

Specification

Sealed radioactive sources

Sources radioactives scellées

Verschlossene radioaktive Präparate

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Foreword

Safety is the prime consideration in establishing a standard for sealed radioactive sources. Industrial users of sealed sources have an enviable record of safe usage. This is the result of careful scrutiny of the application of the sealed source by the regulating authority, the supplier and the user. However, as the application of sealed sources becomes more diversified and widespread, a standard is needed to specify the requirements and characteristics of sealed sources and the essential performance and safety testing methods for particular applications and, thus, to maintain the record of safe usage.

In this standard, the requirements of section two are in agreement with ISO 1677 'Sealed radioactive sources—General'*..

The classification system in section three of this standard is in agreement with ISO 2919 'Sealed radioactive sources—Classification'*. It is based on performance specifications that cover a large range of possible uses of sealed sources; it does not attempt to establish design standards, so that innovations in the manufacture of sealed sources to meet particular requirements are not inhibited. This system provides a sealed source manufacturer with a set of tests to

evaluate the safety of his products under working conditions. It assists a user of such sealed sources to select types that suit the application he has in mind, especially where protection against the release of radioactive material, with consequent exposure to ionizing radiation, is concerned. It may be of guidance to the regulating authority.

The performance specifications require that sealed sources under test, after being subjected to certain temperature, pressure, impact, vibration and puncture tests, be evaluated by an appropriate leak test. A compendium of appropriate leak test methods, developed to produce uniformity of practice, is included in appendix D. This appendix is in agreement with an ISO Technical Report 'Sealed radioactive sources—Leak test methods'*. In course of time other leak test methods may be added.

The classification system is modelled on USA standard USASI N 5.10, which also gives a number of comparable leak test methods.

BS 3513 'Specification for gamma-radiography sealed sources', being largely superseded by this standard, has been withdrawn.

*Awaiting publication.

Sealed radioactive sources

Section one. General

1. Scope

This standard specifies the general requirements, production tests, marking, certificate and method of classification of sealed radioactive sources. Fuel elements are specifically not covered in this standard.

The classification system is based on a variety of performance criteria that cover the conditions likely to be met with in service.

Appendix D gives a number of leak test methods for sealed radioactive sources for use primarily in evaluating the effects of the performance criteria tests on prototype sources, but the methods may also be used for production or other testing.

2. References

The title of the British Standard referred to in this standard is given on the inside back cover.

3. Definitions

For the purposes of this British Standard the following definitions apply. Other terms are defined in BS 3455.

3.1 capsule. Protective envelope to prevent leakage of the radioactive material.

3.2 device. Any piece of equipment designated to utilize sealed source(s).

3.3 dummy sealed source. Facsimile of a radioactive sealed source of exactly the same material and construction as the radioactive sealed source but containing, in place of the radioactive material, a substance resembling it as closely as practicable in physical and chemical properties.

3.4 leakage. Transfer of radioactive material from the sealed source to the environment.

3.5 model. Descriptive term or number to identify a specific sealed source design.

3.6 non-leachable. Term used to convey that the radioactive material is virtually insoluble in water and is not convertible into dispersible products.

3.7 prototype source. Original of a model of a sealed source that serves as a pattern for the manufacture of all sealed sources identified by the same model designation.

3.8 prototype testing. Performance testing of a new radioactive sealed source before sealed sources of such design are put into actual use.

3.9 quality control. Such tests and procedures as are necessary to establish the ability of the sealed sources to comply with the performance characteristics for that sealed source design.

3.10 radiation output. Number of particles and/or photons of ionizing radiation emitted per unit time from the sealed source in defined geometry. This is best expressed in terms of radiation fluence rate.

3.11 radiotoxicity. Of a radionuclide; the ability of a nuclide to produce injury, by virtue of its emitted radiations, when incorporated in the human body.

3.12 sealed source. Radioactive source sealed in a capsule or having a bonded cover, the capsule or cover being strong enough to prevent contact with and dispersion of the radioactive material under the conditions of use and wear for which the sealed source was designed.

3.13 sealed source holder. Mechanical support for the sealed source.

3.14 sealed source in device. Applying to industrial radiography and gamma gauges and irradiation sources; sealed source that remains in the shielding during use.

3.15 simulated source. Facsimile of a radioactive sealed source, the capsule of which is made with exactly the same materials and construction as those of the sealed source that it represents but containing, in place of the radioactive material, a substance with mechanical, physical and chemical properties as close as possible to those of the radioactive material and containing radioactive material in tracer quantity only. The tracer is in a form soluble in a solvent that does not attack the capsule and has an activity compatible with its use in a glove box*.

Section two. Requirements

4. General requirements

The sealed source capsule

- (a) shall be free from surface radioactive contamination;
- (b) shall be leak-free;
- (c) shall be physically and chemically compatible with its contents;
- (d) shall not contribute significantly to the activity of the radioactive material in the case of a sealed source produced by direct irradiation.

*For example:

$^{90}\text{Sr} + ^{90}\text{Y}$ as soluble salt: 50 μCi

^{60}Co as soluble salt: 20 μCi .

5. Production tests

5.1 General. Production tests to ensure that the capsule is free from surface radioactive contamination and leaks shall be carried out on each sealed source by the manufacturer.

5.2 Freedom from surface contamination.

Except as in 5.4 the method of test shall be either

- (a) the wipe (smear) test as given in D.2.1. If the detected activity on the swab is less than 5 nCi, the sealed source is considered to be free from surface contamination; or
- (b) the immersion test as given in D.2.3. If the detected activity in the liquid used is less than 5 nCi, the sealed source is considered to be free from surface contamination.

NOTE. The method at (a) above is generally applicable but is difficult to use if the sealed source is small. The method at (b) above cannot be applied in all cases since a suitable liquid cannot always be found.

5.3 Freedom from leakage

NOTE. Before testing for leakage it should be ensured that the sealed source capsule is free from surface contamination.

Except as in 5.4 one of the leak test methods given in appendix D shall be used and the criteria given therein for freedom from leaks shall be satisfied.

5.4 Alternative methods. If the characteristics (e.g. dimensions, chemical composition etc.) of the sealed source are such that no test method specified in 5.2 or 5.3 is applicable, another equivalent method shall be established by agreement between the manufacturer and the purchaser.

6. Sealed source marking

Whenever physically possible the sealed source capsule shall be durably and legibly marked with the following information, which is given in order of priority:

- (a) serial number;
- (b) mass number and chemical symbol of the radionuclide;
- (c) nominal activity;
- (d) the manufacturer's name or symbol;
- (e) for neutron sources, the target nuclide.

The marking of the capsule shall be done before the sealed source is tested.

The above information, together with the classification designation (see clause 9), should also be given on the sealed source container or holder or accompanying document.

7. Sealed source certificate

The manufacturer shall provide a certificate with every sealed source or sealed source batch.

The certificate shall in every case state

- (a) the name of the manufacturer;
- (b) the classification designation (see clause 9);
- (c) the serial number of the sealed source and the chemical symbol and mass number of the radionuclide;
- (d) the nominal activity;
- (e) the equivalent activity* and/or radiation

output in terms of fluence rate as appropriate on a specified date;

(f) the method used and the result of the test for freedom from surface contamination;

(g) the method used and the result of the test for freedom from leakage.

In addition the certificate may include as appropriate a detailed description of the sealed source, in particular

(h) (for the capsule) dimensions, material, thickness and method of sealing;

(i) (for the active contents) chemical and physical form, dimensions, mass or volume, and percentage of undesirable radionuclides from the point of view of the use to which the sealed source is to be put.

In the case of neutron sources both the radionuclide and the target nuclide, if any, should be described.

In all cases the magnitude of the output of any accompanying radiations should be stated, e.g. the exposure rate of gamma radiation accompanying the useful emission from a $^{226}\text{Ra}/\text{Be}$ source. Where the decay in the output is anomalous and does not follow that of the principal radionuclide, the decay pattern should be described or illustrated.

Purely as an illustration, an example of a certificate for a sealed source is given in appendix E.

Section three. Classification

8. General

This classification system specifies sets of tests to evaluate the safety of sealed sources under working conditions. The tests fall into several groups, namely, exposure to abnormally high and low temperatures and a variety of mechanical tests. Each test can be applied in several degrees of severity. The criterion of pass or fail depends on leakage of the contents of the sealed source. Appendix D gives a number of leak test methods.

In appendix C is a list, which is not intended to be comprehensive, of typical applications of sealed sources with a suggested test schedule for each application. These schedules are minimum requirements corresponding to the applications in the broadest sense. Subclauses 10.2 and 10.3 list factors to be considered for applications in specially severe conditions.

This classification system makes no attempt to classify either the design of sealed sources and their method of construction or their calibration in terms of the radiation emitted.

9. Classification designation

The classification shall be designated by the code 'BS 5288/' followed by a letter and five digits†.

The letter shall be either 'C' or 'E'. 'C' designates that the activity level of the sealed source does not exceed the limit established in appendix B.

'E' designates that the activity level of the sealed source exceeds the limit established in appendix B.

The first digit shall be the class number that describes the performance for temperature.

The second digit shall be the class number that

*See ICRU Report 10c 'Radioactivity' (NBS Handbook 86).

†It is anticipated that ISO 2919, when published, will be identical to section three of this British Standard. The international designation code will then be 'ISO/' followed by the same letter and the same five digits as obtained from this section.

describes the performance for external pressure.

The third digit shall be the class number that describes the performance for impact.

The fourth digit shall be the class number that describes the performance for vibration.

The fifth digit shall be the class number that describes the performance for puncture.

For example, following appendix C a typical industrial radiography sealed source designed for use unprotected would be designated 'BS 5288/C43515'. The letter X in the designation in place of a digit would indicate that a special performance test had been carried out.

10. General considerations

10.1 Explanation of appendices A, B and C and table 1

10.1.1 Classification of radionuclides according to radiotoxicity (appendix A). This annex, based on ICRP Publication 5, classifies radionuclides into four groups according to radiotoxicity.

10.1.2 Activity level (appendix B). This appendix establishes a maximum activity of sealed sources for each of the four radiotoxicity groups in appendix A below which a separate evaluation of the specific usage and design is not required.

Sealed sources containing more than the maximum activity shall be subject to further evaluation of the specific usage and design. The activity level of a sealed source for purposes of classification according to appendix B shall be that at the time of its manufacture.

Appendix B also defines the physical form of the radionuclide within the sealed source as 'leachable and/or highly reactive' or 'non-leachable and not highly reactive'. If it is considered necessary to make a test to evaluate these properties experimentally, then the physical and chemical form and the geometrical shape of the radionuclide used to determine these properties shall be the same as the physical, chemical and geometrical shape of the radioactive material within the sealed source.

10.1.3 Sealed source performance requirements for typical uses (appendix C). Appendix C is a list of some typical applications in which a sealed source or source-device will be used, together with an estimate of their minimum performance requirements. This estimate takes into account normal usage and reasonable accidental risks but does not include exposure to fire or explosion. For sealed sources normally mounted in devices, the assignment of a particular class number for a particular use took account of the additional protection afforded the sealed source by the device. Thus for all uses shown in appendix C the class numbers specify the tests to which the sealed source shall be subjected, except that for the category ion generators the complete source-device combination may be tested. Obviously, appendix C does not cover all uses of

sealed sources. If the particular use or accidental risks are likely to differ from the values suggested in the estimate, or if the sealed source use is not shown, the specifications of the sealed source shall be considered on an individual basis by the supplier, the user, and the regulating authority. The numbers shown in appendix C refer to the class numbers used in table 1.

Attention is called to the IAEA tests for special form radioactive material*. These are not of general application but may be relevant when formulating special tests.

10.1.4 Classification of sealed source performance standards (table 1). This is a list of environmental test conditions to which a sealed source may be subjected. The tests are arranged in order of increasing severity.

The classification of each sealed source type shall be determined by actual testing of two sources (either sealed, prototype, dummy or simulated) of that type for each test in table 1, or by derivation from previous tests that demonstrate that the source would pass the test if the test were performed. Different specimens may be used for each of the tests.

Compliance with the tests shall be determined by the ability of the source to maintain its integrity after each test is performed.

A source with more than one encapsulation shall be deemed to have complied with a test if it can be demonstrated that at least one encapsulation has maintained its integrity after the test.

Leak test methods for sealed radioactive sources are given in appendix D. When leak testing a simulated source (i.e. one containing radioactive material of only tracer quantity) the sensitivity of the chosen method has to be adequate.

10.2 Fire, explosion and corrosion. Appendix C does not consider accidental exposure of the sealed source or the source-device to fire, explosion and corrosion. In the evaluation of sealed sources and source-device combinations, the manufacturer and the user have to consider the probability of subjection to fire, explosion and corrosion and the possible results. Factors that should be considered in determining the need for actual testing are

- (a) consequences of loss of activity,
- (b) quantity of active material contained in the sealed source,
- (c) radiotoxicity,
- (d) chemical and physical form of the material and the geometrical shape,
- (e) environment in which it is used, and
- (f) protection afforded to the sealed source or source-device combination.

10.3 Radiotoxicity and solubility. Radiotoxicity of the radionuclide shall be considered only when the activity of the sealed source exceeds the value shown in appendix B. The specification of any sealed source

*IAEA Safety Series No. 6, 'Regulations for the safe transport of radioactive materials', 1973, paragraphs 726 to 737.