INTERNATIONAL STANDARD

ISO 3167

Fourth edition
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Plastics — Multipurpose test specimens

Plastiques — Éprouvettes à usages multiples

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 3167 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical properties*.

This fourth edition cancels and replaces the third edition (ISO 3167:1993), which has been revised to reduce the tolerances on specimen dimensions.

Annexes A and B of this International Standard are for information only.

Plastics — Multipurpose test specimens

1 Scope

This International Standard specifies requirements relating to multipurpose test specimens for plastic moulding materials intended for processing by injection or direct compression moulding.

Specimens of types A and B are tensile test specimens from which, with simple machining, specimens for a variety of other tests can be taken (see annex A). Because they have such wide utility, these tensile specimens are referred to in this International Standard as multipurpose test specimens.

The principal advantage of a multipurpose test specimen is that it allows all the test methods mentioned in annex A to be carried out on the basis of comparable mouldings. Consequently, the properties measured are coherent as all are measured with specimens in the same state. In other words, it can be expected that test results for a given set of specimens will not vary appreciably due to unintentionally different moulding conditions. On the other hand, if desired, the influence of moulding conditions and/or different states of the specimens can be assessed without difficulty for all of the properties measured.

For quality-control purposes, the multipurpose test specimen may serve as a convenient source of further specimens not readily available. Furthermore, the fact that only one mould is required may be advantageous.

The use of multipurpose test specimens shall be agreed upon by the interested parties, because there may be significant differences between properties of the multipurpose test specimens and those specified in the relevant test methods.

The main modification with respect to the previous edition of this International Standard lies in narrowing the tolerances on the radius of the shoulder of specimen types A and B. Taking into account the fact that many moulds based on the previous edition are still in use, the changes are introduced as recommendations only. It is intended to change from recommended to mandatory use at the next revision. Thereby a time span of about 10 years is provided, allowing a gradual transition in the course of regular mould replacement. See also annex B.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 293:1986, *Plastics — Compression moulding test specimens of thermoplastic materials*

ISO 294-1:1996, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 1: General principles, and moulding of multipurpose and bar test specimens*

ISO 295:—[1)], *Plastics — Compression moulding of test specimens of thermosetting materials*

ISO 2818:1994, *Plastics — Preparation of test specimens by machining*

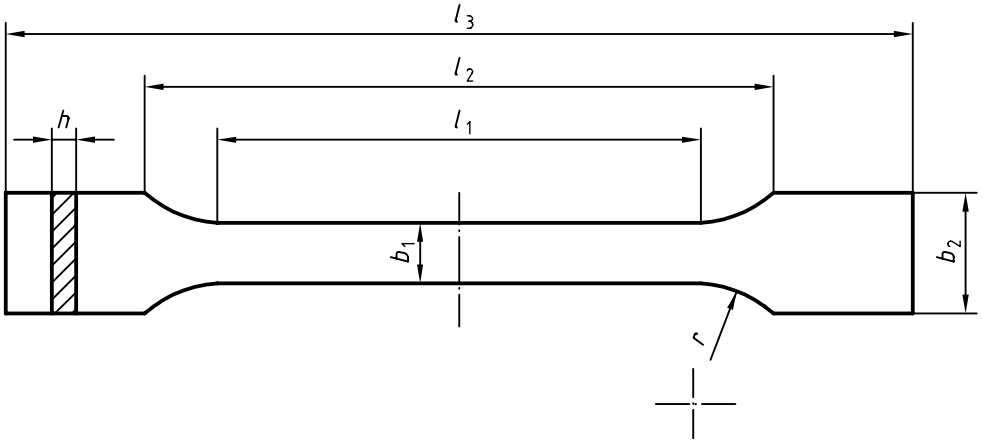
1) To be published. (Revision of ISO 295:1991)

ISO 10724-1:1998, *Plastics — Injection moulding of test specimens of thermosetting powder moulding compounds (PMCs) — Part 1: General principles and moulding of multipurpose test specimens*

3 Dimensions of test specimens

For the purposes of this International Standard, the preferred multipurpose test specimen is the type A tensile specimen shown in Figure 1. This can be made suitable for a variety of other tests by simple cutting, because the length l_1 of its narrow parallel-sided portion is 80 mm $\pm$ 2 mm.

Dimensions in millimetres



	Specimen type	A	B
l_3	Overall length[a]	$\geqslant$ 150 Recommended value[b] 170	$\geqslant$ 150
l_1	Length of narrow parallel-sided portion	80 $\pm$ 2	60,0 $\pm$ 0,5
r	Radius	20 to 25 Recommended value[b] 24 $\pm$ 1	$\geqslant$ 60[c] Recommended value[b] 60,0 $\pm$ 0,5
l_2	Distance between broad parallel-sided portions[d]	104 to 113	106 to 120 Recommended range[b] 106 to 110
b_2	Width at ends	20,0 $\pm$ 0,2	
b_1	Width of narrow portion	10 $\pm$ 0,2	
h	Thickness	4,0 $\pm$ 0,2	

[a] The recommended overall length of 170 mm for type A is consistent with ISO 294-1 and ISO 10724-1. For some materials, the length of the tabs may need to be extended (e.g. to give an overall length of 200 mm) to prevent breakage or slippage in the jaws of the test machine.

[b] The recommended values and ranges may become mandatory on occasion of the next revision of the standard. The lower tolerances on the radius reduce the ranges of the stress concentrations that are found at the transitions between the narrow parallel-sided and the rounded portions. Together with the smaller tolerance on the distance between the broad parallel-sided portions for type B, a common value of the initial distance between jaws can be used for tensile testing (see ISO 527-2).

[c] $r = \dfrac{(l_2 - l_1)^2 + (b_2 - b_1)^2}{4\,(b_2 - b_1)}$

[d] Resulting from l_1, r, b_1 and b_2, but within the indicated tolerance.

Figure 1 — Type A and B multipurpose test specimens

4 Preparation of test specimens

4.1 General

Test specimens shall be prepared in accordance with the relevant material specification. When none exists, specimens shall be either directly compression or injection moulded from the material in accordance with ISO 293, ISO 294-1, ISO 295:— or ISO 10724-1, as appropriate, or machined in accordance with ISO 2818 from plates that have been compression or injection moulded from the compound.

Strict control of all conditions of the specimen preparation is essential to ensure that all test specimens in a set are actually in the same state.

All surfaces of the test specimens shall be free from visible flaws, scratches or other imperfections. With moulded specimens all flash, if present, shall be removed, taking care not to damage the moulded surface.

The broad sides of each specimen shall be suitably marked (see the note), for injection-moulded specimens to distinguish between the sides formed by the cavity plate and the fixed plate of the mould (see ISO 294-1 or ISO 10724-1), for compression-moulded and machined specimens to identify any asymmetry resulting from the underlying moulding process.

NOTE Asymmetry with respect to thickness may influence the flexural properties, including the temperature of deflection under load (see annex A).

For injection-moulded specimens, the sides can be identified by the impressions of the ejection pins and by the draft angle. Compression-moulded and machined specimens shall be marked at their shoulders. ISO bars taken from the central part of multipurpose test specimens shall be marked outside their central 40 mm section, which is loaded by flexural testing.

4.2 Injection moulding of multipurpose test specimens

Type A test specimens shall be injection moulded as specified in ISO 294-1 or ISO 10724-1, as appropriate, and under conditions defined in the relevant International Standard for the material under examination.

4.3 Compression moulding of multipurpose test specimens

Type B test specimens shall be compression moulded directly to their final dimensions as specified in ISO 293 or ISO 295:—, as appropriate, and under conditions defined in the relevant International Standard for the material under examination.

4.4 Machining of multipurpose test specimens

4.4.1 Machining of test specimens shall be performed either as specified in ISO 2818 or as agreed upon by the interested parties.

4.4.2 Test specimens having a width of 10 mm shall be cut symmetrically from the central parallel-sided portion of the multipurpose test specimen.

The surface of the central parallel-sided portion of the test specimen shall remain as moulded:

— The width of the machined portions of the specimen shall be not less than that of the central parallel-sided portion, but may exceed the width of the latter by not more than 0,2 mm.

— During the machining operation, care shall be taken to avoid any damage to the moulded surfaces of the central portion.

For test specimens longer than 80 mm, the broad ends of the type A multipurpose test specimen (or type B for test specimens longer than 60 mm) shall be machined to the width of the central parallel-sided portion.

4.4.3 Type B multipurpose test specimens shall be machined from suitably processed compression-moulded plates (see 4.3).

5 Report on preparation of test specimens

The report shall contain the following information:

a) a reference to this International Standard;

b) an indication of the specimen type (A or B);

c) the type, source, manufacturer's code, grade and form, including history, etc., if known;

d) the method of moulding and the conditions used;

e) the method of machining and the conditions used;

f) the number of test specimens produced;

g) the standard atmosphere for conditioning, plus any special conditioning treatment if required by the standard for the material or product concerned;

h) the date of preparation.

Annex A
(informative)

Recommended applications for multipurpose test specimens or parts thereof

Method	Reference[a]	Type of specimen and/or dimensions mm
Tensile test	ISO 527-2	A or B
Tensile creep test	ISO 899-1:—	A or B
Flexural test	ISO 178:2001	80 × 10 × 4
Flexural creep test	ISO 899-2:—	80 × 10 × 4
Compressive test	ISO 604:—	(10 to 50) × 10 × 4
Impact strength — Charpy	ISO 179-1 and ISO 179-2	80 × 10 × 4
Impact strength — Izod	ISO 180	80 × 10 × 4
Impact strength — tensile	ISO 8256	80 × 10 × 4
Temperature of deflection under load	ISO 75-2:—	80 × 10 × 4
Vicat softening temperature	ISO 306	$(\geqslant 10) \times 10 \times 4$
Hardness, ball indentation	ISO 2039-1:2001	$(\geqslant 20) \times 20 \times 4$
Environmental stress cracking	ISO 22088-2:—, ISO 22088-3:— and ISO 22088-4:—	A or B or 80 × 10 × 4
Density	ISO 1183-3	30 × 10 × 4
Oxygen index	ISO 4589-2 and ISO 4589-3	80 × 10 × 4
Comparative tracking index (CTI)	IEC 60112	15 × 15 × 4
Electrolytic corrosion	IEC 60426	30 × 10 × 4
Coefficient of linear expansion	ISO 11359-2	$(> 30) \times 10 \times 4$

[a] See Bibliography.

Annex B
(informative)

Consequences of changes in geometry

B.1 Test specimen length

The length of 170 mm may be too short for some materials in connection with a distance between the grips of 115 mm. While the test specimen length of 170 mm is sufficient for the large majority of tensile tests, clamping problems occasionally arise with highly reinforced grades and with very ductile ones.

If 170 mm is too short for some materials, this is even more true for the length of $\geqslant$ 150 mm that was used in the previous edition. The "$\geqslant$"-sign gives the freedom to use lengths $>$ 170 mm, which is also allowed in this edition. This recommendation is in line with ISO 294-1.

B.2 Radius tolerance

Taking into account the tolerances, the length l_2 between the shoulders is

106,125 mm $\leqslant l_2 \leqslant$ 112,526 mm this edition

103,996 mm $\leqslant l_2 \leqslant$ 112,526 mm previous edition

The clamping distance (in ISO 527-2) remains unchanged:

$L =$ 115 mm $\pm$ 1 mm

The shortest possible distance from clamp to shoulder is:

$s_{\text{min}} =$ 0,737 (same for this and previous edition)

The longest possible distance from clamp to shoulder is:

this edition: 4,932 mm

previous edition: 6,002 mm

This is not a very big change, but it affects the effective length. It may be used to determine nominal strain data in the pre-yield range for e.g. modulus determination under severe conditions, where extensometers cannot be used, e.g. in temperature-controlled enclosures, by using grip separation only. However, the effective length is quite sensitive to radius changes, and limiting the radius tolerance reduces possible error sources when utilizing this method. It may be introduced in ISO 527-2 on the occasion of the next revision.

The reduction of the radius tolerance of **machined** specimens allows the use of a common clamping distance of (115 ± 1) mm. This is the main benefit of the proposal.

B.3 Notch factor

When the type A specimen, with a radius of 20 mm to 25 mm, was introduced in addition to the type B specimen (radius $\geqslant$ 60 mm) in the previous edition of ISO 3167, calculations were made to compare the two types of specimen.

Assuming linear-elastic material behaviour, notch factors of 1,045 (for $r = 60$ mm) and 1,143 ($r = 20$ mm) were found. Therefore tensile strength differences of about 10 % could be expected, and were also found in machined test specimens of brittle materials. However, when testing injection-moulded specimens, a reduction in tensile strength at yield of

$-1\ \% \pm 1\ \%$ (average of 22 materials)

was found. Compared to the radius reduction from 60 mm to 20 mm, the recommended increase from (20 mm to 25 mm) to (23 mm to 25 mm) will result in only a very minor reduction of the notch factor, with negligible effect on the test results.

Changes in tensile strength at yield values due to the radius tolerance reduction for injection-moulded specimens are not to be expected. There may be a slight increase in strain-at-break values.

Bibliography

[1] ISO 75-2:—[1)], *Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite*

[2] ISO 178:2001, *Plastics — Determination of flexural properties*

[3] ISO 179-1:2000, *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test*

[4] ISO 179-2:1997, *Plastics — Determination of Charpy impact properties — Part 2: Instrumented impact test*

[5] ISO 180:2000, *Plastics — Determination of Izod impact strength*

[6] ISO 306:1994, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*

[7] ISO 527-2:1993, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

[8] ISO 604:—[2)], *Plastics — Determination of compressive properties*

[9] ISO 899-1:—[3)], *Plastics — Determination of creep behaviour — Part 1: Tensile creep*

[10] ISO 899-2:—[4)], *Plastics — Determination of creep behaviour — Part 2: Flexural creep by three-point loading*

[11] ISO 1183-3:1999, *Plastics — Methods for determining the density of non-cellular plastics — Part 3: Gas pyknometer method*

[12] ISO 2039-1:2001, *Plastics — Determination of hardness — Part 1: Ball indentation method*

[13] ISO 4589-2:1996, *Plastics — Determination of burning behaviour by oxygen index — Part 2: Ambient-temperature test*

[14] ISO 4589-3:1996, *Plastics — Determination of burning behaviour by oxygen index — Part 3: Elevated-temperature test*

[15] ISO 8256:1990, *Plastics — Determination of tensile-impact strength*

[16] ISO 11359-2:1999, *Plastics — Thermomechanical analysis (TMA) — Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature*

[17] ISO 22088-2:—[5)], *Plastics — Determination of resistance to environmental stress cracking (ESC) — Part 2: Constant tensile stress method*

[18] ISO 22088-3:—[6)], *Plastics — Determination of resistance to environmental stress cracking (ESC) — Part 3: Bent strip method*

1) To be published. (Revision of ISO 75-2:1993)

2) To be published. (Revision of ISO 604:1993)

3) To be published. (Revision of ISO 899-1:1993)

4) To be published. (Revision of ISO 899-2:1993)

5) To be published. (Revision of ISO 6252:1992)

6) To be published. (Revision of ISO 4599:1986)

[19] ISO 22088-4:—[7)], *Plastics — Determination of resistance to environmental stress cracking (ESC) — Part 4: Ball or pin impression method*

[20] IEC 60112:1979, *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions*

[21] IEC 60426:1973, *Test methods for determining electrolytic corrosion with insulating materials*

7) To be published. (Revision of ISO 4600:1992)

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