Sealed Radiation Sources

POLATOM

The company

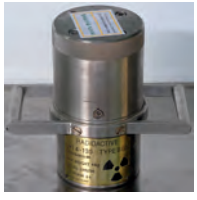
Radioisotope Centre POLATOM is a part of National Centre for Nuclear Research (NCBJ). With over 50 years of experience in the isotopes we are focused on the following products: radiopharmaceuticals, standard solutions and reference sources, radiochemicals and listed here industrial sealed sources .
At present our products are regularly used in more than 70 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 cares for the quality of your radiographs and supplies high activity sources with small active part.

We have experience, qualifications and facilities to provide the highest level of service in handling radioactive materials and various types of gamma radiography equipment.

We can offer you loading of sealed source in your projector or holder in our facility and send back the projector ready to work. In case you require a source dispatched in our container – we use containers type A or the following B(U) containers: UKI 4x135; ZKI 4x150; UK12S; UK50S; SUK50.



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

				maximum activity for nuclide			
Container type/	Height	Diameter	Mass**	Ir-192	Co-60	Se-75	Yb-169
	[mm]	[mm]	[kg]	[TBq]	[GBq]	[TBq]	[TBq]
UKI 4x135*	270	146	50	4.99	3.36	37	74
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	-

* Maximum activity in each of four channels
** With transport case / cylinder.

Standards, quality control and safety

Radioisotope Centre POLATOM implemented Quality Assurance System according to **PN-EN-ISO 9001:2009 (ISO 9001:2008)** in production, sales of radioactive products and radiopharmaceuticals, services of isotopic equipment, dispatching and transport of radioactive materials. 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 (20min) +80°C (1h)	-40°C (20min) +180°C (1h)	-40°C (20min) +400°C (1h) and thermal shock to 20°C	-40°C (20min) +600°C (1h) and thermal shock to 20°C	-40°C (20min) +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	50g from 1m*	200g from 1m*	2kg from 1m*	5kg from 1m*	20kg from 1m*
Vibrations	No test	3 times 10 min 25Hz to 500Hz at 49m/s^2 (5g)[a]	3 times 10 min 25Hz to 50Hz at 49m/s^2 (5 g)[a] and 50Hz to 90Hz at 0.635mm peak to peak and 90Hz to 500Hz at 98m/s^2 (10 g)[a]	3 times 30 min 25Hz to 80Hz at 1.5 mm peak to peak and 80Hz to 2000Hz at 196 m/s^2 (20g)[a]	Not used	Not used
Puncture	No test	1g from 1m*	10g from 1m*	50g from 1m*	300g from 1m*	1kg from 1m*

[a] 1g=9.8 m/s^2.

* or equivalent imparted energy

Quality control

Testing for leakage and contamination - **ISO 9978: 1992**.

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

HA steel | HB steel | YA steel | YA titanium | HC steel | HK steel | HG steel

A unique source number is visible on the 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 10mm 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 Eγ [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:

Yb-169

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: YA
Identification: by serial number

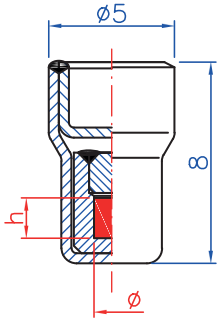
Code	Capsule type	Active part Φ [mm] x h [mm]	Maximum activity [GBq]	[Ci]
YB1YAT	YA	1x1 (cylinder)	166.5	4.5
YB1YAT	YA	1.4x1.6 (cylinder)	444	12
YB2YAT	YA	0.8 (sphere)	259	7
YB2YAT	YA	1 (sphere)	333	9

Other active sizes but below specified maximum - on request

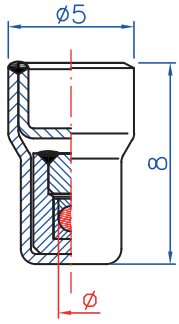
Activity depends on enrichment of target material

Capsule dimensions and safety performance testing

Code	Capsule type	External dimensions Φ [mm] x h [mm]	Capsule material	ISO classification
YB1YAT	YA	5x8	titanium	C 64444
YB2YAT	YA	5x8	titanium	C 64444



YA Capsule



Selenium-75

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

Radiation energies Eγ [MeV]:

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

Radioactive decay:

Se-75

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

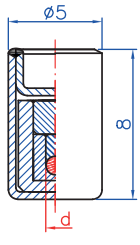
Description: Double capsule containing the isotope as pressed selenium powder. Internal titanium or vanadium capsule laser welded, external stainless steel capsule argon arc welded.
Capsules: HC, M12, M14
Identification: by serial number

Code	Active part d [mm] x l [mm]	Nominal activity [GBq]	[Ci]
SE1HC	1 (sphere)	148	4
GS75M12/M14.40	2x2	740	40
GS75M12/M14.90	2.5x2.5	1480	60
GS75M12/M14.140	3x3	2960	80
GS75M12/M14.140	3x3	3330	90

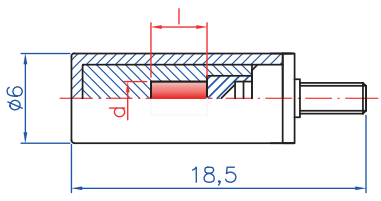
Capsule dimensions and safety performance testing

Code	Capsule type	External dimensions Φ [mm] x h [mm]	External capsule material	ISO classification
SE1HC	HC	5x8	Steel*	C 66445
GS75M12	M12	6x18.5	Steel*	C 63545
GS75M14	M14	6x27	Steel*	C 63545

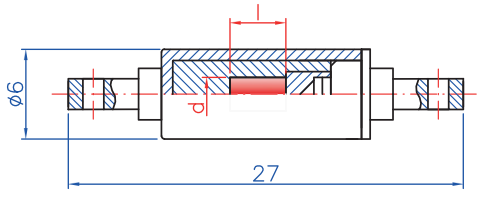
*-steel 12X18H10T



HC



M 12



M 14

Iridium-192

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

Radiation energies Eγ [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:

Ir-192

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

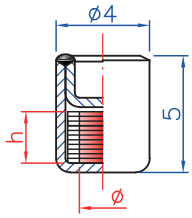
Description: Stainless steel capsule argon arc welded, containing iridium pellets.
Single capsules: HA, HB, YA
Double capsules: HC(HA/HC), HK(HB/HK), HG (HD/HG)
Identification: by serial number

Code	Capsule type	Active part Φ [mm] x h [mm]	Maximum activity [GBq]	[Ci]
IR1..	HA, HB, YA, HC, HK, HG	1.0x0.4	148	4
		1.0x0.6	222	6
		1.0x1.0	333	9
		1.5x1.0	666	18
		1.5x1.2	740	20
		1.5x1.6	1036	28
		2.0x1.0	1110	30
		2.0x1.2	1332	36
		2.0x1.6	1776	48
		2.0x2.0	2220	60
IR1..	HA, HB, YA, HC, HK	3.0x2.0	3700	100
		3.0x2.2	4070	110
IR1..	HB, YA, HC, HK	3.0x2.4	4440	120
IR1..	HB, YA, HK	3.0x3.0	5920	160
IR1..	YA	3.0x4.0	7400	200

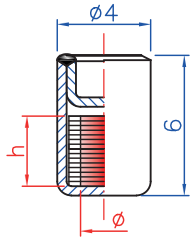
Capsule dimensions and safety performance testing

Code	Capsule type	External dimensions Φ [mm] x h [mm]	Capsule material	ISO classification
IR1HA	HA	4x5	Stainless steel*	C 64344
IR1HB	HB	4x6	Stainless steel*	C 64344
IR1YA	YA	5x8	Stainless steel*	C 64344
IR1HC	HC	5x8	Stainless steel*	C 66545
IR1HK	HK	5x10	Stainless steel*	C 66545
IR1HG	HG	4x7	Stainless steel*	C 66445

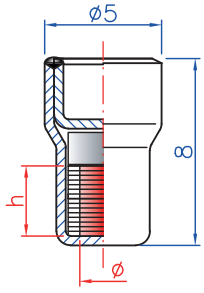
*-steel 1H18N9T



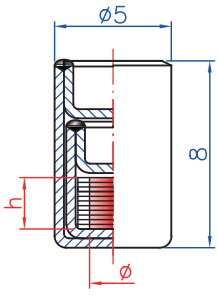
HA Capsule



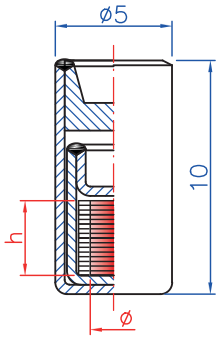
HB Capsule



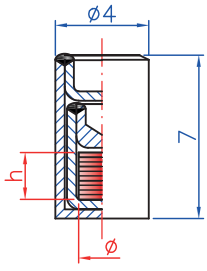
YA Capsule



HC Capsule



HK Capsule



HG Capsule

Cobalt-60

Application: Gamma radiography and process control
Half-life: 5.27 years
Recommended working life: 10 years

Radiation energies Eγ [MeV]:

1.17 (100%)	1.33 (100%)

Radioactive decay Cobalt-60:

Co-60

Months 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

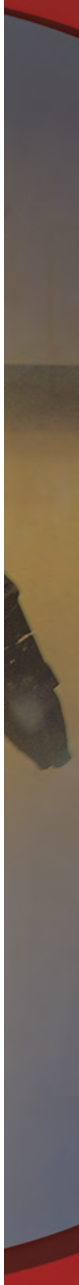
Description: Nickel plated disks of cobalt are sealed in stainless steel capsule, argon arc welded.
Single capsules: HB, YA
Double capsules: HK(HB/HK)
Identification: by serial number

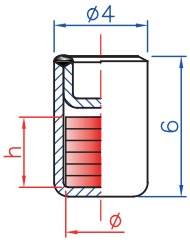
Code	Capsule type	Max active part Φ [mm] x h [mm]	Maximum activity [GBq]	[Ci]
CO1HB	HB	3x3	37	1
CO1YA	YA	3x3	37	1
CO1HK	HK	3x3	370	10

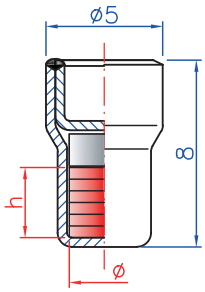
Capsule dimensions and safety performance testing

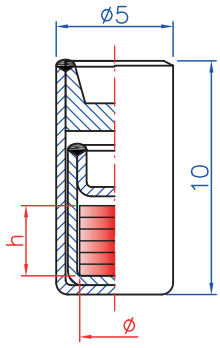
Code	Capsule type	External dimensions Φ [mm] x h [mm]	Capsule material	ISO classification
CO1HB	HB	4x6	Stainless steel*	C 64344
CO1YA	YA	5x8	Stainless steel*	C 64344
CO1HK	HK	5x10	Stainless steel*	C 66545

*-steel 1H18N9T









HB Capsule

YA Capsule

HK Capsule

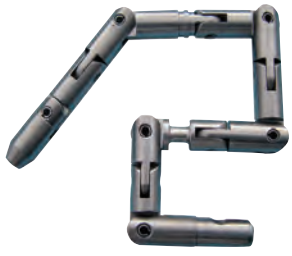
Source loading services

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 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 = 3.7×10^{10} Bq 1 Bq = 2.7×10^{-11} 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 = 2.58×10^{-4} 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

POLATOM

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