
Packaging — Transport packaging for dangerous goods — Test methods

*Emballages — Emballages de transport pour marchandises
dangereuses — Méthodes d'essai*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 122, *Packaging*, Subcommittee SC 3, *Performance requirements and tests for means of packaging, packages and unit loads (as required by ISO/TC 122)*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 261, *Packaging*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 16495:2013), which has been technically revised.

The main changes are as follows:

- changes to [Table B.1](#), [Table B.2](#), [Table B.3](#), [Table C.1](#), [Table D.1](#), [Table D.2](#) and [Table D.3](#);
- additional requirements in [Annex H](#), “H.2 Preparation” added;
- deletion of Table H.1;
- editorial improvements.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document was developed to provide requirements and test procedures to meet the multi-modal United Nations Recommendations on the Transport of Dangerous Goods Model Regulations referred to as “UN Recommendations” throughout this document, and successful passing of the tests may lead to the allocation of an appropriate UN packaging mark. The UN Recommendations have been developed by the United Nations Subcommittee of Experts on the Transport of Dangerous Goods as a ‘model regulation’ in the light of technical progress, the advent of new substances and materials, the exigencies of modern transport systems and, above all, the need to ensure the safety of people, property and the environment. Amongst other aspects, the UN Recommendations cover principles of classification and definition of classes, listing of the principal dangerous goods, general packing requirements, testing procedures, marking, labelling or placarding, and shipping documents. In addition, there are special recommendations related to particular classes of goods.

The UN Recommendations are given legal entity by the provisions of a series of international modal agreements and national legislation for the transport of dangerous goods. The international agreements include the following:

- The European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) (covering most of Europe)^[4];
- Regulations concerning the International Carriage of Dangerous Goods by Rail (RID) (covering most of Europe, parts of North Africa and the Middle East)^[5];
- The International Maritime Dangerous Goods Code (IMDG Code) (worldwide)^[6];
- The International Civil Aviation Organization’s Technical Instructions for the Safe Transport of Dangerous Goods by Air (ICAO TIs) (worldwide)^[7].

Application of this document presupposes awareness of the requirements of these international agreements and the relevant national regulations for domestic transport of dangerous goods.

It is important to note that there will be certain modal differences from the UN Recommendations and that the schedule for revision of the recommendations and modal provisions may lead to temporary inconsistencies with this document.

It is noted that success in the tests and the allocation of an official UN mark do not on their own authorize the use of a packaging for any dangerous goods, which are subject to the packing instructions published in the various modal regulations.

This document is based on Revision 21 of the UN Recommendations.

Packaging — Transport packaging for dangerous goods — Test methods

1 Scope

This document specifies the information needed for the design type testing of packaging, intermediate bulk containers (IBCs) and large packaging intended for use in the transport of dangerous goods.

NOTE 1 This document can be used in conjunction with one or more of the international regulations set out in the Bibliography.

NOTE 2 The term “packaging” includes packaging for Class 6.2 infectious substances according to the United Nations.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2206, *Packaging — Complete, filled transport packages — Identification of parts when testing*

ISO 2248:1985, *Packaging — Complete, filled transport packages — Vertical impact test by dropping*

ISO 2875:2000, *Packaging — Complete, filled transport packages and unit loads — Water-spray test*

ISO/IEC 17025:2017, *General requirements for the competence of testing and calibration laboratories*

United Nations Recommendations on the Transport of Dangerous Goods — Model Regulations

3 Terms and definitions

For the purposes of this document, the terms and definitions given in the UN Recommendations, Chapter 1.2.1, and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

brimful capacity

volume of water in litres held by the packaging, intermediate bulk container (IBC), inner packaging of a combination packaging and/or large packaging, when filled through the designed filling orifice to the point of overflowing in its normal position of filling, and considered for testing purposes as maximum capacity

3.2

nominal capacity

capacity in litres which, by convention, is used to represent a class of packaging of a similar *brimful capacity* (3.1)

3.3

single packaging

means of packaging that does not require an inner packaging to be capable of performing its containment function and it includes composite packaging

4 Selection and preparation of packaging, IBCs and large packaging for testing

4.1 General

The type of contents (liquid, viscous or solid) is crucial for the selection and preparation of the packaging, IBCs and large packaging for testing

NOTE Guidance on the determination of the type of contents is given in [Annex E](#).

4.2 Selection of packaging, IBCs and large packaging

Sufficient numbers of packaging, IBCs and large packaging per design type shall be:

- a) selected for testing;
- b) examined for damage which might invalidate the tests, in which event the packaging, IBCs and large packaging shall be replaced;
- c) marked with a test reference which shall also be entered on the test record and later used on the test report;
- d) individually weighed to establish the tare or filled gross mass.

The different parts of the packaging shall be identified in accordance with ISO 2206.

NOTE 1 The form of such weighing can vary according to whether the packaging, IBCs and large packaging have been supplied full or empty to the test station. Where the masses of individual empty packaging, IBCs and large packaging are recorded, it is sufficient to record only a typical filled gross mass (or vice versa).

NOTE 2 Under some circumstances it can be desirable to have a range of packaging, IBCs and large packaging tested.

Examples include:

- different sizes but of the same construction;
- a variety of closures;
- a range of solid contents for use.

In such situations selective testing procedure can be used to avoid testing of every possible permutation. The competent authority can allow this procedure after consultation.

4.3 Information to be provided with packaging, IBCs and large packaging

4.3.1 General

Each packaging, IBCs and large packaging type shall be accompanied by a specification for that design type containing the data set outlined in [Annexes B, C or D](#) and by the following additional information contained in [4.3.2](#) to [4.3.6](#) as appropriate.

4.3.2 Test contents – using water and non-dangerous substances

Where the tests are to be carried out using water or other non-dangerous substances, a statement of the packing group for which the packaging is to be tested shall be provided, together with data, enabling

appropriate selection of inert test contents. For liquids, such data shall include the required maximum relative density for the tests together with data on, for instance, the internal pressure test required. For solids, such data shall include mass, grain size and any other relevant characteristics, for example, bulk density or angle of repose, to clearly show equivalence of physical characteristics.

4.3.3 Test contents – using the dangerous substance

Where the tests are to be carried out using the dangerous substance(s) to be transported, a statement of their packing group and their physical characteristics shall be provided.

NOTE This information can be obtained from the Safety Data Sheet for the dangerous substance(s), available from sources such as the manufacturer of the dangerous substance(s).

Liquids shall be defined by their relative density together with viscosity and method of determination. Solids shall be defined by their mass and grain size and any other relevant characteristic, for example, bulk density and angle of repose, to ensure physical characteristics are sufficiently identified and included. This data shall be recorded in the test report (see [Annex A](#)).

Where the tests are carried out using the actual substance to be transported then they shall be applicable for other substances having the same or similar characteristics.

4.3.4 Vapour pressure

For liquids, the vapour pressure (at a given temperature) of the substance to be carried or the hydraulic pressure to be achieved during the tests shall be provided.

4.3.5 Test contents – using articles

Where the packaging and large packaging is intended for the transport of (an) article(s), a statement of the packing group, an appropriate description and drawing(s) of the article(s) and or photographs and details of the way in which dummy articles were filled for the purpose of testing shall be provided.

4.3.6 Closing instructions

Any special filling or closing instructions including, where relevant, the closure torque, or taping patterns shall be provided.

4.3.7 Handling characteristics of IBCs and large packaging

Each IBC and large packaging design shall be accompanied by a statement of its mechanical handling characteristics. This shall relate to bottom lift, top lift or both, as applicable, and number of identical items to be stacked during transport.

4.4 Selection of contents and filling of packaging, IBCs and large packaging prior to testing

4.4.1 General

Single packaging, IBCs, the inner packaging of combination packaging and large packaging shall be filled for drop and stacking tests to not less than:

- 98 % of brimful capacity for liquids, and
- 95 % of brimful capacity for solids.

NOTE There can be exceptions, some flexible packaging (see [4.4.4](#)) and some packaging designed to be transported part full (see [4.4.5](#)).

Packaging, IBCs, the inner packaging of combination packaging and large packaging for liquids, or those capable of containing liquids, shall have their capacity determined as in 4.4.3. For other packages, the capacity shall be determined by other suitable means e.g. by calculation.

4.4.2 Packaging, IBC, inner packaging of combination packaging and large packaging to contain liquids

4.4.2.1 Determination of brimful capacity

The brimful capacity is determined for example by: weighing the empty packaging/IBC/inner packaging including closures [mass empty (m_{ep}) in kg] and weighing the packaging/IBC/inner packaging full [mass brimful (m_p) in kg]. The packaging/IBC/inner packaging shall be filled with water until the water just overflows and then fitting the closure and any surplus mopped up. No steps shall be taken, e.g. by tilting or tapping the packaging/IBC/inner packaging, to enable water to penetrate into a hollow handle/lifting feature or other design feature above the closure.

The following Formula (1) expresses the brimful capacity:

$$b = \frac{m_p - m_{ep}}{d} \quad (1)$$

where

- b is the brimful capacity in litres;
- m_p is the mass in kilograms, of packaging/IBC/inner packaging when brimful with water;
- m_{ep} is the mass in kilograms, of the empty packaging/IBC/inner packaging;
- d is the density of water (=1) in kg/l.

4.4.2.2 Filling of the packaging/IBC/inner packaging

When filling test samples of the above with liquids, at least one sample shall have its capacity and filling level determined as below. Further samples of that design type shall be filled using a dipstick calibrated on the first sample or by mass or volume. The calculation of required volume of liquids for testing shall be as given by Formula (2):

$$V = \frac{b \times 98}{100} \quad (2)$$

where

- V is the required volume of water in litres;
- b is the brimful capacity in litres.

4.4.3 Rigid packaging, rigid IBCs, inner packaging of combination packaging and large packaging to contain solids

Where the packaging/IBC/inner packaging is capable of containing liquids the capacity shall be determined as in 4.4.2.1.

The calculation of required mass of solids for testing shall be:

$$m = \frac{(b \times d) \times 95}{100}$$

where

- m is the required mass in kilograms, of solids;
- b is the brimful capacity either measured or calculated in litres;
- d is the bulk density of the test contents in kg/l.

Alternatively, for cylindrical packaging/IBC/inner packaging the level of fill required to fill the packaging/IBC/inner packaging to at least 95 % of its brimful capacity shall be calculated from its internal height, taking into account any reduction in height caused by the fitting of the closure.

This procedure is not suitable for bags (see 4.4.5).

4.4.4 Flexible packaging, flexible inner packaging and flexible IBCs to contain solids

Flexible packaging/flexible inner packaging (bags) and flexible IBCs shall be filled to the required testing mass at which the designer of the flexible packaging/flexible inner packaging and flexible IBCs intends it to be used or, if known, to the capacity which the user intends to employ using either the substance to be transported or solids of similar characteristics in respect of mass, grain size and flow characteristics. The test contents used shall be recorded in the test report.

4.4.5 Packaging/inner packaging designed to be used part full

Packaging/inner packaging designed to be transported with filling test levels less than 98 % for liquids or less than 95 % for solids shall be filled as prepared for transport to the capacity the user intends to employ. The filled volume and mass shall be recorded in the test report.

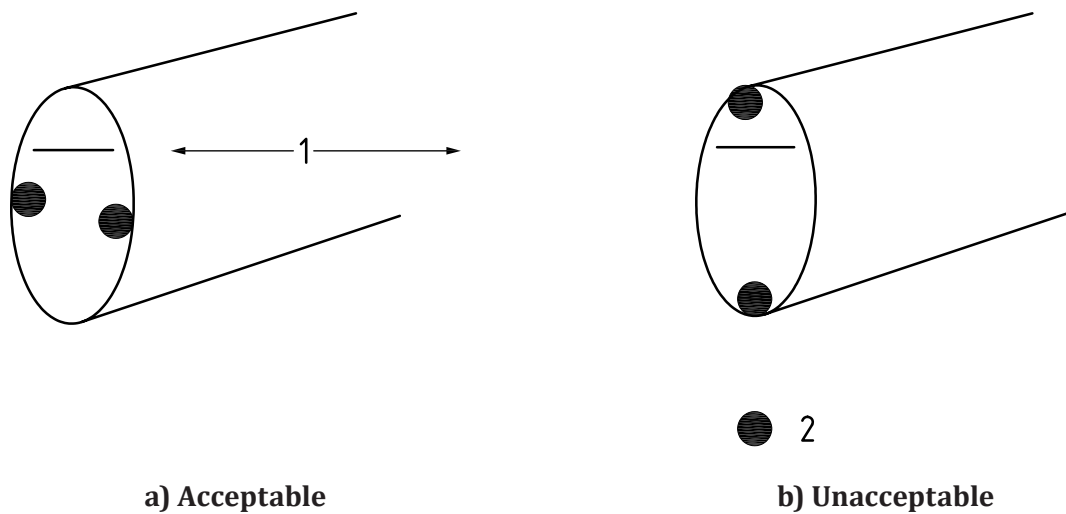
4.5 Closing packaging, IBCs and large packaging

4.5.1 Drums, jerricans, composites and inner packaging, IBCs

Screw type closures shall be tightened to the torque specified by the applicant where appropriate before conditioning, or when specified during or after the conditioning period and shall be recorded in the test report.

Closure torque shall be the same for all tests. If it is necessary to revise a closure torque following a failure in one test, then all tests shall be completed using that torque setting.

Where vented closures are intended for use in the packaging, they shall be fitted for drop and stacking tests. Packaging fitted with vented closures shall be filled and after closing be inverted or laid on their side (see Figure 1) and observed for leakage for a period of 5 min. Leakage from the closure vent will result in termination of the test.

**Key**

- 1 liquid level
2 closure

Figure 1 — Packaging fitted with vented closure, laid on their side

4.5.2 Bags

The packaging shall be closed as it would be for transport.

To ensure that the test packagings are closed in a manner representative of production packaging, the same equipment and the same filling time should be used whenever practicable.

4.5.3 Other packaging

Packaging for solids shall be filled as in [4.4.4](#) and closed in accordance with any special instructions including any fitments or cushioning.

The closure elements used to secure the packaging (e.g. closure tape, where applicable), shall be defined specified in accordance with the specifications given in [Annexes B, C or D](#).

4.6 Check of design type specification with requirements

Following receipt of the sample(s) and their specification (see [4.3.1](#)), a check shall be made that the design type corresponds with the definition of the type and all additional constructional requirements set out for the type in the UN Recommendations.

4.7 Conformity check of test samples with design type specification

The specification of a representative sample of the packaging, IBC and large packaging to be tested shall be checked by visual inspection and actual measurements as detailed in [Annexes B, C or D](#). Aspects such as external dimensions shall be checked at this preparatory stage. A record of each specification check shall be included in the test report. Where a checked sample is found to be outside of the specification tolerances, the samples shall not be accepted as the same design type.

NOTE Aspects (other than external dimensions), such as measurements of material thickness, can be carried out on completion of the test(s).

5 Test methods

Test methods to be followed are specified in the UN Recommendations on the transport of dangerous goods. Additional provisions are described in [Annexes F, G, H, I, J, K, L, M, N, O, P](#) and [Q](#).

6 Facilities for testing

6.1 General requirements

Tests shall be carried out at a testing facility capable of meeting the operational provisions specified in ISO/IEC 17025:2017, Clause 5.

NOTE 1 This does not imply a requirement for accreditation but if appropriate such external approval can be obtained from either a national accreditation body or from the competent authority.

NOTE 2 Testing staff can find it useful to have knowledge of the principles of the dangerous goods regulations as set out in the UN Recommendations.

6.2 Accuracy of measurement equipment

The accuracy of measuring equipment shall be more precise than the accuracy of the measurements in testing, as specified in [6.3](#), unless otherwise approved by the competent authority. The measuring equipment shall be calibrated in accordance with ISO/IEC 17025.

6.3 Accuracy of measurements in testing

Measurement equipment shall be selected such that the uncertainties of individual measurements shall not exceed the following values:

Mass in kilograms (kg):	$\pm 2 \%$
Pressure in kilopascals (kPa):	$\pm 3 \%$
Distance/length in millimetres (mm):	$\pm 2 \%$
Temperature in degrees Celsius ($^{\circ}\text{C}$):	$\pm 1 \text{ }^{\circ}\text{C}$
Humidity in percentage (%):	Tolerances are as specified in the agreed test methods
Time in minutes (min):	$\pm 3 \%$
Torque in Newton metres (Nm):	$\pm 10 \%$

NOTE For some measurements the tolerances can be lower in order to have meaningful measurements, e.g. when measuring masses or dimensions of empty packaging.

Where only maximum or minimum values are specified in this document and the UN Recommendations, tolerances are one-sided.

6.4 Climatic conditions

There shall be adequate climatic facilities to meet the requirements of conditioning during tests.

6.5 Reassessment when failure occurs

If failure occurs, the tests on the packagings submitted shall be ended, unless one of the reassessment procedures is used:

- a) The tests shall be repeated at a lower level of intensity. For example, if two packagings pass and one fails, the hydraulic pressure test at 200 kPa, a fourth packaging shall be tested at 150 kPa and the design type shall be regarded as passing at the latter level;
- b) Where only one packaging fails on one test, that test shall be repeated on twice the normal number of identical packagings for that test. If they all pass, the design type shall be regarded as meeting the test requirements;

Where a reassessment procedure is used, this shall be fully recorded in the test report.

EXAMPLE Where one of the three test packagings fails the drop test in the second orientation, but all the other test packagings have passed the drop test in the first orientation and the other tests (namely leakproofness, internal pressure and stacking), then six packagings are tested in the second orientation.

7 Test report

All packaging, intermediate bulk containers (IBCs) and large packaging tested for conformity with the UN Recommendations shall be the subject of a test report in accordance with [Annex A](#), which should include a specification check prepared in accordance with [Annexes B, C or D](#). It shall be possible to specifically identify the packaging, IBC and large packaging relative to each test report, either by the retention of uniquely referenced packaging, IBCs and large packaging or by inclusion of sufficient photographs and/or drawings with unique references to enable identification of the packaging, IBCs and large packaging and all its components.

The test report shall specify the following:

- a) the test facility (name and address) (see [A.1](#));
- b) the applicant (name and address) (see [A.2](#));
- c) the report number (see [A.3](#));
- d) the date (see [A.4](#));
- e) the manufacturer (see [A.5](#));
- f) the packaging/IBC/large packaging description (see [A.6](#));
- g) the capacities (see [A.7](#));
- h) the test contents (see [A.8](#));
- i) the test description and results (see [A.9](#));
- j) the signature (see [A.10](#)).

Annex A (normative)

Test report

A.1 Test facility (name and address)

This shall be the organization that undertook the actual testing. The front page of the report shall be on the headed paper of the test facility. If headed paper is not available, the report shall be clearly traceable to the author and the test facility.

A.2 Applicant (name and address)

The applicant can be the manufacturer, the user of the packaging/IBC/large packaging or any person in the packaging chain.

A.3 Report number

This shall be a number which enables full traceability back to the original test facility working documents that refer to the original test. The report number shall appear on every page of the report and any annexes. Any subsequent amendments shall include the number and clearly show it is an amendment to or an addition to the original report.

A.4 Date

This shall be the date the report was completed, rather than the date that testing was completed. The report shall also include the date of the start and completion of the tests and the date of receipt of test items.

A.5 Manufacturer

The test report shall include the manufacturer of the packaging.

NOTE As packaging/IBC/large packaging specifications (see [Annexes B, C and D](#)) are a part of the report, the manufacturer's name in the main body of the report can be ignored, provided that this is clearly stated in one of the annexes which can be clearly linked to the main report.

A.6 Packaging/IBC/large packaging description

The description of the packaging design type (including dimensions, closures) shall include the method of manufacture (e.g. blow moulding).

The main report shall include a general description of the packaging/IBC/large packaging. Full details of the packaging/IBC/large packaging components and material shall be included either in the specification as shown in [Annexes B, C or D](#), (provided there is a clear link between it and the main report) or in the main report. A check for conformity with the relevant definition in the regulations shall be included.

NOTE It can also include drawing(s) and/or photographs.