
Elastomeric seals — Material requirements for seals used in pipes and fittings carrying gaseous fuels and hydrocarbon fluids

Garnitures d'étanchéité en élastomères — Exigences matérielles pour les joints utilisés dans les canalisations et les raccords véhiculant des combustibles gazeux et des hydrocarbures liquides

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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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 45, *Rubber and rubber products*, Subcommittee SC 4, *Products other than hoses*.

This second edition cancels and replaces the first edition (ISO 16010:2005), which has been technically revised.

The main changes compared to the previous edition are as follows:

- normative references has been updated to the latest version

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.

Elastomeric seals — Material requirements for seals used in pipes and fittings carrying gaseous fuels and hydrocarbon fluids

1 Scope

This document specifies requirements for elastomeric materials used in seals for supply pipes and fittings, ancillaries and valves at operating temperatures in general from $-5\text{ }^{\circ}\text{C}$ up to $50\text{ }^{\circ}\text{C}$ and in special cases from $-15\text{ }^{\circ}\text{C}$ up to $50\text{ }^{\circ}\text{C}$, for the following:

- a) general applications (see [Table 4](#), type G series):
 - gaseous fuel [manufactured, natural and liquefied petroleum gas (LPG) in the gaseous phase],
 - hydrocarbon fluids with an aromatic content up to 30 % (by volume), including LPG in the liquid phase;
- b) special applications (see [Table 4](#), type H):
 - materials suitable for carrying gaseous fuels containing gas condensates and hydrocarbon fluids of unrestricted aromatic content.

General requirements for finished joint seals are also given; any additional requirements called for by the 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. This document is used where appropriate with product standards which specify performance requirements for joints.

This document is applicable to joint seals for all pipeline materials, including iron, steel, copper and plastics.

In the case of composite sealing rings, the requirements in [5.2.8](#) and [5.2.9](#) apply only when the materials used for any elastomeric parts come into contact with gaseous fuel or hydrocarbon fluid.

Elongation at break, tensile strength, compression set and stress relaxation requirements for materials of hardness classes 80 and 90 apply only when they constitute that part of the seal which participates directly in the sealing function or contributes directly to long-term stability.

This document is not applicable to the following:

- seals made from cellular materials;
- seals with enclosed voids as part of their design;
- seals required to be resistant to flame or to thermal stress;
- seals which contain splices joining pre-vulcanized profile ends.

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 16010:2019(E)

The following referenced documents are indispensable for the application 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 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 188:2011, *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 3384-1:2011, *Rubber, vulcanized or thermoplastic — Determination of stress relaxation in compression at ambient and at elevated temperatures*
- ISO 9691:1992, *Rubber — Recommendations for the workmanship of pipe joint rings — Description and classification of imperfections*
- ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Terms and definitions

No terms and definitions are listed in this document.

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/>

4 Classification

Five classes of material for pipe seals are specified in [Tables 2](#) and [3](#).

A nominal hardness shall be specified within the ranges in [Table 1](#).

Table 1 — Hardness classification

Hardness class	50	60	70	80	90
Range of hardness, IRHD	46 to 55	56 to 65	66 to 75	76 to 85	86 to 95

5 Requirements

5.1 Materials

The materials shall be free of any substances which may have a deleterious effect on the life of the seals, or on the pipe or fittings.

5.2 Finished-seal requirements

5.2.1 Dimensional tolerances

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

5.2.2 Imperfections and defects

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

- surface imperfections in zones involved in the sealing function as described in 4.1.1 of ISO 9691:1992 shall be considered as defects;
- minor surface imperfections in zones not involved in the sealing function as described in 4.1.2.1 b) of ISO 9691:1992 shall not be considered as defects.

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

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

5.2.3 Hardness

When determined by the micro-test specified in ISO 48-2, the hardness shall comply with the requirements given in [Table 2](#) or [3](#).

NOTE If the dimensions of a seal are appropriate, the normal test method specified in ISO 48-2 can be used, provided that the micro-test method is used for referee purposes.

For the same seal, the difference between the minimum and maximum hardness values shall not be more than 4 IRHD. Each value shall be within the specified tolerances.

5.2.4 Tensile strength and elongation at break

Tensile strength and elongation at break shall be determined by the method specified in ISO 37. Dumb-bell shaped test pieces of type 1, 2, 3 or 4 shall be used. Type 2 is the preferred type. The test report shall state the dumb-bell type whenever type 2 is not used.

The tensile strength and the elongation at break shall comply with the requirements given in [Table 2](#) or [3](#).

5.2.5 Compression set in air

5.2.5.1 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.

5.2.5.2 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 comply with the requirements given in [Table 2](#) or [3](#).

If the cross-section of a seal is too small to obtain suitable test pieces, a type B test piece can be prepared either by cutting from a test slab or by moulding a disc (see [5.1](#)).

5.2.5.3 Low-temperature compression set at $-5\text{ }^{\circ}\text{C}$

When determined by the method specified in ISO 815-2 using the small type B test piece and a recovery time of (30 ± 3) min, the compression set after 72 h at $-5\text{ }^{\circ}\text{C}$, when measured at $-5\text{ }^{\circ}\text{C}$, shall comply with the requirements given in [Table 2](#) or [3](#).

5.2.6 Accelerated ageing in air

Test pieces prepared for the determination of hardness (see [5.2.3](#)) and for the determination of tensile strength and elongation at break (see [5.2.4](#)) shall be aged in air at $70\text{ }^{\circ}\text{C}$ for 7 days by the normal oven method specified in ISO 188:2011 (method A).

The changes in hardness, tensile strength and elongation at break shall comply with the requirements given in [Table 2](#) or [3](#).

5.2.7 Stress relaxation in compression

The stress relaxation shall be determined by method A of ISO 3384-1:2011, using a test piece in accordance with [5.1](#), after applying mechanical and thermal conditioning. Measurements shall be taken 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 90 days for the 90-day test. The best-fit straight line shall be determined by regression analysis using a logarithmic time scale, and the correlation coefficients derived from this analysis shall not be lower than 0,93 for the 7-day test and 0,83 for the 90-day test. The 7-day and 90-day requirements in [Tables 2](#) and [3](#) are those derived from these straight lines.

For continuous measurement using an apparatus as described in the first paragraph of 5.2 of ISO 3384-1:2011, the 7-day and 90-day requirements in [Tables 2](#) and [3](#) are those derived from the measurements at 7 days and 90 days.

The stress relaxation in compression shall comply with the requirements given in [Table 2](#) or [3](#) at the following temperatures and times:

- 7 days at $(23 \pm 2)\text{ }^{\circ}\text{C}$;
- 90 days at $(23 \pm 2)\text{ }^{\circ}\text{C}$.

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 90-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.

5.2.8 Volume change in liquid B

When determined by the method specified in ISO 1817, the volume change after 7 days immersion at $23\text{ }^{\circ}\text{C}$ in liquid B and, in addition, followed by drying in air for 4 days at $70\text{ }^{\circ}\text{C}$, shall comply with the requirements given in [Table 2](#) or [3](#).

5.2.9 Volume change in oil

When determined by the method specified in ISO 1817, after 7 days immersion at $70\text{ }^{\circ}\text{C}$ in standard oil No. 3, the volume change shall comply with the requirements given in [Table 2](#) or [3](#).

5.2.10 Ozone resistance

The test piece shall comply with the requirements given in [Table 2](#) or [3](#), when determined by the method specified in ISO 1431-1, under the conditions set out below:

— ozone concentration		(50 ± 5) pphm
— temperature		(40 ± 2) °C
— pre-tension time		72 $\frac{0}{-2}$ h
— exposure time		48 $\frac{0}{-2}$ h
— elongation:	hardness classes 50, 60 and 70	(20 ± 2) %
	hardness class 80	(15 ± 2) %
	hardness class 90	(10 ± 1) %
— relative humidity		(55 ± 10) %

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) pphm.

5.2.11 Compression set at -15 °C

When determined by the method specified in ISO 815-2 using the small type B test piece and a recovery time of (30 ± 3) min, the compression set of elastomeric materials which are intended to be used at temperatures below -5 °C and down to -15 °C shall after 72 h at -15 °C, when measured at -15 °C, comply with the requirements given in [Table 2](#).

6 Test pieces and temperature

6.1 Preparation of test pieces

Unless otherwise specified, test pieces shall be cut from the finished product by the method specified in ISO 23529. If satisfactory test pieces cannot be prepared in accordance with the instructions given for the appropriate test method, they shall be taken from test slabs or sheets of suitable dimensions or shall be moulded in a suitable cavity. They shall be made from the same batch of the elastomer mix as used to make the seals and moulded under conditions which are comparable with those used in production.

For tests in which different sizes of test piece are permissible, the same size of test piece shall be used for each batch and for any comparative purposes.

6.2 Test temperature

Unless otherwise specified, tests shall be carried out at a standard temperature in accordance with ISO 23529.

Two standard laboratory temperatures are given in ISO 23529, but the recommended test temperature (if not already specified) in this document is 23 °C.

Table 2 — Requirements for materials used for seals suitable for carrying gaseous fuel and hydrocarbon fluids with an aromatic content of up to 30 % (by volume) (see Table 4, type G series)

Property	Unit	Test method	Sub-clause	Requirements for hardness classes				
				50	60	70	80	90
Permissible tolerance on nominal hardness	IRHD	ISO 48-2	4.2.3	±5	±5	±5	±5	+3 -5
Tensile strength, min.	MPa	ISO 37	4.2.4	10	10	10	10	10
Elongation at break, min.	%	ISO 37	4.2.4	400	300	200	150 ^a	80 ^a
Compression set, max.								
72 h at 23 °C	%	ISO 815-1	4.2.5.2	10	10	10	15 ^a	15 ^a
24 h at 70 °C	%	ISO 815-1	4.2.5.2	18	18	18	20 ^a	20 ^{a,b}
72 h at -5 °C	%	ISO 815-2	4.2.5.3	25	25	25	40 ^a	40 ^{a,b}
Ageing 7 days at 70 °C		ISO 188	4.2.6					
hardness change, max.	IRHD	ISO 48-2		±5	±5	±5	±5	±5
tensile strength change, max.	%	ISO 37		±15	±15	±15	±15	±15
elongation change, max.	%	ISO 37		+10 -25	+10 -25	+10 -25	+10 -25	+10 -25
Stress relaxation, max.								
7 days at 23 °C	%	ISO 3384-1	4.2.7	12	13	14	15 ^a	15 ^a
90 days at 23 °C	%	ISO 3384-1	4.2.7	18	19	20	22 ^a	22 ^a
Volume change in liquid B after 7 days at 23 °C, max.	%	ISO 1817	4.2.8	+35	+35	+30	+30	+25
Volume change in liquid B and subsequently 4 days' air drying at 70 °C, max.	%	ISO 1817	4.2.8	-15	-12	-10	-10	-10
Volume change in oil No. 3 after 7 days at 70 °C ^c	%	ISO 1817	4.2.9	+10 - 1	+10 - 1	+10 - 1	+10 - 1	+10 - 1
Ozone resistance		ISO 1431-1	4.2.10	No cracking when viewed without magnification				
Compression set after 72 h at -15 °C, max. ^d	%	ISO 815-2	4.2.11	40	40	50	60 ^a	65 ^a

^a Requirements for material of hardness classes 80 IRHD and 90 IRHD are applied only when the material participates directly in the sealing function or contributes directly to long-term stability.

^b For materials with a hardness ≥90 IRHD, the requirement for the compression set at 70 °C is ≤40 % and the requirement for the compression set at -5 °C is ≤50 %.

^c Not applicable to sealing material types GA and GAL (see Table 4).

^d For types GAL and GBL only (see Table 4).

Table 3 — Requirements for materials used for seals suitable for carrying gaseous fuels containing gas condensates and hydrocarbon fluids of unrestricted aromatic content (see [Table 4](#), type H)

Property	Unit	Test method	Sub-clause	Requirements for hardness classes				
				50	60	70	80	90
Permissible tolerance on nominal hardness	IRHD	ISO 48-2	4.2.3	±5	±5	±5	±5	+3 -5
Tensile strength, min.	MPa	ISO 37	4.2.4	8	8	8	10	10
Elongation at break, min.	%	ISO 37	4.2.4	200	200	150	100 ^a	80 ^a
Compression set, max.								
72 h at 23 °C	%	ISO 815-1	4.2.5.2	14	14	15	15 ^a	15 ^a
24 h at 70 °C	%	ISO 815-1	4.2.5.2	14	14	15	15 ^a	15 ^a
72 h at -5 °C	%	ISO 815-2	4.2.5.3	— ^b	45	50	50 ^a	50 ^a
Ageing 7 days at 70 °C		ISO 188	4.2.6					
hardness change, max.	IRHD	ISO 48-2		±3	±3	±3	±3	±3
tensile strength change, max.	%	ISO 37		±15	±15	±15	±15	±15
elongation change, max.	%	ISO 37		+10 -15	+10 -15	+10 -15	+10 -15	+10 -15
Stress relaxation, max.								
7 days at 23 °C	%	ISO 3384-1	4.2.7	13	13	15	15 ^a	15 ^a
90 days at 23 °C	%	ISO 3384-1	4.2.7	19	19	22	22 ^a	22 ^a
Volume change in liquid B after 7 days at 23 °C, max.	%	ISO 1817	4.2.8	+5	+5	+5	+5	+5
Volume change in liquid B and subsequently 4 days' air drying at 70 °C, max.	%	ISO 1817	4.2.8	-2	-2	-2	-2	-2
Volume change in standard oil No. 3 after 7 days at 70 °C	%	ISO 1817	4.2.9	+5 -1	+5 -1	+5 -1	+5 -1	+5 -1
Ozone resistance		ISO 1431-1	4.2.10	No cracking when viewed without magnification				

^a Requirements for material of hardness classes 80 IRHD and 90 IRHD are applied only when the material participates directly in the sealing function or contributes directly to long-term stability.

^b Elastomers of this hardness class should not be used below 0 °C.

7 Quality assurance

Quality assurance testing is not an integral part of this document, but guidance can be obtained from [Annex A](#), which recommends appropriate test frequencies, product control tests and sampling techniques.

Quality assurance should preferably be in accordance with a standard such as ISO 9001 or equivalent.

8 Storage

See [Annex B](#).

9 Designation

Elastomeric seals for pipelines, fittings, ancillaries and valves are designated according to their intended application as described in [Table 4](#). The following information shall be used for a full designation of the seals:

- a) description e.g. SEAL
- b) standard number ISO 16010
- c) nominal size e.g. DN 150
- d) type of application e.g. GB (see [Table 4](#))
- e) rubber type e.g. NBR
- f) joint name e.g. Trade name

EXAMPLE SEAL/ISO 16010/DN 150/GB/NBR/Tradename

Table 4 — Designation of elastomeric seals by type, application and operating temperature

Type	Application	Operating temperature, °C
GA	Gaseous fuel	-5 to +50
GAL	Gaseous fuel	-15 to +50
GB	Hydrocarbon fluids and gaseous fuel	-5 to +50
GBL	Hydrocarbon fluids and gaseous fuel	-15 to +50
H	Aromatic hydrocarbon fluids and gaseous fuels containing gas condensates	-5 to +50

10 Marking and labelling

Each seal, or parcel of seals where the marking of individual seals is not practicable, shall be marked clearly and durably, as listed below, such that the sealing capability is not impaired.

- a) the manufacturer's identification;
- b) the number of this document followed by the seal type and the hardness class, e.g. ISO 16010/GB/60;
- c) the nominal size;
- d) the quarter and year of manufacture, e.g. 3Q05;
- e) the abbreviation for the rubber, e.g. NBR;
- f) in the case of a product made out of a material resistant to a lower concentration of ozone (see [5.2.10](#)), this shall be clearly indicated on the packaging.

EXAMPLE MAN/ISO 16010/GB/60/DN 150/3Q05/NBR