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Title: Draft BS EN ISO 15494 Plastics piping systems for industrial applications — Polybutene (PB), polyethylene (PE), polyethylene of raised temperature resistance (PE-RT), crosslinked polyethylene (PE-X), polypropylene (PP) —Metric series for specifications for components and the system.

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Introduction

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/DIS 15494

Plastics piping systems for industrial applications — Polybutene (PB), polyethylene (PE), polyethylene of raised temperature resistance (PE-RT), crosslinked polyethylene (PE-X), polypropylene (PP) — Metric series for specifications for components and the system

Systèmes de canalisations en matières plastiques pour les applications industrielles — Polybutène (PB), polyéthylène (PE), polyéthylène de meilleure résistance à la température (PE-RT), polyéthylène réticulé (PE-X), polypropylène (PP) — Séries métriques pour les spécifications pour les composants et le système

ICS: 23.040.01

This document is circulated as received from the committee secretariat.

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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).

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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 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 03, *Plastics pipes and fittings for industrial applications*.

This third edition cancels and replaces the second edition (ISO 15494:2005), which has been technically revised.

The main changes are as follows:

- in the text PE 63 has been deleted with the reference graphs and PE-100 RC has been added,
- in [Annex E](#) the impact resistance of pipes and test parameters for round the clock method has been added

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 International Standard specifies the characteristics and requirements for a piping system and its components made from polybutene (PB), polyethylene (PE), polyethylene of raised temperature resistance (PE-RT), crosslinked polyethylene (PE-X), or polypropylene (PP), as applicable, intended to be used for industrial applications above ground or below ground by authorities, design engineers, certification bodies, inspection bodies, testing laboratories, manufacturers, and users.

At the date of publication of this International Standard, standards for piping systems of other plastics used for industrial applications are the following:

ISO 10931, *Plastics piping systems for industrial applications — Poly(vinylidene fluoride) (PVDF) — Specifications for components and the system*

ISO 15493, *Plastics piping systems for industrial applications — Acrylonitrile-butadiene-styrene (ABS), unplasticized poly(vinyl chloride) (PVC-U), chlorinated poly(vinyl chloride) (PVC-C) — Specifications for components and the system — Metric series*

Plastics piping systems for industrial applications — Polybutene (PB), polyethylene (PE), polyethylene of raised temperature resistance (PE-RT), crosslinked polyethylene (PE-X), polypropylene (PP) — Metric series for specifications for components and the system

1 Scope

This International Standard specifies the characteristics and requirements for components such as pipes, fittings, and valves made from one of the following materials intended to be used for thermoplastics piping systems under pressure or vacuum conditions in the field of industrial applications above and below ground:

- polybutene (PB);
- polyethylene (PE);
- polyethylene of raised temperature resistance (PE-RT);
- crosslinked polyethylene (PE-X);
- polypropylene (PP).

NOTE 1 Requirements for industrial valves are given in this International Standard and/or in other standards. Valves are to be used with components conforming to this International Standard provided that they conform additionally to the relevant requirements of this International Standard.

This International Standard is applicable to either PB, PE, PE-RT, PE-X, or PP pipes, fittings, valves, and their joints and to joints with components of other plastics and non-plastic materials, depending on their suitability, intended to be used for the conveyance of liquid and gaseous media as well as solid matter in fluids for industrial applications under pressure or vacuum conditions, such as the following examples:

- chemical plants;
- industrial sewerage engineering;
- power engineering (e.g. cooling and general purpose water);
- mining;
- electroplating and pickling plants;
- semiconductor industry;
- agricultural production plants;
- fire fighting;
- water treatment;
- geothermal;
- compressed air applications.

NOTE 2 Where relevant, national regulations (e.g. water treatment) are applicable, other application areas are permitted if the requirements of this International Standard and/or applicable national requirements are fulfilled. National regulations in respect of fire behaviour and explosion risk are applicable.

Characteristics and requirements which are applicable for all materials (PB, PE, PE-RT, PE-X, or PP) are covered by the relevant clauses of this International Standard. Those characteristics and requirements which are dependent on the material are given in the relevant normative annex for each material (see [Table 1](#)).

Table 1 — Material-specific annexes

Material	Annex
Polybutene (PB)	A
Polyethylene (PE)	B
Polyethylene of raised temperature resistance (PE-RT)	C
Crosslinked polyethylene (PE-X)	D
Polypropylene (PP)	E

Components conforming to any of the product standards listed in the bibliography or with national standards, as applicable, may be used with components conforming to this International Standard, provided that they conform to the requirements for joint dimensions and to the relevant requirements of this International Standard.

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 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

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

ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 1133-1, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 1: Standard method*

ISO 1167-1:2006, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 1: General method*

ISO 1167-2:2006, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 2: Preparation of pipe test pieces*

ISO 1167-3:2007, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 3: Preparation of components*

ISO 1167-4:2007, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 4: Preparation of assemblies*

ISO 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pycnometer method and titration method*

ISO 1183-2, *Plastics — Methods for determining the density of non-cellular plastics — Part 2: Density gradient column method*

ISO 17885, *Plastics piping systems — Mechanical fittings for pressure piping systems — Specifications*

ISO 2505, *Thermoplastics pipes — Longitudinal reversion — Test method and parameters*

ISO 3126, *Plastics piping systems — Plastics components — Determination of dimensions*

- ISO 3127, *Thermoplastics pipes — Determination of resistance to external blows — Round-the-clock method*
- ISO 3501, *Plastics piping systems — Mechanical joints between fittings and pressure pipes — Test method for resistance to pull-out under constant longitudinal force*
- ISO 4065, *Thermoplastics pipes — Universal wall thickness table*
- ISO 4427-1:2007, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 1: General*
- ISO 6964, *Polyolefin pipes and fittings — Determination of carbon black content by calcination and pyrolysis — Test method*
- ISO/TR 7620, *Rubber materials — Chemical resistance*
- ISO 9080:2012, *Plastics piping and ducting systems — Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation*
- ISO 9854-1, *Thermoplastics pipes for the transport of fluids — Determination of Charpy impact properties — Part 1: General test method*
- ISO 9854-2, *Thermoplastics pipes for the transport of fluids — Determination of Charpy impact properties — Part 2: Test conditions for pipes of various materials*
- ISO 10147, *Pipes and fittings made of crosslinked polyethylene (PE-X) — Estimation of the degree of crosslinking by determination of the gel content*
- ISO 11414, *Plastics pipes and fittings — Preparation of polyethylene (PE) pipe/pipe or pipe/fitting test piece assemblies by butt fusion*
- ISO 11922-1:2018, *Thermoplastics pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series*
- ISO 11357-6, *Plastics — Differential scanning calorimetry (DSC) — Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)*
- ISO 12162, *Thermoplastics materials for pipes and fittings for pressure applications — Classification, designation and design coefficient*
- ISO 13477, *Thermoplastics pipes for the conveyance of fluids — Determination of resistance to rapid crack propagation (RCP) — Small-scale steady-state test (S4 test)*
- ISO 13479:2022, *Polyolefin pipes for the conveyance of fluids — Determination of resistance to crack propagation — Test method for slow crack growth on notched pipes*
- ISO 13953, *Polyethylene (PE) pipes and fittings — Determination of the tensile strength and failure mode of test pieces from a butt-fused joint*
- ISO 14531-1, *Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications — Part 1: Pipes*
- ISO 15512, *Plastics — Determination of water content*
- ISO 16135, *Industrial valves — Ball valves of thermoplastics materials*
- ISO 16136, *Industrial valves — Butterfly valves of thermoplastics materials*
- ISO 16137, *Industrial valves — Check valves of thermoplastics materials*
- ISO 16138, *Industrial valves — Diaphragm valves of thermoplastics materials*
- ISO 16139, *Industrial valves — Gate valves of thermoplastics materials*
- ISO 16770, *Plastics — Determination of environmental stress cracking (ESC) of polyethylene — Full-notch creep test (FNCT)*

ISO 16871, *Plastics piping and ducting systems — Plastics pipes and fittings — Method for exposure to direct (natural) weathering*

ISO 18488, *Polyethylene (PE) materials for piping systems — Determination of Strain Hardening Modulus in relation to slow crack growth — Test method*

ISO 18489:2015, *Polyethylene (PE) materials for piping systems — Determination of resistance to slow crack growth under cyclic loading — Cracked Round Bar test method*

ISO 18553, *Method for the assessment of the degree of pigment or carbon black dispersion in polyolefin pipes, fittings and compounds*

ISO 21787, *Industrial valves — Globe valves of thermoplastics materials*

EN 12099, *Plastics piping systems — Polyethylene piping materials and components — Determination of volatile content*

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 Geometrical definitions

NOTE The symbols d_e and e correspond to d_{ey} and e_y , given in other International Standards such as ISO 11922-1.

3.1.1

nominal outside diameter

d_n
specified outside diameter assigned to a nominal size DN/OD

Note 1 to entry: The nominal inside diameter of a socket is equal to the nominal outside diameter of the corresponding pipe.

Note 2 to entry: It is expressed in millimetres.

3.1.2

outside diameter at any point

d_e
value of the measurement of the outside diameter through its cross-section at any point of the pipe, rounded to the next greater 0,1 mm

3.1.3

mean outside diameter

d_{em}
value of the measurement of the outer circumference of the pipe or spigot end of a fitting in any cross-section divided by π ($\approx 3,142$), rounded to the next greater 0,1 mm

3.1.4

mean inside diameter of a socket

arithmetical mean of two measured inside diameters perpendicular to each other

3.1.5

nominal size of flange

DN
numerical designation of the size of a flange for reference purposes and related to the manufacturing dimension in millimetres

3.1.6**out-of-roundness****ovality**

difference between the maximum and the minimum outside diameter in the same cross-section of a pipe or spigot

3.1.7**nominal wall thickness**

e_n

numerical designation of the wall thickness of a component, which is a convenient round number, approximately equal to the manufacturing dimension in millimetres (mm)

Note 1 to entry: For thermoplastics components conforming to the different annexes of ISO 15494, the value of the nominal wall thickness, e_n , is identical to the specified minimum wall thickness at any point, e_{min} .

3.1.8**wall thickness at any point**

e

wall thickness at any point around the circumference of a component rounded to the next greater 0,1 mm

3.1.9**pipe series**

S

dimensionless number for pipe designation conforming to ISO 4065

Note 1 to entry: The relationship between the pipe series, S , and the standard dimension ratio, SDR, is given by the following formula as specified in ISO 4065:

$$S = \frac{SDR - 1}{2}$$

Note 2 to entry: Flanges are designated on the basis of PN.

3.1.10**standard dimension ratio**

SDR

numerical designation of a pipe series, which is a convenient round number, approximately equal to the dimension ratio of the nominal outside diameter, d_n , and the nominal wall thickness, e_n

3.1.11**bend**

Fitting curved in shape which the relative bending radius is $\geq 1 \times d_n$

Note 1 to entry: Bend fittings are manufactured in different ways e.g. injection moulded, prefabricated or swept bends etc.

3.2 Material definitions**3.2.1****Compound**

homogenous extruded mixture of base polymer and additives, i.e. anti-oxidants, pigments, carbon black, UV-stabilizers and others, at a dosage level necessary for the processing and use of components conforming to the requirements of this document

3.2.2**Virgin material**

material in a form such as granules or powder that has not been subjected to use or processing other than that required for its manufacture, and to which no reworked or recyclable materials have been added

3.2.3**Reworked material**

plastics materials from rejected unused products or trimmings that have been manufactured and retained within plants owned and operated by the same legal entity

3.2.4**Base polymer**

Polymer produced by the material supplier for the manufacture of the compound according to this document.

3.2.5**Recyclate**

plastics material resulting from the recycling of pre-consumer and post-consumer plastics products

Note 1 to entry: Also referred to as “secondary raw material” or “recycled plastics” or “regenerate”.

Note 2 to entry: Recycling can be chemical, physical or mechanical

3.2.6**melt mass-flow rate**

MFR

value relating to the viscosity of the molten material at a specified temperature and load

Note 1 to entry: It is expressed in grams per 10 min (g/10 min).

3.3 Definitions related to material characteristics**3.3.1****lower confidence limit of the predicted hydrostatic strength**

σ_{LPL}

quantity with the dimensions of stress, which represents the 97,5 % lower confidence limit of the predicted hydrostatic strength at a temperature, θ , and time, t

Note 1 to entry: It is expressed in megapascals.

3.3.2**minimum required strength**

MRS

value of σ_{LPL} at 20 °C and 50 years, rounded down to the next smaller value of the R10 series or the R20 series

Note 1 to entry: The R10 series conforming to ISO 3^[1] and the R20 series to ISO 497^[2].

3.3.3**design stress**

σ_s

allowable stress for a given application at 20 °C that is derived from the MRS by dividing it by the coefficient C

Note 1 to entry: Design stress can be calculated using the following formula:

$$\sigma_s = \frac{MRS}{C}$$

Note 2 to entry: It is expressed in megapascals.

3.3.4**design coefficient**

C

coefficient with a value greater than one which takes into consideration service conditions as well as the properties of the components of a piping system other than those represented in the lower confidence limit

Note 1 to entry: Minimum design coefficients are defined in ISO 12162.

Note 2 to entry: There might be a need of additional service factors depending on the service conditions as described in [annex F](#) to calculate the overall design coefficient.

3.4 Definitions related to service conditions

3.4.1

nominal pressure

PN

numerical designation used for reference purposes related to the mechanical characteristics of the components of a piping system.

Note 1 to entry: A pressure, in bar, with the numerical value of PN is identical with the pressure, PS, as defined by Reference [3] if both pressures are taken at 20 °C.

Note 2 to entry: For plastics piping systems conveying water, it corresponds to the maximum continuous operating pressure in bar, which can be sustained for water at 20 °C for 50 years, based on the following minimum design coefficient:

$$PN = \frac{10\sigma_s}{[S]} = \frac{20\sigma_s}{SDR-1}$$

where

σ_s is expressed in MPa;

PN is expressed in bar.

Note 3 to entry: 1 bar = 0,1 MPa = 10⁵ Pa; 1 MPa = 1 N/mm².

3.4.2

hydrostatic stress

σ

stress induced in the wall of a pipe when an internal hydrostatic pressure is applied

Note 1 to entry: The hydrostatic stress is related to the applied internal hydrostatic pressure, in bar p , the wall thickness, e , at any point and the mean outside diameter, d_{em} , of a pipe and calculated using the following formula:

$$\sigma = p \frac{d_{em} - e_{min}}{20 e_{min}}$$

Note 2 to entry: Formula is applicable for pipes only.

Note 3 to entry: It is expressed in megapascals.

3.4.3

long-term hydrostatic stress

σ_{LTHS}

quantity with the dimensions of stress, which represents the predicted mean strength at a temperature T and time t

Note 1 to entry: It is expressed in megapascals.

[SOURCE: ISO 9080:2012, 3.9]

4 Symbols and abbreviated terms

4.1 Symbols

C	design coefficient
d_e	outside diameter (at any point)
d_{em}	mean outside diameter
d_n	nominal outside diameter
DN	nominal size of flange
e	wall thickness (at any point)
e_n	nominal wall thickness
h_f	height of the flange adaptor shoulder
l_0	free length
P	internal hydrostatic pressure
p_c	Highest crack-arrest pressure below the lowest crack-propagation pressure
p_s	maximum allowable pressure
r_f	radius of shoulder of flange adapter
T	temperature
t	time
ρ	material density
σ	hydrostatic stress
σ_{LPL}	lower confidence limit of the predicted hydrostatic strength
σ_{LTHS}	long-term hydrostatic strength
σ_s	design stress

4.2 Abbreviated terms

MFR	melt mass-flow rate
MOP	maximum operating pressure
MRS	minimum required strength
OIT	oxidation induction time
PB	polybutene
PE	polyethylene
PE 80	polyethylene designated on the basis of the minimum required strength
PE 100	polyethylene designated on the basis of the minimum required strength

PE 100-RC	polyethylene designated on the basis of the minimum required strength and having raised crack resistance
PE-RT	polyethylene of raised temperature resistance
PE-X	crosslinked polyethylene
PP	polypropylene
PP-H	polypropylene homopolymer
PP-B	polypropylene block-copolymer
PP-R	polypropylene random-copolymer
PP-RCT	polypropylene random-copolymer with modified crystallinity
PN	nominal pressure
S	pipe series S
SDR	standard dimension ratio
TIR	true impact rate

5 Material

5.1 General

The material from which the components are made shall either be PB, PE, PE-RT, PE-X, or PP, as applicable, to which are added those additives that are needed to facilitate the manufacture of pipes, fittings, and valves conforming to this International Standard.

Note For PEX, the material is only existing in form of a component (crosslinked pipe)

The additives used shall be uniformly dispersed.

The additives shall not be dosed separately or together in quantities sufficient to impair the fabrication or fusion characteristics of the component or to impair the chemical, physical, or mechanical characteristics as specified in this International Standard.

5.2 Hydrostatic strength properties

The material shall be evaluated according to ISO 9080 by analysis of sustained pressure tests carried out in accordance with ISO 1167-1 and ISO 1167-2 to classify the material in accordance with ISO 12162.

Conformity of the relevant material to the reference curves given for PB (see [Annex A](#)), PE (see [Annex B](#)), PE-RT (see [Annex C](#)), PE-X (see [Annex D](#)), and PP (see [Annex E](#)) shall be proven according to the applicable Annex of this International Standard.

For design, these reference curves shall be used as a basis.

Classification and verification of conformity to reference curves of the material shall be done by the compound manufacturer.

NOTE In some cases, the component manufacturer can be regarded as the raw compound manufacturer.

Where fittings and valves are manufactured from the same material as pipes, the material classification and verification of conformity to reference curves shall be the same as for pipes.

For the classification and verification of conformity to reference curves of a material intended only for the manufacture of fittings and valves, the test piece can be an injection-moulded or extruded test piece in form of a pipe.

5.3 Material characteristics

5.3.1 General

The details of the material characteristics of PB, PE, PE-RT, PE-X, and PP mechanical and physical properties with requirements are given in the applicable Annex of this International Standard. Biobased material can be used in case the mass balance is required by the purchaser.

5.3.2 Use of reworked and recycle material

The use of the manufacturer's own reworked material obtained during the production and production testing of products conforming this document is permitted in addition to the use of virgin material. Reworked material obtained from external sources and recycle material shall not be used.

5.3.3 Resistance to rapid crack propagation, RCP

For a pipeline systems carrying air or a compressible gas, for design purposes, the resistance of the material to the phenomenon known as rapid crack propagation shall be taken into account (see ISO 4427-1:2007, Annex B). The critical pressure p_c is dependent on the material, pipe diameter, and operating temperature.

The critical pressure p_c measured in accordance with ISO 13477 S4 test shall be greater than 1,5 times the maximum operating pressure of the pipeline system.

Information provided by the pipe or material supplier shall be taken into account when designing an industrial pipeline system for the transport of air or a compressible gas.

ISO 4437-2^[4] defines the maximum operating pressure MOP for Polyethylene (PE) pipe for gas application considering the RCP performance. PE 100 materials can be operated up to 10 bar at 0 °C depending on wall thickness.

Crosslinked polyethylene (PE-X) pipe produced in accordance with ISO 14531-1 has been shown to be resistant to RCP at temperatures down to -50 °C.

Additional consideration shall be taken on the safety and the mechanical performance of the system in case of vacuum and gaseous applications due to potential risk of buckling, collapse or burst

5.4 Materials for components not made from PB, PE, PE-RT, PE-X, or PP

5.4.1 General

All components shall conform to the relevant International Standard(s). Alternative standards may be applied in cases where suitable International Standard(s) do not exist. In all cases, fitness for purpose of the components shall be demonstrated.

Materials and constituent elements used in making the relevant component (including rubber, greases, and any metal parts as may be used) shall have comparable resistance to the external and internal environments as all other elements of the piping system according to this International Standard.

Materials other than PB, PE, PE-RT, PE-X, or PP in contact with components conforming to this International Standard shall not adversely affect the performance of the components or initiate stress cracking.

5.4.2 Metallic materials

All metal parts susceptible to corrosion shall be adequately protected.

When dissimilar metallic materials are used which can be in contact with moisture, steps shall be taken to avoid the possibility of galvanic corrosion.

5.4.3 Sealing materials

Sealing materials shall have no detrimental effects on the properties of the components, joints, and assemblies.

5.4.4 Other materials

Greases or lubricants shall not exude onto fusion areas and shall not affect the long-term performance of materials conforming to this International Standard.

6 General characteristics

6.1 Appearance

When viewed without magnification, the internal and external surfaces of the components shall be smooth, clean, and free from scoring, cavities, and other surface defects to an extent that would prevent conformity to this International Standard. The components shall not contain visible impurities.

Each end of a component shall be square to its axis and shall be deburred.

6.2 Colour

The colour of the components depends on the material used and shall be as given for PB, PE, PE-RT, PE-X, or PP in the applicable Annex of this International Standard.

NOTE Attention is drawn to the need to take account of any relevant legislation relating to the colour coding of piping in respect of its purpose or contents for the location in which the components are intended to be used.

6.3 Influence of UV radiation

Components for external above ground installations shall be adequately protected against UV radiation or the material shall be resistant to UV radiation for the intended application. For products which are usually stored outside in direct sunlight prior to installation, the effect of UV radiation shall be taken into account. To assess materials for resistance to UV radiation for storage purposes, pipe is subject to a cumulative radiant exposure of $\geq 3,5 \text{ GJ/m}^2$ in accordance with ISO 16871. Following this exposure, the pipe is assessed for any significant change in mechanical properties.

For component not for external above ground installations or not stored outside in the direct sunlight by the manufacturer, distributor or on the job site, the effect of UV radiation may be neglected.

6.4 Resistance to rapid crack propagation, RCP

For a pipeline systems carrying air or a compressible gas, for design purposes, the resistance of the material to the phenomenon known as rapid crack propagation shall be taken into account (see ISO 4427-1:2007, Annex B). The critical pressure p_c is dependent on the material, pipe diameter, and operating temperature.

The critical pressure p_c measured in accordance with ISO 13477 S4 test shall be greater than 1,5 times the maximum operating pressure of the pipeline system.

Information provided by the pipe or material supplier shall be taken into account when designing an industrial pipeline system for the transport of air or a compressible gas.

ISO 4437-2^[4] defines the maximum operating pressure MOP for Polyethylene (PE) pipe for gas application considering the RCP performance. PE 100 materials can be operated up to 10 bar at 0 °C depending on wall thickness.

Crosslinked polyethylene (PE-X) pipe produced in accordance with ISO 14531-1 has been shown to be resistant to RCP at temperatures down to $-50\text{ }^{\circ}\text{C}$.

Additional consideration shall be taken on the safety and the mechanical performance of the system in case of vacuum and gaseous applications due to potential risk of buckling, collapse or burst

7 Geometrical characteristics

7.1 General

The measurement shall not be made less than 24 h after manufacture.

Dimensions shall be measured in accordance with ISO 3126 at $(23 \pm 2)\text{ }^{\circ}\text{C}$ after being conditioned for at least 4 h unless specified otherwise in the relevant material annex.

Indirect measurement during the stage of production is allowed at shorter time periods providing that evidence is shown of correlation.

The given figures are schematic sketches only, to indicate the relevant dimensions. They do not necessarily represent the manufactured component(s). The given dimensions shall be followed.

Dimensions not given shall be specified by the manufacturer.

7.2 Mean outside diameters, out-of-roundness (ovality), and tolerances

For components made from PB, PE, PE-RT, PE-X or PP, as applicable, the diameters, out-of-roundness (ovality) and related tolerances shall conform to the applicable annex of this International Standard.

The out-of-roundness (ovality) shall be measured at the point of manufacture.

7.3 Wall thicknesses and related tolerances

For components made from PB, PE, PE-RT, PE-X or PP, as applicable, the wall thicknesses and related tolerances shall conform to the applicable annex of this International Standard.

7.4 Angles

The permitted deviations from the nominal or declared angle for a nonlinear fitting shall be $\pm 2^{\circ}$ where the angle comprises the relevant change of axis of the flow through the fitting.

NOTE The preferred nominal angles for a nonlinear fitting are 45° or 90° .

7.5 Laying lengths

The laying lengths for fittings and valves shall be declared by the manufacturer.

The laying lengths are intended to assist in the design of moulds and are not intended to be used for quality control purposes. ISO 265-1^[5] may be used as a guideline.

7.6 Threads

Threads used for jointing shall conform to ISO 7-1. Where a thread is used as a fastening thread for jointing an assembly (e.g. union nuts), a thread conforming to ISO 228-1 is preferred.

7.7 Mechanical fittings

Mechanical fittings used for jointing shall conform to conform to ISO 17885 provided that their joint dimensions are in accordance with the applicable dimensions of components conforming to this International Standard.

7.8 Joint dimensions of valves

The joint dimensions of valves shall conform to the relevant dimensions of pipes and fittings conforming to this International Standard.

8 Mechanical characteristics

8.1 Resistance to internal pressure of components

Components shall withstand the hydrostatic stress induced by internal hydrostatic pressure without bursting or leaking when tested in accordance with ISO 1167-1, ISO 1167-2, and ISO 1167-3 and the test conditions specified for PB, PE, PE-RT, PE-X, or PP in the applicable annex of this International Standard.

8.2 Calculation of the test pressure for components

8.2.1 Pipes

The hydrostatic test pressure, p , expressed in bar, shall be determined for pipes using [Formula \(1\)](#):

$$\sigma = p \frac{d_{em} - e_{min}}{20 e_{min}} \quad (1)$$

where σ is the hydrostatic stress for PB, PE, PE-RT, PE-X, or PP conforming to the applicable Annex of this International Standard.

8.2.2 Fittings

The hydrostatic test pressure, p , expressed in bar, shall be determined for fittings using [Formula \(2\)](#). For S and SDR respectively, the value of the corresponding pipe shall be taken:

$$p = \frac{10\sigma}{[S]} = \frac{20\sigma}{SDR - 1} \quad (2)$$

8.2.3 Valves

The hydrostatic test pressure, p , expressed in bar, is defined for valves in ISO 16135, ISO 16136, ISO 16137, ISO 16138, ISO 16139, or ISO 21787, as applicable, depending on the valve type.

9 Physical characteristics

The physical characteristics of components made from PB, PE, PE-RT, PE-X, or PP shall conform to the applicable annex of this International Standard.

10 Chemical characteristics

10.1 Effects on the component material(s)

Where fluids other than water are to be conveyed, the effect of the fluid on the component material shall be considered.

The components shall withstand the mechanical, thermal, and chemical demands to be expected and shall be resistant to the fluids to be conveyed.

NOTE 1 Guidance is given in ISO/TR 10358^[6] or by the component manufacturer.

Elastomeric materials used in the production of sealants in terms of classification of chemical resistance against fluids according to application shall be in accordance with type 1 in the ISO/TR 7620 standard.

NOTE 2 Guidance is given in ISO 4433-1^[7] and ISO 4433-2^[8] in case it is necessary to evaluate the chemical resistance and the classification of the pipe for a particular application.

10.2 Effects on the fluids

Where fluids other than water are to be conveyed, the effect of the component material on the fluid shall be considered.

11 Electrical characteristics

The electrical protection that shall be provided during the fusion process depends on the voltage and wave form (AC or DC). Definitions of electrical circuits and applicable protections are found in the relevant IEC standards.

Electrofusion fittings are part of an electrical circuit when connected to the control units.

For voltages greater than 25 V, direct human contact with energized parts shall not be possible when the fitting is in the fusion cycle during assembly in accordance with the instructions of the manufacturers of the fittings and of the assembly equipment, as applicable.

The tolerance on the electrical resistance of the fitting at 23 °C shall be stated by the manufacturer. The resistance shall be in between nominal resistance (–10 %) and nominal resistance [(+10 %) + 0,1 Ω].

NOTE 0,1 Ω is the assumed value of the contact resistance.

The surface finish of the terminal pins shall allow a minimum contact resistance in order to satisfy the resistance tolerance requirements.

12 Performance requirements

12.1 General

When components made from the same material conforming to this International Standard are jointed to each other, the pipes, fittings, valves, and the joints shall conform to the requirements of the applicable annex of this International Standard.

NOTE If test pressures defined for pipes are used for assemblies made from components of dissimilar materials (e.g. screwed joints, flanged joints), the resulting strain exceeds the strain occurring under service conditions. These strains unavoidably cause leakage. Reference is given in the material related isochronous stress-strain-diagrams to define the applicable test pressure.

12.2 Fusion compatibility

The manufacturer of components shall declare which components and materials conforming to this International Standard may be fused by using the same procedures (e.g. times, temperatures, fusion pressures) to conform to the requirements of this International Standard. If there is a need for deviation in fusion procedures, the manufacturer shall state this.

13 Classification of components

The classification of pipes shall be based on the pipe series, S, or the standard dimension ratio, SDR, or the nominal pressure, PN, as applicable.

The classification of fittings shall be based on the corresponding pipe together with the pipe series S or the standard dimension ratio, SDR, or the nominal pressure, PN, as applicable.

Valves shall be classified in accordance with the requirements of ISO 16135, ISO 16136, ISO 16137, ISO 16138, ISO 16139, or ISO 21787, as applicable, depending on the valve type.

14 Design and installation

For the design and installation of thermoplastic piping systems for industrial applications, see [Annex F](#).

15 Declaration of conformity

The manufacturer shall declare conformity to this International Standard by marking the component in accordance with [Clause 16](#) and, under request, issue a statement of conformity.

NOTE Guidance on drafting the Declaration of conformity is given in ISO/IEC 17050-1^[9] and ISO/IEC 17050-2^[10].

16 Marking

16.1 General

Marking elements shall be printed or formed directly on the component or be on a label in such a way that after storage, weathering and handling, and the installation, legibility is maintained.

NOTE The manufacturer is not responsible for marking of the component being illegible due to actions caused during installation and use such as painting, scratching, covering, or by use of detergents, etc. unless agreed upon or specified by the manufacturer.

Marking shall not initiate cracks or other types of defects which adversely influence the performance of the component.

If printing is used, the colouring of the printed information shall differ from the basic colouring of the component.

The size of the marking shall be such that the marking is legible without magnification.

16.2 Minimum required marking of pipes

The minimum required marking of pipes shall conform to [Table 2](#).

Pipes shall be marked at intervals of maximum 1 m, at least once per pipe.

Table 2 — Minimum required marking of pipes

Aspects	Marking or symbol ^c
Number of this standard ^a	ISO 15494
Manufacturer's name and/or trade mark	<i>Name or symbol</i>
Nominal outside diameter, d_n	e.g. 110
Nominal wall thickness, e_n , or pipe series, S, or standard dimension ratio, SDR, or nominal pressure, PN	e.g. 10,0 or e.g. S 5 or SDR 11 or e.g. PN 10
Material ^a	e.g. PP-H
Manufacturer's information	^b
^a If different types of a material are available, this shall be marked, e.g. PP-H or PP-R. ^b For providing traceability, the following details shall be given: — production period, year and month, in figures or in code; — name or code for the production site if the manufacturer is producing at different sites. ^c Information on abbreviations may be found in bibliography [11] and/or in national rules.	

16.3 Minimum required marking of fittings

The minimum required marking of fittings shall conform to [Table 3](#), except for fittings with $d_n \leq 32$ mm, for which the minimum required marking shall be directly on the fitting, as follows:

- manufacturer's name and/or trade mark;
- nominal outside diameter(s);
- material;
- nominal wall thickness, e_n , or pipe series S or SDR or PN, as applicable.

Table 3 — Minimum required marking of fittings

Aspects	Marking or symbol ^e
Number of this standard ^{af}	ISO 15494
Manufacturer's name and/or trade mark	<i>Name or symbol</i>
Nominal outside diameter(s), d_n	e.g. 63-32-63
Nominal wall thickness, e_n , or pipe series, S, or standard dimension ratio, SDR, or nominal pressure, PN	e.g. 5,8 or e.g. S 5 or SDR 11 or e.g. PN 10
Nominal size DN ^b	e.g. DN 50
Material ^c	e.g. PP-H
Manufacturer's information	d

^a This information may either be marked directly on the fitting or on a label attached to the fitting or on the packaging. If different types of a material are available, this shall be marked, e.g. PP-H or PP-R.

^b Applicable to flanges only.

^c If different types of material are available, this shall be marked directly on the fitting or on a label attached to the fitting or on the packaging.

^d For providing traceability, the following details shall be given:

- production period, year and month, in figures or in code;
- name or code for the production site if the manufacturer is producing at different sites.

^e Information on abbreviations may be found in bibliography [11] and/or in national rules.

^f Marking of prefabricated fitting shall be marked in conformity to the referenced standard and to this table.

16.4 Minimum required marking of valves

Valves shall be marked in accordance with the requirements of ISO 16135, ISO 16136, ISO 16137, ISO 16138, ISO 16139, or ISO 21787, as applicable, depending on the valve type.

Annex A (normative)

Specific characteristics and requirements for industrial piping systems made from polybutene (PB)

A.1 Material

A.1.1 Material classification

The material in pipe form shall be evaluated in accordance with ISO 9080:2012 or equivalent where internal pressure tests are made in accordance with ISO 1167-1 and ISO 1167-2 to find the σ_{LPL} values. The σ_{LPL} values thus determined shall at least be as high as the corresponding values of the reference lines. Testing shall be carried out at temperatures stated below.

Temperatures: 20 °C; 60 °C to 82 °C; 95 °C; 110 °C.

NOTE 82 °C is equivalent to 180 °F, commonly used as a test temperature in ASTM standards.

PB shall have a minimum required strength, MRS, at least equal to 12,5 MPa.

NOTE According the scope of ISO 12230^[12], for the sake of simplicity the designation polybutene and the abbreviation PB are used throughout.

The reference lines in this document are the ones of PB homopolymer. (PB-H)

A.1.2 Material verification of conformity to reference curves

To prove conformance with the reference curves, two methods can alternatively be applied:

- mathematical method (ISO 9080):

the σ_{LPL} values, as determined by ISO 9080 in A.1.1, shall at least be as high as the corresponding values of the reference curves at all temperatures and times of relevance;

- graphical method:

The material shall be tested in accordance with 5.2 at 20 °C, 60 °C to 80 °C and 95 °C as well as at various hydrostatic (hoop) stresses in such a way that at each temperature, at least three failure times fall in each of the following time intervals.

- 10 h to 100 h;
- 100 h to 1 000 h;
- 1 000 h to 8 760 h;
- > 8 760 h.

In tests lasting more than 8 760 h, any time which is reached at a certain stress and time at least on or above the relevant reference curve may be considered as failure time

Conformance with the reference curves is demonstrated by plotting the individual experimental results on the graph. At least 97,5 % of them shall lie on or above the following reference curves.

Reference curves:

The mathematical description of the reference curves are given by [Formula \(A.1\)](#) and [Formula \(A.2\)](#) for the temperature range 10 °C to 110 °C, the graphical representation is given in [Figure A.1](#) also for the temperature range of 10 °C to 110 °C.

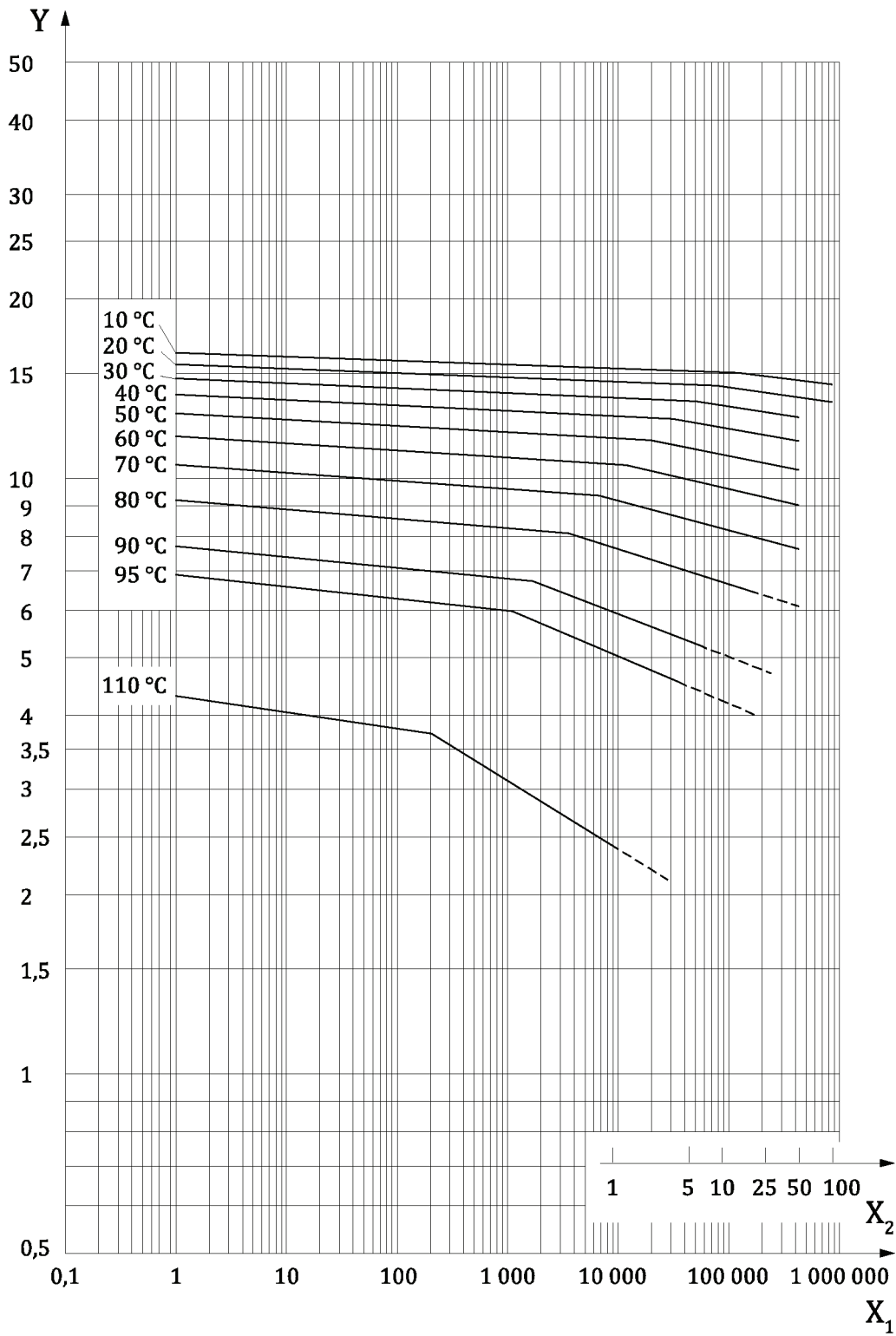
First branch (i.e. the left hand portion of the curves as shown in [Figure A.1](#)).

$$\text{— PB: } \log t = -430,866 - 125\,010,0 \frac{\log \sigma}{T} + 173\,892,7 \cdot \frac{1}{T} + 290,056\,9 \cdot \log \sigma \quad (\text{A.1})$$

Second branch (i.e. the right hand portion of the curves as shown in [Figure A.1](#)).

$$\text{— PB: } \log t = -129,895 - 37\,262,7 \frac{\log \sigma}{T} + 52\,556,48 \cdot \frac{1}{T} + 88,567\,35 \cdot \log \sigma \quad (\text{A.2})$$

NOTE The calculation for PB is based on ISO 12230[12].



Key

- X_1 time to failure, in hours (h)
- X_2 time to failure, in years
- Y hoop stress, in megapascal (MPa)

Figure A.1 — Minimum required hydrostatic strength curves for PB

The endpoints of curves in the graph ([Figure A.1](#)) are given just as an example; the extrapolation time limit for a specific material (endpoints in the regression curves) has to be determined based on the method given in ISO 9080.

A.1.3 Material characteristics

The material from which the components are manufactured shall conform to the requirements given in [Table A.1](#).

Table A.1 — Material characteristics of PB

Characteristic	Requirements ^a	Test parameters		Test method
Pigment dispersion	≤ Grade 3	Preparation of test pieces	Compression or microtome cut ^b	ISO 18553
Thermal stability tested by resistance to internal pressure at 110 °C	No failure during the test period	End caps Orientation Conditioning period Type of test Hydrostatic (hoop) stress Test temperature Test period	Type A according to ISO 1167-1 Free According to ISO 1167-1 Water-in-air 2,4 MPa 110 °C 8 760 h	ISO 1167-1 ISO 1167-2
^a Conformity to the requirements shall be declared by the raw compound manufacturer.				
^b In case of dispute, the compression method shall be used.				

A.1.4 Crystallization

Due to the slow crystallization, crystalline transformation, and shrinkage which takes places after PB compounds are cooled from the melt, physical and mechanical testing in accordance with [A.4.1](#) and measurement of dimensions shall be delayed after extrusion or moulding, according to recommendations obtained from the manufacturer or material supplier. Components manufactured from PB compounds shall be conditioned in accordance with the manufacturer's recommendations prior to measurement of dimensions.

A.2 General characteristics: Colour

Colour shall be agreed upon between manufacturer and purchaser.

A.3 Geometrical characteristics

A.3.1 Dimensions of pipes

A.3.1.1 Diameters and related tolerances

The mean outside diameter, d_{em} , and the related tolerances shall conform to [Table A.2](#), appropriate to the tolerance grade, whereby the average value of the measurements of the outside diameter made at a distance of d_n and $0,1d_n$ from the end of the test pieces shall be within the tolerance range for d_{em} specified in [Table A.2](#).

A.3.1.2 Out-of-roundness

The out-of-roundness for straight lengths shall conform to [Table A.2](#) when measured at the point of manufacture. If other values for the out-of-roundness than those given in [Table A.2](#) are necessary, they shall be agreed upon between manufacturer and purchaser.

For coiled pipes, the maximum out-of-roundness shall be specified by agreement between manufacturer and purchaser.

Table A.2 — Mean outside diameters, related tolerances and out-of-roundness of pipes

Dimensions in millimetres

Nominal outside diameter d_n	Mean outside diameter d_{em} min.	Tolerance of outside diameter Grade A ^a	Out-of-roundness ^b (straight pipes) Grade M ^a max.
12	12,0	+0,3	1,0
16	16,0	+0,3	1,0
20	20,0	+0,3	1,0
25	25,0	+0,3	1,0
32	32,0	+0,3	1,0
40	40,0	+0,4	1,0
50	50,0	+0,5	1,2
63	63,0	+0,6	1,5
75	75,0	+0,7	1,8
90	90,0	+0,9	2,2
110	110,0	+1,0	2,7
125	125,0	+1,2	3,0
140	140,0	+1,3	3,4
160	160,0	+1,5	3,9
180	180,0	+1,7	4,4
200	200,0	+1,8	4,8
225	225,0	+2,1	5,4
250	250,0	+2,3	6,0
^a In accordance with ISO 11922-1.			
^b For straight pipes: Grade M ($0,024d_n$).			
Tolerances of the outside diameter are rounded up to the next 0,1 mm.			

A.3.1.3 Wall thicknesses and related tolerances

The wall thickness, e , and the related tolerances shall conform to [Table A.3](#).

Components intended to be welded shall have a minimum wall thickness of 1,9 mm.

Table A.3 — Wall thicknesses and related tolerances

Dimensions in millimetres

Nominal outside diameter d_n	Wall thickness, e , and related tolerances ^c											
	Pipe series S and standard dimension ratio, SDR											
	S 10 SDR 21		S 8 SDR 17		S 6,3 SDR 13,6		S 5 SDR 11		S 4 SDR 9		S 3,2 SDR 7,4	
	e_n	^a	e_n	^a	e_n	^a	e_n	^a	e_n	^a	e_n	^a
12	1,3 ^b	+0,3	1,3 ^b	+0,3	1,3 ^b	+0,3	1,3 ^b	+0,3	1,4	+0,3	1,7	+0,3
16	1,3	+0,3	1,3	+0,3	1,3	+0,3	1,5	+0,3	1,8	+0,3	2,2	+0,4
20	1,3	+0,3	1,3	+0,3	1,5	+0,3	1,9	+0,3	2,3	+0,4	2,8	+0,4
25	1,3	+0,3	1,5	+0,3	1,9	+0,3	2,3	+0,4	2,8	+0,4	3,5	+0,5
32	1,6	+0,3	1,9	+0,3	2,4	+0,4	2,9	+0,4	3,6	+0,5	4,4	+0,6
40	1,9	+0,3	2,4	+0,4	3,0	+0,4	3,7	+0,5	4,5	+0,6	5,5	+0,7
50	2,4	+0,4	3,0	+0,4	3,7	+0,5	4,6	+0,6	5,6	+0,7	6,9	+0,8
63	3,0	+0,4	3,8	+0,5	4,7	+0,6	5,8	+0,7	7,1	+0,9	8,6	+1,0
75	3,6	+0,5	4,5	+0,6	5,6	+0,7	6,8	+0,8	8,4	+1,0	10,3	+1,2
90	4,3	+0,6	5,4	+0,7	6,7	+0,8	8,2	+1,0	10,1	+1,2	12,3	+1,4
110	5,3	+0,7	6,6	+0,8	8,1	+1,0	10,0	+1,1	12,3	+1,4	15,1	+1,7
125	6,0	+0,7	7,4	+0,9	9,2	+1,1	11,4	+1,3	14,0	+1,5	17,1	+1,9
140	6,7	+0,8	8,3	+1,0	10,3	+1,2	12,7	+1,4	15,7	+1,7	19,2	+2,1
160	7,7	+0,9	9,5	+1,1	11,8	+1,3	14,6	+1,6	17,9	+1,9	21,9	+2,3
180	8,6	+1,0	10,7	+1,2	13,3	+1,5	16,4	+1,8	20,1	+2,2	24,6	+2,6
200	9,6	+1,1	11,9	+1,3	14,7	+1,6	18,2	+2,0	22,4	+2,4	27,4	+2,9
225	10,8	+1,2	13,4	+1,5	16,6	+1,8	20,5	+2,2	25,2	+2,7	30,8	+3,2
250	11,9	+1,3	14,8	+1,6	18,4	+2,0	22,7	+2,4	27,9	+2,9	34,2	+3,6
^a Tolerance of the wall thickness: $0,1e_n + 0,1$ mm, rounded up to the next 0,1 mm.												
^b For $d_n = 12$, a non-preferred wall thickness of 1,1 mm may be chosen.												
^c All dimensions correspond to ISO 4065.												

A.3.2 Dimensions of fittings

A.3.2.1 General

This Annex is applicable for the following types of fittings:

- socket fusion fittings;
- electrofusion fittings;
- flange adaptors and loose backing flanges;
- mechanical fittings.

A.3.2.2 Socket fusion fittings

A.3.2.2.1 Types of socket fusion fittings

Socket fusion fittings (see [Figure A.2](#)) shall be classified in the following two types.

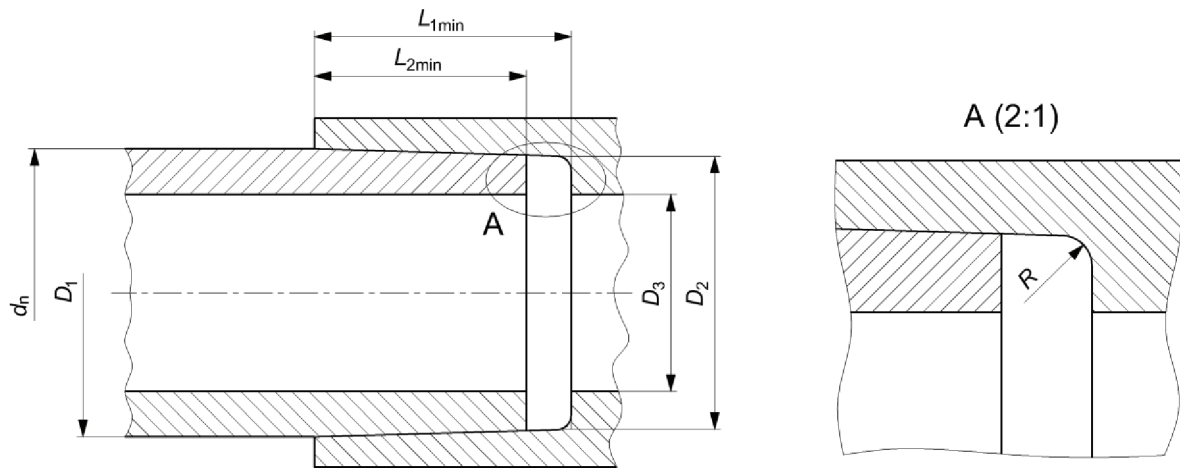
- **Type A:** Fittings intended to be used with pipes having dimensions as given in [A.3.1](#) where no external machining of the pipe is required.

- **Type B:** Fittings intended to be used with pipes having dimensions as given in [A.3.1](#) where machining of the outside surface of the pipe is necessary in accordance with the instructions of the manufacturer.

A.3.2.2.2 Diameters and lengths of sockets

The nominal diameter(s), d_n , of a socket fusion fitting shall correspond to, and be designated by, the nominal outside diameter(s) of the pipe(s) for which it is designed.

The diameters and lengths of sockets for socket fusion fittings of type A shall conform to [Table A.4](#). For socket fusion fittings of type B, the diameters and lengths of sockets shall conform to [Table A.5](#).



Key

- D_1 inside diameter of the socket mouth which comprises the mean diameter of the circle at the inner section of the extension of the socket with the plane of the socket mouth
- D_2 mean inside diameter of the socket root which comprises the mean diameter of the circle in a plane parallel to the plane of the socket mouth and separated from it by a distance of L_{1min}
- D_3 minimum diameter of the flow channel (bore) through the body of a fitting
- L_{1min} minimum socket length which comprises the distance from the socket mouth to the shoulder
- L_{2min} minimum insertion length which comprises the depth of the penetration of the heated pipe end into the socket
- R minimum radius at socket root

Figure A.2 — Diameters and lengths of socket fusion fittings

Table A.4 — Diameters and lengths of sockets for socket fusion fittings of type A

Dimensions in millimetres

Nominal outside diameter of pipe d_n	Mean outside diameter of pipe d_{em} min.	Mean inside diameter				Out-of- round- ness max.	Bore D_3^a min.	Radius at socket root R max.	Socket length L_1^b min.	Penetration of pipe into socket L_2^c min.
		Socket mouth		Socket root						
		D_1		D_2						
		min.		min.						
16	16,0	15,2	+0,3	15,1	+0,3	0,4	9,0	2,5	13,0	9,5
20	20,0	19,2	+0,3	19,0	+0,3	0,4	13,0	2,5	14,5	11,0
25	25,0	24,2	+0,3	23,9	+0,4	0,4	18,0	2,5	16,0	12,5
32	32,0	31,1	+0,4	30,9	+0,4	0,5	25,0	3,0	18,0	14,5
40	40,0	39,0	+0,4	38,8	+0,4	0,5	31,0	3,0	20,5	17,0
50	50,0	48,9	+0,5	48,7	+0,5	0,6	39,0	3,0	23,5	20,0
63	63,0	61,9	+0,5	61,6	+0,5	0,6	49,0	4,0	27,5	24,0
75	75,0	74,3	+0,6	73,1	+0,6	1,0	59,0	4,0	30,0	26,0
90	90,0	89,3	+0,6	87,9	+0,6	1,0	69,0	4,0	33,0	29,0
110	110,0	109,4	+0,6	107,7	+0,6	1,0	85,0	4,0	37,0	32,5

^a Only applicable, if a shoulder exists.

^b Length of the socket (rounded), d16 to d63: $L_{1\min} = 0,3d_n + 8,5$ mm; d75 to 110: $L_{1\min} = 0,2d_n + 15$ mm

^c Penetration of pipe into socket, d16 to d63; $L_{2\min} = L_{1\min} - 3,5$ mm; d75 to d110; No formula available

Table A.5 — Diameters and lengths of sockets for socket fusion fittings of type B

Dimensions in millimetres

Nominal outside diameter of pipe d_n	Mean outside diameter of pipe d_{em} min. max.		Mean inside diameter				Out-of- round- ness max.	Bore D_3^a min.	Radius at sock- et root R max.	Socket length L_1^b min.	Penetration of pipe into socket L_2^c min.
			Socket mouth		Socket root						
			D_1		D_2						
			min.		min.						
16	15,8	16,0	15,2	+0,3	15,1	+0,3	0,4	11,0	2,5	13,0	9,5
20	19,8	20,0	19,2	+0,3	19,0	+0,3	0,4	13,0	2,5	14,5	11,0
25	24,8	25,0	24,2	+0,3	23,9	+0,4	0,4	18,0	2,5	16,0	12,5
32	31,8	32,0	31,1	+0,4	30,9	+0,4	0,5	25,0	3,0	18,0	14,5
40	39,8	40,0	39,0	+0,4	38,8	+0,4	0,5	31,0	3,0	20,5	17,0
50	49,8	50,0	48,9	+0,5	48,7	+0,5	0,6	39,0	3,0	23,5	20,0
63	62,7	63,0	61,9	+0,6	61,6	+0,5	0,6	49,0	4,0	27,5	24,0
75	74,7	75,0	73,7	+0,5	73,4	+0,5	1,0	58,0	4,0	31,0	27,5
90	89,7	90,0	88,6	+0,6	88,2	+0,6	1,0	69,0	4,0	35,5	32,0
110	109,6	110,0	108,4	+0,6	108,0	+0,6	1,0	85,0	4,0	41,5	38,0

^a Only applicable if a shoulder exists.

^b Length of the socket (rounded), $L_{1\min} = 0,3d_n + 8,5$ min.

^c Penetration of pipe into socket, $L_{2\min} = L_{1\min} - 3,5$ mm.

A.3.2.2.3 Other dimensions

Other dimensions of socket fusion fittings shall be specified by the manufacturer.

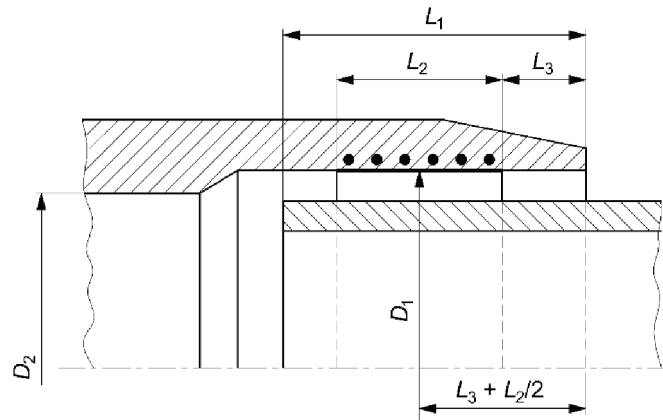
A.3.2.3 Electrofusion fittings

A.3.2.3.1 Dimensions of sockets of electrofusion fittings

The dimensions of sockets of electrofusion fittings (see [Figure A.3](#)) shall conform to [Table A.6](#).

In the case of a fitting having sockets of different sizes (e.g. reduction), each socket shall conform to the requirements of the corresponding nominal diameter.

In case of using spigot end fittings, the outside tubular length of the fusion end shall allow the assembly with an electrofusion fitting.



Key

- D_1 mean inside diameter in the fusion zone measured in a plane parallel to the plane of the mouth at a distance of $L_3 + 0,5L_2$ from that face
- D_2 bore, which is the minimum diameter of the flow channel through the body of the fitting
- L_1 depth of penetration of the pipe or male end of a spigot end fitting; in case of a coupling without stop, it is not greater than half the total length of the fitting
- L_2 heated length within a socket as declared by the manufacturer; to be the nominal length of the fusion zone
- L_3 distance between the mouth of the fitting and the start of the fusion zone as declared by the manufacturer to be the nominal unheated entrance length of the fitting ($L_3 \geq 5$ mm)

Figure A.3 — Dimensions of sockets of electrofusion fittings

Table A.6 — Dimensions of sockets of electrofusion fittings

Dimensions in millimetres

Nominal diameter of fitting d_n	Depth of penetration ^a L_1		Length of the fusion zone L_2
	min.	max.	min.
16	20	35	10
20	20	37	10
25	20	40	10
32	20	44	10
40	20	49	10
50	20	55	10
63	23	63	11
75	25	70	12

^a The manufacturer shall declare the actual maximum and minimum values of D_1 and L_1 to determine suitability for clamping and joint assembly.

Table A.6 (continued)

Nominal diameter of fitting d_n	Depth of penetration ^a L_1		Length of the fusion zone L_2
	min.	max.	min.
90	28	79	13
110	32	85	15
125	35	90	16
140	38	95	18
160	42	101	20

^a The manufacturer shall declare the actual maximum and minimum values of D_1 and L_1 to determine suitability for clamping and joint assembly.

The mean inside diameter of the fitting in the middle of the fusion zone (see D_1 in [Figure A.3](#)) shall be not less than d_n .

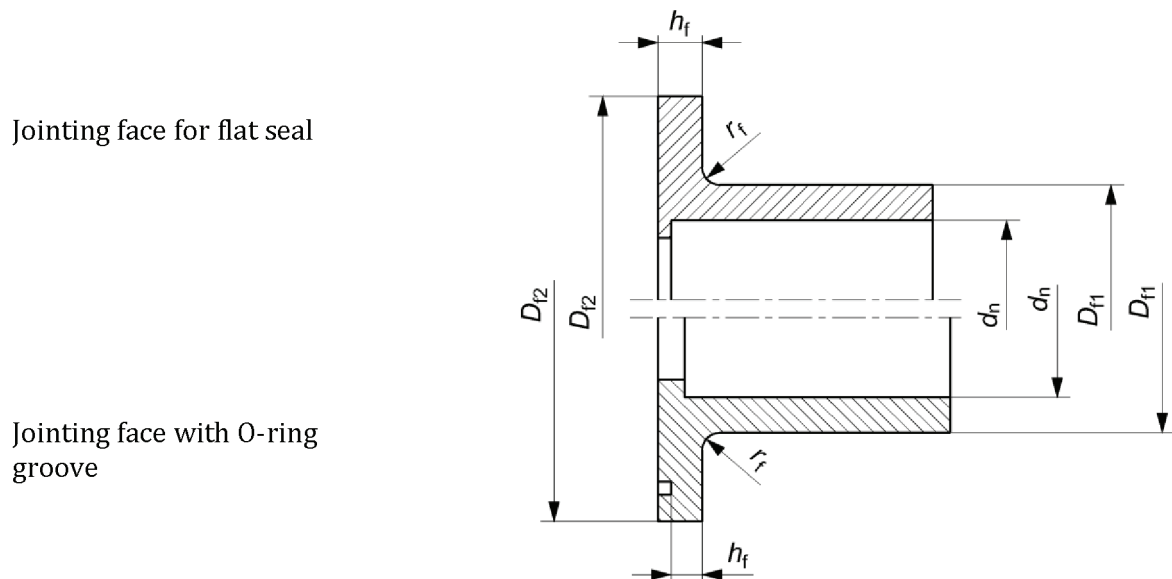
A.3.2.3.2 Other dimensions

Other dimensions of electrofusion fittings shall be specified by the manufacturer.

A.3.2.4 Flange adaptors and loose backing flanges

A.3.2.4.1 Dimensions of flange adaptors for socket fusion

The dimensions of flange adaptors for socket fusion (see [Figure A.4](#)) shall conform to [Table A.7](#).



Key

- D_{f1} outside diameter of flange adaptor
- D_{f2} outer diameter of the chamfer on shoulder
- r_f radius of chamfer on shoulder

Figure A.4 — Dimensions of flange adaptors for socket fusion

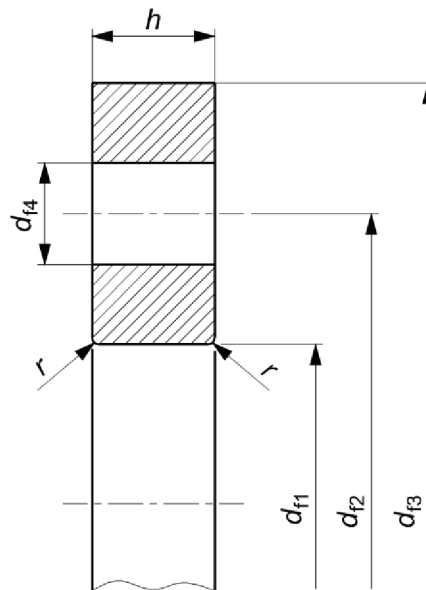
Table A.7 — Dimensions of flange adaptors for socket fusion

Dimensions in millimetres

Nominal outside diameter of the corresponding pipe d_n	Outside diameter of chamfer on shoulder D_{f1}	Outside diameter of flange adaptor D_{f2}	Radius of chamfer on shoulder r_f	Height of the flange adaptor shoulder h_f
16	22	40	3	6
20	27	45	3	7
25	33	58	3	9
32	41	68	3	10
40	50	78	3	11
50	61	88	3	12
63	76	102	4	14
75	90	122	4	16
90	108	138	4	17
110	131	158	4	18

A.3.2.4.2 Dimensions of loose backing flanges for use with flange adaptors for socket fusion

The dimensions of loose backing flanges for use with flange adaptors for socket fusion (see [Figure A.5](#)) shall conform to [Table A.8](#).



Key

- d_{f1} inside diameter of flange
- d_{f2} pitch circle diameter of bolt holes
- d_{f3} outside diameter of flange
- d_{f4} diameter of bolt holes
- r radius of flange
- h thickness of backing ring

NOTE The thickness, h , of the loose backing flange is dependent on the material used.

Figure A.5 — Dimensions of loose backing flanges for use with flange adaptors for socket fusion

Table A.8 — Dimensions of loose backing flanges for use with flange adaptors for socket fusion

Dimensions in millimetres

Nominal outside diameter of the corresponding pipe d_n	Nominal size of flange DN	Inside diameter of flange d_{f1}	Pitch circle diameter of bolt holes d_{f2}	Outside diameter of flange d_{f3} min.	Diameter of bolt holes d_{f4}	Radius of flange r	Number of bolt holes N	Metric thread of bolt
16	10	23	60	90	14	3	4	M12
20	15	28	65	95	14	3	4	M12
25	20	34	75	105	14	3	4	M12
32	25	42	85	115	14	3	4	M12
40	32	51	100	140	18	3	4	M16
50	40	62	110	150	18	3	4	M16
63	50	78	125	165	18	3	4	M16
75	65	92	145	185	18	3	4	M16
90	80	110	160	200	18	3	8	M16
110	100	133	180	220	18	3	8	M16

A.4 Mechanical characteristics

A.4.1 Mechanical characteristics of pipes and fittings

When tested as specified in [Table A.9](#) using the indicated parameters, the components shall withstand the hydrostatic stress without bursting or leaking under the test conditions given in [Table A.10](#).

Table A.9 — Requirements for internal pressure testing

Characteristic	Requirements	Test parameters		Test method
		Hydrostatic (hoop) stress MPa	Time h	
Resistance to internal pressure at 20 °C	No failure during the test period	15,5	≥1	ISO 1167-1 ISO 1167-2 ISO 1167-3
Resistance to internal pressure at 95 °C		6,2	≥165	ISO 1167-1 ISO 1167-2 ISO 1167-3
Resistance to internal pressure at 95 °C		6,0	≥1 000	ISO 1167-1 ISO 1167-2 ISO 1167-3

Table A.10 — Test conditions for internal pressure testing

Test parameters	
End caps	Type A according to ISO 1167-1
Orientation	Free
Conditioning period	In accordance with ISO 1167-1
Type of test	Water-in-water or water-in-air ^a
^a In case of dispute, water-in-water shall be used.	

A.4.2 Mechanical characteristics of valves

The valves shall conform to the requirements of ISO 16135, ISO 16136, ISO 16137, ISO 16138, ISO 16139, or ISO 21787, as applicable, depending on the valve type.

A.5 Physical characteristics

A.5.1 Physical characteristics of pipes

When tested in accordance with the test methods as specified in [Table A.11](#) using the indicated parameters, the pipe shall have physical characteristics conforming to the requirements given in [Table A.11](#).

Table A.11 — Physical characteristics of pipes

Characteristic	Requirements	Test parameters		Test method
Melt mass-flow rate (MFR)	After processing maximum deviation of ± 20 % of the value measured on the batch used to manufacture the pipe	Test temperature Loading mass Time Number of test pieces	190 °C 5 kg or 2,16 kg 10 min According to ISO 1133-1	ISO 1133-1
Thermal stability tested by resistance to internal pressure at 110 °C	No failure during the test period	End caps Orientation Conditioning period Type of test Hydrostatic (hoop) stress Test temperature Test period	Type A according to ISO 1167-1 Free According to ISO 1167-1 Water-in-air 2,4 MPa 110 °C 8 760 h	ISO 1167-1 ISO 1167-2
Longitudinal reversion ^a Wall thickness ≤ 16 mm	≤ 3 % Original appearance of pipe shall remain	Temperature Length of test piece Immersion time: Test method Number of test pieces	110 °C 200 mm 1 h Free Shall conform to ISO 2505	ISO 2505
^a The choice of method A or method B is free. In case of dispute, method B shall be used.				

A.5.2 Physical characteristics of fittings

When tested in accordance with the test method as specified in [Table A.12](#) using the indicated parameters, the fitting shall have physical characteristics conforming to the requirements given in [Table A.12](#).

Table A.12 — Physical characteristics of fittings

Characteristic	Requirements	Test parameters		Test method
Melt mass-flow rate (MFR)	After processing maximum deviation of ± 30 % of the value measured on the batch used to manufacture the fitting	Test temperature Loading mass	190 °C 5 kg or 2,16 kg	ISO 1133-1

A.5.3 Physical characteristics of valves

In addition to the requirements of ISO 16135, ISO 16136, ISO 16137, ISO 16138, ISO 16139, or ISO 21787, as applicable, depending on the valve type, the physical characteristics of valves shall conform to [A.5.2](#).

A.6 Fitness for purpose of the system

Fitness for purpose of the system shall be deemed to apply when test pieces assembled in accordance with [12.2](#) and tested using the test methods and indicated parameters as specified in [Table A.13](#) conforming to the requirements given in [Table A.13](#).

Table A.13 — General requirements for fitness for purpose of the system

Characteristic	Requirements	Test parameters		Test method
Hydrostatic strength at 95 °C	No failure during the test period	End caps Orientation Test temperature Type of test Hydrostatic (hoop) stress Conditioning period Test period	Type A according to ISO 1167-1 Free 95 °C Water-in-water or water-in-air ^a 6,0 MPa ≥1 h 1 000 h	ISO 1167-1 ISO 1167-4
^a In case of dispute, water-in-water shall be used.				