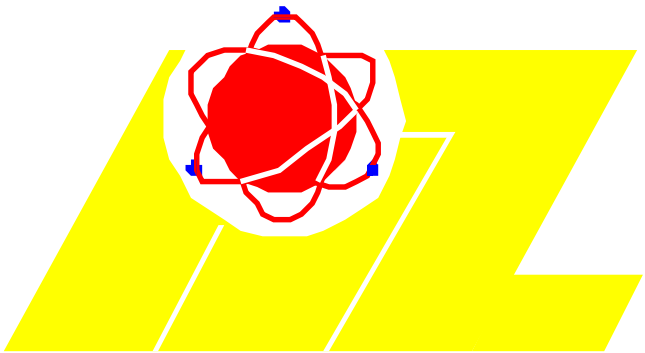
CZECH METROLOGY INSTITUTE
INSPECTORATE FOR IONIZING RADIATION



CATALOGUE OF RADIOACTIVE STANDARDS

QUALITY POLICY OF CMI IIR PRAHA

The Czech Metrology Institute (CMI) - Inspectorate for Ionizing Radiation (IIR) situated in Praha is possessor of the national standard of unit of radioactivity - Bq. It is in the system of metrology of radioactivity the top facility in the Czech Republic. Working of the laboratory of absolute measurements is verified by system of international comparisons, which guarantees highest level of quality control.
To secure of metrological linking-up on radioactivity standard, IIR manufactures wide scale of secondary standards, covering comprehensive spectrum of needs of labs for radioactivity measurement, labs of nuclear medicine, hygienic labs and for needs of legal metrology. Our aim is by means of secondary standards of highest class to improve system of metrology of radioactivity and in the highest possible degree to satisfy the client's requirements and aim at increase in quality and technical level of products. At response on market requirements we are able to develope and produce completely new types of standards.
CMI IIR, Department of Production of Radioactive Standards is holder of the Quality System Certificate DNV No. CERT-07169-2000-AQ-ROT-RvA ISO 9001:2000.

ORDERING INFORMATION

Orders, please send to the distributor:
EUROSTANDARD CZ, Radiová 1, 102 00 Praha 10
Phone/fax: +420 266 020 499
e-mail: info@eurostandard.cz, kits@eurostandard.cz
dutkova@eurostandard.cz
http://www.eurostandard.cz

Technical informations provides the producer:

Czech Metrology Institute – Inspectorate for Ionizing Radiation
Radiová 1, 102 00 Praha 10
Phone/fax: +420 266 020 497(460)/+420 266 020 466
e-mail: pdryak@cmi.cz, rbludovsky@cmi.cz, http://www.cmi.cz
Note: due to technical development some specifications in the catalogue needn`t be actual.
Warning: *phone numbers, e-mail addresses and reference to web page in the footers of the catalogue pages aren`t actual.*

NEUTRON DOZIMETRIC DIODES

DESCRIPTION

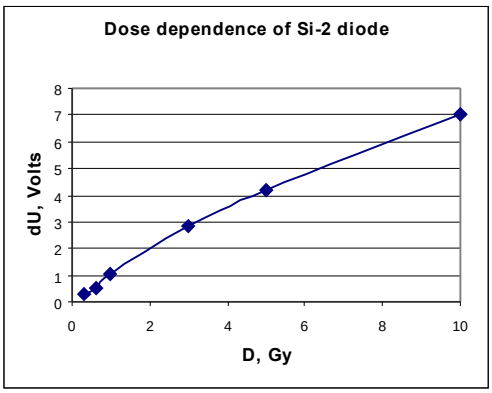
The diodes Si-1 and Si-2 are long base silicon diodes (LBSD) developed for measurement of kerma from heavy particles, particularly fast neutrons. The main physical effect, which is used for kerma measurement, is the change of τ as the minor charge carriers lifetime in silicon after irradiation due to radiation damage in the crystal lattice. Because of the difficulties in lifetime measurement, the forward bias voltage drop on the diode is measured. The change of this voltage ΔU i.e. the difference between the voltage U after irradiation and the initial voltage U_0 is taken as a measure of the radiation damage and is approximately linear function of kerma from fast neutrons. Both types has very low sensitivity for gamma irradiation and so they can be used in mixed gamma – neutron fields. Diodes Si-1 and Si-2 differs in technical specifications, type Si-2 is more sensitive and therefore useful in personal dosimetry (see table).

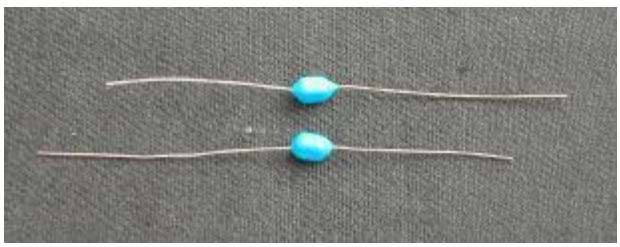
APPLICATION

The main utilisation are: measurement of kerma from fast neutrons for purposes of personal and accidental dosimetry, military dosimetry, mapping of neutron beams.
Si-1 type with great range linearity of dose response is possible to use for mapping of neutron beams and as accindental dosimeter in nuclear facilities, military dosimetry.
Si-2 type is more sensitive and for that reason is useful for accidental personal dosimetry.

MEASUREMENT

The constant current pulse (25 mA, 40 ms) is used for measurement of forward voltage. For this purpose CMI IIR is capable to supply special measuring device.
The dependence of the voltage change of Si-2 diode on the value of the neutron tissue kerma K_n for neutrons from unshielded ^{252}Cf.





TECHNICAL PARAMETERS OF SI-1 AND SI-2 DIODES

Description	Type Si-1	Type Si-2
radiation detected	neutrons with energy > 300 keV	
dimensions	1,2 x 1,8 x 1,8 mm	2 x 2 x 2,5 mm
kerma range	0,1 – 30 Gy	0,01 – 5,0 Gy
kerma neutron energy dependence	less than ± 15 %	less than ± 15 %
fast neutron sensitivity	128 mV/Gy	1 V/Gy
gamma sensitivity	< 0,01 mV/Gy	< 0,4 mV/Gy
encasing	plastics	plastics
initial voltage	0,9 – 1,1 V	1,8 – 2,5 V

STANDARDS FOR ALPHA SPECTROMETRY

DESCRIPTION

The radioactive substance in thin layer on the Pt foil is squeezed to the duraluminium casing with dimensions 25 x 5 mm (diameter x height). The casing has front window with diameter 6 mm. The active area must be carefully protected against moisture, dust and abrasion.

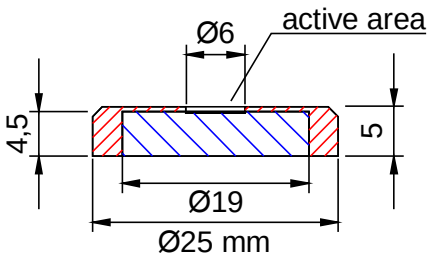
APPLICATION

They are widely used as control sources in comparative measurements, for energy and efficiency calibration of alpha-spectrometers, determination of efficiency of window and windowless counters of α particles.

MEASUREMENT

Flux of α particles to spatial angle 2π sr is determined by 2π proportional counter. Activity is calculated from flux using correction on back scattering, spatial angle and self-absorption.

DIMENSIONS



Nuclide	Half life days	Particle energy keV	Type	Particle flux in 2p sr, s^{-1}	Uncertainty* of flux %	Aktivity kBq	Code
^{239}Pu	$8{,}811.10^{6}$	5147	EA 13	57	0,3	0,1	PUA 13
			EA 14	570	0,3	1,0	PUA 14
^{241}Am	$1{,}578.10^{5}$	5480	EA 13	57	0,3	0,1	AMA 13
			EA 14	570	0,3	1,0	AMA 14
			EA 15	5700	0,3	10	AMA 15
^{241}Am + ^{239}Pu			EA 14	570	0,3	1,0	AMPU 14

*Combined standard uncertainty (P = 68,3 %)

^{226}Ra STANDARD SOLUTIONS

DESCRIPTION

Aqueous solution of the appropriate quantity of ^{226}Ra. Chemical composition of the solution: 1 g $BaCl_2$/l and 10 g HCl/l. EB 0 is the aqueous solution of 1 g $BaCl_2$/l and 10 g HCl/l with very low and determined mass fraction of ^{226}Ra.

APPLICATION

The standards are designed for efficiency calibration of activity (mass) determination of ^{226}Ra or ^{222}Rn. Standard solutions are used either in the form of sealed ampoules for calibration or weighed part of the solution can be added to the analysed sample as so called internal standard. After dilution by EB 0 solution is possible to prepare working standards with activities similar to measured samples. For emanometric determination of ^{226}Ra or ^{222}Rn in water, air and so on, it is possible to transfer them to a washing bottle from which radon is expelled by a stream of gas.

MEASUREMENT

Standard solutions are prepared by dissolving of ^{226}Ra content of standard ES activity of which was determined by comparison of gamma photon flux of the standard with the flux of IIR primary radium standards. Comparison is carried out by means of the $4\pi\gamma$ ionization chamber of IIR.

Nuclide	Half life days	Type	Mass of the solution g	Concentration of ^{226}Ra ng/g	Content of ^{226}Ra ng	Uncertainty* %	Packing	Code
^{226}Ra	584300	EB 6	1	1000	1000	0,5	glass ampoule 1 ml	RAB 6
		EB 7	1	100	100	0,5		RAB 7
		EB 8	1	10	10	0,5		RAB 8
		EB 9	1	1	1	0,6		RAB 9
		EB 10	1	0,1	0,1	0,7		RAB 10
		EB 65	5	1000	5000	0,5	glass ampoule 5 ml	RAB 65
		EB 75	5	100	500	0,5		RAB 75
		EB 85	5	10	50	0,5		RAB 85
		EB 95	5	1	5	0,6		RAB 95
		EB 105	5	0,1	0,5	0,7		RAB 105

^{226}Ra is in the radioactive equilibrium with its short life daughter products
Activity of 1 g ^{226}Ra is $3{,}658 \cdot 10^{10}$ Bq $\pm$ 0,2 %
* Combined standard uncertainty (P = 68,3 %)

PEN POINT MARKER SOURCE

DESCRIPTION

Dried weighted part of standard solution of ^{57}Co is closed in a cylindrical plastic capsule with dimensions 11 x 9 mm (diameter x length). The source is installed on the top of the telescopic holder. Nominal activity is 5 MBq.

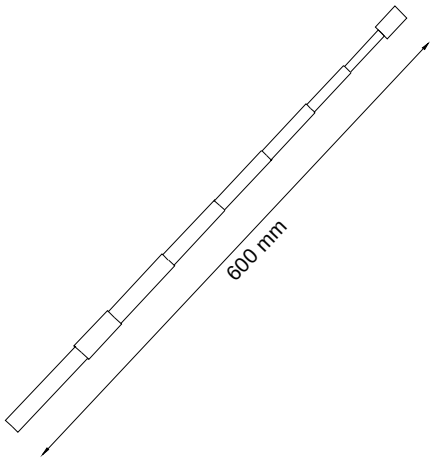
APPLICATION

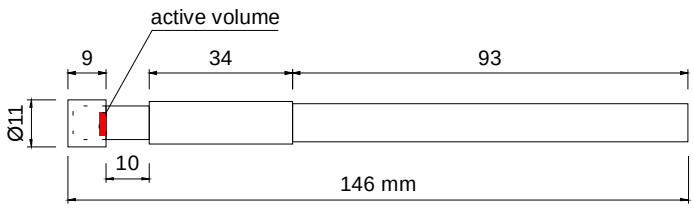
The source is used mainly as a marker in nuclear medicine.

MEASUREMENT

The activity is calculated from the mass of the standard solution.

DIMENSIONS





TYPE: ED 6
CODE: CTD 6

STANDARDS OF X and GAMMA PHOTON FLUX

DESCRIPTION

Standards of X and γ photon flux type EFX and EFF are the point sources with minimum self-absorption emitting homogeneously to angle near 4π sr. The activity is deposited between two welded polyethylene foils with square weight 3,6 ± 0,3 mg.cm^{-2}. The foils are located in the metal ring with outer diameter 40 mm. The active material is located in the centre of the foil.

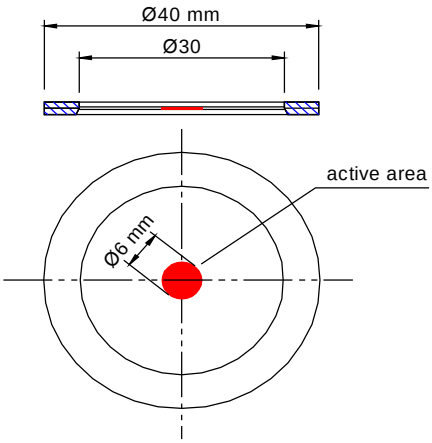
APPLICATION

Standards EFF and EFX are designed for energy and efficiency calibration of counters and spectrometers of X and γ photons. The activity of the standard gives the source strength approximately ~10^4 s^{-1}.

MEASUREMENT

The source strength of the EFX standard is determined by means of a suitable 4π counter. For the standards EFF (emitting photons γ) source emission is calculated from the activity and the known photon yields.

DIMENSIONS



Nuclide	Half life days	Photon energy keV		Photon flux in 4p sr		Uncertainty*	Code
		X - K	g	keV	s^{-1}	%	
^{55}Fe	986	5,888		5,888	10^4	1,5	FMFX
^{57}Co	271,26	6,4	122,06 136,46	122,06 136,46	10^4	1,5	CTFF
^{65}Zn	243,9	8,03	1115,52	8,03	10^4	1,7	ZNFX
^{85}Sr	64,78	13,4	514	13,4	10^4	2,2	SAFX
^{109}Cd	462,6	22	88,035	22	10^4	1,5	CDFX
^{241}Am	157800	13,93 17,61 X_L	26,34 59,54	59,54	10^4	1,9	AMFF

*Combined standard uncertainty (P = 68,3 %)

STANDARDS OF GAMMA PHOTON FLUX

DESCRIPTION

Standards of γ photon flux EFS are the point sources with minimum self-absorption emitting homogeneously to angle near 4π sr. The activity is deposited between two welded polyethylene foils with thickness less than 0,2 mm. Foils are mounted in the metal ring with outer diameter 35 mm. The active material is located in the centre of the foil.

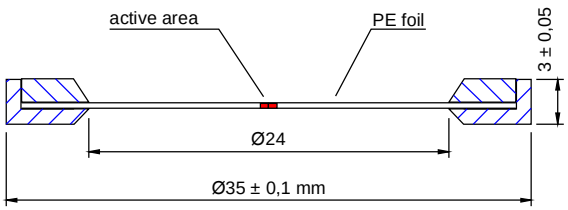
APPLICATION

The standards EFS are designed for energy and efficiency calibration of gamma spectrometers with Ge(Li) and HpGe detectors. Used radionuclides cover energy range 100 keV - 2 MeV.

MEASUREMENT

The activity of the standard is calculated from the mass and specific activity of the standard solution. The specific activity is determined by measurement.

DIMENSIONS



Nuclide	Half life days	Energy keV	Yield of photons, %	Uncertainty* %		Activity kBq	Code
				activity	photon flux		
^{57}Co	271,26	122,06 136,46	85,45 10,77	1,2	1,2 2,2	50	CTS 01
^{139}Ce	137,50	165,853	80,1	1,2	1,3	80	CCS 01
^{203}Hg	46,72	279,19	81,49	1,3	1,4	150	HGS 01
^{85}Sr	64,78	514,0	99,278	1,2	1,2	250	SAS 01

Nuclide	Half life days	Energy keV	Yield of photons, %	Uncertainty* %		Activity kBq	Code
				activity	photon flux		
^{137}Cs	11019	661,649	85,10	1,2	1,2	400	CSS 01
^{54}Mn	312,22	834,83	99,978	1,0	1,0	450	MNS 01
^{60}Co	1925,4	1173,21 1332,47	99,865 99,981	0,8	0,8	700	COS 01
^{88}Y	106,60	898,021 1836,03	93,52 99,36	1,5	1,5	700	YWS 01
^{133}Ba	3897	53,170 79,612 80,989 160,613 223,234 276,402 302,795 355,95 383,78	2,2 3,18 34,2 0,62 0,447 7,17 18,46 62,22 8,93	1,0	4,3 5,3 5,2 2,0 1,8 1,4 1,8	250	BAS 01
^{152}Eu	4858	121,782 244,7 344,281 411,11 444,0 778,91 867,40 964,01 1086,50 1112,05 1408,04	28,40 7,54 26,52 2,246 2,78 12,94 4,14 14,60 10,09 13,56 20,80	1,0 1,0	1,2 1,2 1,2 1,1 1,2 1,2 1,1 1,2 1,1 1,1 1,0	600	EUS 01

*Combined standard uncertainty (P = 68,3 %)

REFERENCE SOURCES FOR GAMMA SPECTROMETRY

DESCRIPTION

A weighed amount of the standard solution is dropped on the disc of filter paper in the polymethylmetacrylate capsule. The capsule is sealed up, when dried. The capsule and the reflector layer of common NaI(Tl) scintillators provide a sufficient filtering of β radiation of relevant radionuclide. For ^{144}Ce this filtration is not sufficient and for the types EG 1 and EG 3 layer of minimum 3,2 mm Al between the standard and the detector is necessary.

APPLICATION

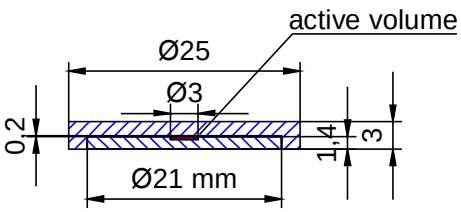
Energy and efficiency calibration of scintillation spectrometers and counters of γ and X radiation. They can serve as reference sources for relative measurements. Their activity is choose so that: standard EG 1 in closed geometry with the NaI(Tl) ϕ 38 x 25 mm ; standard EG 2 inserted to the well of NaJ(TI) ϕ 45 x 50 mm and standard EG 3 located 10 cm from the forehead of NaI(Tl) ϕ38 x 25 mm gives approx. 1700 counts per second for energy higher than 30 keV.

MEASUREMENT

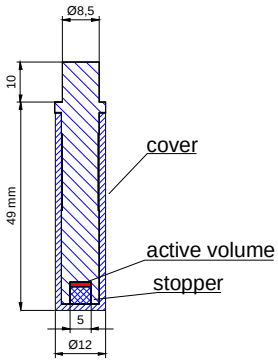
The activity of individual standards is calculated from the mass of the standard solution and is checked by relative measurements of γ photon flux. The specific activity is determined by absolute measurement using 4πβ-γ, 4πα–γ or 4πX-γ coincidence method or 4π proportional counter

DIMENSIONS

Types EG 1 and EG 3



Type EG 2



Nuclide	Half life days	Type	Activity kBq	Photon energy keV	Yield of photons %	Uncertainty* %	Code
^{22}Na	950	EG 1	5	511,0 1275,55	18,66 99,94	1,0	NAG - 1
^{22}Na	950	EG 2	3	511,0 1275,55	18,66 99,94	1,0	NAG - 2
		EG 3	100	511,0 1275,55	18,66 99,94		NAG - 3
		EG 1	13	846,76	99,92		MNG - 1
^{54}Mn	312,22	EG 2	6	846,76	99,92	0,7	MNG - 2
		EG 3	300				MNG - 3
		EG 1	6				CTG - 1
^{57}Co	271,26	EG 2	2	122,06 136,46	85,45 10,77	1,0	CTG - 2
		EG 3	150	122,06 136,46	85,45 10,77		CTG - 3
		EG 3	200				YWG - 3
^{129}I	5,734.10^{9}	EG 1	15	40	0,075	0,6	IZG - 1
		EG 2	5	29 - 33 X_K			IZG - 2
^{133}Ba	3897	EG 1	3	80,989	342	0,8	BAG - 1
		EG 2	2	302,795	18,46		BAG - 2
		EG 3	80	355,95	62,22		BAG - 3
^{137}Cs	11019	EG 1	16	661,649	85,10	0,9	CSG - 1
		EG 2	7				CSG - 2
		EG 3	300				CSG - 3
^{141}Ce	32,50	EG 1	10	145,444	48,43	0,9	CKG - 1
		EG 2	3				CKG - 2
		EG 3	250				CKG - 3
^{144}Ce	284,4	EG 1	30	133,531	11,09	1,1	CEG - 1
		EG 2	8				CEG - 2
		EG 3	600				CEG - 3
^{152}Eu	4858	EG 1	30	from 121 to 1538 keV	depends on energy	0,8	EUG - 1
		EG 2	15				EUG - 2
		EG 3	450				EUG - 3
^{203}Hg	46,72	EG 1	8	279,19	81,49	1,1	HGG - 1
		EG 2	3				HGG - 2
		EG 3	200				HGG - 3
^{241}Am	157800	EG 1	15	59,5364	35,67	0,6	AMG - 1
		EG 2	5				AMG - 2
		EG 3	450				AMG - 2

*Combined standard uncertainty (P = 68,3 %)

STANDARDS FOR LSC

DESCRIPTION

Approximately 5 g of toluene containing [U - ^{14}C]toluene or [U - ^{3}H]toluene are sealed in a glass ampoule.

APPLICATION

Efficiency calibration of measuring systems utilising liquid scintillators or combustion of labelled organic compounds. They are widely used for preparation of working standards for liquid scintillation measurements and can also serve as internal standards. After combustion they are used for calibration of internal gas counters.

MEASUREMENT

Specific activity of the standard solution is determined by suitable absolute method.

Nuclide	Half life days	Chemical form	Type	Activity kBq	Specific activity kBq/g	Mass g	*Uncertainty %	Code
^{14}C	2,089.10^{6}	^{14}C-toluene	EK 1	100	20	5	0,7	CWK
^{3}H	4510	^{3}H-toluene	EK 1	200	40	5	1,3	HWK

*Combined standard uncertainty (P = 68,3 %)

STANDARDS FOR CONTAMINATION MONITORING

DESCRIPTION

The radioactive substance is dissolved in a colour lacquer that is uniformly deposited on a disc metal base in a layer with square weight less than 1 mg. cm^{-2}. The active layer must be protected against organic solvents and temperature exceeding 60 °C.

APPLICATION

Efficiency calibration in measurements of various radionuclides in thin layer particularly for checking of relative measurements in surface, water, air and personnel contamination with α and ß emitting radionuclides. Likewise for checking of stability of contamination monitors. For measurements of contamination can be used also standards EZ with larger active area.

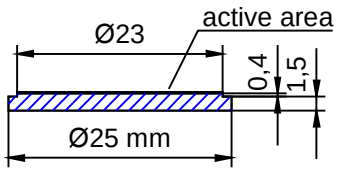
MEASUREMENT

The activity is determined by comparison of α or ß particle flux of the standard with IIR standards. Square weight is calculated from the mass of lacquer and the active area.

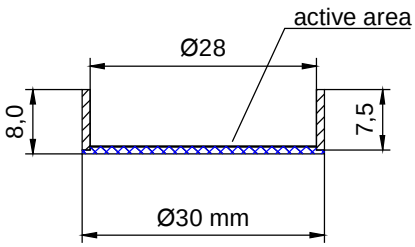
Base	Dimensions mm	Type	Activity Bq
Duraluminium plate	a = 23	EM 1	41,5
	b = 25	EM 2	4,15
	c = 1,5	EM 3	415
	d = 0,5	EM 4	41,5
Duraluminium dish	e = 28	EM12	61,6
	f = 30	EM 22	6,16
	g = 8	EM 32	616
	h = 7	EM 42	61,6
Duraluminium plate	a = 44,5	EM 145	185
	b = 48,5		
	c = 1	EM 445	185
	d = 0,5		

DIMENSIONS

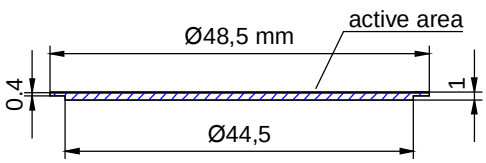
EM 1, 2, 3, 4



EM 12, 22, 32, 42



EM 145, 445



Nuclide	Half life days	Energy, keV			Type	Square activity $Bq.cm^{-2}$	Uncertainty* %	Code
		particles a	particles b	photons g				
^{14}C	$2{,}089.10^{6}$		155		EM 1	10	1,8	CWM 1
					EM 12			CWM 12
					EM 3	100		CWM 3
					EM 32			CWM 32
^{60}Co	1925,4		310	1173 1332	EM 1	10	1,3	COM 1
					EM 12			COM 12
					EM 3	100		COM 3
					EM 32			COM 32
$^{90}Sr^{**}$	10281		540 2260		EM 1	10	1,3	STM 1
					EM 12			STM 12
					EM 145			STM 145
					EM 3	100		STM 3
					EM 32			STM 32
^{137}Cs	11019		520 1170	661	EM 1	10	1,6	CSM 1
					EM 12			CSM 12
					EM 3	100		CSM 3
					EM 32			CSM 32
^{147}Pm	958		220		EM 1	10	2,0	PMM 1
					EM 12			PMM 12
					EM 3	100		PMM 3
					EM 32			PMM 32
^{204}Tl	1384		770		EM 1	10	1,8	TLM 1
					EM 12			TLM 12
					EM 3	100		TLM 3
					EM 32			TLM 32
U_nat	+	4150 4750	190 2310		EM 2	1	2,0	UWM 2
					EM 22			UWM 22
					EM 4	5		UWM 4
					EM 42			UWM 42
^{239}Pu	$8{,}806.10^{6}$	5147			EM 2	1	1,6	PUM 2
					EM 22			PUM 22
					EM 4	10		PUM 4
					EM 42			PUM 42
^{241}Am	157800	5437 5480		60	EM 2	1	1,3	AMM 2
					EM 22			AMM 22
					EM 445	10		AMM 445
					EM 4			AMM 4
					EM 42			AMM 42

*Combined standard uncertainty (P = 68,3 %)

** ^{90}Sr is in radioactive equilibrium with ^{90}Y

+ Uranium with natural abundance of uranium isotopes is mixture of ^{238}U and ^{234}U in radioactive equilibrium containing 0,72 % ^{235}U. Half lifes: ^{238}U - $1{,}65.10^{12}$ days, ^{235}U $2{,}59.10^{11}$ - days, ^{234}U - $9{,}02.10^{7}$ days.

STANDARDS FOR NUCLEAR MEDICINE

DESCRIPTION

Standards in 10 ml penicillin vials in form of polyacrylamide gel, active volume is 5 ml. In case of breaking the vial , polyacrylamide gel prevents from larger contamination, which the radioactive solution would not.

APPLICATION

The standards are used for calibration and checking of measuring devices in nuclear medicine, e.g. activity calibrators.

MEASUREMENT

The activity is determined by measurement in 4π gamma ionization chamber which is the part of national standard of activity.

Nuclide	Half life days	Photon energy keV	Yield of photons %	Activity MBq	Uncertainty* %	Code
^{57}Co	271,26	122,06 136,46	85,45 10,77	5	1,5	CTNM
^{60}Co	1925,4	1173,21 1332,47	99,87 99,98	5	0,8	CONM
^{133}Ba	3897	30,63 30,97 35,00 35,80 80,989 276,402 302,795 355,95 383,78	32,00 61,51 17,00 3,70 34,2 7,17 18,46 62,22 8,93	5	1,2	BANM
^{137}Cs	11019	661,649	85,10	5	1,2	CSNM
^{241}Am	157800	59,54	35,67	5	2,3	AMNM

*Combined standard uncertainty (P = 68,3 %)

^{226}Ra SEALED SOLID STANDARDS

DESCRIPTION

A mixture of $RaSO_4$ and $BaSO_4$ is encapsulated in a cylindrical cell which is soldered, put in a tube or needle with length 13,5 - 25,5 mm and diameter 1,65 - 2,65 mm and soldered again. Both the cell and the outer capsule are made from alloy of 90 % Pt and 10 % Ir. The total wall thickness is 0.5 $\pm$ 0.05 mm which is sufficient to absorb all alpha and beta radiation.

APPLICATION

The standards are designed for calibration of dosimetric instruments, efficiency calibration in activity measurements of ^{226}Ra and other radionuclides. The calibration of dosimetric instruments is based on the knowledge that 1 g of ^{226}Ra with a 0.5 mm Pt filter has an exposure rate $59{,}12 \cdot 10^{-9}$ A. kg^{-1}.

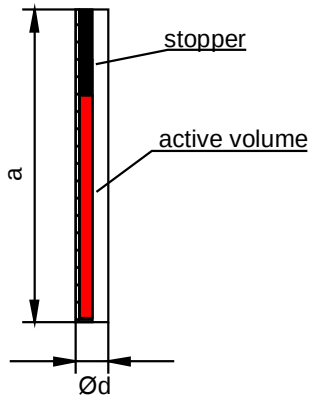
MEASUREMENT

Mass of ^{226}Ra is determined by comparison with IIR primary radium standards by means of $4\pi\,\gamma$ ionization chamber. Radiation of primary standards is filtered with 0,5 mm Pt.

DIMENSIONS

a = 13,5 - 25,5 mm
d = 1,65 - 2,65 mm

+



Nuclide	Half life days	Type[1]	Mass of Ra[2], mg	Uncertainty %[3]	Code
^{226}Ra	584300	EP 10	20	0,5	RAP-22
		EP 9	10	0,5	RAP-12
		EP 8	5	0,5	RAP-53
		EP 1	1	0,5	RAP-13
		EP 14	0,1	0,5	RAP-14
		EP 15	0,01	0,6	RAP-15
		EP 16	0,001	0,7	RAP-16

1. These standards are sealed sources and are tested for leakage
2. Activity of 1 g ^{226}Ra is $3{,}658 \cdot 10^{10}$ Bq
3. Combined standard uncertainty (P = 68,3 %)

QUENCHED STANDARD SET

DESCRIPTION

The set of ten sealed glass vials containing [U-^{14}C]toluene or [U-^{3}H]toluene in the liquid scintillation solution. In each vial is the same activity but different amount of quenching agent (tetrachloromethane). There are two types of vials: 20 ml containing 10 ml of the active solution and 8 ml containing 5 ml. Default scintillator is the toluene scintillator SLT 41; different one is possible on request.

APPLICATION

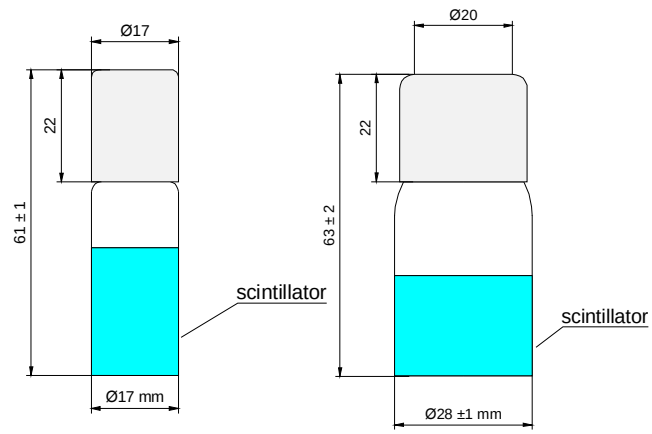
The set of quenched standards is designed for determination of efficiency correction curves in liquid scintillation measurements.

MEASUREMENT

The activity of the standard is calculated from the mass and the specific activity of EK standard in the solution. Control measurement of the set is performed on LS spectrometer.

DIMENSIONS

Minivial Standard vial



Nuclide	Half life days	Activity kBq	Uncertainty* %	Code
^{3}H	4510	8	1,4	HWQT
^{14}C	2,089.10^{6}	5	1,1	CWQT

*Combined standard uncertainty (P = 68,3 %)

RADIOACTIVE STANDARD SOLUTIONS

DESCRIPTION

Approximately 1 or 5 g of the radioactive solution is sealed in a glass ampoule. Review of types and their parameters is in the table no. 1.

APPLICATION

The standards are designed for efficiency calibration of all kinds of detectors, type ER 2 is especially suitable for the calibration of proportional, scintillation and GM counters, types ER 3 and ER X for ionisation chambers. Standard solutions are used either directly or after dilution for preparation of working standards. Application for internal standards is also possible.

MEASUREMENT

The ER 2 and ER 25 standards are directly prepared from a standard solution, the specific activity of which was determined by absolute measurement using the 4 π (α, β, X, e) - γ coincidence method or by a 4π proportional counter. The specific activity of the ER 3 and ER X standards is calculated from the dilution ratio and the specific activity of ER 2 standard solution. Some standards are denoted with suffix K, which means that their activities were determined by measurement on IIR 4π–γ ionisation chamber.

Table 1

Type	Mass g	Specific activity MBq/g	Activity MBq	Packing	Code
ER 1*	1	0,005	0,005	glass ampoule 1 ml	IZR 1(^{129}I)
ER 2	1	0,100	0,100	glass ampoule 1 ml	...R 2
ER 25	5	0,100	0,500	glass ampoule 5 ml	...R 25
ER 3	1	5	5	glass ampoule 1 ml	...R 3
ER X	1 - 5	up to 50	up to 50	glass ampoule 1 or 5 ml	...R X

* it refers only to ^{129}I standards

In table 2 are assigned basic parameters and codes

Table 2

Nuclide	Half life, days	Chemical composition of aqueous solution	Uncertainty* %	Code
^{3}H	4510	H_2O	1,7	HWR
^{7}Be	53,23	30 mg $BeSO_4$/l + 3 g HCl /l	1,0	BER
^{14}C	$2,089 . 10^{6}$	5 g Na_2CO_3/l	1,5	CWR
^{22}Na	950	50 mg NaCl /l + 36 g HCl /l	0,8	NAR
^{24}Na	0,62571	50 mg NaCl /l + 36 g HCl /l	0,6	NKR
^{32}P	14,30	50 mg/ H_3PO_4/l	0,6	PWR
^{35}S	87,46	50 mg Na_2SO_4/l	1,3	SWR
^{42}K	0,515	100 mg $KHCO_3$/l	0,6	KWR
^{45}Ca	162,8	20 mg $CaCl_2$/l + 3 g HCl/l	1,2	CAR
^{51}Cr	27,701	30 mg $CrCl_3$/l + 3 g HCl /l	0,8	CRR
^{54}Mn	312,22	50 mg $MnCl_2$/l + 3 g HCl/l	0,6	MNR
^{55}Fe	986	50 mg $FeCl_3$/l + 3 g HCl/l	2,7	FMR
^{56}Co	77,7	20 mg $CoCl_2$/l + 3 g HCl/l	1,9	CBR
^{57}Co	271,26	20 mg $CoCl_2$/l + 3 g HCl/l	0,8	CTR
^{58}Co	70,78	20 mg $CoCl_2$/l + 3 g HCl/l	1,0	CYR
^{59}Fe	44,54	50 mg $FeCl_3$/l + 3 g HCl/l	0,8	FER
^{95}Nb	35,04	12 mg $(NH_4)_3NbO(C_2O_4)_3$/l + 0,5 g $H_2C_2O_4$/l	0,6	NBR
^{99}Mo	2,750	25 mg $(NH_4)_2MoO_4$/l + 0,3 g NH_4OH/l	1,0	MOR
^{99m}Tc	0,25096	3 g NH_4OH/l	1,5	TCR
^{103}Ru	39,34	50 mg $RuCl_3$/l + 30 g HCl/l	1,2	RKR
^{106}Ru	368,3	50 mg $RuCl_3$/l + 50 mg $RhCl_3$/l + 30 g HCl/l	1,2	RUR
^{109}Cd	462,6	50 mg $CdCl_2$/l + 3 g HCl/l	1,3	CDR
^{113}Sn	115,10	50 mg H_2SnCl_6/l + 216 g HCl/l	1,2	SNR
^{124}Sb	60,20	50 mg $SbCl_3$/l + 70 g HCl/l	1,2	SBR
^{125}I	59,89	50 mg KI/l + 50 mg $Na_2S_2O_3$/l	0,6	ITR
^{129}I	$5,734 . 10^{9}$	4 g KI/l + 10 g $Na_2S_2O_3$/l	0,6	IZR
^{131}I	8,051	50 mg KI/l + 50 mg $Na_2S_2O_3$/l	0,6	IWR
^{132}Te	3,26	50 mg Na_2TeO_3/l + 25 mg KI/l + 25 mg $Na_2S_2O_3$/l	1,3	TER
^{133}Ba	3897	30 mg $BaCl_2$/l + 3 g HCl/l	0,6	BAR
^{134}Cs	753,0	20 mg CsCl/l + 3 g HCl/l	0,8	CGR
^{137}Cs	11019	20 mg CsCl/l + 3 g HCl/l	0,8	CSR
^{139}Ce	137,50	20 mg $CeCl_3$/l + 3 g HCl/l	0,8	CCR
^{141}Ce	32,50	30 mg $CeCl_3$/l + 3 g HCl/l	0,8	CKR
^{144}Ce	284,4	20 mg $CeCl_3$/l + 20 mg $PrCl_3$ + 3 g HCl/l	1,0	CER
^{147}Pm	958,0	20 mg $PrCl_3$ /l + 20 mg $NdCl_3$ + 3 g HCl/l	1,5	PMR
^{152}Eu	4858	30 mg $EuCl_3$/l + 3 g HCl/l	0,6	EUR
^{170}Tm	128,6	30 mg $TmCl_3$/l + 3 g HCl/l	0,6	TMR
^{192}Ir	74,12	50 mg Na_2IrCl_6/l + 3 g HCl/l	0,8	IRR
^{197}Hg	2,671	50 mg $Hg(NO_3)_2$/l + 4 g HNO_3/l + 50 mg H_2SO_4/l	1,5	HKR
^{198}Au	2,6935	50 mg $KAu(CN)_4$/l + 50 mg KCN/l	0,9	AUR
^{203}Hg	46,72	50 mg $Hg(NO_3)_2$/l + 4 g HNO_3/l + 50 mg H_2SO_4/l	1,0	HGR
^{204}Tl	1384	30 mg Tl_2SO_4/l + 3 g HNO_3/l	1,3	TLR
^{210}Po	138,4	25 mg TeO_2/l + 63 g HNO_3/l	1,3	POR
^{210}Pb	8108	20 mg $Pb(NO_3)_2$/l + 20 mg $Bi(NO_3)_3$/l + 25 mg TeO_2/l + 63 g HNO_3/l	1,3	PBR
^{239}Pu	$8,806 . 10^{6}$	63 g HNO_3/l	1,2	PUR
^{241}Am	157800	20 mg $Sm(NO_3)_3$/l + 6,3 g HNO_3/l	0,4	AMR

STANDARDS SIMULATING CONTAMINATED STEEL

DESCRIPTION

Cylinder shape standards type ESCO and ESCS consist of outer case with inserted discs with activity of ^{60}Co or ^{137}Cs. Activity is deposited in points in the net 5 x 5 mm. Discs putting together originate a cylinder with approximately homogeneously deposited activity. Disc and case are made from polished stainless steel. Standard dimension of cylinder is 35 x 15 mm , standard dimension of one disc is 34 x 0,8 mm (diameter x thickness). Other dimensions are made according to requirements of customer.

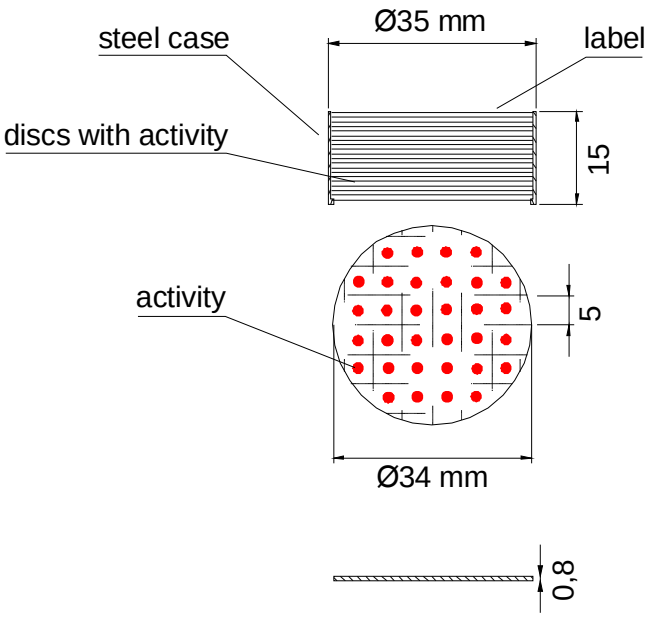
APPLICATION

Standards are designed for efficiency calibration of gamma spectrometers used for checking ^{137}Cs and ^{60}Co activity in steel. These radionuclides can occur in scrap iron as a result of liquidation of medical or industrial sources. According to customer requirements is possible to prepare standards with other radionuclides or
with mixture of radionuclides.

MEASUREMENT

Activity of the standard is calculated from the mass and specific activity of the standard solution. The specific activity is determined by suitable absolute method. Produced sources are checked by comparison with IIR by standards gamma spectrometry with HpGe detector.

DIMENSIONS



CODE: ESCO (^{60}Co), ESCS (^{137}Cs)

^{125}I SIMULATING RADIOACTIVITY STANDARD

DESCRIPTION

1 ml of polymerised mixture of epoxy resin containing ^{241}Am and ^{129}I in the plastic test tube with dimensions 12 x 73 mm (diameter x length). Activities of ^{241}Am and ^{129}I are in such a ratio that resulting spectrum γ on a well type NaI(Tl) detector corresponds as much as possible with ^{125}I γ spectrum. Test tube is closed by plastic stopper.

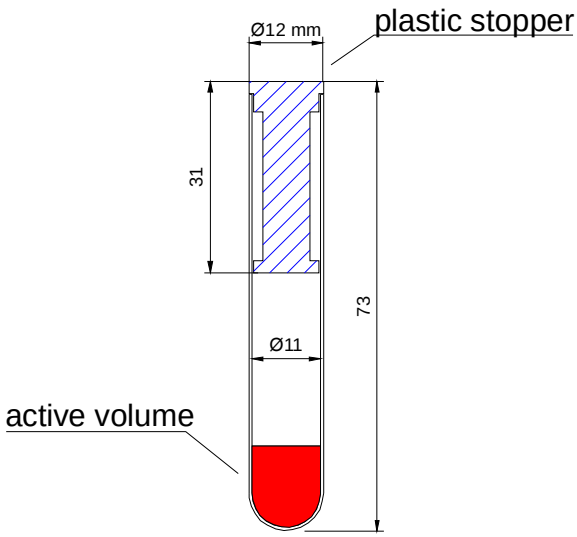
APPLICATION

The standards are designed for the calibration and checking of RIA gamma counters, especially for the measuring of kits with ^{125}I.

MEASUREMENT

The effective activity is determined by the comparison measurement with ^{125}I working standards using the γ spectrometer with a well type NaI(Tl) detector 50 x 50. Nominal activity is 1500 Bq of ^{125}I.
Code: ESIT.

DIMENSIONS



CODE: ESIT

EU GAMMA-CAMERA CALIBRATION STANDARDS

DESCRIPTION

Standards of homogeneity with annular or rectangular shape in a metal case (aluminium alloy).
^{57}Co is homogeneously dispersed in the layer of polymerised epoxy resin.

APPLICATION

They are designed for checking of uniformity of scintillation gamma cameras used in nuclear medicine.
The standards with annular shape are designed for measurement with one head cameras from side of the deck, the standards with rectangular shape are side balanced and therefore they are designed for two and multihead camera systems.

MEASUREMENT

Homogeneity of activity distribution is checked by means of scanner device with HpGe detector and the collimator 1 x 1 cm. Homogeneity, formulated as standard deviation of counts from the area 1 x 1 cm, is less than 1 %.

Nuclide	Half life days	Dimensions of the active layer mm	Thickness of the active layer mm	Activity MBq	Outer dimensions mm	Overall thickness mm	Code
^{57}Co	271,26	ϕ 330	4	40	ϕ 338	15	CTUA 40
				80			CTUA 80
				180			CTUA 180
				400			CTUA 400
		ϕ 400	4	40	ϕ 408	15	CTUB 40
				80			CTUB 80
				180			CTUB 180
				400			CTUB 400
		ϕ 500	4	40	ϕ 508	15	CTUC 40
				80			CTUC 80
				180			CTUC 180
				400			CTUC 400
		580 x 440	8	400	600 x 460	12	CTUH 400

LARGE AREA STANDARDS FOR CONTAMINATION MONITORING

DESCRIPTION

The radioactive substance is dissolved in a colour lacquer which is uniformly deposited on the plate with dimensions 200 x 140 x 1,5 mm in a layer with square weight less than 1 mg. cm^{-2}. The active layer 110 x 150 mm must be protected against long term exposure to organic solvents and temperature exceeding 60 ^{o}C.

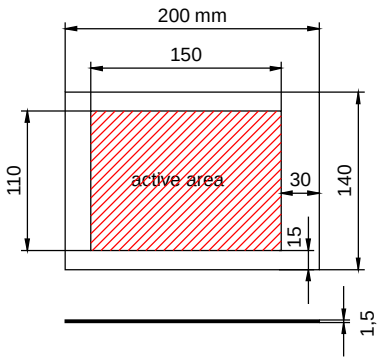
APPLICATION

Efficiency calibration of instruments for monitoring the surface and personal contamination by α and ß emitting radionuclides. Likewise they can be used for checking of contamination monitor stability.

MEASUREMENT

The activity is determined by comparison of α or ß particle flux of the standard with standards of IIR. The square weight is calculated from the mass and the area of the active layer.

DIMENSIONS



Nuclide	Half life days	Energy keV particles a	Energy keV particles b	Energy keV photons g	Type	Square activity Bq.cm^{-2}	Uncertainty* %	Code
^{14}C	2,089. 10^{6}		155		EZ 1	10	1,8	CWZ-1
^{60}Co	1925,4		310	1173 1332	EZ 1	10	1,6	COZ-1
^{90}Sr**	10281		540 2260		EZ 1	10	1,6	STZ-1
^{137}Cs	11019		520 1170	661	EZ 1	10	1,6	CSZ-1
^{147}Pm	958		220		EZ 1	10	1,6	PMZ-1
^{204}Tl	1384		770		EZ 1	10	1,6	TLZ-1
U_{nat}	+	4150 4750	190 2310		EZ 2	1	1,8	UWZ-2
^{239}Pu	8,806 . 10^{6}	5147			EZ 2	1	1,8	PUZ-2
^{241}Am	157800	5437		60	EZ 2	1	1,6	AMZ-2

*Combined standard uncertainty (P = 68,3 %)

** ^{90}Sr is in radioactive equilibrium with ^{90}Y

+ Uranium with natural abundance of uranium isotopes is mixture of ^{238}U and ^{234}U in radioactive equilibrium containing 0,72 % ^{235}U. Half lifes: ^{238}U - 1,65.10^{12} days, ^{235}U 2,59.10^{11} - days, ^{234}U - 9,02.10^{7} days.

BOMAB PHANTOM

DESCRIPTION

The Bottle Manequin Absorber Phantom (BOMAB) is the model of the human body 170 cm tall, separated into ten discrete parts, which can be independently filled. It is made from high density polyethylene, 4.8 – 5 mm thick, internal volume is approximately 55 dm^3. It is supplyed either empty or filled with non active silicone resin with specific density near 1 $g.cm^{-3}$ or filled with the same material containing activity, usually ^{152}Eu. The overall dimensions comply with requirements of Reference Man described in ICRP 23.

application

BOMAB provides a functional simulation for the scattering of radiation in an adult human figure, to calibrate and check of whole body counters used for *in vivo* determination of deposited γ emitting radionuclides.

measurement

The activity is calculated from the specific activity and the mass of used standard solutions and from mass of filler.

DIMENSIONS

description	number, pcs	shape	profile, cm	height, cm	volume, dm^3
head	1	ellipse	19 x 14	20	3,50
neck	1	circle	13 – diameter	10	1,00
thorax	1	ellipse	30 x 20	40	15,00
lumbar	1	ellipse	36 x 20	20	9,00
thigh	2	circle	15 – diameter	40	5,90
leg	2	circle	12 - diameter	40	3,60
arm	2	circle	10 – diameter	60	3,60

MBSS STANDARDS IN MARINELLI BEAKERS

DESCRIPTION

Marinelli beakers are filled with silicone rubber containing uniformly distributed radionuclide or mixture of radionuclides. Default density of the active volume is 0,98 $g.cm^{-3}$ and mean atomic number approaches water. The standards are available in 3 types of polypropylene beakers with default volumes 450, 500 and 1000 ml. Other volumes, nuclides, activities, density (up to 1,6 $g.cm^{-3}$) or beakers are available on request.

APPLICATION

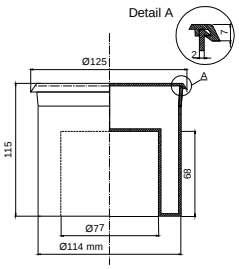
Energy and efficiency calibration of gamma spectrometers .

MEASUREMENTS

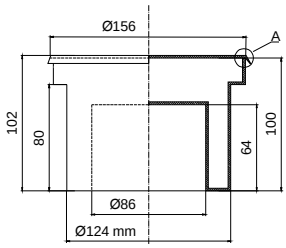
The standards are prepared from the standard solutions ER(EB) whose activity is determined by absolute method. The final sources are checked by measurement on gamma spectrometer with HPGe detector. Combined standard uncertainty of activity is approx. 2 %.

DIMENSIONS

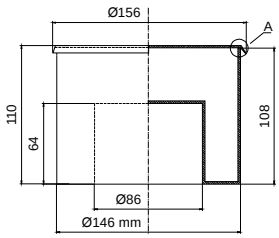
Type 0530G



Type 0540G



Type 1040G



Type	Nuclide	Half life, days	Activity, kBq
MBSS 1	^{152}Eu	4858	3
MBSS 2	mixture according to IEC 697/81	-	40
MBSS 3	^{134}Cs	753	*
MBSS 4	^{137}Cs	11019	3
MBSS 5	^{226}Ra	584300	3
MBSS 6	^{57}Co	271,26	*
MBSS 7	^{60}Co	1925,4	3
MBSS 8	^{241}Am	157800	10
MBSS 9	^{232}Th	$5,15 . 10^{12}$	1,5
MBSS 10	^{153}Gd	241,6	*
MBSS 12	^{133}Ba	3897	*
MBSS 13	^{109}Cd	462,6	20
MBSS 14	^{210}Pb	8108	*
MBSS 15	^{192}Ir	74,12	*
MBSS 16	^{85}Sr	64,78	*
MBSS 17	^{54}Mn	312,22	*
MBSS 18	^{88}Y	106,60	*
MBSS 19	^{139}Ce	137,50	*
MBSS 20	^{40}K	$4,602 . 10^{11}$	1,5

* - on request

^{222}Rn FLOW THROUGH SOURCES

DESCRIPTION

Accurate and long term stable sources of defined activity of ^{222}Rn in gas phase. Radon is released from thin layer of a plastic foil with emanation power approaching 1. The source is constructed as a stainless steel cylindrical case supplied on the ends with the two ball valves and the two aerosol filters connected on the output aperture of the valves. All parts are made from stainless steel or Teflon. The sources are produced in activity range 20, 100, 200, 500, 1000 a 2000 kBq of ^{226}Ra with commercial label RF 20, RF 100, ... RF 2000.

APPLICATION

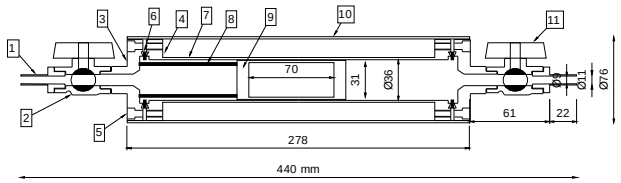
The sources are designed for laboratory and field conditions. The main application is calibration of devices and detectors for activity measurements of ^{222}Rn and ^{226}Ra for environmental research. The user can apply the source in batch or flow through mode.

MEASUREMENT

The activity of ^{226}Ra is determined by comparison with IIR standards, the emanation power by gamma spectrometry on a HpGe detector.

DIMENSIONS

^{222}Rn flow through source type RF



RF source - IIR Praha 2004	
1 - inlet/outlet tube	10 - casing
2 - valve	11 - lever
3 - flange	
4 - flange	
5 - screw M6	
6 - aluminium seal ring	
7 - tube	
8 - holder	
9 - dish with emanator	
Material: stainless steel, Teflon, aluminium and ceramic cement	

SPECIFICATION

Combined standard uncertainty of ^{226}Ra activity	< 1,6 %
Emanation power	>= 0,995
Internal volume	263 cm^3
Maximum flow of carrier gas	10 l/min.
Working temperature and relative moisture	0 - 40 ^{o}C, 0 - 100 %
Dimensions	440 x 76 mm
Weight	3,083 kg