INTERNATIONAL STANDARD

ISO 6993-3

First edition
2006-06-01

Buried, high-impact poly(vinyl chloride) (PVC-HI) piping systems for the supply of gaseous fuels —

Part 3:
Fittings and saddles for a maximum operating pressure of 1 bar (100 kPa)

Systèmes de canalisations enterrées en poly(chlorure de vinyle) à résistance au choc améliorée (PVC-HI) pour réseaux de combustibles gazeux —

Partie 3: Raccords et colliers pour une pression maximale de service de 1 bar (100 kPa)

Reference number
ISO 6993-3:2006(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 6993-3 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 4, *Plastics pipes and fittings for the supply of gaseous fuels*.

This first edition of ISO 6993-3, together with ISO 6993-1, ISO 6993-2 and ISO 6993-4, cancels and replaces ISO 6993:2001, of which it constitutes a technical revision.

ISO 6993 consists of the following parts, under the general title *Buried, high-impact poly(vinyl chloride) (PVC-HI) piping systems for the supply of gaseous fuels*:

— *Part 1: Pipes for a maximum operating pressure of 1 bar (100 kPa)*

— *Part 2: Fittings for a maximum operating pressure of 200 mbar (20 kPa)*

— *Part 3: Fittings and saddles for a maximum operating pressure of 1 bar (100 kPa)*

— *Part 4: Code of practice for design, handling and installation*

Buried, high-impact poly(vinyl chloride) (PVC-HI) piping systems for the supply of gaseous fuels —

Part 3: Fittings and saddles for a maximum operating pressure of 1 bar (100 kPa)

1 Scope

This part of ISO 6993 gives the requirements for full-end load-resistant fittings and saddles made of high-impact poly(vinyl chloride) (PVC-HI) intended to be used for the supply of gaseous fuels through buried pipelines having an operating temperature range of 0 °C up to and including +30 °C and a maximum operating pressure of 1 bar (100 kPa) [1)].

It is applicable only to fittings and saddles manufactured from the high-impact PVC materials PVC-A, PVC-CPE and PVC-EPR. It is applicable to joints with elastomeric sealing elements and of the solvent cement type. The fittings and saddles are suitable for those gases not containing potentially damaging components in such concentrations as to impair the properties of the fitting/saddle material.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 580:2005, *Plastics piping and ducting systems — Injection-moulded thermoplastics fittings — Methods for visually assessing the effects of heating*

ISO 2507-1, *Thermoplastics pipes and fittings — Vicat softening temperature — Part 1: General test method*

ISO 2507-2, *Thermoplastics pipes and fittings — Vicat softening temperature — Part 2: Test conditions for unplasticized poly(vinyl chloride) (PVC-U) or chlorinated poly(vinyl chloride) (PVC-C) pipes and fittings and for high impact resistance poly(vinyl chloride) (PVC-HI) pipes*

ISO 3126, *Plastics piping systems — Plastics components — Determination of dimensions*

ISO 3127, *Thermoplastics pipes — Determination of resistance to external blows — Round-the-clock method*

ISO 4422-3:1996, *Pipes and fittings made of unplasticized poly(vinyl chloride) (PVC-U) for water supply — Specifications — Part 3: Fittings and joints*

ISO 6993-1:2006, *Buried, high-impact poly(vinyl chloride) (PVC-HI) piping systems for the supply of gaseous fuels — Part 1: Pipes for a maximum operating pressure of 1 bar (100 kPa)*

1) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2

ISO 9080, *Plastics piping and ducting systems — Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation*

EN 682:2002, *Elastomeric seals — Material requirements for seals used in pipes and fittings carrying gas and hydrocarbon fluids*

EN 922:1994, *Plastics piping and ducting systems — Pipes and fittings of unplasticized poly(vinyl chloride) (PVC-U) — Specimen preparation for determination of the viscosity number and calculation of the K-value*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms, definitions, symbols and abbreviated terms given in ISO 6993-1 and the following terms, definitions and symbols apply.

3.1 Terms and definitions

3.1.1
fitting
component, other than a pipe, used in a pipeline

EXAMPLE Bend, tee, coupler, end cap.

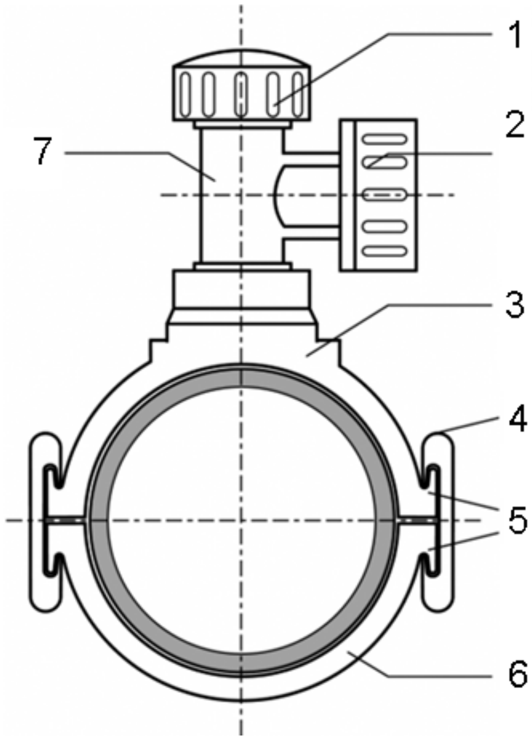
3.1.2
joint
connection between the ends of two components (with smooth spigot-ends and/or sockets)

NOTE In this part of ISO 6993, only solvent weld joints are considered.

3.1.3
socket
end of the fitting into which a smooth spigot-end can be inserted and joined by the solvent weld process

3.1.4
tapping saddle
component, including the necessary parts such as wedges and connector, used to make branches from a main pipeline to a service pipeline of polyethylene (PE) with a maximum d_n of 63

See Figure 1.



Key

1 cap

2 end trust joint

3 upper saddle half

4 clamp

5 wedge

6 lower saddle half

7 tapping tee

Figure 1 — Tapping saddle

3.1.5
bag stopper saddle
component, including the necessary parts such as wedges and balloon entry equipment, used to introduce a balloon into a pipeline in order to temporarily interrupt the gas flow

See Figure 2.

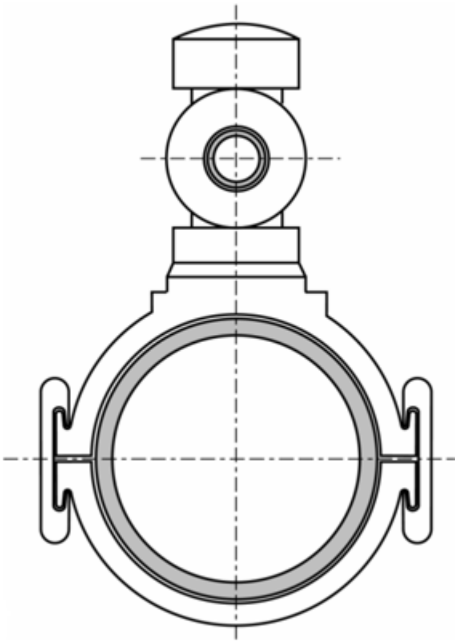


Figure 2 — Bag stopper saddle

3.2 Symbols

d depth/total depth of cracks, delaminations, blisters, or open yield seam, as applicable

L crack/blister length

l key-way length

4 Material

4.1 Material for fittings/saddles

4.1.1 Composition

The fittings and saddles shall be made of high-impact PVC, to which only such additives are added that are necessary to facilitate conformity of the components to this part of ISO 6993.

The impact-resistant modified PVC shall be one of the following compositions:

a) a mixture based on PVC;

b) a blend based on PVC;

c) a copolymer based on PVC;

d) a combination of these types.

The proportion of the impact modifier in the composition shall be at least 7 % by mass.

4.1.2 Long-term strength

The MRS value of the injection-moulding material shall be at least 14 MPa. Conformity to this requirement shall be proven using a long-term evaluation in accordance with ISO 9080. Testing is to be carried out at 20 °C, 40 °C and 60 °C, for periods up to 10 000 h. At 60 °C no knee shall occur before 5 000 h.

For injection-moulding compounds, this test shall be carried out on test pieces in the form of an injection moulded or extruded sample in solid wall pipe form made from the relevant injection-moulding material.

NOTE The MRS evaluation is used for a material qualification and is not intended to be used for a pressure rating.

4.1.3 Vicat softening temperature

The Vicat softening temperature of the injection-moulding material shall be not less than 74 °C when determined in accordance with ISO 2507-1 and ISO 2507-2.

4.1.4 K-value

The K-value of the unplasticized polyvinyl chloride (PVC-U) resin in the injection-moulding material shall exceed 57, when measured in accordance with EN 922.

4.2 Material for elastomeric sealing elements

The material of the elastomeric sealing elements shall conform to EN 682:2002, type G.

The elastomeric sealing element shall have no detrimental effects on the properties of the components.

5 General characteristics of fittings/saddles

5.1 Contaminants

The material of the fitting or saddle shall not be shown to contain any contaminants, such as inorganic particles or agglomerations thereof, exceeding 50 µm in size, when measured in accordance with 11.1 and 11.2.

5.2 Appearance and finish

The appearance and finish of the fitting/saddle shall be examined visually without magnification.

Internal and external surfaces shall be free from grooves, pits, blisters, indications of burning, an unacceptable form of cold-flow and other irregularities that could have a detrimental effect on the mechanical properties of the material and/or on the functional quality of the component.

Transitions in the form shall be smooth, in order to avoid notch influence. The corners in the grooves, in particular for the fixing of the elastomeric sealing elements, shall be rounded.

6 Geometrical characteristics

6.1 Measurements

All dimensions shall be measured in accordance with ISO 3126.

6.2 Fittings

6.2.1 Spigot ends on moulded fittings

The dimensions of spigot ends on moulded fittings shall meet the outside diameter requirements of ISO 6993-1:2006, Table 1.

6.2.2 Sockets on moulded fittings

The geometrical characteristics of fittings for solvent cementing shall be in accordance with ISO 4422-3:1996, 6.1.

6.3 Saddles

6.3.1 General

The dimensions and the admissible tolerances of the saddles shall be in accordance with the values declared by the manufacturer.

6.3.2 Wall thickness and cross-section area

The wall thickness and the cross-section area of those parts of the saddles subject to tangential stresses due to the clamp force of the pipe shall be in accordance with Table 1, for every cross section perpendicular to the direction of the stress.

Table 1 — Wall thickness and cross-section area of saddles

Nominal outside diameter of main pipe d_n	Saddle	
	Minimum wall thickness mm	Minimum cross-section area mm^2
50	4,3	300
63	4,3	325
75	4,3	325
90	4,8	360
110	5,1	450
125	5,5	450
140	5,7	500
160	6,0	560
180	6,4	600
200	6,8	650
225	7,4	800
250	8,1	950
280	8,7	1 025
315	9,4	1 100
355	10,1	1 200
400	11,0	1 300

7 Physical characteristics

When tested in accordance with 11.1 and 11.3 at 150 °C (oven test), injection moulded fittings and saddles shall meet the following requirements (see Figures 3 and 4).

The depth, d, of all cracks, delaminations or blisters occurring within a distance of 1,5 times the wall thickness measured at the injection point, with a minimum of 20 mm, shall not be greater then 30 % of the wall thickness at that point.

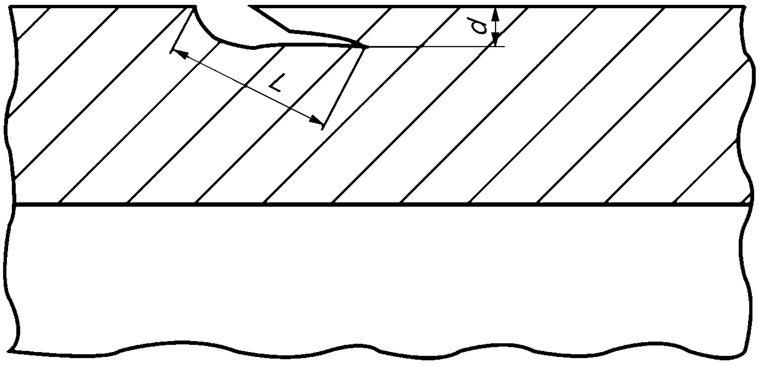
For diaphragm-gated injection moulded fittings or saddles, the depth, d, of all cracks, delaminations or blisters occurring within a distance of 1,0 times the wall thickness of the diaphragm zone shall not be greater than 30 % of the wall thickness at that point.

For ring-injected fittings or saddles, the depth, d, of all cracks, delaminations or blisters occurring within a distance of 1,0 times the wall thickness at the ring gate zone shall not be greater than 30 % of the wall thickness at that point.

For fittings or saddles with a yield seam, the total depth, d, of the opened yield seam shall not be greater than 10 % of the wall thickness at that point.

For all other parts of the surface outside the injection zone, the total depth, d, of cracks or delaminations shall not be greater than 10 % of the wall thickness at that point.

Blisters in the wall shall not be longer than twice the wall thickness at that point, with a maximum length, L, of 20 mm (see Figure 4).



d shall be a maximum of 30 % of the wall thickness.

Figure 3 — Maximum allowable crack depth

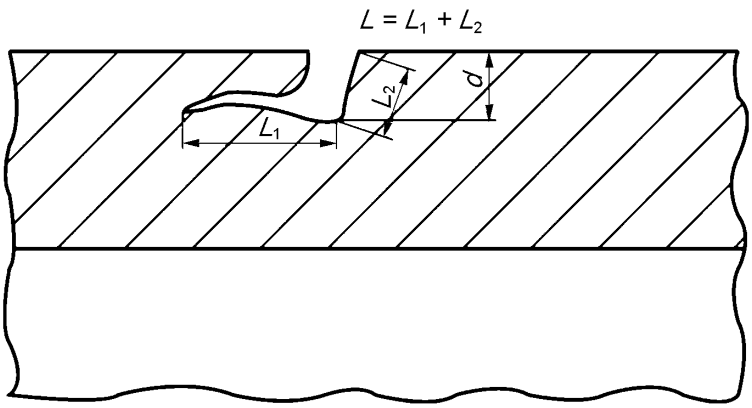


Figure 4 — Maximum allowable crack/blister length

8 Mechanical characteristics

8.1 Fittings

Fittings shall be tested against their resistance to external blows at 0 °C in accordance with 11.1 and Annex A. They shall have a true impact rate (TIR) of no more than 5 % under the test conditions according to Table 2.

8.2 Saddles

Saddles shall be tested against their resistance to external blows at 0 °C in accordance with 11.1 and Annex B. No failure in the saddle or leakage in the connection part shall occur.

Failure is considered to have occurred when there is fracture, cracking or leakage.

Table 2 — Resistance of fittings to external blows — Test conditions

Nominal outside diameter of pipe d_n mm	Striker mass g	Drop height mm
50	750^{+5}_{-0}	$2\,000^{+10}_{-0}$
63	$1\,000^{+10}_{-0}$	
75	$1\,250^{+10}_{-0}$	
90	$1\,500^{+15}_{-0}$	
110	$1\,750^{+15}_{-0}$	
125	$2\,000^{+15}_{-0}$	
140	$2\,250^{+15}_{-0}$	
160	$2\,500^{+15}_{-0}$	
180	$2\,750^{+15}_{-0}$	
⩾ 200	$3\,000^{+15}_{-0}$	

9 Saddle design and construction

The design and construction of the saddle shall be such that, when assembled, no inadmissible constriction and/or deformation occur.

The constriction of the pipe is considered inadmissible when it is greater than the tolerance given for the mean outside diameter in any point (d_{em}) in accordance with of ISO 6993-1:2006, Table 1.

This outside diameter shall be measured directly next to the saddle.

The construction of the saddle shall be such that incorrect assembling is not possible.

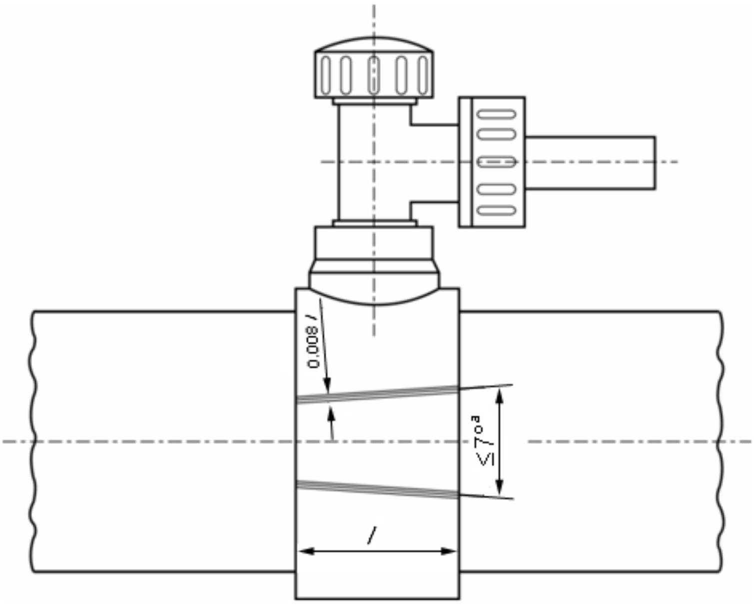
Displacement in an axial direction of parts of the saddle in respect to one another shall not occur.

The key ways of the saddle halves and the clamps shall be self-braking.

The angle of the key ways shall not be greater than 7° (see Figure 5).

The deviation over the plane of the key ways shall not be greater than 0,008 × l, where l is the length of the key way (see Figure 5).

The key ways shall be rounded under a radius of at least 1,5 mm.



l length of key ways

a Angle of key ways.

Figure 5 — Example of sealing element — Key ways

10 Performance requirements

10.1 Fittings — Tensile test for in-line fitting assemblies

When tested in accordance with 11.1 and Annex C at a temperature of 23 °C and at a constant pulling rate of 5 mm/min, neither of the following shall occur:

a) failure of the fitting or joints;

b) pull-out of the PVC-HI pipe.

10.2 Saddles

10.2.1 Tightness of joint between pipe and saddle, with and without mechanical loading

When tested in accordance with 11.1 and Annex D, the joint between the saddle and the pipe or connecting pipe shall be tight at a temperature of 23 °C and an internal air pressure of 2,5 kPa and 100 kPa, respectively, at each of the following conditions:

a) without mechanical loading;

b) with a diametric deflection of 10 % of the pipe at a distance d_n, in millimetres, from the saddle of the socket to the connecting pipe.

10.2.2 Tightness of joint between pipe and saddle under negative pressure and mechanical loading

The joint between the saddle and the pipe shall not leak when tested in accordance with 11.1 and Annex E at a temperature of 23 °C, with a mechanical loading in accordance with 10.2.1 b), and at a negative pressure of 80 kPa maintained for 2 h.

10.2.3 Tightness of lateral connection under constant load/tensile testing at constant speed

The lateral connection of the tapping saddle (the service line connection) shall be tested in accordance with 11.1 and Annex F at a temperature of 23 °C and an internal air pressure of 2,5 kPa. None of the following shall occur:

a) damage or permanent deformation of the fitting to an extent which would prevent compliance with this standard;

b) pull-out of the PE pipe;

c) leakage during or after the tensile test.

11 Test methods

11.1 General

Test samples shall be at least 15 h old.

Unless otherwise specified, the tests shall be carried out in triplicate.

For testing the entire programme, a representative selection of diameters and types shall be used.

11.2 Determination of particle size of contaminants

Five segments are taken at random from the fitting or saddle for testing.

These segments shall be cooled during 20 min in liquid nitrogen in order to prevent deformation while making microtome slices from the segments.

Microtome slices shall be made using a diamond knife.

The microtome slices shall be assessed with a light transmittance microscope with a measuring ocular (0,01 mm division).

The particle size of contaminants in the microtome slices shall not be greater than 50 µm.

11.3 Determination of influence of heat for injection moulded fittings

The injection moulded fittings shall be tested in accordance with ISO 580:2005, method A.

12 Marking

Fittings and saddles shall be marked clearly and durably, in accordance with national regulations, with the word “Gas” and the following information:

a) manufacturer’s name or trademark;

b) material designation “PVC-HI”;

c) manufacturing information in clear figures or in a code providing traceability to the

   1) production period,

   2) cavity number for injection moulded fittings (if relevant), and

   3) production site, if the manufacturer is producing in different sites, nationally and/or internationally.

The marking shall be applied such that the properties of the fittings/saddles are not adversely affected.

In addition to the marking on fittings and saddles according to a) to c), the following marking shall be made only on fittings:

d) nominal jointing diameter;

e) for fittings fabricated out of pipe, the SDR designation (SDR 33 and/or SDR 41) of the piping for which the fitting is intended to be used.

In addition to the marking on fittings and saddles according to a) to c), the following marking shall be made only on saddles:

f) nominal outside diameter of the main pipe;

g) nominal outside diameter of the PE service pipe, including the SDR designation;

h) the dimensions and sliding direction of clamps.

Annex A
(normative)

Determination of resistance to external blows at 0 °C for fittings

A.1 Principle

A striker of a defined mass is launched from a defined height to determine the impact resistance of the fitting.

A.2 Test and conditioning

The test shall be carried out using apparatus and procedures in accordance with ISO 3127, with the exception of the striker nose, which shall be in the form of a hemisphere having a diameter of (25 ± 0,5) mm.

The test shall be carried out using a test and conditioning temperature of (0 ± 1) °C.

A minimum number of 60 blows shall be struck.

A.3 Additional test requirements

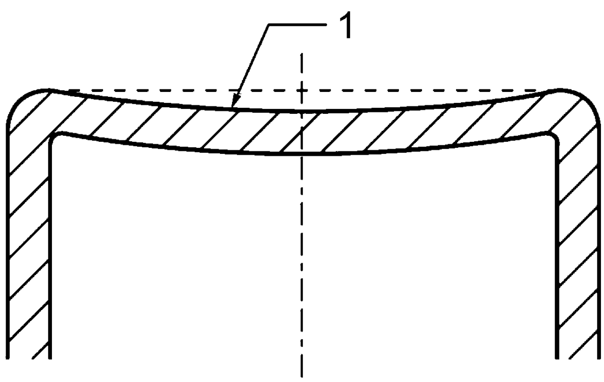
All blows shall be struck “at random”, taking into account those points expected to be sensitive to impact. Such points could be, for example, injection points, yield seams or (sharp) transitions in the construction.

For testing T-pieces, when all three socket-ends are situated in a horizontal plate the support shall be a flat plate.

In all other positions the support shall be an adjusted V-block. In this case, sockets are permitted to be supported only in the axial direction.

For reducers and T-pieces, the striker mass taken shall be that belonging to the respective nominal diameter of the socket. In the transition area the test is performed with the striker mass belonging to the socket with the smallest nominal diameter.

NOTE For end caps with a profile, the bottom is excluded from testing (see Figure A.1).



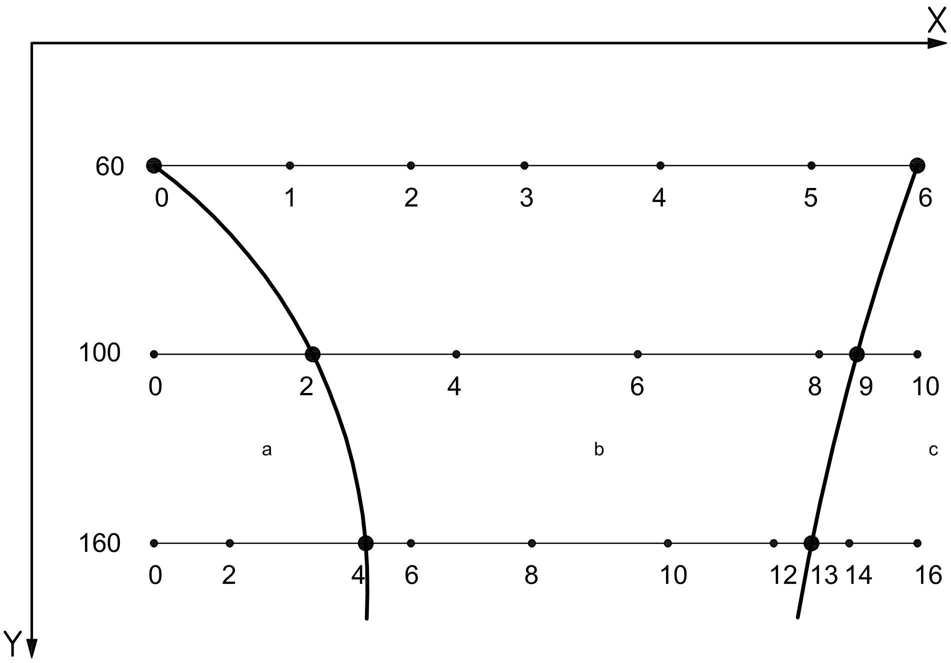
Key

1 profiled bottom

Figure A.1 — Example of profiled bottom

A.4 Interpretation of results

Figure A.2 gives the different areas for the number of failures in relation to the number of blows for which the tested lot with a confidence limit of 90 % has a true impact rate (TIR) smaller than 5 %, or a TIR greater than 5 % and the area where no decision can be taken.



Key

X no. of fractured samples

Y total no. of blows

[a] Lot has TIR < 5 %.

[b] No decision can be taken in this area.

[c] Lot has TIR > 5 %.

Figure A.2 — Number of samples for determination of TIR less than 5 % with confidence limit of 90 %

Annex B
(normative)

Determination of resistance to external blows at 0 °C for saddles

B.1 Principle

A striker of a defined mass is launched from a defined height to determine the impact resistance of the saddle.

B.2 Apparatus

B.2.1 Falling-weight testing machine, in accordance with ISO 3127, except for the striker nose, which shall be flat and have a diameter of 25 mm, and equipped with a test piece holder as shown in Figure B.1. The striker mass shall be 2 000 $^{+5}_{-0}$ g and the drop height 2 000 $^{+5}_{-0}$ mm.

An internal steel pipe of the machine shall support the PVC-HI pipe against toppling at impact. The outside diameter of this steel pipe shall be such that the PVC-HI pipe can slide easily over the steel pipe. This steel pipe shall be fixed rigidly on the frame, so that the direction of the strike is parallel to the axis of the PVC-HI pipe and the striker shall hit the connector of the saddle tee at a distance of (15 ± 2) mm from the end.

An external steel pipe of length (d_n + 10) mm and internal diameter corresponding to the outside diameter of the PVC-HI pipe shall support the saddle against displacement over the PVC-HI pipe at impact.

See Figure B.1.

B.2.2 Cooling facility: water bath or refrigerator capable of maintaining a temperature of (0 ± 1) °C.

B.2.3 Air pressure equipment capable of applying and maintaining an air pressure of (10 ± 1) kPa.

B.3 Test pieces

Five test pieces are required. A test piece shall be assembled in accordance with the manufacturer's instructions and shall consist of a tapping saddle equipped with a saddle tee assembled on a PVC-HI pipe. The free length on each end of the saddle shall be a d_n in millimetres. The pipe shall not be tapped.

B.4 Test temperature and conditioning

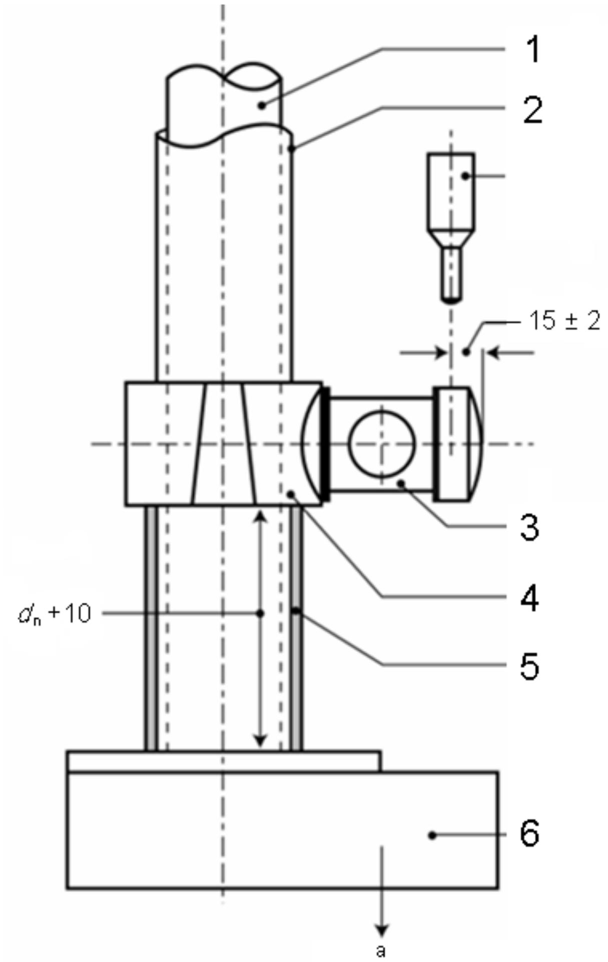
For the test and conditioning, the temperature shall be (0 ± 1) °C. The conditioning time shall be at least 1 h in a water bath or at least 4 h in air.

The test piece shall be tested within 30 s after conditioning.

B.5 Failure criteria

The failure criteria is that no leakage shall occur at an air pressure of (10 ± 2) kPa.

Dimensions in millimetres



Key

1 internal steel pipe

2 striker

3 connector

4 saddle

5 external steel pipe

6 support

a Movable.

Figure B.1 — Falling-weight testing machine, including test piece holder and test piece

B.6 Test procedure

The test shall be performed in accordance with Table B.1.

Table B.1 — Procedure for determining resistance to external blows of saddles

Step	Procedure
1	Assemble the five test pieces in accordance with B.3.
2	Condition the test pieces in accordance with B.4.
3	After this conditioning, place a test piece in the test piece holder in accordance with Figure B.1.
4	Strike the cap of the saddle tee at the point shown in Figure B.1. The strike shall be completed within 30 s after the test piece has been taken out of the cooling facility (B.2.2).
5	Check the test piece against fracture, cracking and air leakage at (10 ± 1) kPa.
6	When there is no failure, the test piece shall be cooled down in a water bath for 15 min or in air for 60 min.
7	After this reconditioning, place the test piece again in the test piece holder such that the strike will be on the opposite side.
8	Strike the cap in accordance with step 4.
9	Check the test piece again for fracture, cracking and air leakage at (10 ± 1) kPa.
10	Perform steps 3 to 9 for the remaining four test pieces.
11	The requirement is fulfilled when there is no failure in the five test pieces.
12	When there is one failure, repeat steps 1 to 10 with a new series of five test pieces.
13	The requirement is fulfilled when there is no failure in this new series of test pieces.

Annex C
(normative)

Determination of tensile resistance of in-line fitting assemblies

C.1 Principle

The fitting assembly is subjected an increasing tensile load and a specified constant pulling rate until a defined test piece elongation until a test piece elongation of 25 % has been reached.

C.2 Apparatus

Tensile testing machine suitable for tensile testing up to the yield point of the PVC-HI pipe and capable of sustaining a constant speed of (5 ± 1) mm/min.

C.3 Test pieces

The test pieces shall consist of a fitting and two connecting PVC-HI pipes, assembled in accordance with the manufacturer's assembly instructions.

The total length of the pipe shall be equivalent to a minimum of five times its nominal outside diameter.

C.4 Test temperature and conditioning

The conditioning and test temperature during the tensile test shall be (23 ± 5) °C.

C.5 Test procedure

The test shall be performed in accordance with Table C.1.

Table C.1 — Procedure for determining tensile resistance of fitting assemblies

Step	Procedure
1	Check the integrity of the assembly by leak testing with air at (2,5 ± 0,5) kPa.
2	Install the fitting assembly between the jaws of the tensile tester.
3	Apply a tensile force using a cross-head speed of (5 ± 1) mm/min until an elongation of the test piece of 25 % is reached. No pipe or fitting failure is allowed.
4	Remove the test piece and check the integrity of the assembly by leak testing with air at (2,5 ± 0,5) kPa.

Annex D
(normative)

Determination of leaktightness of saddle joints by internal air pressure, with and without mechanical loading

D.1 Principle

The leaktightness of a saddle's joints is determined by subjecting a test piece to internal air pressure.

NOTE Tightness testing is performed on test pieces subjected to a diametrical deflection by mechanical loading and without deflection.

D.2 Apparatus

D.2.1 Air pressure equipment capable of applying and maintaining the air pressure at (2,5 ± 0,5) kPa and (100 ± 2) kPa.

D.2.2 Pressure gauge having an accuracy of ± 1 % of the measured values.

D.2.3 Loading jig capable of applying a diametrical deflection of (10 ± 2) % of the pipe on both sides of, and at a distance (d_n ± 2) mm from, the saddle.

D.3 Test piece

The test piece shall be assembled in accordance with the manufacturer's instructions.

The free length of SDR 41 or SDR 33 pipe on both sides of the saddle shall be at least (3 × d_n) mm, with a minimum of 250 mm.

D.4 Test temperature and conditioning

The test and conditioning temperature shall be (23 ± 5) °C.

D.5 Test procedure

The test shall be performed in accordance with Table D.1.

Table D.1 — Procedure for determining leaktightness of joints with internal air pressure

Step	Time min	Procedure
1	0	Apply smoothly for 30 s a pressure of (2,5 ± 0,5) kPa. Check for leakage.
2	10	Increase the pressure smoothly for 30 s to (100 ± 2) kPa. Check for leakage.
3	20	Reduce the pressure to atmospheric pressure. Apply, on both sides of the test piece and at a distance of (d_n ± 2) mm, a diametrical deflection of (10 ± 2) %.
4	25	Apply smoothly for 30 s a pressure of (2,5 ± 0,5) kPa. Check for leakage.
5	35	Increase the pressure smoothly for 30 s to (100 ± 2) kPa. Check for leakage.
— A tolerance of 20 % is permitted on the time per step. — End the testing when leakage occurs and note the test time (and step). — Leakage can be detected by using a soap solution on the joint or by placing the test piece in a water bath. When a soap solution is used, the leakage shall be detected at the start or end of the period when the pressure is applied.		

Annex E
(normative)

Determination of leaktightness of saddle joints under negative pressure and mechanical loading

E.1 Principle

The leaktightness of a saddle's joints against the ingress of water is determined by subjecting a test piece to negative internal air pressure.

NOTE Tightness testing is performed on test pieces subjected to a diametrical deflection by mechanical loading and without deflection.

E.2 Apparatus

E.2.1 Vacuum gauge having an accuracy of ± 1 % of the measured value.

E.2.2 Vacuum pump capable of maintaining the required level of negative pressure of – (80 ± 2) kPa for 2 h + [(20 ± 2) kPa absolute].

E.2.3 Loading jig capable of applying, on both sides of the saddle, a diametrical deflection of (10 ± 2) % of the pipe at a distance of (d_n ± 2) mm from the saddle.

E.2.4 Water bath of sufficient size to keep the test piece completely submersed at a temperature of (23 ± 5) °C.

E.3 Test piece

The test piece, which shall consist of an assembly of pipe and saddle, shall be assembled in accordance with the manufacturer's instructions.

The free length on either end of the fitting shall be at least (3 × d_n) mm with a minimum of 250 mm.

E.4 Test temperature and conditioning

The test and conditioning temperature shall be (23 ± 5) °C.

E.5 Test procedure

The test shall be performed in accordance with Table E.1.

Table E.1 — Procedure for determining leaktightness of joints under negative pressure and mechanical loading

Step	Procedure
1	Choose the SDR class of the connecting pipe and assemble the test pieces in accordance with C.3.
2	Apply, on both sides of the test piece and at a distance of ($d_n \pm 2$) mm, a diametrical deflection of (10 ± 2) %.
3	Place the test pieces in the water bath at 23 °C, completely submersed.
4	Apply a negative pressure of – (80 ± 2) kPa + [(20 ± 2) kPa absolute] to the test piece.
5	Maintain this negative pressure for (120 ± 5) min.
6	After this time, return the pressure to atmospheric pressure.
7	Take the test piece out of the water bath.
8	Check the inside of the test piece for leakage from water ingress.

Annex F
(normative)

Determination of leaktightness under constant load and by tensile testing at constant speed of lateral connections (end-load resistant joints of tapping saddles with PE service pipe lines)

F.1 Principle

The fitting assembly is tested for leaktightness by first being subjected to a specified longitudinal stress by the application of a constant load, and subsequently to extension at a specified constant speed, until the pipe yields; the leaktightness is verified both during and at the end of the test.

F.2 Apparatus

F.2.1 Tensile testing machine suitable for tensile testing up to the yield point of the PE pipe and capable of sustaining a constant force with a maximum variation of 2 % and a constant speed of (25 ± 1) mm/min.

F.2.2 Pressure gauge having an accuracy of ± 1 % of the measured values.

F.2.3 Air pressure equipment capable of applying and maintaining air pressure at (2,5 ± 0,5) kPa.

F.3 Test pieces

The test pieces shall be assembled at −10 °C and +30 °C in accordance with the manufacturer's assembly instructions, with half the number of fitting assemblies (⩾ 3) being assembled at −10 °C and the other half (⩾ 3) at +30 °C. Each half shall be tested in accordance with this annex.

The length of the lateral pipe shall be equivalent to minimum five times its nominal outside diameter.

The free end of the pipe shall be airtight. It shall be possible to connect this end to the pressure supply.

F.4 Test temperature and conditioning

The conditioning and test temperature during the tensile test shall be (23 ± 5) °C.

F.5 Test procedure

The test shall be performed in accordance with Table F.1.

Leakage can be detected using a soap solution.

Table F.1 — Procedure for determining leaktightness of lateral connections, with tensile testing at constant speed

Step	Procedure
1	Install the fitting assembly between the jaws of the tensile tester such that the line of action of the tensile force follows the line of axis of the lateral pipe. The main pipe shall be restrained to keep the lateral pipe in the line of action of the tensile force during testing.
2	Apply smoothly for 30 s a pressure of (2,5 ± 0,5) kPa. Check for leakage.
3	Apply gradually, for a period of approx. 5 min, a tensile force to the assembly until the force, F, corresponds to a stress of 12 MPa induced in the wall of the pipe. Calculate F, in newtons, using the following equation: $F = S\sigma$ where S is the cross-sectional area of the pipe, in square millimetres, calculated using the measured average outside diameter and the minimum wall thickness; σ is the stress (= 12 MPa).
4	Maintain the fitting assembly under this constant force with a maximum variation of ± 2 % for 1 h. Check for leakage. If, during this period, the pipe yields, repeat the test using a new assembly.
5	Increase the tensile force using a cross-head speed of (25 ± 1) mm/min until yield of the PE pipe occurs.
6	Remove the assembly from the tensile tester and check the leaktightness.

Bibliography

[1] ISO 3:1973, *Preferred numbers — Series of preferred numbers*

[2] ISO 497, *Guide to the choice of series of preferred numbers and of series containing more rounded values of preferred numbers*

[3] ISO 527-1:1993, *Plastics — Determination of tensile properties — Part 1: General principles*

[4] ISO 1167-1, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 1: General method*

[5] ISO 4437:1997, *Buried polyethylene (PE) pipes for the supply of gaseous fuels — Metric series — Specifications*

ICS 75.200; 83.140.30

Price based on 25 pages