Your partner for radioactive sources

RADIOACTIVE SOURCES FOR NUCLEAR FACILITIES

KEY APPLICATIONS

Hundreds of radioactive sources are used in nuclear facilities to control and calibrate equipment.
This brochure addresses 4 key application fields :

HEALTH PHYSICS

Detection of radioactive contamination and exposure of nuclear facilities' workers

RADIATION MONITORING SYSTEMS

Monitoring of radiation levels in ambient air and released effluents

LABORATORIES

Detection and characterization of radionuclides in process or environment samples

WASTE CHARACTERIZATION

Radiological characterization of solid wastes for storage purpose

For each application, this brochure presents the most common equipment used in nuclear facilities and relevant sources that LEA can supply.

Don't hesitate to contact us for further information
sales@lea-sources.com www.lea-sources.com

HEALTH PHYSICS

Hundreds of probes and detectors - generally Geiger Muller probes and scintillation detectors – are extensively used in Nuclear Facilities for contamination monitoring of hand-foot, whole body and tools, as well as radiologic surveys and workers' dose rate monitoring.

All these systems must be calibrated and periodically checked with adequate radioactive sources : wide sources for radiation monitors, capsules for dosimeters, linear sources for anthropomorphic phantoms.

Typical sources provided for such equipment are :

	Radiation Monitors	Dosimeters	Anthropo-radiametry
Nuclides	α, β, γ emitters ^{239}Pu, ^{241}Am, ^{14}C, ^{60}Co, ^{137}Cs, ^{90}Sr	γ emitters ^{60}Co, ^{137}Cs	γ emitters ^{60}Co, ^{133}Ba, ^{137}Cs
Activities	From 50 Bq to 10 kBq	From 10 to 500 MBq	From 100 Bq to 2 kBq
Geometries	Wide sources From 3 to 120 mm diameter or 100x100 mm and 100x150 mm	Capsules From 5 to 8 mm diameter and 5 to 15 mm height	Linear sources 5 mm diameter x 160 mm height

RADIATION MONITORS

Nuclear workers are often screened or scan themselves in several locations inside radiological controlled zones, to ensure that they have not been contaminated during operations.

MOBILE SYSTEMS

Immediately nearby workplaces, portable polyradiameters are widely used to screen the most likely contamination locations (hands, feet, head, respiratory tract protection device, tools,...)

Portable Polyradiameter

FIXED SYSTEMS

Between workplaces and radiological uncontrolled zones, several automatic measurement devices are used to detect contamination on objects, tools or workers

Objects or tools monitor

Hand-Foot Monitor

Whole body monitors

Wide Disc Source (example)

Types		Radionuclides	Activities
Disc	α	^{239}Pu, ^{241}Am	0.05 – 0.1 – 0.4 – 0.5 kBq
	β	^{14}C, ^{60}Co, ^{137}Cs, ^{90}Sr	1 – 2 – 4 – 6 – 8 kBq
Square	α	^{241}Am	0.4 – 1 kBq
	β	^{60}Co, ^{137}Cs, ^{90}Sr	4 kBq

Wide Square Source (example)

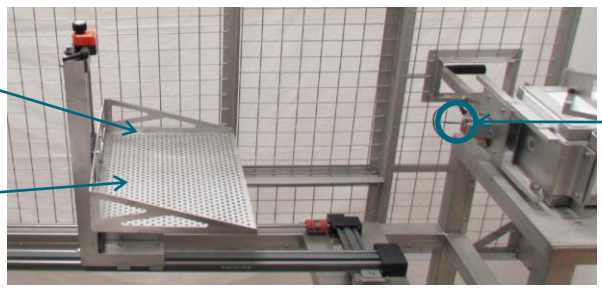
HEALTH PHYSICS

DOSIMETERS

Like radiation protection devices for contamination monitoring, active gamma dosimeters need to be periodically checked.

These calibrations can be performed with small gamma and neutron irradiators, powered by a radioactive capsule (typically in the range of hundreds of MBq or GBq of ^{60}Co,^{137}Cs,^{252}Cf, AmBe).

Probes and radiameters or radiation beacons can also be checked with such a device.



Gamma Irradiator © NUVIA

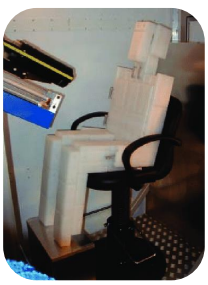
Example of capsule :
^{137}Cs | 400 MBq

Ø 6 mm x h 8 mm

ANTHROPO-RADIAMETRY

BOMAB – BOttle Mannikin ABsorber – and IGOR phantoms are used to calibrate whole body counting systems. These mannikins are filled with radioactive sources in order to simulate internal contaminations.
The BOMAB phantom is composed of 10 polyethylene cylindrical or elliptical bottles, filled with a radioactive liquid.
The IGOR phantom is composed of 70 right-angled polyethylene blocs, filled with linear sealed sources. For each IGOR, LEA produces hundreds of linear sources, composed of gamma emitters – ^{60}Co, ^{133}Ba, ^{137}Cs, ^{152}Eu – alone or mixed.

BOMAB



IGOR™

Linear sources

Tube dimensions : Ø 5 mm x h 160 mm

Available activities (for one source) :
100 Bq – 200 Bq – 500 Bq – 1 kBq – 1.5 kBq

More sources/nuclides available upon request

RADIATION MONITORING SYSTEMS

Radiation Monitoring Systems are used in nuclear facilities to measure radioactivity of liquid or gaseous effluents, and airborne or area radioactivity.

Liquid and gaseous effluents are continuously generated by operating Nuclear Power Plants (for instance the radioactivity potentially released in the environment must be controlled and monitored).

Airborne and area radioactivity are continuously monitored inside radiological controlled zones with fixed systems, to ensure that workers are not exposed to internal contamination. In addition to this collective protection, mobile systems are deployed immediately nearby workplaces.

These systems are calibrated and periodically checked with appropriated radioactive sources : needles or filters for airborne monitors, capsules, charcoals or gas containers for effluents monitors.

AIRBORNE AND AREA MONITORING

Inside radiological controlled zones, airborne and area radioactivity are monitored with fixed beacons and mobile devices.

AIRBORNE MONITORS

α β

Mobile airborne monitors

Fixed airborne monitors

Needle sources Active Ø : 3 mm
Support : Ø 5 mm x L 80 mm

source

Card sources

Filter sources

Active Ø : 30 to 110 mm
Support Ø 40 to 120 mm

Drawer Sources

Types		Radionuclides	Activities
Filter	Mix of αβγ	^{57}Co, ^{60}Co, ^{65}Zn, ^{85}Sr, ^{88}Y, ^{109}Cd, ^{137}Cs, ^{139}Ce, ^{241}Am	10 – 20 – 40 kBq total
Needle	α	^{239}Pu	2 kBq
	βγ	^{137}Cs	2 kBq
Card	α	^{241}Am	0.3 – 0.6 kBq

AREA MONITORS

γ

Fixed area monitors

Capsule sources

Support dimensions :
Ø 8 mm x H 5 mm

Types		RN	Activities
Capsules	γ	^{60}Co ^{137}Cs ^{241}Am	50 – 100 – 370 – 700 kBq

More sources available upon request

RADIATION MONITORING SYSTEMS

LIQUID AND GASEOUS EFFLUENTS RELEASE MONITORING

Monitoring any release of liquid or gaseous effluents is crucial to protect people and the environment around nuclear facilities. Most frequently measured radionuclides around NPPs are ^{3}H, ^{14}C and iodines.
These measurements are performed with in-line or off-line systems which are calibrated and periodically checked with appropriate standard, sealed (capsules, charcoals) or unsealed (gas) sources.

In-line liquid effluent monitors

In-line gaseous effluent monitor

In-line gaseous monitors

Capsule sources

Support dimensions :
Ø 8 mm x H 5 mm

Charcoal sources

Active dimensions :
Surf. deposit : Ø 52 mm
(just behind the charcoal wire rack)
Vol. deposit : Ø 52 mm x H 20 mm
Support dimensions :
Ø 56 mm x H 27 mm

Gas bulb
(3 ml)

Gas container
SG50 or SG3000

Gas bottle
(500 liters)

Types		Radionuclides	Activities
Capsules	γ	^{60}Co, ^{137}Cs, ^{241}Am	50 – 100 – 370 – 700 kBq
Gas	γ	^{85}Kr	240 kBq – 100 MBq
Charcoal	γ	^{133}Ba, ^{137}Cs, ^{152}Eu	4 kBq
	Mix of αβγ	^{51}Cr, ^{54}Mn, ^{57}Co, ^{60}Co, ^{65}Zn, ^{85}Sr, ^{88}Y, ^{109}Cd, ^{113}Sn, ^{137}Cs, ^{139}Ce, ^{241}Am	20 kBq total

More sources available upon request

LABORATORIES

A wide variety of radioactive sources is used in Radiochemistry and Environment laboratories in order to calibrate and check potential deviation of equipment, mainly on Alpha & Gamma counters and spectrometers, as well as Liquid scintillators:

- Single or mixed α, β, γ emitters
- Multiple geometries and matrices (solid, liquid, resin…)
- Activities from 80 Bq to 1 GBq

TYPICAL APPLICATIONS

α Alpha counters used for identification and quantification of alpha emitters through gross count or spectrometry measurements.

β Liquid scintillation counters for quantification of pure beta emitters such as ^{3}H, ^{14}C, ^{90}Sr in liquid samples.

γ Gamma ray detectors made with HPGe (High Purity Germanium) crystal for quantification of γ emitters (^{137m}Ba, ^{110m}Ag,…) or αγ emitters (^{239}Pu, ^{241}Am,…) or βγ emitters (^{137}Cs, ^{60}Co, ^{152}Eu, ^{133}Ba,…).

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Punctual α source (^{232}U, ^{233}U, ^{238}Pu, ^{239}Pu, ^{242}Pu, ^{241}Am, …)

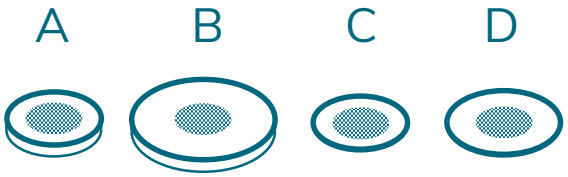
β liquid source (^{3}H, ^{14}C, ^{36}Cl, ^{90}Sr, …)

γ sources kit (^{137}Cs, ^{60}Co, ^{152}Eu, ^{133}Ba, …)

γ or multi γ resin source (^{137}Cs, ^{152}Eu, mix, …)

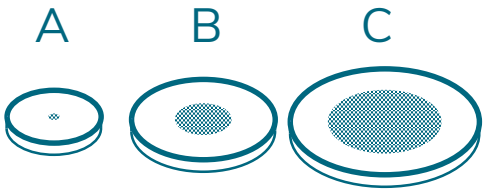
LABORATORIES

α punctual



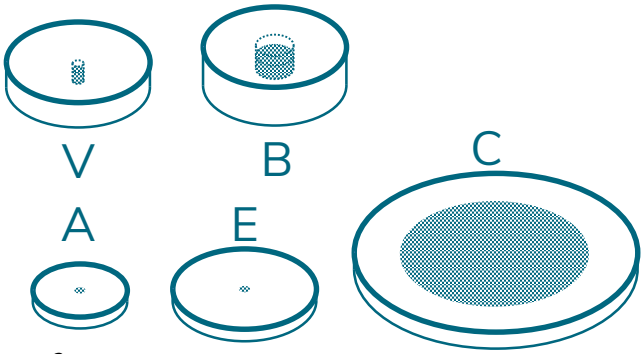
A	B	C	D	
15 mm	15 mm	15 mm	15 mm	: Active Ø
25 mm	38 mm	25 mm	30 mm	: Support Ø
3 mm	3 mm	0,5 mm	0,5 mm	: Support h

β punctual



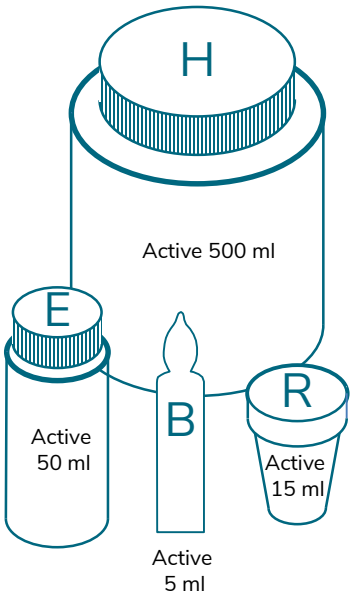
A	B	C	
3 mm	3 mm	30 mm	: Active Ø
25 mm	38 mm	50 mm	: Support Ø
3 mm	3 mm	3 mm	: Support h

γ punctual



V	B		A	E	C	
3 mm	10 mm	: Active Ø	3 mm	3 mm	50 mm	: Active Ø
3 mm	4 mm	: Active h	25 mm	38 mm	75 mm	: Support Ø
38 mm	38 mm	: Support Ø	3 mm	3 mm	4 mm	: Support h
6 mm	10 mm	: Support h				

Liquids and Resins



FREQUENTLY PURCHASED SOURCES

Types		Radionuclides	Activities
Punctual	α	^{238}Pu, ^{239}Pu, ^{241}Am, ^{244}Cm	0.3 – 3 kBq
	β	^{14}C, ^{36}Cl, ^{60}Co, ^{137}Cs, ^{147}Pm, ^{90}Sr	0.08 – 3 kBq
	γ	^{60}Co, ^{133}Ba, ^{137}Cs, ^{152}Eu	4 – 40 – 80 – 400 – 3,500 kBq
Resin	γ	^{60}Co, ^{137}Cs, ^{152}Eu	5 – 37 – 100 – 420 kBq
Liquid	α	^{241}Am, ^{243}Am, ^{244}Cm	0.8 – 4 – 200 kBq
	β	^{3}H, ^{14}C, ^{55}Fe	200 – 400 – 4,000 kBq
	γ	^{60}Co, ^{134}Cs, ^{137}Cs, ^{152}Eu	20 – 200 – 4,000 kBq

More sources available upon request

WASTE CHARACTERIZATION

Before leaving nuclear facilities for storage or disposal, nuclear wastes are characterized with several Non Destructive Assay (NDA) systems. One purpose of these NDA technics is to sort out waste according to AIEA thresholds : HLW (High Level Waste), ILW (Intermediate Level Waste), LLW (Low Level Waste) and VLLW (Very Low Level Waste).

Most of the NDA systems are composed of gamma ray spectrometers and passive neutron systems. NDA systems are often linked to a modeling software to calculate the efficiency curve of the drum to be assayed but radioactive sources are still required for calibration and periodical checks of detectors' efficiencies.

The most common radioactive sources (tens kBq to several MBq) are as follows:

- γ emitters (^{152}Eu, ^{133}Ba, ^{60}Co, ^{137}Cs, ^{241}Am, ...)
- Neutron emitters (^{252}Cf, AmBe)

TYPICAL NDA SYSTEMS

BASED ON GAMMA RAY SPECTROMETRY

γ

Automated GRS systems
(for 100 & 200 liters – 30 & 55 gallons – drums)

Mobile GRS systems

Punctual sources

Radionuclides	Activities
^{60}Co, ^{133}Ba ^{137}Cs ^{152}Eu ^{241}Am	40 – 400 – 700 – 3,500 kBq

More sources and accessories available upon request

BASED ON NEUTRON DETECTORS

n

Passive neutron system for radioactive drums

Ø 6 mm x h 8 mm

Example of **Capsule source** :

RN	Activity
^{252}Cf	70 – 370 – 700 – 1,800 kBq

Special sources such as drums filled with a tailor-made matrix and adapted radioisotopes can be developed upon request

Laboratoire d'Etalons d'Activité

Laboratoire accrédité COFRAC*, établi au cœur de la plateforme industrielle du Tricastin, le LEA **conçoit, produit et distribue des sources radioactives** d'étalonnage et de contrôle.
Le LEA s'appuie sur un réseau de partenaires industriels pour apporter des solutions optimales, notamment pour la fourniture et la reprise de sources de fortes activités ou dédiées à des applications spécifiques.

A COFRAC-accredited lab based at the Tricastin industrial platform in South of France, LEA ***engineers, manufactures and distributes radioactive sources*** *for calibration and control purposes.*
LEA is able to leverage a wide network of industrial partners to provide optimal solutions, in particular for the supply and recovery of high-activity sources and sources dedicated to specific applications.

*accréditation n° 2-6386. Portée disponible sur www.cofrac.fr
accreditation n°2-6386. Scope available at www.cofrac.fr

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