International Standard 2531

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

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

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 2531 was developed by Technical Committee ISO/TC 5, *Metal pipes and fittings*. It has been approved by the member bodies of the following countries :

Austria	India	South Africa, Rep. of
Canada	Israel	Spain
Czechoslovakia	Italy	Switzerland
Denmark	Japan	Turkey
Egypt, Arab Rep. of	Korea, Rep. of	United Kingdom
Finland	Mexico	USA
France	Netherlands	USSR
Germany, F. R.	Poland	Yugoslavia
Hungary	Romania	

The member bodies of the following countries expressed disapproval of the document on technical grounds :

Australia
Belgium

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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 and by its significant proof stress and 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/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.

The requirements of ISO 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 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 pipe-lines for water, other liquids, or gas.

The range of diameters extends from nominal diameter DN 40 to nominal diameter DN 2000 inclusive. The diameter DN 60 shown in parentheses in the tables exists in national standards in certain countries. However, it is recommended that whenever possible it be replaced by the diameter DN 65.

2 REFERENCES

ISO 13, *Grey iron pipes, special castings and grey 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 joint.

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 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 as that of the spigot end of grey iron castings (ISO 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 :

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

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 20 to 26, 32, 33 and 41 to 43,

$K = 14$ for the fittings in tables 27 to 31 and 44 to 46.

If necessary, each particular 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 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 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 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 tests described below 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 shall 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, when not so specified, 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 Flange thickness	$-(1{,}3 + 0{,}001\ DN)$ [1)] $\pm (2 + 0{,}05\ b)$
Pipes cast in sand or metal moulds	Wall thickness Flange thickness	$-(2{,}3 + 0{,}001\ DN)$ [1)] $\pm (3 + 0{,}05\ b)$
Fittings and accessories	Wall thickness Flange thickness	$-(2{,}3 + 0{,}001\ DN)$ [1)] $\pm (3 + 0{,}05\ b)$

1) 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 are as shown in table 2.

TABLE 2

Nominal diameters DN	Standard lengths m
40 to 65	2 – 3 – 4 – 5 – 5,5 – 6
80 to 500	4 – 5 – 5,5 – 6
600 to 1000	4 – 5 – 5,5 – 6 – 7
1200 to 2000	6 – 7 – 8 – 9

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 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. :

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

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 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 and 100 kg;
- to the nearest kilogram for masses above 100 kg.

The 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 200 inclusive	± 8
Pipes centrifugally cast — above DN 200	± 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 sand or metal 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 shall 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 sand or metal moulds**

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

- DN 40 to 300 : 100 pipes
- DN 350 to 600 : 50 pipes
- DN 700 to 1000 : 25 pipes
- DN 1200 to 2000 : 10 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 shall satisfy the requirements of table 7.

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 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.

TABLE 7

Type of casting	Minimum tensile strength R_m	Minimum 0,2 % proof stress[1] $R_{p0,2}$	Minimum elongation after fracture A	
	N/mm²	N/mm²	%	
	DN 40 to 2000	DN 40 to 2000	DN 40 to 1000	DN 1200 to 2000
Pipes centrifugally cast	420	300	10	7
Pipes cast in sand or metal moulds Fittings	400	300	5	–

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

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 hydrostatic 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 bars[1] as a function of the coefficient K (clause 4), be calculated using the following formulae :

- DN 40 to 300 : $p = 0{,}5\ (K + 1)^2$
- DN 350 to 600 : $p = 0{,}5\ K^2$
- DN 700 to 1000 : $p = 0{,}5\ (K - 1)^2$
- DN 1200 to 2000 : $p = 0{,}5\ (K - 2)^2$

The actual test pressures shall not exceed the following values :

- DN 40 to 300 : p = 100 bar
- DN 350 to 600 : p = 80 bar
- DN 700 to 1000 : p = 60 bar
- DN 1200 to 2000 : p = 40 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 hydrostatic 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 required.

17 COATING

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

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

The inside coating shall 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 shall not contain any toxic constituent.

NOTE – The requirements concerning the coating of the various castings are based on similar requirements in ISO 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.

1) 1 bar = 0,1 MPa

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 13 for grey iron pipes and fittings.

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 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 or 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 DN 40 to 200, the thickness is given by the additional formula

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

with a minimum of 6 mm for pipes DN 40 to 65.

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 diameters DN	**Hydrostatic works test pressure** bar
40 to **300**	50
350 to **600**	40
700 to **1000**	32
1200 to **2000**	25

20 DIMENSIONS AND MASSES

$e = \begin{cases} 5{,}8 + 0{,}003\ DN, \text{ with a minimum value of 6, for DN 40 to 65} \\ 5{,}8 + 0{,}003\ DN \text{ for DN 80 to 200} \\ 4{,}5 + 0{,}009\ DN \text{ for DN 250 to 2000} \end{cases}$

Tolerance on $L = \pm 30$[1)]

Symbol :

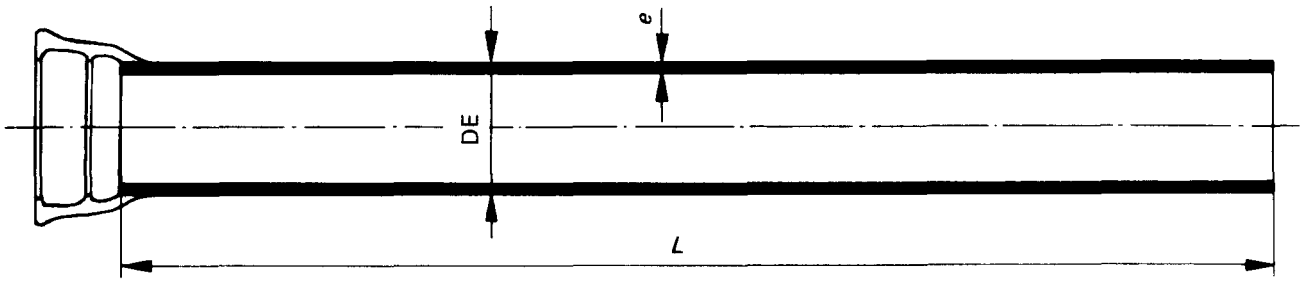

TABLE 9

Dimensions in millimetres — Masses in kilograms

Nominal diameter DN	Barrel			Socket mass (approximate)	Total mass (approximate) for one working length L of :								
	DE	e	Mass per metre (approximate)		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	–	–	–	–	–	–
50	66	6	8	2,1	18	26	34	–	–	–	–	–	–
(60)	77	6	9,4	2,5	–	–	40	49,5	54	59	–	–	–
65	82	6	10,1	2,7	–	–	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	137,1	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	–	–
1000	1 048	13,5	309,3	161,3	–	–	1 399	1 708	1 862	2 017	2 326	–	–
1200	1 255	15,3	420,1	237,7	–	–	–	–	2 548	2 758	3 178	3 799	4 019
1400	1 462	17,1	547,2	279,3	–	–	–	–	–	3 563	4 110	4 637	5 204
1600	1 668	18,9	690,3	375,4	–	–	–	–	–	4 517	5 208	5 898	6 588
1800	1 875	20,7	850,1	490,6	–	–	–	–	–	5 591	6 441	7 291	8 142
2000	2 082	22,5	1 026,3	626,4	–	–	–	–	–	6 784	7 811	8 837	9 863

1) According to the type of joint, the difference between the working length L and the working manufacturing length may reach 100 mm for DN 40 to 1000, and 250 mm for DN 1200 to 2000.

SECTION THREE

FLANGES

21 GENERAL – FLANGES

In ISO 13, only one type of flange has 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 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 50 for nominal pressures PN 10-16-25 and 40, and, for DN 60 and 65, a common design for nominal pressures PN 10 and 16 on the one hand and PN 25 and 40 on the other hand.

Moreover, since a degree of rationalization of flange dimensions and/or drilling details already exists for DN 80 to 200, for the above nominal pressures, and since this rationalization of flange dimensions has been extended to include DN 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	Identical flange dimensions for nominal pressures	Identical drilling details for nominal pressures
40 and **50**		PN 10–16–25–40
60 and **65**	PN 10–16/PN 25–40	
80	PN 10–16–25	PN 16–25
100 to **150**	PN 10–16	PN 10–16
200 to **300**	PN 10–16	

As specified in ISO 13, PN 10 flanges (see tables 11 and 12) may be used on socket pipe-lines 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 one of the tables 11 to 18 hereafter for a selected nominal diameter and nominal pressure.

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

for a bolt diameter $\leqslant 52$: diameter of the bolt + 4 mm;

for a bolt diameter > 52 : diameter of the bolt + 6 mm.

22 DIMENSIONS AND DRILLING DETAILS OF PN 10 FLANGES

22.1 Dimensions

$b =$ { 10 + 0,035 DN, with a minimum value of 16, for DN 40 to 300
10 + 0,025 DN, with a minimum value of 20,5, for DN 350 to 1200
20 + 0,015 DN for DN 1400 to 2000

$s =$ { 0,8 a for DN 40 to 600
0,7 a for DN 700 to 2000

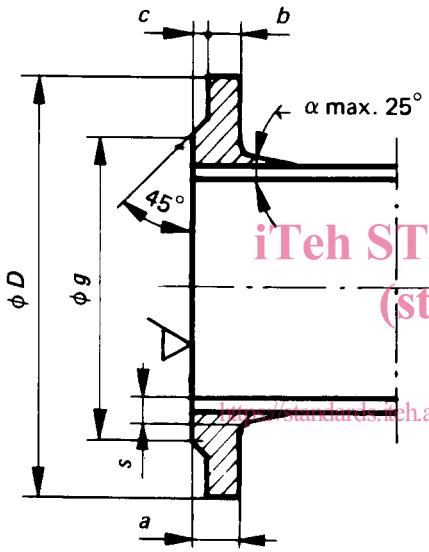

TABLE 11

Dimensions in millimetres — Masses in kilograms

Nominal diameter DN	D	g	a	b	c	s	Approximate flange mass (hatched part)
40	150	83	19	16	3	16	1,7
50	165	98	19	16	3	16	2,1
(60)	175	108	19	16	3	16	2,2
65	185	118	19	16	3	16	2,5
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
1000	1 230	1 111	40	35	5	28	81,4
1200	1 455	1 330	45	40	5	31,5	120,9
1400	1 675	1 530	46	41	5	32	147,8
1600	1 915	1 750	49	44	5	34,5	206,4
1800	2 115	1 950	52	47	5	36,5	236,3
2000	2 325	2 150	55	50	5	38,5	279,4