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Radioactive materials — Packagings — Tests for contents leakage and radiation leakage

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up has the right to be represented on that Committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 2855 was drawn up by Technical Committee ISO/TC 85, *Nuclear energy* (see also page iii), and was circulated to the Member Bodies in August 1974.

It has been approved by the Member Bodies of the following countries :

Australia	France	Sweden
Austria	Germany	Switzerland
Belgium	Hungary	Thailand
Bulgaria	Netherlands	Turkey
Canada	Poland	United Kingdom
Chile	Romania	U.S.A.
Czechoslovakia	South Africa, Rep. of	

No member body expressed disapproval of the document.

This International Standard was prepared by ISO/TC 85/SC 4, *Radioactive sources,* in co-operation with the International Atomic Energy Agency (IAEA) and is aimed at providing methods for testing the containment of transport packagings which have passed the mechanical and physical environmental tests set out in the *Regulations for the safe transport of radioactive materials* established by the IAEA.

The contents leakage test was developed specially for the purpose by the Polish Nuclear Research Institute at the request of the Polish Standards Committee in its capacity as the Secretariat of ISO/TC 85/SC 4.

The radiation leakage test was also developed specially for the purpose through a Research Contract awarded to the Polish Electrotechnical Institute by the IAEA, whose collaboration in permitting the test to be included here is gratefully acknowledged.

These methods cannot be considered universally applicable, since the field of application is limited by the procedures and sensitivity.

It was agreed[1] between the Secretariat of ISO/TC 85/SC 4 and the IAEA that the methods for testing contents leakage and radiation leakage, when accepted by the ISO Council as an International Standard, will be referred to in the *Regulations for the safe tansport of radioactive materials, Advisory material on implementation of the regulations,* issued by the IAEA.

1) Document ISO/TC 85/SC 4 (Secretariat 57) 117, March 1971, *Report on the meeting of experts on contents leakage and radiation leakage testing,* arranged by the IAEA and ISO/TC 85/SC 4, *Radioactive sources,* Secretariat in Vienna at the IAEA Headquarters on February 10, 1971.

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0 INTRODUCTION

The design of packagings for the transport of radioactive materials may be demonstrated as meeting relevant requirements by subjecting prototypes or samples of a particular design to physical and mechanical environmental tests. These tests are described in the IAEA *Regulations for the safe transport of radioactive materials.*

Following the application of these tests it is necessary to demonstrate that the efficiencies of the containment and radiation shielding are maintained to the required degree. This demonstration requires

a) some form of contents leakage test on the containment of the packaging, and

b) some form of radiation leakage test on the radiation shielding of the packaging.

To this end, ISO/TC 85/SC 4 has undertaken development of the methods for contents leakage test and radiation leakage test.

The IAEA regulations[1] relating to containment of type A packaging require that the packaging shall prevent any loss or dispersal of the radioactive contents.

Only in the case of special form radioactive material does the IAEA[2] give a relation between leakage of activity and engineering leaktightness criteria : a standard helium leak rate of 10^{-4} torr·l/s (about 13,33 μPa·m^3/s) for solid content and a rate of 10^{-6} torr·l/s (about 0,133 3 μPa·m^3/s) for liquid content would be considered in most cases to be equivalent to the activity release of 0,05 μCi prescribed in Section VII of the IAEA Regulations[1], paragraph 737.

This International Standard gives only the information that forms the basis of the contents leakage test specified in clause 2 : that a hole of 10^{-3} mm^2 (corresponding to a standard helium leak rate of about 0,1 torr·l/s — about 13,33 mPa·m^3/s) or less will not, under the conditions of this test, permit an initial leakage greater than $1{,}5 \times 10^{-5}$ l/10 min ($1{,}5 \times 10^{-5}$ dm^3/10 min).

The IAEA requirements relating to radiation shielding are the following :

> Type A packaging shall be so designed that if it were subjected to the environmental tests specified in the *Regulations for the safe transport of radioactive materials,* it would prevent any increase of the maximum radiation level recorded or calculated at the external surface for the conditions before the test.
>
> Type B packaging shall be so designed that if it were subjected to the environmental tests, it would retain sufficient radiation shielding to ensure that the radiation level at 1 m from the surface of the package would not exceed 1 rem/h had the package contained sufficient iridium 192 to produce a radiation level of 10 mrem/h at 1 m from the surface before the tests.

The results of the investigations into radiation leakage testing have shown that, for small deformations such as cracks and indentations, it is not possible to detect dose rate increases smaller than 100 % averaged over an area of 1 cm^2 of the surface, and for larger areas in the range of 100 cm^2 it is impossible to detect dose rate increases smaller than 20 %. In most cases the sensitivity of the method described in this International Standard should be sufficient to meet the IAEA requirements for type B packagings.

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies methods for contents leakage and radiation leakage tests of protoypes of packages designed for transport of radioactive materials.

It gives only some of several possible methods for prototype testing for establishing acceptability. It cannot be considered universally applicable.

The tests are intended to provide a means of showing that the efficiencies of the containment system and radiation shielding, respectively, are of the required degree in a package used for transport of radioactive materials.

The contents leakage test is intended to be applied to the containment vessel, for example tinned iron can, or containment system of a prototype type A package which has been subjected to mechanical and physical tests to demonstrate that the design meets the relevant requirements. The test may be applied only in the case of materials in the form of liquids or powders, of moderately low specific activity, for which the sensitivity of the method is considered to be appropriate. The test is not intended for containment vessels and containment systems of such a size or nature that the performance of the test procedure would present undue practical difficulty.

1) *Regulations for the safe transport of radioactive materials* — 1973 revised edition — IAEA Safety Series No. 6, Vienna, 1973.

2) *Advisory material for the application of the IAEA transport regulations,* IAEA Safety Series No. 37, Vienna, 1973.

The radiation leakage test is intended to be applied to the external surface of the radiation shielding, or to the whole package if distance contributes, by design, to the reduction of surface dose rates. The test is not intended for packages of such a size or nature that the performance of the test procedure would present undue practical difficulty.

2 CONTENTS LEAKAGE TEST

2.1 Definitions

2.1.1 containment system : The components of the packaging specified by the designer as intended to retain the radioactive material during transport.

2.1.2 containment vessel : The vessel which forms the whole or part of the containment system.

2.1.3 package : A packaging together with its radioactive contents.

2.2 Test equipment

2.2.1 Immersion tank

The essential apparatus consists of an airtight and watertight tank of cylindrical form which shall be capable of withstanding an internal pressure of at least 0,3 MPa. The volume of the tank shall be such as to accommodate the containment system to be tested, together with sufficient distilled water to fill the tank to a height at least 40 mm above the uppermost surface of the containment system, leaving at the same time enough clearance above the surface of the water to allow the observation of streaming of air bubbles from the containment system under test.

The tank shall be provided with means of securing the containment system at the centre of the tank. The securing device shall not prevent air leaking into or from any part of the system under test. The walls of the tank shall be made of transparent material, or observation windows shall be provided in the walls. The tank shall be so designed that it may be turned in different positions so that any bubbles that may leave the external surfaces of the containment system are free to rise.

2.2.2 Activity measuring instrument

To measure the activity of the water sample taken from the immersion tank, beta or gamma counting equipment is necessary. This can consist of a typical laboratory instrument with which activities of 10^{-11} Ci in the case of beta measurements, or 2×10^{-9} Ci in the case of gamma measurements, can be detected.

2.3 Preparation of containment system for testing

At the time that the entire package is prepared for testing, a radioactive solution shall be introduced into the normal place intended for the radioactive contents. The volume of radioactive solution shall be approximately the same as that of the intended contents. If the radioactive solution is placed directly in contact with the containment vessel, the volume of the solution shall be sufficient to suitably wet the whole inner surface of the vessel.

The radioactive concentration of the solution shall be equal to

$$a = S \times \frac{V_T}{V_S} \times \frac{1}{L}$$

where

a is the radioactive concentration of the active solution, in curies per litre (cubic decimetre);

S is the minimum detectable activity, in curies;

V_T is the volume of distilled water in the measuring tank, in litres (cubic decimetres);

V_S is the volume of water sample to be measured, in litres (cubic decimetres);

L is the minimum detectable leakage, in litres (cubic decimetres), in 10 min; $L = 1{,}5 \times 10^{-5}$ l ($1{,}5 \times 10^{-5}$ dm^3).

It is advisable to use a short-lived radioisotope emitting high-energy beta and gamma rays. For that purpose ^{24}Na can be used in a 1 % aqueous solution of sodium chloride (NaCl). The containment system and the water in the tank shall be kept in the same room for the period of time necessary for equalization of their temperatures.

2.4 Test procedure

The containment system containing the active solution referred to in 2.3 shall be secured within the immersion tank. The tank interior shall be subjected to an air pressure of 0,2 MPa for a period of 15 min. The tank shall then be filled with distilled water to a height at least 40 mm above the uppermost part of the surface of the containment system under test without loss of pressure. After complete immersion of the containment system in water, the pressure of the air in the tank shall be lowered to atmospheric. If no stream of air bubbles appears in the course of 5 min, the immersion tank shall be consecutively turned to positions in which all parts of the external surfaces of the containment system are uppermost and parallel to the surface of the water, and at the same time completely immersed to a depth of 40 mm for a period of 5 min. If no stream of air bubbles appears, the test shall be repeated. Then a sample of water of at least 10^{-1} l (10^{-1} dm^3) shall be taken from the immersion tank and measured for activity.

If no stream of air bubbles is produced from the containment system intended for powders, this containment system shall be considered leakpoof.

If no detectable radioactivity is present in the sample, the containment system intended for liquids shall be considered leakproof.