INTERNATIONAL STANDARD

ISO 4435

First edition
1991-05-15

Unplasticized poly(vinyl chloride) (PVC-U) pipes and fittings for buried drainage and sewerage systems — Specifications

Tubes et raccords en poly(chlorure de vinyle) non plastifié (PVC-U) pour les systèmes d'assainissement enterrés et les égouts souterrains — Spécifications

Reference number
ISO 4435:1991(E)

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 4435 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*.

Annex A of this International Standard is for information only.

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Unplasticized poly(vinyl chloride) (PVC-U) pipes and fittings for buried drainage and sewerage systems — Specifications

1 Scope

This International Standard specifies unplasticized poly(vinyl chloride) (PVC-U) pipes and fittings with elastomeric sealing ring joints for outside diameters from 110 mm to 630 mm and with cemented-type joints for outside diameters from 110 mm to 200 mm, intended for buried gravity drain and sewer pipes for the transportation of soil and waste discharge of domestic and industrial origin, and surface water.

In the case of industrial discharge, chemical and temperature resistance have to be taken into account.

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 265-1:1988, *Pipes and fittings of plastics materials — Fittings for domestic and industrial waste pipes — Basic dimensions: Metric series — Part 1: Unplasticized poly(vinyl chloride) (PVC-U).*

ISO 580:1990, *Injection-moulded unplasticized poly(vinyl chloride) (PVC-U) fittings — Oven test — Test method and basic specifications.*

ISO 1043-1:1987, *Plastics — Symbols — Part 1: Basic polymers and their special characteristics.*

ISO 1167:—[1], *Thermoplastics pipes for the transport of fluids — Resistance to internal pressure — Test method and basic specification.*

ISO 2505:1981, *Unplasticized polyvinyl chloride (PVC) pipes — Longitudinal reversion — Test methods and specification.*

ISO 2507:1982, *Unplasticized polyvinyl chloride (PVC) pipes and fittings — Vicat softening temperature — Test method and specification.*

ISO 3126:1974, *Plastics pipes — Measurement of dimensions.*

ISO 3127:1980, *Unplasticized polyvinyl chloride (PVC) pipes for the transport of fluids — Determination and specification of resistance to external blows.*

ISO 3606:1976, *Unplasticized polyvinyl chloride (PVC) pipes — Tolerances on outside diameters and wall thicknesses.*

ISO 4065:1978, *Thermoplastic pipes — Universal wall thickness table.*

ISO 4633:1983, *Rubber seals — Joint rings for water supply, drainage and sewerage pipelines — Specification for materials.*

1) To be published. (Revision of ISO 1167:1973)

3 Symbols

The main symbols used in this International Standard are listed in table 1.

Table 1 — Symbols

Symbol	Definition
D	Nominal outside diameter of pipe
$D_{e,\,m}$	Mean outside diameter
d_s	Socket inside diameter
e	Nominal wall thickness
e_2	Wall thickness at socket cylindrical part
e_3	Wall thickness at socket groove
l_1	Spigot length } length of engagement
l_2	Socket depth }
l	Nominal length of pipe

NOTE 1 The meanings of symbols A, B, C and H are illustrated in the respective figures.

4 Material

4.1 The material shall consist substantially of poly(vinyl chloride) (PVC) to which may be added only those additives that are needed to facilitate the manufacture of sound, durable pipes and fittings of good surface finish, mechanical strength and opacity.

When sealing rings are retained by means of retaining caps or rings, the retaining caps or rings may be made from polymers other than PVC-U provided that they conform to the same functional dimensions and test requirements as applied to sockets with either loose or fixed sealing rings.

4.2 The use of the manufacturer's own clean rework material conforming to the requirements given in 4.1 is permissible. No other rework material shall be used.

5 Geometrical characteristics

NOTE 2 The figures are schematic sketches only, to help demonstrate relevant dimensions. They do not necessarily represent manufactured components.

All measurements of dimensions shall be carried out in accordance with ISO 3126.

5.1 Pipe dimensions

The pipe dimensions are illustrated in figure 1.

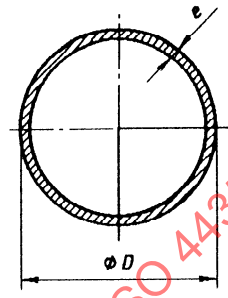

Figure 1 — Dimensions

5.1.1 Outside diameter

The nominal outside diameter D shall be in accordance with table 2 and figure 1.

Table 2 — Nominal outside diameter

Dimensions in millimetres

110	125	160	200	250	315	400	500	630

NOTE 3 Table 2 will be extended to include diameters up to 1 000 mm when the relevant information has been presented and accepted.

Tolerances on outside diameters shall be those given in ISO 3606.

5.1.2 Wall thickness

The nominal wall thickness e shall be in accordance with table 3 and figure 1. The choice of a size range is left to the national standards bodies.

Tolerances on wall thickness shall be those in ISO 3606.

Table 3 — Nominal wall thickness

Dimensions in millimetres

Nominal outside diameter D	Nominal wall thickness, e		
	Reference stiffness, kN/m² 1)		
	2	4	8
	Pipe series 2)		
	S25	S20	S16,7 3)
110	—	3	3,2
125	3	3,1	3,7
160	3,2	4	4,7
200	3,9	4,9	5,9
250	4,9	6,2	7,3
315	6,2	7,7	9,2
400	7,8	9,8	11,7
500	9,8	12,3	14,6
630	12,3	15,4	18,4

1) The reference stiffness values are given as a guide, and may be determined by the method given in ISO 9969.

2) The number of the wall thickness range generally follows the pipe series (S) used in ISO 4065 except that the minimum wall thickness is 3 mm.

3) Deviates from ISO 4065 for technical reasons.

5.1.3 Length of pipe

The nominal length of pipes with sockets is considered to be the distance between the ends minus the socket depth (see figure 2).

The lengths may be supplied as agreed between purchaser, user and manufacturer.

5.1.4 Integral pipe sockets and spigot ends

The basic dimensions shall be in accordance with table 4 and table 5 and figure 3, figure 4, figure 5 and figure 6, with $e_{2,\,min} = 0{,}9e$ and $e_{3,\,min} = 0{,}75e$.

$e_{3,\,min}$ applies only to those parts of the ring seal zone where the fluid contained within the pipe comes into contact with the socket. For those parts of the socket which do not come into contact with the fluid, i.e. beyond the designated ring seal point, walls thinner than e_3 are permitted.

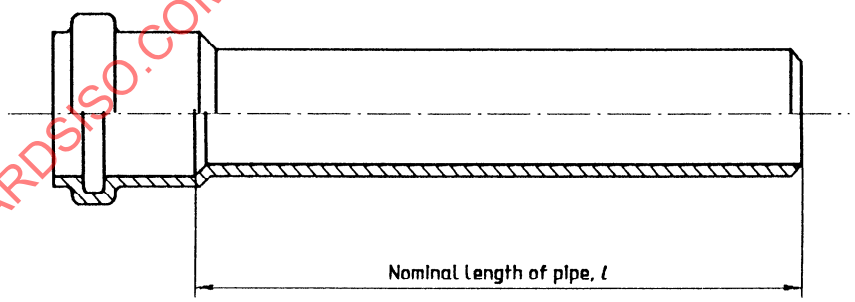

Figure 2 — Length of pipe

Table 4 — Single sockets and spigot ends for elastomeric sealing ring joints

Dimensions in millimetres

Nominal outside diameter	Socket				Spigot end	
	d_s	A	B	C	l_1	H
D	min.	min.	min.	max.	min.	≈
110	110,4	32	6	22	54	6
125	125,4	35	7	26	61	6
160	160,5	42	9	32	74	7
200	200,6	50	12	40	90	9
250	250,8	55	18	70	125	9
315	316	62	20	70	132	12
400	401,2	70	24	70	140	15
500	501,5	80	28	80	160	18
630	631,9	93	34	95	188	23

The performance of a joint made between a single socket and a pipe spigot shall be determined as specified in 9.1.2.4 (angular deflection test) and/or 9.1.2.5 (combined test).

A_{min} for $D \leqslant 200$ mm shall be $0{,}2\ D + 10$ mm.

A_{min} for $D \geqslant 250$ mm shall be $0{,}1\ D + 30$ mm.

The A_{min} values have been chosen mainly on the basis of experience with pipes of 5 m length.

The B values may be smaller for constructions with sealing rings firmly fixed in the groove of the socket.

$$l_{1,\,min} = C_{max} + A_{min}$$

Where sealing rings are firmly fixed and have multiple sealing zones, the dimensions A_{min} and C_{max} should be measured to the effective sealing point as specified by the manufacturer (see figure 5).

C_{max} should then be checked with a gauge as this dimension determines the tightness of the joint.

Retaining caps or rings may be made to other designs and from polymers other than unplasticized poly(vinyl chloride) provided that the finished joint conforms to the same functional test requirements.

Where a sealing ring is retained by means of a retaining cap or ring, the wall thickness in this area shall be calculated by the addition of the wall thicknesses of the corresponding places of the socket and the retaining cap or ring (see figure 4 for an example). In all cases the components shall meet the functional test requirements.

Table 5 — Sockets and spigot ends for cemented-type joints

Dimensions in millimetres

Nominal outside diameter	Socket					Spigot end	
	X series socket[1]		Y series socket[1]				
D	d_s min.	d_s max.	d_s min.	d_s max.	l_2 min.	l_1 min.	H ≈
110	110,2	110,6	110,4	110,8	48	54	6
125	125,2	125,7	125,4	125,9	51	61	6
160	160,2	160,7	160,5	161,0	58	74	7
200	200,2	200,8	200,6	201,1	66	90	9

1) To form the subject of a future International Standard.

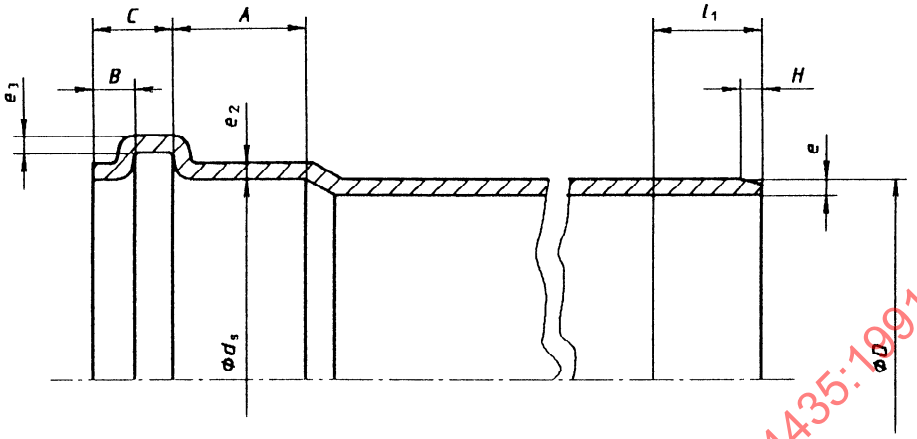

Figure 3 — Basic dimensions of single sockets and spigot ends for elastomeric sealing ring joints

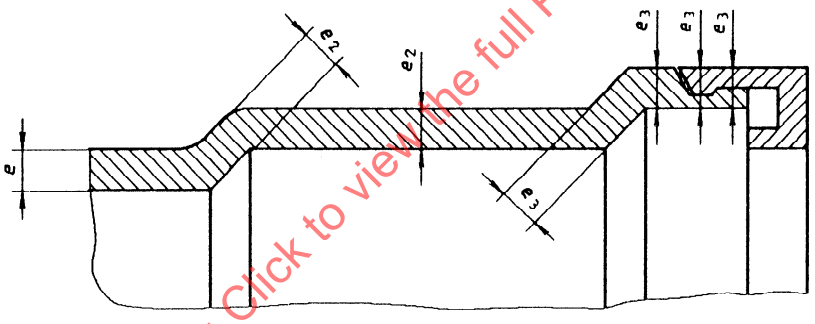

Figure 4 — Example of a seal retaining cap

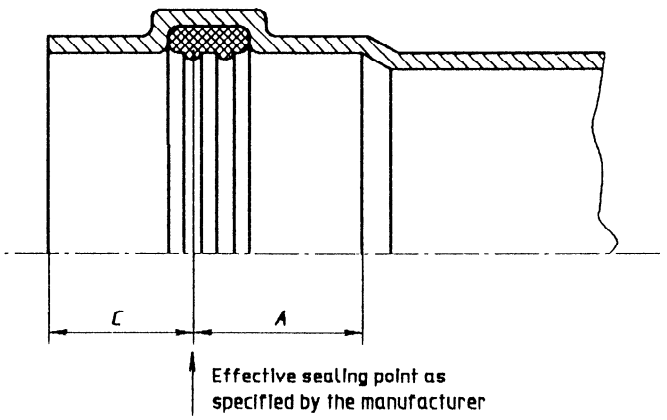

Figure 5 — Effective sealing point

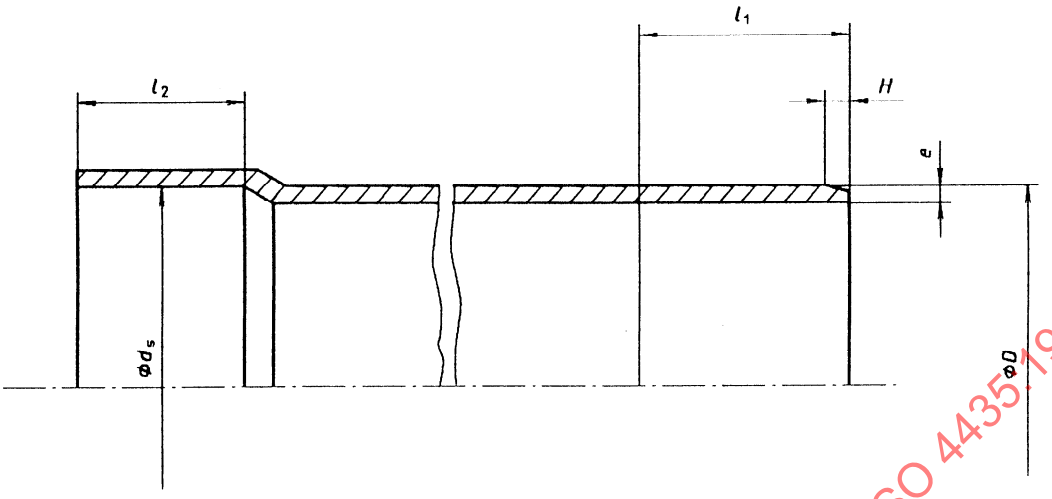

Figure 6 — Basic dimensions of sockets and spigot ends for cemented-type joints

5.2 Dimensions of fittings

5.2.1 Outside diameter

The nominal outside diameter D for the length of the spigot end shall be as given in 5.1.1.

5.2.2 Wall thickness

5.2.2.1 The nominal wall thickness of the body of a fitting shall comply with the values given in table 3.

5.2.2.2 The minimum wall thickness of the socket of a fitting shall be in accordance with the values of e_2 and e_3 given in 5.1.4.

The construction of the fitting shall be such that the stiffness of the fitting is at least equal to the stiffness of the pipe in the same series.

5.2.2.3 Where a sealing ring is retained by means of a retaining cap or ring, the wall thickness in this area shall be calculated by the addition of the wall thicknesses of the corresponding places of the socket and the retaining cap or ring (see figure 4 for an example). In all cases the components shall meet the functional test requirements.

Retaining caps or rings may be made to other designs and from polymers other than unplasticized poly(vinyl chloride), provided that they conform to the same functional test requirements.

5.2.3 Internal diameter

The internal diameter of the socket shall be as given in table 4.

5.2.4 Socket and spigot ends

The dimensions shall be as given in 5.1.4.

5.2.4.1 Fittings with elastomeric sealing rings

5.2.4.1.1 Single-socket fittings

Dimensions shall be as given in table 4 and figure 7. Outside diameters other than those of the socket shall be those of the pipe.

5.2.4.1.2 Double-socket fittings

Dimensions of each socket shall be as given in table 4 and figure 8.

5.2.4.2 Fittings with cemented joints

For single-socket fittings, dimensions shall be as given in table 5.

5.2.5 Basic dimensions

Basic dimensions of fittings shall be calculated in accordance with ISO 265-1.

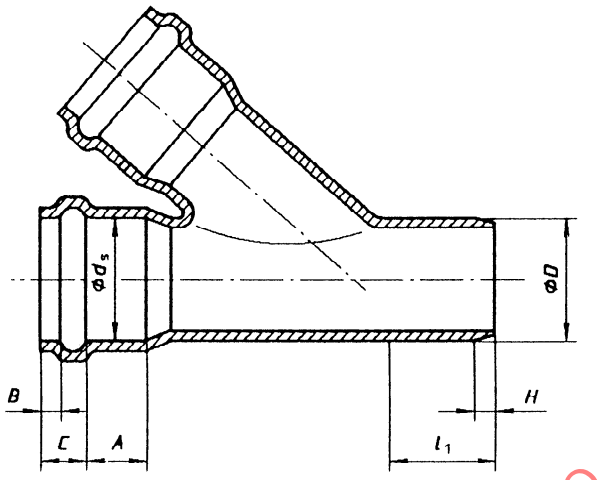

Figure 7 — Dimensions of single-socket fittings

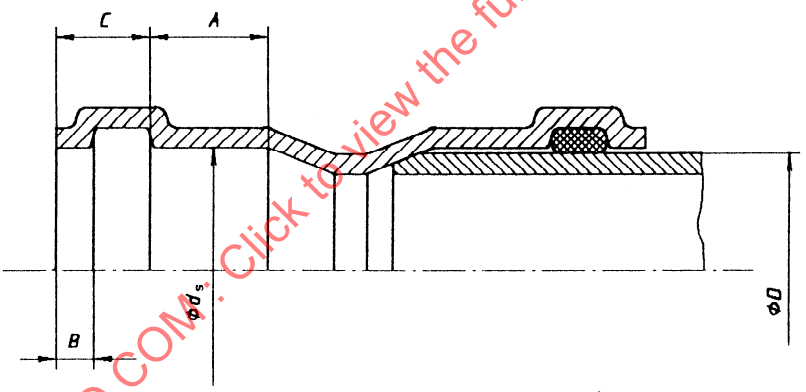

Figure 8 — Dimensions of double-socket fittings

6 Mechanical test requirements

6.1 Pipes

6.1.1 Impact strength

The true impact rate (TIR) shall not exceed 10 % at 20 °C, when the pipe is tested in accordance with ISO 3127.

6.1.2 Internal pressure test

When tested in accordance with the method described in ISO 1167, the pipe shall meet the requirements of table 6.

Table 6 — Internal pressure test requirements

Circumferential stress MPa[1)]	Minimum time to bursting h	Test temperature °C
42	1	20
10[2)]	1 000	60

1) 1 MPa = 1 N/mm²
2) This is a material type test.

6.2 Fittings

6.2.1 Impact strength of injection-moulded and fabricated fittings

For this test, fittings shall be conditioned for 30 min at a temperature of 0 °C ± 1 °C. Within 10 s after the conditioning treatment, five fittings of each diameter and type shall be dropped freely in various positions on to a flat concrete floor from a height of 1 m ± 0,05 m.

If none of the specimens is damaged in the test, the fittings shall be accepted. If one fitting is damaged, the test shall be repeated with five other fittings. None of these last five fittings shall be damaged.

NOTES

4 This is an optional test to be carried out only if required in a national standard, but is mandatory for fittings with retaining caps or rings and for fittings fabricated from pipes.

5 In the context of this test, "damage" means any visible split or any complete breakage in the body of the fitting. Surface scratches, scuffing, or chipping of edges which may occur in the test does not constitute damage.

6.2.2 Fittings manufactured from pipes

The pipes used for manufacturing such fittings shall meet the requirements given in 6.1.1 and 6.1.2.

7 Physical test requirements

7.1 Pipes

7.1.1 Vicat softening temperature

The Vicat softening temperature shall not be less than 79 °C when determined in accordance with ISO 2507.

7.1.2 Reversion

The longitudinal reversion shall not exceed 5 % when determined in accordance with ISO 2505.

7.2 Fittings

7.2.1 Injection-moulded fittings

7.2.1.1 Vicat softening temperature

The Vicat softening temperature shall not be less than 77 °C when determined in accordance with ISO 2507.

7.2.1.2 Oven test

The fittings shall meet the requirements of ISO 580.

7.2.2 Fittings manufactured from pipes

The fittings shall meet the requirements specified in 7.1.1.

The pipes used for manufacturing such fittings shall meet the requirements specified in 7.1.1 and 7.1.2.

8 Elastomeric sealing elements (rings)

8.1 Dimensions

The dimensions of the sealing elements are dependent on the specific jointing system and shall meet the manufacturer's specification.

8.2 Requirements

Elastomeric sealing rings shall be free from substances (for example plasticizers) that can have a detrimental effect on the poly(vinyl chloride) of the pipes and/or fittings.

For further requirements for rubber sealing rings for drainage purposes, see ISO 4633.

Where the design of the socket is such that the sealing ring is not firmly fixed in position, the housing for the ring shall be so designed as to minimize the possibility of the ring being dislodged during the insertion of the pipe spigot to complete the joint.

9 Joint assemblies

9.1 Elastomeric sealing ring joints

9.1.1 Test requirements

9.1.1.1 Internal hydrostatic pressure

When tested by the method described in 9.1.2.1, the joint shall withstand an internal water pressure of up to and including 0,05 MPa (0,5 bar) without leakage.

9.1.1.2 External hydrostatic or internal negative air pressure

When tested by the method described in 9.1.2.2, the joint shall withstand either an external water pressure from 0 up to and including 0,05 MPa (0,5 bar) or alternatively an internal negative air pressure of 0,03 MPa (0,3 bar) [i.e. 0,07 MPa (0,7 bar) absolute].

9.1.1.3 Diameter distortion

When tested by the method described in 9.1.2.3, the joint shall withstand an internal water pressure from 0 up to and including 0,05 MPa (0,5 bar) without leakage.

9.1.1.4 Angular deflection

When tested by the method described in 9.1.2.4, the joint shall withstand an internal water pressure from 0 up to and including 0,05 MPa (0,5 bar) without leakage.

9.1.1.5 Combined test requirements (alternative to 9.1.1.1 to 9.1.1.4)

When tested by the method described in 9.1.2.5, the joint shall perform satisfactorily in the prescribed combination.

9.1.2 Test methods

The tests shall be carried out at an ambient temperature of 23 °C ± 2 °C using cold water.

9.1.2.1 Internal hydrostatic pressure test

The apparatus shall consist of end-sealing devices of size and design appropriate to the type of joint assembly under test.

The sealing devices shall not exert axial loads on the joint assembly prior to the application of the test pressure.

One end-sealing device shall be connected to a source of hydrostatic pressure. A bleed valve shall be provided to enable all air to be vented when hydrostatic pressure is applied. The hydrostatic pressure shall be raised slowly over a period of not less than 15 min to 0,05 MPa (0,5 bar) and shall be maintained at that pressure for at least 15 min.

9.1.2.2 External hydrostatic or internal negative air pressure test

The test apparatus shall be the same as that described in 9.1.2.1, except that means shall be provided for applying external water pressure (see figure 9) or alternatively for providing an equivalent negative pneumatic pressure (partial vacuum) inside the test assembly (see figure 10). When tested by the vacuum method, the leaktightness shall be measured with a precision vacuum manometer. During the test period of 15 min, the external water pressure shall not diminish by more than, or the variation in negative atmospheric pressure shall not exceed, 10 % of the required negative testing pressure.

9.1.2.3 Diameter distortion test

The general features of the apparatus shall be as shown in figure 11 and the apparatus shall be capable of permitting simultaneously the application of a constant distorting load and an increasing internal hydrostatic pressure. The distorting load shall be applied by means of a hydraulic jack acting on a beam which is free to move in the vertical plane through the axis of the pipe. A jig may be provided to hold the connecting pipes in the sockets of the fitting against the end thrust due to the test pressure. The apparatus shall not otherwise support the joint against the internal test pressure.

The distortion load shall be applied to the pipe so as to cause a 5 % reduction in the original outside diameter of the pipe measured at a distance of approximately $0{,}5D$ (with a minimum of 100 mm) from the mouth of the socket. With the distortion load maintained, the water pressure shall be raised slowly to 0,05 MPa (0,5 bar) over a period of not less than 15 min and shall be maintained for at least 15 min.

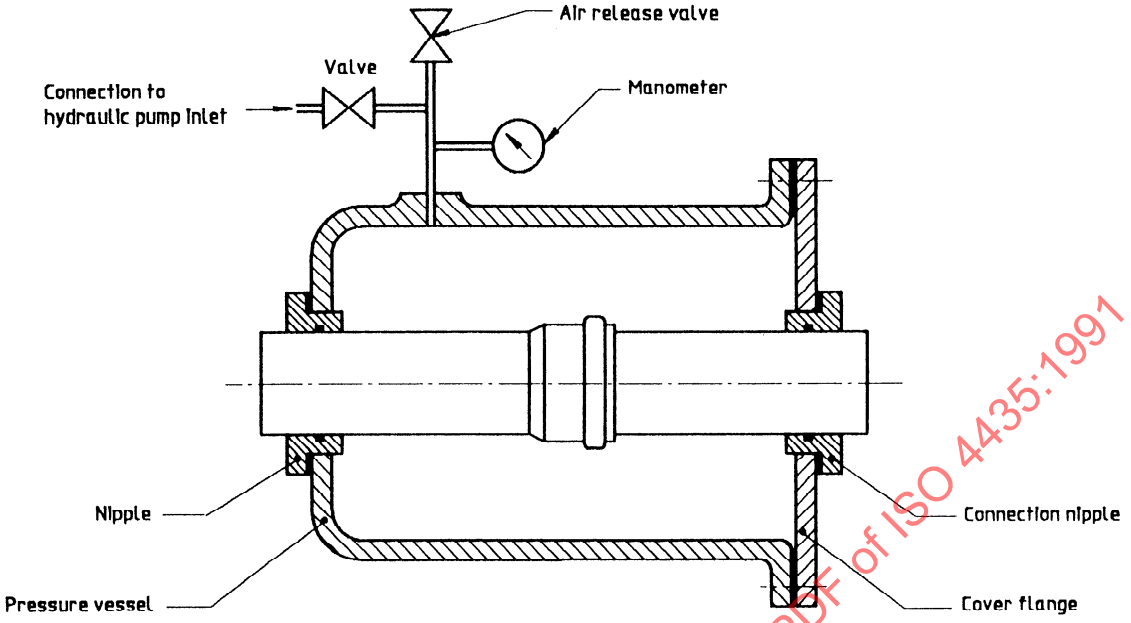

Figure 9 — Apparatus for the external hydrostatic test

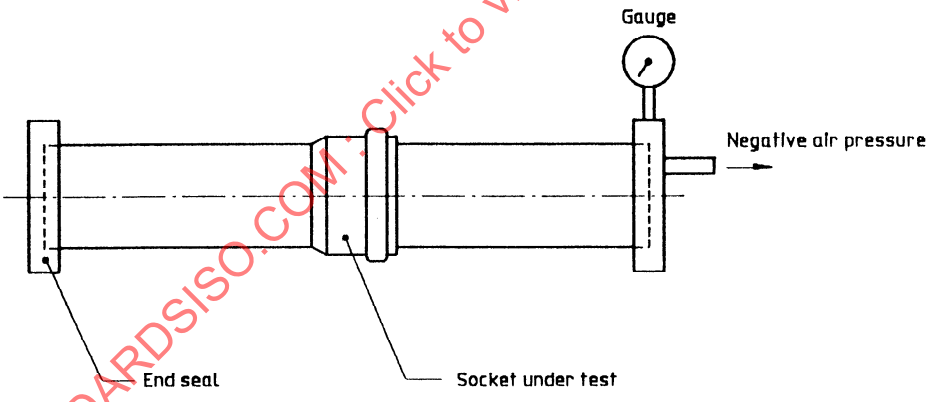

Figure 10 — Apparatus for the internal negative air pressure test

Dimensions in millimetres

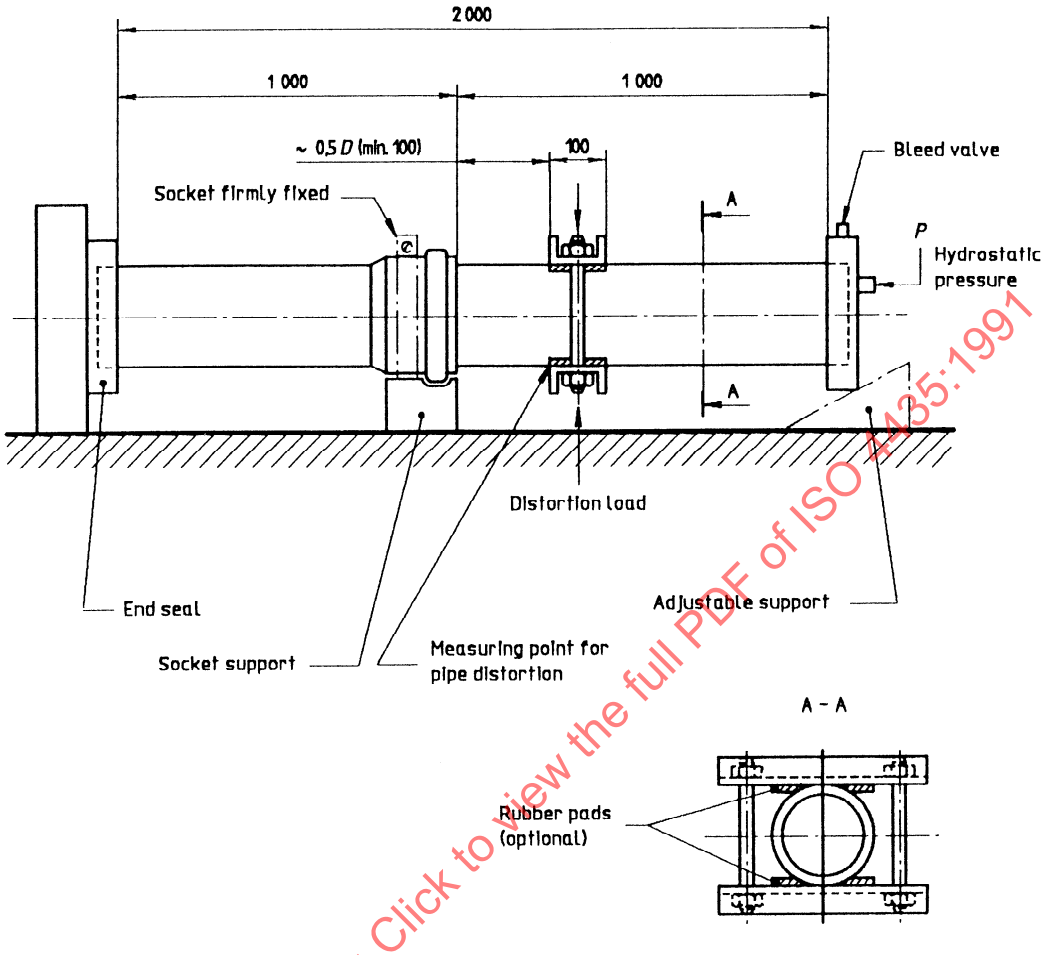

Figure 11 — Apparatus for the diameter distortion test

9.1.2.4 Angular deflection test

The apparatus shall be capable of axially deflecting an assembled pipe joint either by supporting the socket of the fitting and displacing the ends of the pipe, or alternatively by supporting the ends of the pipe and displacing the socket of the fitting; it shall also be capable of permitting application of the test pressure as described in 9.1.2.1.

A jig shall be provided which will hold the connecting pipes in the sockets of the fitting against the end thrust due to the hydrostatic pressure. The apparatus shall not otherwise support the joint against the internal test pressure. The spigot end shall be fully inserted.

The total deflection consists of $\alpha + \beta$ (see figure 12), where α is defined as the free angle and depends on the design of the socket.

The free angle α is determined by inserting the spigot end of a 1 m length of pipe into a socket in well lubricated conditions, and then exerting a force F (at the far end of the pipe) in a plane parallel to the axis of the pipe. The force F, in newtons, is related to the nominal outside diameter of the pipe D, in millimetres, by the equation

$$F = 0{,}1D$$

β is the forced angle and shall have a value of 2°.

The pipe shall be completely filled with water and left in this condition for not less than 5 min with the angular deflection maintained; the water pressure shall then be increased slowly to 0,05 MPa (0,5 bar) over a period of not less than 15 min and shall be maintained for at least 15 min.

This test shall be performed with the pipe deflected in both the horizontal and vertical directions.

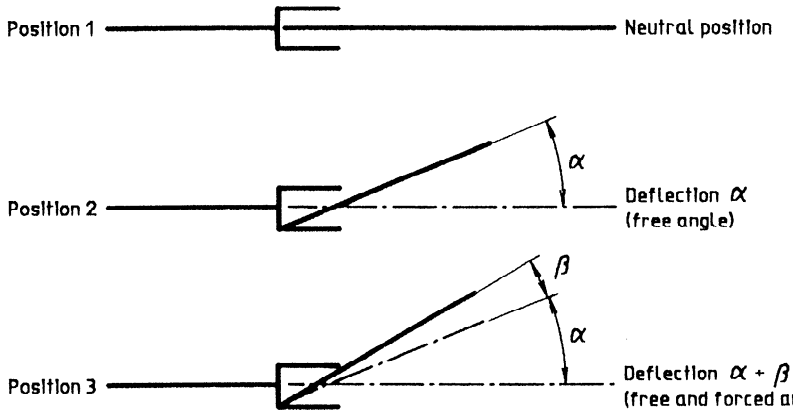

Figure 12 — Angular deflection test

9.1.2.5 Combined test (alternative to 9.1.2.1 to 9.1.2.4)

The combined test shall be carried out as follows:

a) the test assembly shall be filled with water as specified in 9.1.2.1;

b) the distortion of the pipe shall be carried out as described in 9.1.2.3 (no additional hydrostatic pressure is to be applied);

c) the angular deflection shall be applied as described in 9.1.2.4, maintaining the distortion;

d) after applying the distortion and angular deflection to the pipe, the internal water pressure of the test assembly shall be raised slowly over a period of not less than 15 min to 0,05 MPa (0,5 bar), and shall be maintained for at least 15 min;

e) then carry out the internal negative air pressure test as described in 9.1.2.2, combined with the diameter distortion test (9.1.2.3) and the angular deflection test (9.1.2.4).

9.2 Cemented joints

9.2.1 Test requirements

When tested by the method described in 9.2.2, the joint shall withstand the test conditions without leakage.

9.2.2 Test method

The test shall be carried out as described in 9.1.2.1.

10 Delivery conditions

10.1 Appearance

The internal and external surfaces of pipes and fittings shall be smooth, clean and free from grooving, blistering and any other surface defect. The materials shall not contain visible impurities or pores. Pipe ends shall be cleanly cut and the ends of the pipes and fittings shall be square with the axis of the pipe.

10.2 Colour

The colour of pipes and fittings shall normally be brown or grey.

However, white pipes and fittings may be supplied as agreed between purchaser or user and manufacturer in countries where high resistance to solar radiation is a specific requirement.

11 Marking

Pipes, fittings and sealing rings shall be marked clearly and indelibly so that legibility is maintained for the life of the product under normal conditions of storage, weather and use.

The markings may be integral with the product or on a label. The markings shall not damage the product.

11.1 Pipes

Pipes shall be marked with at least the following information:

— manufacturer's name or trade mark;

— pipe material;

— nominal diameter of pipe;

— nominal wall thickness of pipe;

— manufacturing information, in plain text or in code, providing traceability of the production period to within the year and month and the production site if the manufacturer is producing at several national or international sites;

— the number of this International Standard.

Pipes with a nominal laying length up to and including z_2 metres shall be marked at least once. Pipes with a nominal laying length greater than z_2 shall be marked at intervals of z_3 metres at the most. The values of z_2 and z_3 shall be as specified by the authorities in each country.

11.2 Fittings

Fittings shall be marked with at least the following information:

— manufacturer's name or trade mark;

— fitting material (may be given on packing only in the case of PVC, provided this information is not required on each article by national authorities);

— nominal diameter of fitting;

— classification (where applicable);

— values of angles, if any;

— manufacturing information, in plain text or in code, providing traceability of the production period to within the year and month and the production site if the manufacturer is producing at several national or international sites (may be given on packing only, provided this information is not required on each article by national authorities);

— the number of this International Standard (may be given on packing only, provided this information is not required on each article by national authorities).

11.3 Sealing rings

Sealing rings shall be marked with at least the following information:

— manufacturer's name or trade mark;

— nominal dimension of ring;

— manufacturing information, in plain text or in code, providing traceability of the production period to within the year and the production site if manufacturer is producing at several national or international sites.

No markings are required on sealing rings which are moulded to pipes or fittings or any other marked component.

11.4 Designation of the material (in accordance with ISO 1043-1)

PVC-U

Annex A
(informative)

Bibliography

[1] ISO 161-1:1978, *Thermoplastics pipes for the transport of fluids — Nominal outside diameters and nominal pressures — Part 1: Metric series.*

[2] ISO 3633:1991, *Unplasticized poly(vinyl chloride) (PVC-U) pipes and fittings for soil and waste discharge (low and high temperature) systems inside buildings — Specifications.*

[3] ISO/TR 7073:1988, *Recommended techniques for the installation of unplasticized poly(vinyl chloride) (PVC-U) buried drains and sewers.*

[4] ISO 9969:—[2], *Thermoplastics pipes — Determination of short-term ring stiffness — Constant-speed method.*

2) To be published.