INTERNATIONAL STANDARD

**ISO 23711**

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# Elastomeric seals — Requirements for materials for pipe joint seals used in water and drainage applications — Thermoplastic elastomers

*Garnitures d'étanchéité en caoutchouc — Spécification des matériaux pour garnitures d'étanchéité utilisées dans le domaine de l'eau et du drainage — Élastomères thermoplastiques*

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# Contents

Page



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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).

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This document was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 4, *Products (other than hoses)*.

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This second edition cancels and replaces the first edition (ISO 23711:2003), which has been technically revised.

The main changes are as follows:

— the tensile test has been changed so that it is performed in two directions;

— the ageing has been made more severe;

— a new test on stress fall has been added.

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# Elastomeric seals — Requirements for materials for pipe joint seals used in water and drainage applications — Thermoplastic elastomers

## 1 Scope

This document specifies requirements for materials used for moulded seals made of thermoplastic elastomers (TPEs) for joints in:

a) thermoplastic piping systems for non-pressure wastewater discharge (intermittent flow at up to 95 °C) inside buildings;

b) thermoplastic piping systems for non-pressure underground drainage and sewerage (continuous flow at up to 45 °C and intermittent flow at up to 95 °C);

c) thermoplastic rainwater piping systems.

General requirements for finished joint seals are also given; any additional requirements for a particular application are specified in the relevant product standards taking into account that the performance of pipe joints is a function of the seal material properties, seal geometry and pipe joint design.

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## 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 23711:2022
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ISO 37, *Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties*

ISO 48-2, *Rubber, vulcanized or thermoplastic — Determination of hardness — Part 2: Hardness between 10 IRHD and 100 IRHD*

ISO 188, *Rubber, vulcanized or thermoplastic — Accelerated ageing and heat resistance tests*

ISO 815-1, *Rubber, vulcanized or thermoplastic — Determination of compression set — Part 1: At ambient or elevated temperatures*

ISO 815-2, *Rubber, vulcanized or thermoplastic — Determination of compression set — Part 2: At low temperatures*

ISO 1431-1, *Rubber, vulcanized or thermoplastic — Resistance to ozone cracking — Part 1: Static and dynamic strain testing*

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

ISO 3302-1, *Rubber — Tolerances for products — Part 1: Dimensional tolerances*

ISO 3384-1:2019, *Rubber, vulcanized or thermoplastic — Determination of stress relaxation in compression — Part 1: Testing at constant temperature*

ISO 6914:2021, *Rubber, vulcanized or thermoplastic — Determination of ageing characteristics by measurement of stress relaxation in tension*

ISO 9691:1992, *Rubber — Recommendations for the workmanship of pipe joint rings — Description and classification of imperfections*

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ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions 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**
**thermoplastic elastomer**
polymer or blend of polymers that does not require vulcanization or cross-linking during processing, yet has elastic properties at its service temperature

Note 1 to entry: These properties disappear at processing temperature, so that further processing is possible, but return when the material is returned to its service temperature.

## 4 Classification

A nominal hardness of materials shall be specified within the ranges in Table 1.

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**Table 1 — Hardness classification**

| **Hardness class** | 50 | 60 | 70 |
|---|---|---|---|
| **Range of hardness, IRHD** | 46 to 55 | 56 to 65 | 66 to 75 |

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## 5 Finished-seal requirements

### 5.1 Dimensional tolerances

Tolerances shall be specified from the appropriate classes in ISO 3302-1.

### 5.2 Imperfections and defects

The seals shall be free of defects or irregularities, which could affect their function. Classification of imperfections shall be according to ISO 9691 as follows:

— surface imperfections in zones involved in the sealing function as described in ISO 9691:1992, 4.1.1 shall be considered as defects;

— surface imperfections in zones not involved in the sealing function as described in ISO 9691:1992, 4.1.2.1 b) shall not be considered as defects.

Major surface imperfections in zones not involved in the sealing function as described in ISO 9691:1992, 4.1.2.1 a), may be considered as defects. This should be agreed between the interested parties; the acceptance criteria depend upon the seal type or design.

Internal imperfections as described in ISO 9691:1992, 4.2 may be considered as defects. The compressive force can be determined in accordance with ISO 7743. The acceptable limiting values of the compressive force should be agreed between the interested parties; they depend upon the seal type or design.


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## 5.3 Hardness

When determined by the microtest method specified in ISO 48-2, on samples prepared in accordance with 6.1, the hardness shall conform to the requirements given in Table 2.

If the dimensions of a seal are appropriate, the normal test method specified in ISO 48-2 may be used, provided that the microtest method is used for reference purposes.

For the same seal, the difference between the minimum and maximum hardness values shall not be more than 5 IRHD. Each value shall be within the specified tolerances.

## 5.4 Tensile strength and elongation at break

The tensile strength and elongation at break shall be determined by the method specified in ISO 37, in two directions: perpendicular and parallel to the mould flow on dumb-bell test pieces, preferably cut out of a seal or out of a sample plate.

Sample plates (sheets) shall be prepared as specified in 6.1. The tensile strength and elongation at break shall conform to the requirements given in Table 2.

## 5.5 Compression set in air

### 5.5.1 General

If the test piece is taken from a seal, then the measurement shall be carried out as far as possible in the direction of compression of the seal in service at 25 % compression.

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### 5.5.2 Compression set at 23 °C and 70 °C

When determined by the method specified in ISO 815-1, at 23 °C and 70 °C, using the small type B test piece, the compression set shall conform to the requirements given in Table 2.

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### 5.5.3 Low temperature compression set at −10 °C

When determined by the method specified in ISO 815-2 at −10 °C, using the small type B test piece, and the (30 ± 3) min recovery measurement, the compression set of seals used in drainage and sewerage applications shall conform to the requirements given in Table 2.

## 5.6 Accelerated ageing in air

Test pieces prepared for the determination of hardness according to 5.3 and for the determination of tensile strength and elongation at break according to 5.4 shall be aged in air for 14 days at 80 °C by the normal oven method specified in ISO 188.

The changes in hardness, tensile strength and elongation at break shall conform to the requirements given in Table 2.

## 5.7 Stress relaxation in compression

The stress relaxation shall be determined at 23 °C in accordance with ISO 3384-1:2019, method A, using the small cylindrical test piece after applying mechanical and thermal conditioning. Measurements shall be taken at least after 3 h, 1 day, 3 days and 7 days for the 7-day test and after 3 h, 1 day, 3 days, 7 days, 30 days and 100 days for the 100-day test. The best-fit straight line shall be determined by regression analysis using a logarithmic time scale and the correlation coefficients derived from these analyses shall not be lower than 0,93 for the 7-day test and 0,83 for the 100-day test. The 7-day and 100-day requirements in Table 2 are those derived from these straight lines.

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For continuous measurement using an apparatus described in the first paragraph of ISO 3384-1:2019, 5.2, the 7-day and 100-day requirements in Table 2 are those derived from the measurements at 7 days and 100 days, respectively.

The stress relaxation in compression shall conform to the requirements given in Table 2 at the following temperatures and times:

— 7 days at (23 ± 2) °C;

— 100 days at (23 ± 2) °C.

The test temperature shall be maintained within the specified tolerance during the whole period of the test and verified by suitable recording equipment on a continuous basis.

The 100-day test shall be considered as a type approval test.

If the test piece is taken from a seal, then the measurement shall be carried out as far as possible in the direction of compression of the seal in service.

## 5.8 Stress fall

The stress fall shall not exceed the maximum values given in Table 2.

The stress fall shall be determined based on method A given in ISO 6914:2021.

The procedures of ISO 6914:2021 are applicable for the equipment (Clauses 5 and 6), test pieces (Clause 7) and conditioning (Clause 8). The procedure given below is applicable for the test and the calculation of the results.

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Start the test at a standard laboratory temperature (either 23 °C or 27 °C), following the procedure for method A of ISO 6914:2021.

ISO 23711:2022
https://standards.iteh.ai/catalog/standards/sist/
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After 48 h increase the temperature quickly to 70 °C. This can be done either by heating up the oven or by carefully moving the test rig to an oven preheated to 70 °C. The temperature should be constant at 70 °C within 10 min.

After (65 ± 5) min return the test piece to the starting temperature (quickly cool down the oven or return the test rig).

After another 47 h repeat the procedure. After the second period at 70 °C, keep the test piece at the standard laboratory temperature (23 °C or 27 °C) for at least 48 h.

Theoretically the stress will follow a horizontal line after having been for 1 h at a higher temperature, until the line of the initial decrease in stress is crossed. If the 1 h period was enough to have this effect, the drop in stress after the second period will be zero. The second period is introduced to make sure the process is completed. The stress fall is determined by taking the difference between the last value before the first transfer to 70 °C and the value at 23 °C or 27 °C at the end of the test. The principle is shown in Figure 1. It can be useful to use linear regression to determine the value just before the first period at 70 °C. The line after the second period at 70 °C should be almost horizontal.


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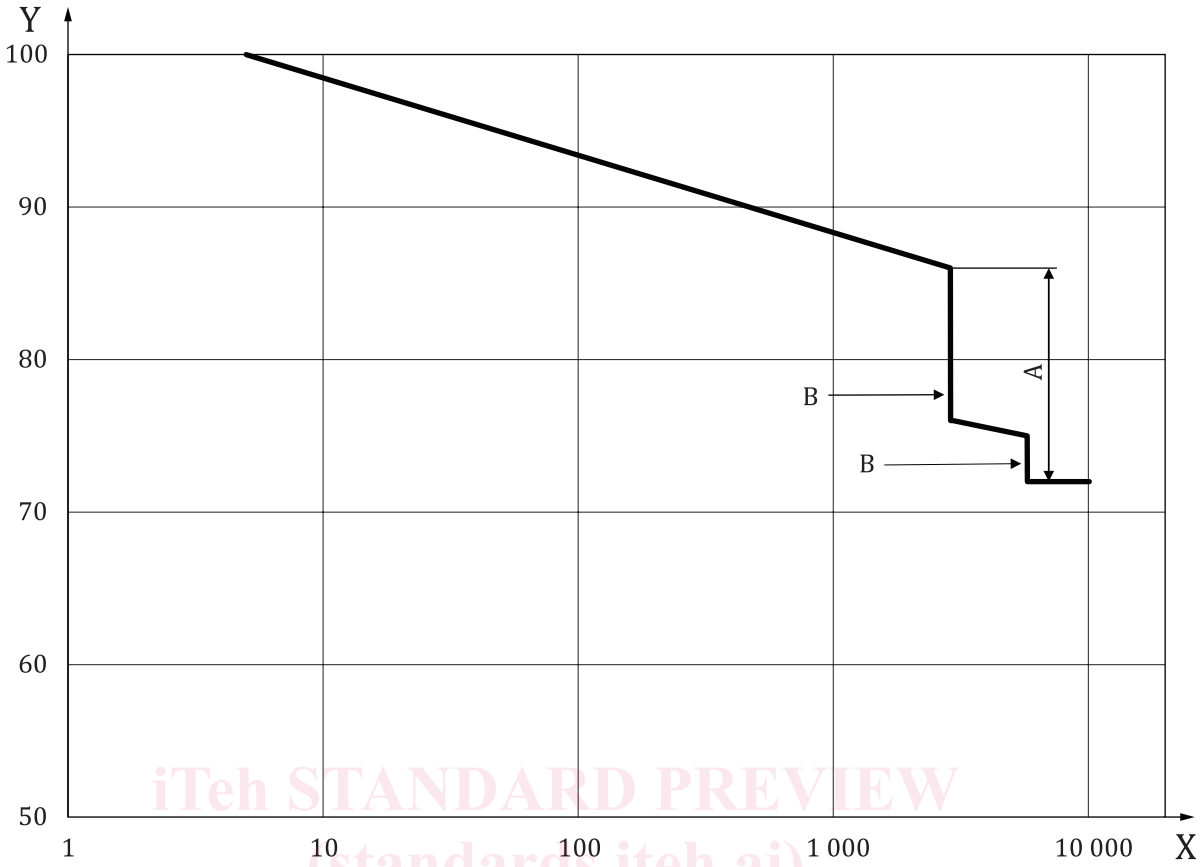


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**Key**

X time, *t*, in min (logarithmic)

Y relative stress in %

A stress fall

B 1 h at 70 °C

ISO 23711:2022
https://standards.iteh.ai/catalog/standards/sist/abdc37b2-d862-4867-8bb9-d9baa02216ff/iso-23711-2022

**Figure 1 — Example of relaxation curve and definition of stress fall**

## 5.9 Volume change in water

When determined by the method specified in ISO 1817, after 7 days of immersion of the test pieces in distilled or deionized water at a temperature of 70 °C, the change in volume shall conform to the requirements given in Table 2.

## 5.10 Ozone resistance

When determined by the method specified in ISO 1431-1, the following conditions are set out:

— ozone concentration (50 ± 5) MPa [≈ (50 ± 5) pphm];

— temperature (40 ± 2) °C;

— pretension time ($72\ ^{+0}_{-2}$) h;

— exposure time ($48\ ^{+0}_{-2}$) h;

— elongation (20 ± 2) %;

— relative humidity (55 ± 10) %.

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The ozone resistance of thermoplastic elastomer sealing elements which are attached to the pipe or fittings shall conform to the requirements given in Table 2.

Sealing elements which are protected by packaging, whether packaged separately or not, up to the time of installation, shall meet the same requirement but using an ozone concentration of (25 + 5) MPa [≈ (25 + 5) pphm].

## 5.11 Change in volume in oil [for type WH only (see Table 3)]

When determined in accordance with ISO 1817, the change in volume after immersion in oil No. 1 for 72 h at 70 °C shall conform to the requirements given in Table 2.

**Table 2 — Physical property requirements for type WT and WH thermoplastic-elastomer (TPE) materials[a] for seals used in thermoplastic non-pressure and rainwater piping systems**

| Property | Unit | Test method | Subclause | Requirements for hardness classes | | |
|---|---|---|---|---|---|---|
| | | | | 50 | 60 | 70 |
| Permissible tolerance on nominal hardness | IRHD | ISO 48-2 (microtest) | 5.3 | ±5 | ±5 | ±5 |
| Tensile strength, min. | MPa | ISO 37 | 5.4 | 3 | 4 | 5 |
| — perpendicular to the flow direction | | | | 70 % of result perpendicular to flow direction | 70 % of result perpendicular to flow direction | 70 % of result perpendicular to flow direction |
| — parallel to the flow direction | | | | | | |
| Elongation at break, min. | % | ISO 37 | 5.4 | 300 | 300 | 300 |
| — perpendicular to the flow direction | | | | 60 % of result perpendicular to flow direction | 60 % of result perpendicular to flow direction | 60 % of result perpendicular to flow direction |
| — parallel to the flow direction | | | | | | |
| Compression set, max. | | | | | | |
| — 72 h at 23 °C | % | ISO 815-1 | 5.5.2 | 25 | 25 | 25 |
| — 24 h at 70 °C | % | ISO 815-1 | 5.5.2 | 40 | 40 | 40 |
| — 72 h at –10 °C | % | ISO 815-2 | 5.5.3 | 65 | 65 | 65 |
| Ageing, 14 days at 80 °C | | ISO 188 | 5.6 | | | |
| — hardness change, max. | IRHD | ISO 48-2 | | ±7 | ±7 | ±7 |
| — tensile strength change, max. | % | ISO 37 | | ±20 | ±20 | ±20 |
| — elongation change, max. | % | ISO 37 | | ±30 | ±30 | ±30 |
| Stress relaxation, max. | | | | | | |
| — 7 days at 23 °C | % | ISO 3384 | 5.7 | 19 | 22 | 24 |
| — 100 days at 23 °C | % | ISO 3384 | 5.7 | 28 | 32 | 35 |
| Stress fall, max. | % | ISO 6914 [b] | 5.8 | 25 | 25 | 25 |
| Volume change in water, max. (7 days at 70 °C) | % | ISO 1817 | 5.9 | $^{+8}_{-1}$ | $^{+8}_{-1}$ | $^{+8}_{-1}$ |
| Ozone resistance | — | ISO 1431-1 | 5.10 | No cracking when viewed without magnification | | |
| **Additional requirement for type WH** | | | | | | |
| Volume change in oil, max. (72 h at 70 °C in oil No. 1) | % | ISO 1817 | 5.11 | $^{+50}_{-10}$ | $^{+50}_{-10}$ | $^{+50}_{-10}$ |

[a] See Table 3.

[b] ISO 6914 is used as basis.

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