



# POLATOM



## Sealed Radiation Sources

2021

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# The company

Radioisotope Centre POLATOM is a part of National Centre for Nuclear Research (NCBJ). With over 50 years of experience in the isotopes we are focused on the following products: radiopharmaceuticals, standard solutions and reference sources, radiochemicals and listed here industrial sealed sources .

At present our products are regularly used in more than 80 countries all over the world.

The company is located in vicinity of MARIA Nuclear Reactor in Otwock, near Warsaw.



## Reliable supplier of sealed radiation sources

The active part of quality sealed source for gamma radiography should be as small as possible.

POLATOM has experience, qualifications and facilities to provide the highest level of service in handling radioactive materials and gamma radiography equipment.

We can offer loading the sealed source to your projector or holder in our facility and sending back the projector ready to work. If you need the source shipped in our container we use the following B(U) containers: UKI 4x135; UKI 10; ZKI 4x150; UK12S; UK50S; SUK50. Containers type A can also be used for limited activity sources.



The overall sizes, weight and maximum activity for B(U) containers are specified below:

Container type	Height [mm]	Diameter [mm]	Mass* [kg]	Maximum activity for nuclide			
				Ir-192 [TBq]	Co-60 [GBq]	Se-75 [TBq]	Yb-169 [TBq]
UKI 4x135**	270	146	50	4.99	3.36	37	74
UKI 10**	370	330	103	7.9	4.5	13	-
ZKI 4x150**	298	150	77	5.55	3.73	41.15	82.30
UK 12S	335	280	100	44	29.6	370	-
UK 50S	415	325	185	215	125	3300	-
SUK 50	420	330	226	500	200	4400	-

\* With transport case / cylinder.

\*\*Maximum activity in each of channels

# Standards, quality control and safety

Radioisotope Centre POLATOM implemented Quality Assurance System according to PN-EN-ISO 9001:2015-10 in design, production, quality control and sales of radioactive products and radiopharmaceuticals, servicing of isotopic apparatus, transport and forwarding of radioactive goods. And also follows the standards for International Control System of radioactive materials.

**ISO 2919** – this international standard establishes a system of classification of sealed radioactive sources based on tests and specifies general requirements, performance tests, production tests, marking and certification.

It provides a set of tests by which manufacturer can evaluate the safety of his products in use. And also specifies the sealed sources classification (performance) requirements for typical use.

Classification of sealed source performance acc. to ISO 2919:2012 (extract):

Test / Class	1	2	3	4	5	6
Temperature	No test	- 40°C (20 min) + 80°C (1h)	- 40°C (20 min) + 180°C (1h)	- 40°C (20 min) + 400°C (1h) and thermal shock to 20°C	- 40°C (20 min) + 600°C (1h) and thermal shock to 20°C	- 40°C (20 min) + 800°C (1h) and thermal shock to 20°C
External pressure	No test	25 kPa absolute to atmospheric pressure	25 kPa absolute to 2 MPa absolute	25 kPa absolute to 7 MPa absolute	25 kPa absolute to 70 MPa absolute	25 kPa absolute to 170 MPa absolute
Impact	No test	50 g from 1m*	200 g from 1m*	2 kg from 1m*	5 kg from 1m*	20 kg from 1m*
Vibrations	No test	3 times 10 min 25 Hz to 500 Hz at 49 m/s <sup>2</sup> (5g) <sup>a</sup>	3 times 10 min 25 Hz to 50 Hz at 49 m/s <sup>2</sup> (5 g <sup>a</sup> and 50 Hz to 90 Hz at 0.635 mm peak to peak and 90 Hz to 500 Hz at 98 m/ s <sup>2</sup> (10g) <sup>a</sup>	3 times 30 min 25 Hz to 80 Hz at 1.5 mm peak to peak and 80 Hz to 2000 Hz at 196 m/s <sup>2</sup> (20g) <sup>a</sup>	Not used	Not used
Puncture	No test	1g from 1m*	10 g from 1m*	50 g from 1m*	300 g from 1m*	1 kg from 1m*

a) 1g=9.8 m/s<sup>2</sup>.

\* or equivalent imparted Energy

## Quality control

Testing for leakage and contamination - **ISO 9978: 2020.**

Immersion test - in boiling fluid according to clause 5.1.2 and then the activity of the fluid is measured. Acceptance limit: 200 Bq (5 nCi).

Other methods, as wipe test, are used sometimes for additional test. Acceptance limit: 200 Bq (5 nCi).

# Safety

International safety standards for protection against ionising radiation as dose rate measurements for containers and projectors are applied to all radioactive sources. This is to ensure safety for user and anybody handling the transport.

All sources are manufactured according to **IAEA Special Form** requirements and handled according to IAEA Regulations for Safe Transport of Radioactive Material, Edition 2012, **IAEA Safety Standard Series No. SSR-6**.

## Sealed sources for radiography

### Capsules



HB steel



YAT titanium



HK steel



HCT titanium

A unique source number is visible on the source capsule.

The following sources are used for approximate steel working thickness:

Source	Class A	Class B
Ytterbium Yb-169	1 - 15 mm	2 - 12 mm
Selenium Se-75	10 - 40 mm	14 - 40 mm
Iridium Ir-192	20 - 100 mm	20 - 90 mm
Cobalt Co-60	40 - 200 mm	60 - 150 mm
Yb-169 for Al and Ti	10 - 70 mm	25 - 55 mm
Se-75 for Al and Ti	35 - 120 mm	-

Steel thickness may be reduced to 10 mm for Ir-192 and to 5 mm for Se-75

### Exposure rate at 1 meter

Nuclide	Activity	Exposure rate	Air KERMA rate
Yb-169	37GBq (1 Ci)	0.125 R/h	1.1 mGy/h
Se-75	37GBq (1 Ci)	0.203 R/h	1.8 mGy/h
Ir-192	37GBq (1 Ci)	0.48 R/h	4.2 mGy/h
Co-60	37GBq (1 Ci)	1.30 R/h	11 mGy/h

# Ytterbium-169

**Main application:** Gamma radiography  
**Half-life:** 32 days  
**Recommended working life:** 6 months

## Radiation energies $E_\gamma$ [MeV]:

0.063 (43.9%)	0.118 (1.9%)	0.198 (35.1%)
0.094 (2.6%)	0.131 (11.2%)	0.261 (1.7%)
0.110 (17.6%)	0.177 (21.5%)	0.308 (10.8%)

## Radioactive decay:

Days from date of measurement	0	2	4	6	8
0	1.000	0.958	0.917	0.878	0.841
10	0.805	0.771	0.739	0.707	0.677
20	0.649	0.621	0.595	0.570	0.546
30	0.522	0.500	0.479	0.459	0.439
40	0.421	0.403	0.385	0.370	0.354
50	0.339	0.325	0.311	0.298	0.285
60	0.273	0.261	0.250	0.240	0.230
70	0.220	0.211	0.202	0.193	0.185
80	0.177	0.170	0.162	0.156	0.149
90	0.143	0.137	0.131	0.125	0.120
100	0.115	0.110	0.105	0.101	0.097

**Description:** Double titanium capsule argon arc welded, containing the isotope as pressed ytterbium oxide.

**Capsules:** YAT

**Identification:** by serial number

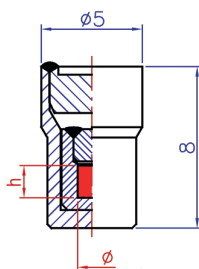
Code	Capsule type	Active part $\Phi$ [mm] x h [mm]	Maximum activity	
			[GBq]	[Ci]
YB3YAT	YAT	1 x 1 (cylinder)	166.5	4.5
YB3YAT	YAT	1.4 x 1.6 (cylinder)	444	12
YB4YAT	YAT	0.8 (sphere)	259	7
YB4YAT	YAT	1 (sphere)	333	9

Other active sizes but below specified maximum - on request

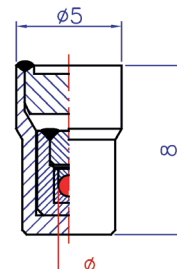
Activity depends on enrichment of target material

## Capsule dimensions special form certification and safety performance testing

Code	Special form certificate No.	Capsule type	External dimensions $\Phi$ [mm] x h [mm]	Capsule material	ISO classification
YB3YAT	PL/0031/S-96	YAT	5 x 8	titanium gr.2	C 66545
YB4YAT	PL/0031/S-96	YAT	5 x 8	titanium gr.2	C 66545



YAT Capsule



# Selenium-75

**Main application:** Gamma radiography  
**Half-life:** 120 days  
**Recommended working life:** 2 years

## Radiation energies $E_\gamma$ [MeV]:

0.066 (1.1%) 0.097 (3.5%)	0.121 (17.3%) 0.136 (59.0%)	0.199 (1.5%) 0.265 (59.1%)	0.280 (25.2%) 0.305 (1.4%)	0.401 (11.6%) and others
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## Radioactive decay:

Days from date of measurement	0	10	20	30	40
0	1.000	0.944	0.891	0.841	0.793
50	0.749	0.707	0.667	0.629	0.594
100	0.561	0.529	0.499	0.471	0.445
150	0.420	0.396	0.374	0.353	0.333
200	0.314	0.297	0.280	0.264	0.249
250	0.235	0.222	0.210	0.198	0.187
300	0.176	0.166	0.157	0.148	0.140
350	0.132	0.125	0.118	0.111	0.105

**Description:** double encapsulation containing the isotope as compressed metal powder of selenium or VSe compound. Inner capsule made of titanium or vanadium alloy sealed by laser welding. Outer capsule made of corrosion resistant steel sealed by argon arc welding.

**Capsules:** GS75M11, GS75M12, SR17, SR18

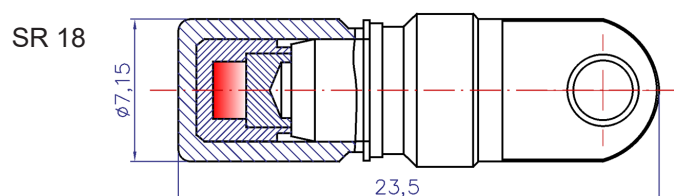
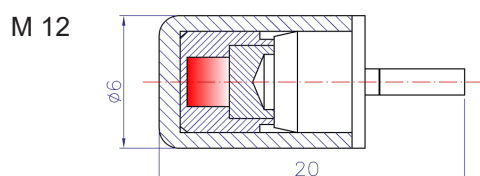
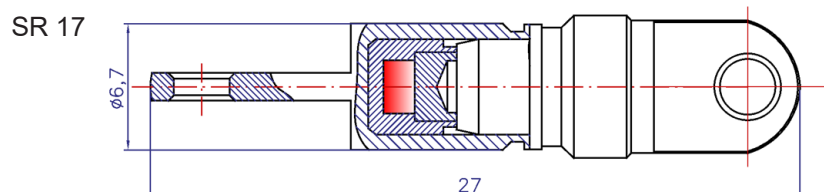
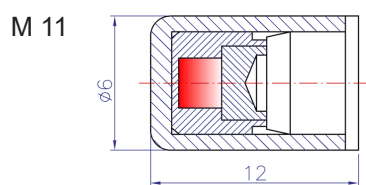
**Identification:** by serial number

**Special form radioactive material certificate No:** RUS/6223/S-96

Code	Active part d [mm] x l [mm]	Max activity	
		[GBq]	[Ci]
GS75M11, GS75M12, SR17, SR18	3 x 3 (2.5 x 2.5)	3700	100

## Capsule dimensions and safety performance testing

Code	Capsule type	External dimensions $\Phi$ [mm] x h [mm]	Capsule material	ISO classification
GS75M11 GS75M12 SR17 SR18	M11 M12 SR17 SR18	6 x 12 6 x 20 6.7 x 27 7.15 x 23.5	inner: titanium or vanadium outer: corrosion - resistant steel	C 63545 C 63545 C 63545 C 63545



# Iridium-192

**Main application:** Gamma radiography  
**Half-life:** 74 days  
**Recommended working life:** 1 year

## Radiation energies $E_\gamma$ [MeV]:

0.206 (3.4%)	0.308 (30.7%)	0.468 (47.0%)	0.589 (4.4%)	0.612 (5.3%)
0.296 (29.6%)	0.316 (82.7%)	0.484 (2.9%)	0.604 (8.2%)	

## Radioactive decay:

Days from date of measurement	0	4	8	12	16
0	1.000	0.963	0.928	0.893	0.861
20	0.829	0.798	0.769	0.741	0.713
40	0.687	0.662	0.637	0.614	0.591
60	0.569	0.548	0.528	0.509	0.490
80	0.472	0.454	0.438	0.422	0.406
100	0.391	0.377	0.363	0.349	0.337
120	0.324	0.312	0.301	0.290	0.279
140	0.269	0.259	0.249	0.240	0.231
160	0.223	0.214	0.207	0.199	0.192
180	0.185	0.178	0.171	0.165	0.159
200	0.153	0.147	0.142	0.137	0.132
220	0.127	0.122	0.118	0.113	0.109

**Description:** stainless steel or titanium capsule argon arc welded, containing iridium pellets.  
**Single capsules:** HB, YAT  
**Double capsules:** HCT(HI/HCT), HCT(HAT/HCT)  
**Identification:** by serial numer

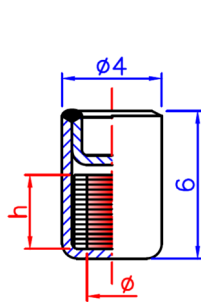
Code	Active part examples $\Phi$ [mm] x h [mm]	Maximum activity (examples)	
		[GBq]	[Ci]
IR2 HCT / IR3 HCT	2.0 x 0.2	333	7
	2.0 x 0.6	666	20
	2.0 x 1.0	1110	30
	2.0 x 1.2	1332	36
	2.0 x 1.6	1776	48
	2.0 x 2.0	2220	55
IR1 HB, YAT / IR3 HCT	3.0 x 2.0	3700	100
	3.0 x 2.2	4070	110
	3.0 x 2.4	4440	120
IR1 HB, YAT	3.0 x 3.0	5920	160
IR1 YAT	3.0 x 4.0	7400	200



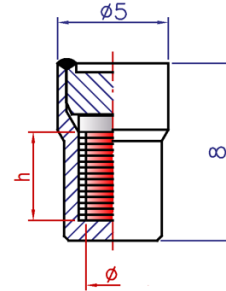
## Capsule dimensions special form certification and safety performance testing

Code	Special form certificate No.	Capsule type	External dimensions $\Phi$ [mm] x h [mm]	Capsule material	ISO classification
IR1HB	PL/0018/S-96	HB	4 x 6	Stainless steel*	C 64344
IR1YAT	PL/0033/S-96	YAT	5 x 8	Titanium gr. 2	C 66445
IR2HCT	PL/0028/S	HCT	5 x 8	Titanium gr. 2	C 66545
IR3HCT	PL/0029/S	HCT	5 x 8	Titanium gr. 2	C 66545

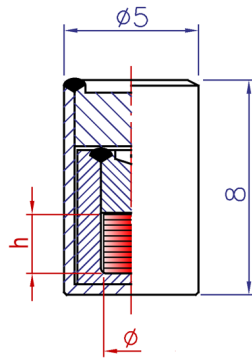
\* 1H18N9T (X6CrNiTi1810)



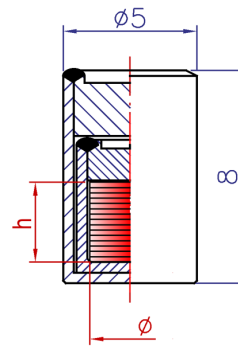
HB Capsule



YAT Capsule



HI/HCT



HAT/HCT



HCT Capsule

# Cobalt-60

**Main application:** Gamma radiography and process control  
**Half-life:** 5.27 years  
**Recommended working life:** 10 years

## Radiation energies $E_\gamma$ [MeV]:

1.17 (100%)	1.33 (100%)
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## Radioactive decay:

Days from date of measurement	0	4	8	12	16
0	1.000	0.957	0.916	0.877	0.839
20	0.803	0.769	0.736	0.704	0.674
40	0.645	0.617	0.591	0.566	0.541
60	0.518	0.496	0.475	0.454	0.435
80	0.416	0.398	0.381	0.365	0.349
100	0.334	0.320	0.306	0.293	0.280
120	0.268	0.257	0.246	0.235	0.225

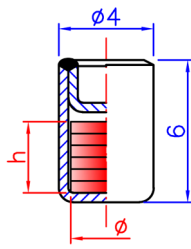
**Description:** Nickel plated disks of cobalt are sealed in stainless steel or titanium capsule(s), argon arc welded.  
**Single capsules:** HB, YAT  
**Double capsules:** HK(HB/HK)  
**Identification:** by serial number

Code	Capsule typ	Max active part $\Phi$ [mm] x h [mm]	Maximum activity	
			[GBq]	[Ci]
CO1HB	HB	3 x 3	37	1
CO1YAT	YAT	3 x 3	37	1
CO1HK	HK	3 x 3	370	10

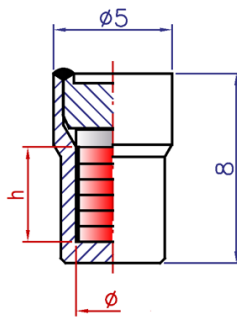
## Capsule dimensions special form certification and safety performance testing

Code	Special form certificate No.	Capsule type	External dimensions $\Phi$ [mm] x h [mm]	Capsule material	ISO classification
CO1HB	PL/0020/S-96	HB	4 x 6	Stainless steel*	C 64344
CO1YAT	PL/0032/S-96	YAT	5 x 8	Titanium gr.2	C 66445
CO1HK	PL/0023/S-96	HK	5 x 10	Stainless steel*	C 66545

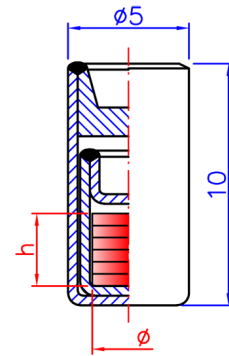
\* steel 1H18N9T (X6CrNiTi1810)



HB Capsule



YAT Capsule

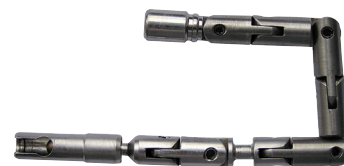


HK Capsule



## Source loading services

The sources may be loaded to various types of projector holders



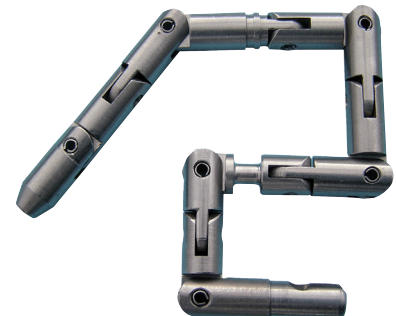
Exertus Dual Ir-192 / Se-75 holder



Gammamat TSI Ir-192 holder



Gammamat TIF Ir-192 holder



Exertus Light / Circa / RID SE4P / Gammamat Se-75 holder



Sentinel holder

# SI Units

The following units are recommended for radioactivity, absorbed dose and dose equivalent. The relationship between the SI units and traditional units is specified in the table below.

Physical quantity	SI unit	Traditional unit	Relationship
Radioactivity	becquerel [Bq]	curie [Ci]	1 Ci = 3.7 x 10 <sup>10</sup> Bq 1 Bq = 2.7 x 10 <sup>-11</sup> Ci
Absorbed dose	gray [Gy]	rad	1 rad = 0.01 Gy 1 Gy = 100 rad
Dose equivalent	sievert (Sv)	rem	1 Sv = 100 rem 1 rem = 0.01 Sv
Exposure dose	C/kg	R	1 R = 2.58 x 10 <sup>-4</sup> C/kg

## Changing the units

### Curies to Becquerels

0.1 mCi	3.7 MBq
0.2 mCi	7.4 MBq
0.5 mCi	18.5 MBq
1 mCi	37 MBq
2 mCi	74 MBq
5 mCi	185 MBq
10 mCi	370 MBq
20 mCi	740 MBq
50 mCi	1.85 GBq
100 mCi	3.7 GBq
200 mCi	7.4 GBq
500 mCi	18.5 GBq
1 Ci	37 GBq
2 Ci	74 GBq
5 Ci	185 GBq
10 Ci	370 GBq
100 Ci	3.7 TBq

### Becquerels to Curies

1 MBq	0.027 mCi
2 MBq	0.054 mCi
5 MBq	0.135 mCi
10 MBq	0.270 mCi
20 MBq	0.540 mCi
50 MBq	1.350 mCi
100 MBq	2.703 mCi
200 MBq	5.405 mCi
500 MBq	13.50 mCi
1 GBq	27.03 mCi
2 GBq	54.04 mCi
5 GBq	135.0 mCi
10 GBq	270.3 mCi
20 GBq	540.5 mCi
50 GBq	1.350 Ci
100 GBq	2.703 Ci
1 TBq	27.03 Ci



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