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ISO 2531

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Ductile iron pipes, fittings and accessories for pressure pipelines

Tuyaux, raccords et pièces accessoires en fonte ductile pour canalisations avec pression

Reference number
ISO 2531 : 1991 (E)

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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*, Sub-Committee SC 2, *Cast iron pipes, fittings and their joints*.

This fourth edition cancels and replaces the third edition (ISO 2531 : 1986), of which it constitutes a technical revision. In particular, the scope has been extended to cover loose flanges.

Introduction

Ductile iron, also called nodular iron or spheroidal graphite iron, is characterized by the presence of spheroidal graphite in the resultant castings.

It differs from flake graphite iron in that it has a higher tensile strength, a high proof stress and high elongation.

These characteristics ensure the suitability of ductile iron pipes and fittings for a majority of pipeline applications.

This International Standard defines dimensions for castings having adequate strength for the majority of conditions of use. However, various methods of strengthening are authorized, particularly where high working pressures could lead to localized areas of high stress.

The value adopted for the density of ductile iron is 7 050 kg/m^3. This value is a compromise between the values measured in various manufacturing countries and provides a reasonably acceptable agreement between the calculated masses and actual masses.

Ductile iron pipes, fittings and accessories for pressure pipelines

Section 1: General

1.1 Scope

This International Standard establishes general specifications completed by specific requirements applicable to

a) ductile iron pipes manufactured by any one of the following four processes:

1) centrifugal casting in lined or unlined metal moulds;

2) centrifugal casting in sand[1] moulds;

3) casting in sand[1] moulds;

4) casting in metal moulds;

b) ductile iron fittings and accessories manufactured by either of the following two processes:

1) casting in sand[1] moulds;

2) casting in metal moulds.

It is applicable to pipes, fittings and accessories for pressure pipelines for water, other liquids, or gas.

Pipes, fittings and accessories may be provided with fixed or loose flanges. It is the responsibility of the manufacturer to define the type of flanges he normally produces and to specify this in his catalogues.

The range of diameters extends from nominal size DN 40 to nominal size DN 2 600 inclusive. DN 60, which is shown in parentheses in the tables, exists in national standards in certain countries. However, it is recommended that whenever possible it be replaced by DN 65.

1.2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this 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 13 : 1978, *Grey iron pipes, special castings and grey iron parts for pressure main lines.*

ISO 6506 : 1981, *Metallic materials — Hardness test — Brinell test.*

ISO 6708 : 1980, *Pipe components — Definition of nominal size.*

1.3 Definition

For the purposes of this International Standard, the definition of nominal size (DN) given in ISO 6708 applies.

1) "Sand" refers to sand or mineral-based materials used in the foundry trade irrespective of the type of bonding agent.

Section 2: General specification

2.1 Types of joints

The pipes and fittings may be supplied with various types of joint.

The specification mainly concerns pipes, fittings with sockets for gasket joints with elastomer packings and flanged fittings.

It may also be used for pipes and fittings having other types of joint — for example, lead-caulked joints, which are still used in certain countries. Castings with these various joints retain the same overall dimensions, making it easier for manufacturers to use interchangeable patterns.

NOTE — The standard external diameter of the spigot end of pipes and fittings remains the same for all types of joint. Furthermore, this external diameter is the same in the common range of nominal sizes as that of the spigot end of grey iron castings (see ISO 13), which makes it easier to joint the new ductile iron pipes or fittings to existing grey iron pipelines.

2.2 Standard iron thickness of pipes and fittings

The standard iron thickness of pipes and fittings is calculated as a function of the nominal size using the formula

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

where

e is the standard wall thickness, in millimetres;

DN is the nominal size;

k is the coefficient selected from a series of whole numbers . . . 8, 9, 10, 11, 12 . . . as laid down in the specific requirements of sections 3, 5 and 6 of this International Standard:

k = 9 for the pipes in table 10,

k = 9; 12; 14 for the flanged pipes in table 28,

k = 9; 10; 12 for the flanged pipes in table 29,

k = 12 for the fittings in tables 32 to 38, 44, 45 and 54 to 57,

k = 14 for the fittings in tables 39 to 43 and 58 to 63.

If necessary, each particular specification shall give an additional formula applicable to small size castings.

The external diameter of the pipes, expressed in millimetres, is fixed as a function of the nominal size and independently of the pipe wall thickness. Increases or decreases in the pipe wall thickness shall be obtained by modification of the actual internal diameter.

The wall thickness of the fittings may be adjusted to the forces acting at each point of the castings, particularly to the mechanical stresses induced by internal pressure. In bends, for example, the wall thickness at the inner radius may be greater than that at the outer radius.

Increases or decreases in the wall thickness of fittings may be obtained by modifications to either the internal or the external diameter of the fittings.

The thickness e indicated in each table and on the drawings of the fittings shall be a mean thickness corresponding to the mass of each casting. The actual thickness at any particular point may be varied to meet local stresses, depending on the shape of the casting.

2.3 Marking

Each pipe, fitting or accessory shall bear at least the following indications:

a) the mark of the manufacturer;

b) an indication that the casting is of ductile iron;

c) an indication of its nominal size (DN).

If necessary, each fitting shall bear an indication of its main characteristics. Pipes, fittings and accessories with a nominal size greater than DN 300 shall also bear the year of manufacture.

The marks may be cast on, painted or cold stamped.

2.4 Quality of pipes, fittings and accessories

After casting, ductile iron pipes, fittings and accessories may be subjected, when necessary, to a suitable heat treatment in order to give them the required mechanical characteristics.

Pipes, fittings and accessories shall not have any defects likely to be detrimental to their use.

Pipes, fittings and accessories showing small imperfections inseparable from the method of manufacture and in no way affecting their use, shall not be rejected. On his own responsibility the manufacturer may remedy slight surface imperfections in a suitable manner.

With the previous agreement of the purchaser or his representative, certain defects may be repaired by any proven process such as welding. In such cases, the purchaser may require one of the tests described below to be carried out.

The pipes shall be such that they can be cut, drilled or machined; in case of dispute they shall be considered as acceptable provided that the superficial hardness does not exceed 230 HB. The superficial hardness of fittings and accessories shall not exceed 250 HB.[1)]

2.5 Tolerances on joints

To ensure interchangeability between supplies from different origins, the plus tolerance on the external diameters of spigot ends of pipes and fittings, as measured circumferentially in the jointing area, shall not be greater than 1 mm.

The tolerances on joints depend on the characteristics peculiar to each type of joint, and shall be as specified in the national standards, or, when not so specified, in the manufacturers' catalogues for the type of joint and the nominal size considered.

NOTE — As a general rule, the tolerances on the sockets are more restricted than the tolerances on the barrel because of the greater thickness and the greater rigidity of the sockets.

2.6 Tolerances on thickness

The tolerances on wall thickness are given in table 1, where DN is the nominal size.

Table 1

Tolerances in millimetres

Type of casting	Tolerance
Pipes centrifugally cast	$-(1{,}3 + 0{,}001\ DN)$ *)
Pipes, fittings and accessories not centrifugally cast	$-(2{,}3 + 0{,}001\ DN)$ *)

*) No limit for the plus tolerance has been set.

2.7 Manufacturing lengths

2.7.1 Spigot and socket pipes

The standard working lengths of spigot and socket pipes are as shown in section 3.

Of the total number of spigot and socket pipes to be supplied in each diameter, the manufacturer may supply up to 10 % in lengths shorter than the standard working length specified, the maximum reduction in length allowed being as given in table 2.

Table 2

Dimensions in metres

Specified length, L	Maximum reduction in length
$L \leqslant 4$	1
$4 < L \leqslant 6$	2
$6 < L$	3

2.7.2 Flanged pipes

The manufacturing working lengths of flanged pipes shall be those specified in national standards or in the manufacturers' catalogues.

2.7.3 Fittings

The standard working lengths of fittings are indicated in section 6.

2.8 Deviations and tolerances on length

This International Standard specifies permissible deviations from the standard working lengths.

These deviations have been selected generously and they allow individual manufacturers to produce castings of differing manufacturing working lengths to accommodate the use of various foundry tackle systems and joint designs.

The manufacturing working lengths shall be those given in manufacturers' catalogues.

This International Standard also specifies where appropriate (see clauses 3.3, 5.2 and 6.3) manufacturing tolerances which shall apply to the manufacturing working lengths.

2.9 Tolerances on the straightness of centrifugally cast pipes

When the pipes are rolled along two gantries separated by approximately two-thirds of the length L of the pipe to be checked, the maximum deviation f_m, in millimetres, shall not be greater than 1,25 times the length L, in metres, of this pipe, i.e.

$$f_m \leqslant 1{,}25\ L$$

1) In the case where pipes or fittings are manufactured from welded elements, a higher hardness is permitted locally at the welds.

2.10 Tolerances on flanges

The dimensional tolerances of flanges are specified in section 4.

2.11 Tolerances on masses

The values of the masses of the sockets given in the tables of this International Standard are approximate.

The masses of pipes and fittings corresponding to each type of joint shall be those specified in the national standards or, when not so specified, in the manufacturers' catalogues; these shall have been calculated by taking the density of cast iron as 7 050 kg/m^3.

The mass of the pipes for each working length, and the mass of the fittings shown in the tables, have been calculated taking into account in each case a socket mass fixed by a linear formula corresponding to average socket masses as manufactured in practice in various countries.

The values indicated for the mass per metre of pipe and the masses of the sockets are rounded off to the nearest 0,1 kg.

The values indicated for the masses of accessories are rounded off

— to the nearest 0,1 kg for masses less than 20 kg;

— to the nearest 0,5 kg for masses between 20 kg and 100 kg;

— to the nearest kilogram for masses above 100 kg.

The tolerances on the standard masses are given in table 3.

NOTES

1 Castings of a greater mass than the maximum should be accepted provided that they comply in every other respect with the requirements of this International Standard.

2 Pipes and fittings below DN 150 need not be weighed individually unless specified by the purchaser in his enquiry or order.

Table 3

Type of casting		Tolerance on standard mass %
Pipes centrifugally cast	up to DN 200 inclusive	± 8
	above DN 200	± 5
Pipes not centrifugally cast Standard fittings except as stated below		± 8
Bends, fittings with branches and non-standard fittings		± 12

2.12 Tensile tests — Test bars

2.12.1 Pipes centrifugally cast

The machined test bar for the tensile test shall be taken from the spigot end of the pipe, at approximately mid-thickness of the wall.

The manufacturer may opt to take the test bar perpendicular or parallel to the axis of the pipe. In case of dispute the test bar shall be taken parallel to the axis of the pipe.

The test bar shall include a cylindrical part, the gauge length of which shall be at least five times its diameter; the diameter of the test bar shall be determined from table 4 according to the thickness of the pipe, e.

Table 4

Dimensions in millimetres

Thickness of pipe, e	Diameter of test bar
$e < 6$	2,5
$6 \leqslant e < 8$	3,5
$8 \leqslant e < 12$	5
$12 \leqslant e$	6

2.12.2 Pipes, fittings and accessories not centrifugally cast

The machined test bar for the tensile test may, at the manufacturer's option, be taken either from a sample attached to the casting or from a sample cast separately. In the latter case it shall be cast from the same iron as that used for the casting. If the casting is subjected to heat treatment, the sample shall be subjected to the same heat treatment. The choice of the method used for casting the sample shall be left to the manufacturer with a view to obtaining soundly cast test bars. The thickness of the sample and the diameter of the test bar are given in table 5 as a function of the mean thickness of the casting.

Table 5

Dimensions in millimetres

Mean thickness of casting	Thickness of sample	Diameter of test bar
< 12	12,5	6
$\geqslant 12$	25	12

The gauge length of the machined test bar shall be at least five times its diameter.

In all cases, the ends of the test bars shall be such that they will fit the testing machine.

2.13 Tensile tests — Method and results

The manufacturer's mechanical tests shall be carried out during manufacture.

The mechanical acceptance tests shall be carried out on castings grouped in batches as follows.

a) **Pipes centrifugally cast**

Each batch shall be made up of pipes cast successively as follows:

- DN 40 to DN 300: 200 pipes
- DN 350 to DN 600: 100 pipes
- DN 700 to DN 1 000: 50 pipes
- DN 1 200 to DN 2 600: 25 pipes

b) **Pipes, fittings and accessories not centrifugally cast**

Castings made from iron of substantially the same composition and, if necessary, having been subjected to the same heat treatment, shall be considered as one batch. The size of such batches shall be limited to 4 t of crude castings, excluding the mass of the risers.

A single casting is considered as one batch if its mass is equal to or greater than 4 t.

The manufacturer shall take a test bar which shall satisfy the requirements of table 6 from one pipe of each batch [see item a)] or from one sample of each batch [see item b)].

If the results of this test are below the specified minimum values, two other test bars shall be taken from the same pipe, or from the same sample in the case of fittings and accessories, and these shall satisfy the same specified requirements.

Pipes from which test bars have been cut shall be included in the supply, along with pipes from which test bars have not been cut.

NOTE — The provisions made for dividing the pipes and fittings into batches and for the heat treatment of the castings, together with the specifying of different diameters of a test bar according to the thickness and type of the casting, contribute towards the accuracy of this test.

2.14 Brinell hardness test

The Brinell hardness value HB, specified in clause 2.4, shall be checked by means of a test carried out on the outer surface of the castings after slight grinding.

The Brinell hardness test shall be carried out in accordance with ISO 6506, with a steel ball of 10 mm, 5 mm or 2,5 mm diameter.

2.15 Maximum working pressure and internal pressure proof test

2.15.1 Maximum working pressure

The maximum working pressures for these pipes, fittings and accessories shall be determined according to the regulations in operation in each country as a function of the works proof test pressure and the anticipated working conditions, i.e. the type of liquid transported, static and transitory overloads, etc.

2.15.2 Internal pressure proof test

2.15.2.1 Pipes centrifugallly cast

Centrifugally cast pipes shall be subjected to a works hydrostatic test for a duration of at least 10 s at a minimum pressure defined by the corresponding specific requirements.

It is recommended that this pressure p, expressed in bars[1] as a function of the coefficient k (clause 2.2), be calculated using the following formulae:

- DN 40 to DN 300: $p = 0{,}5\,(k + 1)^2$
- DN 350 to DN 600: $p = 0{,}5\,k^2$
- DN 700 to DN 1 000: $p = 0{,}5\,(k - 1)^2$
- DN 1 200 to DN 2 000: $p = 0{,}5\,(k - 2)^2$
- DN 2 200 to DN 2 600: $p = 0{,}5\,(k - 3)^2$

Table 6

Type of casting	Tensile strength R_m min. N/mm²	0,2 % proof stress*) (non-proportional elongation) $R_{p0,2}$ min. N/mm²	Percentage elongation after fracture A min.	
	DN 40 to DN 2 600	DN 40 to DN 2 600	DN 40 to DN 1 000	DN 1 200 to DN 2 600
Pipes centrifugally cast	420	300**)	10	7
Pipes, fittings and accessories not centrifugally cast	400	300	5	5

*) The proof stress shall be measured only by special agreement between the manufacturer and the purchaser and under conditions which shall be specified in the order.

**) Values of $R_{p0,2}$ between 270 N/mm² and 300 N/mm² are allowed when the elongation after fracture is greater than or equal to 12 % for pipes of DN 40 to DN 1 000 or 10 % for pipes of DN 1 200 to DN 2 600.

1) 1 bar = 10^5 Pa

The actual test pressures shall not exceed the following values:

- DN 40 to DN 300: p = 100 bar
- DN 350 to DN 600: p = 80 bar
- DN 700 to DN 1 000: p = 60 bar
- DN 1 200 to DN 2 000: p = 40 bar
- DN 2 200 to DN 2 600: p = 25 bar

2.15.2.2 Pipes, fittings and accessories not centrifugally cast

Pipes, fittings and accessories not centrifugally cast shall be subjected to a leak-tightness test carried out with water or air, under the conditions indicated by the relevant specific requirements.

2.15.2.3 Acceptance criteria

After completion of the test there shall be no visible signs of leakage, sweating or other fault of any kind.

NOTE — Because of their great mechanical strength, ductile iron pipes and fittings may be used for a very wide range of working conditions. The hydrostatic test or leak-tightness test pressures are therefore indicated in the specific requirements applicable to each type of casting. For pipes and fittings used for the conveyance of gas, air pressure or other appropriate tests should be carried out.

2.16 Coating

Except when otherwise specified, all pipes, fittings and accessories shall be coated inside and outside.

The coatings shall dry rapidly with good adherence, and shall not scale off.

The inside coating shall not contain constituants soluble in water or ingredients liable to impart any taste or smell to the water after suitable washing of the mains. For pipelines carrying potable water, or alimentary fluids, the inside coating shall not contain any toxic constituant.

NOTE — The requirements concerning the coating of the various castings are based on similar requirements to those given in ISO 13 for grey iron pipes and fittings. Technical specifications concerning cement mortar internal linings for pipes are the subject of ISO 4179 : 1985, *Ductile iron pipes for pressure and non-pressure pipelines — Centrifugal cement mortar lining — General requirements*, and ISO 6600 : 1980, *Ductile iron pipes — Centrifugal cement mortar lining — Composition controls of freshly applied mortar.* Other specifications regarding external protection are under study.

2.17 Inspection

If the purchaser wishes to inspect the pipes, fittings and accessories, such inspection shall be undertaken at the works of the manufacturer. The equipment and labour necessary for the carrying out of the inspection shall be provided by the manufacturer.

The inspector appointed by the purchaser and accredited to the manufacturer shall be advised previously of the time at which the inspection operations will take place.

The inspector may witness the sampling, the preparation and testing of the test pieces, the checking of dimensions, the weighing and the hydraulic tests.

The inspection and weighing of the pipes, fittings and accessories may be carried out after coating.

Should the purchaser or his representative not be present when these operations are carried out at the time agreed upon, the manufacturer shall be entitled to proceed with the inspection without the purchaser or his representative being present.

NOTE — The requirements concerning inspection of the various castings are based on similar requirements to those given in ISO 13 for grey iron pipes and fittings.

Section 3: Spigot and socket pipes

3.1 General — Pipes

This section defines (see table 10) a range of ductile iron pipes which satisfy most normal needs, particularly in the conveyance and distribution of water or gas under pressure.

The thickness of the pipes is defined as a function of their diameter by linear formulae, as given in ISO 13 for grey iron pipes.

In case of particular needs, other pipe ranges, having smaller or greater wall thicknesses, may be envisaged.

Table 10 deals with ductile iron spigot and socket pipes used for the transportation and distribution of water, other liquids, or gas under pressure. It applies equally to double spigot pipes.

Their iron thickness e (see figure 1) has been calculated as a function of the nominal size DN, using the formula given in clause 2.2, with 9 as the value for k, thus

$$e = 4{,}5 + 0{,}009 \text{ DN}$$

However, for pipes DN 40 to DN 200, the thickness is given by the additional formula

$$e = 5{,}8 + 0{,}003 \text{ DN}$$

with a minimum of 6 mm.

In these formulae

e is the standard wall thickness, in millimetres;

DN is the nominal size of the pipe.

3.2 Standard working length

The standard working lengths of spigot and socket pipes are given in table 7.

Table 7

Nominal size DN	Standard working lengths m
40 ⩽ DN ⩽ 65	2—3—4—5—5,5—6
80 ⩽ DN ⩽ 500	4—5—5,5—6
600 ⩽ DN ⩽ 2 600	4—5—5,5—6—7—8—9

NOTE — Not all the standard working lengths are available in all countries and consequently they cannot be required.

3.3 Deviations and tolerances on length

The deviation on standard working lengths and the tolerance on manufacturing working lengths are given in table 8.

They are applied irrespective of nominal size DN and length.

Table 8

Values in millimetres

Deviation on standard working length	± 250
Tolerance on manufacturing working length	± 30

3.4 Works test pressure

The hydrostatic works test pressure for the pipes shown in table 10 is indicated in table 9.

Table 9

Nominal size DN	Hydrostatic works test pressure bar
40 ⩽ DN ⩽ 300	50
350 ⩽ DN ⩽ 600	40
700 ⩽ DN ⩽ 1 000	32
1 200 ⩽ DN ⩽ 2 000	25
2 200 ⩽ DN ⩽ 2 600	18

3.5 Dimensions and masses — Class k = 9

See figure 1 and table 10.

$$e = \begin{cases} 5{,}8 + 0{,}003\ \text{DN, with a minimum value of 6 mm, for DN 40 to DN 200} \\ 4{,}5 + 0{,}009\ \text{DN, for DN 250 to DN 2 600} \end{cases}$$

Symbol:

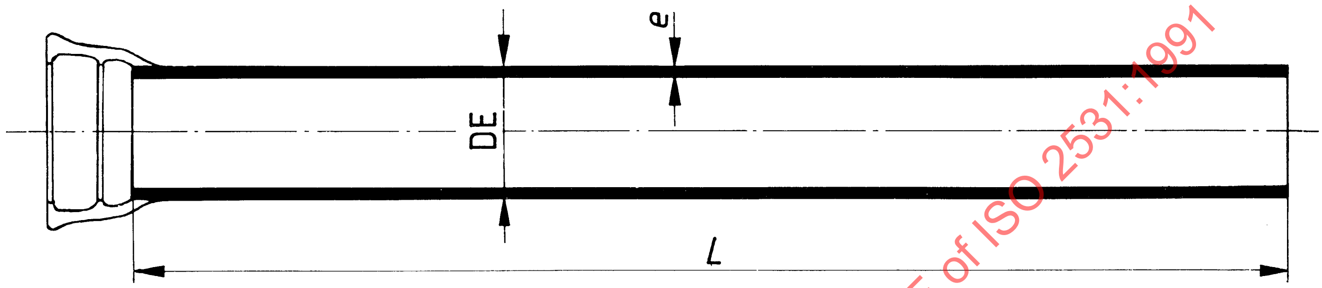


Figure 1

Table 10

Dimensions in millimetres — Masses in kilograms

Nominal size DN	Barrel DE	Barrel e	Barrel Mass per metre (approximate)	Socket mass (approximate)	Total mass (approximate) for one working length L of 2 m	3 m	4 m	5 m	5,5 m	6 m	7 m	8 m	9 m
40	56	6	6,6	1,7	15	21,5	28	34,5	38	41,5	—	—	—
50	66	6	8	2,1	18	26	34	42	46	50	—	—	—
(60)	77	6	9,4	2,5	21,5	30,5	40	49,5	54	59	—	—	—
65	82	6	10,1	2,7	23	33	43	53	58,5	63,5	—	—	—
80	98	6	12,2	3,4	—	—	52	64,5	70,5	76,5	—	—	—
100	118	6,1	15,1	4,3	—	—	64,5	80	87,5	95	—	—	—
125	144	6,2	18,9	5,7	—	—	81,5	100	110	119	—	—	—
150	170	6,3	22,8	7,1	—	—	98,5	121	133	144	—	—	—
200	222	6,4	30,6	10,3	—	—	133	163	179	194	—	—	—
250	274	6,8	40,2	14,2	—	—	175	215	235	255	—	—	—
300	326	7,2	50,8	18,6	—	—	222	273	298	323	—	—	—
350	378	7,7	63,2	23,7	—	—	277	340	371	403	—	—	—
400	429	8,1	75,5	29,3	—	—	331	407	445	482	—	—	—
500	532	9	104,3	42,8	—	—	460	564	616	669	—	—	—
600	635	9,9	137,3	59,3	—	—	608	745	813	882	1 019	1 156	1 293
700	738	10,8	173,9	79,1	—	—	775	949	1 036	1 123	1 296	1 470	1 644
800	842	11,7	215,2	102,6	—	—	963	1 179	1 286	1 394	1 609	1 824	2 039
900	945	12,6	260,2	129,9	—	—	1 171	1 431	1 561	1 691	1 951	2 212	2 472
1 000	1 048	13,5	309,3	161,3	—	—	1 399	1 708	1 862	2 017	2 326	2 636	2 945
1 200	1 255	15,3	420,1	237,7	—	—	1 918	2 338	2 548	2 758	3 178	3 599	4 019
1 400	1 462	17,1	547,2	279,3	—	—	2 468	3 015	3 289	3 563	4 110	4 657	5 204
1 600	1 668	18,9	690,3	375,4	—	—	3 137	3 827	4 172	4 517	5 208	5 898	6 588
1 800	1 875	20,7	850,1	490,6	—	—	3 891	4 741	5 166	5 591	6 441	7 291	8 142
2 000	2 082	22,5	1 026,3	626,4	—	—	4 732	5 758	6 271	6 784	7 811	8 837	9 863
2 200	2 288	24,3	1 218,3	784,2	—	—	5 657	6 876	7 485	8 094	9 312	10 531	11 749
2 400	2 495	26,1	1 427,2	966,2	—	—	6 675	8 102	8 816	9 529	10 957	12 384	13 811
2 600	2 702	27,9	1 652,4	1 173,7	—	—	7 783	9 436	10 262	11 088	12 741	14 393	16 045

Section 4: Flanges

4.1 General — Flanges

In ISO 13, only one type of flange has been adopted for grey iron pipelines. The increase in pressures permissible in ductile iron pipelines, and the extension of the range of uses to which they may be put, have led to the inclusion of four types of flange corresponding to the nominal pressures PN 10, PN 16, PN 25 and PN 40 respectively.

Because they have identical drilling details, it has been possible to adopt a single design for flanges DN 40 and DN 50 for nominal pressures PN 10, PN 16, PN 25 and PN 40, and, for DN 60 and DN 65, a common design for nominal pressures PN 10 and PN 16 on the one hand and PN 25 and PN 40 on the other.

Moreover, since a degree of rationalization of flange dimensions and/or drilling details already exists for DN 80 to DN 200, for the above nominal pressures, and since this rationalization of flange dimensions has been extended to include DN 250 and DN 300 for nominal pressures PN 10 and PN 16, the multiplicity of designs has been reduced as shown in table 11.

Table 11

Nominal size DN	Identical flange dimensions for nominal pressures PN	Identical drilling details for nominal pressures PN
40 and **50**	10—16—25—40	10—16—25—40
60 and **65**	10—16—25—40	10—16 / 25—40
80	10—16—25—40	10—16—25—40
100	10—16 / 25—40	10—16 / 25—40
125 and **150**	10—16	10—16 / 25—40
200 to **300**	10—16	

As specified in ISO 13, PN 10 flanges (see tables 16 and 17) may be used on socket pipelines up to pressures of approximately 15 bar.

The flanges may have a machined raised face and drilled holes; they may also be supplied as cast where particularly accurate moulding processes are used, while respecting the dimensional requirements shown in tables 16 to 27 hereafter for a selected nominal size and nominal pressure.

Flanges can be cast integral with the corresponding casting or cast separately and attached by any known means, such as screwing and welding.

They can also be fixed or removable. The latter arrangement makes casting mounting and PN change easier. Loose flanges can be used under the same service conditions as fixed flanges.

A loose flange is comprised of a ring, in one or several parts bolted together, which bears on an end joint collar. The ring can be freely rotated around the pipe axis and can thus be positioned for alignment with the bolt holes. The external diameter and the drilling details are the same for fixed and loose flanges.

It should be noted that the diameters of bolt holes of the various types of flange are 1 mm larger than those envisaged for pipelines not laid in the ground. This increase makes it easier to assemble the castings, which is sometimes difficult in the case of underground pipelines.

The diameter of the holes has been fixed according to the nominal diameter of the bolts in accordance with the following rule:

- for a bolt ⩽ M20: nominal diameter of the bolt + 3 mm;
- for a bolt > M20 but ⩽ M52: nominal diameter of the bolt + 4 mm;
- for a bolt > M52: nominal diameter of the bolt + 6 mm.

4.2 Tolerances on dimensions

4.2.1 Tolerances on diameters

The tolerances on external diameters and raised face diameters are given in table 12.

Table 12

Dimensions in millimetres

<table>
<tr><th rowspan="3">Dimension</th><th colspan="27">DN</th></tr>
<tr><th>40</th><th>50</th><th>60</th><th>65</th><th>80</th><th>100</th><th>125</th><th>150</th><th>200</th><th>250</th><th>300</th><th>350</th><th>400</th><th>500</th><th>600</th><th>700</th><th>800</th><th>900</th><th>1 000</th><th>1 200</th><th>1 400</th><th>1 600</th><th>1 800</th><th>2 000</th><th>2 200</th><th>2 400</th><th>2 600</th></tr>
<tr><th colspan="27">Tolerance</th></tr>
<tr><td>External diameter, D</td><td colspan="3">± 4</td><td colspan="4">± 4,5</td><td colspan="4">± 5,5
PN 16
DN 250 } + 5,5
DN 300 } − 2,5</td><td colspan="4">± 6,5</td><td colspan="4">± 7,5</td><td>± 8,5</td><td>± 10</td><td colspan="6">± 12</td></tr>
<tr><td>Raised face diameter, d_1</td><td colspan="7">± 4</td><td>+ 4,5
− 4,0</td><td colspan="5">+ 5,5
− 4,5</td><td colspan="2">+ 6,5
− 5,0</td><td colspan="4">+ 7,5
− 5,5</td><td colspan="2">+ 8,5
− 5,5</td><td>+ 9,0
− 5,5</td><td colspan="5">+ 10
− 6</td></tr>
</table>

4.2.2 Tolerances on raised face height

The tolerances on raised face height are given in table 13.

Table 13

Dimensions in millimetres

Height of raised face, f_1	Tolerance
3	+ 1,5 − 2,0
4	+ 2 − 3
5	+ 2,5 − 4,0

4.2.3 Tolerance on thickness

The tolerance on flange thickness, b, is given in table 14 ($b = C - f_1$).

Table 14

Dimensions in millimetres

Type of flange	Tolerance
Integrally cast flanges	± (3 + 0,05 b)
Welded and screwed-on flanges	± (2 + 0,05 b)

4.2.4 Tolerances on flange drillings

The tolerances on bolt hole diameters, pitch circle diameters and centre to centre of adjacent bolt holes are given in table 15.

Table 15

Dimensions in millimetres

Dimension	Bolt hole diameter		
	ø19 to ø28	ø31 to ø56	⩾ ø62
	Tolerance		
Bolt hole diameter, L_2	$^{+0,5}_{0}$	$^{+0,5}_{0}$	$^{+1}_{0}$
Pitch circle diameter, K	± 2	± 2,8	± 4,8
Centre to centre of adjacent bolt holes	± 2	± 2,8	± 4,8

4.2.5 Tolerance on parallelism of bolting surface with joint face

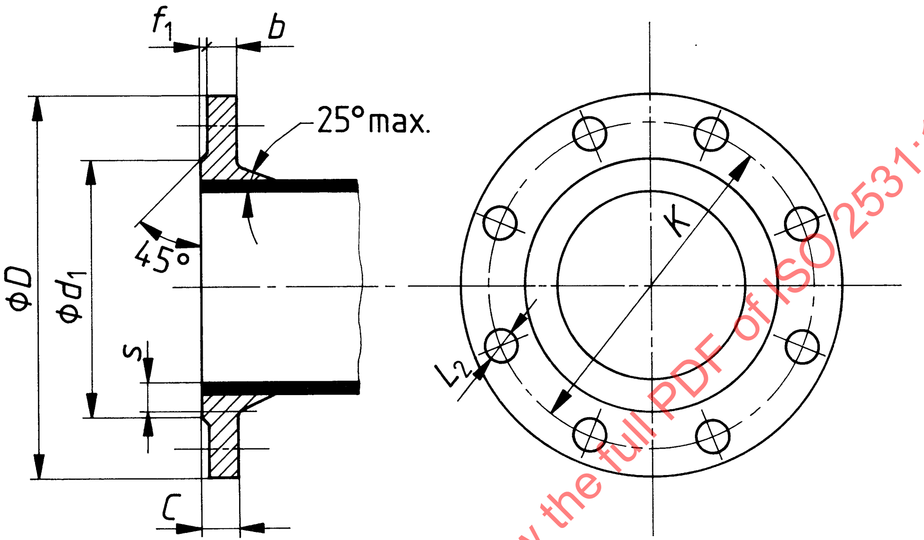
The tolerance on parallelism of the bolting surface, behind the flange, with the joint face shall be 2° max.

4.3 Dimensions and drilling details of PN 10 flanges

4.3.1 Fixed flanges (see figure 2 and tables 16 and 17)

$$b = \begin{cases} 10 + 0{,}035\ \text{DN, with a minimum value of 16 mm, for DN 40 to DN 300} \\ 10 + 0{,}025\ \text{DN, with a minimum value of 20,5 mm, for DN 350 to DN 1 200} \\ 20 + 0{,}015\ \text{DN, for DN 1 400 to DN 2 600} \end{cases}$$

$$s = \begin{cases} 0{,}8\,C\text{, for DN 40 to DN 600} \\ 0{,}7\,C\text{, for DN 700 to DN 2 600} \end{cases}$$



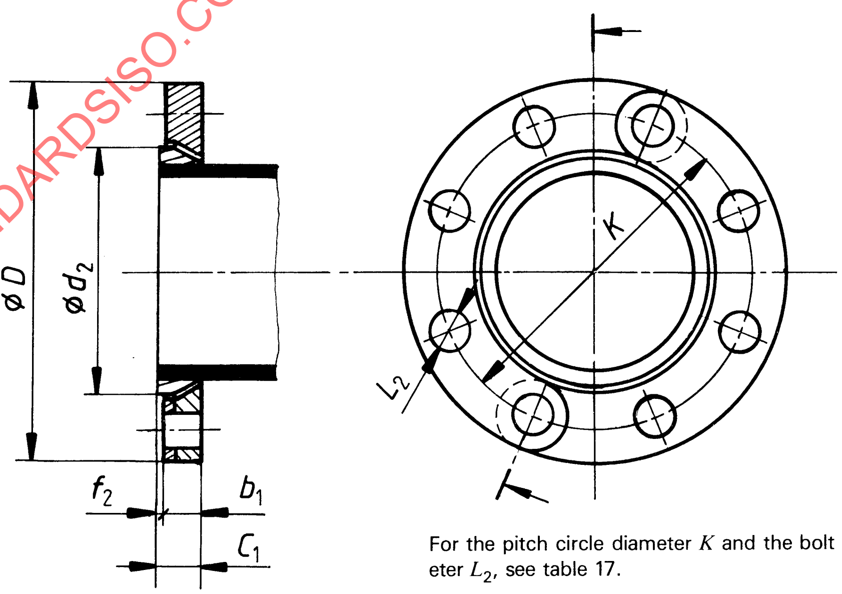
This view may not represent the exact number of holes.

Refer to column "Number of holes" in table 17 to obtain the exact number.

Figure 2

4.3.2 Loose flanges (see figure 3 and table 18)

b_1 = 14 + 0,06 DN, with a minimum value of 19 mm



For the pitch circle diameter K and the bolt hole diameter L_2, see table 17.

This view may not represent the exact number of holes.

Refer to column "Number of holes" in table 17 to obtain the exact number.

Figure 3

Table 16

Dimensions in millimetres — Masses in kilograms

Nominal size DN	D	d_1	C	b	f_1	s 1)	Approximate flange mass (hatched part)
40	150	84	19	16	3	15	1,7
50	165	99	19	16	3	15	2,1
(60)	175	108	19	16	3	15	2,2
65	185	118	19	16	3	15	2,5
80	200	132	19	16	3	15	2,9
100	220	156	19	16	3	15	3,3
125	250	184	19	16	3	15	4
150	285	211	19	16	3	15	4,9
200	340	266	20	17	3	16	6,8
250	400	319	22	19	3	17,5	9,6
300	455	370	24,5	20,5	4	19,5	12,8
350	505	429	24,5	20,5	4	19,5	14,1
400	565	480	24,5	20,5	4	19,5	16,3
500	670	582	26,5	22,5	4	21	21,8
600	780	682	30	25	5	24	30,8
700	895	794	32,5	27,5	5	23	40,5
800	1 015	901	35	30	5	24,5	54,8
900	1 115	1 001	37,5	32,5	5	26,5	64,3
1 000	1 230	1 112	40	35	5	28	81,4
1 200	1 455	1 328	45	40	5	31,5	120,9
1 400	1 675	1 530	46	41	5	32	147,8
1 600	1 915	1 750	49	44	5	34,5	206,4
1 800	2 115	1 950	52	47	5	36,5	236,3
2 000	2 325	2 150	55	50	5	38,5	279,4
2 200	2 550	2 370	59	53	6	41,5	345,6
2 400	2 750	2 570	62	56	6	43,5	398,8
2 600	2 960	2 780	65	59	6	45,5	436,9

1) Dimension s is for the sole purpose of calculating the mass.

Table 17

Dimensions in millimetres

Nominal size DN	D	K	Holes		Bolts
			Number	Diameter L_2	Nominal diameter
40	150	110	4	19	M16
50	165	125	4	19	M16
(60)	175	135	4	19	M16
65	185	145	4	19	M16
80	200	160	8 1)	19	M16
100	220	180	8	19	M16
125	250	210	8	19	M16
150	285	240	8	23	M20
200	340	295	8	23	M20
250	400	350	12	23	M20
300	455	400	12	23	M20
350	505	460	16	23	M20
400	565	515	16	28	M24
500	670	620	20	28	M24
600	780	725	20	31	M27
700	895	840	24	31	M27
800	1 015	950	24	34	M30
900	1 115	1 050	28	34	M30
1 000	1 230	1 160	28	37	M33
1 200	1 455	1 380	32	40	M36
1 400	1 675	1 590	36	43	M39
1 600	1 915	1 820	40	49	M45
1 800	2 115	2 020	44	49	M45
2 000	2 325	2 230	48	49	M45
2 200	2 550	2 440	52	56	M52
2 400	2 760	2 650	56	56	M52
2 600	2 960	2 850	60	56	M52

1) For flanges with nominal diameter DN 80 and nominal pressure PN 10, the number of holes may be reduced to 4 at the purchaser's request, in order to permit coupling with an existing flange of an old pipeline.

Table 18

Dimensions in millimetres — Masses in kilograms

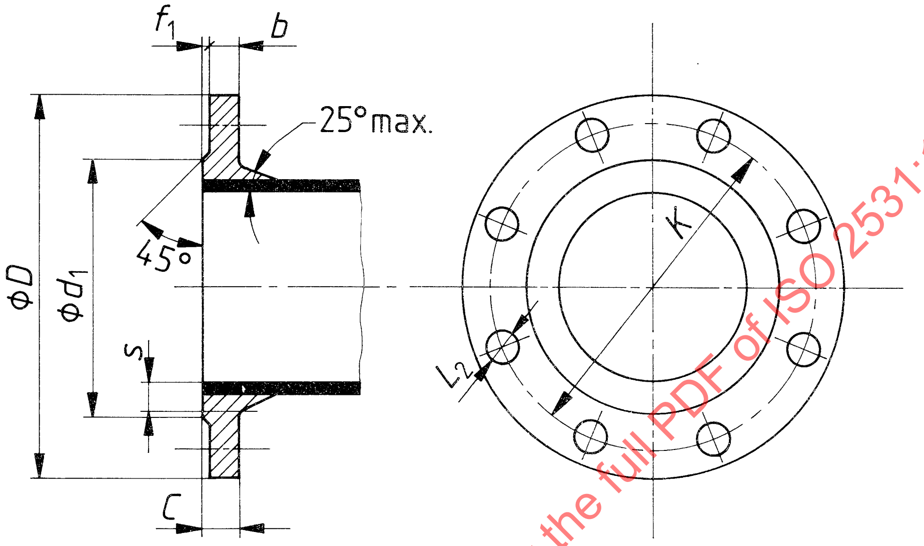
Nominal size DN	D	d_2	C_1	b_1	f_2	Approximate flange mass (hatched parts)
40	150	84	22	19	3	1,8
50	165	99	22	19	3	2,1
(60)	175	108	22	19	3	2,3
65	185	118	22	19	3	2,8
80	200	132	22	19	3	2,9
100	220	156	23	20	3	3,4
125	250	184	24,5	21,5	3	4,4
150	285	211	26	23	3	5,7
200	340	266	29	26	3	8,2
250	400	319	32	29	3	11,7
300	455	370	36	32	4	15,3
350	505	429	39	35	4	19,5
400	565	480	42	38	4	22,1
500	670	582	48	44	4	33
600	780	682	55	50	5	43,9

4.4 Dimensions and drilling details of PN 16 flanges

4.4.1 Fixed flanges (see figure 4 and tables 19 and 20)

$$b = \begin{cases} 10 + 0{,}035\ \text{DN, with a minimum value of 16 mm, for DN 40 to DN 1 200} \\ 20 + 0{,}025\ \text{DN, for DN 1 400 to DN 2 600} \end{cases}$$

$$s = \begin{cases} 0{,}8\ C\text{, for DN 40 to DN 600} \\ 0{,}7\ C\text{, for DN 700 to DN 2 600} \end{cases}$$



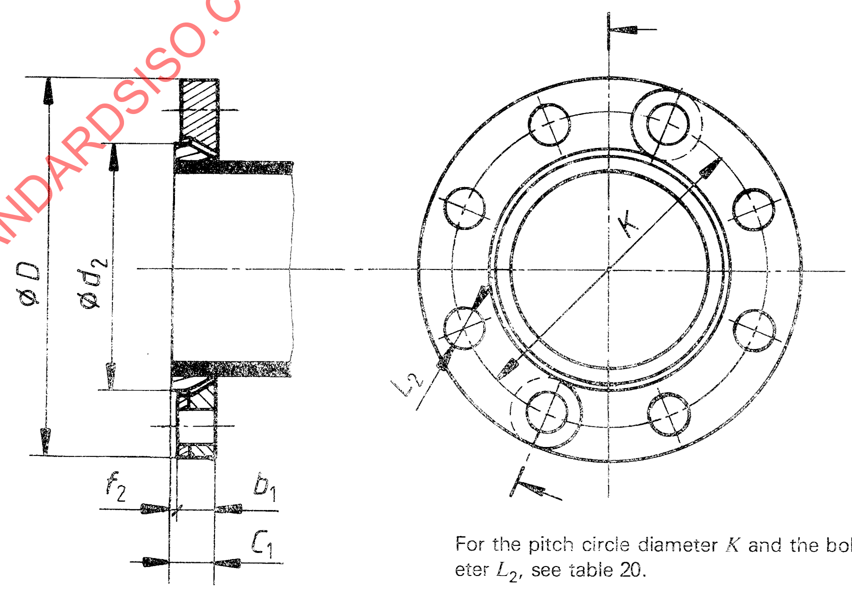
This view may not represent the exact number of holes.

Refer to column "Number of holes" in table 20 to obtain the exact number.

Figure 4

4.4.2 Loose flanges (see figure 5 and table 21)

b_1 = 14 + 0,06 DN, with a minimum value of 19 mm



For the pitch circle diameter K and the bolt hole diameter L_2, see table 20.

This view may not represent the exact number of holes.

Refer to column "Number of holes" in table 20 to obtain the exact number.

Figure 5

Table 19

Dimensions in millimetres — Masses in kilograms

Nominal size DN	D	d_1	C	b	f_1	s[1)]	Approximate flange mass (hatched part)
40	150	84	19	16	3	15	1,7
50	165	99	19	16	3	15	2,1
(60)	175	108	19	16	3	15	2,2
65	185	118	19	16	3	15	2,5
80	200	132	19	16	3	15	2,9
100	220	156	19	16	3	15	3,3
125	250	184	19	16	3	15	4
150	285	211	19	16	3	15	4,9
200	340	266	20	17	3	16	6,6
250	400	319	22	19	3	17,5	9,2
300	455	370	24,5	20,5	4	19,5	12,4
350	520	429	26,5	22,5	4	21	17,2
400	580	480	28	24	4	22,5	21,9
500	715	609	31,5	27,5	4	25	37
600	840	720	36	31	5	29	57,3
700	910	794	39,5	34,5	5	27,5	55,6
800	1 025	901	43	38	5	30	74
900	1 125	1 001	46,5	41,5	5	32,5	88,2
1 000	1 255	1 112	50	45	5	35	122,9
1 200	1 485	1 328	57	52	5	40	185,2
1 400	1 685	1 530	60	55	5	42	215,9
1 600	1 930	1 750	65	60	5	45,5	308,4
1 800	2 130	1 950	70	65	5	49	362,2
2 000	2 345	2 150	75	70	5	52,5	432,2
2 200	2 555	2 370	81	75	6	56,5	512,3
2 400	2 765	2 570	86	80	6	60	601
2 600	2 965	2 780	91	85	6	63,5	672

1) Dimension s is for the sole purpose of calculating the mass.

Table 20

Dimensions in millimetres

Nominal size DN	D	K	Holes: Number	Holes: Diameter L_2	Bolts: Nominal diameter
40	150	110	4	19	M16
50	165	125	4	19	M16
(60)	175	135	4	19	M16
65	185	145	4	19	M16
80	200	160	8	19	M16
100	220	180	8	19	M16
125	250	210	8	19	M16
150	285	240	8	23	M20
200	340	295	12	23	M20
250	400	355	12	28	M24
300	455	410	12	28	M24
350	520	470	16	28	M24
400	580	525	16	31	M27
500	715	650	20	34	M30
600	840	770	20	37	M33
700	910	840	24	37	M33
800	1 025	950	24	40	M36
900	1 125	1 050	28	40	M36
1 000	1 255	1 170	28	43	M39
1 200	1 485	1 390	32	49	M45
1 400	1 685	1 590	36	49	M45
1 600	1 930	1 820	40	56	M52
1 800	2 130	2 020	44	56	M52
2 000	2 345	2 230	48	62	M56
2 200	2 555	2 440	52	62	M56
2 400	2 765	2 650	56	62	M56
2 600	2 965	2 850	60	62	M56

Table 21

Dimensions in millimetres — Masses in kilograms

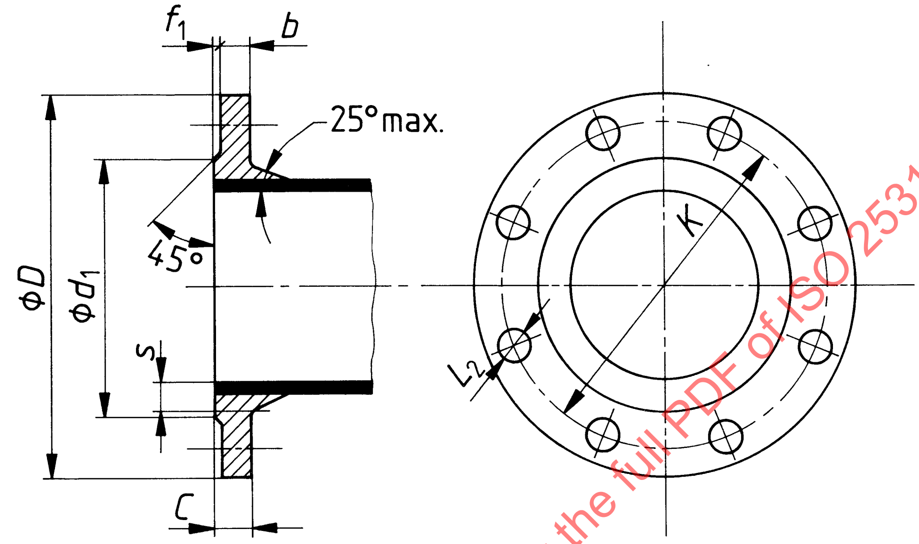
Nominal size DN	D	d_2	C_1	b_1	f_2	Approximate flange mass (hatched parts)
40	150	84	22	19	3	1,8
50	165	99	22	19	3	2,1
(60)	175	108	22	19	3	2,3
65	185	118	22	19	3	2,8
80	200	132	22	19	3	2,9
100	220	156	23	20	3	3,4
125	250	184	24,5	21,5	3	4,4
150	285	211	26	23	3	5,7
200	340	266	29	26	3	8,1
250	400	319	32	29	3	11,3
300	455	370	36	32	4	14,6
350	520	429	39	35	4	20,3
400	580	482	42	38	4	26,6
500	715	609	48	44	4	46
600	840	720	55	50	5	68,9

4.5 Dimensions and drilling details of PN 25 flanges

4.5.1 Fixed flanges (see figure 6 and tables 22 and 23)

$$b = \begin{cases} 10 + 0{,}045\ \text{DN, with a minimum value of 16 mm, for DN 40 to DN 1 200} \\ 20 + 0{,}035\ \text{DN, for DN 1 400 to DN 2 000} \end{cases}$$

$$s = \begin{cases} 0{,}8\ C\text{, for DN 40 to DN 600} \\ 0{,}7\ C\text{, for DN 700 to DN 2 000} \end{cases}$$



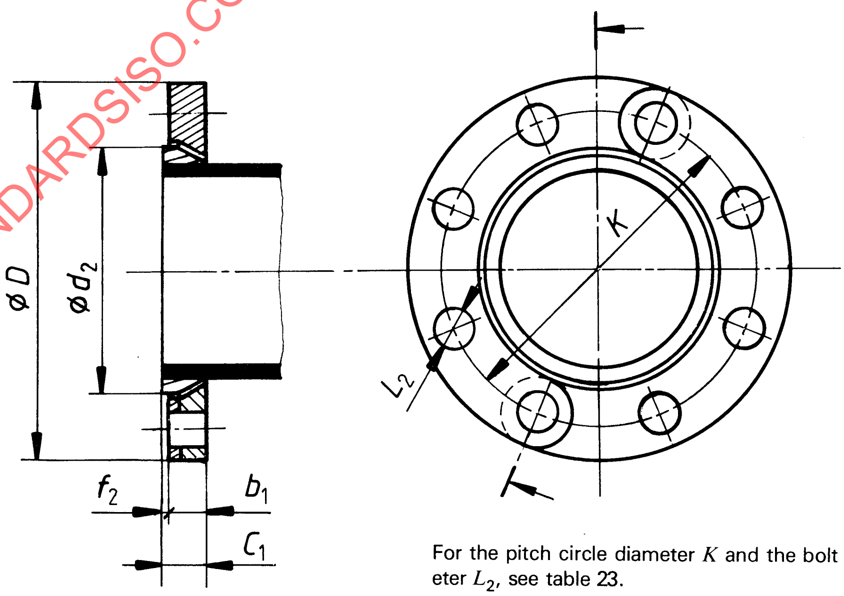
This view may not represent the exact number of holes.

Refer to column "Number of holes" in table 23 to obtain the exact number.

Figure 6

4.5.2 Loose flanges (see figure 7 and table 24)

b_1 = 14 + 0,06 DN, with a minimum value of 19 mm



For the pitch circle diameter K and the bolt hole diameter L_2, see table 23.

This view may not represent the exact number of holes.

Refer to column "Number of holes" in table 23 to obtain the exact number.

Figure 7

Table 22

Dimensions in millimetres — Masses in kilograms

Nominal size DN	D	d_1	C	b	f_1	s[1)]	Approximate flange mass (hatched part)
40	150	84	19	16	3	15	1,7
50	165	99	19	16	3	15	2,1
(60)	175	108	19	16	3	15	2,1
65	185	118	19	16	3	15	2,4
80	200	132	19	16	3	15	2,9
100	235	156	19	16	3	15	3,8
125	270	184	19	16	3	15	4,6
150	300	211	20	17	3	16	5,9
200	360	274	22	19	3	17,5	8,7
250	425	330	24,5	21,5	3	19,5	13,1
300	485	389	27,5	23,5	4	22	18
350	555	448	30	26	4	24	25,5
400	620	503	32	28	4	25,5	33,2
500	730	609	36,5	32,5	4	29	48,7
600	845	720	42	37	5	33,5	71,5
700	960	820	46,5	41,5	5	32,5	90,3
800	1 085	928	51	46	5	35,5	123,2
900	1 185	1 028	55,5	50,5	5	39	148,6
1 000	1 320	1 140	60	55	5	42	200,7
1 200	1 530	1 350	69	64	5	48,5	284,7
1 400	1 755	1 560	74	69	5	52	368,1
1 600	1 975	1 780	81	76	5	56,5	485,5
1 800	2 195	1 985	88	83	5	61,5	601,9
2 000	2 425	2 210	95	90	5	66,5	784,9

1) Dimension s is for the sole purpose of calculating the mass.

Table 23

Dimensions in millimetres

Nominal size DN	D	K	Holes Number	Holes Diameter L_2	Bolts Nominal diameter
40	150	110	4	19	M16
50	165	125	4	19	M16
(60)	175	135	8	19	M16
65	185	145	8	19	M16
80	200	160	8	19	M16
100	235	190	8	23	M20
125	270	220	8	28	M24
150	300	250	8	28	M24
200	360	310	12	28	M24
250	425	370	12	31	M27
300	485	430	16	31	M27
350	555	490	16	34	M30
400	620	550	16	37	M33
500	730	660	20	37	M33
600	845	770	20	40	M36
700	960	875	24	43	M39
800	1 085	990	24	49	M45
900	1 185	1 090	28	49	M45
1 000	1 320	1 210	28	56	M52
1 200	1 530	1 420	32	56	M52
1 400	1 755	1 640	36	62	M56
1 600	1 975	1 860	40	62	M56
1 800	2 195	2 070	44	70	M64
2 000	2 425	2 300	48	70	M64

Table 24

Dimensions in millimetres — Masses in kilograms

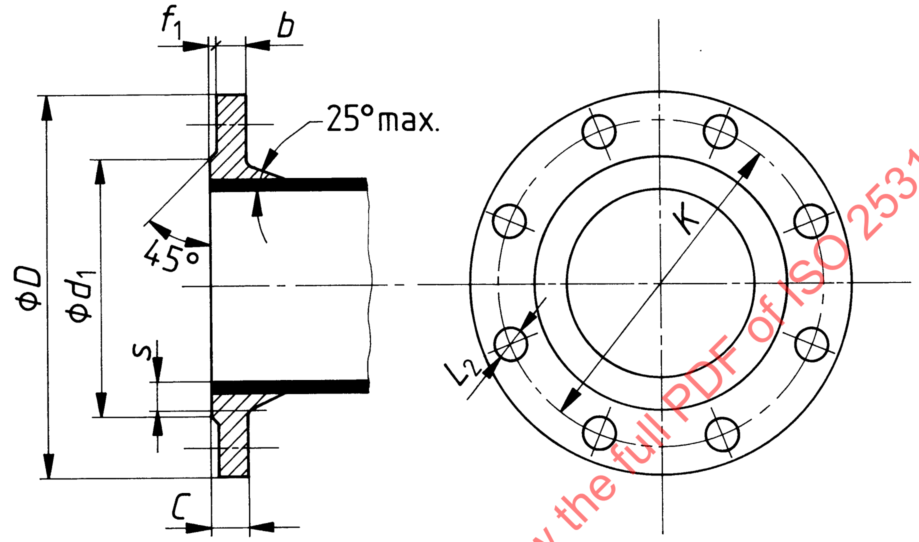
Nominal size DN	D	d_2	C_1	b_1	f_2	Approximate flange mass (hatched parts)
40	150	84	22	19	3	1,8
50	165	99	22	19	3	2,1
(60)	175	108	22	19	3	1,9
65	185	118	22	19	3	2,9
80	200	132	22	19	3	3
100	235	156	23	20	3	3,9
125	270	184	24,5	21,5	3	5,3
150	300	211	26	23	3	6,7
200	360	274	29	26	3	9,2
250	425	330	32	29	3	14,2
300	485	389	36	32	4	18,2
350	555	448	39	35	4	26,4
400	620	503	42	38	4	36,6
500	730	609	48	44	4	52
600	845	720	55	50	5	71,9

4.6 Dimensions and drilling details of PN 40 flanges

4.6.1 Fixed flanges (see figure 8 and tables 25 and 26)

$$b = \begin{cases} 10 + 0{,}045\ \text{DN, with a minimum value of 16 mm, for DN 40 to DN 100} \\ 10 + 0{,}085\ \text{DN, for DN 125 to DN 400} \\ 20 + 0{,}055\ \text{DN, for DN 500 and DN 600} \end{cases}$$

$$s = \begin{cases} 0{,}8\ C\text{, for DN 40 to DN 100} \\ 0{,}7\ C\text{, for DN 125 to DN 600} \end{cases}$$



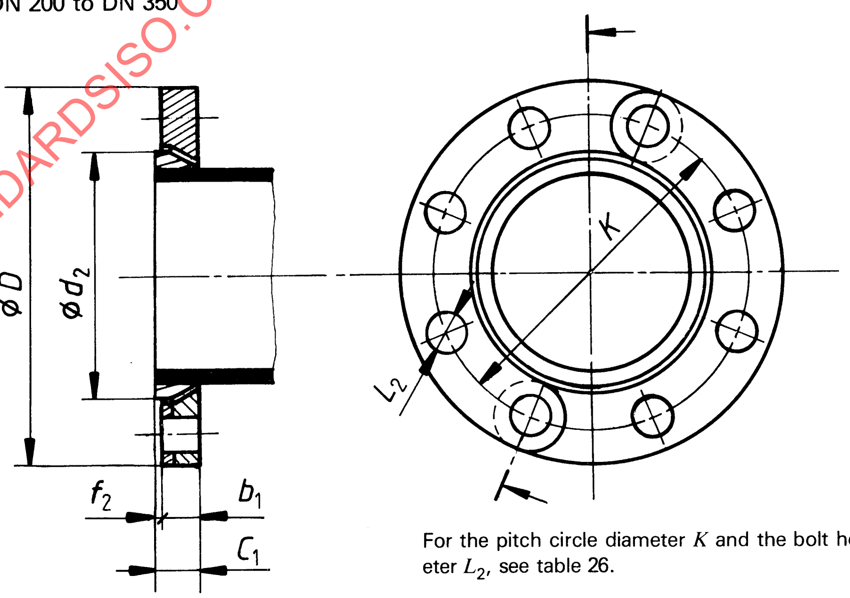
This view may not represent the exact number of holes.

Refer to column "Number of holes" in table 26 to obtain the exact number.

Figure 8

4.6.2 Loose flanges (see figure 9 and table 27)

$$b_1 = \begin{cases} 14 + 0{,}06\ \text{DN, with a minimum value of 19 mm, for DN 40 to DN 150} \\ 14 + 0{,}08\ \text{DN, for DN 200 to DN 350} \end{cases}$$



For the pitch circle diameter K and the bolt hole diameter L_2, see table 26.

This view may not represent the exact number of holes.

Refer to column "Number of holes" in table 26 to obtain the exact number.

Figure 9

Table 25

Dimensions in millimetres — Masses in kilograms

Nominal size DN	D	d_1	C	b	f_1	s[1]	Approximate flange mass (hatched part)
40	150	84	19	16	3	15	1,7
50	165	99	19	16	3	15	2,1
(60)	175	108	19	16	3	15	2,1
65	185	118	19	16	3	15	2,4
80	200	132	19	16	3	15	2,9
100	235	156	19	16	3	15	3,8
125	270	184	23,5	20,5	3	16,5	5,9
150	300	211	26	23	3	18	8
200	375	284	30	27	3	21	14
250	450	345	34,5	31,5	3	24	23,2
300	515	409	39,5	35,5	4	27,5	33,5
350	580	465	44	40	4	31	46,7
400	660	535	48	44	4	33,5	66,9
500	755	615	52	48	4	36,5	82,3
600	890	735	58	53	5	40,5	124,1

1) Dimension s is for the sole purpose of calculating the mass.

Table 26

Dimensions in millimetres

Nominal size DN	D	K	Holes: Number	Holes: Diameter L_2	Bolts: Nominal diameter
40	150	110	4	19	M16
50	165	125	4	19	M16
(60)	175	135	8	19	M16
65	185	145	8	19	M16
80	200	160	8	19	M16
100	235	190	8	23	M20
125	270	220	8	28	M24
150	300	250	8	28	M24
200	375	320	12	31	M27
250	450	385	12	34	M30
300	515	450	16	34	M30
350	580	510	16	37	M33
400	660	585	16	40	M36
500	755	670	20	43	M39
600	890	795	20	49	M45

Table 27

Dimensions in millimetres — Masses in kilograms

Nominal size DN	D	d_2	C_1	b_1	f_2	Approximate flange mass (hatched parts)
40	150	84	22	19	3	1,8
50	165	99	22	19	3	2,1
(60)	175	108	22	19	3	1,9
65	185	118	22	19	3	2,9
80	200	132	22	19	3	3
100	235	156	23	20	3	3,9
125	270	184	24,5	21,5	3	5,3
150	300	211	26	23	3	6,7
200	375	284	33	30	3	11,4
250	450	345	37	34	3	22,9
300	515	409	42	38	4	31,3
350	580	465	46	42	4	43,2

Section 5: Flanged pipes

5.1 General — Flanged pipes

This section defines six ranges of ductile iron flanged pipes as a function of their thickness and of the method for connecting flanges to the barrel.

It is applicable to

— pipes with integral flanges (see figure 10 and table 28);

— pipes with screwed flanges (see figure 11 and table 29) or with welded flanges [welding neck flanges (see figure 10 and table 28) or slip-on flanges for welding (see figure 11 and table 29)].

The wall thickness e has been calculated as a function of the nominal size DN using the linear formula (see clause 2.2)

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

where

k = 12 and 14 for pipes with integral flanges;

k = 10 and 12 for pipes with screwed flanges;

k = 9 for pipes with welded flanges (welding neck flanges or slip-on flanges for welding).

As for spigot and socket pipes, the wall thicknesses for small diameter pipes are calculated using a complementary formula

$$e = 5{,}8 + 0{,}003\ \mathrm{DN}\ \text{(with a minimum value of 6 mm)}$$

which is applicable to DN 40 to DN 200 for pipes of class k = 9 and DN 40 to DN 125 for pipes of class k = 10.

The national standards or, when not so specified, the manufacturers' catalogues, shall specify which of the two values of coefficient k should be used in the calculation of wall thicknesses for pipes with integral flanges and pipes with screwed flanges.

In compliance with section 4, four types of flanges are provided, corresponding to nominal pressures PN 10, PN 16, PN 25 and PN 40, and these can be connected to pipes in a fixed or removable way. The latter arrangement has the advantage of making casting mounting and PN change easier.

In addition to the wall thicknesses of the pipes, tables 28 and 29 specify the conventional mass per unit length, in kilograms per metre, of the barrel, and the approximate unit mass, in kilograms, of the corresponding flange.

For pipes with integral flanges and pipes with welding neck flanges (see figure 10 and table 28), the flange unit mass is as in section 4.

For pipes with screwed flanges and pipes with slip-on flanges for welding (see figure 11 and table 29), the flange unit mass has been increased by an amount taking account of connecting thicknesses calculated from a linear formula corresponding to the average of the values used in different countries.

The design of the leak-tightness of screwed flanges is left to the manufacturer's choice.

5.2 Lengths and tolerances on length

The manufacturing working lengths of flanged pipes shall be those specified in national standards, or, when not so specified, in the manufacturers' catalogues.

The standard tolerance on manufacturing working lengths is ± 10 mm.

On request by the purchaser in the order, and by agreement between the manufacturer and the purchaser, smaller tolerances can be accepted but they shall be not less than ± 3 mm.

Class $k = 9$ — $e = 5{,}8 + 0{,}003$ DN, with a minimum value of 6 mm, for DN 40 to DN 200; $4{,}5 + 0{,}009$ DN, for DN 250 to DN 600

Class $k = 12$ — $e = 6 + 0{,}012$ DN, with a minimum value of 7 mm, for DN 40 to DN 2 600

Class $k = 14$ — $e = 7 + 0{,}014$ DN, for DN 40 to DN 2 600

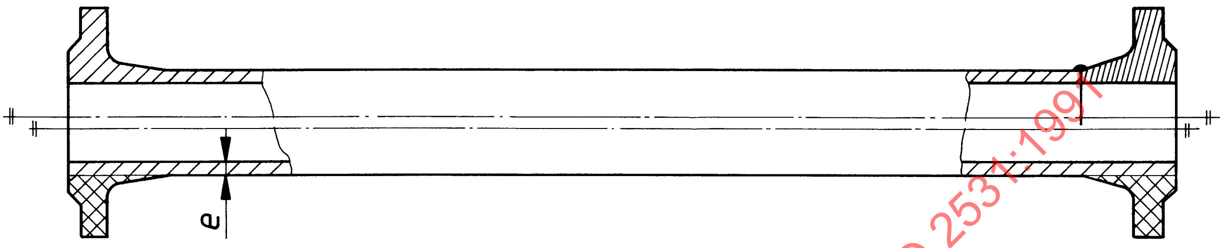


Figure 10

Table 28

Nominal size	Barrel						Flange			
	$k = 9$[1]		$k = 12$[2]		$k = 14$[2]		Unit mass (chequered part) kg			
DN	*e* mm	Mass per metre kg/m	*e* mm	Mass per metre kg/m	*e* mm	Mass per metre kg/m	PN 10	PN 16	PN 25	PN 40
40	6	6,6	7	7,6	7,6	8,1	1,7	1,7	1,7	1,7
50	6	8	7	9,1	7,7	9,9	2,1	2,1	2,1	2,1
(60)	6	9,4	7	10,9	7,8	12	2,2	2,2	2,1	2,1
65	6	10,1	7	11,6	7,9	13	2,5	2,5	2,4	2,4
80	6	12,2	7	14,1	8,1	16,1	2,9	2,9	2,9	2,9
100	6,1	15,1	7,2	17,7	8,4	20,4	3,3	3,3	3,8	3,8
125	6,2	18,9	7,5	22,7	8,8	26,4	4	4	4,6	5,9
150	6,3	22,8	7,8	28	9,1	32,4	4,9	4,9	5,9	8
200	6,4	30,6	8,4	39,7	9,8	46,1	6,8	6,6	8,7	14
250	6,8	40,2	9	52,8	10,5	61,3	9,6	9,2	13,1	23,2
300	7,2	50,8	9,6	67,3	11,2	78,1	12,8	12,4	18	33,5
350	7,7	63,2	10,2	83,1	11,9	96,5	14,1	17,2	25,5	—
400	8,1	75,5	10,8	100	12,6	116,2	16,3	21,9	33,2	—
500	9	104,3	12	138,2	14	160,6	21,8	37	48,7	—
600	9,9	137,1	13,2	181,8	15,4	211,3	30,8	57,3	71,5	—
700	—	—	14,4	230,8	16,8	268,4	40,5	55,6	—	—
800	—	—	15,6	285,5	18,2	332,1	54,8	74	—	—
900	—	—	16,8	345,4	19,6	401,7	64,3	88,2	—	—
1 000	—	—	18	410,6	21	477,7	81,4	122,9	—	—
1 200	—	—	20,4	557,8	23,8	649	120,9	185,2	—	—
1 400	—	—	22,8	726,8	26,6	845,7	147,8	215,9	—	—
1 600	—	—	25,2	916,9	29,4	1 067	206,4	308,4	—	—
1 800	—	—	27,6	1 129,3	32,2	1 314,2	236,3	362,2	—	—
2 000	—	—	30	1 363,4	35	1 586,8	279,4	432,2	—	—
2 200	—	—	32,4	1 618,6	37,8	1 883,9	345,6	512,3	—	—
2 400	—	—	34,8	1 896,2	40,6	2 207	398,8	601,1	—	—
2 600	—	—	37,2	2 195,6	43,4	2 555,5	436,9	672	—	—

1) Applicable to centrifugally cast pipes with welding neck flanges.

2) Applicable to cast pipes with integral flanges.

Class k = 9 } e = { 5,8 + 0,003 DN, with a minimum value of 6 mm, for DN 40 to DN 200
4,5 + 0,009 DN, for DN 250 to DN 2 600

Class k = 10 } e = { 5,8 + 0,003 DN, with a minimum value of 6 mm, for DN 40 to DN 100
5 + 0,010 DN, for DN 125 to DN 2 600

Class k = 12 } e = { 6 + 0,012 DN, for DN 40 to DN 2 600

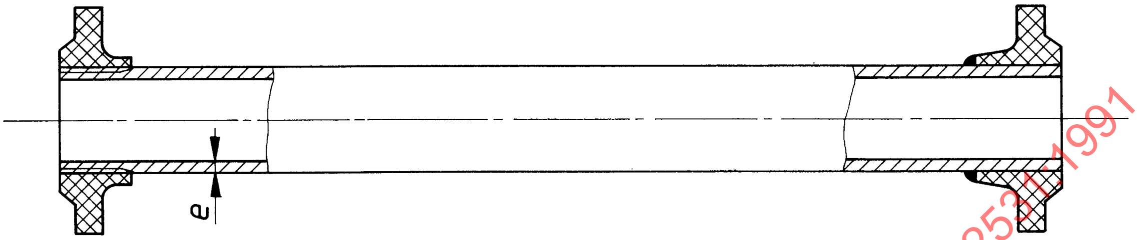


Figure 11

Table 29

Nominal size	Barrel						Flange			
	k = 9[1)]		k = 10[2)]		k = 12[2)]		Unit mass (chequered part) kg			
DN	e mm	Mass per metre kg/m	e mm	Mass per metre kg/m	e mm	Mass per metre kg/m	PN 10	PN 16	PN 25	PN 40
40	6	6,6	6	6,6	6,5	7,1	2	2	2	2
50	6	8	6	8	6,6	8,7	2,5	2,5	2,5	2,5
(60)	6	9,4	6	9,4	6,7	10,4	2,7	2,7	2,6	2,6
65	6	10,1	6	10,1	6,8	11,3	3	3	2,9	2,9
80	6	12,2	6	12,2	7	14,1	3,5	3,5	3,5	3,5
100	6,1	15,1	6,1	15,1	7,2	17,7	4	4	4,5	4,5
125	6,2	18,9	6,3	19,2	7,5	22,7	5	5	5,6	6,9
150	6,3	22,8	6,5	23,5	7,8	28	6,1	6,1	7,1	9,2
200	6,4	30,6	7	33,3	8,4	39,7	8,5	8,3	10,4	15,7
250	6,8	40,2	7,5	44,3	9	52,8	11,8	11,4	15,3	25,4
300	7,2	50,8	8	56,3	9,6	67,3	15,6	15,2	20,8	36,3
350	7,7	63,2	8,5	69,6	10,2	83,1	17,6	20,7	29	—
400	8,1	75,5	9	83,7	10,8	100	20,5	26,1	37,4	—
500	9	104,3	10	115,6	12	138,2	27,6	42,8	54,5	—
600	9,9	137,1	11	152	13,2	181,8	38,4	64,9	79,1	—
700	10,8	173,9	12	193	14,4	230,8	50,2	65,3	—	—
800	11,7	215,2	13	238,7	15,6	285,5	66,7	85,9	—	—
900	12,6	260,2	14	288,7	16,8	345,4	78,7	102,6	—	—
1 000	13,5	309,3	15	343,2	18	410,6	98,6	140,1	—	—
1 200	15,3	420,1	17	466,1	20,4	557,8	144,2	208,5	—	—
1 400	17,1	547,2	19	607,2	22,8	726,8	178,2	246,3	—	—
1 600	18,9	690,3	21	766	25,2	916,9	244,7	346,7	—	—
1 800	20,7	850,1	23	943,4	27,6	1 129,3	283,5	409,4	—	—
2 000	22,5	1 026,3	25	1 139	30	1 363,4	336,4	489,2	—	—
2 200	24,3	1 218,3	27	1 352,1	32,4	1 618,6	413,2	579,9	—	—
2 400	26,1	1 427,2	29	1 583,9	34,8	1 896,2	478	680,3	—	—
2 600	27,9	1 652,42	31	1 833,9	37,2	2 195,6	528,6	763,7	—	—

1) Applicable to centrifugally cast pipes with slip-on flanges for welding.
2) Applicable to centrifugally cast pipes with screwed flanges.

Section 6: Fittings

6.1 General — Fittings

In general, ductile iron fittings are of designs similar to those of grey iron fittings (see ISO 13) and their ends are flanged or, preferably, socketed.[1)]

The greater mechanical strength of ductile iron has made it possible to improve the design of fittings and to reduce their dimensions. This makes it easier to lay mains in congested urban areas of large towns, and results in a reduction in the size of valve chambers, the dimensions of which depend mainly on the space occupied by the fittings.

Flanged socket pieces (see table 32) and straight collars (see table 34) have an internal diameter enlarged sufficiently to allow the adjacent pipes to slide through, facilitating the dismantling and the longitudinal adjustment of pipeline sections.

The double-socket bends (see tables 35 to 38) have lengths increasing in proportion to their angle of deviation, their bearing surface on the thrust blocks thus being adjusted to the size of the lateral forces which they exert on these thrust blocks.

The use of reducing flanges (see tables 50 to 53) and double-flanged tapers (see table 45) has made it possible to simplify the range of flanged-branch tees (see tables 39 to 42 and 58 to 63); the use of a combination of these fittings makes it possible to provide users with the greatest number of possibilities with the smallest number of types of castings.

The effect of this arrangement based on market statistics is to reduce stores both at the manufacturer's works and at the customer's premises and also to make supply easier.

Double-socket tapers (see table 44), used mainly for a reduction in diameter, have the shortest practicable lengths.

Double-flanged tapers (see table 45), generally placed between two successive diameters, have a length in proportion to the variation in diameter, each side being sloped at 5° to the centre-line, and chosen so as to reduce the pressure loss when the tapers are used to increase the diameter.

Table 32 and those following are for ductile iron fittings for pressure pipelines for the transportation and distribution of water, other liquids, or gas.

6.2 Thickness

The thickness of fittings has been calculated as a function of the nominal size DN by using the formula in clause 2.2, with the following values for k.

k = 14 for tees, thus

$$e = 7 + 0{,}014\ \text{DN}$$

k = 12 for other fittings, thus

$$e = 6 + 0{,}012\ \text{DN}$$

For DN 40 to DN 65, the thickness of the fittings has been limited to 7 mm, so that, taking the tolerances into account, the thickness of the fittings is always at least equal to that of the pipes of the same nominal size.

1) This preference for fittings with sockets is justified by many advantages, defined below.

In a mains, the position of the fittings — bends, tees, etc. — is nearly always governed by the layout of the pipelines and rarely coincides with the end of a pipe.

It is generally necessary to insert, between the last standard-length pipe and the fitting, a shorter section obtained by cutting a standard-length pipe into two pieces. The first piece is used before the fitting and the second immediately after, one of these pieces being without a socket. The double-socket fittings provide the pipelines with the additional socket which would otherwise be missing and, because of this, it is not necessary to abandon certain lengths of double-spigot pipe on the site.

Double-socket fittings, as compared with the other fittings, have the following advantages:

- mechanical strength increased by the presence at each of their ends of a very strong socket;
- excellent stability on thrust-blocks which can extend over the whole length of the fittings;
- complete accessibility of joints which are clear of thrust blocks;
- simplification of orders and of the supply of spares by the elimination of numerous duplicating types of fittings;
- facility of moulding on symmetrical pattern plates giving good conditions of accuracy and productivity.

6.3 Deviations and tolerances on length

6.3.1 Deviations on standard working lengths

The permissible deviations on the standard working lengths of fittings with sockets and fittings with flanges are given in table 30.

Table 30

Type of fitting	Length	Deviation mm
Flanged socket Flanged spigot Collar Taper	L	DN 40 to DN 1 200 : ± 25 DN 1 400 to DN 2 600 : ± 35
Bend 1/4	t	± (15 + 0,03 DN)
Bend 1/8	t	± (10 + 0,025 DN)
Bend 1/16 and 1/32	t	DN 40 to DN 1000 : ± (10 + 0,02 DN) DN 1200 to DN 2600 : ± (10 + 0,025 DN)
Tee	L and h	DN 40 to DN 1 200 : $^{+50}_{-25}$ DN 1 400 to DN 2 600 : $^{+75}_{-35}$

6.3.2 Tolerances on manufacturing working lengths

The standard tolerance on the manufacturing working lengths of all fittings with flanges in all nominal sizes is ± 10 mm (see clause 2.8).

On request in the order and by agreement between the manufacturer and the purchaser, smaller tolerances can be accepted but not less than

± 3 mm for DN ⩽ 600, and
± 4 mm for DN ⩾ 700.

6.4 Works leak-tightness test

The fittings shall be submitted at the works to a leak-tightness test (see 2.15.2.2) carried out either with air at a pressure of 1 bar or with water at the pressure given in table 31.

Table 31

Nominal size DN	Hydrostatic leak-tightness test pressure bar
40 ⩽ DN ⩽ 300	25
350 ⩽ DN ⩽ 600	16
700 ⩽ DN ⩽ 2 600	10

6.5 Flanged socket

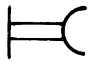
See figure 12 and table 32.

e = 12 (0,5 + 0,001 DN), with a minimum value of 7 mm

$$d = \begin{cases} 25 + 1{,}05\ \text{DN, for DN 40 to DN 1 200} \\ 35 + 1{,}03\ \text{DN, for DN 1 400 to DN 2 600} \end{cases}$$

$$L = \begin{cases} 120 + 0{,}1\ \text{DN (rounded off to the nearest multiple of 5), for DN 40 to DN 1 200} \\ 170 + 0{,}1\ \text{DN (rounded off to the nearest multiple of 5), for DN 1 400 to DN 2 600} \end{cases}$$

Symbol:



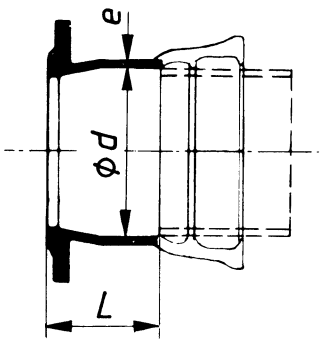


Figure 12

Table 32

Dimensions in millimetres

Masses in kilograms

Nominal size DN	e	d	L	Mass (approximate) with flange: PN 10	PN 16	PN 25	PN 40
40	7	67	125	4,5	4,5	4,5	4,5
50	7	78	125	5,4	5,4	5,4	5,4
(60)	7	88	125	6	6	5,9	5,9
65	7	93	125	6,4	6,4	6,3	6,3
80	7	109	130	7,4	7,4	7,4	7,4
100	7,2	130	130	9	9	9,5	9,5
125	7,5	156	135	11,5	11,5	12,1	13,4
150	7,8	183	135	14,2	14,2	15,2	17,3
200	8,4	235	140	20,5	20	22	27,5
250	9	288	145	28	27,5	31,5	41,5
300	9,6	340	150	37	36,5	42	57,5
350	10,2	393	155	45	48	56	—
400	10,8	445	160	55	60	71	—
500	12	550	170	78	93	104	—
600	13,2	655	180	108	135	149	—
700	14,4	760	190	144	159	—	—
800	15,6	865	200	189	208	—	—
900	16,8	970	210	235	258	—	—
1 000	18	1 075	220	293	324	—	—
1 200	20,4	1 285	240	456	521	—	—
1 400	22,8	1 477	310	654	723	—	—
1 600	25,2	1 683	330	887	989	—	—
1 800	27,6	1 889	350	1 125	1 251	—	—
2 000	30	2 095	370	1 414	1 567	—	—
2 200	32,4	2 301	390	1 767	1 934	—	—
2 400	34,8	2 507	410	2 150	2 352	—	—
2 600	37,2	2 713	480	2 563	2 798	—	—

6.6 Flanged spigot

See figure 13 and table 33.

e = 12 (0,5 + 0,001 DN), with a minimum value of 7 mm

$L = \begin{cases} 320 + 0{,}4 \text{ DN (rounded off to the nearest multiple of 5), with a maximum value of 600 mm, for DN 40 to DN 1 200} \\ 220 + 0{,}35 \text{ DN, for DN 1 400 to DN 2 600} \end{cases}$

Symbol:

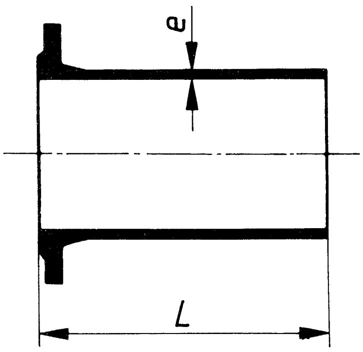


Figure 13

Table 33

Dimensions in millimetres — Masses in kilograms

Nominal size DN	e	L	Mass (approximate) with flange: PN 10	PN 16	PN 25	PN 40
40	7	335	4,2	4,2	4,2	4,2
50	7	340	5,2	5,2	5,2	5,2
(60)	7	345	5,8	5,8	5,7	5,7
65	7	345	6,5	6,5	6,4	6,4
80	7	350	7,8	7,8	7,8	7,8
100	7,2	360	9,6	9,6	10,2	10,2
125	7,5	370	12,4	12,4	13	14,3
150	7,8	380	15,6	15,6	16,6	18,7
200	8,4	400	22,5	22,5	24,5	30
250	9	420	32	31,5	35,5	45,5
300	9,6	440	43	42,5	47,5	63
350	10,2	460	52	55	64	—
400	10,8	480	64	70	81	—
500	12	520	94	109	121	—
600	13,2	560	133	159	173	—
700	14,4	600	179	194	—	—
800	15,6	600	226	245	—	—
900	16,8	600	272	295	—	—
1 000	18	600	328	369	—	—
1 200	20,4	600	456	520	—	—
1 400	22,8	710	664	732	—	—
1 600	25,2	780	922	1 024	—	—
1 800	27,6	850	1 196	1 322	—	—
2 000	30	920	1 534	1 687	—	—
2 200	32,4	990	1 948	2 115	—	—
2 400	34,8	1 060	2 409	2 611	—	—
2 600	37,2	1 130	2 918	3 153	—	—

6.7 Collar

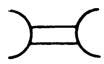
See figure 14 and table 34.

e = 12 (0,5 + 0,001 DN), with a minimum value of 7 mm

$d = \begin{cases} 25 + 1{,}05 \text{ DN, for DN 40 to DN 1 200} \\ 35 + 1{,}03 \text{ DN, for DN 1 400 to DN 2 600} \end{cases}$

$L = \begin{cases} 150 + 0{,}1 \text{ DN (rounded off to the nearest multiple of 5), for DN 40 to DN 1 200} \\ 200 + 0{,}1 \text{ DN, for DN 1 400 to DN 2 600} \end{cases}$

Symbol:



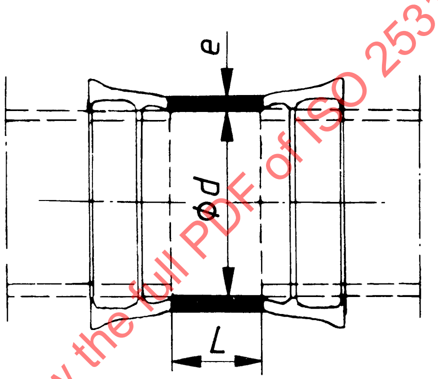


Figure 14

Table 34

Dimensions in millimetres — Masses in kilograms

Nominal size DN	e	d	L	Mass (approximate)
40	7	67	155	4,6
50	7	78	155	5,4
(60)	7	88	155	6,3
65	7	93	155	6,6
80	7	109	160	7,9
100	7,2	130	160	9,9
125	7,5	156	165	12,9
150	7,8	183	165	15,9
200	8,4	235	170	23
250	9	288	175	31,5
300	9,6	340	180	41
350	10,2	393	185	52
400	10,8	445	190	64
500	12	550	200	93
600	13,2	655	210	129
700	14,4	760	220	172
800	15,6	865	230	223
900	16,8	970	240	282
1 000	18	1 075	250	349
1 200	20,4	1 285	270	560
1 400	22,8	1 477	340	816
1 600	25,2	1 683	360	1 094
1 800	27,6	1 889	380	1 427
2 000	30	2 095	400	1 818
2 200	32,4	2 301	420	2 272
2 400	34,8	2 507	440	2 794
2 600	37,2	2 713	460	3 390

6.8 Double-socket 1/4 bend

See figure 15 and table 35.

e = 12 (0,5 + 0,001 DN), with a minimum value of 7 mm

t = 20 + DN

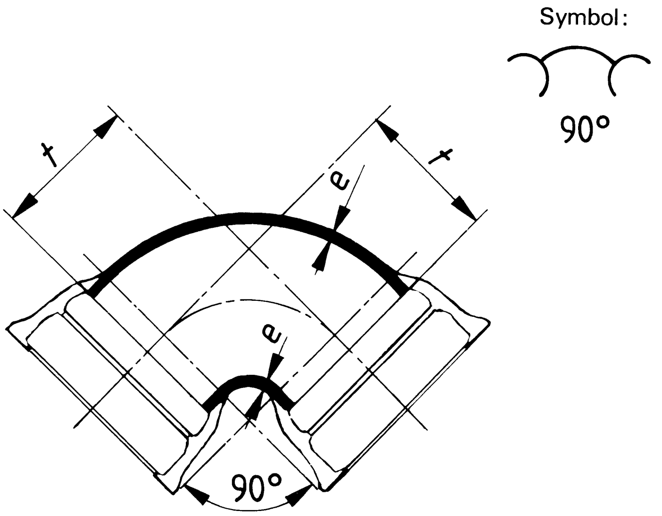


Figure 15

Table 35

Dimensions in millimetres — Masses in kilograms

Nominal size DN	e	t	Mass (approximate)
40	7	60	4,2
50	7	70	5,3
(60)	7	80	6,3
65	7	85	6,9
80	7	100	8,6
100	7,2	120	11,4
125	7,5	145	15,7
150	7,8	170	20,5
200	8,4	220	33
250	9	270	48,5
300	9,6	320	68

6.9 Double-socket 1/8 bend

See figure 16 and table 36.

e = 12 (0,5 + 0,001 DN), with a minimum value of 7 mm

t = 20 + 0,44 DN (rounded off to the nearest multiple of 5), for DN 40 to DN 1 200
t = 180 + 0,24 DN (rounded off to the nearest multiple of 5), for DN 1 400 to DN 2 600

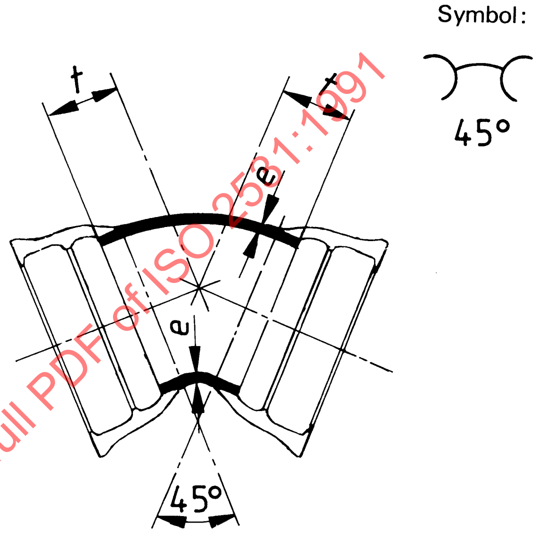


Figure 16

Table 36

Dimensions in millimetres — Masses in kilograms

Nominal size DN	e	t	Mass (approximate)
40	7	40	4
50	7	40	5
(60)	7	45	5,3
65	7	50	6,3
80	7	55	7,7
100	7,2	65	10,1
125	7,5	75	13,6
150	7,8	85	17,4
200	8,4	110	27
250	9	130	38,5
300	9,6	150	53
350	10,2	175	70
400	10,8	195	89
500	12	240	139
600	13,2	285	202
700	14,4	330	282
800	15,6	370	378
900	16,8	415	496
1 000	18	460	635
1 200	20,4	550	986
1 400	22,8	515	1 273
1 600	25,2	565	1 740
1 800	27,6	610	2 296
2 000	30	660	2 970
2 200	32,4	710	3 762
2 400	34,8	755	4 665
2 600	37,2	805	5 721

6.10 Double-socket 1/16 bend

See figure 17 and table 37.

e = 12 (0,5 + 0,001 DN), with a minimum value of 7 mm

t =
- 20 + 0,22 DN (rounded off to the nearest multiple of 5), for DN 40 to DN 1 200
- 90 + 0,12 DN (rounded off to the nearest multiple of 5), for DN 1 400 to DN 2 600

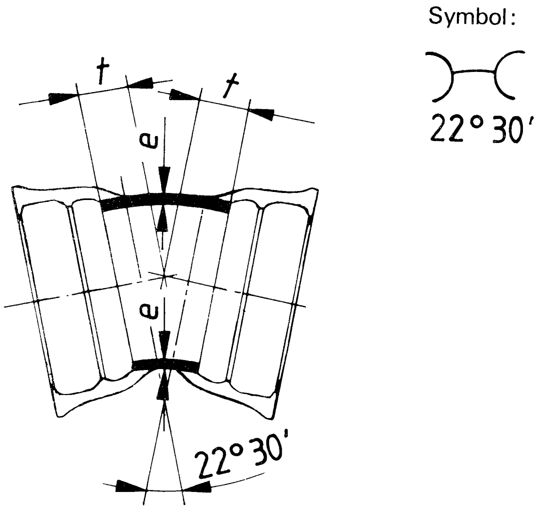


Figure 17

Table 37

Dimensions in millimetres — Masses in kilograms

Nominal size DN	e	t	Mass (approximate)
40	7	30	3,8
50	7	30	4,8
(60)	7	35	5,5
65	7	35	6,0
80	7	40	7,3
100	7,2	40	9,3
125	7,5	50	12,6
150	7,8	55	15,9
200	8,4	65	24
250	9	75	33,5
300	9,6	85	44,5
350	10,2	95	58
400	10,8	110	74
500	12	130	111
600	13,2	150	157
700	14,4	175	217
800	15,6	195	287
900	16,8	220	373
1 000	18	240	470
1 200	20,4	285	716
1 400	22,8	260	933
1 600	25,2	280	1 259
1 800	27,5	305	1 663
2 000	30	330	2 144
2 200	32,4	355	2 707
2 400	34,8	380	3 359
2 600	37,2	400	4 087

6.11 Double-socket 1/32 bend

See figure 18 and table 38.

e = 12 (0,5 + 0,001 DN), with a minimum value of 7 mm

t =
- 20 + 0,11 DN (rounded off to the nearest multiple of 5), for DN 40 to DN 1 200
- 45 + 0,06 DN (rounded off to the nearest multiple of 5), for DN 1 400 to DN 2 000
- 60 + 0,06 DN (rounded off to the nearest multiple of 5), for DN 2 200 to DN 2 600

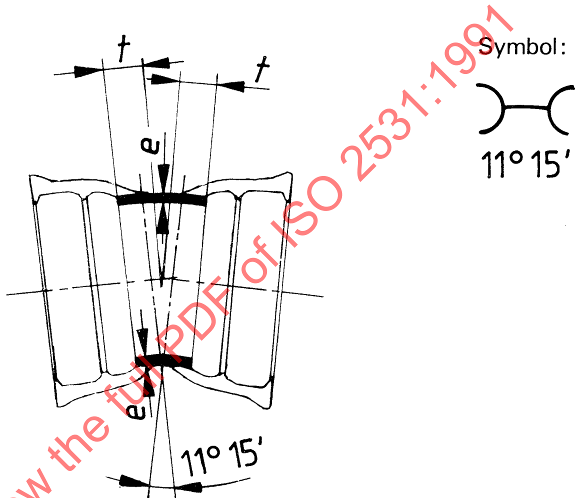


Figure 18

Table 38

Dimensions in millimetres — Masses in kilograms

Nominal size DN	e	t	Mass (approximate)
40	7	25	3,7
50	7	25	4,7
(60)	7	25	5,4
65	7	25	5,9
80	7	30	7,1
100	7,2	30	8,9
125	7,5	35	11,9
150	7,8	35	14,8
200	8,4	40	22
250	9	50	30,5
300	9,6	55	40,5
350	10,2	60	52
400	10,8	65	65
500	12	75	96
600	13,2	85	134
700	14,4	95	181
800	15,6	110	239
900	16,8	120	305
1 000	18	130	381
1 200	20,4	150	568
1 400	22,8	130	747
1 600	25,2	140	1 007
1 800	27,6	155	1 331
2 000	30	165	1 702
2 200	32,4	190	2 183
2 400	34,8	205	2 709
2 600	37,2	215	3 290

6.12 Double-socket tee with flanged branch

6.12.1 DN 40 to DN 200

See figure 19 and table 39.

$e = 14\ (0{,}5 + 0{,}001\ \mathrm{DN})$

$e_1 = 14\ (0{,}5 + 0{,}001\ \mathrm{dn})$

$L = 70 + 0{,}06\ \mathrm{DN} + 1{,}16\ \mathrm{dn}$ (rounded off to the nearest multiple of 5)

$h = 100 + 0{,}6\ \mathrm{DN} + 0{,}2\ \mathrm{dn}$ (rounded off to the nearest multiple of 5)

Symbol:

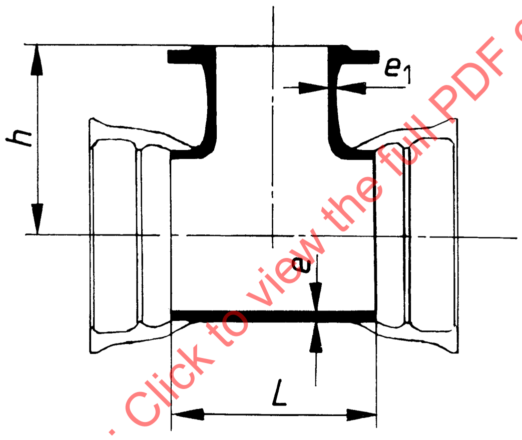


Figure 19

Table 39

Dimensions in millimetres — Masses in kilograms

Body			Branch			Mass (approximate) with flange:			
Nominal size DN	e	L	Nominal size dn	e_1	h	PN 10	PN 16	PN 25	PN 40
40	7,6	120	**40**	7,6	130	6,9	6,9	6,9	6,9
50	7,7	130	**50**	7,7	140	8,6	8,6	8,5	8,5
(60)	7,8	145	**(60)**	7,8	150	10	10	9,9	9,9
65	7,9	150	**65**	7,9	150	10,9	10,9	10,8	10,8
80	8,1	170	**80**	8,1	165	13,5	13,5	13,5	13,5
100	8,4	170	**80**	8,1	175	15,8	15,8	15,8	15,8
	8,4	190	**100**	8,4	180	17,2	17,2	17,7	17,7
125	8,8	170	**80**	8,1	190	19,4	19,4	19,4	19,4
	8,8	195	**100**	8,4	195	21	21	21,5	21,5
	8,8	225	**125**	8,8	200	23	23	24	25,5
150	9,1	170	**80**	8,1	205	23	23	23	23
	9,1	195	**100**	8,4	210	24,5	24,5	25	25
	9,1	255	**150**	9,1	220	29,5	29,5	30,5	32,5
200	9,8	175	**80**	8,1	235	31,5	31,5	31,5	31,5
	9,8	200	**100**	8,4	240	33,5	33,5	34	34
	9,8	255	**150**	9,1	250	39	39	40	42
	9,8	315	**200**	9,8	260	45,6	46	47,5	53

6.12.2 DN 250 to DN 600

See figure 20 and table 40.

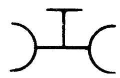
e = 14 (0,5 + 0,001 DN)

e_1 = 14 (0,5 + 0,001 dn)

L = 70 + 0,06 DN + 1,16 dn (rounded off to the nearest multiple of 5)

h = 100 + 0,6 DN + 0,2 dn (rounded off to the nearest multiple of 5)

Symbol:



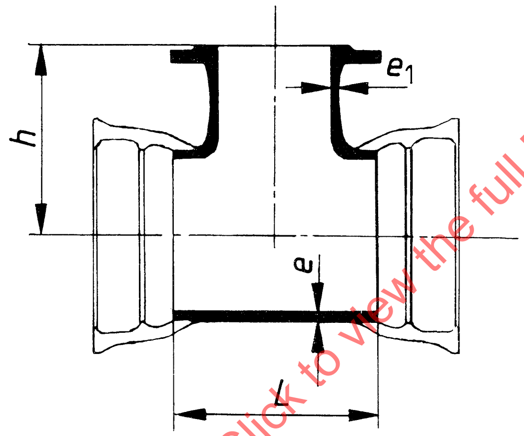


Figure 20

Table 40

Dimensions in millimetres | Masses in kilograms

Body			Branch			Mass (approximate) with flange:			
Nominal size DN	e	L	Nominal size dn	e_1	h	PN 10	PN 16	PN 25	PN 40
250	10,5	200	**100**	8,4	270	43,5	43,5	44	44
	10,5	315	**200**	9,8	290	57	57	59	64,5
	10,5	375	**250**	10,5	300	65	66	69	79
300	11,2	205	**100**	8,4	300	55	55	56	56
	11,2	320	**200**	9,8	320	71	70	73	73
	11,2	435	**300**	11,2	340	89	91	95	110
350	11,9	205	**100**	8,4	330	68	68	68	—
	11,9	325	**200**	9,8	350	86	86	88	—
	11,9	495	**350**	11,9	380	117	120	129	—
400	12,6	210	**100**	8,4	360	83	83	83	—
	12,6	325	**200**	9,8	380	103	102	104	—
	12,6	560	**400**	12,6	420	150	156	167	—
500	14	215	**100**	8,4	420	116	116	117	—
	14	330	**200**	9,8	440	142	141	143	—
	14	565	**400**	12,6	480	199	205	216	—
	14	680	**500**	14	500	232	247	259	—
600	15,4	340	**200**	9,8	500	189	189	191	—
	15,4	570	**400**	12,6	540	258	263	274	—
	15,4	800	**600**	15,4	580	340	366	380	—

6.12.3 DN 700 to DN 1 200

See figure 21 and table 41.

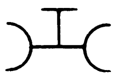
e = 14 (0,5 + 0,001 DN)

e_1 = 14 (0,5 + 0,001 dn)

L = 70 + 0,06 DN + 1,16 dn (rounded off to the nearest multiple of 5)[1)]

h = 75 + 0,6 DN + 0,15 dn (rounded off to the nearest multiple of 5)

Symbol:



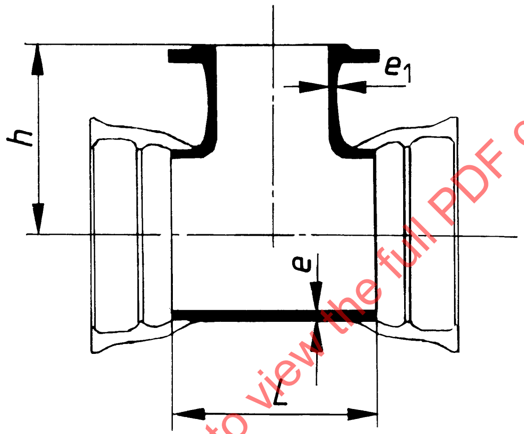


Figure 21

Table 41

Dimensions in millimetres — Masses in kilograms

Body			Branch			Mass (approximate) with flange:		
Nominal size DN	e	L	Nominal size dn	e_1	h	PN 10	PN 16	PN 25
700	16,8	345	**200**	9,8	525	242	242	—
	16,8	575	**400**	12,6	555	320	325	—
	16,8	925	**700**	16,8	600	460	475	—
800	18,2	350	**200**	9,8	585	306	306	—
	18,2	580	**400**	12,6	615	398	403	—
	18,2	1 045	**600**	15,4	645	579	605	—
	18,2	1 045	**800**	18,2	675	623	642	—
900	19,6	355	**200**	9,8	645	379	379	—
	19,6	590	**400**	12,6	675	490	495	—
	19,6	1 170	**600**	15,4	705	748	774	—
	19,6	1 170	**900**	19,6	750	814	838	—
1 000	21	360	**200**	9,8	705	462	462	—
	21	595	**400**	12,6	735	591	596	—
	21	1 290	**600**	15,4	765	947	973	—
	21	1 290	**1 000**	21	825	1 044	1 086	—
1 200	23,8	840	**600**	15,4	885	1 000	1 027	—
	23,8	1 070	**800**	18,2	915	1 190	1 210	—
	23,8	1 300	**1 000**	21	945	1 406	1 448	—

1) The length L of tees for nominal sizes DN greater than 600 and for dn 600 is equal to that of tees with the same nominal sizes of the body and of the branch.

6.12.4 DN 1 400 to DN 2 600

See figure 22 and table 42.

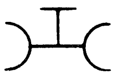
$e = 14\ (0{,}5 + 0{,}001\ \text{DN})$

$e_1 = 14\ (0{,}5 + 0{,}001\ \text{dn})$

$L = 250 + 0{,}06\ \text{DN} + 1{,}16\ \text{dn}$ (rounded off to the nearest multiple of 5)

$h = 120 + 0{,}55\ \text{DN} + 0{,}15\ \text{dn}$

Symbol:



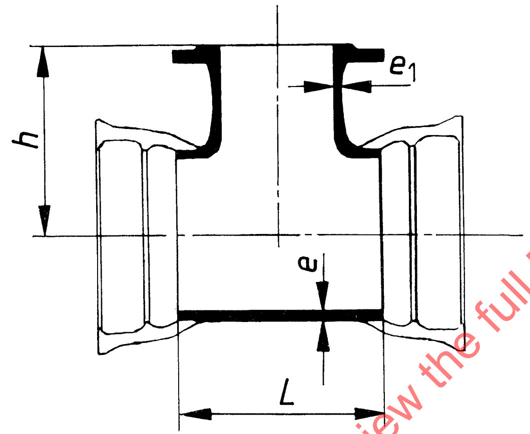


Figure 22

Table 42

Dimensions in millimetres — Masses in kilograms

Body			Branch			Mass (approximate) with flange:	
Nominal size DN	e	L	Nominal size dn	e_1	h	PN 10	PN 16
1 400	26,6	1 030	**600**	15,4	980	1 478	1 505
	26,6	1 260	**800**	18,2	1 010	1 709	1 728
	26,6	1 495	**1 000**	21	1 040	1 955	1 996
1 600	29,4	1 040	**600**	15,4	1 090	1 908	1 934
	29,4	1 275	**800**	18,2	1 120	2 192	2 211
	29,4	1 505	**1 000**	21	1 150	2 480	2 522
	29,4	1 740	**1 200**	23,8	1 180	2 799	2 863
1 800	32,2	1 055	**600**	15,4	1 200	2 414	2 440
	32,2	1 285	**800**	18,2	1 230	2 748	2 767
	32,2	1 520	**1 000**	21	1 260	3 095	3 137
	32,2	1 750	**1 200**	23,8	1 290	3 460	2 524
2 000	35	1 065	**600**	15,4	1 310	2 988	3 015
	35	1 530	**1 000**	21	1 370	3 790	3 832
	35	1 995	**1 400**	26,6	1 430	4 645	4 713
2 200	37,8	1 080	**600**	15,4	1 420	3 647	3 674
	37,8	1 775	**1 200**	23,8	1 510	5 056	5 119
	37,8	2 470	**1 800**	32,2	1 600	6 579	6 705
2 400	40,6	1 090	**600**	15,4	1 530	4 383	4 409
	40,6	1 785	**1 200**	23,8	1 620	6 005	6 069
	40,6	2 480	**1 800**	32,2	1 710	7 734	7 860
2 600	43,4	1 100	**600**	15,4	1 640	5 205	5 231
	43,4	2 030	**1 400**	26,5	1 750	7 704	7 772
	43,4	2 725	**2 000**	35	1 850	9 713	9 866

6.13 All-socket tee

See figure 23 and table 43.

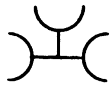
e = 14 (0,5 + 0,001 DN)

L = 70 + 0,06 DN + 1,16 dn (rounded off to the nearest multiple of 5)

h = 35 + 0,5 DN + 0,11 dn (rounded off to the nearest multiple of 5)

e_1 = 14 (0,5 + 0,001 dn)

Symbol:



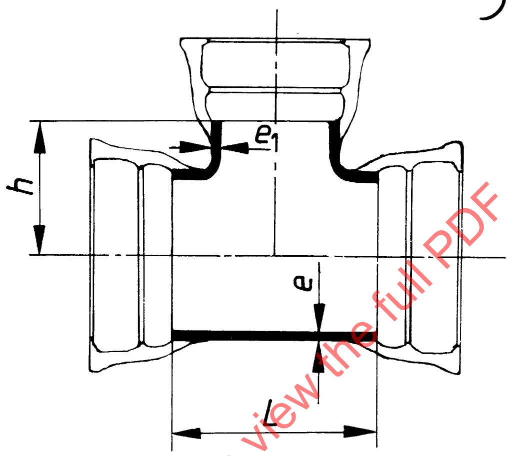


Figure 23

Table 43

Dimensions in millimetres — Masses in kilograms

Body			Branch			Mass (approximate)
Nominal size DN	e	L	**Nominal size dn**	e_1	h	
40	7,6	120	**40**	7,6	60	4,5
50	7,7	130	**50**	7,7	65	5,6
(60)	7,8	145	**(60)**	7,8	70	6,9
65	7,9	150	**65**	7,9	75	7,5
80	8,1	120	**40**	8,1	80	10,2
	8,1	170	**80**	8,1	85	12,4
100	8,4	120	**40**	8,4	90	12,3
	8,4	145	**(60)**	8,4	90	13,8
	8,4	170	**80**	8,4	95	14,8
	8,4	190	**100**	8,4	95	16,1
125	8,8	125	**40**	8,8	100	15,3
	8,8	225	**125**	8,8	110	22
150	9,1	125	**40**	9,1	115	18,7
	9,1	170	**80**	9,1	120	21,5
	9,1	195	**100**	9,1	120	23,5
	9,1	255	**150**	9,1	125	28
200	9,8	130	**40**	9,8	140	26,4
	9,8	175	**80**	9,8	145	30
	9,8	200	**100**	9,8	145	32
	9,8	255	**150**	9,8	150	37
	9,8	315	**200**	9,8	155	43

6.14 Double-socket taper

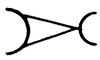
See figure 24 and table 44.

e_1 = 12 (0,5 + 0,001 DN), with a minimum value of 7 mm

e_2 = 12 (0,5 + 0,001 dn), with a minimum value of 7 mm

$$L = \begin{cases} 50 + 2\,(\text{DN} - \text{dn}), \text{ for DN 50 to DN 300} \\ 60 + 2\,(\text{DN} - \text{dn}), \text{ for DN 350 to DN 600} \\ 80 + 2\,(\text{DN} - \text{dn}), \text{ for DN 700 to DN 1 200} \\ 160 + (\text{DN} - \text{dn}), \text{ for DN 1 400 to DN 2 600} \end{cases}$$

Symbol:



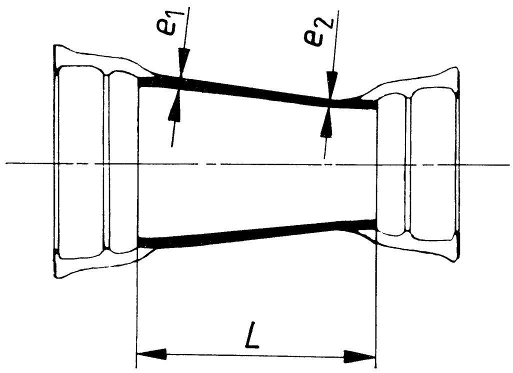


Figure 24

Table 44

Dimensions in millimetres — Masses in kilograms

Larger diameter		Smaller diameter			
Nominal size DN	e_1	**Nominal size dn**	e_2	L	**Mass** (approximate)
50	7	**40**	7	70	4,2
(60)	7	**50**	7	70	5,2
65	7	**50**	7	80	5,7
80	7	**(60)**	7	90	7,1
	7	**65**	7	80	6,6
100	7,2	**80**	7	90	8,5
125	7,5	**80**	7	140	10,8
	7,5	**100**	7,2	100	11,1
150	7,8	**80**	7	190	13,5
	7,8	**100**	7,2	150	13,8
	7,8	**125**	7,5	100	14,1
200	8,4	**100**	7,2	250	20,5
	8,4	**125**	7,5	200	20,5
	8,4	**150**	7,8	150	21
250	9	**125**	7,5	300	29
	9	**150**	7,8	250	29
	9	**200**	8,4	150	29
300	9,6	**150**	7,8	350	39,5
	9,6	**200**	8,4	250	39,5
	9,6	**250**	9	150	38,5
350	10,2	**200**	8,4	360	52
	10,2	**250**	9	260	51
	10,2	**300**	9,6	160	49,5
400	10,8	**250**	9	360	66
	10,8	**300**	9,6	260	64
	10,8	**350**	10,2	160	62
500	12	**350**	10,2	360	98
	12	**400**	10,8	260	94
600	13,2	**400**	10,8	460	142
	13,2	**500**	12	260	131
700	14,4	**500**	12	480	194
	14,4	**600**	13,2	280	178
800	15,6	**600**	13,2	480	252
	15,6	**700**	14,4	280	229
900	16,8	**700**	14,4	480	318
	16,8	**800**	15,6	280	288
1 000	18	**800**	15,6	480	392
	18	**900**	16,8	280	354
1 200	20,4	**1 000**	18	480	570
1 400	22,8	**1 200**	20,4	360	711
1 600	25,2	**1 400**	22,8	360	951
1 800	27,6	**1 600**	25,2	360	1 235
2 000	30	**1 800**	27,6	360	1 566
2 200	32,4	**2 000**	30	360	1 948
2 400	34,8	**2 200**	32,4	360	2 374
2 600	37,2	**2 400**	34,8	360	2 877

6.15 Double-flanged taper

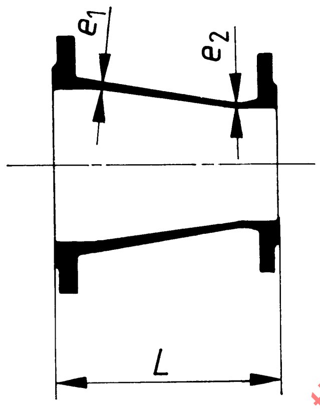
See figure 25 and table 45.

e_1 = 12 (0,5 + 0,001 DN), with a minimum value of 7 mm

e_2 = 12 (0,5 + 0,001 dn), with a minimum value of 7 mm

$$L = \left\{ \begin{array}{l} 150 \text{ for } (\text{DN} - \text{dn}) = 10 \\ 200 \text{ for } 15 \leqslant (\text{DN} - \text{dn}) \leqslant 25 \\ 300 \text{ for } (\text{DN} - \text{dn}) = 50 \\ 600 \text{ for } (\text{DN} - \text{dn}) = 100 \end{array} \right\} \text{ for DN 50 to DN 1 000}$$

L = 2,15 DN − 1,85 dn + 60, for DN 1 200 to DN 2 600



Symbol:

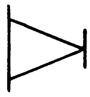


Figure 25

Table 45

Dimensions in millimetres | Masses in kilograms

Larger diameter: Nominal size DN	Larger diameter: e_1	Smaller diameter: Nominal size dn	Smaller diameter: e_2	L	Mass (approximate) with flange: PN 10	PN 16	PN 25	PN 40
50	7	**40**	7	150	5,1	5,1	5,1	5,1
(60)	7	**50**	7	160	5,8	5,8	5,7	5,7
65	7	**50**	7	200	6,7	6,7	6,6	6,6
80	7	**(60)**	7	200	7,5	7,5	7,4	7,4
80	7	**65**	7	200	7,9	7,9	7,8	7,8
100	7,2	**80**	7	200	9,3	9,3	9,8	9,8
125	7,5	**100**	7,2	200	11,3	11,3	12,5	13,8
150	7,8	**125**	7,5	200	14	14	15,5	18,9
200	8,4	**150**	7,3	300	22	21,5	25	31,5
250	9	**200**	8,4	300	30	29,5	35,5	51
300	9,6	**250**	9	300	40,5	39,5	49	74,5
350	10,2	**300**	9,6	300	49,5	52	66	—
400	10,8	**350**	10,2	300	58	67	86	—
500	12	**400**	10,3	600	110	130	153	—
600	13,2	**500**	12	600	149	190	216	—
700	14,4	**600**	13,2	600	195	236	—	—
800	15,6	**700**	14,4	600	250	285	—	—
900	16,8	**800**	15,6	600	308	352	—	—
1 000	18	**900**	16,8	600	373	438	—	—
1 200	20,4	**1 000**	18	790	586	692	—	—
1 400	22,8	**1 200**	20,4	850	814	947	—	—
1 600	25,2	**1 400**	22,8	910	1 103	1 273	—	—
1 800	27,6	**1 600**	25,2	970	1 436	1 664	—	—
2 000	30	**1 800**	27,6	1 030	1 800	2 079	—	—
2 200	32,4	**2 000**	30	1 090	2 250	2 570	—	—
2 400	34,8	**2 200**	32,4	1 150	2 765	3 134	—	—
2 600	37,2	**2 400**	34,8	1 210	3 311	3 748	—	—

6.16 Blank flange PN 10

See figure 26 and table 46.

$$b = \begin{cases} 10 + 0{,}035\ DN, \text{ with a minimum value of 16 mm, for DN 40 to DN 300} \\ 10 + 0{,}025\ DN, \text{ with a minimum value of 20,5 mm, for DN 350 to DN 1 200} \\ 20 + 0{,}015\ DN, \text{ for DN 1 400 to DN 2 600} \end{cases}$$

Symbol:

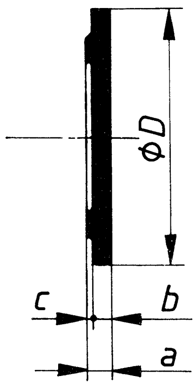


Figure 26

Table 46

Dimensions in millimetres — Masses in kilograms

Nominal size DN	D	a	b	c	Mass (approximate)
40	150	19	16	3	2
50	165	19	16	3	2,4
(60)	175	19	16	3	2,7
65	185	19	16	3	3,1
80	200	19	16	3	3,5
100	220	19	16	3	4,3
125	250	19	16	3	5,6
150	285	19	16	3	7,2
200	340	20	17	3	11
250	400	22	19	3	16,9
300	455	24,5	20,5	4	24
350	505	24,5	20,5	4	29,5
400	565	24,5	20,5	4	36,5
500	670	26,5	22,5	4	56
600	780	30	25	5	85
700	895	32,5	27,5	5	123
800	1 015	35	30	5	172
900	1 115	37,5	32,5	5	224
1 000	1 230	40	35	5	293
1 200	1 455	45	40	5	575
1 400	1 675	46	41	5	739
1 600	1 915	49	44	5	1 239
1 800	2 115	52	47	5	1 717
2 000	2 325	55	50	5	2 272
2 200	2 550	59	53	6	2 253
2 400	2 760	62	56	6	2 781
2 600	2 960	65	59	6	3 365

NOTE — For flanges of nominal size greater than or equal to DN 350, the centre of blank flanges may be dished.

6.17 Blank flange PN 16

See figure 27 and table 47.

$$b = \begin{cases} 10 + 0{,}035\ DN, \text{ with a minimum value of 16 mm, for DN 40 to DN 1 200} \\ 20 + 0{,}025\ DN, \text{ for DN 1 400 to DN 2 600} \end{cases}$$

Symbol:

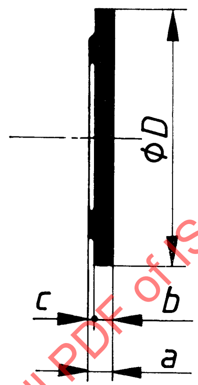


Figure 27

Table 47

Dimensions in millimetres — Masses in kilograms

Nominal size DN	D	a	b	c	Mass (approximate)
40	150	19	16	3	2
50	165	19	16	3	2,4
(60)	175	19	16	3	2,7
65	185	19	16	3	3,1
80	200	19	16	3	3,5
100	220	19	16	3	4,3
125	250	19	16	3	5,6
150	285	19	16	3	7,2
200	340	20	17	3	10,8
250	400	22	19	3	16,6
300	455	24,5	20,5	4	23,5
350	520	26,5	22,5	4	33,5
400	580	28	24	4	44,5
500	715	31,5	27,5	4	77
600	840	36	31	5	121
700	910	39,5	34,5	5	156
800	1 025	43	38	5	218
900	1 125	46,5	41,5	5	286
1 000	1 255	50	45	5	387
1 200	1 485	57	52	5	662
1 400	1 685	60	55	5	994
1 600	1 930	65	60	5	1 409
1 800	2 130	70	65	5	1 858
2 000	2 345	75	70	5	2 407
2 200	2 555	81	75	6	3 097
2 400	2 765	86	80	6	3 863
2 600	2 965	91	85	6	4 716

NOTE — For flanges with nominal size greater than or equal to DN 350, the centre of blank flanges may be dished.

6.18 Blank flange PN 25

See figure 28 and table 48.

$b = 10 + 0{,}045$ DN, with a minimum value of 16 mm

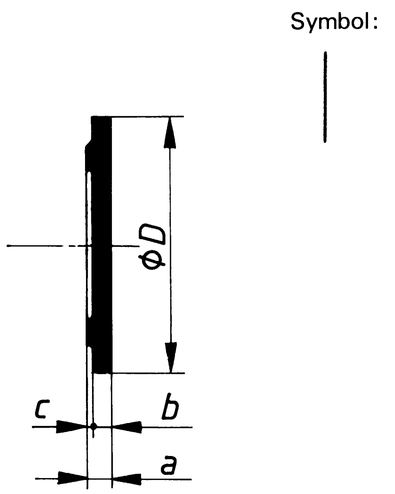


Figure 28

Table 48

Dimensions in millimetres — Masses in kilograms

Nominal size DN	D	a	b	c	Mass (approximate)
40	150	19	16	3	2
50	165	19	16	3	2,4
(60)	175	19	16	3	2,6
65	185	19	16	3	2,9
80	200	19	16	3	3,5
100	235	19	16	3	4,8
125	270	19	16	3	6,2
150	300	20	17	3	8,3
200	360	22	19	3	13,3
250	425	24,5	21,5	3	21
300	485	27,5	23,5	4	30
350	555	30	25	4	43,5
400	620	32	28	4	58
500	730	36,5	32,5	4	94
600	845	42	37	5	144

6.19 Blank flange PN 40

See figure 29 and table 49.

$b = 10 + 0{,}085$ DN, with a minimum value of 16 mm

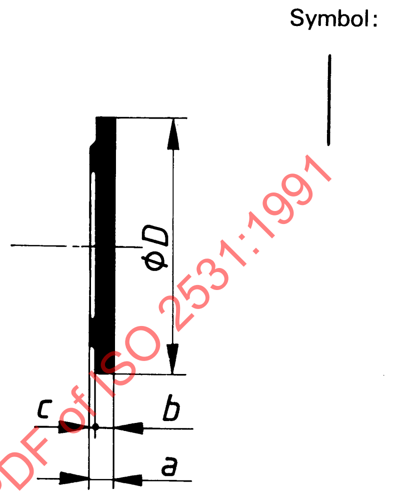


Figure 29

Table 49

Dimensions in millimetres — Masses in kilograms

Nominal size DN	D	a	b	c	Mass (approximate)
40	150	19	16	3	2
50	165	19	16	3	2,4
(60)	175	19	16	3	2,6
65	185	19	16	3	2,9
80	200	19	16	3	3,7
100	235	19	16	3	5,1
125	270	23,5	20,5	3	8,3
150	300	26	23	3	11,4
200	375	30	27	3	20,5
250	450	34,5	31,5	3	34,5
300	515	39,5	35,5	4	51

6.20 Reducing flange PN 10

See figure 30 and table 50.

b =
- 10 + 0,035 DN, with a minimum value of 16 mm, for DN 200
- 10 + 0,025 DN, with a minimum value of 20,5 mm, for DN 350 to DN 1 000

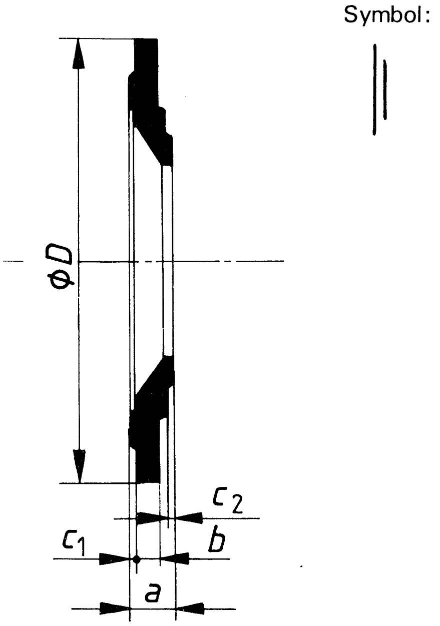


Figure 30

Table 50

Dimensions in millimetres — Masses in kilograms

Larger diameter				Smaller diameter			
Nominal size DN	D	b	c_1	**Nominal size dn**	c_2	a	**Mass** (approximate)
200	340	17	3	**80**	3	40	13,3
	340	17	3	**100**	3	40	13,2
	340	17	3	**125**	3	40	13,5
350	505	20,5	4	**250**	3	48	32
400	565	20,5	4	**250**	3	48	39
	565	20,5	4	**300**	4	49	38
700	895	27,5	5	**500**	4	56	102
900	1 115	32,5	5	**700**	5	63	165
1 000	1 230	35	5	**700**	5	63	222
	1 230	35	5	**800**	5	68	209

6.21 Reducing flange PN 16

See figure 31 and table 51.

b = 10 + 0,035 DN, with a minimum value of 16 mm

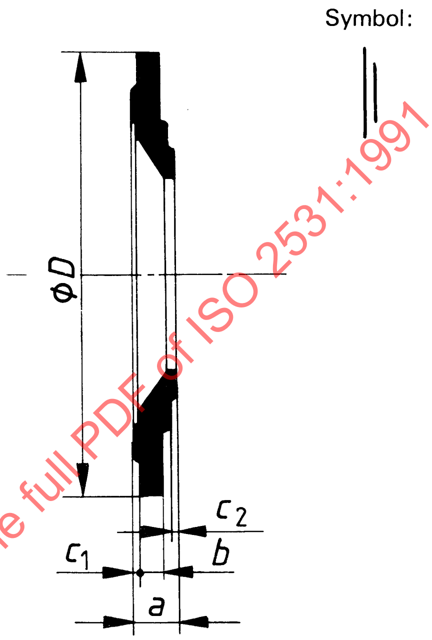


Figure 31

Table 51

Dimensions in millimetres — Masses in kilograms

Larger diameter				Smaller diameter			
Nominal size DN	D	b	c_1	**Nominal size dn**	c_2	a	**Mass** (approximate)
200	340	17	3	**80**	3	40	13
	340	17	3	**100**	3	40	13
	340	17	3	**125**	3	40	13,3
350	520	22,5	4	**250**	3	54	36,5
400	580	24	4	**250**	3	54	46
	580	24	4	**300**	4	55	44,5
700	910	34,5	5	**500**	4	67	134
900	1 125	41,5	5	**700**	5	73	200
1 000	1 255	45	5	**700**	5	73	285
	1 255	45	5	**800**	5	77	260