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Ductile iron pipes, fittings and accessories for pressure pipe-lines

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

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FOREWORD

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Ductile iron pipes, fittings and accessories for pressure pipe-lines

SECTION ONE

GENERAL SPECIFICATION

0 INTRODUCTION

Ductile iron, also called nodular iron or spheroidal graphite iron, is characterized by the presence, in the resultant castings, of spheroidal graphite in a quantity sufficient to give the iron of these castings the mechanical characteristics defined in this International Standard.

The high mechanical characteristics of ductile iron make it possible to manufacture pipes and fittings having adequate strength for all uses.

Various methods of strengthening are authorized, however, particularly where high working pressures have to be applied to fittings having a large diameter branch, in which the resulting stress in the metal may be too high.

Ductile iron differs from grey iron by its greater tensile strength, by its significant proof stress and its significant elongation after fracture. Tensile tests on machined specimens permit the measurement of these different characteristics. It is for this reason, using values compatible with the different manufacturing processes, that this test is now in general use for all pipes, fittings and accessories for ductile iron pipe-lines.

The value adopted for the density of ductile iron is 7 050 kg/m³. 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.

The requirements of ISO/R 13 concerning the quality of the cast iron have been adapted to ductile iron and defined more accurately as far as both the origin of the metal and its characteristics are concerned, but leaving it to the manufacturers to choose from the various methods of processing the molten metal.

1 SCOPE AND FIELD OF APPLICATION

This International Standard comprises a general specification 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 sand¹⁾ moulds;
- 3) casting in sand¹⁾ moulds;
- 4) casting in metal moulds.

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

- 1) casting in sand¹⁾ moulds;
- 2) casting in metal moulds.

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

The range of diameters extends from nominal diameter No. 80 to nominal diameter No. 1 000 inclusive, this range having already been adopted for grey iron pipe-lines in ISO/R 13. It is possible without difficulty to extend this range to include smaller or larger diameters and this will be the subject of a separate International Standard.

2 REFERENCES

ISO/R 13, *Cast iron pipes, special castings and cast iron parts for pressure main lines.*

ISO/R 79, *Brinell hardness test for steel*, Amendment 1.

1) By sand is to be understood sand or mineral-based materials used in the foundry trade irrespective of the type of bonding agent used.

3 TYPES OF JOINTS

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

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

It may also be used for pipes and fittings having other types of joints — 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 as that of the spigot end of grey iron castings (ISO/R 13), which makes it easier to joint the new ductile iron pipes or fittings to existing grey iron pipe-lines.

4 THICKNESS OF PIPES AND FITTINGS

The standard thickness of pipes and fittings is calculated as a function of their nominal diameter by the formula :

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

where

e is the standard wall thickness in millimetres;

DN is the nominal diameter;

K is the coefficient selected from a series of whole numbers . . . 8, 9, 10, 11, 12 . . . and as determined in the specific requirements of sections two and four of this International Standard :

$K = 9$ for the pipes in table 9,

$K = 12$ for the fittings in tables 18 to 24, 29, 30 and 37 to 39,

$K = 14$ for the fittings in tables 25 to 28 and 40 to 42.

If necessary, each special specification shall give an additional formula applicable to small diameter castings.

The external diameter of the pipes, expressed in millimetres, is fixed as a function of the nominal diameter 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 in each point of the casting, 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 fitting.

5 MARKING

Each pipe, fitting or accessory shall bear the mark of the manufacturer, an indication that the casting is of ductile iron, and an indication of its nominal diameter. If necessary, each fitting shall bear an indication of its main characteristics. Pipes, fittings and accessories with a nominal diameter greater than DN No. 300 shall also bear the year of manufacture.

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

6 PROCESSING OF THE IRON

The iron to be used for the casting of pipes, fittings and accessories shall be prepared, at the choice of the manufacturer, in a cupola, an active mixer or any other suitable metallurgical apparatus, and shall be made, as the case may be, from pig iron or molten iron, iron or steel scrap, with such ferro-alloy and other additives as shall be necessary because of the manufacturing process to produce in the resultant castings a ductile iron complying with the requirements of this International Standard.

7 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 must 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 such 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 following tests described later to be carried out.

The pipes should 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 must not exceed 250 HB.

8 TOLERANCES ON JOINTS

The tolerances on joints depend on the characteristics peculiar to each type of joint and shall be specified in the national standards, or, where not specified in these standards, in the manufacturers' catalogues for the type of joint and the nominal diameter 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.

9 TOLERANCES ON THICKNESS

The tolerances on wall thickness and flange thickness are as given in table 1, where

b is the standard thickness of the flange in millimetres;

DN is the nominal diameter.

TABLE 1

Dimensions in millimetres

Type of casting	Dimension	Tolerance
Pipes centrifugally cast in sand or metal moulds	Wall thickness	$-(1,3 + 0,001 \text{ DN})^*$
	Flange thickness	$\pm (2 + 0,05 b)$
Pipes cast in sand or in metal moulds	Wall thickness	$-(2,3 + 0,001 \text{ DN})^*$
	Flange thickness	$\pm (3 + 0,05 b)$
Fittings and accessories	Wall thickness	$-(2,3 + 0,001 \text{ DN})^*$
	Flange thickness	$\pm (3 + 0,05 b)$

* No limit for the plus tolerance has been set (see note to clause 12).

10 MANUFACTURING LENGTHS AND TOLERANCES ON LENGTH

The tolerances on length for the pipes and fittings take into account variations due to shrinkage and growth, depending on the composition and heat treatment of the ductile iron. These tolerance limits have been generously chosen to make it possible, by using interchangeable patterns, to manufacture castings which may have slightly different working lengths, depending on the type of joint with which they are provided.

10.1 Spigot and socket pipes

The standard manufacturing lengths of spigot and socket pipes can be as shown in table 2.

TABLE 2

Dimensions in metres

Nominal diameter DN	Standard lengths
up to No. 500 inclusive	4 – 5 – 5,5 – 6
above No. 500	4 – 5 – 5,5 – 6 – 7

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 lengths specified, the allowed reduction in length being given in table 3.

TABLE 3

Dimensions in metres

Specified length	Reduction in length
4	0,5 – 1
over 4	0,5 – 1 – 1,5 – 2

The permitted tolerances on the standard manufacturing lengths of pipes are indicated in section two.

10.2 Fittings

The standard manufacturing lengths of fittings and the permitted tolerances on these lengths are indicated in section four.

11 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. :

$$f_m \leq 1,25 L$$

12 TOLERANCES ON MASSES

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

The masses of pipes and fittings corresponding to each type of joint shall be specified in the national standards or, when lacking, in the manufacturers' catalogues; these shall have been calculated by taking the density of cast iron as 7 050 kg/m³.

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 of less than 20 kg;
- to the nearest 0,5 kg for masses of between 20 and 100 kg;
- to the nearest kilogram for masses above 100 kg.

The permitted tolerances on the standard masses are given in table 4.

TABLE 4

Type of casting	Tolerance on standard mass %
Pipes centrifugally cast { up to DN No. 200 inclusive above DN No. 200	± 8 ± 5
Pipes cast in sand or metal moulds Standard fittings except as stated below }	± 8
Bends, fittings with branches, and non-standard fittings	± 12

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

13 TENSILE TESTS – TEST BARS

13.1 Pipes centrifugally cast in metal moulds or in sand moulds

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, and its axis must be parallel to the axis of the pipe.

The test bar shall include a cylindrical part, the gauge length of which shall be equal to five times its diameter; the latter shall be as given in table 5, according to the thickness of the pipe.

TABLE 5
Dimensions in millimetres

Thickness of pipe	Diameter of test bar
less than 5	2,0
5 and above, but below 6	2,5
6 and above, but below 7	3,0
7 and above, but below 8	3,5
8 and above, but below 10	4,0
10 and above, but below 12	5,0
12 and above	6,0

13.2 Pipes, fittings and accessories cast in sand or metal moulds

The machined bar for the tensile test shall be taken from a sample cast separately, but from the same iron as that used for the castings, and, if necessary, having been 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 bar are given in table 6, dependent on the mean thickness of the casting.

TABLE 6
Dimensions in millimetres

Mean thickness of casting	Thickness of sample	Diameter of test bar
less than 12	12,5	6
12 or above	25	12

The gauge length of the machined bar shall be equal to five times its diameter.

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

14 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 in metal moulds or in sand moulds

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

- up to and including DN No. 300 : 100 pipes
- DN No. 350 to DN No. 600 inclusive : 50 pipes
- above DN No. 600 : 25 pipes

b) Pipes, fittings and accessories cast in sand or metal moulds

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 tonnes of crude castings, excluding the mass of the risers.

For one pipe, or from one sample of each batch in the case of fittings and accessories, the manufacturer shall take one test bar which must satisfy the requirements of table 7.

TABLE 7

Type of casting	Minimum tensile strength R_m	Minimum 0,2 % proof stress* $R_{p0,2}$	Minimum elongation after fracture A
	N/mm ² **	N/mm ² **	%
Pipes centrifugally cast	420	300	10
Pipes cast in sand or metal moulds	400	300	5
Fittings			

* The proof stress shall only be measured upon special agreement and under conditions which shall be specified in the order.

** 1 N/mm² ≈ 0,102 kgf/mm².

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 must satisfy the same specified requirements.

Pipes from which test bars have been cut shall be accepted by the purchaser as complete lengths.

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.

15 BRINELL HARDNESS TEST

The Brinell hardness, HB, specified in clause 7, 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/R 79, Amendment 1, with a steel ball of 10 mm or 5 mm diameter.

16 MAXIMUM WORKING PRESSURE AND INTERNAL PRESSURE PROOF TEST

16.1 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: type of liquid transported, static and transitory overloads, etc.

16.2 Internal pressure proof test

16.2.1 Spigot and socket pipes

Pipes shall be subjected to a works hydraulic test for a duration of 15 s at a minimum pressure defined by the corresponding specific requirements.

It is recommended that this pressure p , expressed in bars¹⁾ as a function of the coefficient K (clause 4), be calculated using the following formulae:

- DN No. 80 to No. 300 inclusive $p = 0,5 (K + 1)^2$
- DN No. 350 to No. 600 inclusive $p = 0,5 K^2$
- DN No. 700 to No. 1 000 inclusive $p = 0,5 (K - 1)^2$

The actual test pressures must not exceed the following values:

- DN No. 80 to No. 300 inclusive $p = 100$ bar
- DN No. 350 to No. 600 inclusive $p = 80$ bar
- DN No. 700 to No. 1 000 inclusive $p = 60$ bar

16.2.2 Fittings

Fittings shall be subjected to a leak-tightness test carried out with water or air, under the conditions indicated by the relevant specific requirements.

NOTE – Because of their great mechanical strength, ductile iron pipes and fittings may be used for a very wide range of working

conditions. The hydraulic test or leak-tightness test pressures are indicated, therefore, in the specific requirements applicable to each type of casting. For gas pipes, special tests may be contemplated.

17 COATING

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

The coating must dry rapidly with good adherence and not scale off.

The inside coating must not contain any constituent soluble in water or any ingredient liable to impart any taste or smell to the water after suitable washing out of the mains. For pipe-lines carrying potable water, or alimentary fluids, the inside coating must not contain any toxic constituent.

NOTE – The requirements concerning the coating of the various castings are based on similar requirements in ISO/R 13 for grey iron pipes and fittings. Technical specifications concerning cement mortar internal linings for pipes will be the subject of a separate International Standard.

18 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 operations of inspection will normally take place.

The inspector may witness the sampling, the preparation and testing of the test pieces, the checking of dimensions and masses 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 in ISO/R 13 for grey iron pipes and fittings.

1) 1 bar $\approx$ 1,02 kgf/cm².

SECTION TWO

SPIGOT AND SOCKET PIPES

19 GENERAL – PIPES

Section two of this International Standard defines (see table 9) a range of ductile iron pipes which satisfy most of the 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/R 13 for grey iron pipes.

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

Table 9 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 thickness e has been calculated, as a function of the nominal diameter DN , by the formula given in clause 4 using 9 as the value for K , thus

$$e = 4,5 + 0,009 DN$$

However, for pipes up to DN No. 200 inclusive, the thickness is given by the additional formula

$$e = 5,8 + 0,003 DN$$

In these formulae

e is the standard wall thickness in millimetres;

DN is the nominal diameter.

The hydrostatic works test pressure for these pipes is shown in table 8.

TABLE 8

Nominal diameter DN No.	Works test pressure bar
80 to 300	50
350 to 600	40
700 to 1 000	32

20 DIMENSIONS AND MASSES

$$e = \begin{cases} 5,8 + 0,003 \text{ DN for DN No. 80 to 200} \\ 4,5 + 0,009 \text{ DN for DN No. 250 to 1 000} \end{cases}$$

Tolerance on $L = \pm 30^*$

Symbol :

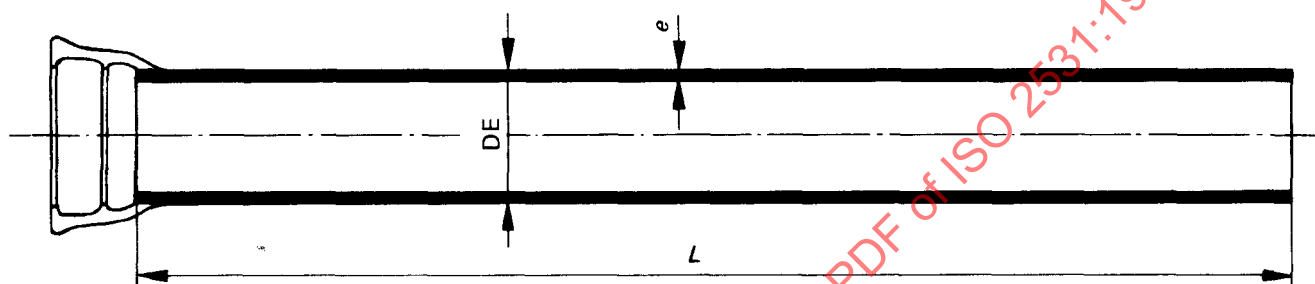
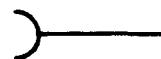


TABLE 9

Dimensions in millimetres

Masses in kilograms

Nominal diameter DN No.	Barrel			Socket mass (approximate)	Total mass (approximate) for one working length L of :				
	DE	e	Mass for 1 m (approximate)		4 m	5 m	5,5 m	6 m	7 m
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	137,1	59,3	608	745	813	882	1 019
700	738	10,8	173,9	79,1	775	949	1 036	1 123	1 296
800	842	11,7	215,2	102,6	963	1 179	1 286	1 394	1 609
900	945	12,6	260,2	129,9	1 171	1 431	1 561	1 691	1 951
1 000	1 048	13,5	309,3	161,3	1 399	1 708	1 862	2 017	2 326

* According to the type of joint, the difference between the working length L and the standard length may reach 100 mm.

SECTION THREE

FLANGES

21 GENERAL – FLANGES

In ISO/R 13 only one type of flange had been adopted for grey iron pipe-lines. The increase in pressures permissible in ductile iron pipe-lines, and the extension of the range of uses to which they may be put, have led to the inclusion of three types of flange corresponding to the nominal pressures PN 10, PN 16 and PN 25 respectively.

However, since a degree of rationalization of flange dimensions and/or drilling details already exists for nominal diameters up to and including No. 200, for the above nominal pressures, and since this rationalization of flange dimensions has been extended to include nominal diameters Nos. 250 and 300 for nominal pressures PN 10 and PN 16, the multiplicity of designs has been reduced as shown in table 10.

TABLE 10

Nominal diameters DN No.	Identical flange dimensions for nominal pressures	Identical drilling details for nominal pressures
80	PN 10, PN 16 and PN 25	PN 16 and PN 25
100 to 150	PN 10 and PN 16	PN 10 and PN 16
200 to 300	PN 10 and PN 16	—

As specified in ISO/R 13, PN 10 flanges (see tables 11 and 12) may be used on socket pipe-lines up to pressures of approximately 15 bar.

It should be noted that the diameters of bolt holes of the various types of flange are 1 mm larger than those envisaged for pipe-lines not laid in the ground. This increase makes it easier to assemble the castings, which is sometimes difficult in the case of underground pipe-lines. It also permits the use of larger diameter bolts whenever this is justified by considerations of resistance to corrosion.

The flange 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 one of the tables 11 to 16 hereafter, for a selected nominal diameter and nominal pressure.

22 DIMENSIONS AND DRILLING DETAILS OF PN 10 FLANGES

22.1 Dimensions

$$b = \begin{cases} 10 + 0,035 \text{ DN for DN No. 80 to 300 with minimum 16} \\ 10 + 0,025 \text{ DN for DN No. 350 to 1 000 with minimum 20,5} \end{cases}$$

$$s = \begin{cases} 0,8 a \text{ for DN No. 80 to 600} \\ 0,7 a \text{ for DN No. 700 to 1 000} \end{cases}$$

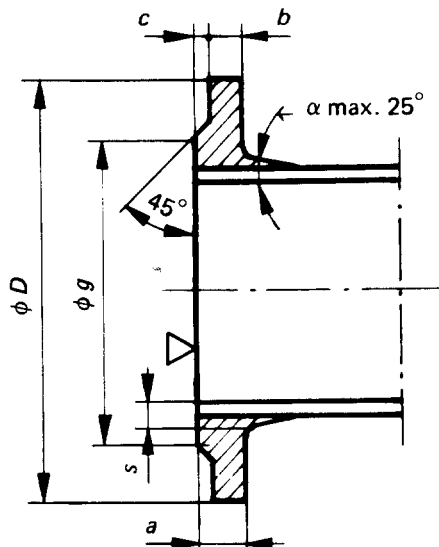


TABLE 11

Dimensions in millimetres

Masses in kilograms

Nominal diameter DN No.	D	g	a	b	c	s	Approximate flange mass (hatched part)
80	200	133	19	16	3	15	3
100	220	153	19	16	3	15	3,3
125	250	183	19	16	3	15	4
150	285	209	19	16	3	15	4,9
200	340	264	20	17	3	16	6,8
250	400	319	22	19	3	17,5	9,6
300	455	367	24,5	20,5	4	19,5	12,8
350	505	427	24,5	20,5	4	19,5	14,1
400	565	477	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	797	32,5	27,5	5	23	40,5
800	1 015	904	35	30	5	24,5	54,8
900	1 115	1 004	37,5	32,5	5	26,5	64,3
1 000	1 230	1 111	40	35	5	28	81,4

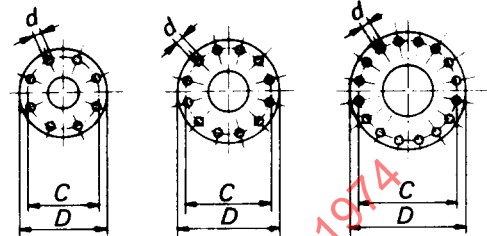
22.2 Drilling details

DN No.

80 to 200

250 and 300

350 and 400



DN No.

500 and 600

700 and 800

900 and 1 000

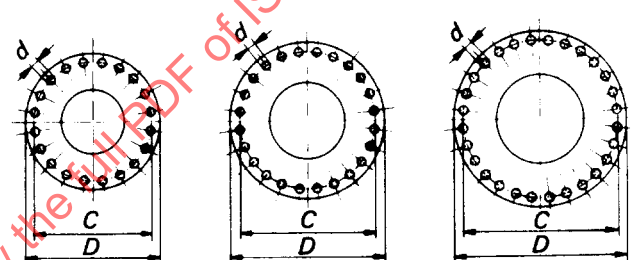


TABLE 12

Dimensions in millimetres

Nominal diameter DN No.	D	C	Holes		Bolts
			Number	Diameter d	Diameter
80	200	160	8*	19	16
100	220	180	8	19	16
125	250	210	8	19	16
150	285	240	8	23	20
200	340	295	8	23	20
250	400	350	12	23	20
300	455	400	12	23	20
350	505	460	16	23	20
400	565	515	16	28	24
500	670	620	20	28	24
600	780	725	20	31	27
700	895	840	24	31	27
800	1 015	950	24	34	30
900	1 115	1 050	28	34	30
1 000	1 230	1 160	28	37	33

* For flanges with nominal diameter 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 pipe-line.

23 DIMENSIONS AND DRILLING DETAILS OF PN 16 FLANGES

23.1 Dimensions

$b = 10 + 0,035 \text{ DN}$ with minimum 16

$s = \begin{cases} 0,8 a & \text{for DN No. 80 to 600} \\ 0,7 a & \text{for DN No. 700 to 1 000} \end{cases}$

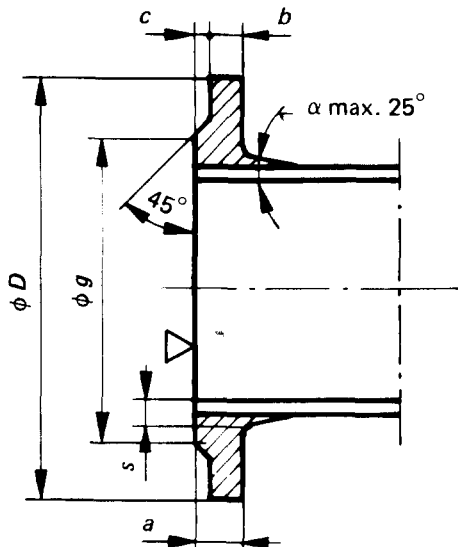


TABLE 13

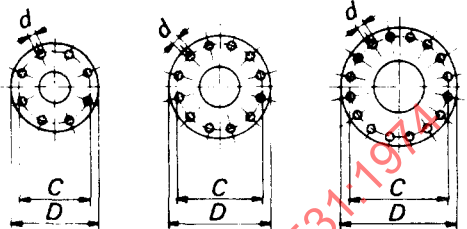
Dimensions in millimetres Masses in kilograms

Nominal Diameter DN No.	D	g	a	b	c	s	Approximate flange mass (hatched part)
80	200	133	19	16	3	15	2,9
100	220	153	19	16	3	15	3,3
125	250	183	19	16	3	15	4
150	285	209	19	16	3	15	4,9
200	340	264	20	17	3	16	6,6
250	400	319	22	19	3	17,5	9,2
300	455	367	24,5	20,5	4	19,5	12,4
350	520	432	26,5	22,5	4	21	17,2
400	580	484	28	24	4	22,5	21,9
500	715	606	31,5	27,5	4	25	37
600	840	721	36	31	5	29	57,3
700	910	791	39,5	34,5	5	27,5	55,6
800	1 025	898	43	38	5	30	74
900	1 125	998	46,5	41,5	5	32,5	88,2
1 000	1 255	1 115	50	45	5	35	122,9

23.2 Drilling details

DN No.

80 to 150 200, 250 and 300 350 and 400



DN No.

500 and 600 700 and 800 900 and 1 000

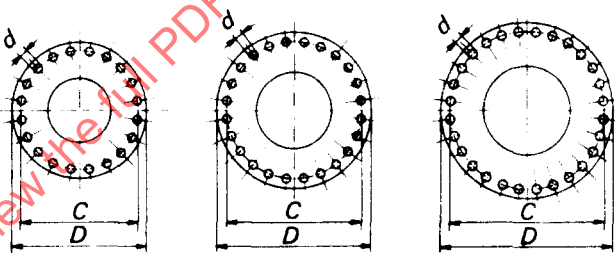


TABLE 14

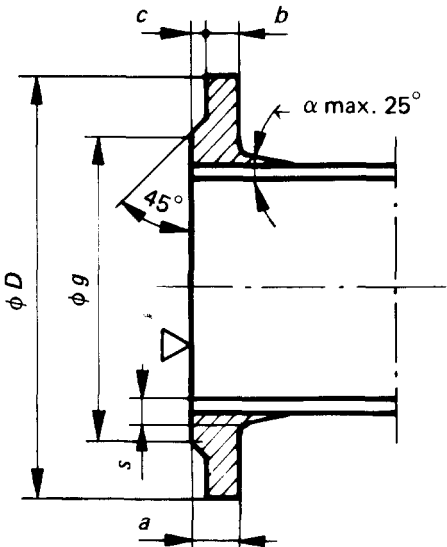
Dimensions in millimetres

Nominal diameter DN No.	D	C	Holes		Bolts
			Number	Diameter d	Diameter
80	200	160	8	19	16
100	220	180	8	19	16
125	250	210	8	19	16
150	285	240	8	23	20
200	340	295	12	23	20
250	400	355	12	28	24
300	455	410	12	28	24
350	520	470	16	28	24
400	580	525	16	31	27
500	715	650	20	34	30
600	840	770	20	37	33
700	910	840	24	37	33
800	1 025	950	24	40	36
900	1 125	1 050	28	40	36
1 000	1 255	1 170	28	43	39

24 DIMENSIONS AND DRILLING DETAILS OF PN 25 FLANGES

24.1 Dimensions

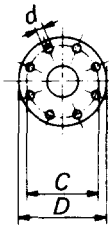
$b = 10 + 0,045 \text{ DN}$ with minimum 16
 $s = 0,8 a$



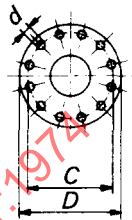
24.2 Drilling details

DN No.

80 to 150

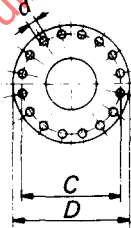


200 to 250



DN No.

300, 350 and 400



500 and 600

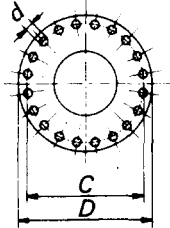


TABLE 15

Dimensions in millimetres Masses in kilograms

Nominal diameter DN No.	D	g	a	b	c	s	Approximate flange mass (hatched part)
80	200	133	19	16	3	15	2,9
100	235	159	19	16	3	15	3,8
125	270	184	19	16	3	15	4,6
150	300	214	20	17	3	16	5,9
200	360	274	22	19	3	17,5	8,7
250	425	331	24,5	21,5	3	19,5	13,1
300	485	389	27,5	23,5	4	22	18
350	555	446	30	26	4	24	25,5
400	620	503	32	28	4	25,5	33,2
500	730	613	36,5	32,5	4	29	48,7
600	845	718	42	37	5	33,5	71,5

TABLE 16

Dimensions in millimetres

Nominal diameter DN No.	D	C	Holes		Bolts
			Number	Diameter d	Diameter
80	200	160	8	19	16
100	235	190	8	23	20
125	270	220	8	28	24
150	300	250	8	28	24
200	360	310	12	28	24
250	425	370	12	31	27
300	485	430	16	31	27
350	555	490	16	34	30
400	620	550	16	37	33
500	730	660	20	37	33
600	845	770	20	40	36

SECTION FOUR

FITTINGS

25 GENERAL – FITTINGS

In general, the ductile iron fittings are of designs similar to those of grey iron fittings (see ISO/R 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.

The flange-socket pieces (see table 18) and the straight collars (see table 20) have an internal diameter enlarged sufficiently to allow the adjacent pipes to slide through, facilitating the dismantling and the longitudinal adjustment of the pipe-line sections.

The double-socket bends (see tables 21 to 24) 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 introduction of reducing flanges (see tables 34 to 36) has made it possible to simplify the range of flanged-branch tees (see tables 25 and 42); 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 works and at the customers' and also to make supply easier.

Up to and including nominal diameter No. 200, the range of the branches of double-socket tees with flanged branches (see tables 25 to 27) specifies all diameters smaller than and

equal to the nominal diameter of the body of the tee, with the exception of the nominal diameter No. 125 which is in less common use; the range of the branches of all flanged tees (see tables 40 to 42) is substantially the same; that of all-socket tees (see table 28) is limited to the most common smaller nominal diameters i.e. : DN No. 80, No. 100 and No. 150, and to the nominal diameter of the body of the tee.

Above nominal diameter DN No. 200, only tees with flanged branches are specified, the range of these branches including all the principal diameters up to the diameter of the body.

The connection of a pipe-line of another diameter with these tees is achieved through a double-flanged taper (see table 30) or a reducing flange (see tables 34 to 36).

Double-socket tapers (see table 29), used mainly for a reduction in diameter, have the shortest practicable lengths.

Double-flanged tapers (see table 30), 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.

Tables 18 and those following are for ductile iron fittings for pressure pipe-lines for the transportation and distribution of water, other liquids, or gas under pressure.

The thicknesses have been calculated as a function of the nominal diameter DN by using the formula in clause 4, with the following values for K :

$$K = 14 \text{ for tees, thus } e = 7 + 0,014 \text{ DN}$$

$$K = 12 \text{ for other fittings, thus } e = 6 + 0,012 \text{ DN}$$

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

In a main, the position of the fittings — bends, tees, etc. — is nearly always governed by the layout of the pipe-line 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 pipe-line 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.

The fittings shall be submitted at the works to a leak-tightness test carried out either with air at a pressure of 1 bar or with water at the pressure indicated in table 17.

TABLE 17

Nominal diameter DN No.	Hydrostatic leak-tightness test pressure bar
80 to 300	25
350 to 600	16
700 to 1 000	10

26 FLANGED SOCKET

$$e = 12 (0,5 + 0,001 \text{ DN})$$

$$d = 25 + 1,05 \text{ DN}$$

$$L = 120 + 0,10 \text{ DN (rounded off to } \pm 5)$$

$$\text{Tolerances on } L = \pm 25$$

Symbol :

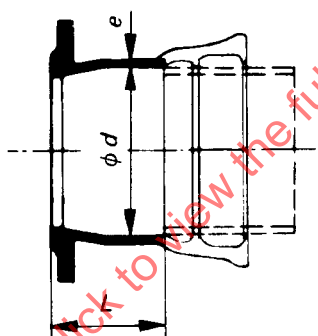


TABLE 18

Dimensions in millimetres

Masses in kilograms

Nominal diameter DN No.	<i>e</i>	<i>d</i>	<i>L</i>	Mass (approximate) with flange :		
				PN 10	PN 16	PN 25
80	7	109	130	7,5	7,4	7,3
100	7,2	130	130	9	9	9,5
125	7,5	156	135	11,5	11,5	12,1
150	7,8	183	135	14,2	14,2	15,2
200	8,4	235	140	20,5	20	22
250	9	288	145	28	27,5	31,5
300	9,6	340	150	37	36,5	42
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	—

27 FLANGED SPIGOT

$e = 12 (0,5 + 0,001 \text{ DN})$
 $L = 320 + 0,4 \text{ DN (with maximum = 600)}$
(rounded off to ± 5)

Tolerances on $L = \pm 25$

Symbol :

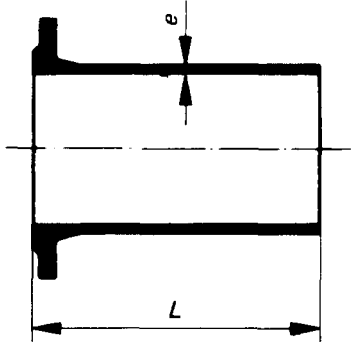


TABLE 19

Dimensions in millimetres Masses in kilograms

Nominal diameter DN No.	e	L	Mass (approximate) with flange :		
			PN 10	PN 16	PN 25
80	7	350	7,9	7,8	7,8
100	7,2	360	9,6	9,6	10,2
125	7,5	370	12,4	12,4	13
150	7,8	380	15,6	15,6	16,6
200	8,4	400	22,5	22,5	24,5
250	9	420	31,5	32	35,5
300	9,6	440	41,5	42,5	47,5
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	—

28 COLLAR

$e = 12 (0,5 + 0,001 \text{ DN})$
 $d = 25 + 1,05 \text{ DN}$
 $L = 150 + 0,1 \text{ DN (rounded off to } \pm 5)$

Tolerances on $L = \pm 25$

Symbol :

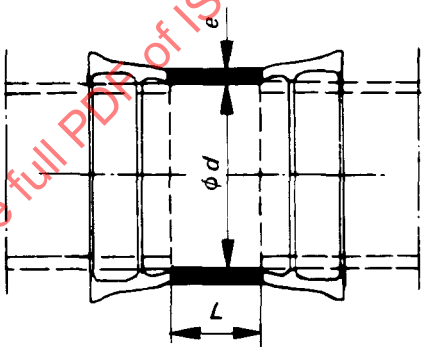
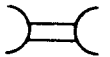


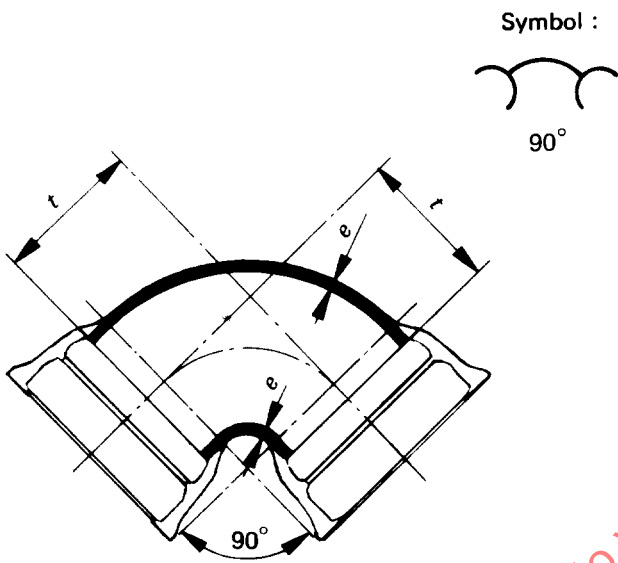
TABLE 20

Dimensions in millimetres Masses in kilograms

Nominal diameter DN No.	e	d	L	Mass (approximate)
80	7	109	160	7,9
100	7,2	130	160	7,9
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

29 DOUBLE-SOCKET 1/4 BEND

$e = 12 (0,5 + 0,001 \text{ DN})$
 $t = 20 + \text{DN}$
Tolerances on $t = \pm (15 + 0,03 \text{ DN})$



30 DOUBLE-SOCKET 1/8 BEND

$e = 12 (0,5 + 0,001 \text{ DN})$
 $t = 20 + 0,44 \text{ DN}$ (rounded off to ± 5)
Tolerances on $t = \pm (10 + 0,025 \text{ DN})$

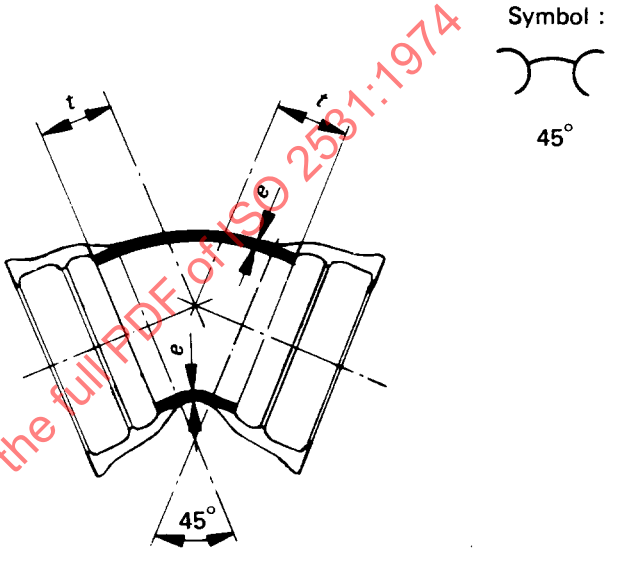


TABLE 22

Dimensions in millimetres			Masses in kilograms
Nominal diameter DN No.	<i>e</i>	<i>t</i>	Mass (approximate)
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

TABLE 21

Dimensions in millimetres		Masses in kilograms	
Nominal diameter DN No.	<i>e</i>	<i>t</i>	Mass (approximate)
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

31 DOUBLE-SOCKET 1/16 BEND

$e = 12 \text{ (} 0,5 + 0,001 \text{ DN)}$
 $t = 20 + 0,22 \text{ DN (rounded off to } \pm 5)$
Tolerances on $t = \pm (10 + 0,02 \text{ DN})$

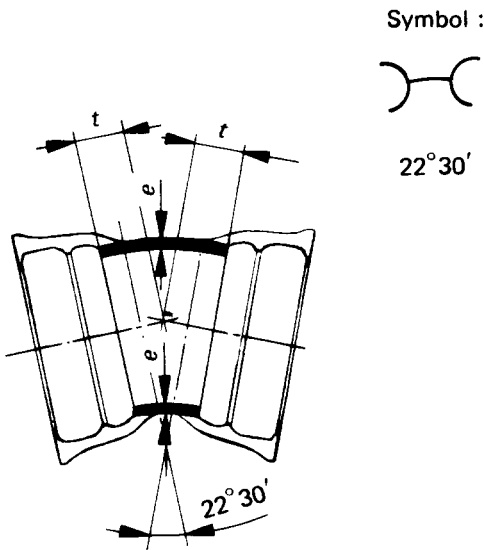


TABLE 23

Dimensions in millimetres		Masses in kilograms	
Nominal diameter DN No.	e	t	Mass (approximate)
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

32 DOUBLE-SOCKET 1/32 BEND

$e = 12 \text{ (} 0,5 + 0,001 \text{ DN)}$
 $t = 20 + 0,11 \text{ DN (rounded off to } \pm 5)$
Tolerances on $t = \pm (10 + 0,02 \text{ DN})$

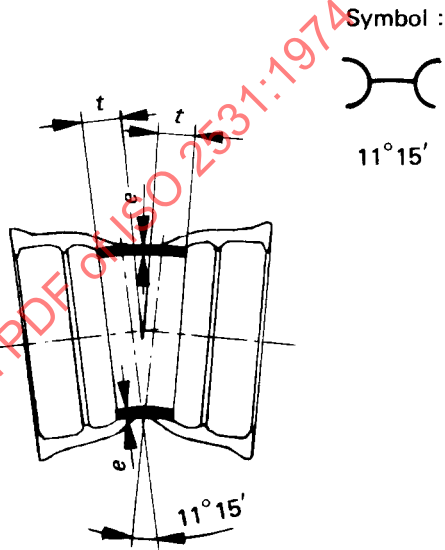


TABLE 24

Dimensions in millimetres		Masses in kilograms	
Nominal diameter DN No.	e	t	Mass (approximate)
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

33 DOUBLE-SOCKET TEE WITH FLANGED BRANCH

33.1 DN No. 80 to No. 200

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

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

$$L = 70 + 0,06 \text{ DN} + 1,16 \text{ dn (rounded off to } \pm 5)$$

$$h = 100 + 0,6 \text{ DN} + 0,2 \text{ dn (rounded off to } \pm 5)$$

$$\text{Tolerances on } L \text{ and } h = \begin{matrix} + 50 \\ - 25 \end{matrix}$$

Symbol :

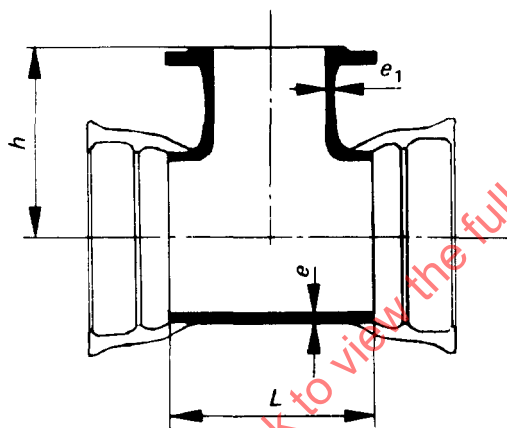


TABLE 25

Dimensions in millimetres

Masses in kilograms

Body			Branch			Mass (approximate) with flange :		
Nominal diameter DN No.	e	L	Nominal diameter dn No.	e_1	h	PN 10	PN 16	PN 25
80	8,1	170	80	8,1	165	13,6	13,5	13,5
100	8,4	170	80	8,1	175	16	15,8	15,8
	8,4	190	100	8,4	180	17,2	17,2	17,7
125	8,8	170	80	8,1	190	19,5	19,4	19,4
	8,8	195	100	8,4	195	21	21	21,5
	8,8	225	125	8,8	200	23	23	24
150	9,1	170	80	8,1	205	23	23	23
	9,1	195	100	8,4	210	24,5	24,5	25
	9,1	255	150	9,1	220	29,5	29,5	30,5
200	9,8	175	80	8,1	235	31,5	31,5	31,5
	9,8	200	100	8,4	240	33,5	33,5	34
	9,8	255	150	9,1	250	39	39	40
	9,8	315	200	9,8	260	45,5	45	47,5

33.2 DN No. 250 to No. 600

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

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

$L = 70 + 0,06 \text{ DN} + 1,16 \text{ dn}$ (rounded off to ± 5)

$h = 100 + 0,6 \text{ DN} + 0,2 \text{ dn}$ (rounded off to ± 5)

Tolerances on L and $h = \begin{smallmatrix} + 50 \\ - 25 \end{smallmatrix}$

Symbol :

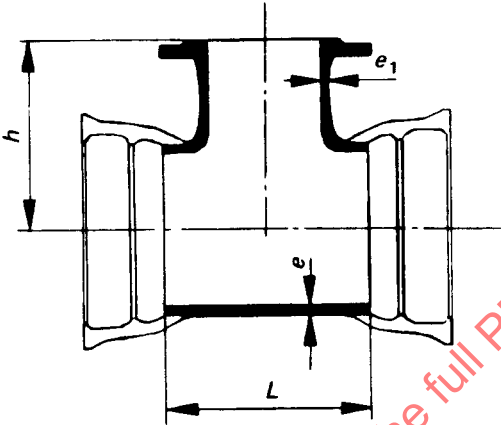


TABLE 26

Dimensions in millimetres

Masses in kilograms

Body			Branch			Mass (approximate) with flange :		
Nominal diameter DN No.	e	L	Nominal diameter dn No.	e_1	h	PN 10	PN 16	PN 25
250	10,5	200	100	8,4	270	43,5	43,5	44
	10,5	315	200	9,8	290	57	57	59
	10,5	375	250	10,5	300	65	66	69
300	11,2	205	100	8,4	300	55	55	56
	11,2	320	200	9,8	320	71	70	73
	11,2	435	300	11,2	340	89	91	95
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

33.3 DN No. 700 to No. 1 000

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

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

$$L^* = 70 + 0,06 \text{ DN} + 1,16 \text{ dn (rounded off to } \pm 5)$$

$$h = 75 + 0,6 \text{ DN} + 0,15 \text{ dn (rounded off to } \pm 5)$$

Tolerances on L and $h = \begin{smallmatrix} + 50 \\ - 25 \end{smallmatrix}$

Symbol :

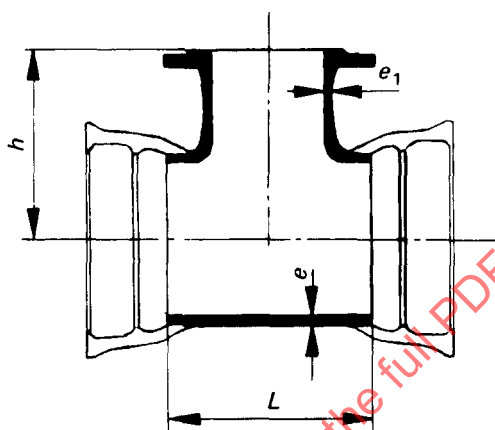


TABLE 27

Dimensions in millimetres

Masses in kilograms

Body			Branch			Mass (approximate) with flange :		
Nominal diameter DN No.	e	L	Nominal diameter dn No.	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	—

* The length L of tees for nominal diameters $\text{DN} > \text{DN No. 600}$ and for dn No. 600 is equal to that of tees with the same nominal diameters of the body and of the branch.

34 ALL-SOCKET TEE

$e = 14 (0,5 + 0,001 \text{ DN})$
 $L = 70 + 0,06 \text{ DN} + 1,16 \text{ dn}$ (rounded off to ± 5)
 $h = 35 + 0,5 \text{ DN} + 0,11 \text{ dn}$ (rounded off to ± 5)
Tolerances on L and on $h = \begin{smallmatrix} + 50 \\ - 25 \end{smallmatrix}$

Symbol :

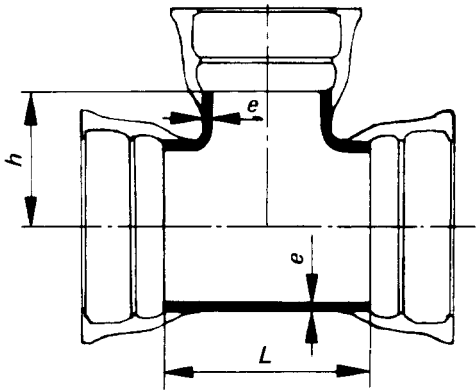
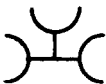


TABLE 28

Dimensions in millimetres Masses in kilograms

Body			Branch			Mass (approximate)
Nominal diameter DN No.	e	L	Nominal diameter dn No.	e	h	
80	8,1	170	80	8,1	85	12,4
100	8,4	170	80	8,4	95	14,8
100	8,4	190	100	8,4	95	16,1
125	8,8	225	125	8,8	110	22
150	9,1	170	80	9,1	120	21,5
150	9,1	195	100	9,1	120	23,5
150	9,1	255	150	9,1	125	28
200	9,8	175	80	9,8	145	30
200	9,8	200	100	9,8	145	32
200	9,8	255	150	9,8	150	37
200	9,8	315	200	9,8	155	43

35 DOUBLE-SOCKET TAPER

$e_1 = 12 (0,5 + 0,001 \text{ DN})$ $e_2 = 12 (0,5 + 0,001 \text{ dn})$
 $L = \begin{cases} 50 + 2 (\text{DN} - \text{dn}) & \text{for DN No. 100 to 300} \\ 60 + 2 (\text{DN} - \text{dn}) & \text{for DN No. 350 to 600} \\ 80 + 2 (\text{DN} - \text{dn}) & \text{for DN No. 700 to 1 000} \end{cases}$

Tolerances on $L = \pm 25$

Symbol :

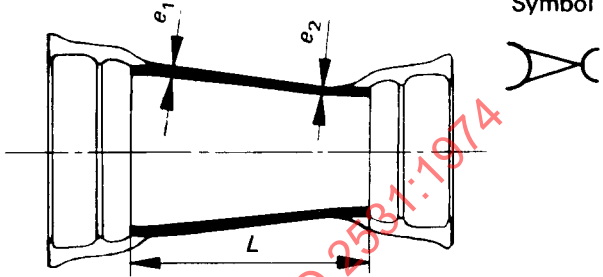


TABLE 29

Dimensions in millimetres Masses in kilograms

Larger diameter		Smaller diameter		L	Mass (approximate)
Nominal diameter DN no.	e_1	Nominal diameter dn No.	e_2		
100	7,2	80	7	90	8,5
125	7,5	80	7	140	10,8
150	7,8	100	7,2	100	11,1
				190	13,5
				150	13,8
200	8,4	125	7,5	100	14,1
				250	20,5
				200	20,5
				150	21
250	8,4	100	7,2	250	20,5
				200	20,5
				150	21
				150	21
300	9	125	7,5	300	29
				250	29
				250	29
				150	29
350	9,6	150	7,8	350	39,5
				250	39,5
				250	39,5
				150	38,5
400	10,2	200	8,4	360	52
				260	51
				260	51
				160	49,5
500	10,2	250	9,6	360	66
				260	64
				260	64
				160	62
600	10,8	300	9,6	360	98
				260	94
				260	94
				260	94
700	12	350	10,2	360	142
				260	131
				260	131
				260	131
800	12	400	10,8	460	194
				280	178
				280	178
				280	178
900	13,2	400	10,8	460	252
				280	229
				280	229
				280	229
1000	14,4	500	12	480	318
				280	288
				280	288
				280	288
1000	15,6	600	13,2	480	392
				280	354
				280	354
				280	354
1000	16,8	700	14,4	480	392
				280	354
1000	18	800	15,6	480	392
				280	354
1000	18	900	16,8	480	392
				280	354

36 DOUBLE-FLANGED TAPER

$$e_1 = 12 (0,5 + 0,001 \text{ DN})$$

$$e_2 = 12 (0,5 + 0,001 \text{ dn})$$

$$L = \begin{cases} 200 & \text{for } (\text{DN} - \text{dn}) \leq 25 \\ 300 & \text{for } (\text{DN} - \text{dn}) = 50 \\ 600 & \text{for } (\text{DN} - \text{dn}) = 100 \end{cases}$$

Tolerances on $L = \pm 10$

Symbol :

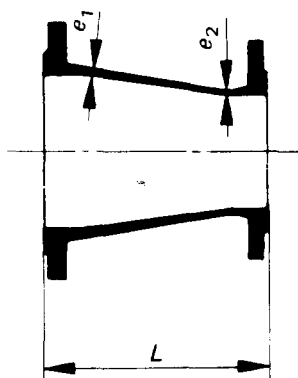


TABLE 30

Dimensions in millimetres

Masses in kilograms

Larger diameter		Smaller diameter		L	Mass (approximate) with flange :		
Nominal diameter DN No.	e_1	Nominal diameter dn No.	e_2		PN 10	PN 16	PN 25
100	7,2	80	7	200	9,4	9,3	9,8
125	7,5	100	7,2	200	11,3	11,3	12,5
150	7,8	125	7,5	200	14	14	15,5
200	8,4	150	7,8	300	22	21,5	25
250	9	200	8,4	300	30	29,5	35,5
300	9,6	250	9	300	40,5	39,5	49
350	10,2	300	9,6	300	49,5	52	66
400	10,8	350	10,2	300	58	67	86
500	12	400	10,8	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	—

37 BLANK FLANGE PN 10

$$b = \begin{cases} 10 + 0,035 \text{ DN for DN No. 80 to 300 with minimum 16} \\ 10 + 0,025 \text{ DN for DN No. 350 to 1 000 with minimum 20,5} \end{cases}$$

Symbol :

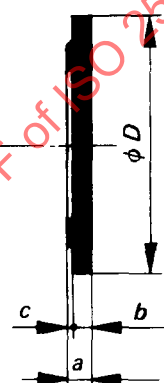


TABLE 31

Dimensions in millimetres

Masses in kilograms

Nominal diameter DN No.	D	a	b	c	Mass (approximate)
80	200	19	16	3	3,6
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

NOTE — For flanges of nominal diameters $\geq$ DN No. 350 the centre of blank flanges may be dished.