12ML01 mixture and on the other mixes available. Other geometries are available on request.

EGS point γ sources

Technical Information

Radionuclides are placed between 2 hot-sealed polyester foils approximately 125 µm thick each, then mounted in a plexiglass ring.

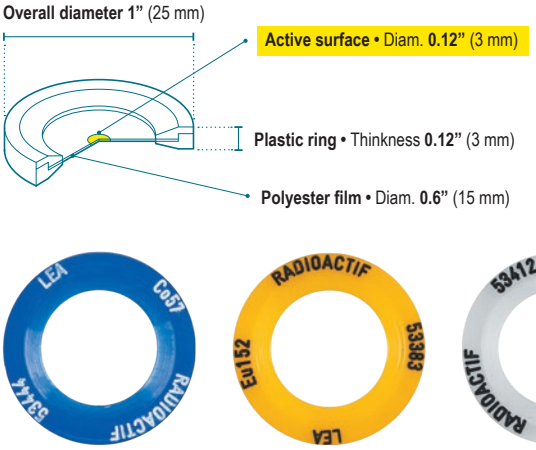
The radiological characteristics of the sources are measured with calibrated NaI scintillators or HPGe semi-conductors.

Production Range

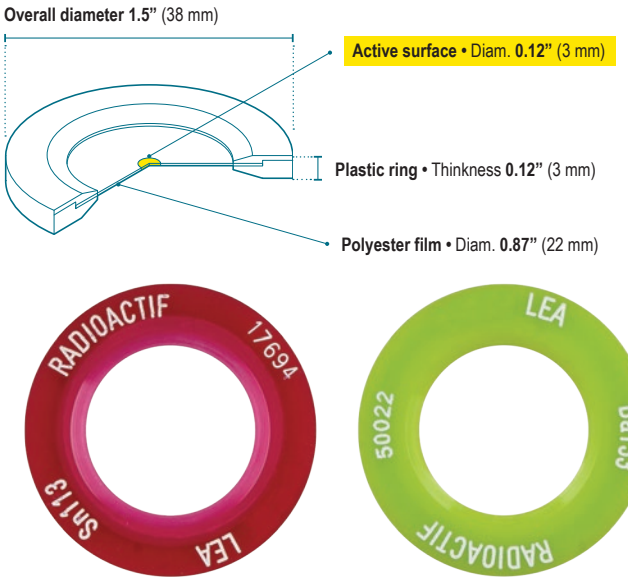
Catalog References	Custom/On Request
Active Diameter	
3 mm • 0.12 in	From 3 to 50 mm From 0.12 to 2 in
External Diameter	
25 mm • 1 in	From 25 to 75 mm From 1 to 3 in
38 mm • 1.5 in	
Activity	
4 kBq • 0.1 µCi	From 2 to 1000 kBq From 0.05 to 27 µCi
40 kBq • 1.1 µCi	
400 kBq • 11 µCi	
700 kBq • 19 µCi	
Radionuclide	
^{22}Na, ^{57}Co, ^{60}Co, ^{88}Y, ^{133}Ba, ^{137}Cs, ^{152}Eu, ^{241}Am	^{110m}Ag, ^{139}Ce, ^{51}Cr, ^{134}Cs, ^{59}Fe, ^{131}I, ^{54}Mn, ^{113}Sn (Non-exhaustive list)

Standard geometries

Type A



Type E



For A and E types, the distance between the active part and the height of the ring is 0.08 in.

Kits Available

EGS A sources are also available in kits containing 9 sources of 0.11µCi (4kBq), 1.1µCi (40kBq), 11µCi (400kBq), 19µCi (700kBq) : ^{241}Am, ^{57}Co, ^{60}Co, ^{51}Cr, ^{137}Cs, ^{54}Mn, ^{22}Na, ^{85}Sr, ^{88}Y. Other activities are available on request.

**Due to the short half life of Cr51, Mn54, and Sr85, these sources are only available twice per year in April and November. Orders must be placed no later than February 28 and October 31 in order to receive these sources by these months. Alternatively, those radionuclides may be substituted for others to be available anytime.

Reference/Product No.

Radionuclide	Activity	k=2 measurement uncertainty	Reference
	Under COFRAC* accreditation		
^{241}Am	4000 Bq • 0.11 µCi	≤ 3.5%	**Am241 EGS [Type] 10**
	40000 Bq • 1.1 µCi	≤ 3.5%	**Am241 EGS [Type] 15**
^{133}Ba	4000 Bq • 0.11 µCi	≤ 2%	**Ba133 EGS [Type] 10**
	40000 Bq • 1.1 µCi	≤ 2%	**Ba133 EGS [Type] 15**
	400000 Bq • 11 µCi	≤ 2%	**Ba133 EGS [Type] 20**
^{57}Co	4000 Bq • 0.11 µCi	≤ 2%	**Co57 EGS [Type] 10**
	40000 Bq • 1.1 µCi	≤ 1.7%	**Co57 EGS [Type] 15**
	400000 Bq • 11 µCi	≤ 1.7%	**Co57 EGS [Type] 20**
^{60}Co	4000 Bq • 0.11 µCi	≤ 2%	**Co60 EGS [Type] 10**
	40000 Bq • 1.1 µCi	≤ 1.5%	**Co60 EGS [Type] 15**
	400000 Bq • 11 µCi	≤ 1.5%	**Co60 EGS [Type] 20**
^{51}Cr	4000 Bq • 0.11 µCi	≤ 3.5%	**Cr51 EGS [Type] 10**
	40000 Bq • 1.1 µCi	≤ 2%	**Cr51 EGS [Type] 15**
	400000 Bq • 11 µCi	≤ 2%	**Cr51 EGS [Type] 20**
^{137}Cs	4000 Bq • 0.11 µCi	≤ 2.5%	**Cs137 EGS [Type] 10**
	40000 Bq • 1.1 µCi	≤ 2%	**Cs137 EGS [Type] 15**
	400000 Bq • 11 µCi	≤ 2%	**Cs137 EGS [Type] 20**
^{152}Eu	4000 Bq • 0.11 µCi	≤ 3%	**Eu152 EGS [Type] 10**
	40000 Bq • 1.1 µCi	≤ 3%	**Eu152 EGS [Type] 15**
^{54}Mn	4000 Bq • 0.11 µCi	≤ 2%	**Mn54 EGS [Type] 10**
	40000 Bq • 1.1 µCi	≤ 2%	**Mn54 EGS [Type] 15**
	400000 Bq • 11 µCi	≤ 2%	**Mn54 EGS [Type] 20**
^{22}Na	4000 Bq • 0.11 µCi	≤ 2%	**Na22 EGS [Type] 10**
	40000 Bq • 1.1 µCi	≤ 2%	**Na22 EGS [Type] 15**
	400000 Bq • 11 µCi	≤ 2%	**Na22 EGS [Type] 20**
^{85}Sr	4000 Bq • 0.11 µCi	≤ 2%	**Sr85 EGS [Type] 10**
	40000 Bq • 1.1 µCi	≤ 2%	**Sr85 EGS [Type] 15**
	400000 Bq • 11 µCi	≤ 2%	**Sr85 EGS [Type] 20**
^{88}Y	4000 Bq • 0.11 µCi	≤ 2%	**Y88 EGS [Type] 10**
	40000 Bq • 1.1 µCi	≤ 2%	**Y88 EGS [Type] 15**
	400000 Bq • 11 µCi	≤ 2%	**Y88 EGS [Type] 20**
12ML01**	30000 Bq • 0.8 µCi	[3%, 6%]	**12ML01 EGS [Type] 15**

How to compose reference:
Replace **[Type]** with the letter **A** or **E** according to the required geometry.
For example:
Am241 EGS A 20

Standard manufacturing tolerance: ± 30%

IAEA Category: 5

ISO2919 Classification: C11111

*Scope N°2-6386 available at www.cofrac.fr or upon request.

** The 12ML01 mixture – 241Am, 109Cd,139Ce, 57Co, 60Co, 51Cr, 137Cs, 113Sn, 54Mn, 65Zn, 85Sr, 88Y – generates around 15 peaks over an energy range from 60 keV to 1836 keV. The quantity of each radionuclide is chosen so that the counting rates of the main peak of each radionuclide are the same order of magnitude. Other geometries are available on request.

Due to the short half life of several contained radionuclides in the 12ML01 mixture, it is only available twice per year in April and November. Orders must be placed at least one month prior to receive this mixed source by these production months.

See appendices for additional information on the 12ML01 mixture and on the other mixes available.

EGS point γ sources

Technical Information

Radionuclides are deposited in the cavity of a rigid and leak-tight plexiglass cylinder. The cavity is sealed with a plexiglass cap.

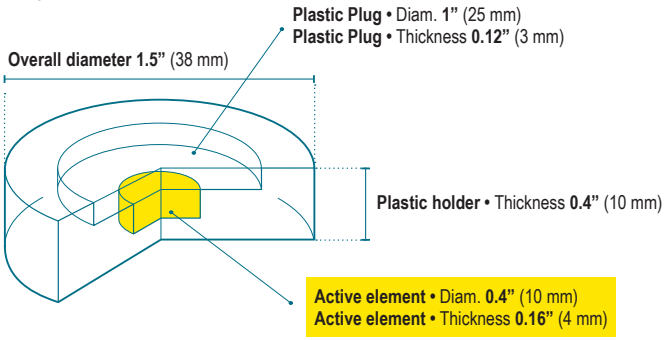
The radiological characteristics of the sources are measured with calibrated NaI scintillators, HPGe semi-conductors or ionization chambers.

Production Range

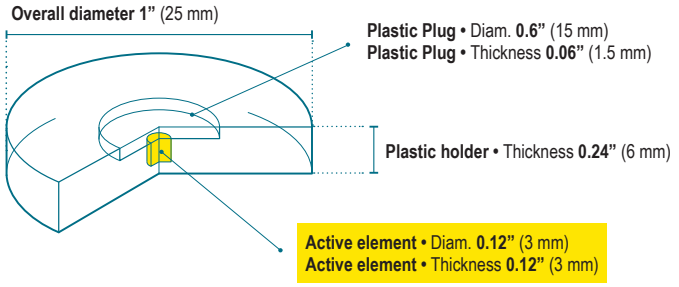
Catalog References	Custom/On Request
Active Diameter	
3 mm • 0.12 in	From 3 to 50 mm From 0.12 to 2 in
10 mm • 0.4 in	
External Diameter	
38 mm • 1.5 in	From 25 to 75 mm From 1 to 3 in
Activity	
4 kBq • 0.1 µCi	From 2 to 40000 kBq From 0.05 to 10 MBq
40 kBq • 1.1 µCi	
400 kBq • 11 µCi	
1500 kBq • 41 µCi	
3500 kBq • 95 µCi	
Radionuclide	
^{60}Co, ^{133}Ba, ^{137}Cs, ^{152}Eu, ^{241}Am	^{110m}Ag, ^{139}Ce, ^{51}Cr, ^{134}Cs, ^{59}Fe, ^{131}I, ^{54}Mn, ^{113}Sn (Non-exhaustive list)

Standard geometries

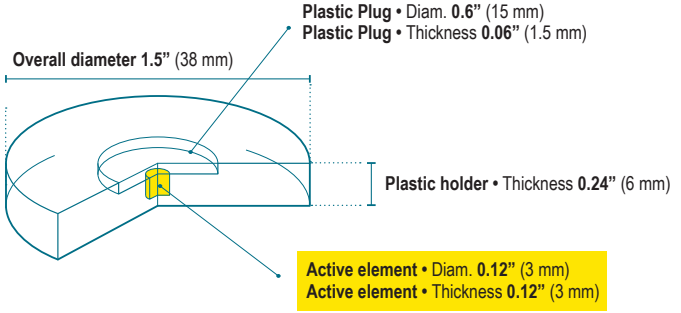
Type B



Type H



Type V



Reference/Product No.

Radionuclide	Activity	k=2 measurement uncertainty	Reference
^{241}Am	4 kBq • 0.11 µCi	≤ 5%*	**Am241 EGS [Type] 10**
	40 kBq • 1.1 µCi	≤ 5%*	**Am241 EGS [Type] 15**
	400 kBq • 11 µCi	≤ 5%*	**Am241 EGS [Type] 20**
^{133}Ba	4 kBq • 0.11 µCi	≤ 5%*	**Ba133 EGS [Type] 10**
	40 kBq • 1.1 µCi	≤ 5%*	**Ba133 EGS [Type] 15**
	400 kBq • 11 µCi	≤ 5%*	**Ba133 EGS [Type] 20**
	1500 kBq • 41 µCi	≤ 5%*	**Ba133 EGS [Type] 30**
	3500 kBq • 95 µCi	≤ 5%*	**Ba133 EGS B 40*** **
^{57}Co	4 kBq • 0.11 µCi	≤ 5%*	**Co57 EGS [Type] 10**
	40 kBq • 1.1 µCi	≤ 5%*	**Co57 EGS [Type] 15**
	400 kBq • 11 µCi	≤ 5%*	**Co57 EGS [Type] 20**
	1500 kBq • 41 µCi	≤ 5%*	**Co57 EGS [Type] 30**
	3500 kBq • 95 µCi	≤ 5%*	**Co57 EGS [Type] 40**
^{60}Co	4 kBq • 0.11 µCi	≤ 5%*	**Co60 EGS [Type] 10**
	40 kBq • 1.1 µCi	≤ 5%*	**Co60 EGS [Type] 15**
	400 kBq • 11 µCi	≤ 5%*	**Co60 EGS [Type] 20**
	1500 kBq • 41 µCi	≤ 5%*	**Co60 EGS [Type] 30**
	3500 kBq • 95 µCi	≤ 5%*	**Co60 EGS B 40*** **
^{137}Cs	4 kBq • 0.11 µCi	≤ 5%*	**Cs137 EGS [Type] 10**
	40 kBq • 1.1 µCi	≤ 5%*	**Cs137 EGS [Type] 15**
	400 kBq • 11 µCi	≤ 5%*	**Cs137 EGS [Type] 20**
	1500 kBq • 41 µCi	≤ 5%*	**Cs137 EGS [Type] 30**
	3500 kBq • 95 µCi	≤ 5%*	**Cs137 EGS B 40*** **
^{152}Eu	4 kBq • 0.11 µCi	≤ 5%*	**Eu152 EGS [Type] 10**
	40 kBq • 1.1 µCi	≤ 5%*	**Eu152 EGS [Type] 15**
	400 kBq • 11 µCi	≤ 5%*	**Eu152 EGS [Type] 20**
	1500 kBq • 41 µCi	≤ 5%*	**Eu152 EGS [Type] 30**
	3500 kBq • 95 µCi	≤ 5%*	**Eu152 EGS B 40*** **

How to compose reference:
Replace **[Type]** with the letter **B**, **V** or **H** according to the required geometry.
For example:
Cs137 EGS B 40

Standard manufacturing tolerance: ± 30%

IAEA Category: 5

ISO2919 Classification: C22212

* The calibration of sources can be performed on request, according to COFRAC** accredited protocols. The measurement uncertainties at k=2 are lower than or equal to 3%.

**Scope N°2-6386 available at www.cofrac.fr or upon request.

*** Only available in type B geometry.

EXS point X sources

Technical Information

Radionuclides are placed between 2 hot-sealed polyester foils approximatly 75 µm thick each, then mounted in a plexiglass ring.

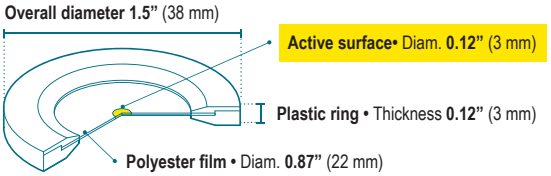
The radiological characteristics of the sources are measured with calibrated NaI scintillators or HPGe semi-conductors.

Production Range

Catalog References	Custom/On Request
Active Diameter	
3 mm • 0.12 in	From 3 to 50 mm From 0.12 to 2 in
External Diameter	
38 mm • 1.5 in	From 25 to 75 mm From 1 to 3 in
4π sr flux	
16000 X.s-1	From 1000 X.s-1 to 400000 X.s-1
Radionuclide	
^{55}Fe, ^{109}Cd	^{65}Zn, ^{85}Sr

Standard geometries

Type B



The distance between the active part and the height of the ring is 0.8 in.

Reference/Product No.

Radionuclide	4π sr X flux	k=2 measurement uncertainty	Equivalent activity	Reference
	Under COFRAC* accreditation			
^{109}Cd	16000 X.s^{-1}	≤ 5%	15700 Bq • 0.42 µCi	**Cd109 EXS B 10**
^{55}Fe	16000 X.s^{-1}	≤ 5%	15700 Bq • 0.42 µCi	**Fe55 EXS B 10**

Standard manufacturing tolerance: ± 30%

IAEA Category: 5 • ISO2919 Classification: C11111

*Scope N°2-6386 available at www.cofrac.fr or upon request.

EGE γ sources in vegetable matrix

Technical Information

Our vegetable matrix is made with dry and crushed plants. Radionuclides are mixed in the volume of the matrix.

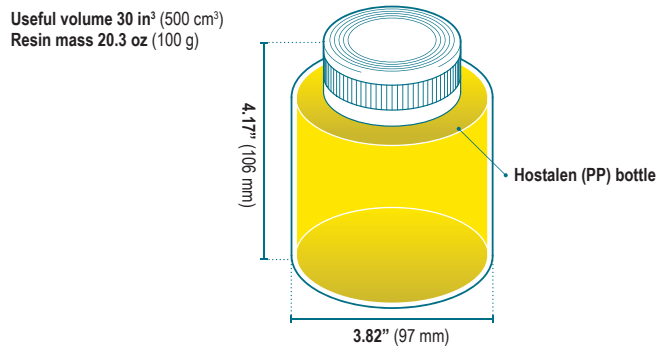
The whole is put in a standard container or in a container adapted to your needs. Source activity is measured with NaI scintillators or HPGe semi-conductors.

Production Range

Catalog References	Custom/On Request
Activity	
1 kBq • 0.03 µCi	From 1 to 1000 kBq From 0.03 to 27 µCi
Radionuclide	
Mix 12ML01	^{241}Am, ^{109}Cd, ^{139}Ce, ^{57}Co, ^{60}Co, ^{51}Cr, ^{137}Cs, ^{113}Sn, ^{54}Mn, ^{22}Na, ^{85}Sr, ^{88}Y (Non-Exhaustive list)

Standard geometries

SG500N Type V



Reference/Product No.

Radionuclide	Activity	k=2 measurement uncertainty		Reference
12ML01*	1 kBq • 0.03 µCi	[8% ; 8.5%]	15700 Bq • 0.42 µCi	**12ML01 EGE V 1KBQ**

Standard manufacturing tolerance: ± 30%. IAEA Category: 5 • ISO2919 Classification: C11111

* The 12ML01 mixture – ^{241}Am, ^{109}Cd, ^{139}Ce, ^{57}Co, ^{60}Co, ^{51}Cr, ^{137}Cs, ^{113}Sn, ^{54}Mn, ^{65}Zn, ^{85}Sr, ^{88}Y – generates around 15 peaks over an energy range from 60 keV to 1836 keV. The quantity of each radionuclide is chosen so that the counting rates of the main peak of each radionuclide are the same order of magnitude. See appendices for additional information on the 12ML01 mixture and on the other mixes available. Other geometries are available on request.

EGR γ sources in resin matrix

Technical Information

Radionuclides are incorporated into a thermosetting resin, which is then poured into container.

Our resin sources are sealed sources and are characterized by water equivalent activity, to avoid risks and constraints associated with liquid sources. The radiological characteristics of the sources are measured with calibrated NaI scintillators or HPGe semi-conductors.

Production Range

Catalog References	Custom/On Request
Container	
15 ml	Any type of container with a volume between 10 ml and 3000 ml.
50 ml	
250 ml	
450 ml	
500 ml	
1000 ml	
3000 ml	
Activity	
5 kBq • 0.14 µCi	From 100 Bq to 1 MBq From 0.003 to 27 µCi
18 kBq • 0.5 µCi	
37 kBq • 1 µCi	
55 kBq • 1.5 µCi	
74 kBq • 2 µCi	
Radionuclide	
^{133}Ba, ^{137}Cs, ^{152}Eu Mix 12ML01	^{51}Cr, ^{54}Mn, ^{57}Co, ^{60}Co, ^{65}Zn, ^{85}Sr, ^{88}Y, ^{109}Cd, ^{113}Sn, ^{134}Cs, ^{137}Cs, ^{139}Ce, ^{241}Am (Non-exhaustive list)

Reference/Product No.

Radionuclide	Water equivalent activity	k=2 measurement uncertainty	Reference
	Under COFRAC* accreditation		
^{152}Eu	37000 Bq • 1 µCi	≤ 5%	**Eu152 EGR [Type] 15**
^{133}Ba	37000 Bq • 1 µCi	≤ 5%	**Ba133 EGR [Type] 15**
^{137}Cs	37000 Bq • 1 µCi	≤ 5%	**Cs137 EGR [Type] 15**
12ML01**	5000 Bq • 0.14 µCi	[3% ; 6%]	**12ML01 EGR [Type] 05**
	18000 Bq • 0.5 µCi	[3% ; 6%]	**12ML01 EGR [Type] 10**
	37000 Bq • 1 µCi	[3% ; 6%]	**12ML01 EGR [Type] 15**
	55000 Bq • 1.5 µCi	[3% ; 6%]	**12ML01 EGR [Type] 20**
	74000 Bq • 2 µCi	[3% ; 6%]	**12ML01 EGR [Type] 30**

How to compose reference:
Replace **[Type]** with the letter **E**, **F**, **G**, **H**, **I**, **K**, **L**, **M** or **R** according to the required geometry.
For example:
Ba133 EGR E 15

Standard manufacturing tolerance: ± 30% | IAEA Category: 5 • ISO2919 | Classification: C11111

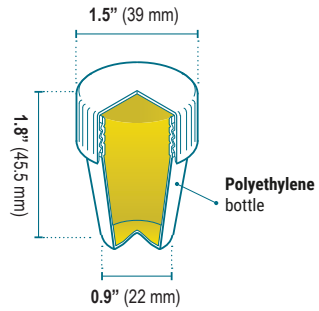
*Scope N°2-6386 available at www.cofrac.fr or upon request.

** The 12ML01 mixture – ^{241}Am, ^{109}Cd, ^{139}Ce, ^{57}Co, ^{60}Co, ^{51}Cr, ^{137}Cs, ^{113}Sn, ^{54}Mn, Zn, ^{85}Sr, ^{88}Y – generates around 15 peaks over an energy range from 60 keV to 1836 keV. The quantity of each radionuclide is chosen so that the counting rates of the main peak of each radionuclide are the same order of magnitude. See appendices for additional information on the 12ML01 mixture and on the other mixes available. Other geometries are available on request.

Standard Geometries

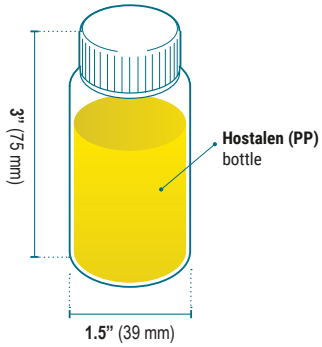
Type R *SG15*

Useful volume 0.92 in³ (15 cm³)



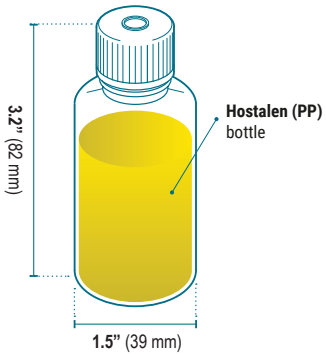
Type E *SG50*

Useful volume 3.1 in³ (50 cm³)



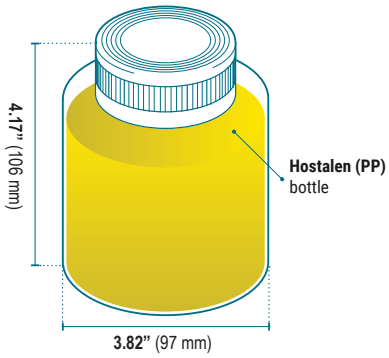
Type F

Useful volume 3.1 in³ (50 cm³)



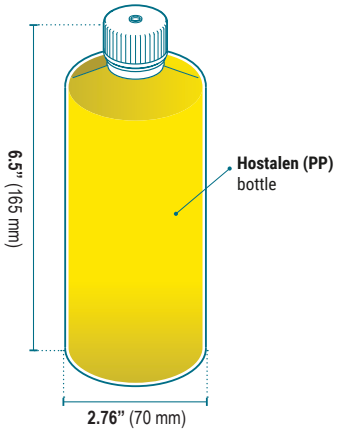
Type H *SG500*

Useful volume 30 in³ (500 cm³)



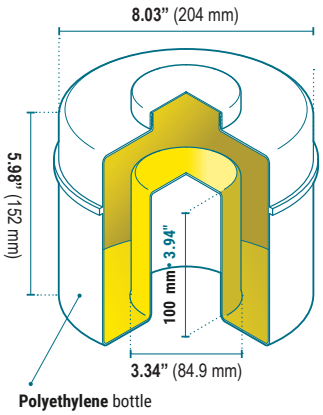
Type G

Useful volume 30 in³ (500 cm³)



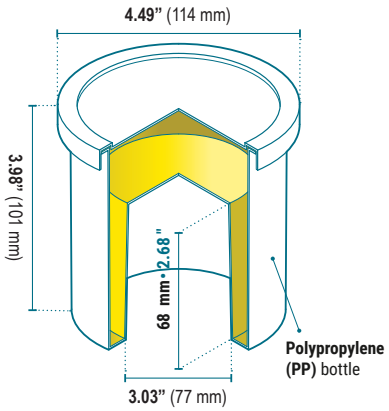
Type L *SG3000*

Useful volume 183 in³ (3000 cm³)
Resin mass 121.7 oz (3450 g)



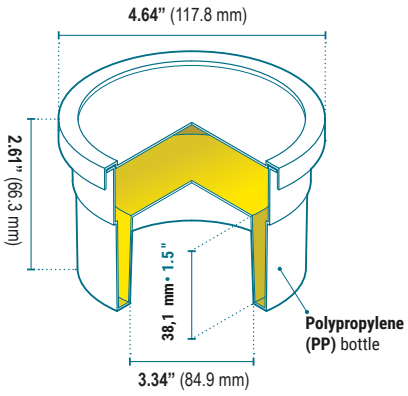
Type I *Marinelli*

Useful volume 27 in³ (450 cm³)
Resin mass 18.3 oz (518 g)



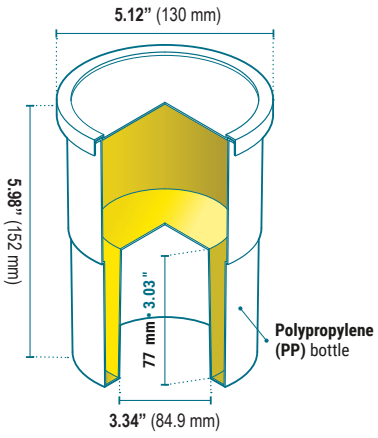
Type M *Marinelli*

Useful volume 15 in³ (250 cm³)
Resin mass 10.1 oz (287 g)



Type K *Marinelli*

Useful volume 61 in³ (1000 cm³)
Resin mass 40.6 oz (1150 g)



ESB γ sources in paper matrix

Technical Information

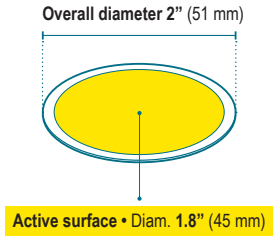
Radionuclides are deposited on a filter paper, which is then hot-sealed between two thin polyester foils. Source activity is measured with NaI scintillators or HPGe semi-conductors.

Production Range

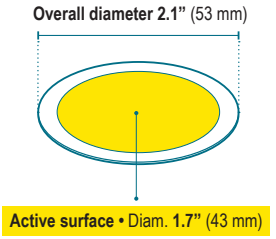
Catalog References	Custom/On Request
Active Diameter	
43 mm • 1.7 in	From 15 to 160 mm From 0.6 to 6.3 in
45 mm • 1.8 in	
47 mm • 1.9 in	
50 mm • 2 in	
53 mm • 2.1 in	
60 mm • 2.4 in	
120 mm • 4.7 in	
External Diameter	
51 mm • 2.01 in	From 20 to 170 mm From 0.8 to 6.7 in
53 mm • 2.1 in	
60 mm • 2.4 in	
63 mm • 2.5 in	
70 mm • 2.8 in	
130 mm • 5.1 in	
Activity	
10000 Bq • 0.3 µCi	From 1 kBg to 1 MBq From 0.03 to 27 µCi
20000 Bq • 0.5 µCi	
40000 Bq • 1.1 µCi	
Radionuclide	
12ML01*	^{51}Cr, ^{54}Mn, ^{57}Co, ^{60}Co, ^{65}Zn, ^{85}Sr, ^{88}Y, ^{109}Cd, ^{113}Sn, ^{134}Cs, ^{139}Ce, ^{241}Am(Non-exhaustive list)

Standard geometries

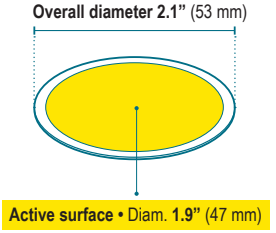
Type M45-51



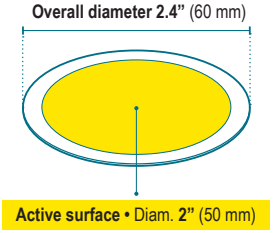
Type M43



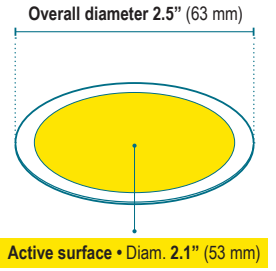
Type M47-53



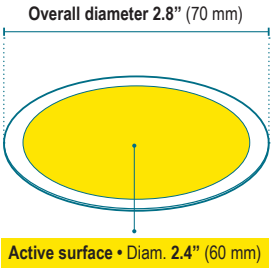
Type M50



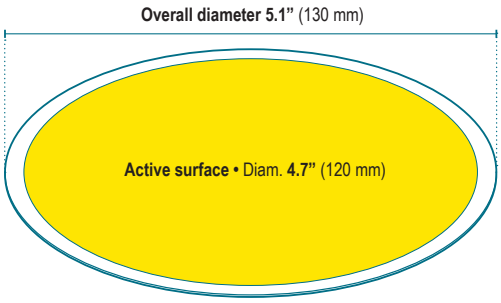
Type M53



Type M60



Type M120



Reference/Product No.

Radionuclide	Activity	k=2 measurement uncertainty	Reference
12ML01*	10000 Bq • 0.3 µCi	≤ 10%	**12ML01 ESB [Type] [10KBQ]**
	20000 Bq • 0.5 µCi	≤ 10%	**12ML01 ESB [Type] [20KBQ]**
	40000 Bq • 1.1 µCi	≤ 10%	**12ML01 ESB [Type] [40KBQ]**

Standard manufacturing tolerance: ± 30%
IAEA Category: 5
ISO2919 Classification: C11111

* The 12ML01 mixture – ^{241}Am, ^{109}Cd, ^{139}Ce, ^{57}Co, ^{60}Co, ^{51}Cr, ^{137}Cs, ^{113}Sn, ^{54}Mn, ^{65}Zn, ^{85}Sr, ^{88}Y – generates around 15 peaks over an energy range from 60 keV to 1836 keV. The quantity of each radionuclide is chosen so that the counting rates of the main peak of each radionuclide are the same order of magnitude. See appendices for additional information on the 12ML01 mixture and on the other mixes available.

How to compose reference:
Replace **[Type]** with the codes **M43**, **M50**, **M53**, **M60**, **M120**, **M45-51**, or **M47-53** according to the required geometry.

For example:
12ML01 ESB M47-53 [10KBQ]

liquid sources

Handling Precautions

Liquid sources are considered as unsealed sources.

PPE (goggles, gloves, overalls, lead protection as appropriate) must be worn. The use of accessories (tweezers, file, ampoule holder and ampoule breaker) is recommended to limit radiological exposure and to reduce the risk of contamination. During a dilution, the diluent used must have the same chemical composition and the same nonradioactive material concentration as the provided source (LEA provides on request the chemical carriers used for the manufacture of its sources).

ELS liquid sources

Technical Information

The specific activity of our liquid sources is characterized by means of NaI scintillators, HPGe semi-conductors or liquid scintillation analyzers.
They are calibrated under COFRAC* protocols. The measurement uncertainty varies between 1% and 8% depending on the radionuclide and the geometry.

Activities

The specific activity levels available as catalog reference are:

- 0. 001 µCi/g (0.04 kBq/g)
- 0.01 µCi/g (0.4 kBq/g)
- 1.1 µCi/g (40 kBq/g)
- 21.6 µCi/g (800 kBq/g)
- 261.2 µCi/g (8 000 kBq/g)

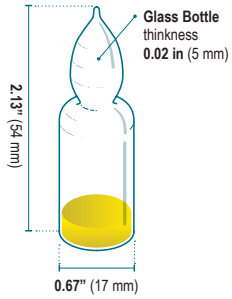
Standard geometries

- Ampoules
- V-Vial bottles
- Penicillin bottles
- Standardized bottles

Our liquid sources can be conditioned in other geometries offered in our catalog or provided by the customer.

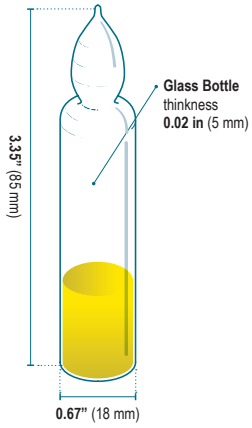
Type A *Ampoule*

Useful volume 0.06 in³ (1 cm³)



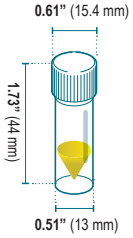
Type B *Ampoule*

Useful volume 0.31 in³ (5 cm³)



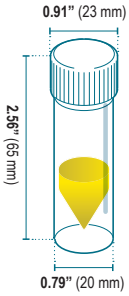
Type U *V-Vial*

Useful volume 0.06 in³ (1 cm³)



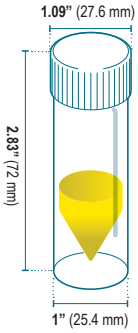
Type V *V-Vial*

Useful volume 0.31 in³ (5 cm³)



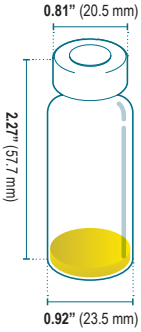
Type W *V-Vial*

Useful volume 0.61 in³ (10 cm³)



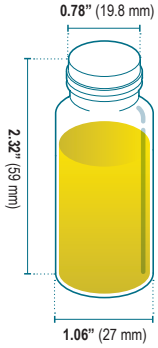
Type D *Penicillin*

Useful volume 0.06 in³ (1 cm³)



Type J *Penicillin*

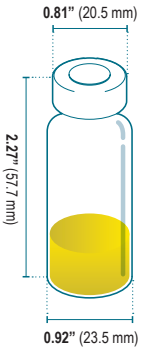
Useful volume 1.22 in³ (20 cm³)



*Maximum activity = 0.001 µCi/g

Type L *Penicillin*

Useful volume 0.31 in³ (5 cm³)



Reference/Product No. - ELS liquid sources

Geometries [Type]

- Ampoules..... **A** or **B**
- V-Vial..... **U**, **V** or **W**
- Penicillin ..... **D**, **J*** or **L**

Activity [Act]

- 0.001 µCi/g
- 0.01 µCi/g
- 1.1 µCi/g
- 21.6 µCi/g
- 261.2 µCi/g
- Other activity on request

How to compose reference:

Replace **[Type]** and **[Act]** with the letter and the value according to the required geometry and activity.

For example, a 5ml ampoule (Type B) containing 1.1 µCi/g (40 kBq/g) of ^{137}Cs is referenced as **Cs137 ELS B 40kBq/g**.

	Radionuclide	Chemical form	Carrier	Reference	Notes
α αγ	^{237}Np	HCL 6N ou HNO_3 3N	Oxalic acid [33µg/g]	**NP237 ELS [Type] [Act]**	Available geometries: A, B, U, V, W Max = 800 kBq/g
	^{241}Am	HNO_3 1N	$EuCl_3$ [10µg/g]	**Am241 ELS [Type] [Act]**	Available geometries: A, B, U, V, W Max = 800 kBq/g Max = 8000 kBq/g for Type A & B
β	^{3}H	H_2O	-	**H3 ELS [Type] [Act]**	Only available in A and B type Max = 800 kBq/g
	^{14}C	H_2O	D-glucose [50µg/g] Formaldehyde [1mg/g]	**C14 ELS [Type] [Act]**	Max = 800 kBq/g
	^{32}P	HCL 0,1N	Na_2HPO_4 [10µg/g]	**P32 ELS [Type] [Act]**	Max = 800 kBq/g
	^{35}S	HCL 0,1N	Na_2SO_4 [10µg/g]	**S35 ELS [Type] [Act]**	Max = 800 kBq/g
	^{36}Cl	H_2O	NaCl [10µg/g]	**Cl36 ELS [Type] [Act]**	Max = 800 kBq/g
	^{63}Ni	HCL 0,1N	$NiCl_2$ [10µg/g]	**Ni63 ELS [Type] [Act]**	Max = 800 kBq/g
	^{89}Sr	HCL 0,1N	$SrCl_2$ [20µg/g]	**Sr89 ELS [Type] [Act]**	Max = 800 kBq/g
	^{90}Sr + ^{90}Y	HCL 0,1N	$SrCl_2$ [20µg/g] + YCl_3 [10µg/g]	**Sr90 ELS [Type] [Act]**	-
	^{99}Tc	H_2O	-	**Tc99 ELS [Type] [Act]**	Max = 800 kBq/g
	^{147}Pm	HCL 0,1N	$LaCl_3$ [10µg/g]	**Pm147 ELS [Type] [Act]**	Max = 800 kBq/g

	Radionuclide	Chemical form	Carrier	Reference	Notes
βγ γ	^{22}Na	HCL 0,1N	NaCl [10µg/g]	**Na22 ELS [Type] [Act]**	-
	^{51}Cr	HCL 0,1N	$CrCl_3$ [60µg/g]	**Cr51 ELS [Type] [Act]**	-
	^{54}Mn	HCL 0,1N	$MnCl_2$ [26µg/g]	**Mn54 ELS [Type] [Act]**	-
	^{55}Fe	HCL 0,1N	$FeCl_3$ [10µg/g]	**Fe55 ELS [Type] [Act]**	-
	^{57}Co	HCL 0,1N	$CoCl_2$ [10µg/g]	**Co57 ELS [Type] [Act]**	-
	^{59}Fe	HCL 1N	FeCl3 [10µg/g]	**Fe59 ELS [Type] [Act]**	-
	^{60}Co	HCL 0,1N	$CoCl_2$ [10µg/g]	**Co60 ELS [Type] [Act]**	-
	^{65}Zn	HCL 0,1N	$ZnCl_2$ [55µg/g]	**Zn65 ELS [Type] [Act]**	-
	^{85}Sr	HCL 0,1N	$SrCl_2$ [20µg/g]	**Sr85 ELS [Type] [Act]**	-
	^{88}Y	HCL 0,1N	YCl_3 [10µg/g]	**Y88 ELS [Type] [Act]**	-
	^{109}Cd	HCL 1N	$CdCl_2$ [10µg/g]	**Cd109 ELS [Type] [Act]**	-
	^{110M}Ag	NH_4OH 0.1N ou 1N	AgCN [10µg/g]	**Ag110 ELS [Type] [Act]**	-
	^{113}Sn	HCL 6N	$SnCl_4$ [10µg/g]	**Sn113 ELS [Type] [Act]**	-
	^{125}I	H_2O	$Na_2S_2O_3$ [50µg/g] + NaI [50µg/g]	**I125 ELS [Type] [Act]**	-
	^{129}I	H_2O	$Na_2S_2O_3$ [50µg/g] + NaI [50µg/g]	**I129 ELS [Type] [Act]**	-
	^{131}I	H_2O	$Na_2S_2O_3$ [50µg/g] + NaI [50µg/g]	**I131 ELS [Type] [Act]**	-
	^{133}Ba	HCL 1N	$BaCl_2$ [33µg/g]	**Ba133 ELS [Type] [Act]**	-
	^{134}Cs	HCL 0,1N	CsCl [10µg/g]	**Cs134 ELS [Type] [Act]**	-
	^{137}Cs	HCL 0,1N	CsCl [10µg/g]	**Cs137 ELS [Type] [Act]**	-
	^{139}Ce	HCL 0,1N	$CeCl_3$ [10µg/g]	**Ce139 ELS [Type] [Act]**	-
	^{152}Eu	HCL 1N	EuCl3 [10µg/g]	**Eu152 ELS [Type] [Act]**	-
Mix γ	12ML01*	HCL 1N	???	**12ML01 ELS [Type] [Act]**	Available: • 0.002 µCi/g • 0.02µCi/g • 1.1 µCi/g • 21.6 µCi/g

Standard manufacturing tolerance: ± 30% | IAEA Category: 5

* The 12ML01 mixture – ^{241}Am, ^{109}Cd, ^{139}Ce, ^{57}Co, ^{60}Co, ^{51}Cr, ^{137}Cs, ^{113}Sn, ^{54}Mn, ^{65}Zn, ^{85}Sr, ^{88}Y – generates around 15 peaks over an energy range from 60 keV to 1836 keV. The quantity of each radionuclide is chosen so that the counting rates of the main peak of each radionuclide are the same order of magnitude. See appendices for additional information on the 12ML01 mixture and on the other mixes available. Other geometries are available on request.

waste drum

Waste Drum Standard

Technical Information

Radionuclides: ^{241}Am, ^{60}Co, ^{137}Cs, ^{152}Eu, ^{133}Ba, alone or mixed

Activities: from 3nCi to 3mCi

Matrix: PVC, foam, steel,…

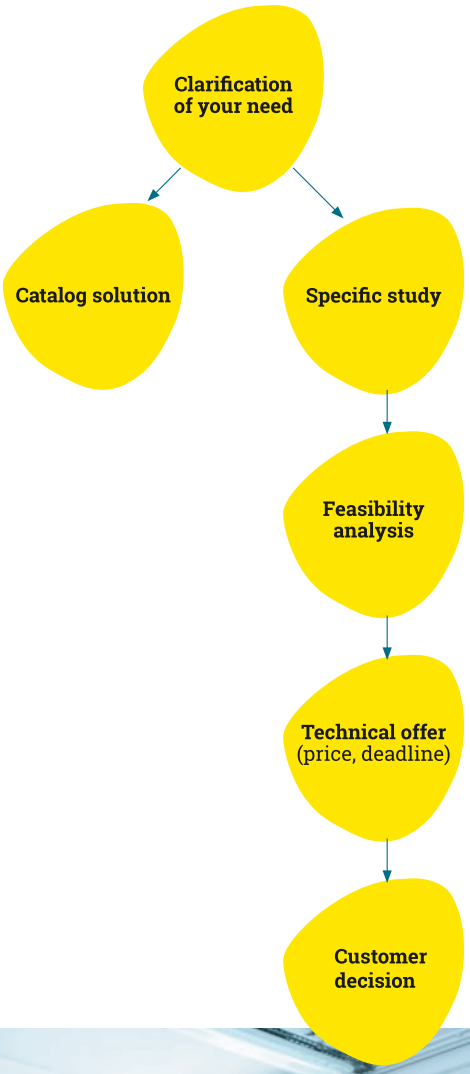
Waste: 100 or 200 liters drums, Mesh boxes

Sealed Source: ISO2919 C11111

custom sources

Custom sources

Beyond the catalog references presented in the previous pages, LEA can also produce tailored-made sources suited to your needs.



How it Works

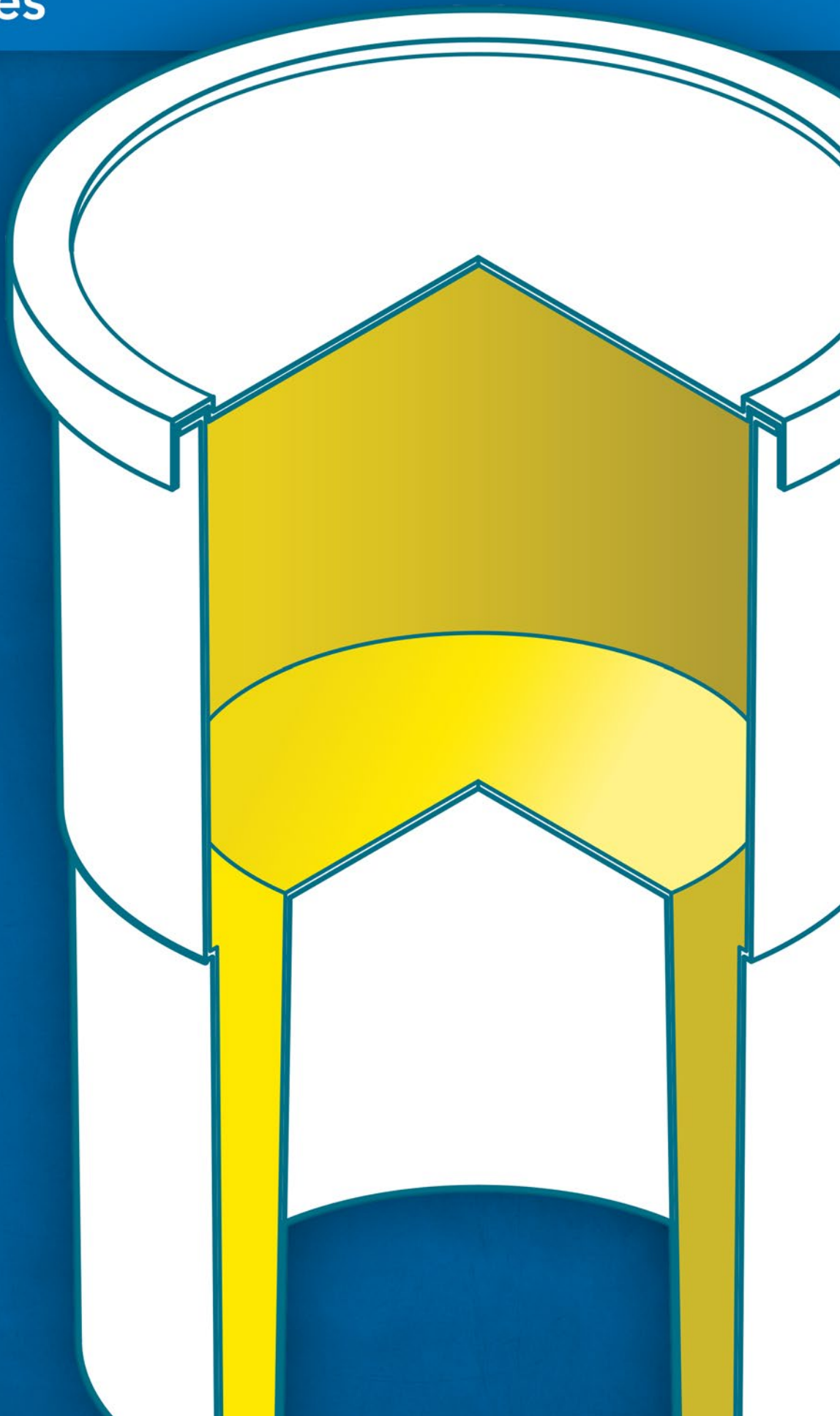
Based on your needs and specifications, an internal study is initiated to validate:

- The production feasibility (manufacturing and measuring if necessary) of the source in accordance with the scope of the LEA's license.
- The possibility to issue a calibration certificate under COFRAC* accreditation.
- The level of uncertainty of the measurement.
- The type of packaging and associated transport, or we will suggest a catalog source close to your desired specification.

This feasibility study also helps defining the price and schedule associated with the requested supply. If the source is close to one of our catalog references, the completion time can be very short (a few weeks).

For more complex cases, requiring R&D and/or an LEA license upgrade, the time associated with the study and the necessary funding are then communicated to you for prior validation.

appendices



Relevant regulations

Based in France, LEA operates under the authorization of the French Nuclear Safety Authority ASN (license No. F530042) according to France's Public Health regulation. LEA is licensed to manufacture, distribute, import and export nuclides, sources, products or devices for industrial, medical and research applications.

Our sealed sources meet the requirements of ISO 2919, which validates their quality as sealed sources following specific tests.

LEA also abides by the transportation regulations, both European (ADR) and international (IAEA ICAO, IATA).

Some sources are subject to export control on dual-use goods in accordance with CE Regulation 428/2009 from council of 5 May 2009 and its upcoming revisions. These sources are subject of a specific certification request (End User Certificate). They are clearly identified in red in the catalog.

Threshold for the radionuclides concerned by the dual purpose measure :

Whatever the activity :

Uranium 233	Uranium 235	Plutonium 239

If the activity is greater than 0.7mCi (26MBq) :
Neptunium 237

If the activity is greater than 10mCi (0.37 GBq) :
Radium 226

If the activity is greater than 100mCi (3.7 GBq) :

Actinium 225	Actinium 227	Californium 253
Curium 240	Curium 241	Curium 242
Curium 243	Curium 244	Einsteinium 253
Einsteinium 254	Gadolinium	148 Plutonium 236
Plutonium 238	Polonium 208	Polonium 209
Polonium 210	Radium 223	Thorium 227
Thorium 228	Uranium 230	Uranium 232

Whatever the activity of Americium 241:
Any AmBe neutron source to be exported outside the European Union

We kindly remind our foreign customers to strictly comply with the regulatory requirements of the country in which they own and use the sources provided by LEA.

Quality and traceability

LEA's quality system meets requirement of French and international standards. LEA is:

- **ISO 9001 certified** (certificate 2019/83489.1) ;
- **COFRAC* accredited** (for calibration in the field of ionising radiation; NF EN ISO/IEC 17025: 2017, scope N°2-6386 available on www.cofrac.fr or upon request).

LEA is accredited by COFRAC*, France's accreditation body signatory to ILAC MRA** in the field of calibration of ionizing radiations, in accordance with ISO 17025:2017. LEA's traceability to the International System of Units (SI) is performed through calibrations with LNHB (Laboratoire National Henri Becquerel), France's National Metrology Institute **(equivalent to NIST in the US)**. LNHB is also accredited by COFRAC in the field of calibration of ionizing radiations. Both NIST and LNHB are signatories to CIPM-MRA***, meaning NIST and LNHB mutually recognize the validity of their calibrations and certificates. Therefore, through both COFRAC accreditation and calibrations traceable to LNHB, **LEA certificates provide the same traceability to SI as NIST-traceable certificates**.

- Our radiation protection management system is certified according to the order of November 27, 2013 relating to companies operating in establishments carrying out nuclear activities by the Qualianor organization (certificate No.296-R).

Therefore, every year several internal and external audits are carried out by independent organizations and contribute to ensure optimal quality.

* Scope N°2-6386 available on www.cofrac.fr or upon request.
** ILAC MRA: International Laboratory Accreditation Cooperation Mutual Recognition Arrangement
*** CIPM-MRA: International Committee for Weights and Measures - Mutual Recognition Arrangement

Calibration certificate

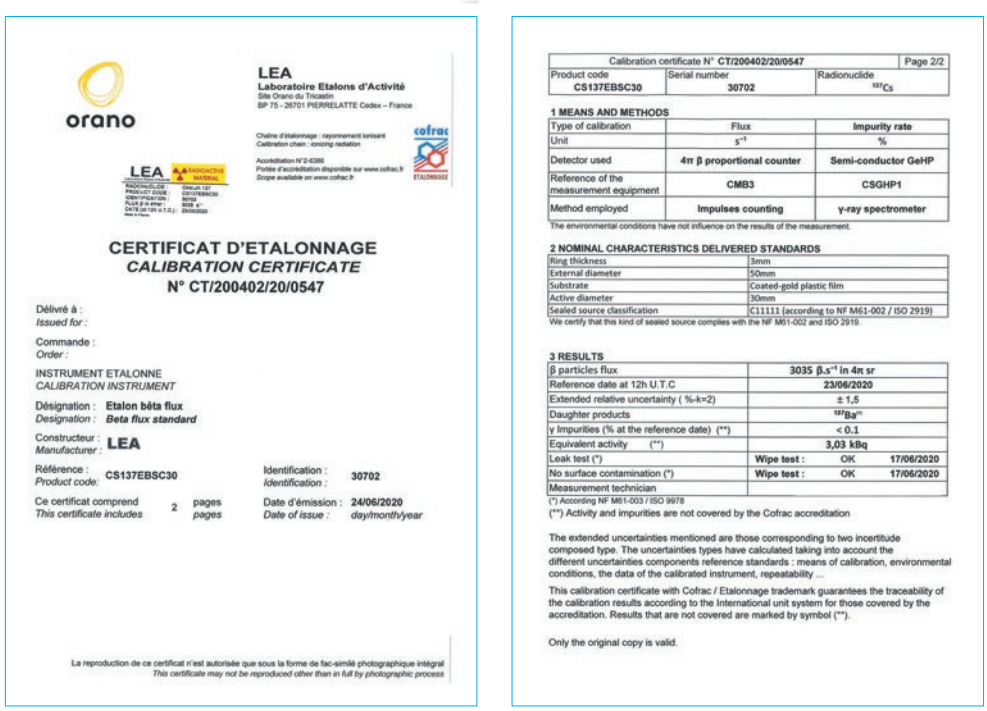
Each source calibrated under COFRAC* accreditation scope will be supplied with a COFRAC* calibration certificate, which mentions the calibration result and related uncertainty, the measurement method. The possible impurity content can be mentioned upon request.

LEA can also supply sources without a COFRAC* calibration certificate:

- Atandard sources, which calibration is performed out of LEA's COFRAC* accreditation scope,
- Check sources with a nominal activity level.

The certificate must be kept for the whole duration of the source's detention (the calibration certificate will be requested during the spent source recovery process).

Upon request and according to your applications, LEA can also provide a sealed source calibration certificate.



LEA
Laboratoire Etalons d'Activité
Site Orano du Tricastin
BP 75 - 26701 PIERRELATTE Cedex – France

orano

CERTIFICAT D'ETALONNAGE
CALIBRATION CERTIFICATE
N° CT/200402/20/0547

Délivré à : *Issued for :*
Commande : *Order :*
INSTRUMENT ETALONNE *CALIBRATION INSTRUMENT*
Désignation : **Etalon bêta flux** *Designation :* ***Beta flux standard***
Constructeur : *Manufacturer :* **LEA**
Référence : **CS137EBSC30** *Product code*
Identification : *Identification :* **30702**
Ce certificat comprend **2** pages *This certificate includes* **2** *pages*
Date d'émission : *Date of issue :* **24/06/2020** *day/month/year*

La reproduction de ce certificat n'est autorisée que sous la forme de fac-similé photographique intégral
This certificate may not be reproduced other than in full by photographic process

Calibration certificate N° CT/200402/20/0547 — Page 2/2

Product code	Serial number	Radionuclide
CS137EBSC30	30702	^{137}Cs

1 MEANS AND METHODS

Type of calibration	Flux	Impurity rate
Unit	s^{-1}	%
Detector used	4π β proportional counter	Semi-conductor GeHP
Reference of the measurement equipment	CMB3	CSGHP1
Method employed	Impulses counting	γ-ray spectrometer

The environmental conditions have not influence on the results of the measurement.

2 NOMINAL CHARACTERISTICS DELIVERED STANDARDS

Ring thickness	3mm
External diameter	50mm
Substrate	Coated-gold plastic film
Active diameter	30mm
Sealed source classification	C11111 (according to NF M61-002 / ISO 2919)

We certify that this kind of sealed source complies with the NF M61-002 and ISO 2919

3 RESULTS

β particles flux	3035 $\beta.s^{-1}$ in 4π sr		
Reference date at 12h U.T.C	23/06/2020		
Extended relative uncertainty (%-k=2)	± 1,5		
Daughter products	$^{137}Ba^{m}$		
γ Impurities (% at the reference date) (**)	< 0.1		
Equivalent activity (**)	3,03 kBq		
Leak test (*)	Wipe test :	OK	17/06/2020
No surface contamination (*)	Wipe test :	OK	17/06/2020
Measurement technician			

(*) According NF M61-003 / ISO 9978
(**) Activity and impurities are not covered by the Cofrac accreditation

The extended uncertainties mentioned are those corresponding to two incertitude composed type. The uncertainties types have calculated taking into account the different uncertainties components reference standards : means of calibration, environmental conditions, the data of the calibrated instrument, repeatability ...

This calibration certificate with Cofrac / Etalonnage trademark guarantees the traceability of the calibration results according to the International unit system for those covered by the accreditation. Results that are not covered are marked by symbol (**).

Only the original copy is valid.

COFRAC calibration certificate example*

* Scope N°2-6386 available on www.cofrac.fr or upon request.

Manufacturing tolerances

Product type	Deviation from the nominal activity
Nominal solutions	± 30%
Standard sealed sources and standard solutions	± 30%
Medical products: flood sources, pen point markers, dose calibrator sources	- 15% - + 30%

Recommended working life

The quality of calibration standards can deteriorate due to physical & chemical phenomena (eg. degradation of liquid's homogeneity, loss of active deposits' adherence over time) and usage conditions (frictions, dust...).

From a physical integrity standpoint, the recommended working life of sealed sources according to ISO2919 is 10 years in normal usage conditions (usage guidelines provided with our sources).

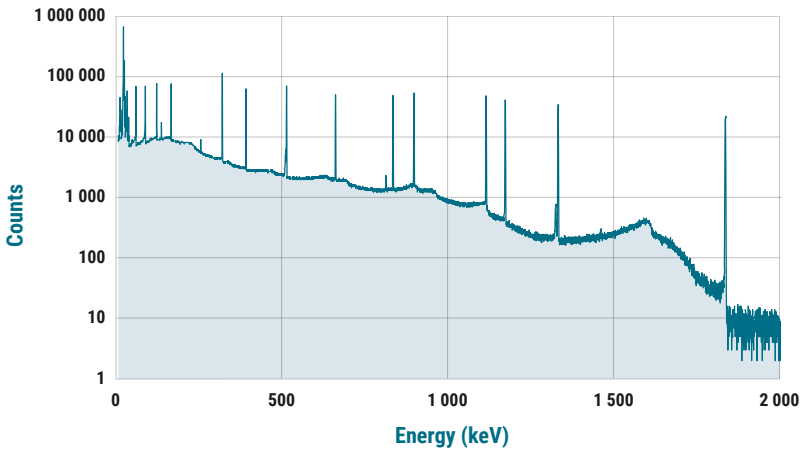
From a metrological standpoint, our metrological values are valid in our calibration's conditions. We recommend using these values no longer than 2 radioactive periods, with a maximum of 2 years from the reference calibration date, due to cumulative uncertainties from radioactive periods as well as interactions between matter and ionizing radiations.

12ML01 Mixture

Composition of the mixture

12ML01 60 keV – 1 836 keV

Radionuclides	Main rays	% in activity (indicatif)	Emission spectrum
^{51}Cr	320 keV	22,1%	
^{54}Mn	835 keV	5,8%	
^{57}Co	122 keV 137 keV	1,1%	
^{60}Co	1 173 keV 1 333 keV	8,2%	
^{65}Zn	1 116 keV	16,5%	
^{85}Sr	514 keV	3,7%	
^{88}Y	898 keV 1 836 keV	6,9%	
^{109}Cd	88 keV	22,4%	
^{113}Sn	392 keV	4,1%	
^{137}Cs	662 keV	5,6%	
^{139}Ce	166 keV	1,4%	
^{241}Am	60 keV	2,2%	



Any other mix of 241Am, 133Ba, 60Co, 137Cs and 152Eu can be produced on request for specific activities.

Technical information

Uncertainties

Uncertainty is the estimate of a possible variation between the level of activity measured by LEA and the actual activity.

The uncertainty indicated in the calibration certificate corresponds to the expanded uncertainty expressed with a k=2 enlargement factor. The value of the enlargement factor is related to the desired confidence level:

- 68% for k = 1
- 95% for k = 2
- 99% for k = 3

These percentages correspond to the application of the gaussian mathematical function.

Units

The unit of radioactivity adopted by the International System of Units (SI) is becquerel (Bq). This unit corresponds to the transformation of a nucleus with emission of ionizing radiation. This is called disintegration. Bq = the number of decays of one nucleus per second.

The other unit, still in use, is the curie (Ci) which corresponds to the number of nuclei that disintegrate in one gram of radium 226 per second (old system).
1 Ci = 3.7 x 10^{10} Bq

Conversion table Becquerel/Curie

1 Bq	≈ 27 pCi	1 Ci	≈ 37 GBq
1 kBq	≈ 27 nCi	1 mCi	≈ 37 MBq
1 MBq	≈ 27 µCi	1 µCi	≈ 37 kBq
1 GBq	≈ 27 mCi	1 nCi	≈ 37 Bq
1 TBq	≈ 27 Ci	1 pCi	≈ 37 mBq

T = tera (10^{12})	m = milli (10^{-3})
G = giga (10^{9})	µ = micro (10^{-6})
M = mega (10^{6})	n = nano (10^{-9})
k = kilo (10^{3})	p = pico (10^{-12})

Calibration standard

A calibration standard is a source which activity is defined well enough in order to be used for equipment calibration. Measurement of calibration standards must meet traceability equipments to SI.

Radioactive purity

The standards described in this catalog are produced from raw materials containing a minimum of radioactive impurities. Care is taken to minimize impurities throughout the production process. Impurities in the finished products are identified and analyzed using α or γ spectrometry.

Impurity contents are stated in the calibration certificate at the reference date.

Nuclear data

RN	PERIOD			MAIN EMISSIONS *							
				α		β			X		
	Years	Days	Seconds	E (MeV)	Ratio	E Max (keV)	E moy (keV)	Ratio	E (keV)	Ratio	E (ke
Ag110m		2,50E+02	2,16E+07	-	-	83.1 529.9	21.6 165.3	67.5% 30.8%	-	-	657 763 884 937 1384 1505
Am241	432,6	1,58E+05	1,37E+10	5.388 5.443 5.486	1.7% 13.2% 84.5%	-	-	-	13.8 17.1 21.2	13.0% 18.9% 4.8%	59,
Ba133	10,5	3,83E+03	3,33E+08	-	-	-	-	-	30.6 31.0 35.1 35.9	34.0% 62.8% 18.2% 4.6%	81. 302 356 383
C14	5 700	2,08E+06	1,80E+11	-	-	156,5	49,2	100%	-	-	-
Ca45		1,63E+02	1,41E+07	-	-	256,4	77,2	100%	-	-	-
Cd109		4,62E+02	3,99E+07	-	-	-	-	-	22.0 22.2 25.0 25.5	29.0% 54.7% 15.1% 2.6%	88
Ce139		1,38E+02	1,19E+07	-	-	-	-	-	33.0 33.4 37.9 38.8	22.8% 41.9% 12.5% 3.1%	165
Cl36	301 000	1,10E+08	9,50E+12	-	-	708,6	251,2	98,1%	-	-	-
Cm244	18,1	6,61E+03	5,71E+08	5.763 5.805	23.3% 76.7%	-	-	-	17,1	8,7%	-
Co57		2,72E+02	2,35E+07	-	-	-	-	-	6.4 7.1	50.0% 7.1%	14. 122 136
Co60	5,27	1,92E+03	1,66E+08	-	-	317,3	95,6	99,8%	-	-	1173 1332
Cr51		2,77E+01	2,39E+06	-	-	-	-	-	4.9 5.4	20.1% 2.7%	32
Cs134	2,06	7,52E+02	6,51E+07	-	-	88.8 415.4 658.1	23.5 123.5 210.0	27.2% 2.5% 70.2%	-	-	563 569 604 795 802
Cs137	30,1	1,10E+04	9,48E+08	-	-	514.0 1175.6	174.3 416.3	94.4% 5.6%	31.8 32.2	1.9% 3.6%	661
Eu152	13,5	4,93E+03	4,27E+08	-	-	175.4 384.8 695.6 1474.5	47.4 112.3 221.7 535.4	1.8% 2.4% 13.8% 8.2%	6.4 39.5 40.1 45.5 46.7	13.0% 20.8% 37.7% 11.8% 3.0%	121 244 344 778 867 964
Fe55	2,75	1,00E+03	8,67E+07	-	-	-	-	-	5.9 6.5	25.0% 3.4%	-
Fe59		4,45E+01	3,84E+06	-	-	273.6 465.9	81.0 149.5	45.2% 53.3%	-	-	1099 1291
H3	12,3	4,49E+03	3,89E+08	-	-	18,6	5,7	100%	-	-	-
I125		5,94E+01	5,13E+06	-	-	-	-	-	27.2 27.5 31.1 31.8	39.7% 74.0% 21.2% 4.6%	35,
I129	16 100 000	5,88E+09	5,08E+14	-	-	-	-	-	27.2 27.5 31.1 31.8	39.7% 74.0% 21.2% 4.6%	35,
I131		8,02E+00	6,93E+05	-	-	247.9 333.8 606.3	69.4 96.6 191.6	2.1% 7.4% 89.4%	29.5 29.8	1.5% 2.8%	284 364 63
Mn54		3,13E+02	2,71E+07	-	-	-	-	-	5.4 6.0	22.7% 3.1%	834
Na22	2,60	9,49E+02	8,21E+07	-	-	546,4	215,5	89.8%	-	-	51 1274
Ni63	98,7	3,60E+04	3,11E+09	-	-	67,0	17,4	100%	-	-	-
Np237	2 140 000	7,81E+08	6,75E+13	4.766 4.771 4.788	9.5% 25.0% 47.0%	-	-	-	15,7	54,5%	29. 86.
P32		1,43E+01	1,23E+06	-	-	1710,7	695,5	100%	-	-	-
Pm147	2,62	9,56E+02	8,28E+07	-	-	224,7	62,0	100%	-	-	-
Pu238	87,7	3,20E+04	2,77E+09	5.456 5.499	28.8% 71.0%	-	-	-	16,2	10,6%	-
Pu239	24 100	8,80E+06	7,61E+11	5.106 5.144 5.157	11.9% 17.1% 70.8%	-	-	-	16,2	4,7%	129 375 413 451
S35		8,73E+01	7,54E+06	-	-	167,1	48,6	100%	-	-	-
Sn113		1,15E+02	9,94E+06	-	-	-	-	-	24.0 24.2 27.3 27.9	27.7% 51.9% 14.6% 2.8%	255 391
Sr85		6,49E+01	5,60E+06	-	-	-	-	-	13.3 13.4 15.0	17.2% 33.0% 8.0%	51
Sr89		5,06E+01	4,37E+06	-	-	1495,1	584,6	100%	-	-	-
Sr90	28,8	1,05E+04	9,09E+08	-	-	545,9	195,7	100%	-	-	-
Tl204	3,79	1,38E+03	1,20E+08	-	-	763,7	243,9	97,1%	-	-	-
Tc99	214 000	7,81E+07	6,75E+12	-	-	293,7	85,4	100%	-	-	-
U233	1 590	5,80E+05	5,02E+10	4.729 4.783 4824	1.6% 13.2% 84.4%	-	-	-	15,7	5,3%	-
Y88		1,07E+02	9,21E+06	-	-	-	-	-	14.1 14.2 15.9 16.1	17.3% 33.2% 8.2% 1.1%	898 1836
Zn65		2,44E+02	2,11E+07	-	-	329,9	143,1	1,4%	8.0 8.9	34.7% 4.8%	511 1115

γ		SPECIFIC ACTIVITY		IAEA EXEMPTION THRESHOLDS**		FRANCE EXEMPTION THRESHOLDS***	
				Solid source	Liquid source	Solid source	Liquid source
eV)	Ratio	Bq/g	Ci/g	Activity (kBq)	Concentration (kBq/g)	Activité • Activity (kBq)	Concentration (Bq/g)
.8 .9 .7 .5 4.3 6.0	94.4% 22.3% 74.0% 34.5% 24.7% 13.2%	1,76E+14	4 751	1 000 kBq	0,01 kBq/g	1 000 kBq	0,0001 kBq/g
5	35,8%	1,27E+11	3,43	10 kBq	0,001 kBq/g	10 kBq	0,0001 kBq/g
0 .8 .0 .8	32.9% 18.3% 62.1% 8.9%	9,43E+12	255	1 000 kBq	0,1 kBq/g	1 000 kBq	-
	-	1,66E+11	4,48	10 000 kBq	10 kBq/g	10 000 kBq	0,001 kBq/g
	-	6,58E+14	17 795	10 000 kBq	10 kBq/g	10 000 kBq	0,1 kBq/g
3	3,6%	9,59E+13	2 593	1 000 kBq	10 kBq/g	1 000 kBq	0,001 kBq/g
,9	79,9%	2,52E+14	6 822	1 000 kBq	0,1 kBq/g	1 000 kBq	0,001 kBq/g
	-	1,22E+09	0,033	1 000 kBq	10 kBq/g	1 000 kBq	0,001 kBq/g
	-	2,99E+12	80,9	10 kBq	0,01 kBq/g	10 kBq	0,001 kBq/g
4 .1 .5	9.1% 85.5% 10.8%	3,12E+14	8 425	1 000 kBq	0,01 kBq/g	1 000 kBq	0,001 kBq/g
3.2 2.5	100% 100%	4,18E+13	1 130	100 kBq	0,01 kBq/g	100 kBq	0,0001 kBq/g
0	9,8%	3,42E+15	92 383	10 000 kBq	1 kBq/g	10 000 kBq	0,1 kBq/g
.2 .2 .7 .8 .0	8.4% 15.4% 97.6% 85.5% 8.7%	4,78E+13	1 292	10 kBq	0,01 kBq/g	10 kBq	0,0001 kBq/g
,7	85%	3,21E+12	86,8	10 kBq	0,01 kBq/g	10 kBq	0,0001 kBq/g
.8 .7 .3 .9 .4 .1	28.4% 7.6% 26.6% 13.0% 4.2% 14.5%	6,43E+12	174	1 000 kBq	0,01 kBq/g	1 000 kBq	0,0001 kBq/g
	-	8,75E+13	2 365	1 000 kBq	10 kBq/g	1 000 kBq	1 kBq/g
9.2 1.6	56.6% 43.2%	1,84E+15	49 723	1 000 kBq	0,01 kBq/g	1 000 kBq	0,001 kBq/g
	-	3,58E+14	9 676	1 000 000 kBq	1 000 kBq/g	1 000 000 kBq	0,1 kBq/g
5	6,7%	6,50E+14	17 578	1 000 kBq	1 kBq/g	1 000 kBq	0,1 kBq/g
5	6,7%	6,37E+06	0,00017	100 kBq	0,1 kBq/g	100 kBq	0,00001 kBq/g
.3 .5 7	6.1% 81.2% 7.3%	4,59E+15	124 189	1 000 kBq	0,1 kBq/g	1 000 kBq	0,01 kBq/g
,8	100%	2,86E+14	7 719	1 000 kBq	0,01 kBq/g	1 000 kBq	0,0001 kBq/g
1 4.5	178% 100%	2,31E+14	6 241	1 000 kBq	0,01 kBq/g	1 000 kBq	0,0001 kBq/g
	-	2,13E+12	57,5	100 000 kBq	100 kBq/g	100 000 kBq	0,1 kBq/g
4 5	15.3% 12.3%	2,61E+07	0,00070	1 kBq	0,001 kBq/g	1 kBq	0,001 kBq/g
	-	1,06E+16	285 566	100 kBq	1 kBq/g	100 kBq	1 kBq/g
	-	3,43E+13	927	10 000 kBq	10 kBq/g	10 000 kBq	1 kBq/g
	-	6,33E+11	17,1	10 kBq	0,001 kBq/g	10 kBq	0,0001 kBq/g
.3 .0 .7 .5	0.00631% 0.00154% 0.00146% 0.000187%	2,30E+09	0,062	10 kBq	0,001 kBq/g	10 kBq	0,0001 kBq/g
	-	1,58E+15	42 710	100 000 kBq	100 kBq/g	100 000 kBq	0,1 kBq/g
.1 .7	2.1% 65.0%	3,71E+14	10 037	10 000 kBq	1 kBq/g	10 000 kBq	0,001 kBq/g
4	98,5%	8,76E+14	23 680	1 000 kBq	0,1 kBq/g	1 000 kBq	0,001 kBq/g
	-	1,07E+15	29 002	1 000 kBq	1 kBq/g	1 000 kBq	1 kBq/g
	-	5,10E+12	138	10 kBq	0,01 kBq/g	10 kBq	0,001 kBq/g
	-	1,71E+13	462,475	10 kBq	10 kBq/g	10 kBq	0,001 kBq/g
	-	6,24E+08	0,017	10 000 kBq	10 kBq/g	10 000 kBq	0,001 kBq/g
	-	3,57E+10	0,965	10 kBq	0,001 kBq/g	10 kBq	0,001 kBq/g
.0 6.1	93.9% 99.3%	5,15E+14	13 911	1 000 kBq	0,01 kBq/g	1 000 kBq	-
.0 6.5	2.8% 50.2%	3,04E+14	8 230	1 000 kBq	0,01 kBq/g	1 000 kBq	0,0001 kBq/g

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