Quality control

Testing for leakage and contamination

Stringent tests for leakage are an essential feature of radioactive sources production. The methods adopted depend on the design and intended application of the source, and also on statutory requirements. Where necessary, tests can be specially modified to meet particular requirements.

The standard methods used for testing radiation sources are listed below.

Wipe test A
The source is wiped with a swab or tissue, moistened with ethanol or water; the activity removed is measured. Limit: 185 Bq, 0.005 μCi.

Wipe test B
The source is wiped with a swab or tissue, moistened with ethanol or water; the activity removed is measured. Limit: 1.85 kBq, 0.05 μCi.

Bubble test D
The source is immersed in a suitable liquid (ethanediol) and the pressure in the vessel reduced to 100 mm of mercury. No bubbles must be observed.

Immersion test F
The source is immersed in water at 50 °C for 8 hours and the activity in the water measured.
Limit: 1.85 kBq, 0.05 μCi.

Immersion test L
The source is immersed in water at 50 °C for 4 hours and the activity in the water measured.
Limit: 185 Bq, 0.005 μCi.

Immersion test M
The source is immersed in water which is raised to 100 °C and held at that temperature for 10 min. The water is then removed, the source cooled, and the procedure repeated twice. Sources are passed if the activity extracted in the final procedure does not exceed 185 Bq, 0.005 μCi.

Helium mass spectograph test H
Limit: leak rate of 10^{-8} standard cm^3/sec.

All tests are performed in accordance with ISO 9978 (1992) "Radiation Protection – Sealed Radioactive Sources – Leakage Test Methods."

IAEA Special Form

'Special Form' is a test specification for sealed sources given in the IAEA transport regulations.
(IAEA Safety Series No. 6, 1985 edition, as amended 1990), or updated version TS – R – 1 (1996)

The required tests are:
impact test
percussion test
bending test (only for long, slender sources)
heat test
After each test the source must be subjected to leak testing.

Source working life

The *'recommended working life'* is our recommendation of the period within which the source should be replaced or subjected to integrity testing to confirm the sources suitability for continued use. The period given has been assessed on the basis of such factors as, toxicity of nuclide, total initial activity, source construction (e.g., capsule design, source insert type, etc.), half-life of nuclide, typical application environments, operational experience, test performance data, etc.

Adverse environments could affect the appearance and integrity of a source. It is the user's responsibility to regularly inspect and test the source in order to assess at what point during the "recommended working life" the source should be replaced.

ANSI Classification

American National Standards Institute has proposed a system of classification of sealed radioactive sources based on safety requirements for typical uses (See ANSI N542 – 1977, or ANSI/HPS N 43.6 – 1997).

"This system provides a manufacturer of sealed radioactive sources with a set of tests to evaluate the safety of his products under working conditions. It also assists a user of such sealed sources to select types which suit the application he has in mind, especially where protection against the release of radioactive material is concerned."

The tests to which specimen sources are subjected are listed in Table 1.

Each test can be applied in several degrees of severity. Test results are expressed as a five figure code to indicate the severity of the tests.

These figures are preceded by the letter C or E to show whether the source activity is less than or greater than certain limits. These limits depend upon the toxicity, solubility and reactivity of the active component of the source.

C indicates that the activity level of the source does not exceed the prescribed limit and
E that the limit is exceeded.

Table 1. Classification of sealed source performance standards

Test	Class 1	2	3	4	5	6	X
Temperature	No Test	– 40 °C (20 min) + 80 °C (1 hr)	– 40 °C (20 min) + 180 °C (1 hr)	– 40 °C (20 min) – 400 °C (1 hr) and thermal shock 400 °C to 20 °C	– 40 °C (20 min) – 600 °C (1 hr) and thermal shock 600 °C	– 40 °C (20 min) – 800 °C (1 hr) thermal shock 800 °C to 20 °C	Special Test
External pressure	No Test	25 kN/m^2 abs. (3.6 lb/in^2) to atmosphere	25 kN/m^2 abs. to 2 MN/m^2 (290 lb/in^2) abs.	25 kN/m^2 abs. to 7 MN/m^2 (1 015 lb/in^2) abs.	25 kN/m^2 abs. to 70 MN/m^2 (10 153 lb/in^2) abs.	25 kN/m^2 abs. to 170 MN/m^2 (24 656 lb/in^2) abs.	Special Test
Impact	No Test	50 g (1.8 oz) from 1 m (3.28 ft) and free drop ten times to a steel surface from 1.5 m (4.92 ft)	200 g (7 oz) from 1 m	2 kg (4.4 lb) from 1 m	5 kg (11 lb) from 1 m	20 kg (44 lb) from 1 m	Special Test
Vibration	No Test	30 min 25 to 500 Hz at 5 g peak amp	30 min 25 to 50 Hz at 5 g peak amp and 50 to 90 Hz at 0.635 mm amp. peak to peak and 90 to 500 Hz at 10 g	90 min 25 to 80 Hz at 1.5 mm amp. peak to peak and 80 to 2000 Hz at 20 g	Not Used	Not Used	Special Test
Puncture	No Test	1 g (15.4 gr) from 1 m (3.28 ft)	10 g (154 gr) from 1 m	50 g (1.76 oz) from 1 m	300 g (10.6 oz) from 1 m	1 kg (2.2 lb) from 1 m	Special Test

Notes to Table 1.

1. Details of the testing procedures are given in ANSI N 542 or ANSI/HPS N 43.6 – 1997. A further class X can be used where a special test procedure has been adopted.
2. **External pressure**
   100 kN/m^2 = 1 atmosphere (approx.)
3. **Impact Test**
   The source, positioned on a steel anvil, is struck by a steel hammer of the required weight, the hammer has a flat striking surface, 25 mm diam. with the edges rounded.
4. **Puncture test**
   The source, positioned on a hardened steel anvil, is struck by a hardened pin, 6 mm long, 3 mm diam., with hemispherical end, fixed to a hammer of the required weight.

Performance requirements for typical uses

Typical applications in which sealed radioactive sources may be used, with minimum performance requirements are also given in ANSI N 542 or ANSI/HPS N 43.6 – 1997 (see Table 2 below). These recommendations take into account normal usage and reasonable accidental risks, but do not include exposure to the risk of fire, explosion or corrosion.

Table 2. Sealed source performance requirements for typical uses.

Sealed source use		Sealed source test and class Temperature	Pressure	Impact	Vibration	Puncture
Industrial radiography	Unprotected source	4	3	5	1	5
	Source in device	4	3	3	1	3
Gamma gauges (medium and high energy)	Unprotected source	4	3	3	3	3
	Source in device	4	3	2	3	2
Beta gauges and sources for low energy gamma gauges or X-ray fluorescence analysis (excluding gas-filled sources)		3	3	2	2	2
Oil well logging		5	6	5	2	2
Portable moisture and density gauges (including hand held or dolly transported)		4	3	3	3	3
General neutron source application (excluding reactor start-up)		4	3	3	2	3
Calibration sources, activity greater than 1.11 MBq, 30 μCi		2	2	2	1	2
Gamma irradiation sources	Unprotected source	4	3	4	2	4
	Source in device	4	3	3	2	3
Ion generators (source-device combination may be tested)	Chromatography	3	2	2	1	1
	Static eliminators	2	2	2	2	2
	Smoke detectors	3	2	2	2	2
Medical	Radiography	3	2	3	1	2
	Gamma teletherapy	5	3	5	2	4
	Beta teletherapy	5	3	3	2	2
	Interstitial and intracavitary appliances*	5	3	2	1	1
	Surface applicators	4	3	3	1	2

*Sources of this nature may be subject to severe deformation in use. Manufacturers and users may wish to formulate additional or special test procedures.

If the sealed source has a 'C' classification,
Table 2 can be used directly to assess the suitability of the source for the proposed application provided that there is no significant fire, explosion or corrosion hazard.

If such a hazard does exist, the user and the manufacturer have to consider the following factors to determine whether additional testing is required:

1. consequences of loss of activity,
2. quantity of active material contained in the source,
3. radiotoxicity,
4. chemical and physical form of the material and the geometrical shape,
5. environment in which it is to be used,
6. protection afforded to the source or source-device combination.

Laboratory applications

The ANSI classification system does not refer explicitly to sources designed for research laboratory usage because of the wide variety of applications and environments in which such sources might be used.

If the sealed source has an 'E' classification,
Table 2 cannot be used directly.

To determine whether any additional testing is necessary, an evaluation of the fire, explosion and corrosion hazards must first be made and a separate evaluation of the use and design of the source.

Some of our source designs exceed the recommendations of Table 2 and may therefore be acceptable for the applications listed despite the 'E' classification.

Special applications

No test program can cover all possible combinations of environments to which a source may be exposed.

Users should therefore consult our technical staff before using sources in potentially adverse environments.

Consideration should be given to all materials used in close proximity to a radiation source for compatibility with the source. Some materials can undergo radiolysis and produce corrosive compounds (e.g., halogenated compounds should be avoided).