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**Ductile iron pipes, fittings, accessories
and their joints compatible with
plastic (PVC or PE) piping systems,
for water applications and for plastic
pipeline connections, repair and
replacement**

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*Tuyaux, raccords et accessoires en fonte ductile et leurs assemblages
compatibles avec les canalisations plastiques (PVC ou PE) pour
la distribution d'eau et pour les connexions, réparations et
remplacements des canalisations en plastiques*

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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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 5, *Ferrous metal pipes and metallic fittings*, Subcommittee SC 2, *Cast iron pipes, fittings and their joints*.

This corrected version of ISO 16631:2016 incorporates the following correction:

- in [Table 8](#), “PFA” has been changed to “PEA”.

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Ductile iron pipes, fittings, accessories and their joints compatible with plastic (PVC or PE) piping systems, for water applications and for plastic pipeline connections, repair and replacement

1 Scope

This International Standard specifies the requirements and test methods applicable to ductile iron pipes, fittings, accessories and their joints with dimensions compatible with plastic (PVC or PE) piping systems:

- to replace or repair existing plastic pipelines;
- to convey water (e.g. for human consumption, raw water, etc.);
- operated with or without pressure;
- installed below or above ground;
- defined according to their external diameter (DN/OD series);
- classified according to pressure (C class).

The pressure class specified in this International Standard is C25. This pressure resistance level will meet or exceed those of plastic pipes. These ductile iron pipes, fittings, accessories and joints can be used along with plastic pipelines where they are needed (for example, with higher pressure rating sections, higher traffic load, etc.), for the construction of water pipelines.

The dimensions of the products according to this International Standard, in the size range DN/OD 50 to DN/OD 225, are compatible with those of plastic pipes (ISO 1452-2 for PVC and ISO 4427-2 for PE). The spigots of plastic pipes used for water applications can be inserted into sockets of pipes manufactured according to this International Standard. The spigots and sockets of products defined in this International Standard are not dimensionally compatible with the products defined in ISO 2531.

This International Standard gives specifications for materials, dimensions and tolerances, mechanical properties and standard coatings and linings of pipes, fittings and accessories. It also gives performance requirements for all components including joints.

This International Standard covers pipes, fittings and accessories cast by any type of foundry process or manufactured by fabrication of cast components, as well as corresponding joints in the size range DN/OD 50 to DN/OD 225 inclusive.

It is applicable to pipes, fittings and accessories which are

- manufactured with socketed or spigot ends for jointing by means of various types of gaskets (which are not within the scope of this International Standard), and
- compulsory delivered internally and externally coated.

This International Standard is also applicable to socketed fittings which include flanged connections.

NOTE In this International Standard, all pressures are relative pressures expressed in bar¹⁾.

1) 100 kPa = 1 bar.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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 1452-2, *Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure — Unplasticized poly(vinyl chloride) (PVC-U) — Part 2: Pipes*

ISO 2531, *Ductile iron pipes, fittings, accessories and their joints for water applications*

ISO 4016, *Hexagon head bolts — Product grade C*

ISO 4034, *Hexagon regular nuts (style 1) — Product grade C*

ISO 4179, *Ductile iron pipes and fittings for pressure and non-pressure pipelines — Cement mortar lining*

ISO 4427-2, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 2: Pipes*

ISO 4633, *Rubber seals — Joint rings for water supply, drainage and sewerage pipelines — Specification for materials*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 7005-2, *Metallic flanges — Part 2: Cast iron flanges*

ISO 7091, *Plain washers — Normal series — Product grade C*

ISO 8179-1, *Ductile iron pipes — External zinc-based coating — Part 1: Metallic zinc with finishing layer*

ISO 8179-2, *Ductile iron pipes — External zinc coating — Part 2: Zinc rich paint with finishing layer*

ISO 8180, *Ductile iron pipelines — Polyethylene sleeving for site application*

ISO 10802, *Ductile iron pipelines — Hydrostatic testing after installation*

ISO 10804, *Restrained joint systems for ductile iron pipelines — Design rules and type testing*

ISO 13846, *Plastics piping systems — End-load-bearing and non-end-load-bearing assemblies and joints for thermoplastics pressure piping — Test method for long-term leaktightness under internal water pressure*

ISO 16132, *Ductile iron pipes and fittings — Seal coats for cement mortar linings*

3 Terms and definitions

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

3.1 ductile iron
type of cast iron used for pipes, fittings and accessories in which graphite is present primarily in spheroidal form

3.2 pipe
casting of uniform bore, with straight axis, having either socket, spigot or flanged ends, except for flanged sockets, flanged spigots and collars which are classified as fittings

3.3**fitting**

casting other than a pipe, which allows pipeline deviation, change of direction or bore

Note 1 to entry: In addition, flanged sockets, flanged spigots, flange adaptors and collars are also classified as fittings.

3.4**accessory**

component other than a pipe or fitting, which is used in a pipeline, such as

- glands and bolts for *mechanical flexible joints* (3.14), and
- glands, bolts and locking rings or segments for *restrained joints* (3.15).

Note 1 to entry: Valves and hydrants of all types are not covered by the term accessory.

3.5**component**

product defined in 3.2 to 3.4

3.6**flange**

end of a pipe or fitting, extending perpendicular to its axis, with bolt holes equally spaced on a circle

Note 1 to entry: A flange may be fixed (e.g. integrally cast, threaded-on or welded-on) or adjustable; an adjustable flange comprises a ring, in one or several parts bolted together, which bears on an end joint hub and can be freely rotated around the pipe axis before jointing.

3.7**spigot**

male end of a pipe or fitting

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3.8**spigot end**

maximum insertion depth of the spigot plus 50 mm

3.9**socket**

female end of a pipe or fitting to make the connection with the spigot of the next component

3.10**gasket**

sealing component of a joint

3.11**joint**

connection between the ends of pipes and/or fittings in which a gasket is used to effect a seal

3.12**flexible joint**

joint which provides significant angular deflection and movement parallel and/or perpendicular to the pipe axis

3.13**push-in flexible joint**

flexible joint assembled by pushing the spigot through the gasket into the socket of the mating component

3.14

mechanical flexible joint

flexible joint in which sealing is obtained by applying pressure to the gasket by mechanical means, e.g. a gland

3.15

restrained joint

joint in which a means is provided to prevent separation of the assembled joint

3.16

flanged joint

joint between two flanged ends

3.17

nominal size

DN/OD

alphanumeric designation of size for components of a pipework system, which is used for reference purposes

Note 1 to entry: It comprises the letters DN/OD followed by a dimensionless whole number which is indirectly related to the physical size, in millimetres, of the outside diameter of the end connections.

3.18

nominal size

DN

alphanumeric designation of size for components of a pipework system, which is used for reference purposes

Note 1 to entry: It comprises the letters DN followed by a dimensionless whole number, which is indirectly related to the physical size, in millimetres, of the bore or outside diameter of the end connections.

[ISO 16631:2016](http://www.iso.org/iso/16631)

[SOURCE: ISO 6708:1995, 2.1, modified] <http://www.iso.org/iso/16631>
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3.19

nominal pressure

PN

numerical designation expressed by a number which is used for reference purposes

Note 1 to entry: All components of the same nominal size DN/OD designated by the same PN number have compatible mating dimensions (see ISO 7268).

3.20

allowable operating pressure

PFA

maximum internal pressure, excluding surge, that a component can safely withstand in permanent service and designated, C

3.21

maximum allowable operating pressure

PMA

maximum internal pressure, including surge, that a component can safely withstand in service

3.22

allowable site test pressure

PEA

maximum hydrostatic pressure that a newly installed component can withstand for a relatively short duration, when either fixed above ground level or laid and backfilled underground, in order to measure the integrity and tightness of the pipeline

Note 1 to entry: This test pressure is different from the system test pressure which is related to the design pressure of the pipeline.

3.23**diametral stiffness of a pipe**

characteristic of a pipe which allows it to resist diametral deflection under loading

3.24**longitudinal bending resistance**

characteristic of a pipe which allows it to resist bending deformations under loading when installed

3.25**batch**

quantity of castings from which a sample may be taken for testing purposes during manufacture

3.26**type test**

proof-of-design test which is done once and is repeated only after change of design

3.27**laying length of a socket and spigot pipe**

laying length L_e , equal to the overall length of pipe (L_{tot}) minus the maximum spigot insertion depth (L_i) as given by the manufacturer and as shown in [Figure 4](#)

3.28**standardized length**

standardized length of socketed pipes and fittings (L_u or l_u for branches) is equal to the overall length L_{tot} minus the depth of socket (L_2) as indicated in the manufacturer's catalogues, as shown in [Figure 5](#) for pipes and [Figure 6](#) to [14](#) for fittings

3.29**spigot end**

maximum insertion depth of the spigot plus 50 mm

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3.30**deviation**

amount by which the design length may differ from the standardized length of a pipe or a fitting

Note 1 to entry: Pipes and fittings are designed to a length selected in the range of standardized length plus or minus the deviation. They are manufactured to this length plus or minus the tolerance (see [8.1.4](#)).

3.31**ovality**

out of roundness of a pipe section, equal to:

$$100 \frac{(A_1 - A_2)}{(A_1 + A_2)}$$

where

A_1 is the maximum axis of the pipe cross-section, in millimetres;

A_2 is the minimum axis of the pipe cross-section, in millimetres.

3.32**hoop stress**

σ

stress in a pipe or fitting under pressure, acting tangentially to the perimeter of a transverse section

3.33**thickness**

e_{nom}

nominal thickness of a pipe or a fitting

3.34

minimum thickness

nominal thickness of a pipe or a fitting minus the manufacturing tolerance

4 Technical requirements

4.1 General

General requirements, pressure classification and dimensional requirements, material characteristics, coatings and linings, marking and packaging and handling are specified in [4.2](#), [4.3](#), [4.4](#), [4.5](#), [4.6](#), [4.7](#) and [4.8](#), respectively.

When, by agreement between the manufacturer and the purchaser, pipes and fittings, with different pressure classes, lengths and/or coatings and other types of fittings are supplied with reference to this International Standard, they shall comply with all the other requirements of this International Standard.

4.2 General requirements

4.2.1 Pipes and fittings nominal sizes

The standardized nominal sizes DN/OD of pipes and fittings are as follows according to ISO 161-1:

— 50, 63, 75, 90, 110, 125, 140, 160, 180, 200 and 225.

4.2.2 Surface condition

Pipes, fittings and accessories shall be free from defects and surface imperfections which could impair their compliance with the requirements of [Clauses 4 and 5](#).

Repairs which affect the wall thickness are not allowed. Pipe whose wall thickness is below the local minimum thickness required, after repair, shall be rejected.

4.2.3 Types of joints and interconnection

4.2.3.1 General

Joint design and gasket shapes are beyond the scope of this International Standard.

Rubber gasket materials shall conform to the requirements of ISO 4633 for water applications. When materials other than rubber are necessary, they shall conform to the appropriate ISO standards.

4.2.3.2 Flexible joints

Pipes and fittings with flexible joints shall be in accordance with [4.3.2](#) for their spigot ends external diameters DE and their tolerances. This provides the possibility of interconnection between components equipped with different types of flexible joints. In addition, each type of flexible joint shall be designed to meet the leaktightness requirements of [Clause 5](#).

4.2.3.3 Restrained joints

Restrained joints for ductile iron pipelines shall be designed in accordance with ISO 10804. Their spigot ends external diameters DE and their tolerances shall comply with [4.3.2](#).

4.2.3.4 Flanged joints

4.2.3.4.1 General

Flanged joints designed according to this International Standard meet the performance requirements of ISO 2531.

By agreement between the manufacturer and supplier, special socketed pipes for welding can be identified and delivered.

4.2.3.4.2 All flanged pipes and fittings

Flanged pipe and flanged fittings, in which all connections ends are flanges, are in conformity with ISO 2531. Flanges are in conformity with ISO 7005-2.

NOTE No other specification to all flanged components will be given in this International Standard; reference documents are ISO 2531 and ISO 7005-2.

4.2.3.4.3 Fittings with DN/OD dimensions including flanges

Fittings including flanges shall be classified by PN number.

Flange joints shall be designed such that they can be attached to flanges whose dimensions and tolerances comply with ISO 7005-2. This ensures interconnection between all flanged components (pipes, fittings, valves, etc.) of the same flange DN and PN and adequate joint performance.

Bolts and nuts shall comply as a minimum with the requirements of ISO 4016 and ISO 4034, grade 4.6, where washers are required that they shall comply with ISO 7091.

Although it does not affect interconnection, the manufacturer shall indicate in his catalogue whether the products are normally delivered with fixed flanges or loose (or rotatable) flanges.

4.2.4 Materials in contact with water intended for human consumption

When used under the conditions for which they are designed, in permanent or in temporary contact with water intended for human consumption, ductile iron pipes, fittings and their joints shall not have detrimental effects on the properties of that water for its intended use.

Ductile iron pipeline systems, including pipes, fittings and accessories, are comprised of various materials. When used for conveying water intended for human consumption, the materials in contact with water shall meet the relevant requirements of the national standards or regulations in the country of use with respect to effect on water quality.

The following are the materials in contact with water:

- internal linings of the pipes and the fittings;
- internal linings of the socket of the pipes and fittings;
- external coating of the spigot, including the spigot end;
- external coating of the chamfer;
- gasket material.

4.3 Pressure classification and dimensional requirements

4.3.1 Pressure classification

4.3.1.1 General

Components with flexible joints shall be classified by the allowable operating pressure in bar (PFA), prefixed by the letter C.

Components with flanged joints shall be classified by the PN number of the flange.

4.3.1.2 Pressure class

The pressure class of components with flexible joints is C25.

Allowable pipeline pressures shall be as follows:

- allowable operating pressure (PFA) = C = 25 bar;
- maximum allowable operating pressure (PMA) = 1,2 × PFA = 30 bar;
- allowable site test pressure (PEA) = PMA + 5 = 35 bar.

4.3.1.3 Allowable pressures of components with flanged joints

Allowable pressures of components are as given in [Table 1](#).

Table 1 — Allowable pressures of components with flanged joints

Pressure class PN	Allowable operating pressure	Maximum allowable operating pressure	Allowable site test pressure
	PFA bar	PMA bar	PEA bar
10	10	12	17
16	16	20	25
25	25	30	35

Appropriate limitations shall be taken into account, which can prevent the full range of these pressures being used in an installed pipeline. For example, operation at the PFA values may be limited by the lower pressure capability of other pipeline components, e.g. flanged pipework, certain types of tees and specific designs of flexible joints. When other limitations exist due to the joint type or to any specific design arrangement, they shall be given in the manufacturer's handbook or catalogues.

4.3.2 Diameter

[Table 10](#) specifies the values of the external diameter, DE, and positive and negative tolerances of the spigot end of pipes, when measured as specified in [6.1.1](#).

The external diameter of the pipe barrel shall be such as to allow the assembly of the joint over at least two thirds of the pipe length from the spigot end to allow the pipe to be cut on site.

[Table 16](#) gives the values of the external diameter, DE, and positive and negative tolerances of the spigot end of flanged spigot fittings, when measured as specified in [6.1.1](#).

The values given in [Table 16](#), for flanged spigot, allow inserting spigot end in PVC and PE pipes sockets in compliance with ISO 1452-2 and ISO 4427-2. Ductile iron pipe spigot end in accordance with this International Standard shall not be directly inserted in PVC and PE pipes sockets in compliance with ISO 1452-2 and ISO 4427-2 (refer to [Annex F](#)).

4.3.3 Wall thickness

The wall thickness of the pipes shall be in conformity with [Table 11](#) and [Table 14](#) for fittings, when measured in accordance with [6.1.2](#).

The manufacturing tolerance on nominal pipe wall thickness shall be less than 0,8 mm. The minimum thickness can only appear locally at a few distinct points, not along the length or the circumference of the pipe.

The manufacturing tolerance on nominal fitting wall thickness shall be less than 1,0 mm.

NOTE These thicknesses are defined in order

- to reach the characteristics of C25 components as specified in [4.3.1.2](#) and using the design procedure specified in ISO 10803, and
- to manufacture components using the state of the art of casting technologies (refer to Bibliography).

4.3.4 Length

4.3.4.1 Socket and spigot pipes

Pipes shall be supplied to the standardized lengths given in [Table 12](#).

4.3.4.2 Fittings

Fittings shall be supplied to the lengths as given in [Tables 15](#) to [22](#) except that alternatively, socket fittings may be supplied to the lengths of the national standard of the country of manufacture.

4.3.5 Straightness of pipes

Pipes shall be straight, with a maximum deviation of 0,125 % of their length.

The verification of this requirement is normally carried out by visual inspection but in case of doubt or in case of dispute, the deviation shall be measured in accordance with [6.2](#).

4.4 Material characteristics

4.4.1 Tensile properties

Pipes, fittings and accessories made of ductile iron shall have the tensile properties given in [Table 2](#).

Table 2 — Tensile properties

Type of casting	Minimum tensile strength, R_m MPa	Minimum elongation after fracture, A %
Pipes centrifugally cast	420	10
Fittings	420	5

During the manufacturing process, the manufacturer shall carry out suitable tests to verify these tensile properties. These tests may either be

- a batch sampling system whereby samples are obtained from the pipe spigot or, for fittings, from samples cast separately or integrally with the casting concerned. Test bars shall be machined from these samples and tensile tested in accordance with [6.3](#), or
- a system of process control testing (e.g. non-destructive) where a positive correlation can be demonstrated with the tensile properties specified in [Table 2](#). Testing verification procedures shall