INTERNATIONAL STANDARD

ISO 2531

Fifth edition
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Ductile iron pipes, fittings, accessories and their joints for water or gas applications

Tuyaux, raccords et accessoires en fonte ductile et leurs assemblages pour l'eau ou le gaz

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Contents

Page

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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 2531 was prepared by Technical Committee ISO/TC 5, *Ferrous metal pipes and metallic fittings*, Subcommittee SC 2, *Cast iron pipes, fittings and their joints*.

This fifth edition cancels and replaces the fourth edition (ISO 2531:1991), of which it constitutes a technical revision. Its scope has been extended to include performance requirements and type testing of joints. Its style and presentation have been reviewed and improved.

Annexes A, B and C of this International Standard are for information only.

Ductile iron pipes, fittings, accessories and their joints for water or gas applications

1 Scope

This International Standard specifies the requirements and test methods applicable to ductile iron pipes, fittings, accessories and their joints for the construction of pipelines

— to convey water (e.g. potable water) or gas;

— operated with or without pressure;

— installed below or above ground.

NOTE — In this International Standard, all pressures are relative pressures expressed in bars[1)].

This International Standard gives specifications for materials, dimensions and tolerances, mechanical properties and standard coatings 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, of a size range extending from DN 40 to DN 2 600 inclusive.

It is applicable to pipes, fittings and accessories which are

— manufactured with socketed, flanged or spigot ends for jointing by means of various types of gaskets which are not within the scope of this International Standard;

— normally delivered internally and externally coated.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of the publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on the International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 4179:1985, *Ductile iron pipes for pressure and non-pressure pipelines — Centrifugal cement mortar lining — General requirements.*

ISO 4633:1996, *Rubber seals — Joint rings for water supply, drainage and sewerage pipelines — Specification for materials.*

1) 100 kPa = 1 bar

ISO 6447:1983, *Rubber seals — Joint rings used for gas supply pipes and fittings — Specification for material.*

ISO 6506-1:— [2], *Metallic materials — Hardness testing — Brinell test — Part 1: Test method.*

ISO 6708:1995, *Pipeworks components — Definition and selection of DN (nominal size).*

ISO 7005-2:1988, *Metallic flanges — Part 2: Cast iron flanges.*

ISO 7268:1983, *Pipe components — Definition of nominal pressure.*

ISO 7268/Amd 1:1984, Amendment 1 to ISO 7268:1983.

ISO 7483:1991, *Dimensions of gaskets for use with flanges to ISO 7005.*

ISO 8179-1:1995, *Ductile iron pipes — External coating — Part 1: Metallic zinc with finishing layer.*

ISO 8179-2:1995, *Ductile iron pipes — External coating — Part 2: Zinc rich paint with finishing layer.*

ISO 8180:1985, *Ductile iron pipes — Polyethylene sleeving.*

ISO 10804-1:1996, *Restrained joint systems for ductile iron pipelines — Part 1: Design rules and type testing.*

EN 1092-2:1997, *Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 2: Cast iron flanges.*

3 Definitions

For the purposes of this International Standard, the following definitions apply:

3.1 ductile iron: Type of 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. In addition, flanged sockets, flanged spigots and collars are also classified as fittings.

3.4 accessory: Any casting other than a pipe or fitting, which is used in a pipeline, such as:

— glands and bolts for mechanical flexible joints (see 3.13);

— glands, bolts and locking rings or segments for restrained joints (see 3.14).

NOTE — Valves and hydrants of all types are not covered by the term accessory.

3.5 flange: flat, circular end of a pipe or fitting, extending perpendicular to its axis, with bolt holes equally spaced on a circle.

NOTE — 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.

3.6 collar; coupling: Connecting piece used to join together the spigots of mating pipes or fittings.

2) To be published. (Revision of ISO 6506:1981 and ISO 410:1982)

3.7 spigot: Male end of a pipe or fitting.

3.8 socket: Female end of a pipe or fitting to make the joint with the spigot of an adjacent component.

3.9 gasket: Sealing component of a joint.

3.10 joint: Connection between the ends of pipes and/or fittings in which a gasket is used to effect a seal.

3.11 flexible joint: Joint which provides significant angular deflection and movement parallel and/or perpendicular to the pipe axis.

3.12 push-in flexible joint: Flexible joint assembled by pushing the spigot through the gasket into the socket of the mating component.

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

3.14 restrained joint: Joint in which a means is provided to prevent separation of the assembled joint.

3.15 flanged joint: Joint between two flanged ends.

3.16 nominal size (DN): Numerical designation of size which is common to all components in a piping system. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions (see ISO 6708).

3.17 nominal pressure (PN): Numerical designation expressed by a number which is used for reference purposes. All components of the same nominal size DN designated by the same PN number have compatible mating dimensions (see ISO 7268 and its Amendment 1).

3.18 allowable operating pressure (PFA): Internal pressure, excluding surge, that a component can safely withstand in permanent service.

3.19 allowable maximum operating pressure (PMA): Maximum internal pressure, including surge, that a component can safely withstand in service.

3.20 allowable 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 — This test pressure is different from the system test pressure (STP), which is related to the design pressure of the pipeline and is intended to ensure its integrity and leaktightness.

3.21 diametral stiffness of a pipe: Characteristic of a pipe which allows it to resist diametral deflection under loading.

3.22 batch: Quantity of castings from which a sample may be taken for testing purposes during manufacture.

3.23 type test: Proof-of-design test which is done once and is repeated only after change of design.

3.24 length: Effective length of a pipe or fitting, as shown in the figures in clause 8.

NOTE — For flanged pipes and fittings, the effective length L (l for branches) is equal to the overall length. For socketed pipes and fittings, the effective length L_u (l_u for branches) is equal to the overall length minus the spigot insertion depth as indicated in the manufacturer's catalogues.

3.25 deviation: Amount by which the design length may differ from the standardized length of a pipe or a fitting.

NOTE — Pipes and fittings are designed to a length selected in the range of standard length plus or minus the deviation (see table 4); they are manufactured to this length plus or minus the tolerance given in table 5.

3.26 ovality: Out of roundness of a pipe section, equal to

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

where

A_1 is the maximum axis, in millimetres, and

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

4 Technical requirements

4.1 General

4.1.1 Pipes and fittings

Nominal sizes, thicknesses, lengths and coatings are specified in 4.1.1, 4.2.2, 4.2.3, 4.4 and 4.5, respectively. When, by agreement between manufacturer and purchaser, pipes and fittings with different lengths, thicknesses and/or coatings, and other types of fittings than those given in 8.3 and 8.4 are supplied according to this International Standard, they shall comply with all the other requirements of this International Standard.

The standard nominal sizes DN of pipes and fittings are the following:

40, 50, 60, 65, 80, 100, 125, 150, 200, 250, 300, 350, 400, 450, 500, 600, 700, 800, 900, 1 000, 1 100, 1 200, 1 400, 1 500, 1 600, 1 800, 2 000, 2 200, 2 400, 2 600.

The functional properties of ductile iron pipes are those given in annex C.

The pressures PFA, PMA and PEA (see 3.18, 3.19 and 3.20) are those indicated in the national standards or regulations.

NOTE — When installed and operated under the conditions for which they are designed (see annexes A and B), ductile iron pipes, fittings, accessories and their joints maintain all their functional characteristics over their operating life, due to constant material properties, to the stability of their cross-section and to their design with high safety factors.

4.1.2 Surface condition and repairs

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.

When necessary, pipes and fittings may be repaired, for example by welding, to remove surface imperfections and localized defects which do not affect the entire wall thickness, provided that the repaired pipes and fittings comply with all the requirements of clauses 4 and 5.

4.1.3 Types of joints and interconnection

4.1.3.1 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 and ISO 6447 for gas applications. When materials other than rubber are necessary (e.g. for flanged joints), they shall conform to the appropriate ISO standards.

4.1.3.2 Flanged joints

The dimensions and tolerances of the flanges of pipes and fittings shall comply with ISO 7005-2 or EN 1092-2 and flange gaskets with ISO 7483. This ensures interconnection between all flanged components (pipes, fittings, valves, etc.) of the same DN and PN and adequate joint performance.

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

4.1.3.3 Flexible joints

Pipes and fittings with flexible joints shall be in accordance with 4.2.1.1 for their spigot 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 performance requirements of 5.2.

NOTES

1 For interconnection with certain types of joints operating within a tighter tolerance range on DE, the manufacturer's guidance should be followed as to the means of ensuring adequate joint performance up to the highest pressures (e.g. measurement and selection of external diameter).

2 For interconnection with existing pipelines which can have external diameters not in accordance with 4.2.1.1, the manufacturer's guidance will be followed as to the appropriate means of interconnection (e.g. adaptors).

4.1.3.4 Restrained joints

Restrained joints for ductile iron pipelines shall be designed in accordance with ISO 10804-1. Their spigot external diameters DE and their tolerances shall comply with 4.2.1.1.

4.1.4 Materials in contact with potable water

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.

NOTE — When applicable, refer to national standards or regulations on the effects of materials on the quality of water.

4.2 Dimensional requirements

4.2.1 Diameter

4.2.1.1 Outer diameter

Table 11 in 8.1 specifies the values of the outer diameter DE of the spigot end of pipes and fittings, when measured circumferentially using a circumferential tape in accordance with 6.1.1. The positive tolerance is + 1 mm and applies to all thickness classes of pipes and also to flanged-spigot fittings.

The negative tolerance depends on the design of each type of joint and shall be as specified in national standards, or, when not so specified, in manufacturers' catalogues, for the type of joint and the nominal size considered.

In addition, the ovality (see 3.26) of the spigot end of pipes and fittings shall

— remain within the tolerances on DE for DN 40 to 200;

— not exceed 1 % of DE for DN 250 to DN 600 or 2 % for DN > DN 600.

NOTE — The manufacturer's recommendations should be followed with respect to the necessity and means of ovality correction; certain types of flexible joints can accept the maximum ovality without the need for spigot re-rounding prior to jointing.

4.2.1.2 Inner diameter

The nominal values of the inner diameters of centrifugally cast pipes, expressed in millimetres, are approximately equal to the numbers indicating their nominal sizes DN.

4.2.2 Wall thickness

The nominal iron wall thickness of pipes and fittings shall be calculated as a function of the nominal size, DN, by the following formula, with a minimum of 6 mm for centrifugally cast pipes and 7 mm for pipes not centrifugally cast and fittings:

$$e = K\,(0{,}5 + 0{,}001\ DN)$$

where

e is the nominal wall thickness, in millimetres;

DN is the nominal size;

K is a coefficient used for thickness class designation. It is selected from a series of whole numbers: 7, 8, 9, 10, 11, 12, ...

The standardized thickness classes of pipes are given in 8.1 and 8.2; other thicknesses are possible for pipes by agreement between manufacturer and purchaser.

For fittings, the thickness e, given in tables and in figures in 8.3 and 8.4, is the nominal thickness corresponding to the main part of the body. The actual thickness at any particular point shall be increased where necessary to meet localized high stresses depending on the size and shape of the casting (e.g. at inner radius of bends, at the branch-body junction of tees, etc.).

The tolerances on nominal wall thickness of pipes and fittings shall be as given in table 1. The measurement of wall thickness shall be in accordance with 6.1.2.

Table 1

Dimensions in millimetres

Type of casting	e	Tolerance[1)]
Pipes centrifugally cast	6	– 1,3
	> 6	– (1,3 + 0,001 DN)
Pipes not centrifugally cast and fittings	7	– 2,3
	> 7	– (2,3 + 0,001 DN)

1) A negative tolerance only is given so as to ensure sufficient resistance to internal pressure.

4.2.3 Length

4.2.3.1 Lengths of socket and spigot pipes

Pipes shall be supplied to the lengths given in table 2.

Table 2

Dimensions in metres

DN	Standardized lengths, L_u[1)]
40 and 50	3
60 to 600	4 or 5 or 5,5 or 6 or 9
700 and 800	4 or 5,5 or 6 or 7 or 9
900 to 2 600	4 or 5 or 5,5 or 6 or 7 or 8,15 or 9
NOTE — Not all the standardized lengths are available in all countries.	
1) See 3.24.	

The manufacturers' design lengths L_u (see 3.24) shall be within a deviation (see 3.25) of ± 250 mm with respect to the lengths given in table 2 and shall be given in their catalogues. The actual length L_u shall be measured in accordance with 6.1.3 and shall not differ from the manufacturer's design length by more than the tolerance given in table 5. Of the total number of socket and spigot pipes to be supplied in each diameter, the percentage of shorter pipes shall not exceed 10 %.

NOTES

1 Pipes cut for test purposes may be excluded from the 10 % limitation and treated as full length pipes.

2 When pipes are ordered on a meterage basis, the manufacturer may determine the required quantity of pipes to be supplied by the summation of the measured individual pipe effective lengths.

4.2.3.2 Lengths of flanged pipes

The lengths of flanged pipes shall be as given in table 3. Other lengths are available by agreement between manufacturer and purchaser.

Table 3

Dimensions in metres

Type of pipe	DN	Standardized lengths, L[1)]
With cast-on flanges	40 to 2 600	0,5 or 1 or 2 or 3
With screwed-on or welded-on flanges	40 to 600	2 or 3 or 4 or 5
	700 to 1 000	2 or 3 or 4 or 5 or 6
	1 100 to 2 600	4 or 5 or 6 or 7
1) See 3.24.		

4.2.3.3 Lengths of fittings

Fittings shall be supplied to the lengths as given in 8.3 and 8.4.

NOTE — Two series of dimensions are shown, the series A and the new series B, generally limited up to DN 450 at this stage.

The permissible deviations (see 3.25) on the lengths of series A fittings shall be as given in table 4.

Table 4

Dimensions in millimetres

Type of fitting	DN	Deviation
Flanged sockets Flanged spigots Collars, tapers	40 to 1 200 1 400 to 2 600	± 25 ± 35
Tees	40 to 1 200 1 400 to 2 600	+ 50 – 25 + 75 – 35
Bends 90° (1/4)	40 to 2 600	± (15 + 0,03 DN)
Bends 45° (1/8)	40 to 2 600	± (10 + 0,025 DN)
Bends 22° 30' (1/16) and 11° 15' (1/32)	40 to 1 200 1 400 to 2 600	± (10 + 0,02 DN) ± (10 + 0,025 DN)

4.2.3.4 Tolerances on lengths

The tolerances on lengths shall be as given in table 5.

Table 5

Dimensions in millimetres

Type of casting	Tolerance
Socket and spigot pipes (full length or shortened)	± 30
Fittings for socketed joints	± 20
Pipes and fittings for flanged joints	± 10[1)]
1) By agreement between manufacturer and purchaser, smaller tolerances are possible, but not less than ± 3 mm for DN ⩽ 600 and ± 4 mm for DN > 600.	

4.2.4 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 dispute the deviation shall be measured in accordance with 6.2.

4.3 Material characteristics

4.3.1 Tensile properties

Pipes, fittings and accessories made of ductile iron shall have the tensile properties given in table 6.

During the manufacturing process the manufacturer shall carry out suitable tests to verify these tensile properties; these tests may be

a) either 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

b) a system of process control testing (e.g. non-destructive) where a positive correlation can be demonstrated with the tensile properties specified in table 6. Testing verification procedures shall be based on the use of comparitor samples having known and verifiable properties. This system of testing shall be supported by tensile testing in accordance with 6.3.

Table 6

Type of casting	Minimum tensile strength, R_m MPa	Minimum elongation percent after fracture, A	
	DN 40 to DN 2 600	DN 40 to DN 1 000	DN 1 100 to DN 2 600
Pipes centrifugally cast	420	10	7
Pipes not centrifugally cast, fittings and accessories	420	5	5

NOTES

1 By agreement between manufacturer and purchaser, the 0,2 % proof stress ($R_{p\,0,2}$) may be measured. It shall be not less than:

270 MPa when A ⩾ 12 % for DN 40 to 1 000 or A ⩾ 10 % for DN > 1 000;

300 MPa in other cases.

2 For centrifugally cast pipes of DN 40 to DN 1 000, the minimum elongation after fracture shall be 7 % for thickness classes greater than K12.

4.3.2 Brinell hardness

The hardness of the various components shall be such that they can be cut, tapped, drilled and/or machined with standard tools. In case of dispute, the hardness shall be measured according to 6.4.

The Brinell hardness shall not exceed 230 HB for centrifugally cast pipes and 250 HB for not centrifugally cast pipes, fittings and accessories. For components manufactured by welding, a higher Brinell hardness is allowed in the heat-affected zone of the weld.

4.4 Coating and linings for pipes

Pipes shall normally be delivered internally and externally coated.

4.4.1 External coatings

Depending on the external conditions of use (see annex A) and taking into account existing national standards, the following coatings may be supplied:

— metallic zinc with finishing layer, in accordance with ISO 8179-1;

— zinc rich paint with finishing layer, in accordance with ISO 8179-2;

— thicker metallic zinc with finishing layer;

— polyethylene sleeving, in accordance with ISO 8180;

— polyurethane;

— polyethylene;

— fibre cement mortar;

— adhesive tapes;

— bituminous paint;

— epoxy.

When ISO standards do not exist, these coatings shall comply with national standards, or with an agreed technical specification.

4.4.2 Internal linings

Depending on the internal conditions of use (see annex B) and taking into account existing national standards, the following linings may be supplied:

— Portland cement (with or without additives) mortar, in accordance with ISO 4179;

— high alumina (calcium aluminate) cement mortar, in accordance with ISO 4179;

— blast furnace slag cement mortar, in accordance with ISO 4179;

— cement mortar with seal-coat;

— polyurethane;

— polyethylene;

— epoxy;

— bituminous paint.

When ISO standards do not exist, these linings shall comply with national standards, or with an agreed technical specification.

4.5 Coatings and linings for fittings and accessories

Fittings and accessories shall normally be delivered internally and externally coated.

4.5.1 External coatings

Depending on external conditions of use (see annex A) and taking into account existing national standards, the following coatings may be supplied:

— bituminous paint or synthetic resin paint;

— epoxy;

— zinc with finishing layer;

— polyethylene sleeving, in accordance with ISO 8180;

— polyurethane;

— adhesive tapes.

When ISO standards do not exist, these coatings shall comply with national standards, or with an agreed technical specification.

4.5.2 Internal linings

Depending on the internal conditions of use (see annex B) and taking into account existing national standards, the following linings may be supplied:

— bituminous paint or synthetic resin paint;

— Portland cement (with or without additives) mortar;

— high alumina (calcium aluminate) cement mortar;

— blast furnace slag cement mortar;

— cement mortar lining with seal-coat;

— polyurethane;

— polyethylene;

— epoxy.

When ISO standards do not exist, these linings shall comply with national standards, or with an agreed technical specification.

4.6 Marking

All pipes and fittings shall be durably and legibly marked and shall bear at least the following indications:

— the manufacturer's name or mark;

— the identification of the year of manufacture;

— the identification as ductile iron;

— the DN;

— the PN rating of flanges when applicable;

— the reference to this International Standard;

— the identification of pipes which have been tested for gas applications.

The first five markings above shall be cast-on or cold stamped. The last two indications can be applied by any method, e.g. painted on the castings or attached to the packaging.

5 Leaktightness requirements

5.1 Pipes and fittings

Pipes and fittings shall be designed to be leaktight at their allowable test pressure (PEA). They shall be tested in accordance with 6.5 or 6.6, as applicable, and shall exhibit no visible leakage, sweating or any other sign of failure.

5.2 Flexible joints

5.2.1 General

All flexible joints for ductile iron pipes and components shall be designed in compliance with the requirements of 5.2. If the design has been tested and documented by the manufacturer and successfully used for a minimum of ten years, the performance of a type test in accordance with 5.2.2 for internal pressure and in accordance with 5.2.3 for external pressure is only required for significant changes in design which could adversely affect the performance of the joint.

Joint designs shall be type tested to demonstrate leaktightness to both internal and external pressure under the most unfavourable conditions of castings tolerances and joint movements.

There shall be a type test for at least one DN for each of the groupings given in table 7. One DN is representative of a grouping when the performances are based on the same design parameters throughout the size range.

Table 7

DN groupings	40 to 250	300 to 600	700 to 1 000	1 100 to 2 000	2 200 to 2 600
Preferred DN in each grouping	200	400	800	1 600	2 400

If a grouping covers products of different designs and/or manufactured by different processes, the grouping shall be subdivided.

NOTE — If for a manufacturer a grouping contains only one DN, this DN may be considered as part of the adjacent grouping provided that it is of identical design and manufactured by the same process.

The type tests shall be carried out in the configuration of maximum design radial gap between the components to be jointed (smallest spigot together with largest socket).

In the type test, the maximum gap shall be equal to the maximum design radial gap with a tolerance of plus 0 % minus 5 %. The internal socket diameter may be machined to achieve this, even if the resulting diameter is slightly outside the normal manufacturing tolerance.

Restrained flexible joints shall be designed and tested in accordance with ISO 10804-1.

5.2.2 Internal pressure

The leaktightness of joints to internal pressure shall be type tested in accordance with 7.1 at a test pressure which shall be not less than their declared allowable test pressure PEA; the joints shall exhibit no visible leakage in the two following positions:

a) joint aligned and subjected to shear: the shear force across the joint, expressed in N, shall be not less than 30 times DN;

b) joint deflected: the test angular deflection shall be the maximum allowable deflection indicated in the manufacturer's catalogue, but not less than 3° for DN 40 to DN 300, 2° for DN 350 to DN 600, 1° for DN 700 to DN 2 600.

5.2.3 External pressure

The leaktightness of joints to external pressure shall be type tested in accordance with 7.2; the joints shall exhibit no visible leakage when subjected to a shear load, expressed in newtons, not less than 30 times DN.

The test pressure shall be not less than 1 bar.

6 Test methods

6.1 Dimensions

6.1.1 External diameter

Pipes with sockets and spigot ends shall be measured at their spigot end by means of a circumferential tape for compliance with the outer diameter tolerance. They can also be verified by means of pass-fail gauges.

In addition, the pipes shall be visually inspected at their spigot end for compliance with the ovality tolerance and, in case of doubt, checked by measurement of the maximum and minimum axes. This control may also be carried out by pass-fail gauges.

The frequency of testing is related to the system of production and quality control used by the manufacturer.

6.1.2 Wall thickness

Pipe wall thickness compliance shall be demonstrated by the manufacturer; he may use a combination of various means, such as:

— pipe weight control;

— direct wall thickness measuring or gauging by suitable equipment, such as mechanical or ultrasonic equipment.

The frequency of testing is related to the system of production and quality control used by the manufacturer.

6.1.3 Length

The length of centrifugally cast pipes with sockets and spigot ends shall be measured by means of suitable equipment

— on the first pipe cast from a new mold, for full length pipes;

— on the first cut pipe, for pipes which are systematically cut to a predetermined length.

6.2 Straightness of pipes

The pipe shall be rolled on two supports or rotated along its axis on rollers, which in each case are separated by at least two thirds of the standard pipe length.

The point of maximum deviation from the true axis shall be determined, and the deviation measured at that point shall not exceed the limit fixed in 4.2.4.

6.3 Tensile test

6.3.1 Sampling

The thickness of the sample and the diameter of the test bar shall be as indicated in table 8.

6.3.1.1 Centrifugally cast pipes

A sample shall be cut from the spigot end of the pipe. This sample may be cut perpendicular to or parallel with the pipe axis, but in case of dispute the parallel to axis sample shall be used.

6.3.1.2 Pipes not centrifugally cast, fittings and accessories

Samples shall be taken, at the manufacturer's option, either from an integrally cast sample, from a sample attached to the casting, or from a sample cast separately. In the latter case, it shall be cast from the same metal as that used for the casting. If the casting is subjected to heat treatment, the sample shall be subjected to the same heat treatment.

6.3.2 Test bar

A test bar shall be machined from each sample to be representative of the metal at the mid-thickness of the sample, with a cylindrical part having the diameters given in table 8.

The test bars shall have a gauge length at least five times the nominal test bar diameter. The ends of the test bars shall be such that they will fit the testing machine.

The surface roughness of the machined gauge length of the test bar shall be such that $R_z \leqslant 6{,}3$.

Two methods of measuring the tensile strength may be used at the manufacturer's option:

Method A:

Produce the test bar to a nominal diameter ± 10 %, measure the actual diameter before the test with an accuracy of ± 0,01 mm and use this measured diameter to calculate the cross-sectional area and the tensile strength; or

Method B:

Produce the test bar to a nominal area S_0 within a specified tolerance on the diameter (see table 8) and use the nominal area to calculate the tensile strength.

Table 8

Type of casting	Test bar method A	Test bar, method B		
	Nominal diameter mm	Nominal area S_0 mm²	Nominal diameter mm	Tolerance on diameter mm
Centrifugally cast pipes with wall thickness of				
less than 6 mm	2,5	5	2,52	± 0,01
6 mm, up to but not including 8 mm	3,5	10	3,57	± 0,02
8 mm, up to but not including 12 mm	5	20	5,05	± 0,02
12 mm and over	6	30	6,18	± 0,03
Pipes, fittings and accessories not centrifugally cast:				
integrally cast samples	5	20	5,05	± 0,02
separately cast sample:				
thickness 12,5 mm for casting thickness less than 12 mm	6	30	6,18	± 0,03
thickness 25 mm for casting thickness 12 mm and over	12 or 14	—	—	—

6.3.3 Equipment and test method

The tensile testing machine shall have suitable holders or grips to attach to the test bar ends so as to positively apply the test load axially. The testing machine shall have a force range suitable for testing the bars to failure whilst indicating the load applied.

The rate of stressing shall be as constant as possible within the limits of 6 N/mm² per second to 30 N/mm² per second.

The tensile strength shall be calculated by dividing the maximum force sustained by the test bar by the cross-sectional area of the test bar before testing. The elongation shall be measured by piecing together the broken parts of the test bar and taking the ratio of the extended gauge length to the original gauge length. Alternatively, the elongation may be measured directly by means of an extensometer.

6.3.4 Test results

Test results shall comply with table 6. If they do not comply, the manufacturer shall

a) in the case where the metal does not achieve the required mechanical properties, investigate the reason and ensure that all castings in the batch are either re-heat-treated or rejected; castings which have been re-heat-treated are then re-tested in accordance with 6.3;

b) in the case of a defect in the test bar, carry out a further test. If it passes, the batch is accepted; if not, the manufacturer has the option to proceed in accordance with a) above.

NOTE — The manufacturer may limit the amount of rejection by making additional tests, in order of manufacture, until the rejected batch of castings is bracketed by a successful test at each end of the interval in question.

6.3.5 Test frequency

The frequency of testing is related to the system of production and quality control used by the manufacturer (see 4.3.1). The maximum batch sizes shall be as given in table 9.

Table 9

Type of casting	DN	Maximum batch size	
		Batch sampling system	Process control testing system
Centrifugally cast pipes	40 to 300 350 to 600 700 to 1 000 1 100 to 2 600	200 pipes 100 pipes 50 pipes 25 pipes	1 200 pipes 600 pipes 300 pipes 150 pipes
Pipes not centrifugally cast, fittings and accessories	All sizes	4 t[1)]	48 t[1)]

1) Mass of crude castings, excluding risers.

6.4 Brinell hardness

When Brinell hardness tests are carried out (see 4.3.2), they shall be performed either on the casting in dispute or on a sample cut from the casting. The surface to be tested shall be suitably prepared by slight local grinding, and the test shall be carried out in accordance with ISO 6506-1 using a steel ball of 2,5 mm or 5 mm or 10 mm diameter.

6.5 Works leaktightness test of pipes and fittings for water applications

6.5.1 General

Pipes and fittings shall be tested in accordance with 6.5.2 and 6.5.3 respectively. The test shall be carried out on all pipes and fittings before the application of their external and internal coatings, except for the metallic zinc coating of pipes which may be applied before the test.

The test apparatus shall be suitable for applying the specified test pressures to the pipes and/or fittings. It shall be equipped with a pressure gauge having an accuracy of ± 3 %.

6.5.2 Centrifugally cast pipes

Centrifugally cast pipes shall be subjected to a works hydrostatic test for a duration of at least 10 s at the minimum internal test pressures given in table 10.

6.5.3 Pipes not centrifugally cast and fittings

At the manufacturer's option, they shall be submitted to a hydrostatic pressure test, or to an air test, or to any other leaktightness test of equivalent performance.

When the hydrostatic pressure test is carried out, it shall be in the same way as for centrifugally cast pipes (see 6.5.2), except for the test pressures, which shall be as given in table 10.

When the air test is carried out it shall be with an internal pressure of at least 1 bar and an inspection time not less than 10 s; for leak detection, the castings shall be either uniformly coated on the external surface by a suitable foaming agent or submerged in water.

Table 10

DN	Minimum works test pressure bar		
	Pipes centrifugally cast		Pipes not centrifugally cast and fittings[1]
	$K < 9$	$K \geqslant 9$	All thickness classes
40 to 300	$0,5\ (K + 1)^2$	50	25[2]
350 to 600	$0,5\ K^2$	40	16
700 to 1 000	$0,5\ (K - 1)^2$	32	10
1 100 to 2 000	$0,5\ (K - 2)^2$	25	10
2 200 to 2 600	$0,5\ (K - 3)^2$	18	10

1) The works hydrostatic test pressure for fittings is less than that for pipes because the shape of the fittings makes it difficult to provide sufficient restraint to high internal pressures during the test.

2) 16 bar for pipes and fittings with PN 10 flanges.

6.6 Works leaktightness test of pipes and fittings for gas applications

Pipes and fittings shall be subjected to an air test with an internal pressure of at least 1 bar and an inspection time not less than 10 s for fittings and 30 s for pipes. For leak detection, pipes and fittings are submerged in water or uniformly coated on their external surface by a suitable foaming agent.

NOTE — National regulations may specify special safety requirements which must be observed during air testing.

7 Type tests

7.1 Leaktightness of joints to internal pressure

This type test shall be carried out on an assembled joint comprising two pipe sections at least 1 m long each (see figure 1).

The test apparatus shall be capable of providing suitable end restraints, whether the joint is in the aligned position, or deflected, or subjected to a shear load. It shall be equipped with a pressure gauge having an accuracy of ± 3 %.

The shear load W shall be applied to the spigot end by means of a V-shaped block with an angle of 120°, located at approximately $0,5 \times$ DN in millimetres or 200 mm from the socket face (whichever is the largest); the socket shall bear on a flat support. The load W shall be such that the resultant shear force F across the joint is equal to the value specified in 5.2.2, taking into account the mass M of the pipe and its contents and the geometry of the test assembly:

$$W = \frac{F \times c - M(c - b)}{c - a}$$

where

W, F and M are expressed in newtons;

a, b and c are given in figure 1.

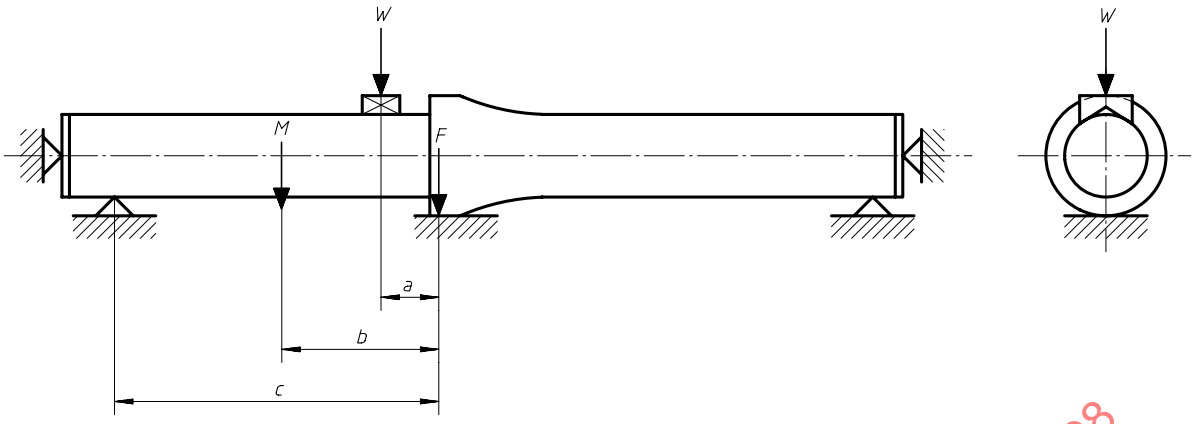

Figure 1

The test assembly shall be filled with water and suitably vented of air, except for gas applications, where the joints shall be tested with air. The pressure shall be raised steadily until it reaches the test pressure given in 5.2.2; the rate of pressure increase shall not exceed 1 bar/s. The test pressure shall be kept constant within ± 0,5 bar for at least 2 h during which the joint shall be thoroughly inspected every 15 min.

7.2 Leaktightness of joints to external pressure

This type test assembly, which applies only to push-in flexible joints, shall comprise two joints made with two pipe sockets connected together and one double-spigot piece so as to create an annular chamber allowing to test one joint under internal pressure and one joint under external pressure (see figure 2).

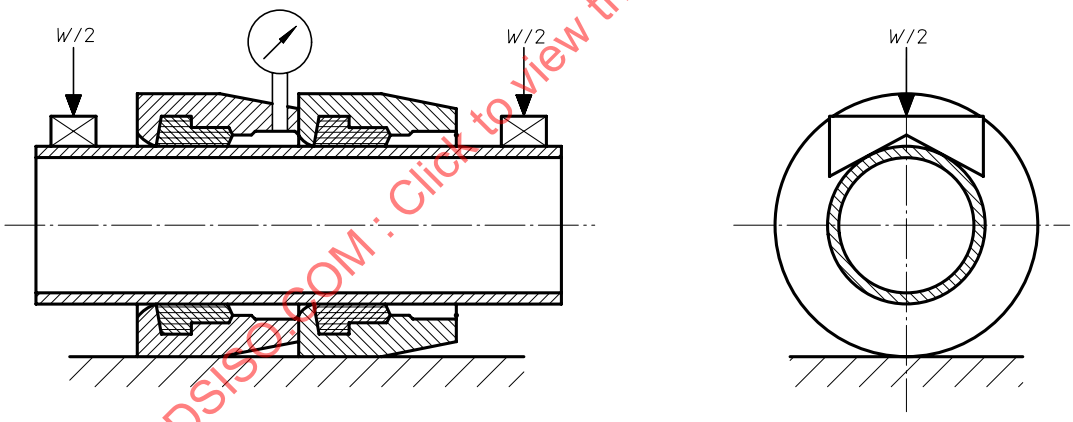

Figure 2

The test assembly shall be subjected to the shear load defined in 5.2.3; one half of this load shall be applied to the spigot end on each side of the test assembly, by means of a V-shaped block with an angle of 120°, located at approximately $0,5 \times DN$ in millimetres or 200 mm from the end of sockets (whichever is the largest); the sockets shall bear on a flat support.

The test assembly shall then be filled with water and suitably vented of air. The pressure shall be steadily increased until it reaches the test pressure given in 5.2.3 and then kept constant within ± 0,1 bar for at least 2 h, during which the internal side of the joint subjected to external pressure shall be thoroughly inspected every 15 min.

8 Tables of dimensions

8.1 Socket and spigot pipes

The dimensions of socket and spigot pipes shall be as shown in figure 3 and as given in table 11.

The values of L_u are given in table 2. For external and internal coatings, see 4.4.

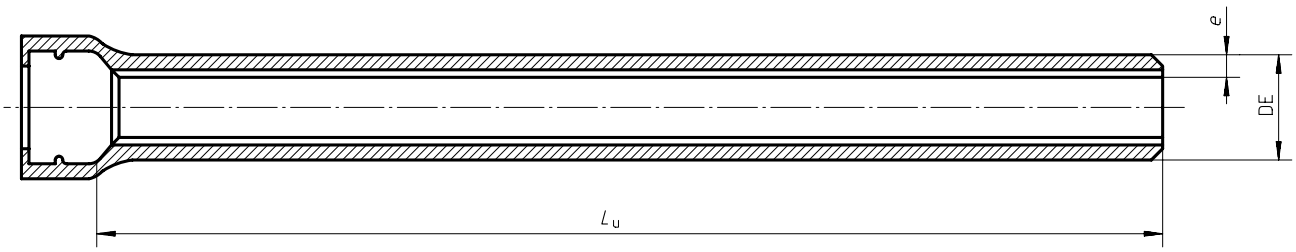

Figure 3

Table 11

Dimensions in millimetres

DN	External diameter DE[1)]	Iron wall thickness, *e*, K9
40	56	6
50	66	6
60	77	6
65	82	6
80	98	6
100	118	6
125	144	6
150	170	6
200	222	6,3
250	274	6,8
300	326	7,2
350	378	7,7
400	429	8,1
450	480	8,6
500	532	9
600	635	9,9
700	738	10,8
800	842	11,7
900	945	12,6
1 000	1 048	13,5
1 100	1 152	14,4
1 200	1 255	15,3
1 400	1 462	17,1
1 500	1 565	18
1 600	1 668	18,9
1 800	1 875	20,7
2 000	2 082	22,5
2 200	2 288	24,3
2 400	2 495	26,1
2 600	2 702	27,9

1) A tolerance of + 1 mm applies (see 4.2.1.1).

8.2 Flanged pipes

Standardized thickness classes, DNs and PNs of flanged pipes are specified in 8.2.1 to 8.2.3. The values of *L* are given in table 3. For coatings and linings, see 4.4.

NOTE — Dimensions of flanges are in conformity with ISO 7005-2 and EN 1092-2.

8.2.1 Centrifugally cast pipes with welded-on flanges

DN 40	to	DN 450:	K9 for PN 10, PN 16, PN 25 and PN 40
DN 500	and	DN 600 :	K9 for PN 10, PN 16 and PN 25; K 10 for PN 40
DN 700	to	DN 1 600:	K9 for PN 10, PN 16 and PN 25
DN 1 800	to	DN 2 600:	K9 for PN 10 and PN 16

8.2.2 Centrifugally cast pipes with screwed-on flanges

DN 40	to	DN 450:	K9 or K10 for PN 10, PN 16, PN 25 and PN 40
DN 500	and	DN 600:	K9 or K10 for PN 10, PN 16 and PN 25; K10 for PN 40
DN 700	to	DN 1 200:	K10 for PN 10, PN 16 and PN 25
DN 1 400	to	DN 2 600:	K10 for PN 10 and PN 16

8.2.3 Pipes with integrally cast flanges

DN 40	to	DN 600:	K12 for PN 10, PN 16, PN 25 and PN 40
DN 700	to	DN 1 600:	K12 for PN 10, PN 16 and PN 25
DN 1 800	to	DN 2 600:	K12 for PN 10 and PN 16

8.3 Fittings for socketed joints

In tables 12 to 20, all the dimensions are nominal values and are given in millimetres. The values of L_u and l_u have been rounded off to the nearest multiple of five.

For coating and linings, see 4.5.

8.3.1 Flanged sockets

See figure 4 and table 12.

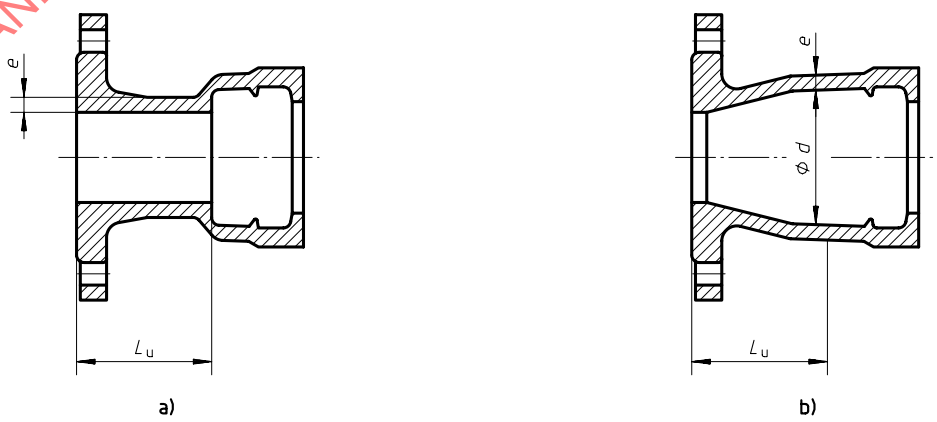

Figure 4

Table 12

DN	*e*	L_u		*d*
		Series A	Series B	
40	7	125	75	67
50	7	125	85	78
60	7	125	100	88
65	7	125	105	93
80	7	130	105	109
100	7,2	130	110	130
125	7,5	135	115	156
150	7,8	135	120	183
200	8,4	140	120	235
250	9	145	125	288
300	9,6	150	130	340
350	10,2	155	135	393
400	10,8	160	140	445
450	11,4	165	145	498
500	12	170	—	550
600	13,2	180	—	655
700	14,4	190	—	760
800	15,6	200	—	865
900	16,8	210	—	970
1 000	18	220	—	1 075
1 100	19,2	230	—	1 180
1 200	20,4	240	—	1 285
1 400	22,8	310	—	1 477
1 500	24	330	—	1 580
1 600	25,2	330	—	1 683
1 800	27,6	350	—	1 889
2 000	30	370	—	2 095
2 200	32,4	390	—	2 301
2 400	34,8	410	—	2 507
2 600	37,2	480	—	2 713

8.3.2 Flanged spigots

See figure 5 and table 13.

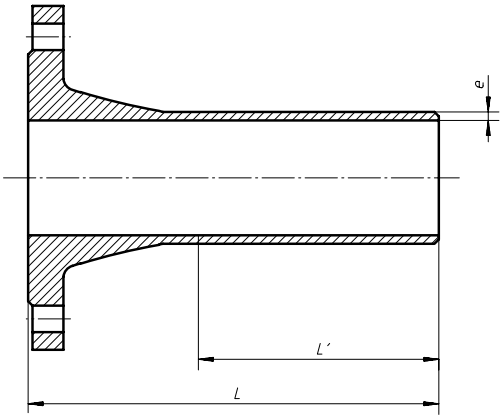

Figure 5

8.3.3 Collars

See figure 6 and table 13.

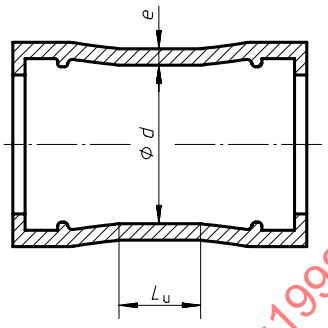

Figure 6

Table 13

DN	e	Flanged spigots			Collars		
		L		L'	L_u		d
		Series A	Series B		Series A	Series B	
40	7	335	335	200	155	155	67
50	7	340	340	200	155	155	78
60	7	345	345	200	155	155	88
65	7	345	345	200	155	155	93
80	7	350	350	215	160	160	109
100	7,2	360	360	215	160	160	130
125	7,5	370	370	220	165	165	156
150	7,8	380	380	225	165	165	183
200	8,4	400	400	230	170	170	235
250	9	420	420	240	175	175	288
300	9,6	440	440	250	180	180	340
350	10,2	460	460	260	185	185	393
400	10,8	480	480	270	190	190	445
450	11,4	500	500	280	195	195	498
500	12	520	—	290	200	—	550
600	13,2	560	—	310	210	—	655
700	14,4	600	—	330	220	—	760
800	15,6	600	—	330	230	—	865
900	16,8	600	—	330	240	—	970
1 000	18	600	—	330	250	—	1 075
1 100	19,2	600	—	330	260	—	1 180
1 200	20,4	600	—	330	270	—	1 285
1 400	22,8	710	—	390	340	—	1 477
1 500	24	750	—	410	350	—	1 580
1 600	25,2	780	—	430	360	—	1 683
1 800	27,6	850	—	470	380	—	1 889
2 000	30	920	—	500	400	—	2 095
2 200	32,4	990	—	540	420	—	2 301
2 400	34,8	1 060	—	570	440	—	2 507
2 600	37,2	1 130	—	610	460	—	2 713

NOTE — The length *L'* is the length of the spigot end to which the value of DE and its tolerance, as given in table 11, apply.

8.3.4 Double socket 90° (1/4) bends

See figure 7 and table 14.

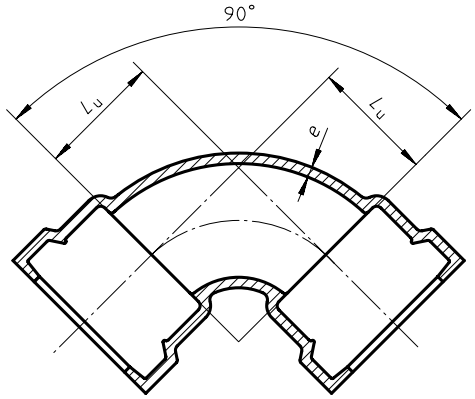

Figure 7

8.3.5 Double socket 45° (1/8) bends

See figure 8 and table 14.

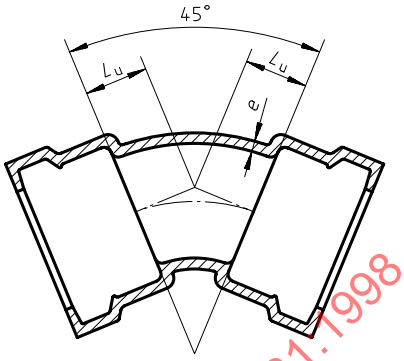

Figure 8

Table 14

DN	e	90° (1/4) bends		45° (1/8) bends	
		L_u		L_u	
		Series A	Series B	Series A	Series B
40	7	60	85	40	85
50	7	70	85	40	85
60	7	80	90	45	90
65	7	85	90	50	90
80	7	100	85	55	50
100	7,2	120	100	65	60
125	7,5	145	115	75	65
150	7,8	170	130	85	70
200	8,4	220	160	110	80
250	9	270	240	130	135
300	9,6	320	280	150	155
350	10,2	—	—	175	170
400	10,8	—	—	195	185
450	11,4	—	—	220	200
500	12	—	—	240	—
600	13,2	—	—	285	—
700	14,4	—	—	330	—
800	15,6	—	—	370	—
900	16,8	—	—	415	—
1 000	18	—	—	460	—
1 100	19,2	—	—	505	—
1 200	20,4	—	—	550	—
1 400	22,8	—	—	515	—
1 500	24	—	—	540	—
1 600	25,2	—	—	565	—
1 800	27,6	—	—	610	—
2 000	30	—	—	660	—
2 200	32,4	—	—	710	—
2 400	34,8	—	—	755	—
2 600	37,2	—	—	805	—

8.3.6 Double socket 22° 30' (1/16) bends

See figure 9 and table 15.

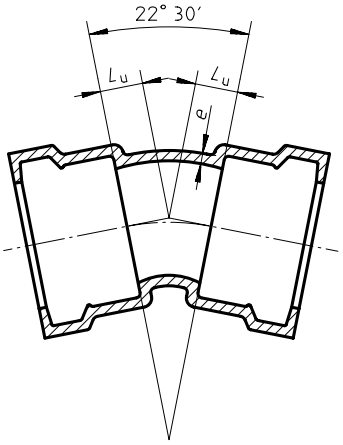

Figure 9

8.3.7 Double socket 11° 15' (1/32) bends

See figure 10 and table 15.

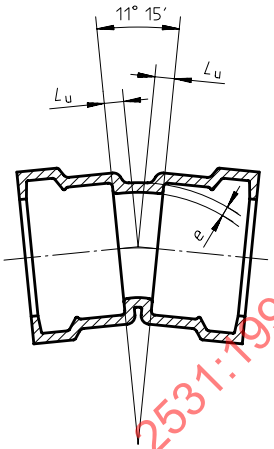

Figure 10

Table 15

DN	e	22° 30' (1/16) bends		11° 15' (1/32) bends	
		L_u		L_u	
		Series A	Series B	Series A	Series B
40	7	30	30	25	25
50	7	30	30	25	25
60	7	35	35	25	25
65	7	35	35	25	25
80	7	40	40	30	30
100	7,2	40	50	30	30
125	7,5	50	55	35	35
150	7,8	55	60	35	40
200	8,4	65	70	40	45
250	9	75	80	50	55
300	9,6	85	90	55	55
350	10,2	95	100	60	60
400	10,8	110	110	65	65
450	11,4	120	120	70	70
500	12	130	—	75	—
600	13,2	150	—	85	—
700	14,4	175	—	95	—
800	15,6	195	—	110	—
900	16,8	220	—	120	—
1 000	18	240	—	130	—
1 100	19,2	260	—	140	—
1 200	20,4	285	—	150	—
1 400	22,8	260	—	130	—
1 500	24	270	—	140	—
1 600	25,2	280	—	140	—
1 800	27,6	305	—	155	—
2 000	30	330	—	165	—
2 200	32,4	355	—	190	—
2 400	34,8	380	—	205	—
2 600	37,2	400	—	215	—

8.3.8 All-socket tees

See figure 11 and table 16.

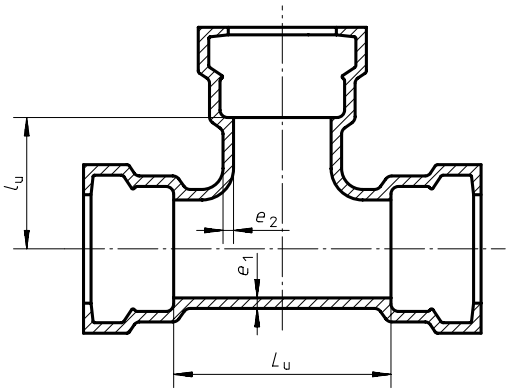

Figure 11

Table 16

DN × dn	Body			Branch		
	e_1	L_u		e_2	l_u	
		Series A	Series B		Series A	Series B
40 × 40	7	120	155	7	60	75
50 × 50	7	130	155	7	65	75
60 × 60	7	145	155	7	70	80
65 × 65	7	150	155	7	75	80
80 × 40	7	120	155	7	80	80
80 × 80	7	170	175	7	85	85
100 × 40	7,2	120	155	7	90	90
100 × 60	7,2	145	155	7	90	90
100 × 80	7,2	170	165	7	95	90
100 × 100	7,2	190	195	7,2	95	100
125 × 40	7,5	125	155	7	100	105
125 × 80	7,5	170	175	7	105	105
125 × 100	7,5	195	195	7,2	110	115
125 × 125	7,5	225	225	7,5	110	115
150 × 40	7,8	125	160	7	115	115
150 × 80	7,8	170	180	7	120	120
150 × 100	7,8	195	200	7,2	120	125
150 × 150	7,8	255	260	7,8	125	130
200 × 40	8,4	130	165	7	140	140
200 × 80	8,4	175	180	7	145	145
200 × 100	8,4	200	200	7,2	145	150
200 × 150	8,4	255	260	7,8	150	155
200 × 200	8,4	315	320	8,4	155	160
250 × 80	9	180	185	7	170	185
250 × 100	9	200	205	7,2	170	190
250 × 150	9	260	265	7,8	175	190
250 × 200	9	315	320	8,4	180	190
250 × 250	9	375	380	9	190	190
300 × 100	9,6	205	210	7,2	195	220
300 × 150	9,6	260	265	7,8	200	220
300 × 200	9,6	320	325	8,4	205	220
300 × 250	9,6	375	380	9	210	220
300 × 300	9,6	435	440	9,6	220	220

NOTE — The main nominal size is designated DN and the nominal size of the branch is designated dn.

8.3.9 Double-socket tees with flanged branch, DN 40 to DN 250

See figure 12 and table 17.

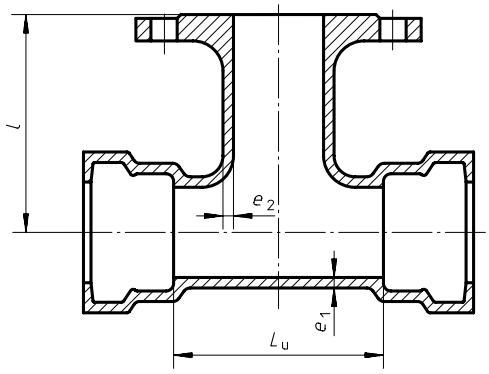

Figure 12

Table 17

DN × dn	Body			Branch		
	e_1	L_u		e_2	l	
		Series A	Series B		Series A	Series B
40 × 40	7	120	155	7	130	130
50 × 50	7	130	155	7	140	140
60 × 40	7	—	155	7	—	130
60 × 60	7	145	155	7	150	150
65 × 40	7	—	155	7	—	130
65 × 65	7	150	155	7	150	155
80 × 40	7	—	155	7	—	135
80 × 60	7	—	155	7	—	155
80 × 80	7	170	175	7	165	165
100 × 40	7,2	—	155	7	—	145
100 × 60	7,2	—	155	7	—	165
100 × 80	7,2	170	165	7	175	170
100 × 100	7,2	190	195	7,2	180	180
125 × 40	7,5	—	155	7	—	160
125 × 60	7,5	—	155	7	—	180
125 × 80	7,5	170	175	7	190	185
125 × 100	7,5	195	195	7,2	195	195
125 × 125	7,5	225	225	7,5	200	200
150 × 40	7,8	—	160	7	—	170
150 × 60	7,8	—	160	7	—	190
150 × 80	7,8	170	180	7	205	200
150 × 100	7,8	195	200	7,2	210	205
150 × 125	7,8	—	230	7,5	—	215
150 × 150	7,8	255	260	7,8	220	220
200 × 40	8,4	—	165	7	—	195
200 × 60	8,4	—	165	7	—	215
200 × 80	8,4	175	180	7	235	225
200 × 100	8,4	200	200	7,2	240	230
200 × 125	8,4	—	235	7,5	—	240
200 × 150	8,4	255	260	7,8	250	245
200 × 200	8,4	315	320	8,4	260	260
250 × 60	9	—	165	7	—	260
250 × 80	9	180	185	7	265	265
250 × 100	9	200	205	7,2	270	270
250 × 150	9	260	265	7,8	280	280
250 × 200	9	315	320	8,4	290	290
250 × 250	9	375	380	9	300	300

NOTE — The main nominal size is designated DN and the nominal size of the branch is designated dn.

8.3.10 Double-socket tees with flanged branch, DN 300 to DN 700

See figure 12 and table 18.

Table 18

DN × dn	Body			Branch		
	e_1	L_u		e_2	l	
		Series A	Series B		Series A	Series B
300 × 60	9,6	—	165	7	—	290
300 × 80	9,6	180	185	7	295	295
300 × 100	9,6	205	210	7,2	300	300
300 × 150	9,6	260	265	7,8	310	310
300 × 200	9,6	320	325	8,4	320	320
300 × 250	9,6	—	380	9	—	330
300 × 300	9,6	435	440	9,6	340	340
350 × 60	10,2	—	170	7	—	320
350 × 80	10,2	—	185	7	—	325
350 × 100	10,2	205	210	7,2	330	330
350 × 150	10,2	—	270	7,8	—	340
350 × 200	10,2	325	325	8,4	350	350
350 × 250	10,2	—	385	9	—	360
350 × 350	10,2	495	500	10,2	380	380
400 × 80	10,8	185	190	7	355	355
400 × 100	10,8	210	210	7,2	360	360
400 × 150	10,8	270	270	7,8	370	370
400 × 200	10,8	325	330	8,4	380	380
400 × 250	10,8	—	385	9	—	390
400 × 300	10,8	440	445	9,6	400	400
400 × 400	10,8	560	560	10,8	420	420
450 × 100	11,4	215	215	7,2	390	390
450 × 150	11,4	270	270	7,8	400	400
450 × 200	11,4	330	330	8,4	410	410
450 × 250	11,4	390	390	9	420	420
450 × 300	11,4	445	445	9,6	430	430
450 × 400	11,4	560	560	10,8	450	450
450 × 450	11,4	620	620	11,4	460	460
500 × 100	12	215	—	7,2	420	—
500 × 200	12	330	—	8,4	440	—
500 × 400	12	565	—	10,8	480	—
500 × 500	12	680	—	12	500	—
600 × 200	13,2	340	—	8,4	500	—
600 × 400	13,2	570	—	10,8	540	—
600 × 600	13,2	800	—	13,2	580	—
700 × 200	14,4	345	—	8,4	525	—
700 × 400	14,4	575	—	10,8	555	—
700 × 700	14,4	925	—	14,4	600	—

NOTE — The main nominal size is designated DN and the nominal size of the branch is designated dn.

8.3.11 Double-socket tees with flanged branch, DN 800 to DN 2 600

See figure 12 and table 19.

Table 19

DN × dn	Body		Branch	
	e_1	L_u Series A	e_2	l Series A
800 × 200	15,6	350	8,4	585
800 × 400	15,6	580	10,8	615
800 × 600	15,6	1 045	13,2	645
800 × 800	15,6	1 045	15,6	675
900 × 200	16,8	355	8,4	645
900 × 400	16,8	590	10,8	675
900 × 600	16,8	1 170	13,2	705
900 × 900	16,8	1 170	16,8	750
1 000 × 200	18	360	8,4	705
1 000 × 400	18	595	10,8	735
1 000 × 600	18	1 290	13,2	765
1 000 × 1 000	18	1 290	18	825
1 100 × 400	19,2	600	10,8	795
1 100 × 600	19,2	830	13,2	825
1 200 × 600	20,4	840	13,2	885
1 200 × 800	20,4	1 070	15,6	915
1 200 × 1 000	20,4	1 300	18	945
1 400 × 600	22,8	1 030	13,2	980
1 400 × 800	22,8	1 260	15,6	1 010
1 400 × 1 000	22,8	1 495	18	1 040
1 500 × 600	24	1 035	13,2	1 035
1 500 × 1 000	24	1 500	18	1 595
1 600 × 600	25,2	1 040	13,2	1 090
1 600 × 800	25,2	1 275	15,6	1 120
1 600 × 1 000	25,2	1 505	18	1 150
1 600 × 1 200	25,2	1 740	20,4	1 180
1 800 × 600	27,6	1 055	13,2	1 200
1 800 × 800	27,6	1 285	15,6	1 230
1 800 × 1 000	27,6	1 520	18	1 260
1 800 × 1 200	27,6	1 750	20,4	1 290
2 000 × 600	30	1 065	13,2	1 310
2 000 × 1 000	30	1 530	18	1 370
2 000 × 1 400	30	1 995	22,8	1 430
2 200 × 600	32,4	1 080	13,2	1 420
2 200 × 1 200	32,4	1 775	20,4	1 510
2 200 × 1 800	32,4	2 470	27,6	1 600
2 400 × 600	34,8	1 090	13,2	1 530
2 400 × 1 200	34,8	1 785	20,4	1 620
2 400 × 1 800	34,8	2 480	27,6	1 710
2 600 × 600	37,2	1 100	13,2	1 640
2 600 × 1 400	37,2	2 030	22,8	1 750
2 600 × 2 000	37,2	2 725	30	1 850

NOTE — The main nominal size is designated DN and the nominal size of the branch is designated dn.

8.3.12 Double-socket tapers

See figure 13 and table 20.

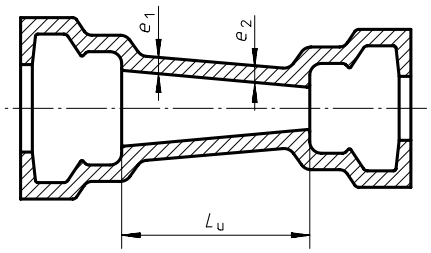

Figure 13

Table 20

DN × dn	e_1	e_2	L_u	
			Series A	Series B
50 × 40	7	7	70	75
60 × 50	7	7	70	75
65 × 50	7	7	80	75
80 × 40	7	7	—	80
80 × 60	7	7	90	80
80 × 65	7	7	80	80
100 × 60	7,2	7	—	120
100 × 80	7,2	7	90	85
125 × 60	7,5	7	—	190
125 × 80	7,5	7	140	135
125 × 100	7,5	7,2	100	120
150 × 80	7,8	7	190	190
150 × 100	7,8	7,2	150	150
150 × 125	7,8	7,5	100	115
200 × 100	8,4	7,2	250	250
200 × 125	8,4	7,5	200	230
200 × 150	8,4	7,8	150	145
250 × 125	9	7,5	300	335
250 × 150	9	7,8	250	250
250 × 200	9	8,4	150	150
300 × 150	9,6	7,8	350	370
300 × 200	9,6	8,4	250	250
300 × 250	9,6	9	150	150
350 × 200	10,2	8,4	360	370
350 × 250	10,2	9	260	260
350 × 300	10,2	9,6	160	160
400 × 250	10,8	9	360	380
400 × 300	10,8	9,6	260	260
400 × 350	10,8	10,2	160	155
450 × 350	11,4	10,2	260	270
450 × 400	11,4	10,8	160	160
500 × 350	12	10,2	360	—
500 × 400	12	10,8	260	—

Table 20 *(concluded)*

DN × dn	e_1	e_2	L_u	
			Series A	Series B
600 × 400	13,2	10,8	460	—
600 × 500	13,2	12	260	—
700 × 500	14,4	12	480	—
700 × 600	14,4	13,2	280	—
800 × 600	15,6	13,2	480	—
800 × 700	15,6	14,4	280	—
900 × 700	16,8	14,4	480	—
900 × 800	16,8	15,6	280	—
1 000 × 800	18	15,6	480	—
1 000 × 900	18	16,8	280	—
1 100 × 1 000	19,2	18	280	—
1 200 × 1 000	20,4	18	480	—
1 400 × 1 200	22,8	20,4	360	—
1 500 × 1 400	24	22,8	260	—
1 600 × 1 400	25,2	22,8	360	—
1 800 × 1 600	27,6	25,2	360	—
2 000 × 1 800	30	27,6	360	—
2 200 × 2 000	32,4	30	360	—
2 400 × 2 200	34,8	32,4	360	—
2 600 × 2 400	37,2	34,8	360	—

NOTE — The larger nominal size is designated DN and the smaller nominal size is dn.

8.4 Fittings for flanged joints

Standardized PN are those given in 8.2.3.

In tables 21 to 30, all the dimensions are nominal values and are given in millimetres. For coatings and linings, see 4.5.

8.4.1 Double-flanged 90° (1/4) bends

See figure 14 and table 21.

8.4.2 Double-flanged duckfoot 90° (1/4) bends

See figure 15 and table 21.

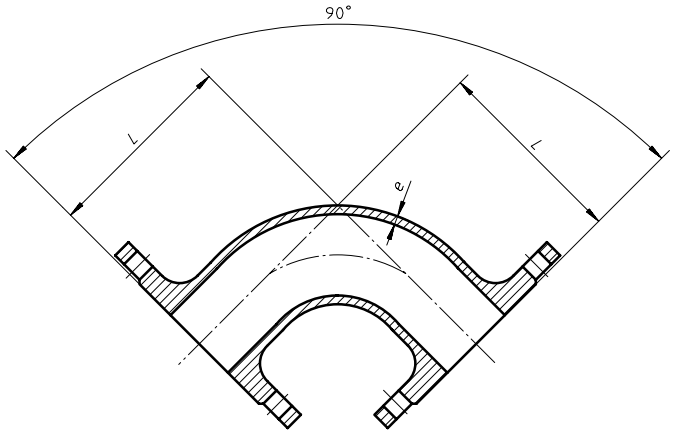

Figure 14

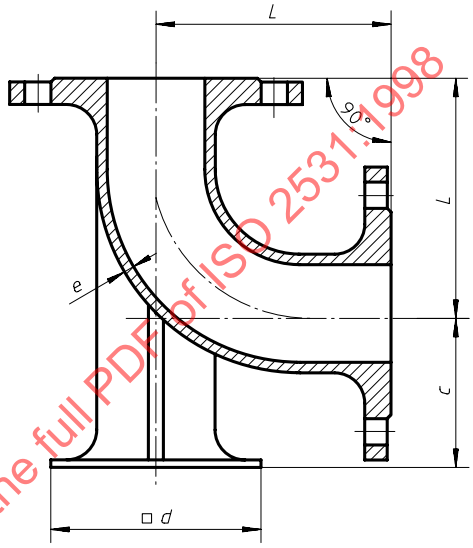

Figure 15

Table 21

DN	A and B series				
	e	90° (1/4) bends	90° (1/4) duckfoot bends		
		L	*L*	*c*	*d*
40	7	140	—	—	—
50	7	150	150	95	150
60	7	160	160	100	160
65	7	165	165	100	165
80	7	165	165	110	180
100	7,2	180	180	125	200
125	7,5	200	200	140	225
150	7,8	220	220	160	250
200	8,4	260	260	190	300
250	9	350	350	225	350
300	9,6	400	400	255	400
350	10,2	450	450	290	450
400	10,8	500	500	320	500
450	11,4	550	550	355	550
500	12	600	600	385	600
600	13,2	700	700	450	700
700	14,4	800	—	—	—
800	15,6	900	—	—	—
900	16,8	1 000	—	—	—
1 000	18	1 100	—	—	—

8.4.3 Double-flanged 45° (1/8) bends

See figure 16 and table 22.

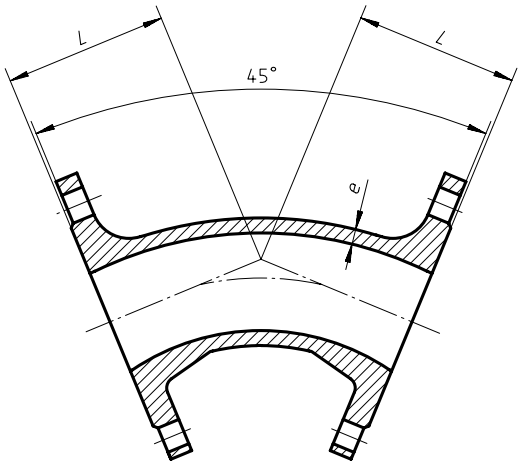

Figure 16

Table 22

DN	*e*	*L*	
		Series A	Series B
40	7	140	140
50	7	150	150
60	7	160	160
65	7	165	165
80	7	130	130
100	7,2	140	140
125	7,5	150	150
150	7,8	160	160
200	8,4	180	180
250	9	350	245
300	9,6	400	275
350	10,2	300[1)]	300
400	10,8	325[1)]	325
450	11,4	350	350
500	12	375	—
600	13,2	425[1)]	—
700	14,4	480[1)]	—
800	15,6	530[1)]	—
900	16,8	580[1)]	—
1 000	18	630[1)]	—
1 100	19,2	695	—
1 200	20,4	750	—
1 400	22,8	775	—
1 500	24	810	—
1 600	25,2	845	—
1 800	27,6	910	—
2 000	30	980	—
2 200	32,4	880	—
2 400	34,8	945	—
2 600	37,2	1 005	—

1) These values are slightly different from those in the fourth edition of ISO 2531 because they have been rounded to the nearest 5 mm as all others.

8.4.4 All-flanged tees, DN 40 to DN 250

See figure 17 and table 23.

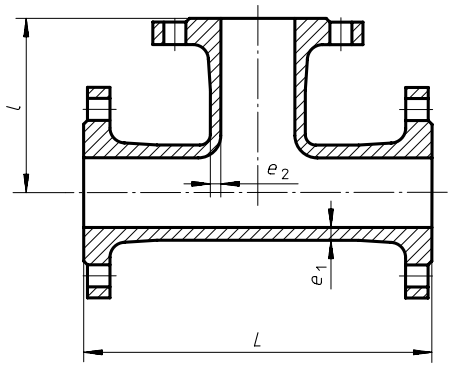

Figure 17

Table 23

DN × dn	Body			Branch		
	e_1	L		e_2	l	
		Series A	Series B		Series A	Series B
40 × 40	7	280	255	7	140	130
50 × 50	7	300	280	7	150	140
60 × 40	7	300	—	7	130	—
60 × 60	7	320	300	7	160	150
65 × 65	7	330	305	7	165	150
80 × 40	7	—	310	7	—	135
80 × 60	7	—	310	7	—	155
80 × 80	7	330	330	7	165	165
100 × 40	7,2	—	320	7	—	145
100 × 60	7,2	—	320	7	—	165
100 × 80	7,2	360	330	7	175	170
100 × 100	7,2	360	360	7,2	180	180
125 × 40	7,5	—	330	7	—	160
125 × 60	7,5	—	330	7	—	180
125 × 80	7,5	400	350	7	190	185
125 × 100	7,5	400	370	7,2	195	195
125 × 125	7,5	400	400	7,5	200	200
150 × 40	7,8	—	340	7	—	170
150 × 60	7,8	—	340	7	—	190
150 × 80	7,8	440	360	7	205	200
150 × 100	7,8	440	380	7,2	210	205
150 × 125	7,8	440	410	7,5	215	215
150 × 150	7,8	440	440	7,8	220	220
200 × 40	8,4	—	365	7	—	195
200 × 60	8,4	—	365	7	—	215
200 × 80	8,4	520	380	7	235	225
200 × 100	8,4	520	400	7,2	240	230
200 × 125	8,4	—	435	7,5	—	240
200 × 150	8,4	520	460	7,8	250	245
200 × 200	8,4	520	520	8,4	260	260
250 × 60	9	—	385	7	—	260
250 × 80	9	—	405	7	—	265
250 × 100	9	700	425	7,2	275	270
250 × 150	9	—	485	7,8	—	280
250 × 200	9	700	540	8,4	325	290
250 × 250	9	700	600	9	350	300

NOTE — The main nominal size is designated DN and the nominal size of the branch is designated dn.

8.4.5 All-flanged tees, DN 300 to DN 700

See figure 17 and table 24.

Table 24

DN × dn	Body			Branch		
	e_1	L		e_2	l	
		Series A	Series B		Series A	Series B
300 × 60	9,6	—	405	7	—	290
300 × 80	9,6	—	425	7	—	295
300 × 100	9,6	800	450	7,2	300	300
300 × 150	9,6	—	505	7,8	—	310
300 × 200	9,6	800	565	8,4	350	320
300 × 250	9,6	—	620	9	—	330
300 × 300	9,6	800	680	9,6	400	340
350 × 60	10,2	—	430	7	—	320
350 × 80	10,2	—	445	7	—	325
350 × 100	10,2	850	470	7,2	325	330
350 × 150	10,2	—	530	7,8	—	340
350 × 200	10,2	850	585	8,4	325	350
350 × 250	10,2	—	645	9	—	360
350 × 350	10,2	850	760	10,2	425	380
400 × 80	10,8		470	7		355
400 × 100	10,8	900	490	7,2	350	360
400 × 150	10,8	—	550	7,8	—	370
400 × 200	10,8	900	610	8,4	350	380
400 × 250	10,8	—	665	9	—	390
400 × 300	10,8	—	725	9,6	—	400
400 × 400	10,8	900	840	10,8	450	420
450 × 100	11,4	950	515	7,2	375	390
450 × 150	11,4	—	570	7,8	—	400
450 × 200	11,4	950	630	8,4	375	410
450 × 250	11,4	—	690	9	—	420
450 × 300	11,4	—	745	9,6	—	430
450 × 400	11,4	—	860	10,8	—	450
450 × 450	11,4	950	920	11,4	475	460
500 × 100	12	1 000	535	7,2	400	420
500 × 200	12	1 000	650	8,4	400	440
500 × 400	12	1 000	885	10,8	500	480
500 × 500	12	1 000	1 000	12	500	500
600 × 200	13,2	1 100	700	8,4	450	500
600 × 400	13,2	1 100	930	10,8	550	540
600 × 600	13,2	1 100	1 165	13,2	550	580
700 × 200	14,4	650	—	8,4	525	—
700 × 400	14,4	870	—	10,8	555	—
700 × 700	14,4	1 200	—	14,4	600	—

NOTE — The main nominal size is designated DN and the nominal size of the branch is designated dn.

8.4.6 All-flanged tees, DN 800 to DN 2 600

See figure 17 and table 25.

Table 25

DN × dn	Body		Branch	
	e_1	L Series A	e_2	l Series A
800 × 200	15,6	690	8,4	585
800 × 400	15,6	910	10,8	615
800 × 600	15,6	1 350	13,2	645
800 × 800	15,6	1 350	15,6	675
900 × 200	16,8	730	8,4	645
900 × 400	16,8	950	10,8	675
900 × 600	16,8	1 500	13,2	705
900 × 900	16,8	1 500	16,8	750
1 000 × 200	18	770	8,4	705
1 000 × 400	18	990	10,8	735
1 000 × 600	18	1 650	13,2	765
1 000 × 1 000	18	1 650	18	825
1 100 × 400	19,2	980	8,4	795
1 100 × 600	19,2	1 210	13,2	825
1 200 × 600	20,4	1 240	13,2	885
1 200 × 800	20,4	1 470	15,6	915
1 200 × 1 000	20,4	1 700	18	945
1 400 × 600	22,8	1 550	13,2	980
1 400 × 800	22,8	1 760	15,6	1 010
1 400 × 1 000	22,8	2 015	18	1 040
1 500 × 600	24	1 575	13,2	1 035
1 500 × 1 000	24	2 040	18	1 095
1 600 × 600	25,2	1 600	13,2	1 090
1 600 × 800	25,2	1 835	15,6	1 120
1 600 × 1 000	25,2	2 065	18	1 150
1 600 × 1 200	25,2	2 300	20,4	1 180
1 800 × 600	27,6	1 655	13,2	1 200
1 800 × 800	27,6	1 885	15,6	1 230
1 800 × 1 000	27,6	2 120	18	1 260
1 800 × 1 200	27,6	2 350	20,4	1 290
2 000 × 600	30	1 705	13,2	1 310
2 000 × 1 000	30	2 170	18	1 370
2 000 × 1 400	30	2 635	22,8	1 430
2 200 × 600	32,4	1 560	13,2	1 420
2 200 × 1 200	32,4	2 220	20,4	1 510
2 200 × 1 800	32,4	2 880	27,6	1 600
2 400 × 600	34,8	1 620	13,2	1 530
2 400 × 1 200	34,8	2 280	20,4	1 620
2 400 × 1 800	34,8	2 940	27,6	1 710
2 600 × 600	37,2	1 680	13,2	1 640
2 600 × 1 400	37,2	2 560	22,8	1 760
2 600 × 2 000	37,2	3 220	30	1 850

NOTE — The main nominal size is designated DN and the nominal size of the branch is designated dn.