STATE SCIENTIFIC CENTER–
RESEARCH INSTITUTE OF ATOMIC REACTORS

ROSATOM STATE CORPORATION ENTERPRISE

CATALOGUE

RADIOACTIVE SOURCES AND RADIOCHEMICALS

STATE SCIENTIFIC CENTER–
RESEARCH INSTITUTE OF ATOMIC REACTORS

ROSATOM STATE CORPORATION ENTERPRISE

CATALOGUE

RADIOACTIVE SOURCES AND RADIOCHEMICALS

Second Edition. Revised and Expanded

Dimitrovgrad
2019

UDC 621.039.8(085.2)
SCSTI 58.31.01
LBC 24.13

Catalogue. Radioactive Sources and Radiochemicals:
2nd Edition. Revised and Expanded-Dimitrovgrad: JSC "SSC RIAR",
2019. — 45 pages.

The Catalogue summarizes information about radioactive sources and radiochemicals produced by JSC "SSC RIAR", key specifications, quality management system and quality control data.

References

L — source length; l — active core length; D — source diameter; d — active core diameter; H — height; B — width; s — thickness.

Dose rate is measured at 1 m distance from the source.
The category of radiation hazard and safety class of sources are given in accordance with the Federal Regulations and Rules in the field of atomic energy use "General Provisions for the Safety of Radioactive Sources" (NP-038-16), strength class is in accordance with the State Standard "Sealed Ionizing Radiation Sources. Strength Classes and Test Methods "(GOST R 52241-2004 (ISO 2919: 1999)).
The specified lifetime of the source is shown from the date of its manufacture.

Areas of sources applications:

— industry (radiography, radiometric and analytical equipment, portable power sources, photon/ionizing emission sources);

— medicine (raw material for radiopharmaceuticals);

— scientific research.

ISBN 978-5-94831-179-1

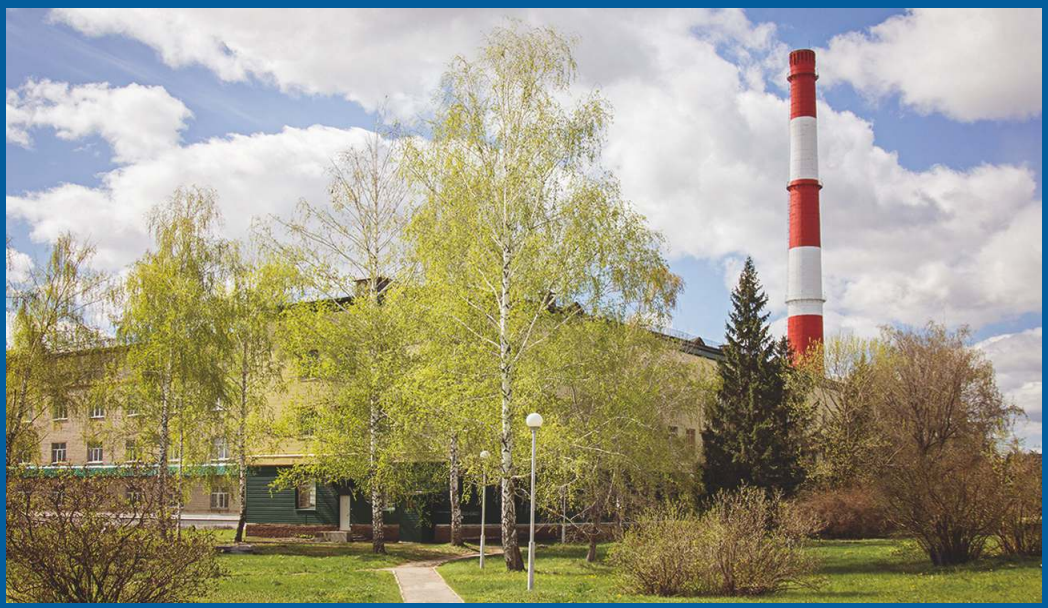
Contents

Alexander Tuzov
Director of JSC "SSC RIAR"

For several years JSC "SSC RIAR" has been holding its strong position in producing high specific activity radioisotopes in both the Russian and world markets. Currently, the Institute continues implementing projects aimed at modernizing existing and creating new areas for the radioisotopes production and widening the nomenclature of radioisotope products. We are ready to meet stakeholder representatives for more detailed acquaintance with our production capabilities and available products and to discuss mutually beneficial cooperation.

The following features contribute to the uniqueness of RIAR's radionuclides production:
— Six research reactors under operation, three of which are used to accumulate radionuclides;
— Radiochemical facilities to handle irradiated materials up to 100 kCi (3 700 TBq);
— Facilities to manufacture a wide range of sealed sources;
— Engineering and process systems to support the production infrastructure;
— Radwaste collection, processing and disposal facilities;
— Own fleet of special-purpose vehicles and certified transport packages;
— Highly-qualified staff and management having many-year experience in both the Russian and world markets.

JSC "SSC RIAR" is the only Russian manufacturer of:
—Isotopes of curium and berkelium as radioactive sources and radiochemicals;
— Nickel-63, Strontium-89, Ruthenium-106, Cesium-131, Gadolinium-153, Lutetium-177, Tungsten-188;
— Cobalt-60 sealed sources with high specific activity (more than 250 Ci/g (9.25 TBq/g)) and Selenium-75.



QMS for Radionuclides Production

Since 2012, JSC “SSC RIAR” has developed, documented, implemented and maintained a quality management system that meets the requirements of ISO 9001 (GOST R ISO 9001) “Quality Management Systems. Requirements". Measures are developed and implemented to improve its performance aimed at meeting the requirements and consumers' demands for quality of products. The quality management system covers various activities of the Institute, including the radionuclides production.
Certification Association "Russian Register", being a member of IQNet International Certification Network , acknowledged that the QMS of JSC "SSC RIAR" complied with the ISO 9001:2008 and GOST P ISO 9001 requirements in terms of design, production and delivery of radioactive sources and radiochemicals.
In 2018, the quality management system of JSC “SSC RIAR” was recertified. The Russian Register Association found that the management system functioned, continued developing in accordance with the principle of sustainable improvement, was efficient and met the audit criteria. According to the audit results, certificates were issued as of 22.08.2018:
- № 18.1390.026 - on compliance with the requirements of ISO 9001: 2015 in the Russian Register Certification System;
- № 18.1395.026 - on compliance with the requirements of GOST R ISO 9001-2015 in the Russian Register Certification System;
- № RU-18.1390.026 - on compliance with the requirements of ISO 9001: 2008 in the IQNet International Certification Network.

Quality Control

Main consumer characteristics of radionuclides are radiation parameters. The applied methods, measuring instruments and reference sources have passed through metrological certification. Main safety criteria for sealed ionizing sources are their tightness and level of surface contamination. Methods to control these parameters comply with the requirements of the international standard ISO 9978: 1992 (E) (GOST R 51919-2002).

RADIATION PARAMETERS TO BE VERIFIED:

Gamma sources:

— exposure rate at 1 m from the source;
— equivalent source activity (calculated);
— gamma spectrum.

Neutron sources:

— neutron flux from the source;
— radionuclide activity (calculated);
— uniformity of radionuclide activity for lengthy sources (source lengthwise).

RADIOCHEMICALS PARAMETERS TO BE VERIFIED:

— activity (total, specific), radioactive concentration;
— purity (radiochemical, radionuclide, chemical);
— chemical composition.

METHODS OF CONTROL APPLIED:

Immersion test. The source is immersed into liquid that is neutral for capsule material but perfectly leaches radioactive substances. The liquid is heated for 10 minutes to boiling and cooled. The cycle is repeated twice. The activity of all the liquid should not exceed 0.2 kBq (about 5 nCi).

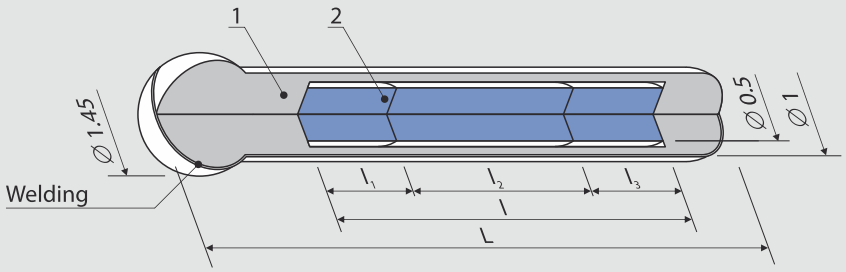
Helium leak detection. The source is placed in a pressure test cell where pumpdown is done to achieve pressure not exceeding 13.3 Pa. The cell is filled with technically pure helium up to 1 MPa. The sample is kept during 0.5-2 h at such pressure. Then, the pressure is reduced to atmospheric pressure, and the sample is taken out from the cell, cleaned by dry nitrogen blowing and moved to a measuring cell where pumpdown is done to reach the pressure required for the used helium leak detector type. The helium leak detector is connected to the cell to measure helium flow according to the detector operation manual. If the measured helium flow does not exceed the value specified in the international standard ISO 9978:1992(E) the source proves to be sealed.

Vacuum bubble test is used for process control. The source is immersed into liquid (ethylene glycol, alcohol, silicone oil or water) in a vacuum cell where pressure is reduced to 15-25 kPa. Absence of bubbles for 1 minute proves the source tightness.

Swab test consists in taking possible radioactive contamination from the source surface with a wet or dry swab. The swab may be wetted with water, diluted nitric acid or another solution inactive for capsule material but actively removing radioactive contamination. If measured swab activity does not exceed 0.2 kBq (about 5 nCi), the sealed source surface proves to be non-contaminated.

1. Radioactive Sources

^{60}Co Cobalt-60



General view of the source: 1 — capsule; 2 — active core

Key specifications

Specification	Description
Design	Lengthy sealed capsule
Capsule material	Austenitic stainless steel or titanium alloy
Active core material*	Cobalt-60, metal
Emitting area	Lateral surface
Strength class	ISO/99/S 65344
Specified lifetime	10 years

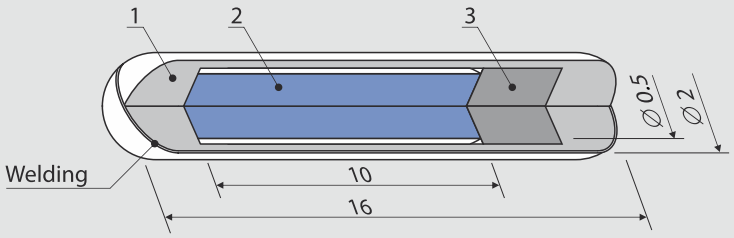
* Non-uniformity of activity distribution lengthwise the source does not exceed (2.5 ± 0.5) % at the ratio of end sections (I_1 and I_3) linear activity to central section (I_2).

GC60M1 source specifications

Source type	Size, mm						Nominal exposure dose rate**, nA/kg	Nominal equivalent activity**, MBq (mCi)	Radiation hazard category (safety class)
	D	L	d	l	$I_1 = I_3$	I_2			
GC60M11.75	1.0	25.0	0.5	20.0	5.0	10.0	0.19	75 (2.0)	5 (2)
GC60M11.85							0.21	85 (2.3)	
GC60M11.95							0.24	95 (2.6)	
GC60M11.105							0.27	105 (2.8)	
GC60M12.85		35.0		30.0		20.0	0.21	85 (2.3)	
GC60M12.95							0.24	95 (2.6)	
GC60M12.105							0.27	105 (2.8)	
GC60M12.115							0.29	115 (3.1)	

**Allowed deviations for medical- and industrial-purpose sources make +20 and ±20 %, respectively.

^{60}Co Cobalt-60



General view of the source: 1 — capsule; 2 — active core; 3 — plug

Key specifications

Specification	Description
Design	Sealed capsule
Capsule material	Austenitic stainless steel or titanium alloy
Active core material *	Cobalt-60, metal
Emitting area	Lateral surface
Strength class	ISO/99/S 65344
Specified lifetime	10 years

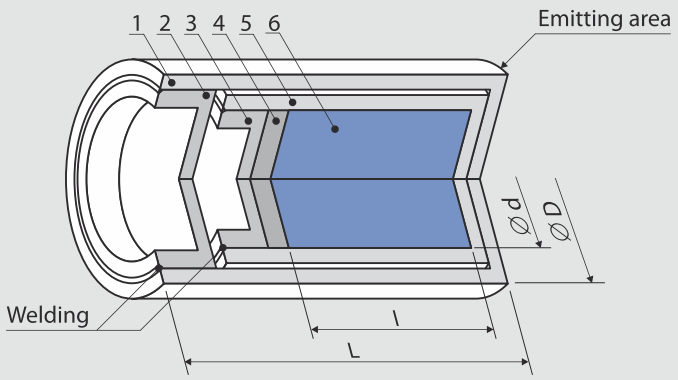
*Non-uniformity of activity distribution lengthwise the source does not exceed (2.5 ± 0.5) %.

GC60M4 source specifications

Source type	Size, mm				Nominal exposure dose rate**, nA/kg	Nominal equivalent activity**, MBq (mCi)	Radiation hazard category (safety class)
	D	L	d	l			
GC60M41.207	2.0	16.0	0.5	10.0	0.50	200 (5.4)	5 (2)
GC60M41.257					0.63	250 (6.8)	
GC60M41.307					0.75	300 (8.1)	4 (2)
GC60M41.357					0.87	350 (9.5)	

** Allowed deviations for medical-and industrial-purpose sources make +20 and ±20 %, respectively.

^{60}Co Cobalt-60



General view of the source: 1 — outer capsule; 2 — outer plug; 3 — inner plug; 4 — fastener; 5 — inner capsule; 6 — active core

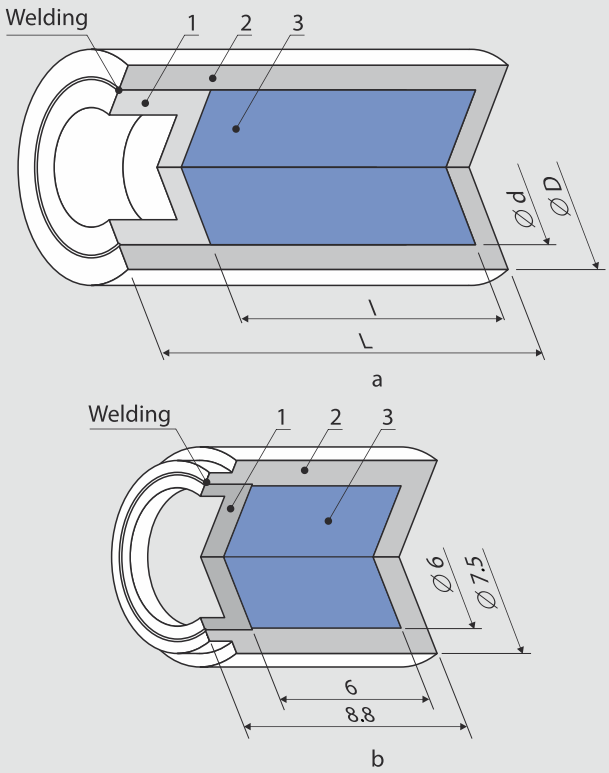
Key specifications

Specification	Description
Design	Sealed double encapsulated design
Capsule material	Austenitic stainless steel
Active core material	Cobalt-60, metal
Emitting area	Bottom
Strength class	ISO/99/S 65444
Specified lifetime	15 years

GC60T source specifications

Source type	Size, mm				Max exposure dose rate, mA/kg	Max equivalent activity, TBq (kCi)	Radiation hazard category (safety class)
	D	L	d	l			
GC60T01	13.6	36.9	10.3	29.9	0.331	133 (3.60)	1 (1)
GC60T02	18.2		15.0		0.626	252 (6.81)	
GC60T03	23.6		20.3		1.380	555 (15.00)	
GC60T04	23.0	22.5	20.0	16.4	0.534	215 (5.81)	
GC60T05		33.0		26.9	0.921	370 (10.00)	
GC60T06	21.3	36.9	18.0	29.9			

^{60}Co Cobalt-60



General view of sources GC60R (a) and GC60M9 (b):
1 — cover; 2 — capsule; 3 — active core

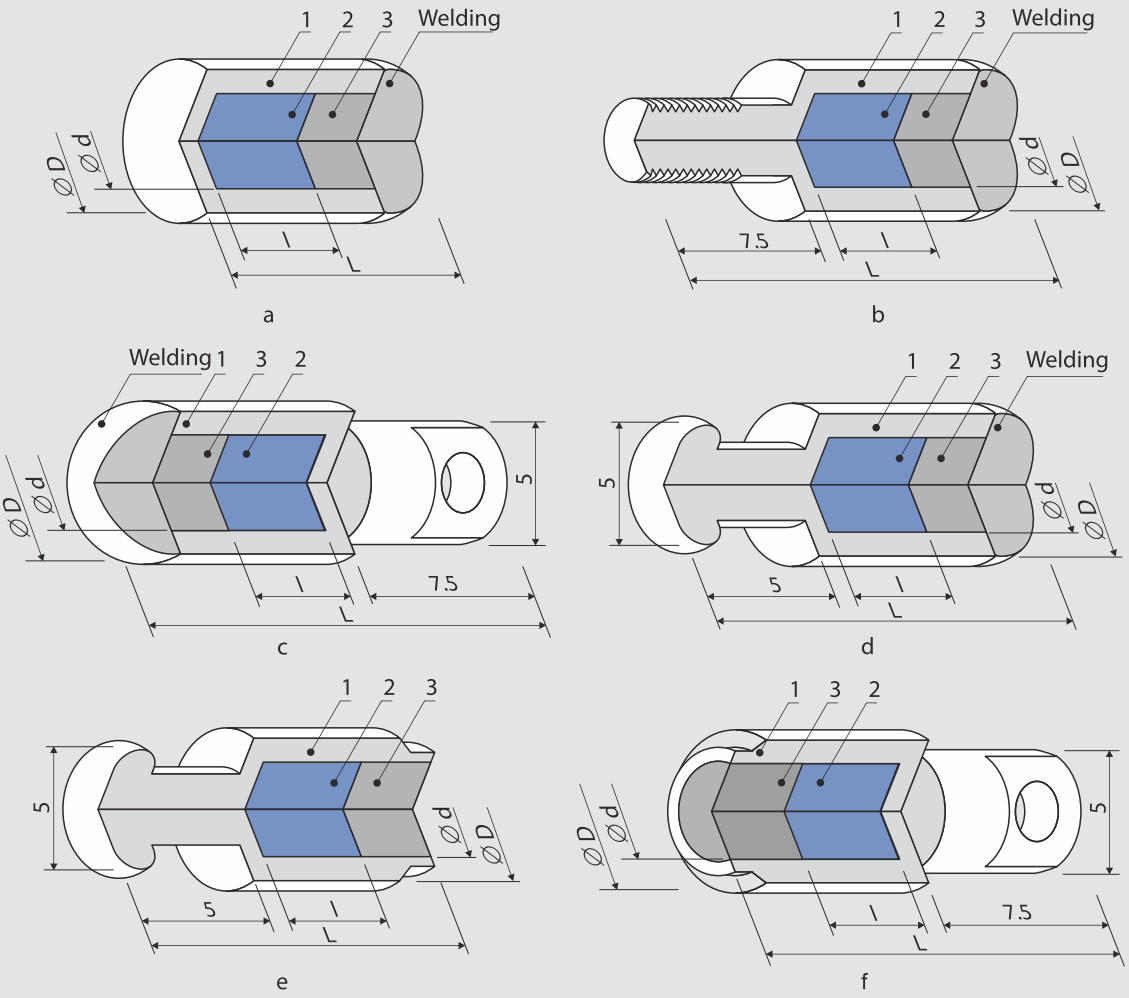
Key specifications

Specification	Description
Design	Sealed capsule
Capsule material	Austenitic stainless steel
Active core material	Cobalt-60, metal
Emitting area	Lateral or bottom
Strength class	ISO/99/S(E) 65444
Specified lifetime	15 years

Specifications of sources GC60R and GC60M9

Source type	Size, mm				Max exposure dose rate, μA/kg	Max equivalent activity, TBq (Ci)	Radiation hazard category (safety class)
	D	L	d	l			
GC60R01	9.0	13.7	7.0	10.4	64.5	25.9 (700)	2 (1)
GC60R02	6.0	11.7	4.2	4.6	13.9	5.6 (150)	
GC60R03		7.0		3.5	9.2	3.7 (100)	
GC60R04		16.0	3.2	3.4	4.7	1.9 (50)	
GC60M09	7.5	8.8	6.0	6.0	36.9	14.8 (400)	

^{60}Co Cobalt-60



General view of sources GC60M311 and GC60M321 (a), GC60M312 and GC60M322 (b), GC60M313 and GC60M323 (c), GC60M314 and GC60M324 (d), GC60M315 (e), GC60M325 (f):
1 — capsule; 2 — active core; 3 — plug

Key specifications

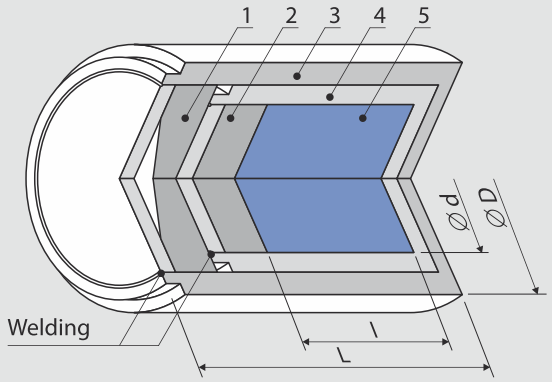
Specification	Description
Design	Sealed capsule with a configurable tail to fasten the source to the flow detector transporter
Capsule material	Austenitic stainless steel
Active core material	Cobalt-60, metal
Emitting area	Bottom
Strength class	ISO/99/S(E) 65445
Specified lifetime	15 years

^{60}Co Cobalt-60

GC60M3 source specifications

Source type	Size, mm				Max exposure dose rate, µA/kg	Max equivalent activity, GBq (Ci)	Radiation hazard category (safety class)
	D	L	d	l			
GC60M311.211	6.0	11.0	1.5	1.5	0.4	137 (3.7)	3 (1)
GC60M312.211		18.5					
GC60M313.211							
GC60M314.211		16.0					
GC60M311.511		11.0	2.0	2.0	0.8	274 (7.4)	
GC60M312.511		18.5					
GC60M313.511							
GC60M314.511		16.0					
GC60M311.112		11.0	2.5	2.5	1.6	548 (14.8)	2 (1)
GC60M312.112		18.5					
GC60M313.112							
GC60M314.112		16.0					
GC60M311.212		11.0	3.0	3.0	6.9	2 320 (62.7)	
GC60M312.212		18.5					
GC60M313.212							
GC60M314.212		16.0					
GC60M311.312		11.0	3.5	3.5	11.0	3 700 (100.0)	
GC60M312.312		18.5					
GC60M313.312							
GC60M314.312		16.0					
GC60M311.412		11.0	4.0	4.0	17.0	5 550 (150.0)	
GC60M312.412		18.5					
GC60M313.412							
GC60M314.412		16.0					
GC60M315	7.0	18.0	5.1	5.4	28.0	9 250 (250.0)	
GC60M321.212	10.0	15.0	3.0	3.0	6.9	2 320 (62.7)	
GC60M322.212		22.5					
GC60M323.212							
GC60M324.212		20.0					
GC60M321.412		15.0	4.0	4.0	17.0	5 550 (150.0)	
GC60M322.412		22.5					
GC60M323.412							
GC60M324.412		20.0					
GC60M321.812		15.0	5.0	5.0	28.0	9 640 (260.5)	
GC60M322.812		22.5					
GC60M323.812							
GC60M324.812		20.0					
GC60M321.113		15.0	6.0	6.0	50.0	16 600 (449.0)	
GC60M322.113		22.5					
GC60M323.113							
GC60M324.113		20.0					
GC60M325		18.0	7.1	8.3	55.0	18500 (500.0)	

^{60}Co Cobalt-60



General view of the source: 1 — outer plug; 2 — inner plug; 3 — outer capsule; 4 — inner capsule; 5 — active core

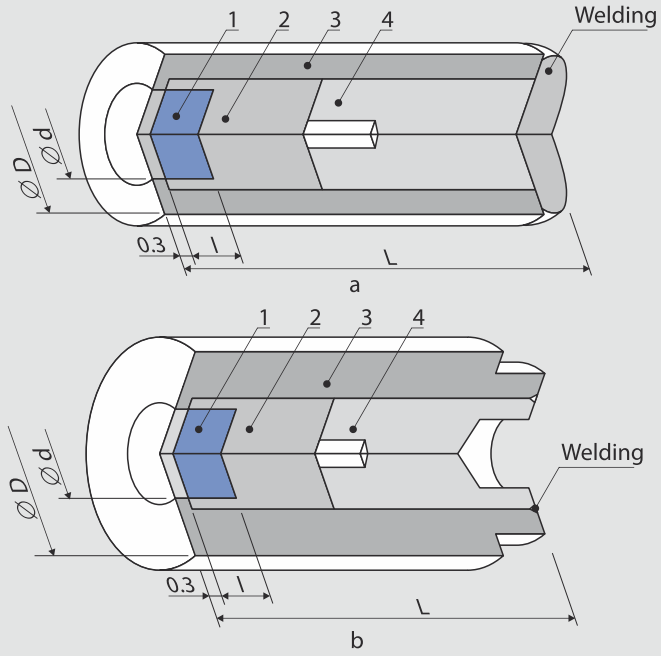
Key specifications

Specification	Description
Design	Sealed double encapsulated design
Capsule material	Austenitic stainless steel
Active core material	Cobalt-60, metal
Emitting area	Lateral
Strength class	ISO/99/S(E) 65444
Specified lifetime	15 years

COG source specifications

Source type	Size, mm				Max exposure dose rate, µA/kg	Max equivalent activity, TBq (Ci)	Radiation hazard category (safety class)
	D	L	d	l			
COG-101	6.0	12.4	3.2	2.1	0.75	0.30 (8)	3 (1)
COG-102		13.4		3.1	1.64	0.66 (18)	2 (1)
COG-103		14.4		4.1	2.76	1.10 (30)	
COG-104		15.4		5.1	3.69	1.48 (40)	
COG-111	7.5	14.0	4.7	3.7	8.29	3.33 (90)	
COG-112		15.0		4.7	10.10	4.07 (110)	
COG-113		16.0		5.7	12.90	5.18 (140)	
COG-114		17.0		6.7	14.30	5.73 (155)	
COG-121	9.0	16.0	6.2	5.7	21.20	8.51 (230)	
COG-122		17.0		6.7	28.00	11.28 (305)	
COG-123		18.0		7.7	32.30	12.95 (350)	
COG-131	10.5	17.0	7.7	6.7	43.80	17.57 (475)	
COG-132		18.0		7.7	49.80	20.00 (540)	
COG-133		19.0		8.7	59.00	23.70 (640)	

^{153}Gd Gadolinium-153



General view of sources PhG153M11, PhG153M12 (a) and PhG153M13(b):
1 — active core; 2 — insert; 3 — capsule; 4 — plug

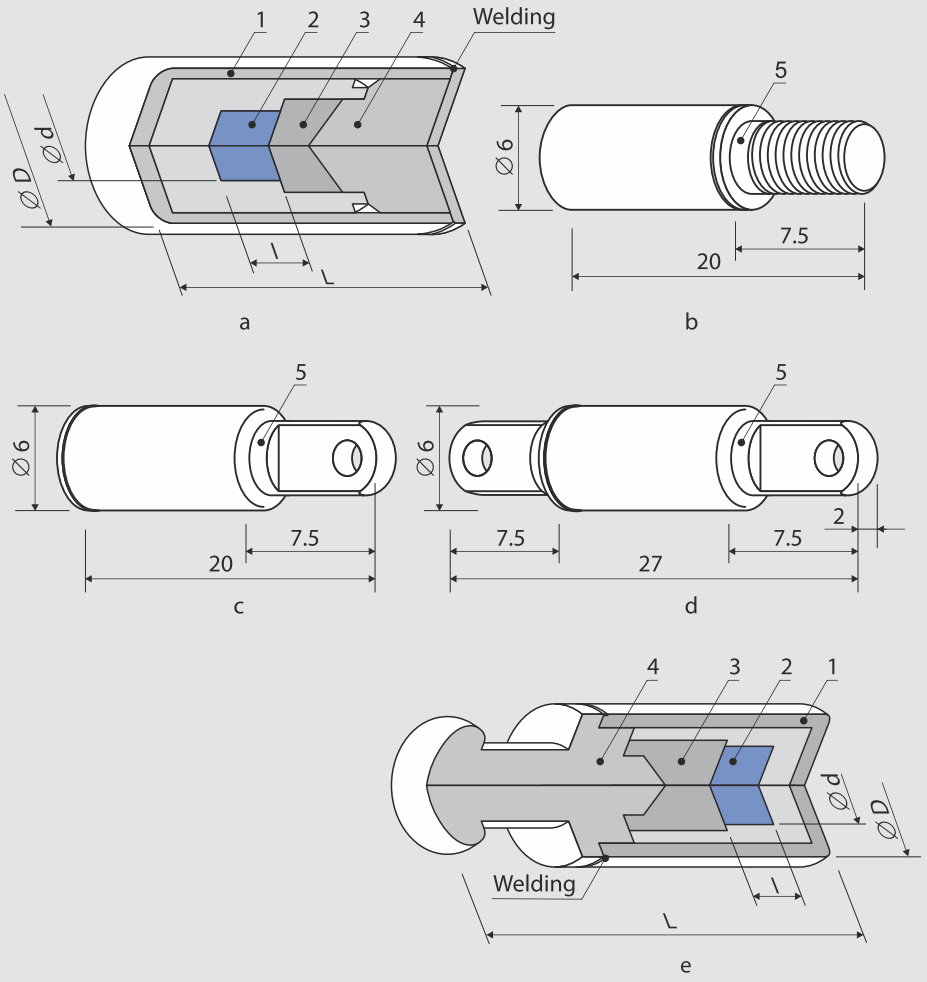
Key specifications

Specification	Description
Design	Sealed capsule
Capsule material	Titanium alloy
Active core material	Gadolinium-153, oxide
Emitting area	Bottom
Strength class	ISO/99/S 65444
Specified lifetime	5 years

PhG153M1 source specifications

Source type	Size, mm				Max photon flux 44 keV, $\times 10^9$ $s^{-1} \cdot sr^{-1}$	Max activity, GBq (Ci)	44 keV to 100 keV photon flux ratio, relative units	Radiation hazard category (safety class)
	D	L	d	l				
PhG153M11.410	5.7	16.0	3.0	2.00	1.2	37.0 (1.0)	1.35	4 (2)
PhG153M11.49				0.05	0.3	4.4 (0.12)		5 (2)
PhG153M12.110			2.0	2.00	0.4	11.0 (0.3)		4 (2)
PhG153M13.410	7.0	10.0	3.0		1.2	37.0 (1.0)		
PhG153M13.49				0.05	0.3	4.4 (0.12)		5 (2)

^{75}Se Selenium-75



General view of sources
GS75M11 with no tail (a),
GS75M12 with a screw tail (b),
GS75M13 with a blade-shaped tail (c),
GS75M14 with a two-sided blade-shaped tail (d),
GS75M15 with a spherical tail (e):
1 — outer capsule; 2 — active core;
3 — inner capsule; 4 — plug; 5 — tail

^{75}Se Selenium-75

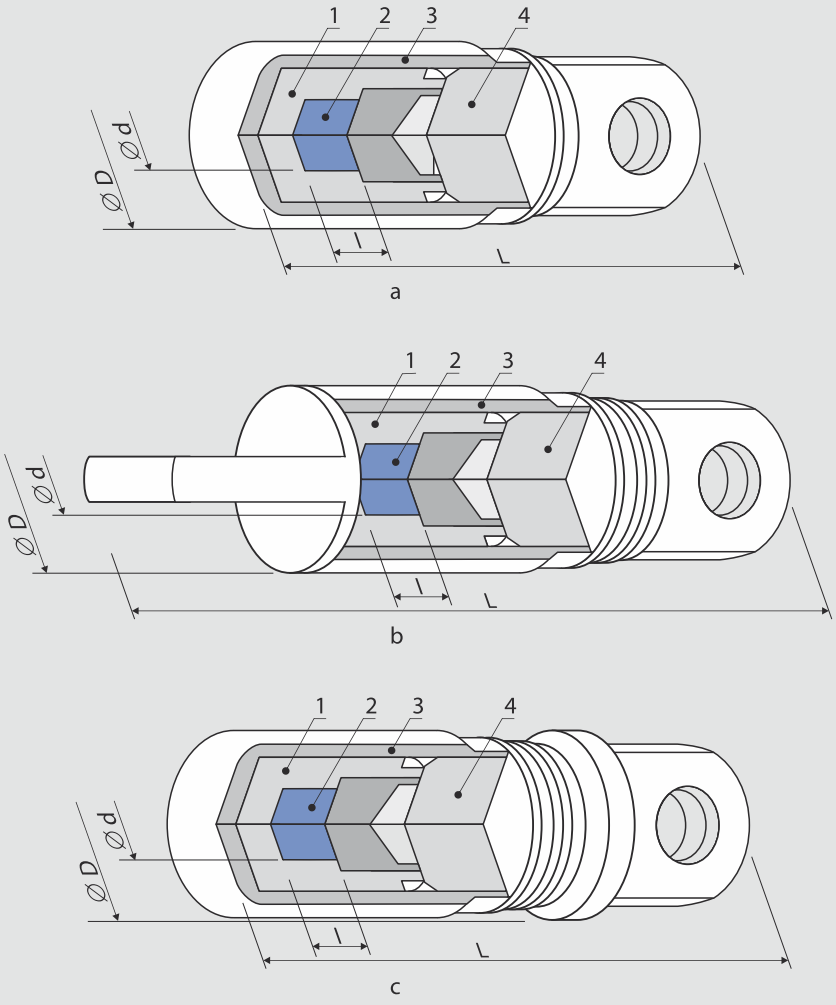
Key specifications

Specification	Description
Design	Sealed double encapsulated design
Capsule material: • inner • outer	 Vanadium metal or titanium alloy Austenitic stainless steel
Active core material	Selenium-75, metal
Emitting area	Lateral or bottom
Strength class	ISO/99/S 63545
Specified lifetime	5 years

GS75M1 source specifications

Source type	Size, mm				Max exposure dose rate, µA/kg	Max equivalent activity, TBq (Ci)	Radiation hazard category (safety class)
	D	L	d	l			
GS75M11.10	6	12	1.0	1.0	0.143	0.37 (10)	3 (1)
GS75M12.10		20					
GS75M13.10							
GS75M14.10		27					
GS75M15.10		19					
GS75M11.20		12	1.5	1.5	0.286	0.74 (20)	
GS75M12.20		20					
GS75M13.20							
GS75M14.20		27					
GS75M15.20		19					
GS75M11.40		12	2.0	2.0	0.571	1.48 (40)	
GS75M12.40		20					
GS75M13.40							
GS75M14.40		27					
GS75M15.40		19					
GS75M11.90		12	2.5	2.5	1.290	3.33 (90)	2 (1)
GS75M12.90		20					
GS75M13.90							
GS75M14.90		27					
GS5M15.90		19					
GS75M11.140		12	3.0	3.0	2.000	5.18 (140)	
GS75M12.140		20					
GS75M13.140							
GS75M14.140		27					
GS75M15.140		19					
GS75M11.200		12	3.5	3.5	2.860	7.40 (200)	
GS75M12.200		20					
GS75M13.200							
GS75M14.200		27					
GS75M15.200		19					

^{75}Se Selenium-75



General view of sources SR16(a), SR17 (b) and SR18 (c):
1—inner capsule; 2 — active core; 3 — outer capsule; 4 — plug

^{75}Se Selenium-75

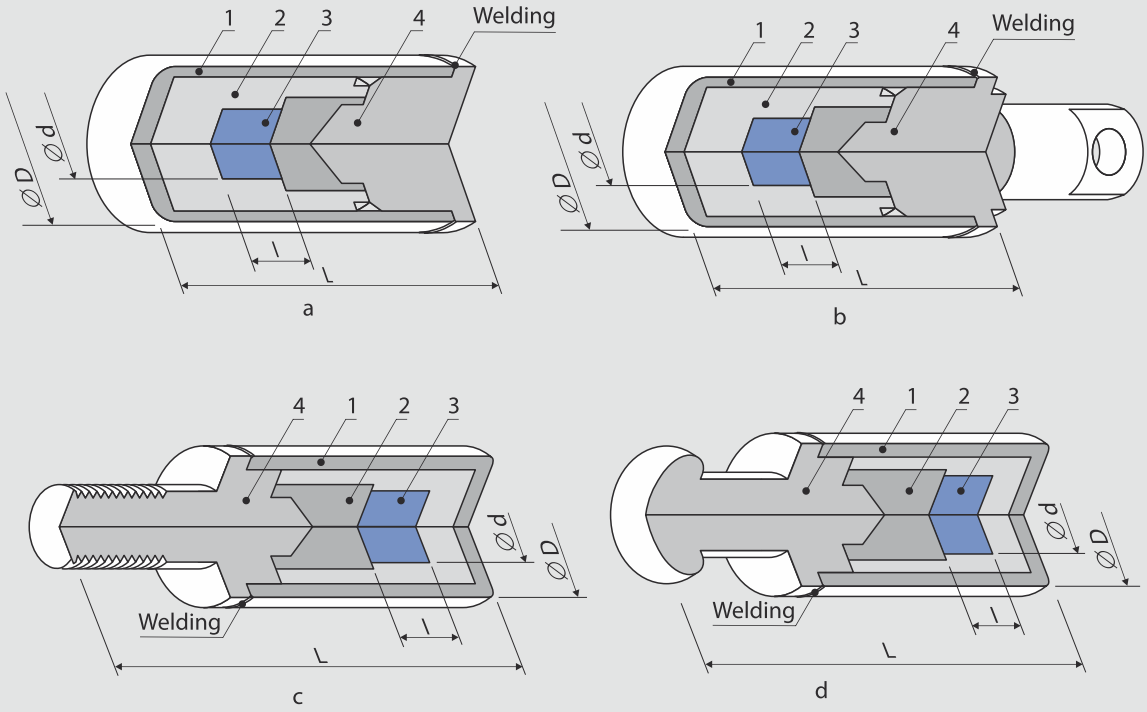
Key specifications

Specification	Description
Design	Sealed double encapsulated design with one or two tails to fasten the source to the flow detector transporter
Capsule material: • inner • outer	 Vanadium metal or titanium alloy Austenitic stainless steel
Active core material	Selenium-75, metal
Emitting area	Lateral or bottom
Strength class	ISO/99/S 63545
Specified lifetime	5 years

SR source specifications

Source type	Size, mm				Max exposure dose rate, μA/kg	Max equivalent activity, TBq (Ci)	Radiation hazard category (safety class)
	D	L	d	l			
SR16.10	7.15	19.5	1.0	1.0	0.143	0.37 (10)	3 (1)
SR17.10	6.70	27.0					
SR18.10	7.15	23.5					
SR16.20	7.15	19.5	1.5	1.5	0.286	0.74 (20)	
SR17.20	6.70	27.0					
SR18.20	7.15	23.5					
SR16.40	7.15	19.5	2.0	2.0	0.571	1.48 (40)	
SR17.40	6.70	27.0					
SR18.40	7.15	23.5					
SR16.90	7.15	19.5	2.5	2.5	1.290	3.33 (90)	2 (1)
SR17.90	6.70	27.0					
SR18.90	7.15	23.5					
SR16.140	7.15	19.5	3.0	3.0	2.000	5.18 (140)	
SR17.140	6.70	27.0					
SR18.140	7.15	23.5					
SR16.200	7.15	19.5	3.5	3.5	2.860	7.40 (200)	
SR17.200	6.70	27.0					
SR18.200	7.15	23.5					

^{192}Ir Iridium-192



General view of sources GI192M31 with no tail (a),
GI192M33 with a blade-shaped tail (b), GI192M32 with a screw tail (c),
Gil 92M34 with a spherical tail (d):
1 — outer body; 2 — inner capsule;
3 — active core; 4 — plug

Key specifications

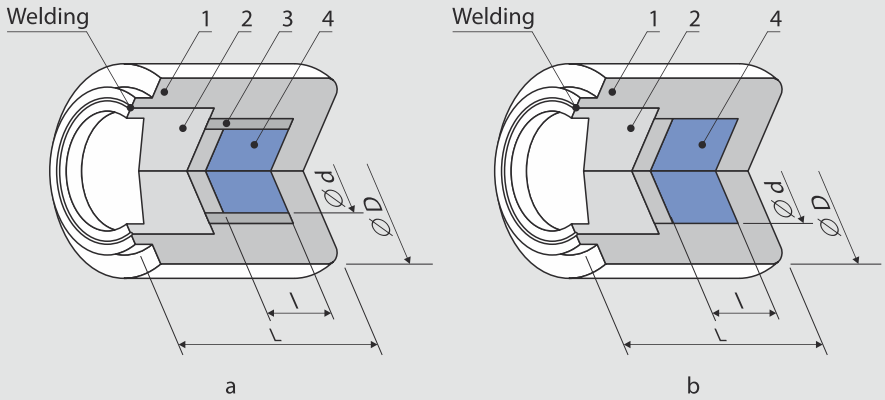
Specification	Description
Design	Sealed double encapsulated design with no tail or with a configurable tail to fasten the source to the flow detector transporter
Capsule material: • inner • outer	 Titanium alloy Austenitic stainless steel
Active core material	Iridium-192, metal disks
Emitting area	Bottom
Strength class	ISO/99/S(E) 65446
Specified lifetime	3 years

^{192}Ir Iridium-192

GI192M3 source specifications

Source type	Size, mm				Max exposure dose rate, μA/kg	Max equivalent activity, TBq (Ci)	Radiation hazard category (safety class)
	D	L	d	l			
GI192M31.1	6	12	0.5	0.5	0.064	0.07 (1.9)	4 (2)
GI192M32.1		20					
GI192M33.1							
GI192M34.1		19					
GI192M31.2		12	1.0	1.0	0.440	0.48 (13)	3 (1)
GI192M32.2		20					
GI192M33.2							
GI192M34.2		19					
GI192M31.3		12	1.5	1.5	1.340	1.50 (41)	2 (1)
GI192M32.3		20					
GI192M33.3							
GI192M34.3		19					
GI192M31.4		12	2.0	2.0	2.860	3.15 (85)	
GI192M32.4		20					
GI192M33.4							
GI192M34.4		19					
GI192M31.5		12	2.5	2.5	4.540	5.00 (135)	
GI192M32.5		20					
GI192M33.5							
GI192M34.5		19					
GI192M31.6		12	3.0	3.0	6.700	7.40 (200)	
GI192M32.6		20					
GI192M33.6							
GI192M34.6		19					
GI192M31.7		12	3.5	3.5	9.400	10.40 (280)	
GI192M32.7		20					
GI192M33.7							
GI192M34.7		19					

^{192}Ir Iridium-192



General view of sources GI192M51 and GI192M52 (a), GI192M53-GI192M58 (b):
1 — capsule; 2 — plug; 3 — bushing; 4 — active core

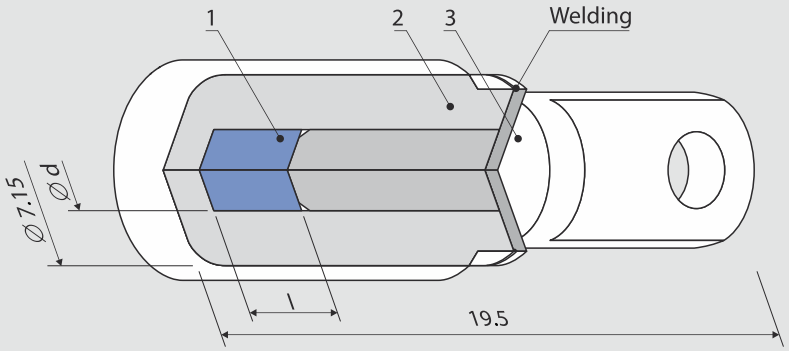
Key specifications

Specification	Description
Design	Sealed capsule
Capsule material	Austenitic stainless steel or titanium alloy
Active core material	Iridium-192, metal disks
Emitting area	Lateral or bottom
Strength class for capsules: • austenitic stainless steel • titanium alloy	 ISO/99/S(E) 65446 ISO/99/S(E) 65344
Specified lifetime	3 years

GI192M5 source specifications

Source type	Size, mm				Max exposure dose rate, μA/kg	Max equivalent activity, TBq (Ci)	Radiation hazard category (safety class)
	D	L	d	l			
GI192M51	4.0	5.0	0.5	0.5	0.064	0.07 (1.9)	4 (2)
GI192M52			1.0	1.0	0.440	0.48 (13)	3 (1)
GI192M53			1.5	2.0	1.340	1.50 (40)	2 (1)
GI192M54			2.0	2.0	2.860	3.10 (85)	
GI192M55	5.0	6.0	2.5	2.5	4.540	5.00 (135)	
GI192M56			3.0	3.0	6.700	7.40 (200)	
GI192M56-1		7.0		4.0	7.900	8.80 (240)	
GI192M57	6.0		3.5	3.5	9.400	10.40 (240)	
GI192M58			4.0	4.0	11.000	12.00 (324)	

^{192}Ir Iridium-192



General view of the source: 1 — active core; 2 — capsule; 3 — plug

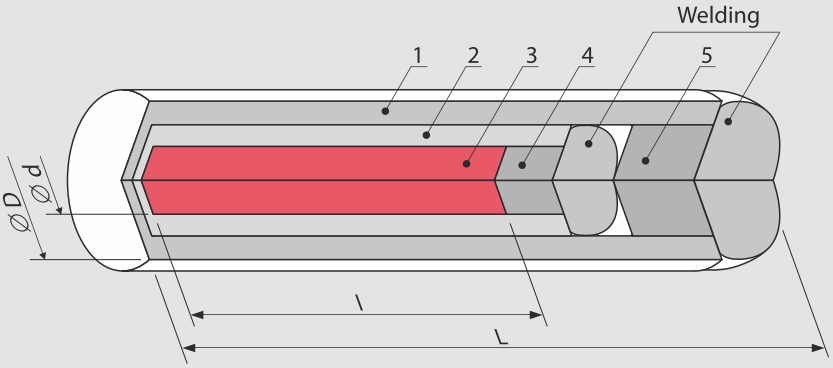
Key specifications

Specification	Description
Design	Sealed capsule
Capsule material	Austenitic stainless steel
Active core material	Iridium-192, metal disks
Emitting area	Lateral
Strength class	ISO/99/S(E) 65446
Specified lifetime	3 years

GI192M6 source specifications

Source type	Size, mm				Max exposure dose rate, μA/kg	Max equivalent activity, TBq (Ci)	Radiation hazard category (safety class)
	D	L	d	l			
GI192M61	7.15	19.5	1.5	1.5	1.34	1.50 (40)	2 (1)
GI192M62			2.0	2.0	2.86	3.15 (85)	
GI192M63			3.5	3.0	6.70	7.40 (200)	
GI192M64			3.5	3.5	9.40	10.40 (280)	
GI192M65			4.0	4.0	11.00	12.00 (324)	

^{252}Cf Californium-252



General view of the source: 1 — outer capsule; 2 — inner capsule; 3 — active core; 4 — inner plug; 5- outer plug

Key specifications

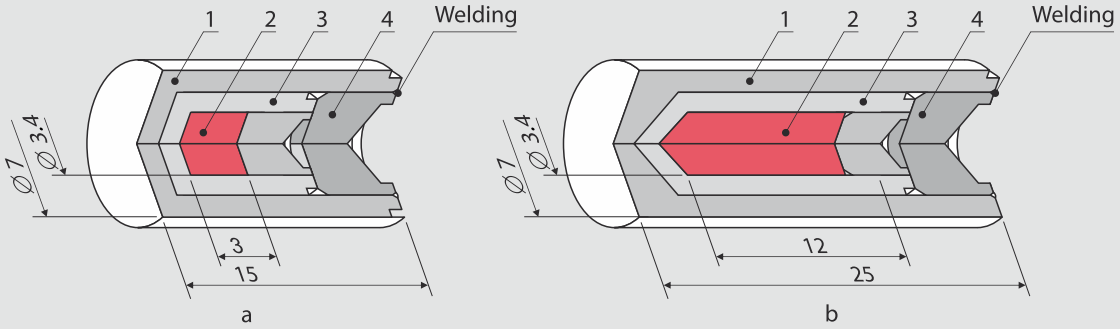
Specification	Description
Design	Sealed double encapsulated design
Capsule material	Austenitic stainless steel
Active core material*	Californium-252, oxide
Strength class	ISO/99/S(E)E65445
Specified lifetime	10 years

* Linear non-uniformity of Cf-252 distribution in the source is no higher ± 15 %.

NC252M4 source specifications

Source type	Size, mm				Max neutron flux into angle of 4π, x10^9 s^{-1}	Cf- 252 mass in the source, µg, max	Max activity, GBq (Ci)	Radiation hazard category (safety class)
	D	L	d	l				
NC252M41	3.0	15.0	1.4	9.0	6.75	2 920	58 (1.57)	3 (1)
NC252M44	2.9	9.8	1.4	4.5	2.70	1 168	23 (0.62)	

^{252}Cf Californium-252



General view of sources NC252M11 (a) and NC252M12 (b):
1 — outer capsule; 2 — active core; 3 — inner capsule; 4 — plug

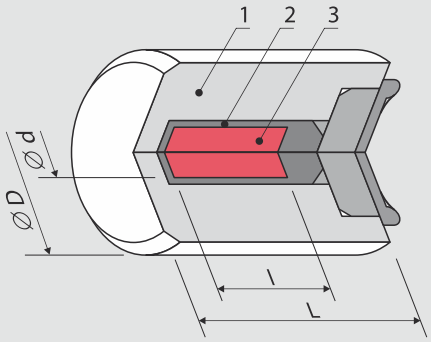
Key specifications

Specification	Description
Design	Sealed double encapsulated design
Capsule material	Austenitic stainless steel
Active core material	Californium-252, oxide
Strength class	ISO/99/S(E) 66546
Specified lifetime	15 years

NC252M1 source specifications

Source type	Size, mm				Max neutron flux into angle of 4π, x10^9 s^{-1}	Cf-252 mass in the source, μg, max	Max activity, GBq (Ci)	Radiation hazard category (safety class)
	D	L	d	l				
NC252M11	7.0	15.0	3.4	3.0	1.35	584	11.6 (0.313)	4 (2)
NC252M12		25.0		12.0	27.00	11 678	232.0 (6.27)	2 (1)

^{252}Cf Californium-252



General view of the source: 1 — outer capsule; 2 — inner capsule; 3 — active core

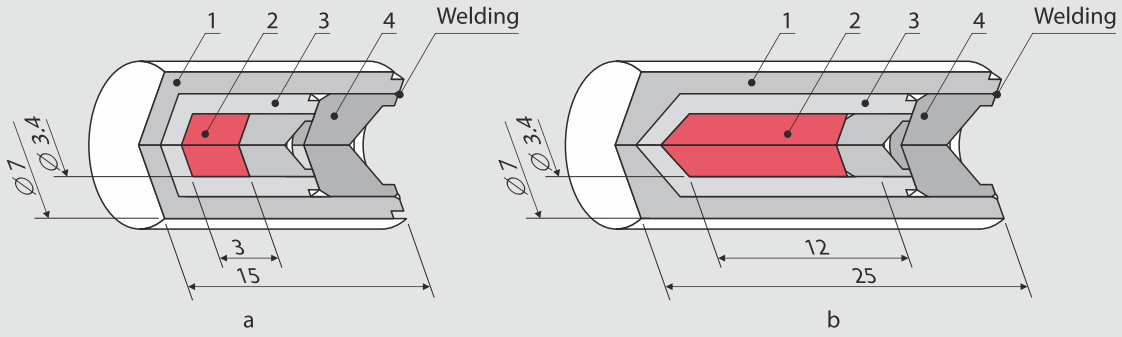
Key specifications

Specification	Description
Design	Sealed double encapsulated design
Capsule material	Austenitic stainless steel
Active core material	Californium-252, oxide
Strength class	ISO/99/S(E) 66546
Specified lifetime	15 years

NC252M5 source specifications

Source type	Size, mm				Max neutron flux into angle of 4π, x10^9 s^{-1}	Cf-252 mass in the source, μg, max	Max activity, GBq (Ci)	Radiation hazard category (safety class)
	D	L	d	l				
NC252M5	7.8	10.0	1.4	4.5	2.7	1 168	23.0 (0.63)	3 (1)

^{244,248}Cm Curium-244 Curium-248



General view of sources NC244M11 and NC248M11 (a), NC244M12 and NC248M12 (b):
1— outer capsule; 2 — active core; 3 — inner capsule; 4 — plug

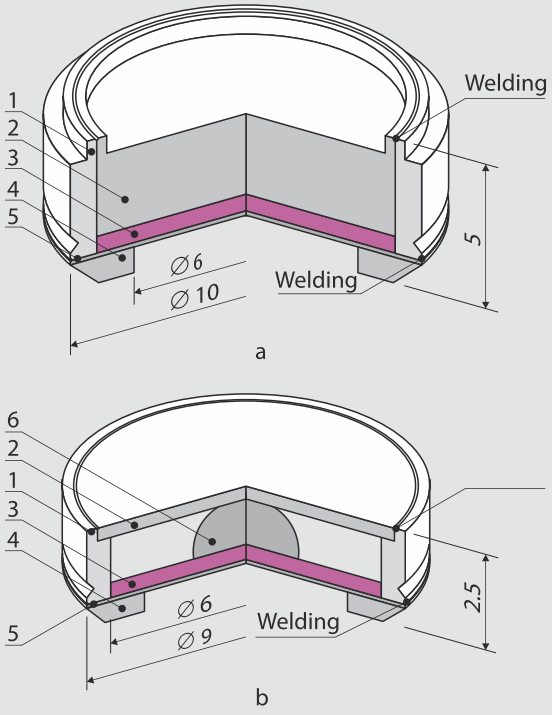
Key specifications

Specification	Description
Design	Sealed double encapsulated design
Capsule material	Austenitic stainless steel
Active core material	Curium-244 or Curium-248, oxide
Strength class	ISO/99/S(E) 66546
Specified lifetime	15 years

NC244M11 and NC248M12 source specifications

Source type	Size, mm				Max neutron flux into angle of 4π, x10^{9} s^{-1}	Radionuclide mass in the source, mg, max	Max activity, TBq (Ci)	Radiation hazard category (safety class)
	D	L	d	l				
NC244M11	7.0	15.0	3.4	3.0	4.0	370	1.1 (29.7)	2 (1)
NC248M11					2.0	49	7.4·10^{-6} (2.0·10^{-4})	5 (2)
NC244M12		25.0		12.0	4.0	370	1.1 (29.7)	2 (1)
NC248M12					2.0	49	7.4·10^{-6} (2.0·10^{-4})	5 (2)

^{244}Cm Curium-244



General view of sources ASC244.28 (a) and ASC244-1.28 (b):
1 — body; 2 — plug; 3 — active core; 4 — washer, 5 — window; 6 — spacer insert

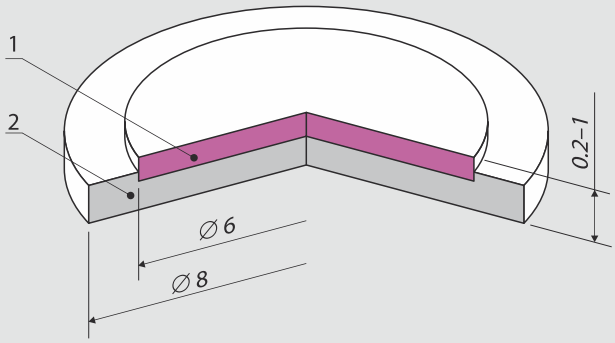
Key specifications

Specification	Description
Design	Sealed single encapsulated design
Capsule material	Titanium alloy
Active core material	Curium-244 alloy fixed on a metal substrate
Emitting area	Window at the source end face
Strength class	ISO/99/S 22211
Specified lifetime	2 years

ASC244 source specifications

Source type	Size, mm			Max activity, MBq (mCi)	Alpha particles max energy, MeV	Radiation hazard category (safety class)
	D	L	d			
ASC244.28	9.0	2.5	6	185 ± 40 (5 ± 1)	5.2	5 (2)
ASC244-1.28	10.0	5.0				

^{244}Cm Curium-244



General view of the source: 1 — active core; 2 — substrate

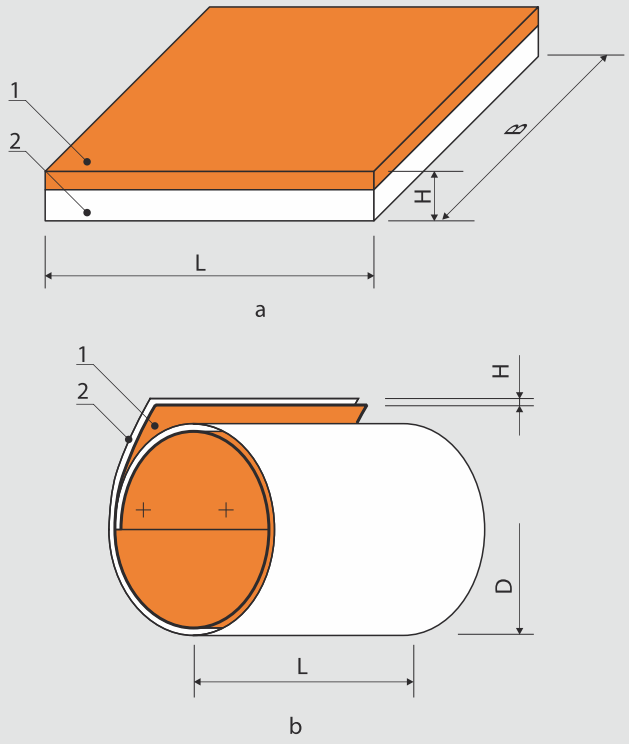
Key specifications

Specification	Description
Design	Disk, unsealed design
Substrate material	Metal platinum, iridium, silicon or austenitic stainless steel
Active core material	Curium-244, alloy with a substrate material
Specified lifetime	2 years

AC244D source specifications

Source type	Size, mm			Active core	Max activity, MBq (mCi)	α-line half-width, keV (fraction from 5.8 MeV), %	Radiation hazard category (safety class)
	D	d	s				
AC244D.28	8	6 ± 1	0.2–1.0	Curium-244-silicon compound	150–220 (4–6)	More than 145 (2.5)	5 (2)
AC244D.38 (for backscattering spectroscopy)				Curium-244-platinum-austenitic stainless steel alloy		More than 170 (2.9)	
AC244D.19 (to be used in X-ray fluorescent analyzers)				Curium-244-platinum alloy	500–1600 (14–43)	700–1 600 (12–28)	4(2)

^{63}Ni Nickel-63



General view of sources BN63.P (a) and BN63.C (b): 1 — active core; 2 — substrate

Key specifications

Specification	Description
Design	Unsealed source as a plate or cylindrical spot-welded substrate
Substrate material	Nickel alloy
Active core material	Nickel-63 as a metal layer
Specified lifetime	5 years

Source specifications

Source type	Size, mm				Max activity, MBq (mCi)
	L	B	H	D	
BN63.P	10–30	2–10	0.05	–	555 (15)
BN63.C	7	–		7	

2. Radiochemicals

^{51}Cr Chromium-51

Specifications

Parameter	Value
Chemical form	Chromium (III) chloride/sodium chromate
Specific activity of chromium-51, TBq/g chromium (Ci/g)	No less than 3.7 (100)
Chromium-51 activity concentration, GBq/ml (mCi/ml)	No more than 9.25 (250)
Ratio of total activity of impurities (manganese-54, cobalt-60, cobalt-58, zinc-65) to chromium-51 activity, %	No more than 0.1
Solvent concentration (hydrochloric acid /sodium hydroxide), mol/l	0.1–2.0/0.5–1.0

^{54}Mn Manganese-54

Specifications

Parameter	Value
Chemical form	Manganese (II) chloride
Specific activity of manganese-54, TBq/g manganese (Ci/g)	No less than 1.11 (30)
Manganese-54 activity concentration, GBq/ml (Ci/ml)	No less than 0.37 (0.01)
Ratio of total activity of gamma-emitting impurities to manganese-54 activity, %	No more than 0.03
Solvent concentration (hydrochloric acid), mol/l	0.5

^{55}Fe Iron-55

Specifications

Parameter	Value
Chemical form	Iron (III) chloride
Specific activity of iron-55, TBq/g iron (Ci/g)	No less than 1.48 (40)
Iron-55 activity concentration, GBq/ml (Ci/ml)	No less than 37 (1)
Ratio of total activity of gamma-emitting impurities to iron-55 activity, %	No more than 0.1
Ratio of total mass of non-radioactive impurities to iron-55 activity, mg/TBq (mg/Ci)	No more than 0.7 ($2.5 \cdot 10^{-2}$)
Solvent concentration (hydrochloric acid), mol/l	0.5–4.0

^{63}Ni Nickel-63

Specifications

Parameter	Value
Chemical form	Nickel chloride / Nickel nitrate
Specific activity of nickel-63, TBq/g nickel (Ci/g)	No less than 0.37 (10)
Ratio of total activity of impurities to nickel-63 activity, %: • scandium-46, manganese-54, iron-59, cobalt-60, cobalt-58, zinc-65, antimony-122, antimony-124, chromium-51; • alpha-emitting nuclides	No more than 10^{-3} No more than 10^{-5}
Ratio of total mass of non-radioactive impurities (iron, manganese, chromium, cobalt, copper, zinc, cadmium, tin, lead) to nickel mass, %	No more than 0.1
Solvent concentration (hydrochloric / nitric acid), mol/l	0.1–1.0

^{89}Sr Strontium-89 (no-carrier added)

Specifications

Parameter	Value
Chemical form	Strontium chloride
Specific activity of strontium-89, TBq/g strontium (Ci/g)	No less than 11.1 (300)
Strontium-89 activity concentration, GBq/ml (mCi/ml)	No less than 3.7 (100)
Ratio of total activity of impurities to strontium-89 activity, %: • strontium-90; • gamma-emitting radionuclides	 No more than $2 \cdot 10^{-4}$ No more than 0.35
Ratio of total mass of non-radioactive impurities to strontium-89 activity, mg/TBq (mg/Ci)	No more than 149 (5.5)
Solvent concentration (hydrochloric acid), mol/l	0.0005–0.1

^{89}Sr Strontium-89 (carrier added)

Specifications

Parameter	Value
Chemical form	Strontium chloride
Specific activity of strontium-89, GBq/g strontium (Ci/g)	No less than 7.4 (0.2)
Strontium-89 activity concentration, GBq/ml (mCi/ml)	No less than 0.74 (20)
Ratio of total activity of impurities to strontium-89 activity, %: • strontium-90; • strontium-85, barium-131, barium-140, lanthanum-140	 No more than $2 \cdot 10^{-4}$ No more than 0.15
Ratio of total mass of non-radioactive impurities to strontium-89 activity, mg/TBq (mg/Ci)	No more than 149 (5.5)
Solvent concentration (hydrochloric acid), mol/l	0.0005–0.1

^{99}Mo Molybdenum-99

Specifications

Parameter	Value
Chemical form	Sodium molybdate
Specific activity of molybdenum-99 (nca), TBq/g (Ci/g)	No less than 37 (1 000)
Molybdenum-99 activity concentration, GBq/ml (mCi/ml)	No less than12.95 (350)
Radiochemical purity ($^{99}MoO_4^{2-}$ content), %	No less than 95
Ratio of total activity of impurities to molybdenum-99 activity, %: • iodine-131, ruthenium-103, tellurium-132; • gamma-emitting radionuclides except for molybdenum-99, technetium-99m, iodine-131, ruthenium-103, tellurium-132; • beta-emitting radionuclides (strontium-89 and strontium-90); • alpha-emitting radionuclides	 No more than $5{\cdot}10^{-3}$ No more than $1{\cdot}10^{-2}$ No more than $6{\cdot}10^{-5}$ No more than $1{\cdot}10^{-7}$
Solvent concentration (sodium hydroxide), mol/l	0.2–0.3

^{106}Ru Ruthenium-106

Specifications

Parameter	Value
Chemical form	Ruthenium (III, IV) chloride
Specific activity of ruthenium-106, TBq/g ruthenium (Ci/g)	No less than10 (270)
Ruthenium-106 activity concentration, GBq/ml (Ci/ml)	No less than 0.74 (20)
Ratio of total activity of impurities to ruthenium-106 activity, %: • gamma-emitting radionuclides except for ruthenium-103; • alpha-emitting radionuclides	 No more than 0.08 No more than $1{\cdot}10^{-6}$
Ratio of total mass of non-radioactive impurities to ruthenium mass, %	No more than 5
Solvent concentration (hydrochloric acid), mol/l	No less than 6

^{125}I Iodine-125

Specifications

Parameter	Value
Chemical form	Sodium iodide
Specific activity of iodine-125, GBq/mg iodine (Ci/mg)	No less than 629.0 (17.0)
Iodine-125 activity concentration, GBq/ml (mCi/ml)	No more than 55.5 (1.5)
Radiochemical purity, %	No less than 99.2
Iodine-126 to iodine-125 activity ratio, %	No more than 0.001
Solvent concentration (hydrochloric acid), mol/l (mg/ml)	0.01–0.05 (0.4–2.0)
pH	8.0–11.0

^{131}I Iodine-131

Specifications (as-manufactured)

Parameter	Value
Chemical form	Sodium iodide
Specific activity of iodine -131, GBq/mg iodine(Ci/mg)	185–740 (5–20)
Iodine-131 activity concentration, GBq/ml (Ci/ml)	1.85–370 (0.05–10)
Radiochemical purity	No less than 95.0
Ratio of total activity of impurities (selenium-75, tellurium-123m) to iodine-131 activity, %	No more than 0.1
Solvent concentration (sodium hydroxide /sodium hydrocarbonate and carbonate), mol/l (mg/ml)	0.01–0.05 (0.4–2.0)
Solvent pH (sodium hydroxide /sodium hydrocarbonate and carbonate)	8.0–12.0/8.0–10.6

^{153}Gd Gadolinium-153

Specifications

Parameter	Value
Chemical form	Gadolinium oxide/ chloride/nitrate
Specific activity of gadolinuim-153, TBq/g gadolinium (Ci/g)	Not less than 2.6 (70)
Ratio of total activity of impurities (europium-152, europium -154, europium -156, terbium-160) to gadolinium -153 activity, %	Not more than $7 \cdot 10^{-4}$
Ratio of total mass of non-radioactive impurities (sodium, calcium, silicon, aluminum, iron, magnesium, chromium, nickel, boron, titanium, samarium, europium) to gadolinium-153 activity, mg/TBq (mg/Ci)	Not more than 41 (1.5)

^{177}Lu Lutetium-177 (no-carrier added)

Specifications

Parameter	Value
Chemical form	Lutetium chloride
Specific activity of lutetium-177, TBq/g lutetium (kCi/g)	Not less than 1110 (30)
Lutetium-177 activity concentration, TBq/ml (Ci/ml)	Not more than 11.1(30)
Ratio of activity of impurities to lutetium-177 activity, %: • lutetium-177m; • ytterbium-175; • cobalt-60, cobalt-58, zinc-65, manganese-54, iron-59, chromium-51	 Not more than 0.02 Not more than 0.001 Not more than 0.01
Solvent concentration (hydrochloric acid), mol/l	0.1

^{188}W Tungsten-188

Specifications

Parameter	Value
Chemical form	Sodium tungstate
Specific activity of tungsten-188, GBq/g tungsten (Ci/g)	No less than 111 (3)
Tungsten-188 activity concentration, GBq/ml (Ci/ml)	No less than 0.74 (20)
Ratio of total activity of gamma-emitting impurities (excepting rhenium-186, osmium-191, iridium-192) to tungsten-188 activity, %	No more than 1
Solvent concentration (sodium hydroxide), mol/l	0.005–5.0

^{223}Ra Radium-223

Specifications

Parameter	Value
Chemical form	Radium chloride
Radium-223 activity concentration, MBq/ml (mCi/ml)	No less than10 (0.27)
Ratio of activity of the radionuclide to radium-223 activity; %: • actinium-227; • thorium-227	 No more than10^{-5} No more than10^{-3}
Ratio of total activity of impurities (excepting actinium-227 and its daughter isotopes) to radium-223 activity, %	No more than10^{-3}
Ratio of total mass of non-radioactive impurities (barium, calcium, iron, chromium, nickel, lead) to radium-223 activity, mg/GBq (mg/Ci)	No more than 0.54 (20)
Solvent concentration (hydrochloric acid), mol/l	0.001–0.5

^{224}Ra Radium-224

Specifications

Parameter	Value
Chemical form	Radium cloride
Radium-224 activity concentration, MBq/ml (mCi/ml)	No less than 1 (0.027)
Thorium-228 to radium-224 activity ratio, %	No more than 10^{-3}
Ratio of total activity of impurities (excepting thorium-228 and its daughter isotopes) to radium-224 activity, %	No more than 0.01
Ratio of total mass of non-radioactive impurities (barium, calcium, iron, chromium, nickel, lead) to radium-224 activity, mg/GBq (mg/Ci)	No more than 1.4 (50)
Solvent concentration (hydrochloric acid), mol/l	0.001–0.5

^{228}Th Thorium-228

Specifications

Parameter	Value
Chemical form	Thorium nitrate
Specific activity of thorium-228, TBq/g (Ci/g)	No less than 11.1 (300)
Thorium-228 activity concentration, MBq/ml (mCi/ml)	No less than10 (0,27)
Ratio of total activity of impurities to thorium-228 activity, %: • radium-226 and actinium-227; • radionuclides, except for radium-226, actinium-227 and their decay products, including daughter products of thorium-228	No more than10^{-3} No more than 10^{-4}
Solvent concentration (nitric acid), mol/l	0.1–8.0

^{242}Pu Plutonium-242

Specifications

Parameter	Value
Chemical form	Plutonium (IV) oxide
Specific activity of plutonium-242, MBq/g oxide (mCi/g)	No less than 110 (2.97)
Mass fraction, %: • plutonium; • plutonium-242 in the mixture of plutonium isotopes; • total of non-radioactive impurities (sodium, calcium, boron, silicon, aluminum, iron, magnesium, chromium, nickel, titanium)	 No less than 86 No less than 90 No more than 1
Ratio of activity of impurities to plutonium -242 activity: • americium-241; • curium-244; • radionuclides — fission products (zirconium-95, niobium-95, ruthenium-103, ruthenium-106, rhodium-106, cesium-134, cesium-137, cerium-141, cerium-144, praseodymium-144, europium-152, europium-154)	 No more than 0.1 No more than 2 No more than 0.1

^{243}Am Americium-243

Specifications

Parameter	Value
Chemical form	Americium oxide
Specific activity of americium-243, GBq/g oxide (mCi/g)	Not less than 6 (162)
Mass fraction, %: • americium; • mixture of plutonium-238 and plutonium-240 isotopes; • curium-244; • californium-252; • total of non-radioactive impurities (sodium, calcium, silicon, aluminum, iron, magnesium, chromium, nickel, boron, titanium)	 No less than 86 No more than 0.1 No more than 0.5 No more than $5 \cdot 10^{-4}$ No more than 1
Molar fraction of americium-243 in the americium isotopes mixture, %	No less than 96
Ratio of total activity of impurities to americium-243 activity: • curium-242 and curium-244; • radionuclides — fission products (zirconium-95, niobium-95, ruthenium-103, ruthenium-106, rhodium-106, cesium-134, cesium-137, cerium-141, cerium-144, praseodymium-144, europium-152, europium-154)	 No more than 4 No more than 0.05

^{244}Cm Curium-244

Specifications

Parameter	Value
Chemical form	Curium oxide
Specific activity of curium-244, TBq/g (Ci/g)	No less than 2.0 (54)
Mass fraction, %: • curium; • curium -244 in the mixture of curium isotopes; • americium-241 and americium -243 mixture; • plutonium-238 and plutonium-240 mixture; • californium-252; • total of non-radioactive impurities (sodium, calcium, silicon, aluminum, iron, magnesium, chromium, nickel, boron, titanium)	 More than 86 More than 85 No more than 1.0 No more than 0.2 No more than $2 \cdot 10^{-3}$ No more than 1.0
Ratio of total activity of radionuclide impurities (zirconium-95, niobium-95, ruthenium-106, rhodium-106, cesium-134, cesium-137, cerium-141, cerium-144, praseodymium-144, europium-152, europium-154) to curium-244 activity	No more than $5 \cdot 10^{-4}$

^{248}Cm Curium-248

Specifications

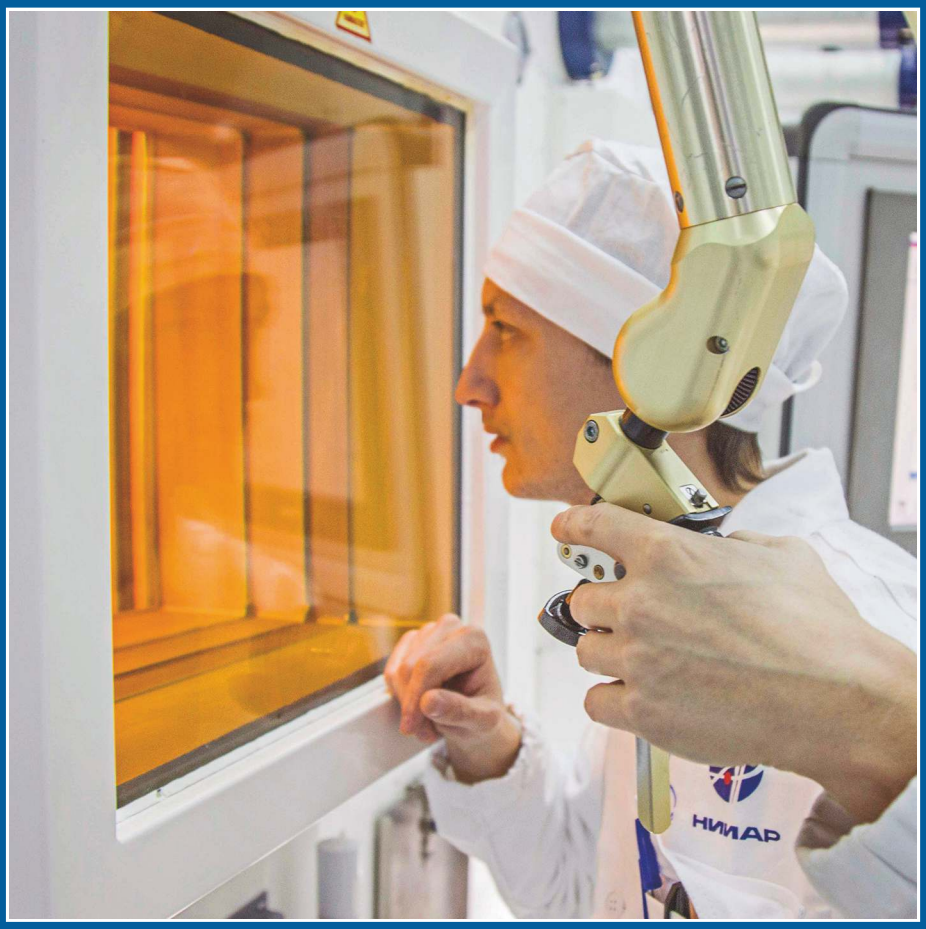
Parameter	Value
Chemical form	Curium nitrate
Specific activity of curium-248, kBq/g (μCi/g)	15 (0.41)
Molar fraction of curium-248 in the mixture of curium isotopes, %	More than 94
Ratio of activity of impurities to curium-248 activity: • curium-244; • californium-252; • zirconium-95, niobium-95, ruthenium-106, rhodium-106, cesium-134, cesium-137, cerium-141, cerium-144, praseodymium-144, europium-152, europium-154	 No more than 50 No more than 0.5 No more than 10
Ratio of total mass of non-radioactive impurities (sodium, calcium, silicon, aluminum, iron, magnesium, chromium, nickel, boron, titanium) to curium-248 mass	No more than 1

^{249}Bk Berkelium-249

Specifications

Parameter	Value
Chemical form	Berkelium nitrate
Specific activity of berkelium-249, GBq/mg (Ci/mg)	No less than 59 (1.6)
Ratio of total activity of impurities to berkelium -249 beta-activity: • beta-emitting • alpha-emitting	 No more than 0.008 No more than 0.0006
Ratio of total mass of non-radioactive impurities (sodium, calcium, silicon, aluminum, iron, magnesium, chromium, nickel, boron, titanium) to berkelium-249 mass	No more than 2

3. Additional Information



Contacts

Joint Stock Company "State Scientific Center — Research Institute of Atomic Reactors"

Russian Federation, 433510, Ulyanovsk region, Dimitrovgrad, Zapadnoye Shosse, 9
Tel.: +7 (84235) 9-83-83
Fax: +7 (84235) 9-83-84
E-mail: niiar@niiar.ru
Website: http://www.niiar.ru

Delivery of isotope products, utilization of spent sources

Alexander ZVIR
Deputy Director for Production Activities
Tel.: +7 (84235) 7-98-98
E-mail: zvir@niiar.ru

Marketing, transportation, logistics

Fedor GRIGORYEV
Deputy Director for Development & International Activities
Tel.: +7 (84235) 7-92-70
E-mail: feagrigoryev@niiar.ru

Technical issues

Oleg ANDREEV
Head of Division for Radioactive Sources & Radiochemicals
Tel.: +7 (84235) 7-91-06
E-mail: oiandreev@niiar.ru, orip@niiar.ru

You are welcome for further information about JSC "SSC RIAR"

Catalogue
Radioactive Sources and Radiochemicals

Promotional literature

Second edition. Revised and Expanded

Edited by Natalia Chertukhina
Desktop published and designed by Viktor Nedashkovsky
Contributor in charge: Alexander Zvir, Oleg Andreev
Translated by Irina Korneeva, Olga Vinokurova

Passed for printing on June 26, 2019. Format 60x84/8
Publisher's signature: ~ 5. Conventional printed sheet: 5.23. Four-color process. Coated paper
Myriad Pro, Myriad Pro Light
150 copies. Order No. XXX

Camera-ready by PR Office of JSC "SSC RIAR"
Russian Federation, 433510, Ulyanovsk region, Dimitrovgrad, Zapadnoye Shosse, 9
Tel.: +7 (84235) 9-01-96, Fax: +7 (84235) 9-83-84
E-mail: bri@niiar.ru, website: www.niiar.ru

Printed by Publishing House "Pechatny Dvor"
432049, Ulyanovsk, Pushkaryova str., 27

Classification of sealed radioactive sources by strength classes

The International Standardization Organization (ISO) has developed a classification system for sealed radioactive sources that specifies the requirements ensuring their safe uses (ISO 2919). Russian Standard GOST R 52241-2004 developed based on ISO 2919 sets forth requirements for strength of the sources intended for the use in a range of typical applications. The sources are grouped by strength grades associated with typical applications. The established regulations are confirmed by testing.

All sealed radionuclide sources produced in JSC "SSC RIAR" were tested for compliance with the requirements of regulatory documents GOST R 50629-93 "Special Form Radioactive Material. General Technical Requirements and Test Methods" and GOST R 52241-2004 (ISO 2919: 1999) "Radionuclide Ionizing Radiation Sealed Sources. Strength Classes and Test Methods", which is confirmed by certificates of approval for special form radioactive material issued by a competent authority of the State Atomic Energy Corporation ROSATOM.
The sealed source class appears as an ISO Code that includes a letter and five digits. Letter C indicates that the sealed source activity does not exceed the maximum value depending on toxicity, solubility and reactivity of the source active core. Letter E means that the radionuclide activity in the source exceeds the specified value. Five digits are associated with the class numbers that characterize resistance to temperature, external pressure, impact, vibration and puncture. If necessary, a digit showing the bending test type is added in parenthesis to the source code.

All sources and simulated sources (prototypes) are tested for compliance with the IAEA's safety requirements and regulations for special form radioactive materials (Regulations for the Safe Transport of Radioactive Material, IAEA, 2012; Safety Requirements No. SSR-6, IAEA, 2013, Vienna). These requirements are also specified in Russian Standard GOST R 50629-93. Tests for compliance with the special form radioactive material include drop test from a height of 9 m, impact test, temperature test and bending test.

ISBN 978-5-94831-183-8