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## Plastics — Acquisition and presentation of comparable multipoint data —

### Part 3: Environmental influences on properties

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*Plastiques — Acquisition et présentation de données multiples comparables —*

*Partie 3: Effets induits par l'environnement sur les propriétés*

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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](http://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](http://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](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical behaviour*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 249, *Plastics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 11403-3:2014), of which it constitutes a minor revision.

The changes compared to the previous edition are as follows:

- unified the indication methods of the unit;
- unified the quotation of the specimen shape in ISO 20753;
- changed the [Annex B](#) from "informative" to "normative";
- performed the editorial corrections.

A list of all parts in the ISO 11403 series can be found on the ISO website.

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](http://www.iso.org/members.html).

## Introduction

This document has been prepared because users of plastics find sometimes that available data cannot be used readily to compare the properties of similar materials, especially when the data have been supplied by different sources. Even when the same standard tests have been used, they often allow the adoption of a wide range of alternative test conditions, and the data obtained are not necessarily comparable. The purpose of this document is to identify specific methods and conditions of test to be used for the acquisition and presentation of data in order that valid comparisons between materials can be made. These data are not necessarily suitable for design.

The ISO 10350 series<sup>[2][8]</sup> is concerned with single-point data. Such data represent the most basic method for characterizing materials and are useful for the initial stages of material selection. This document identifies test conditions and procedures for the measurement and presentation of a more substantial quantity of data. Each property here is characterized by multipoint data which demonstrate how that property depends upon important variables such as time, temperature and environmental effects. Additional properties are also considered in this document. These data therefore enable more discriminating decisions to be made regarding the material's suitability for a particular application. Some data are also considered adequate for undertaking predictions of performance in service and of optimum processing conditions for moulding a component, although it should be recognized that, for purposes of design, additional data are often needed. One reason for this is that some properties are strongly dependent upon the physical structure of the material. The test procedures referred to in this document employ standard test specimens, and the polymer structure in these specimens may be significantly different from that in specific regions of a moulded component. Under these circumstances, therefore, the data are not suitable for accurate design calculations for product performance. The material supplier should be consulted for specific information on the applicability of data.

The ISO 10350 series together with the ISO 11403 series define the means for acquiring and presenting a core set of comparable data for use in material selection. Use of these International Standards should result in a rationalization of effort and a reduction of cost associated with provision of these data. Furthermore, reference to these International Standards simplifies the development of data models for the computerized storage and exchange of data concerning material properties.

Where appropriate, values for test variables have been specified by this document. For some tests however, owing to the wide range of conditions over which different plastics perform, the standard gives guidance in the selection of certain test conditions so that they cover the operating range for that polymer. Because, in general, the properties and performance specifications for different polymers differ widely, there is no obligation to generate data under all the test conditions specified in this document.

Data on a wide range of properties are needed to enable plastics to be selected and used in the large variety of applications to which they are suited. ISO standards describe experimental procedures which are suitable for the acquisition of relevant information on many of these properties. For other properties, however, ISO standards either do not exist or exhibit shortcomings that complicate their use at present for the generation of comparable data (see [Annex A](#)). The ISO 11403 series has therefore been divided into parts so that each part can be developed independently. In this way, additional properties can be included as new or revised standards become available.

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# Plastics — Acquisition and presentation of comparable multipoint data —

## Part 3: Environmental influences on properties

### 1 Scope

This document specifies test procedures for the acquisition and presentation of multipoint data which demonstrate the behaviour of plastics under the following environments:

- prolonged exposure to heat;
- liquid chemicals;
- environmental stress cracking under a constant tensile stress;
- artificial weathering.

The tests are listed in order of increasing severity of the environment. By testing under the least severe environments first, it is possible to make informed judgements regarding whether tests under more severe conditions are worthwhile.

### 2 Normative references

[ISO/FDIS 11403-3](https://standards.iteh.ai/catalog/standards/sist/3ef52d9b-f99a-4b83-ac32-0185c83d551e/iso-11403-3)

[https://standards.iteh.ai/catalog/standards/sist/3ef52d9b-f99a-4b83-ac32-](https://standards.iteh.ai/catalog/standards/sist/3ef52d9b-f99a-4b83-ac32-0185c83d551e/iso-11403-3)

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 175, *Plastics — Methods of test for the determination of the effects of immersion in liquid chemicals*

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

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

ISO 294-2, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 2: Small tensile bars*

ISO 295, *Plastics — Compression moulding of test specimens of thermosetting materials*

ISO 1268 (all parts), *Fibre-reinforced plastics — Methods of producing test plates*

ISO 1817, *Rubber, vulcanized or thermoplastic — Determination of the effect of liquids*

ISO 2578, *Plastics — Determination of time-temperature limits after prolonged exposure to heat*

ISO 4892-2:2013, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

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

ISO 10724-2, *Plastics — Injection moulding of test specimens of thermosetting powder moulding compounds (PMCs) — Part 2: Small plates*

ISO 20753, *Plastics — Test specimens*

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

#### 3.1 multipoint data

data characterizing the behaviour of a plastics material by means of a number of test results for a property measured over a range of test conditions

#### 3.2 indicative property

property that has been selected to reveal the influence of an environment on a material through a comparison of measurements of the property before and after exposure

#### 3.3 indicative data

ratios of mean values of indicative properties after and before exposure

Note 1 to entry: They give a measure of the severity of the influence of an environment on a material for specific exposure conditions (see A.2).

#### 3.4 tensile work to break

$W_{tB}$

area under a plot of the applied stress against the grip displacement in a tensile test, the applied stress being determined from the ratio of the tensile force to the minimum initial cross-sectional area of the specimen

Note 1 to entry: It is expressed in kilojoules per square metre (kJ/m<sup>2</sup>).

### 4 Specimen preparation

In the preparation of specimens by injection or compression moulding, the procedures described in ISO 293, ISO 294-1, ISO 294-2, ISO 295, ISO 10724-1, ISO 10724-2 or ISO 1268 (all parts) shall be used. The method of moulding and the conditions depend on the material being moulded. If these conditions are specified in the International Standard appropriate to the material, then they shall be adopted, where possible, for the preparation of every specimen on which data are obtained using this document. For those plastics for which moulding conditions have not yet been standardized, the conditions employed shall be within the range recommended by the polymer manufacturer and shall, for each of the processing methods, be the same for every specimen. Where moulding conditions are not stipulated in any International Standard, the values used for the parameters in [Table 1](#) shall be recorded with the data for that material.

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Table 1 — Moulding parameters

Type of moulding material	Moulding method and standard (where applicable)	Moulding parameters
Thermoplastic	Injection, ISO 294-1 and ISO 294-2	Melt temperature Mould temperature Injection velocity
Thermoplastic	Compression, ISO 293	Moulding temperature Moulding time Cooling rate Demoulding temperature
Thermosetting	Injection, ISO 10724-1 and ISO 10724-2	Injection temperature Mould temperature Injection velocity Cure time
Thermosetting	Compression, ISO 295	Mould temperature Moulding pressure Cure time
Plastics composites	Test plate production, ISO 1268 (all parts)	Fibre content Mould temperature Moulding pressure Cure time

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## 5 Conditioning

For materials having properties that are significantly dependent upon the concentration of absorbed water, specimens shall be in equilibrium with an atmosphere of  $(50 \pm 5) \% \text{ RH}$  at  $(23 \pm 2) ^\circ\text{C}$  before exposure to the environment, and for indicative property measurements prior to exposure (see the note) with the exception of tests for prolonged exposure to heat (see 6.5). For these materials, consult the relevant material standard for procedures for conditioning specimens. For materials with properties that are not significantly sensitive to absorbed water, specimens shall be conditioned in accordance with the International Standard appropriate to the material. If no materials standard is available, condition test specimens at  $(23 \pm 2) ^\circ\text{C}$  and  $(50 \pm 10) \% \text{ RH}$  for a minimum length of time of 88 h (see ISO 291). Reference to the use of any special conditioning shall be recorded with the data in the tables in Clause 7.

NOTE The water content can change during exposure to an environment, either through exposure to an elevated temperature or, in the case of exposure to a chemical, through exchange of water with the chemical.

## 6 Test requirements

### 6.1 General

In acquiring data for the properties included in this document, the exposure procedures described in the corresponding ISO test standard for each property shall be followed.

Where tests are carried out at temperatures other than  $23 ^\circ\text{C}$ , temperature values shall be chosen from the series of integral multiples of  $10 ^\circ\text{C}$ .

## 6.2 Indicative properties and indicative data

See [A.2](#).

For each of the test requirements in [6.5](#) to [6.8](#), data shall be recorded as ratios of certain indicative property values obtained at 23 °C before and after specified conditions of exposure. The tensile strength and the tensile work to break are indicative properties that are common to each of the environmental exposure tests. The tensile strength is either the yield stress  $\sigma_Y$  or, for brittle materials, the stress at break  $\sigma_B$  (see ISO 527-1) and is determined by dividing the value for the force at yield or break by the minimum initial cross-sectional area of the specimen in the waisted region. The tensile work to break  $W_{tB}$  is determined from a conventional tensile test used to obtain the tensile strength and is normalized with respect to the minimum initial cross-sectional area of the specimen. In this document, all indicative data are recorded as a ratio of a measurement after exposure to a measurement prior to exposure. It is therefore not necessary to specify units for indicative property measurements but clearly these shall be consistent throughout a series of measurements of each property.

## 6.3 Test specimens

See [A.2](#) and [A.3](#).

For the determination of indicative properties, either the ISO 20753/A11 multipurpose test specimen or the ISO 20753/CW13 (or CW23) small tensile specimen (see [Figure 1](#)) may be used. The small specimen shall have a thickness of 3 mm  $\pm$  0,1 mm and is recommended for materials that exhibit ductile failure prior to exposure (see [A.2](#)). The small specimen may be prepared by injection moulding (see ISO 294-2 for thermoplastics), or by machining the shape from sheet or compression moulded plates having a thickness of 3 mm  $\pm$  0,1 mm (see ISO 2818). Where appropriate, the moulding conditions specified in the relevant material standard shall be used. For the determination of environmental stress cracking resistance (see [6.7](#)), the multipurpose test specimen shall be used, machined where necessary as shown in [Figure 2](#) (see also [A.5](#)).

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## 6.4 Test speed

For polymers that, prior to exposure, show no yielding and have a strain at break  $\epsilon_B$  less than or equal to 10 % when tested at a speed of 50 mm/min (see ISO 527-1), a test speed of 5 mm/min  $\pm$  1 mm/min shall be used with the multipurpose test specimen and 1 mm/min  $\pm$  0,2 mm/min with the small tensile specimen. For materials that yield, or where  $\epsilon_B > 10$  % before exposure, these speeds shall be 50 mm/min  $\pm$  10 mm/min and 10 mm/min  $\pm$  2 mm/min respectively for the two specimen types.

The test speeds for indicative property measurements after exposure to the environment shall be the same as those adopted for tests prior to exposure and shall be recorded with the data in [Clause 7](#).

## 6.5 Prolonged exposure to heat: ISO 2578

For materials that absorb moisture, specimens shall be as moulded and contained so as to avoid changes in water content prior to all thermal exposures and reference tests.

The indicative properties are:

- 1: the tensile strength  $\sigma_Y$  or  $\sigma_B$  (see [6.2](#));
- 2: the tensile work to break  $W_{tB}$  (see [6.2](#)).

Determine the reference values of each indicative property at (23  $\pm$  2) °C, using a minimum of five specimens (see also [6.4](#)).

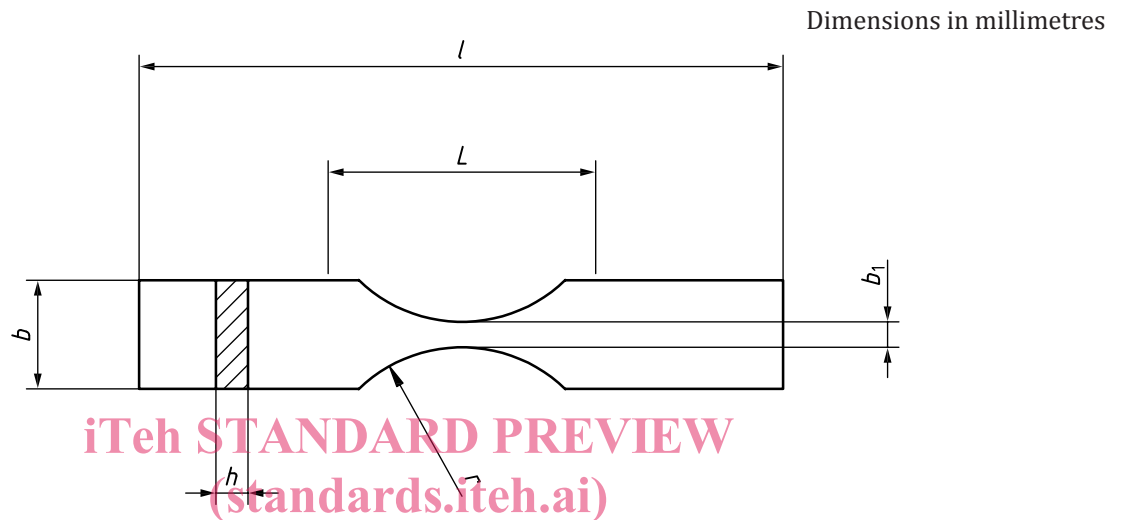
Expose specimens to elevated temperatures selected to enable thermal endurance profiles to be determined.

After exposure, specimens shall be stored at (23  $\pm$  2) °C for between 16 h and 96 h before the measurement of indicative properties. For materials that absorb moisture, the specimens shall be

sealed during this time interval in order to prevent any change in the moisture content. Determine the thermal endurance graphs corresponding to a threshold value of 50 % of each indicative property. A minimum of five specimens shall be used at each exposure time, a minimum of five exposure times for each indicative property at each temperature and a minimum of four temperatures for determining the profile for each property.

NOTE Some of the exposure times can yield results that can be used for the determination of both of the property profiles.

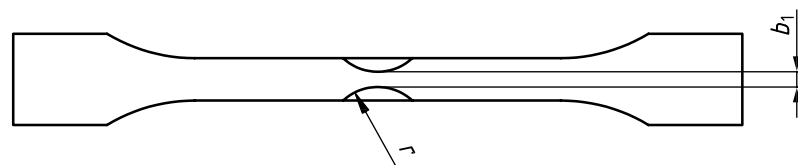
Record the temperature index TI corresponding to a time limit of 20 000 h and the halving interval HIC for each indicative property as shown by [Table 2](#).



**Key**

$l$	overall length	60	<a href="https://standards.iteh.ai/catalog/standards/sist/3ef52d9b-f99a-4b83-ac32-01fb5cB5d55/iso-fdis-11403-3">ISO/FDIS 11403-3</a>
$b$	width at ends	$10 \pm 0,2$	
$b_1$	minimum width	$3 \pm 0,2$	
$r$	radius	$15 \pm 1$	
$h$	thickness	$3 \pm 0,2$	
$L$	initial distance between grips	$25 \pm 2$	

**Figure 1 — Details of the ISO 20753/CWx3 small tensile specimen**



**Key**

$r$	radius
$b_1$	minimum width

NOTE Prepared by machining the central waist so that it is identical to that in the small tensile specimen (see [Figure 1](#)).

**Figure 2 — Test specimen for the measurement of environmental stress cracking resistance under tensile stress**