



RIAR
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STATE SCIENTIFIC CENTER —
RESEARCH INSTITUTE OF ATOMIC REACTORS



CATALOGUE

RADIOACTIVE SOURCES AND RADIOCHEMICALS



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Second Edition. Revised and Expanded

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Catalogue. Radioactive Sources and Radiochemicals:
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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:



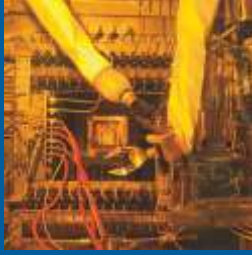
— industry (radiography, radiometric and analytical equipment, portable power sources, photon/ionizing emission sources);



— medicine (raw material for radiopharmaceuticals);



— scientific research.



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*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

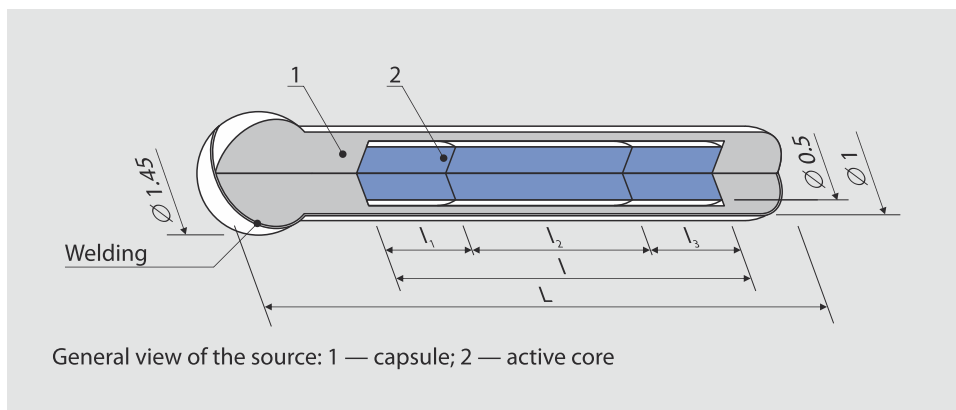


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Gamma sources

⁶⁰Co

Cobalt-60



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 $(2.5 \pm 0.5) \%$ at the ratio of end sections (l_1 and l_3) linear activity to central section (l_2).

GC60M1 source specifications

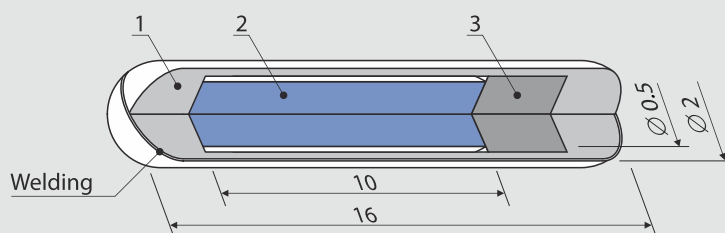
Source type	Size, mm						Nominal exposure dose rate**, nA/kg	Nominal equivalent activity**, MBq (mCi)	Radiation hazard category (safety class)
	D	L	d	l	$l_1 = l_3$	l_2			
GC60M11.75	1.0	25.0	0.5	20.0	5.0	10.0	0.19	75 (2.0)	5 (2)
GC60M11.85							0.21	85 (2.3)	
GC60M11.95							0.24	95 (2.6)	
GC60M11.105							0.27	105 (2.8)	
GC60M12.85		35.0	0.5	30.0	5.0	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 $\pm 20 \%$, respectively.

Gamma sources

⁶⁰Co

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 $(2.5 \pm 0.5) \%$.

GC60M4 source specifications

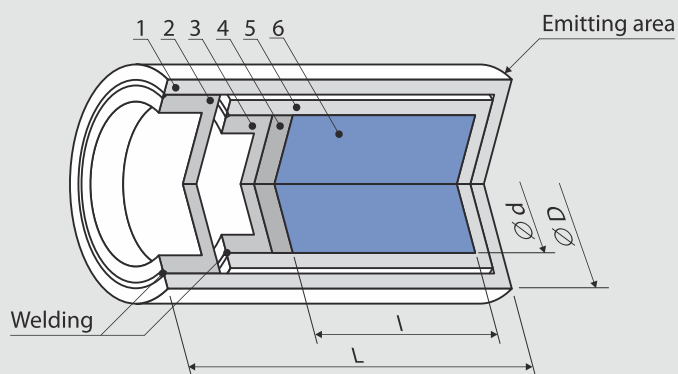
Source type	Size, mm				Nominal exposure dose rate**, nA/kg	Nominal equivalent activity**, MBq (mCi)	Radiation hazard category (safety class)
	D	L	d	l			
GC60M41.207	2.0	16.0	0.5	10.0	0.50	200 (5.4)	5 (2)
GC60M41.257					0.63	250 (6.8)	
GC60M41.307					0.75	300 (8.1)	4 (2)
GC60M41.357					0.87	350 (9.5)	

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

Gamma sources

⁶⁰Co

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

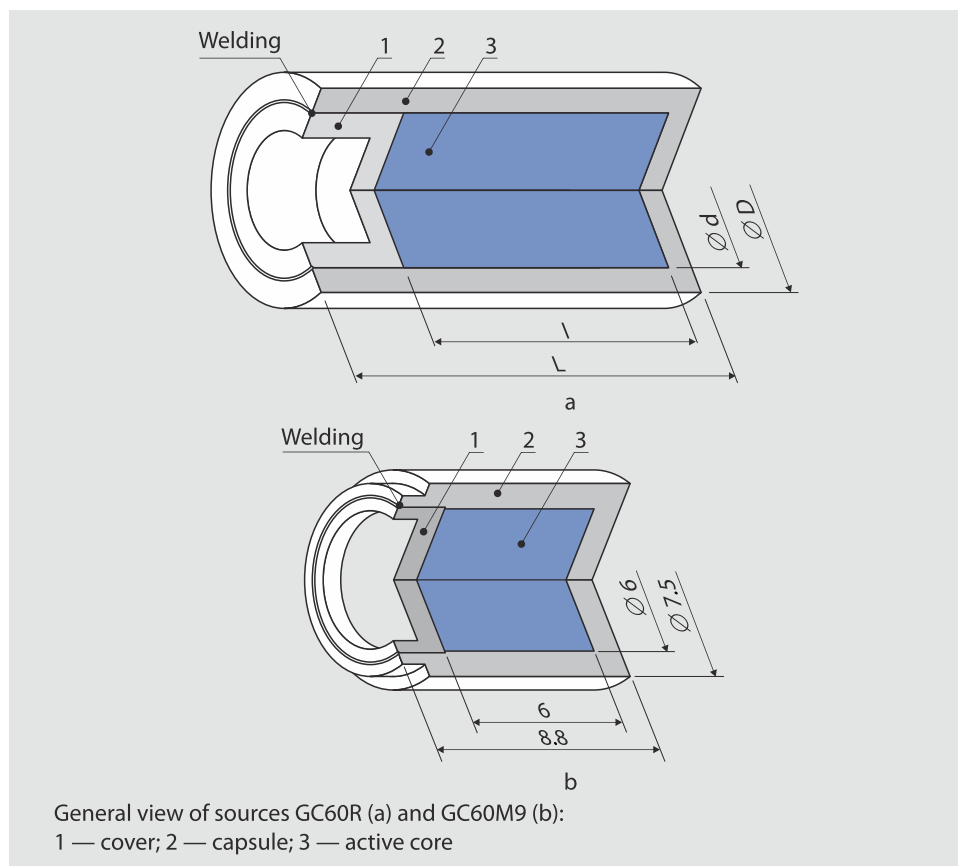
Specification	Description
Design	Sealed double encapsulated design
Capsule material	Austenitic stainless steel
Active core material	Cobalt-60, metal
Emitting area	Bottom
Strength class	ISO/99/S 65444
Specified lifetime	15 years

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	0.534	215 (5.81)		
GC60T05		33.0		26.9	0.921	370 (10.00)	
GC60T06	21.3	36.9	18.0	29.9			

⁶⁰Co

Cobalt-60



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

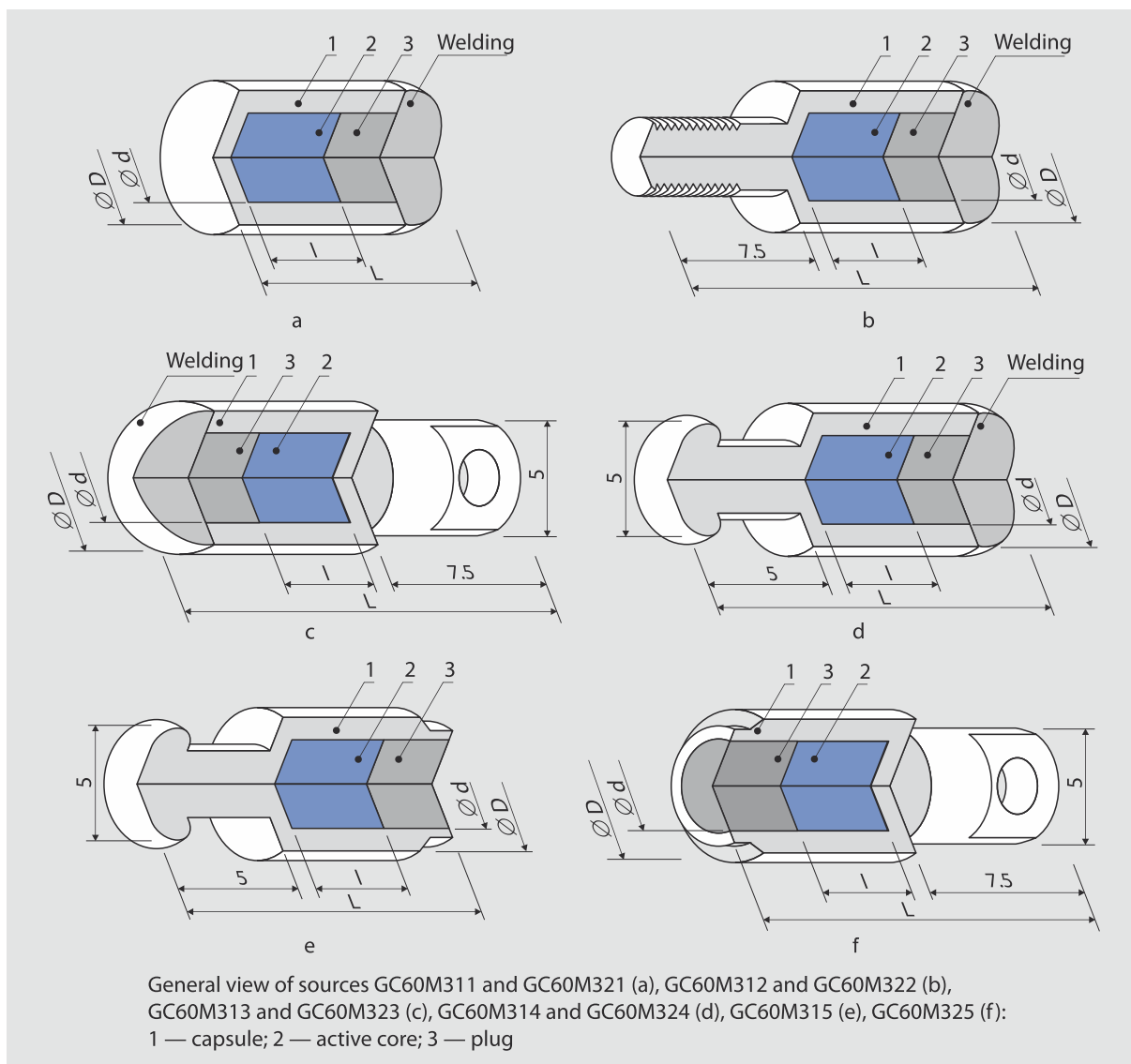
Specifications of sources GC60R and GC60M9

Source type	Size, mm				Max exposure dose rate, $\mu\text{A}/\text{kg}$	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)	

Gamma sources

⁶⁰Co

Cobalt-60



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

Gamma sources



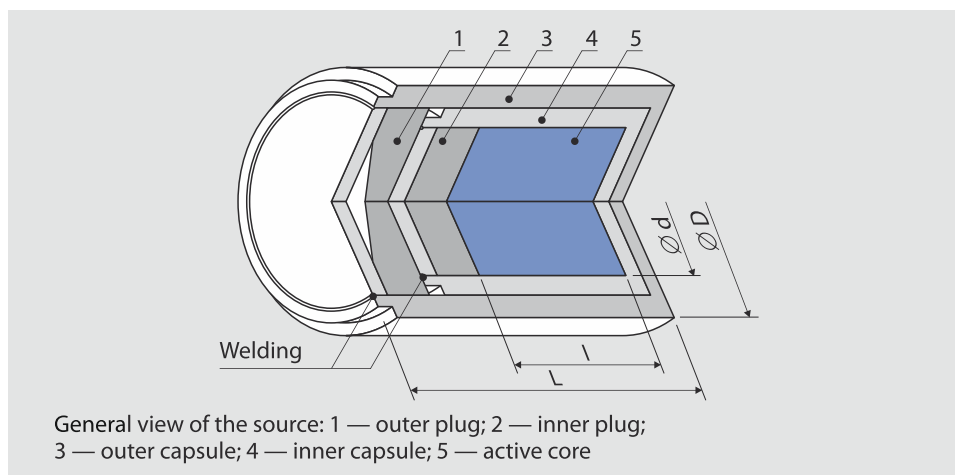
GC60M3 source specifications

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

Gamma sources

⁶⁰Co

Cobalt-60

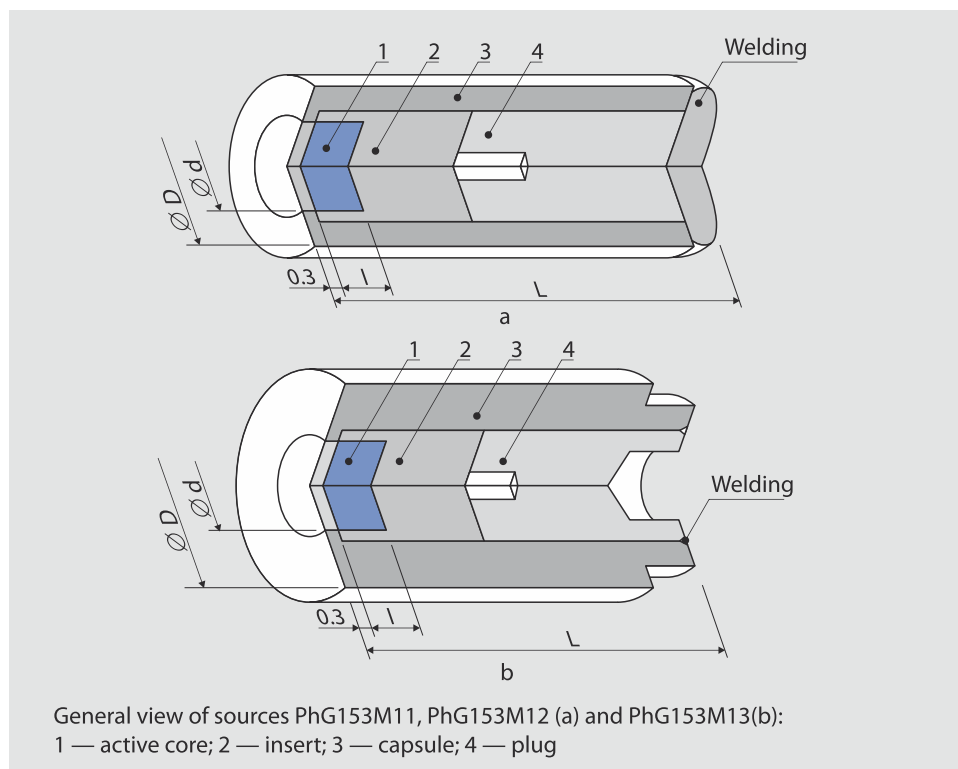


Key specifications

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, $\mu\text{A}/\text{kg}$	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)	
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)	2 (1)
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)	

¹⁵³Gd**Gadolinium-153****Key specifications**

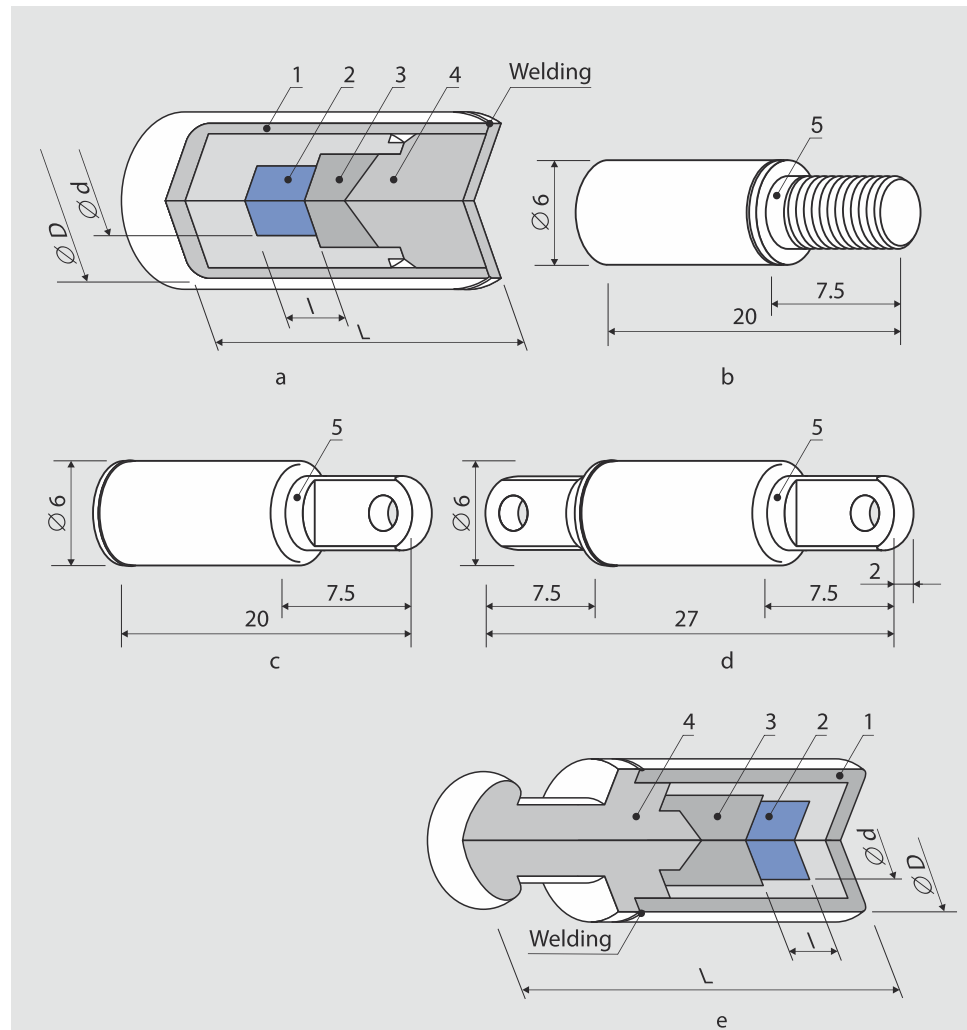
Specification	Description
Design	Sealed capsule
Capsule material	Titanium alloy
Active core material	Gadolinium-153, oxide
Emitting area	Bottom
Strength class	ISO/99/S 65444
Specified lifetime	5 years

PhG153M1 source specifications

Source type	Size, mm				Max photon flux 44 keV, $\times 10^9 \text{ s}^{-1} \cdot \text{sr}^{-1}$	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	1.35	4 (2)	
PhG153M11.49				0.05	0.3		5 (2)	
PhG153M12.110	7.0	10.0	2.0	0.4	11.0 (0.3)		4 (2)	
PhG153M13.410			2.00	1.2	37.0 (1.0)			
PhG153M13.49			0.05	0.3	4.4 (0.12)		5 (2)	

⁷⁵Se

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

⁷⁵Se

Selenium-75



Key specifications

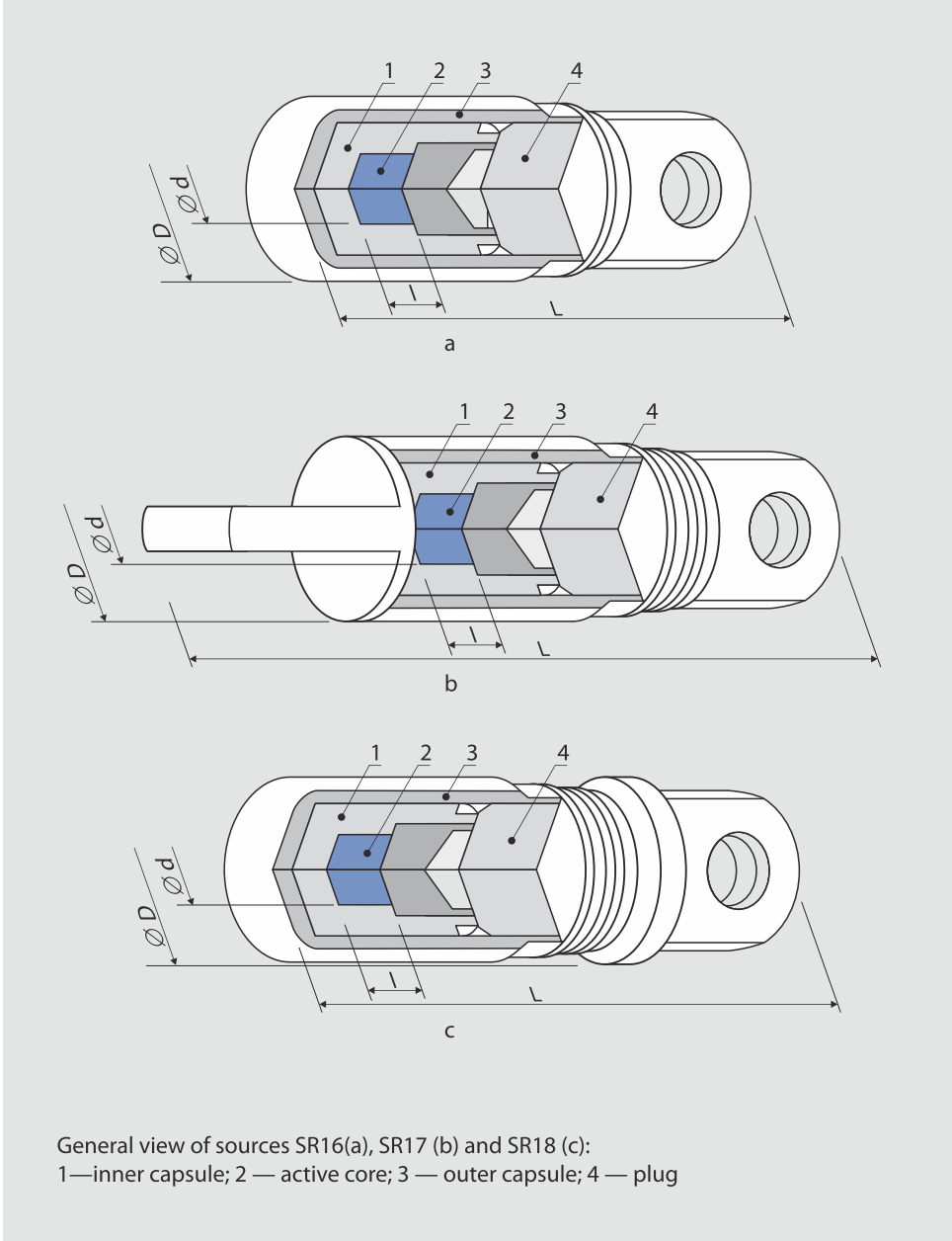
Specification	Description
Design	Sealed double encapsulated design
Capsule material: <ul style="list-style-type: none"> • inner • outer 	Vanadium metal or titanium alloy Austenitic stainless steel
Active core material	Selenium-75, metal
Emitting area	Lateral or bottom
Strength class	ISO/99/S 63545
Specified lifetime	5 years

GS75M1 source specifications

Source type	Size, mm				Max exposure dose rate, $\mu\text{A}/\text{kg}$	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		27					
GS75M14.10		19					
GS75M15.10		12					
GS75M11.20		20	1.5	1.5	0.286	0.74 (20)	
GS75M12.20		27					
GS75M13.20		19					
GS75M14.20		12					
GS75M15.20		20					
GS75M11.40		27					
GS75M12.40		19					
GS75M13.40		12					
GS75M14.40		20	2.5	2.5	1.290	3.33 (90)	
GS75M15.40		27					
GS75M11.90		19					
GS75M12.90		12					
GS75M13.90		20					
GS75M14.90		27					
GS75M15.90		19					
GS75M11.140	12						
GS75M12.140	20	3.5	3.5	2.860	7.40 (200)		
GS75M13.140	27						
GS75M14.140	19						
GS75M15.140	12						
GS75M11.200	20						
GS75M12.200	27						
GS75M13.200	19						
GS75M14.200	12						
GS75M15.200	20						


⁷⁵Se

Selenium-75



⁷⁵Se

Selenium-75

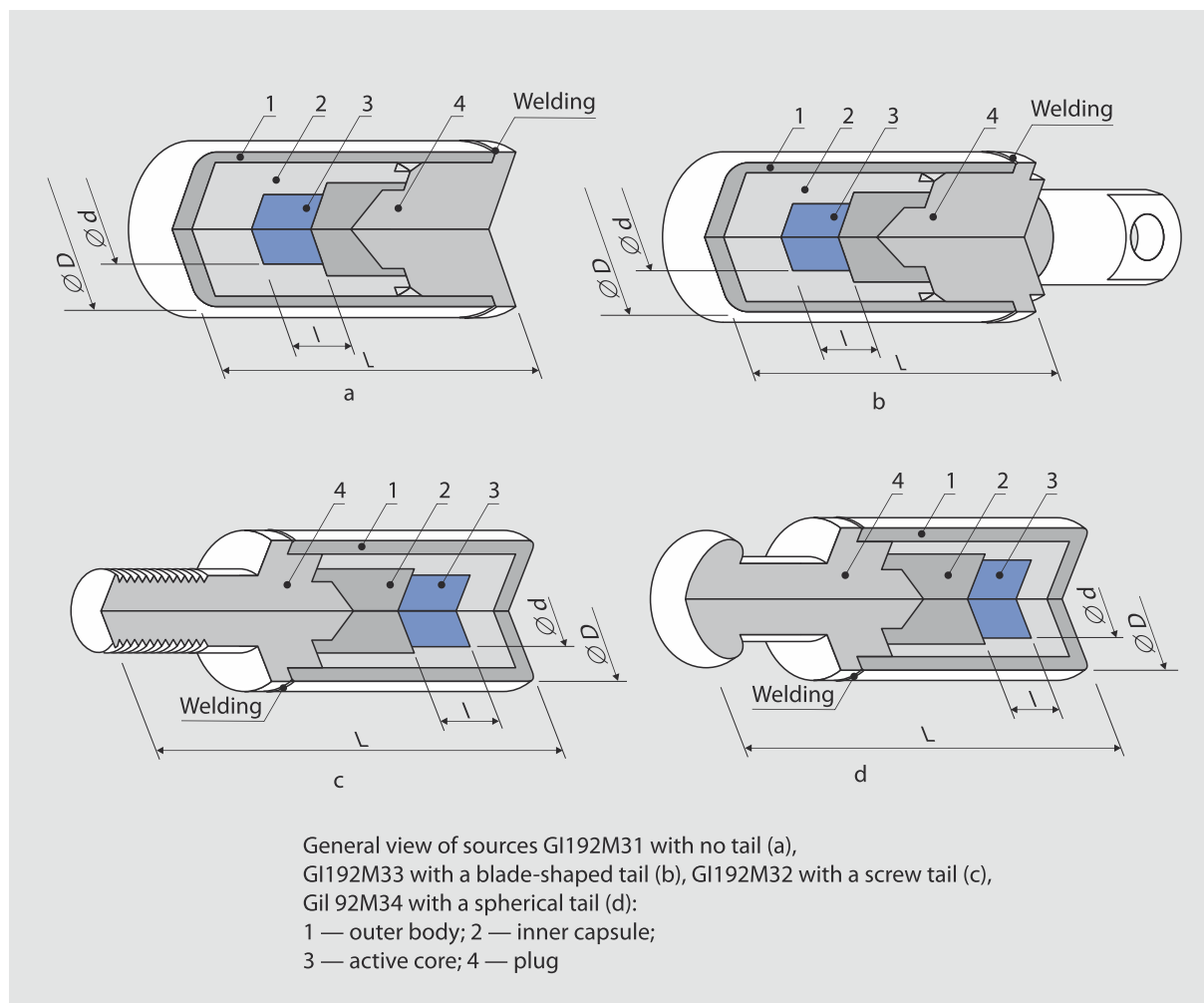


Key specifications

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, $\mu\text{A}/\text{kg}$	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)	
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****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	Titanium alloy
• outer	Austenitic stainless steel
Active core material	Iridium-192, metal disks
Emitting area	Bottom
Strength class	ISO/99/S(E) 65446
Specified lifetime	3 years

Gamma sources

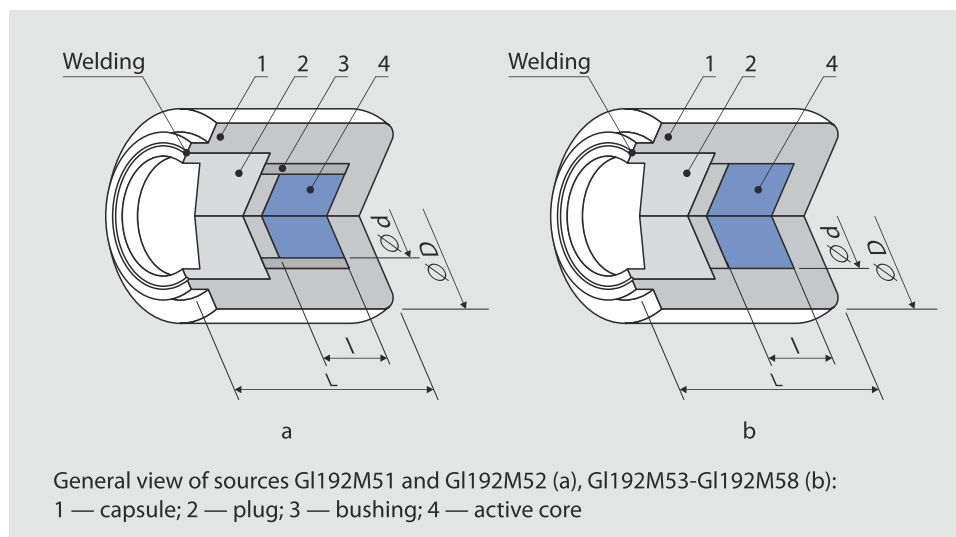
^{192}Ir

Iridium-192



GI192M3 source specifications

Source type	Size, mm				Max exposure dose rate, $\mu\text{A}/\text{kg}$	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		19					
GI192M34.1		12	1.0	1.0	0.440	0.48 (13)	3 (1)
GI192M31.2		20					
GI192M32.2		19					
GI192M33.2		12	1.5	1.5	1.340	1.50 (41)	2 (1)
GI192M34.2		20					
GI192M31.3		19					
GI192M32.3		12	2.0	2.0	2.860	3.15 (85)	
GI192M33.3		20					
GI192M34.3		19					
GI192M31.4		12	2.5	2.5	4.540	5.00 (135)	
GI192M32.4		20					
GI192M33.4		19					
GI192M34.4		12	3.0	3.0	6.700	7.40 (200)	
GI192M31.5		20					
GI192M32.5		19					
GI192M33.5		12	3.5	3.5	9.400	10.40 (280)	
GI192M34.5		20					
GI192M31.6		19					
GI192M32.6	12	3.5	3.5	9.400	10.40 (280)		
GI192M33.6	20						
GI192M34.6	19						
GI192M31.7	12	3.5	3.5	9.400	10.40 (280)		
GI192M32.7	20						
GI192M33.7	19						
GI192M34.7	12	3.5	3.5	9.400	10.40 (280)		
GI192M31.8	20						
GI192M32.8	19						

^{192}Ir **Iridium-192****Key specifications**

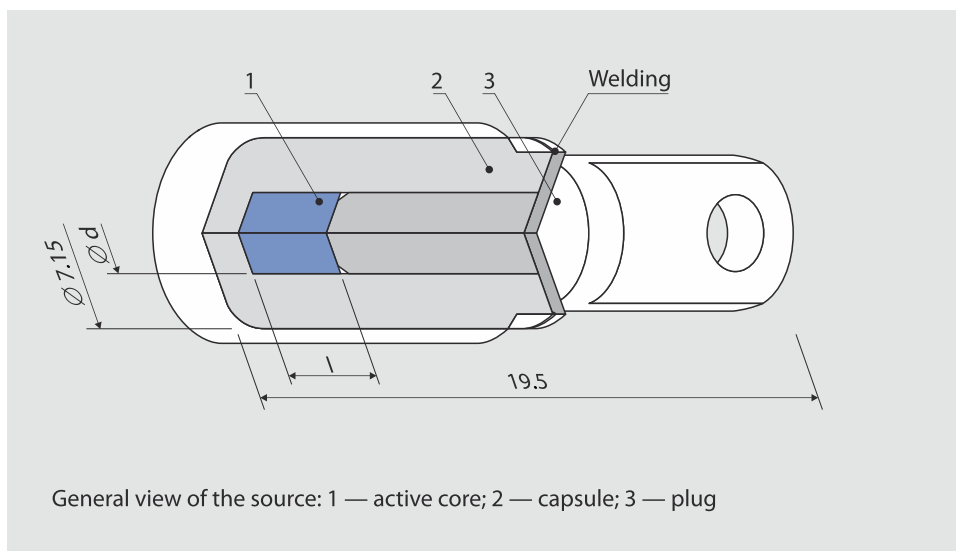
Specification	Description
Design	Sealed capsule
Capsule material	Austenitic stainless steel or titanium alloy
Active core material	Iridium-192, metal disks
Emitting area	Lateral or bottom
Strength class for capsules: • austenitic stainless steel • titanium alloy	ISO/99/S(E) 65446 ISO/99/S(E) 65344
Specified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

GI192M5 source specifications

Source type	Size, mm				Max exposure dose rate, $\mu\text{A}/\text{kg}$	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			4.0	4.0	7.900	8.80 (240)	
GI192M57	6.0	7.0	3.5	3.5	9.400	10.40 (240)	2 (1)
GI192M58			4.0	4.0	11.000	12.00 (324)	

¹⁹²Ir

Iridium-192



Key specifications

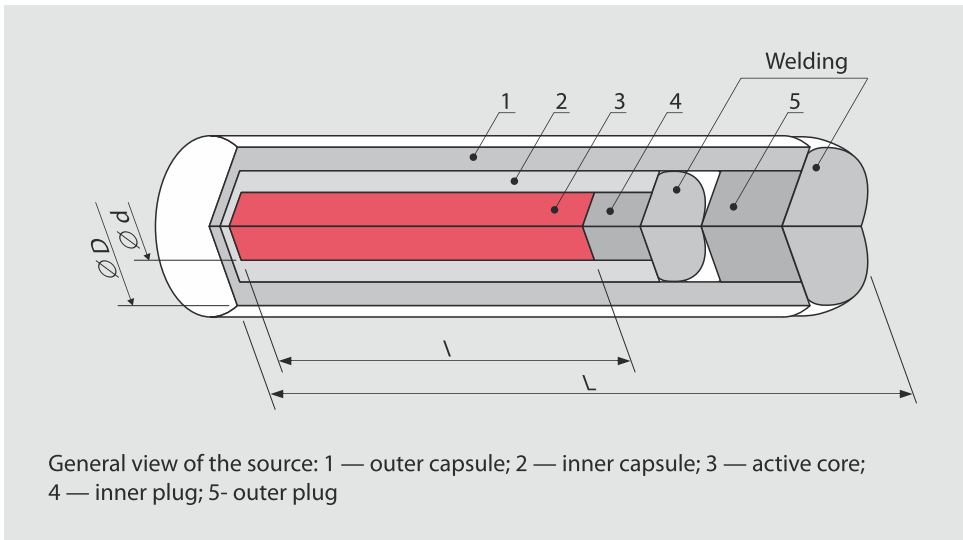
Specification	Description
Design	Sealed capsule
Capsule material	Austenitic stainless steel
Active core material	Iridium-192, metal disks
Emitting area	Lateral
Strength class	ISO/99/S(E) 65446
Specified lifetime	3 years

GI192M6 source specifications

Source type	Size, mm				Max exposure dose rate, $\mu\text{A}/\text{kg}$	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)	

²⁵²Cf

Californium-252



Key specifications

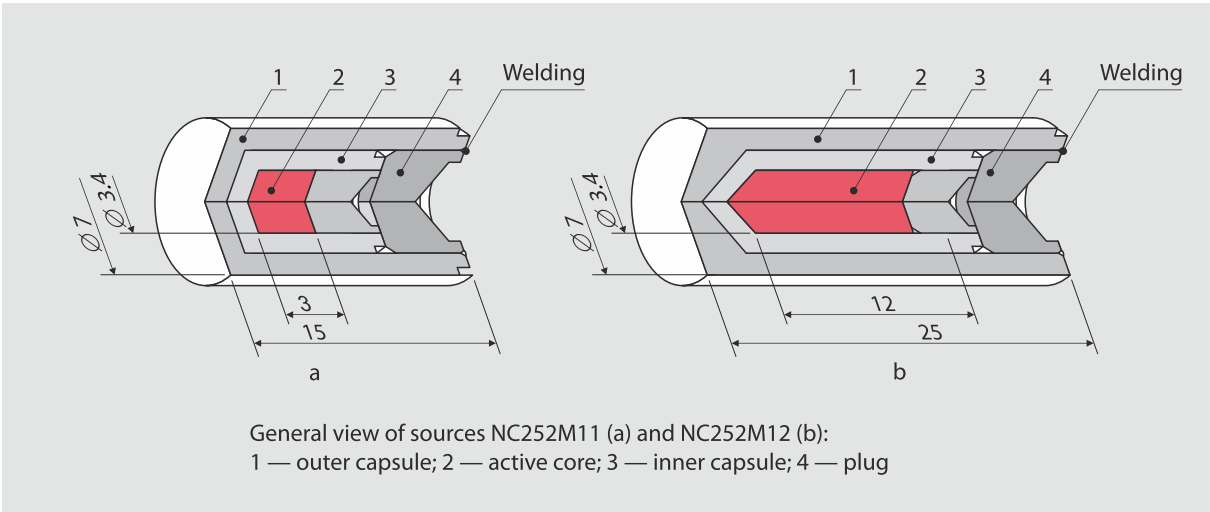
Specification	Description
Design	Sealed double encapsulated design
Capsule material	Austenitic stainless steel
Active core material*	Californium-252, oxide
Strength class	ISO/99/S(E)E65445
Specified lifetime	10 years

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

NC252M4 source specifications

Source type	Size, mm				Max neutron flux into angle of 4π , $\times 10^9 \text{ s}^{-1}$	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)	

²⁵²Cf Californium-252



Key specifications

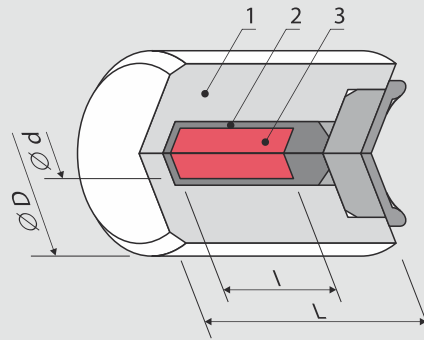
Specification	Description
Design	Sealed double encapsulated design
Capsule material	Austenitic stainless steel
Active core material	Californium-252, oxide
Strength class	ISO/99/S(E) 66546
Specified lifetime	15 years

NC252M1 source specifications

Source type	Size, mm				Max neutron flux into angle of 4π , $\times 10^9 \text{ s}^{-1}$	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)

²⁵²Cf

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

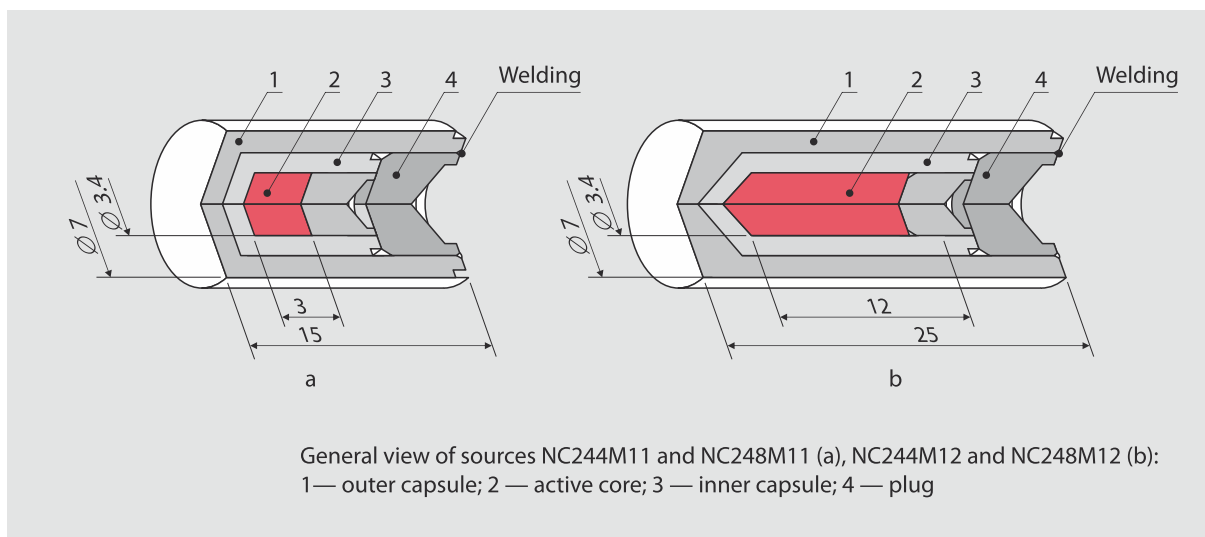
NC252M5 source specifications

Source type	Size, mm				Max neutron flux into angle of 4π , $\times 10^9 \text{ s}^{-1}$	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)

Neutron sources

244,
248
Cm

Curium-244
Curium-248



Key specifications

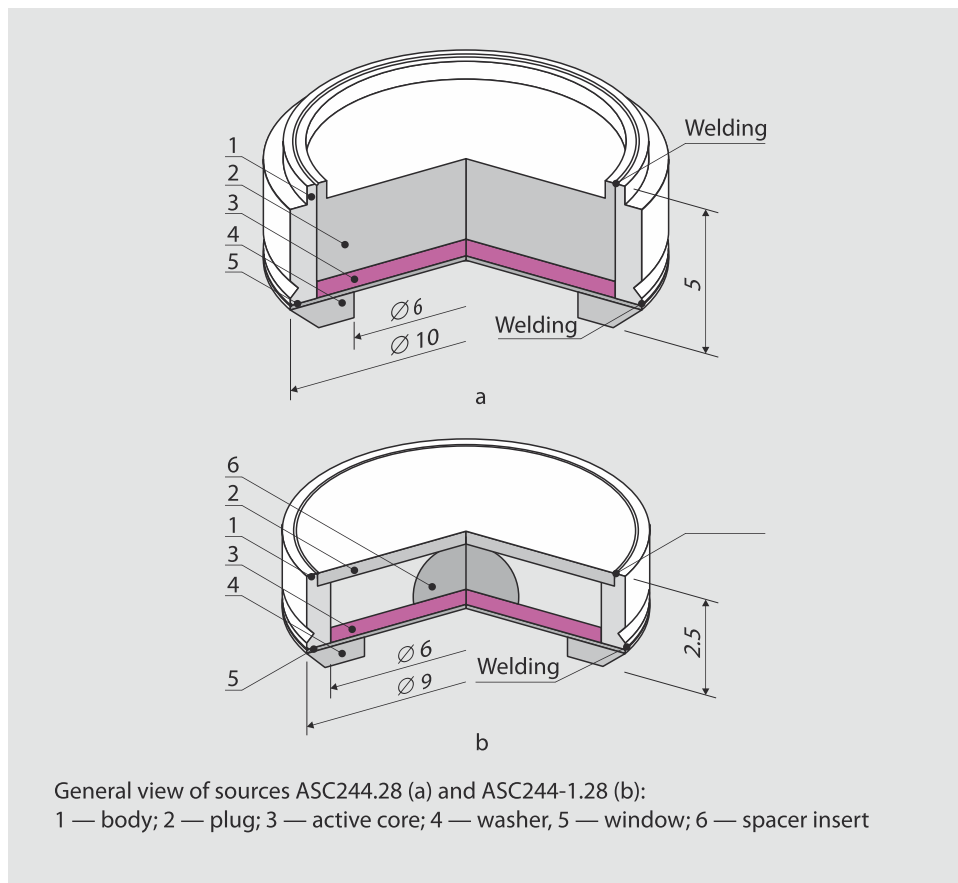
Specification	Description
Design	Sealed double encapsulated design
Capsule material	Austenitic stainless steel
Active core material	Curium-244 or Curium-248, oxide
Strength class	ISO/99/S(E) 66546
Specified lifetime	15 years

NC244M11 and NC248M12 source specifications

Source type	Size, mm				Max neutron flux into angle of 4π , $\times 10^9 \text{ s}^{-1}$	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	$7.4 \cdot 10^{-6}$ ($2.0 \cdot 10^{-4}$)	5 (2)
NC244M12		25.0	12.0	4.0	370	1.1 (29.7)	2 (1)	
NC248M12				2.0	49	$7.4 \cdot 10^{-6}$ ($2.0 \cdot 10^{-4}$)	5 (2)	

²⁴⁴Cm

Curium-244



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

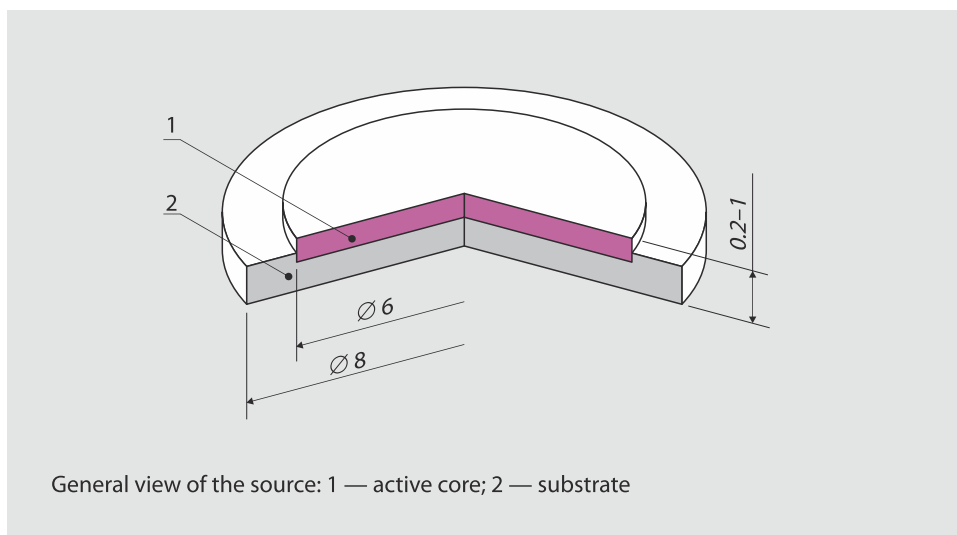
ASC244 source specifications

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				

Alpha sources

²⁴⁴Cm

Curium-244

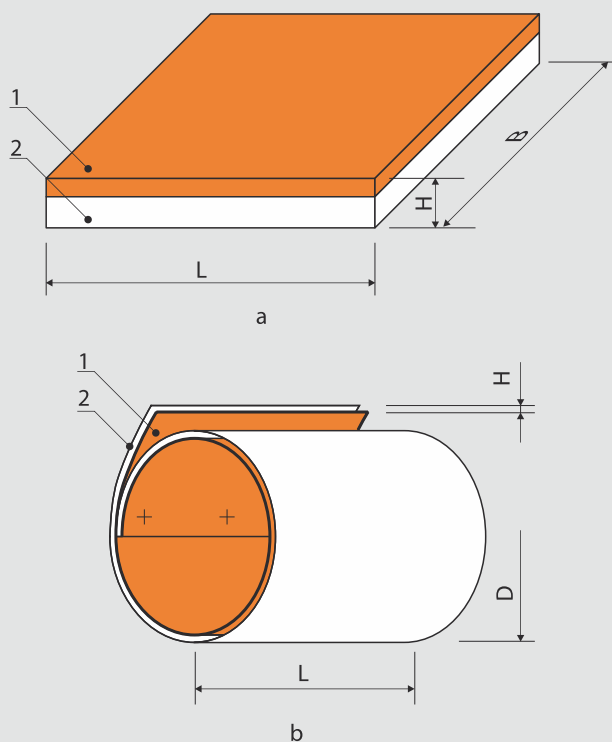


Key specifications

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)

⁶³Ni**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



Chromium-51	32
Manganese-54	32
Iron-55	33
Nickel-63	33
Strontium-89 (nca)	34
Strontium-89 (ca)	34
Molybdenum-99	35
Ruthenium-106	35
Iodine-125	36
Iodine-131	36
Gadolinium-153	37
Lutetium-177	37
Tungsten-188	38
Radium-223	38
Radium-224	39
Thorium-228	39
Plutonium-242	40
Americium-243	40
Curium-244	41
Curium-248	41
Berkelium-249	42

⁵¹Cr

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

⁵⁴Mn

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

⁵⁵Fe**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 (2.5·10 ⁻²)
Solvent concentration (hydrochloric acid), mol/l	0.5–4.0

⁶³Ni**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

⁸⁹Sr

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, %: <ul style="list-style-type: none"> • 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

⁸⁹Sr

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, %: <ul style="list-style-type: none"> • 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

⁹⁹Mo**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 than 12.95 (350)
Radiochemical purity (⁹⁹ MoO ₄ ²⁻ content), %	No less than 95
Ratio of total activity of impurities to molybdenum-99 activity, %: <ul style="list-style-type: none"> • 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 5·10 ⁻³ No more than 1·10 ⁻² No more than 6·10 ⁻⁵ No more than 1·10 ⁻⁷
Solvent concentration (sodium hydroxide), mol/l	0.2–0.3

¹⁰⁶Ru**Ruthenium-106****Specifications**

Parameter	Value
Chemical form	Ruthenium (III, IV) chloride
Specific activity of ruthenium-106, TBq/g ruthenium (Ci/g)	No less than 10 (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, %: <ul style="list-style-type: none"> • gamma-emitting radionuclides except for ruthenium-103; • alpha-emitting radionuclides 	No more than 0.08 No more than 1·10 ⁻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

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

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

¹⁵³Gd

Gadolinium-153



Specifications

Parameter	Value
Chemical form	Gadolinium oxide/ chloride/nitrate
Specific activity of gadolinium-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)

¹⁷⁷Lu

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

¹⁸⁸W

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

²²³Ra

Radium-223



Specifications

Parameter	Value
Chemical form	Radium chloride
Radium-223 activity concentration, MBq/ml (mCi/ml)	No less than 10 (0.27)
Ratio of activity of the radionuclide to radium-223 activity; %: • actinium-227; • thorium-227	No more than 10^{-5} No more than 10^{-3}
Ratio of total activity of impurities (excepting actinium-227 and its daughter isotopes) to radium-223 activity, %	No more than 10^{-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

²²⁴Ra

Radium-224



Specifications

Parameter	Value
Chemical form	Radium chloride
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

²²⁸Th

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 than 10 (0,27)
Ratio of total activity of impurities to thorium-228 activity, %: <ul style="list-style-type: none"> • radium-226 and actinium-227; • radionuclides, except for radium-226, actinium-227 and their decay products, including daughter products of thorium-228 	No more than 10^{-3} No more than 10^{-4}
Solvent concentration (nitric acid), mol/l	0.1–8.0

²⁴²Pu

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, %: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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

²⁴³Am

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, %: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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

²⁴⁴Cm

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, %: <ul style="list-style-type: none"> • 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 $5 \cdot 10^{-4}$

²⁴⁸Cm

Curium-248



Specifications

Parameter	Value
Chemical form	Curium nitrate
Specific activity of curium-248, kBq/g (μ Ci/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: <ul style="list-style-type: none"> • 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

²⁴⁹Bk

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: <ul style="list-style-type: none"> • 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



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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.



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