INTERNATIONAL STANDARD

ISO 6993-4

First edition
2006-06-01

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

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

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

Partie 4: Code de pratique pour la conception, la manutention et l'installation

Reference number
ISO 6993-4:2006(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 6993-4 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 6993-4, together with ISO 6993-1, ISO 6993-2 and ISO 6993-3, 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*

Introduction

This part of ISO 6993 addresses the common basic principles for gas supply systems. Its users need to be aware that more detailed national standards and/or codes of practice might exist in the ISO member countries and that these will take precedence over this part of ISO 6993, which is intended to be applied in association with those national standards and/or codes of practice related to the above-mentioned basic principles.

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

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

1 Scope

This part of ISO 6993 specifies a code of practice for the design, handling and installation of high-impact poly(vinyl chloride) (PVC-HI) pipes and fittings 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)].

The code of practice covers mains and service lines, and gives provisions for the design, installation, storage, handling, transportation and quality control of PVC-HI pipes and fittings up to and including an outside diameter of 400 mm, as well as backfilling, pipe system testing and commissioning.

The pipes and fittings are suitable for those gases which do not contain potentially damaging components in such concentrations as to impair the properties of the pipe/fitting 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 4437:1997, *Buried polyethylene (PE) pipes for the supply of gaseous fuels — Metric series — Specifications*

ISO 6993-1, *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)*

ISO 6993-3, *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)*

ISO 7005 (all parts), *Metallic flanges*

ISO 7387-1:1983; *Adhesives with solvents for assembly of PVC-U pipe elements — Characterization — Part 1: Basic test methods*

ISO 8085 (all parts), *Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels — Metric series — Specifications*

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

EN 12327:2000, *Gas supply systems — Pressure testing, commissioning and decommissioning procedures — Functional requirements*

---

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions and symbols apply.

3.1
clearance
shortest distance between the outer limits of two objects

3.2
design pressure
pressure on which design calculations are based

3.3
gas supply system
pipeline systems, including pipe work and their associated stations or plants, for the transmission and distribution of gas

3.4
nominal outside diameter
d_n
numerical designation of size which is common to all components in a thermoplastics piping system other than flanges and components designated by thread size

NOTE It is a convenient round number for reference purposes.

NOTE For metric pipes conforming to ISO 161-1, the nominal outside diameter, expressed in millimetres, is the minimum mean outside diameter $d_{em,min}$.

3.5
nominal wall thickness
e_n
numerical designation of the wall thickness of a component, approximately equal to the manufacturing dimension

NOTE 1 It is a convenient round number for reference purposes.

NOTE 2 It is expressed in millimetres (mm).

3.6
main
pipework in a gas supply system to which a number of gas consumers are connected via service lines

3.7
out-of-roundness
difference between the measured maximum outside diameter and the measured minimum outside diameter in the same cross-sectional plane of the pipe

3.8
maximum operating pressure
MOP
maximum effective pressure of the gas in a piping system, expressed in bars, which is allowed in continuous use

NOTE 1 It takes into account the physical and the mechanical characteristics of the components of the piping system.

NOTE 2 The MOP is given by the equation:

$$\mathrm{MOP} = \frac{20 \times \mathrm{MRS}}{C \times (\mathrm{SDR} - 1)}$$

where

MRS is the minimum required strength (see ISO 6993-1);

SDR is the standard dimension ratio.

3.9
standard dimension ratio
SDR
numerical designation of a pipe series, which is approximately equal to the ratio of the nominal outside diameter, d_n, to the nominal wall thickness, e_n:

$$\text{SDR} = \frac{d_n}{e_n}$$

NOTE It is a convenient round number for reference purposes.

3.10
pipeline components
elements from which a pipeline is constructed including, in PVC-HI pipeline systems, the distinct elements of straight pipes, fittings and ancillaries

EXAMPLE 1 Fittings: socket joint, saddle, reducer, tee, factory-made bend/elbow, end-cap.

EXAMPLE 2 Ancillaries: valve, flange.

3.11
installer
trained person authorized by the pipeline operator to assemble PVC-HI systems from pipes and fittings, based on a written procedure agreed by the pipeline operator

3.12
overall service [design] coefficient
C
overall coefficient with a value greater than 1, which takes into consideration service conditions as well as properties of the pipeline components

3.13
pipeline operator
private or public organization responsible for the design, construction, operation and maintenance of a gas supply system

3.14
service line
pipework in a gas supply system that connects a gas consumer with a main

3.15
depth of cover
vertical distance between the top of a buried pipe and the normal surface after finishing work

3.16
high-impact poly(vinyl chloride)
PVC-HI
mixture of unplasticized PVC and an impact-resistance modifier

4 Design

4.1 General

Written laying procedures, authorized by the pipeline operator, shall be made available prior to the construction of a pipeline. The laying procedure shall include specification of the pipe and fitting materials to be used, the trenching and backfilling requirements, the pressure testing and commissioning procedures.

The selection of materials, SDR series, dimensions and assembly techniques shall be the responsibility of the pipeline operator.

It is an established practice in PVC-HI distribution systems to construct service lines in polyethylene in order to take advantage of the natural flexibility of this material.

4.2 Materials and components

The maximum operating pressure (MOP) for PVC-HI gas supply systems is 1 bar (100 kPa). Pipes shall meet the requirements of ISO 6993-1. The most commonly used SDR values are 41 and 33. For specific applications, other SDR values can be taken from all series stated in ISO 4065 and ISO 161-1.

Assembly techniques in systems with a MOP above 200 mbar (20 kPa) and up to and including 1 bar (100 kPa) shall be of the end thrust type in accordance with ISO 6993-3.

For systems with a MOP up to and including 200 mbar (20 kPa) both the end thrust type assembly or the push-in type of fittings in accordance with ISO 6993-2 may be used.

Rubber parts for other components shall be in accordance with EN 682:2002, type G. Polyethylene service line materials shall be in accordance with ISO 4437 and the relevant part of ISO 8085.

Other components not covered by the above-mentioned International Standards shall conform to the relevant International Standards or national standards, and/or national or international specifications.

4.3 Assembly techniques

4.3.1 Slip-on socket joints (for gas supply systems with MOP $\leqslant$ 20 kPa)

Because of the relatively low operating pressure, the joints in PVC-HI gas supply systems with a MOP up to and including 200 mbar (20 kPa) do not normally need to be tensile-resistant. In special situations, provision shall be made to prevent pipes from sliding out of the sockets by using external clamps or anchors.

Socket joints consist of a spigot (end) and a PVC-HI socket, in which gas tightness is achieved by the use of a rubber ring, tightened between the spigot and the socket. Distinction is made between sockets with, and those without, a stop shoulder or dead stop (see Figure 1).

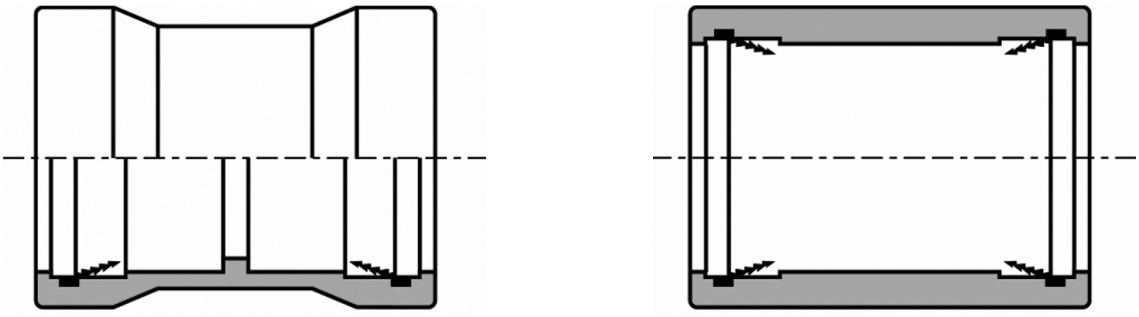
Tees, reducers and elbows also may bear socket joints or have spigot ends.

4.3.2 Solvent-cement socket joints

Solvent cement is used to effect a seal between close-fitting spigots and sockets. The resulting joint is end-load bearing.

4.3.3 Tapping saddles

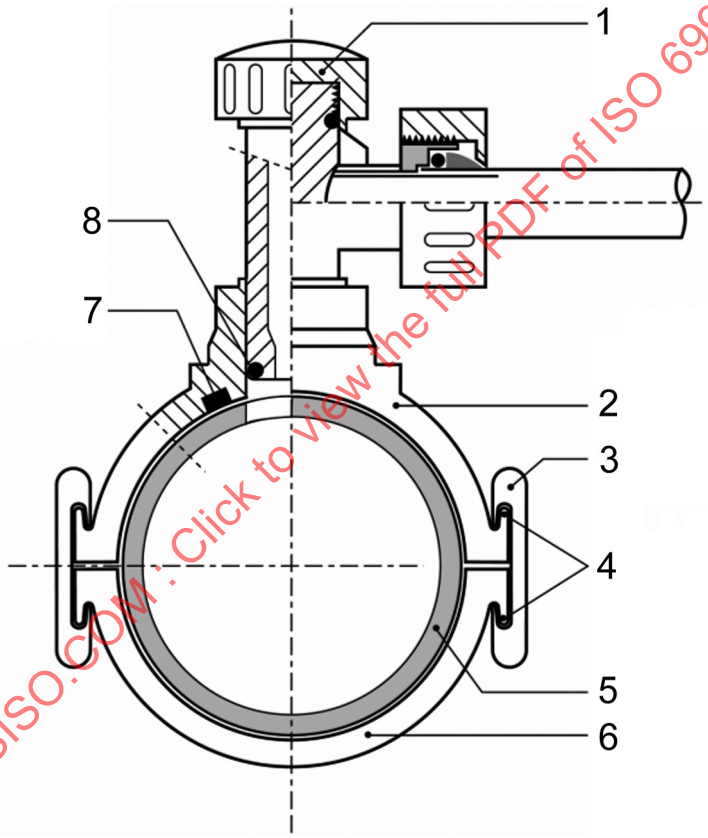
Tapping saddles are used for connecting service lines to a main (see Figure 2).



a) Socket joint

b) Sleeve joint

Figure 1 — Straight socket joints



Key

1 sealing cap
2 upper half of saddle
3 clamp
4 wedge
5 main
6 lower half of saddle
7 rubber seal
8 O-ring

Figure 2 — Tapping saddle with PE service line

4.3.4 Bag stopper saddles

Bags stoppers are used for temporarily stopping the gas stream, thereby making it possible to work on the pipe system without gas pressure. A bag is inserted in the pipe via a bag stopper saddle, and then inflated by means of a hand pump (see Figure 3). When the work is done, the bag stopper is deflated and removed, after which the saddle is sealed with a cap.

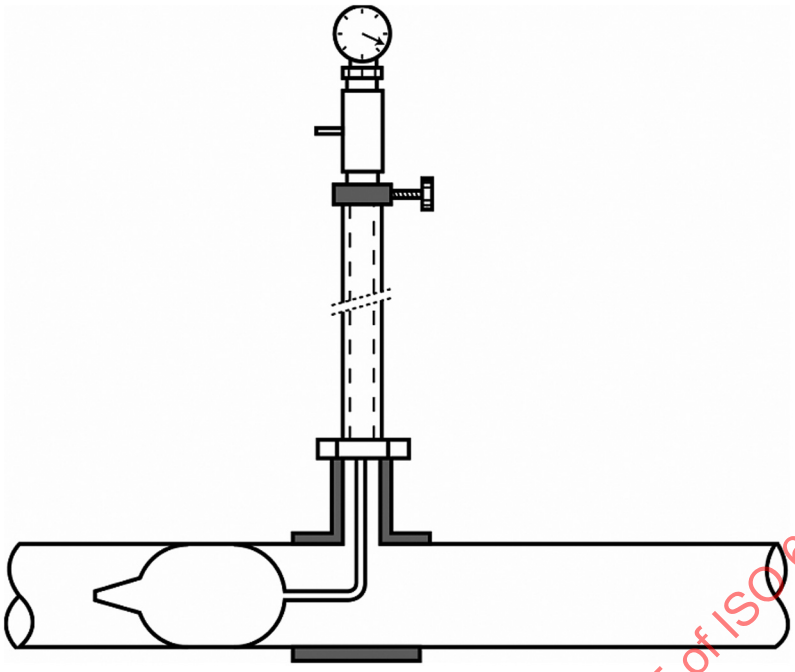


Figure 3 — Insertion of bag stopper via bag stopper saddle

4.3.5 Mechanical joints for ancillaries

Joints of this type are assembled in a mechanical way, whereby gas tightness is achieved by compression using a rubber ring, see, for example, Figure 4.

Other types of mechanical jointing systems exist. The manufacturer's instructions shall be followed at all times.

Mechanical jointing systems also include metal-to-PVC-HI transition fittings.

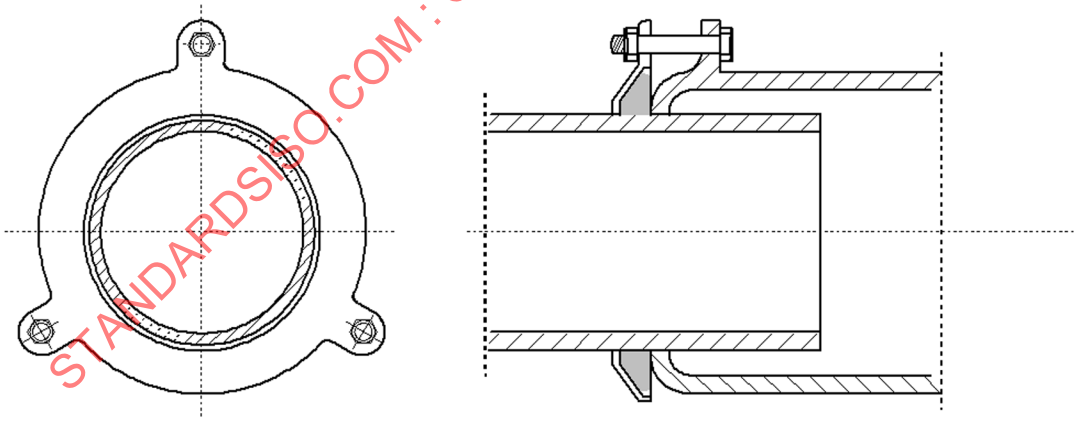


Figure 4 — Mechanical metal joints

4.3.6 Flange joints for ancillaries

Flanged joints shall comply with ISO 7005.

5 Installation

5.1 Assembly procedures

All joints shall be assembled in accordance with the manufacturer's written instructions.

5.2 Training

The installer shall be competent in the appropriate laying and jointing of the pipes. He/she shall possess the necessary skill and knowledge to produce good quality work. Installers shall receive formal training under the supervision of a qualified instructor. The pipeline operator may require a certificate indicating that he/she has attained an adequate standard of competence in accordance with national or local regulations.

5.3 Jointing of systems

5.3.1 Slip-on socket joints MOP ⩽ 20 kPa

PVC-HI pipes for low pressure systems are typically supplied with bevelled ends. These pipe ends need therefore not be treated any further. Pipe sections can be cut to length using a fine-tooth saw or a special-purpose cutter, see Figure 5.

The pipe end shall be squared off. In the case of sawing it is advisable to use a mitre box. After sawing, the pipe end is bevelled off using a file or a special-purpose bevelling tool (see Figure 6).

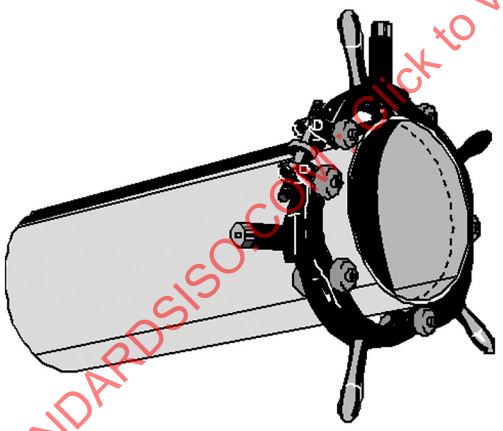


Figure 5 — Special-purpose cutter for plastics pipes

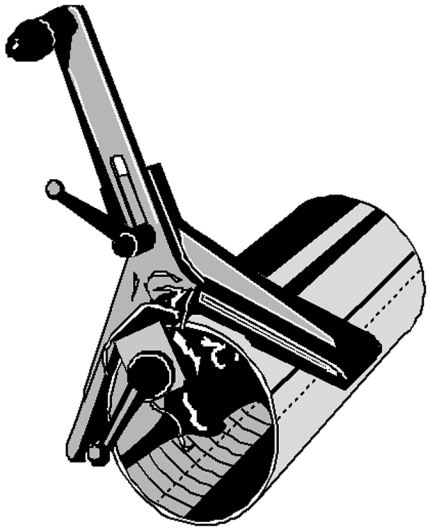


Figure 6 — Special-purpose bevelling tool

Burrs, if any, shall be removed. If the pipe is bevelled off with a file, it is important to use approximately the same bevel angle as that of the factory-supplied pipe. Blunt edges can damage the rubber sleeve.

Before making the joint, it is checked that the inside and outside of the pipe, the socket and the rubber sleeve are free from dirt. In doing so, special attention shall be paid to the back of the sleeve. If necessary, the parts shall be cleaned.

A lubricant specified by the pipe and socket manufacturer is applied evenly on the pipe ends and socket. Measures shall be taken to prevent sand or other impurities from sticking to the lubricant and from entering the joint. Consequently, the joint shall be made off the ground, for instance by putting blocks under the pipes.

The socket is slid over the pipe up to the stop shoulder or dead stop. In the case of larger diameters, a lever can be used to apply the required force (see Figure 7). The socket shall be protected from damage by the placing of a wooden block between the socket and the bar.

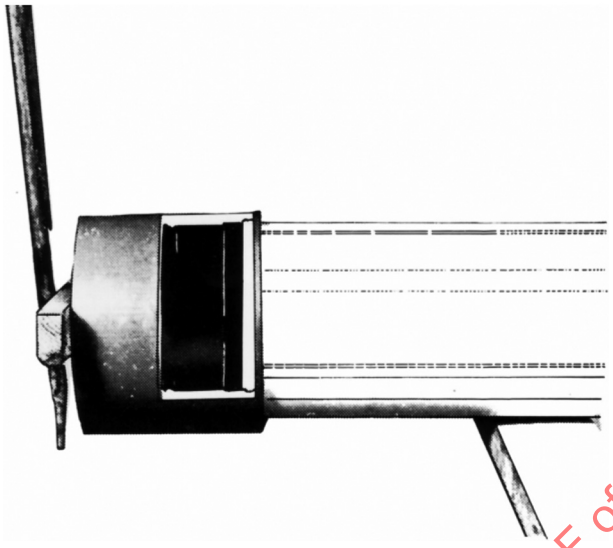


Figure 7 — Use of lever

Before inserting of the second pipe, the depth of engagement is checked by marking the distance from the pipe end to the pipe with a pencil.

5.3.2 Solvent-cement socket joints

The spigot end shall be cut square and all burrs removed from both the outside and inside edges.

The spigot shall be marked with a pencil line at a distance equivalent to the internal depth of the socket. Alternative methods of marking may be used, provided that they do not damage the pipe. Scoring of the pipe is not permitted.

The joint shall be tested for fit. An interference fit shall be reached before the pencilled mark is reached.

The area between the pencilled mark and the spigot end and the interior of the socket shall be dried, and then cleaned and degreased with a cloth moistened with the prescribed cleaning fluid.

The joints shall be coated with solvent cement, using clean, suitably-sized, brushes or applicators that will not contaminate the solvent cement. The solvent cement shall be identified according ISO 7387-1 and their properties shall conform to the appropriate standards. The coating shall be applied evenly to the internal surface of the socket for the full engagement length, and then to the external section of the spigot up to the mark. The socket coating shall be as light as possible in order to minimize the accumulation of excess solvent in the socket and pipe after jointing.

While the surfaces are still wet, the pipe end shall be inserted in the socket and the pipe pushed in up to, but not beyond, the pencilled mark. Excessive force shall not be used. The joint shall be firmly restrained for a period at least as long as that recommended by the manufacturer of the cement.

Care shall be taken to ensure that the end of the pipe is in the socket squarely, and in the same alignment and grade as the preceding pipes or fittings.

Excess and spilt solvent cement, if any, shall be wiped from the outside and, where possible, from the inside of the joint. Excess solvent cement may result in “solvent cracking” of the pipe at a later stage.

NOTE Joints can take up to 24 h to cure, depending on manufacturer’s recommendations.

In order to ensure sound joints, the following special precautions shall be observed.

— Containers of solvent cement shall be kept tightly sealed when not in use to prevent loss of solvent which could result in a loss of the bond strength of the cement. Solvent cements can have a limited shelf life and shall be used strictly in accordance with the manufacturer's instructions.

— When work is being performed under cold conditions, extra curing time shall be allowed to compensate for the lower temperature. Joints need to be restrained for longer periods at lower temperatures.

— Special precautions shall be taken to keep the jointing surfaces dry when jointing is being performed in wet conditions.

5.3.3 Saddles

The main to which the branch is to be made shall be dug out and cleared in such a way that the pipe can be cleaned and the saddle fitted. The pipe shall be cleaned carefully. After checking that the saddle and the rubber ring are free from dirt, if necessary, they shall be cleaned. The mixing of parts of different manufacturers or of different nominal sizes is not permitted.

The rubber ring is placed in the chamber concerned. The top and bottom halves of the saddle can now be fitted around the pipe, checking that the rubber ring remains inside the chamber. Because of their construction, the top and bottom halves of the saddle can be assembled relative to each other in one way only.

The clamps are fitted and tightened evenly by hand. Both clamps shall now have been slid almost equally far over the wedges. Hammering lightly, alternately on both clamps, they are then tightened further.

Both clamps shall be hammered onto the wedges such that they are in line with the top and bottom saddle edges. A plastic or wooden hammer shall be used for tightening the clamps.

5.3.4 Fitting tapping tees

Tapping tee/saddle connections come in two types depending on the make: a factory-glued type or a screw connection/O-ring type. The screw connection types are designed in such a way that the outlet of the tee can be positioned at any angle to the main (see Figure 8).

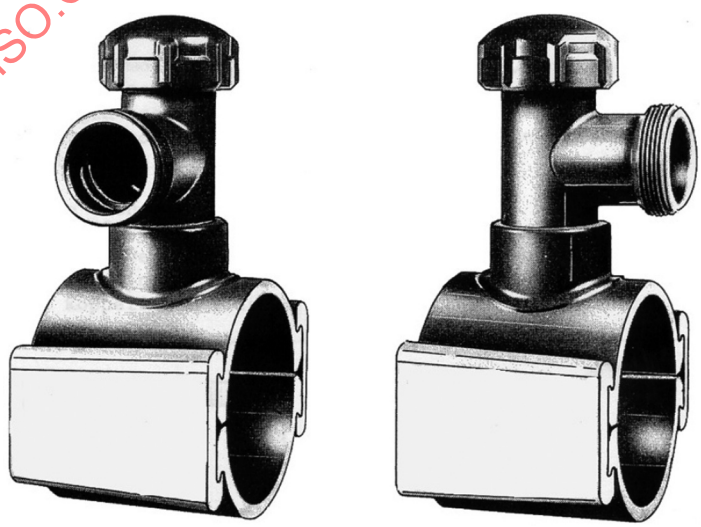


Figure 8 — Different outlet positions

The tee shall be screwed in entirely and then turned back until the desired position of the outlet is reached. This shall be one full turn at the most.

It shall be checked that the tapping tee/saddle connections are fitted in accordance with the manufacturer's instructions. For an example, see Figure 9.

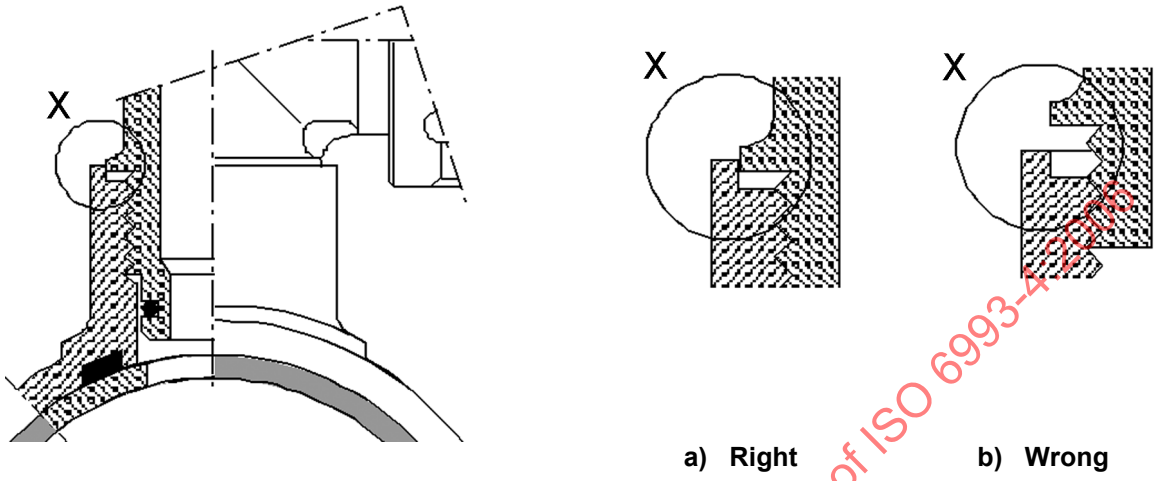


Figure 9 — Fitting of tapping tee/saddle connections

Before making the connection, after checking that the construction is free from dirt, if necessary, it shall be cleaned.

The connection shall be made by hand; it is not permitted to use tools. A lubricant shall not be applied to the O-ring.

5.3.5 Connecting service pipes

End trust joints are used for connecting PE service lines (see Figure 10).

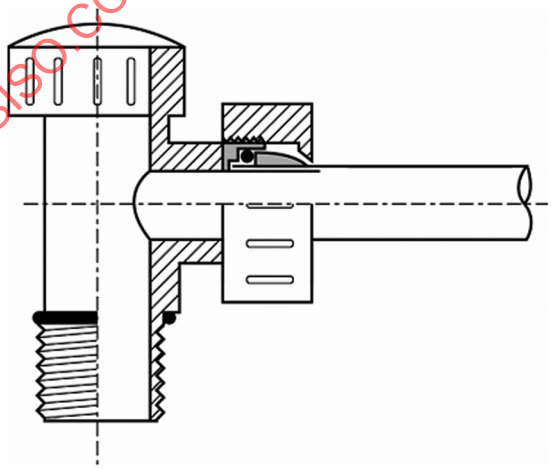


Figure 10 — Connection with end trust joint

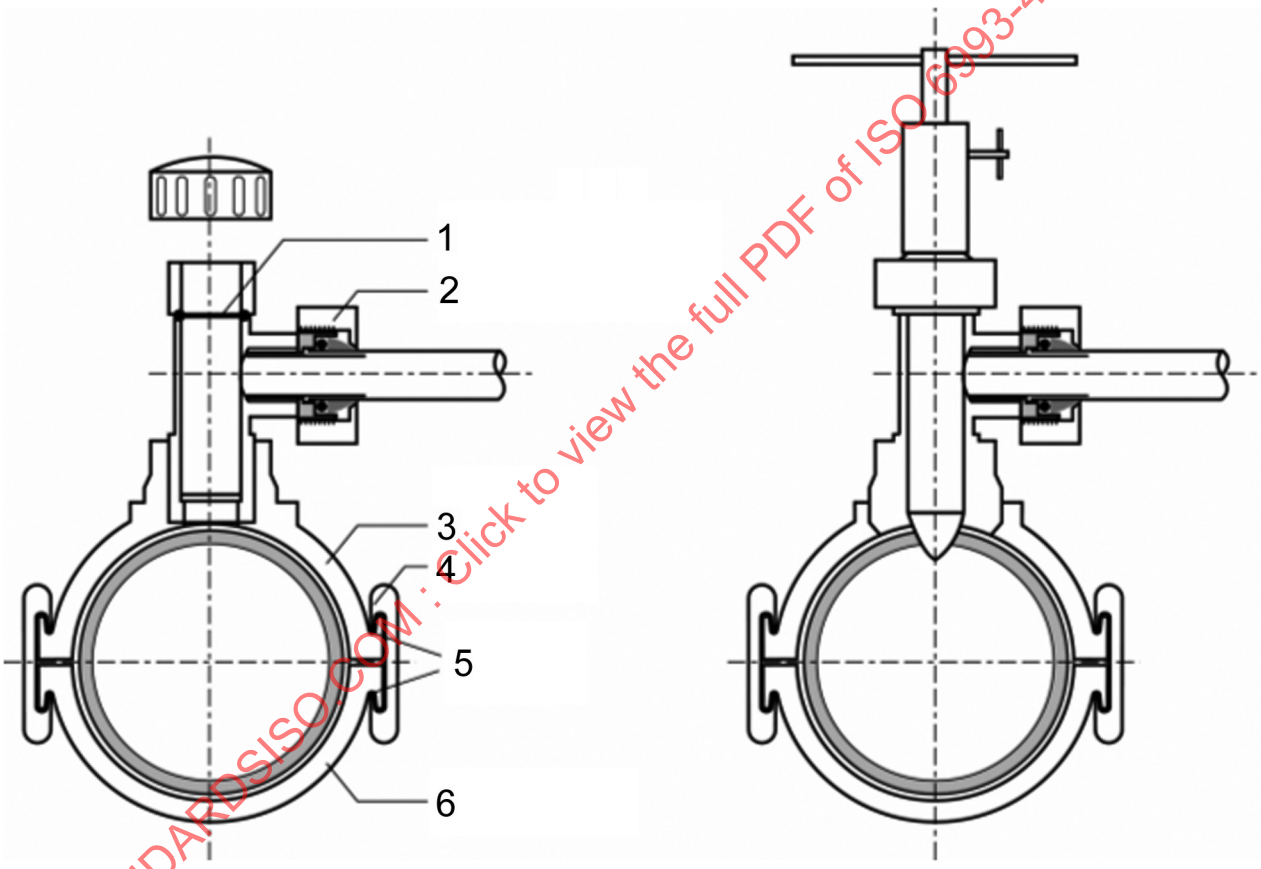
Service pipes shall be connected in accordance with the manufacturer's instructions. Before making the connection, it is checked that the construction is free from dirt and, if necessary, it shall be cleaned.

The connection shall be made by hand; it is not permitted to use tools. A lubricant shall not be applied to the rubber seals.

Care shall be taken to ensure that the pipe support selected corresponds to the SDR series of the service pipe.

5.3.6 Tapping

The main is tapped right through the tapping tee. To do so, the sealing cap must first be removed. The hole is cut using a core cutter, which is removed after cutting (see Figure 11). When the adequate equipment is used and the correct working procedure is followed, no gas is released.



Key

1 self-closing gas valve
2 end trust joint
3 upper half of saddle
4 clamp
5 wedge
6 lower half of saddle

Figure 11 — Tapping

The thread is cleaned, if necessary, and the sealing cap fitted. It is not permitted to use tools for tightening the cap. The same procedure may be followed for tapping pressurized mains.

Tapping shall be prepared for in such a way that the work can be carried out quickly and properly.

5.4 Laying

5.4.1 General

Major changes of direction of a pipe shall, wherever possible, be achieved by means of prefab/preformed bends or moulded fittings. A socket joint allows a change in direction of about 3°, due to the play between pipe and socket. As a socket holds two joints, on the spot of a socket a maximum change of about 6° in the course of the pipe can be accomplished without using preformed bends.

The normal minimum clearance between the PVC-HI pipe system and any other underground structure shall be $\geqslant$ 200 mm. If the minimum clearance cannot be observed a protection barrier shall be installed. Special precautions shall be taken if the gas pipeline crosses or is laid alongside a hot-water or steam pipeline, gasoline pipe, petrol station or high voltage cable.

The position of the pipeline shall be recorded before backfilling.

To minimize the possibility of damage to the pipeline by external influences, one of the following measures may be taken:

a) placing a warning tape vertically above and along the pipe;

b) placing a tracer wire at the same depth as the pipe for future underground location;

c) placing a permanent visible above ground marking of the pipeline, especially in cases of road, railway or water crossings, at blow-off devices, on private land, at boundaries between plots of lands, or at points where the right of way changes direction.

5.4.2 Trench

Excavating and backfilling of the trench shall be in accordance with the requirements of the written procedure.

The width of the trench bottom shall be large enough to allow correct installation and backfilling.

In uniform, relatively soft, fine-grained soils free of large flints, stones and other hard objects, and where the bottom of the trench can readily be brought to an even finish providing a uniform support for the pipes over their whole length, it may be permissible to lay pipes of all nominal sizes without the need for special preparation of the trench bottom.

5.4.3 Valves

Valves are available with either metal or plastics bodies. With metal-body valves, special precautions shall be taken against corrosion.

Valves shall be installed so that they do not expose the PVC-HI pipe to unnecessary stress during opening or closing.

5.4.4 Jointing to existing systems

Where there can be a release of gas in the working area, static charge accumulation shall be avoided.

New pipe sections can be added to, built into and jointed on top of existing piping systems [2].

---

2) “Added to” means the extension of an existing piping system, “built into” means inserting a constructional element into an existing piping system, for which the system needs to be decommissioned, and “jointed on top of” means fitting a constructional element on top of an existing piping system, for which the system does not need to be decommissioned.

After jointing, the assemblies shall be checked for tightness using a soap solution.

The following table shall be used for jointing PVC-HI pipes:

Table 1 — Jointing PVC-HI pipes to existing systems

Working method	Shut-off device	Requirement/remark
Built into/added on main.	Valve, bag stoppers. For diameters ⩾ 160 mm, two bag stoppers shall be fitted in series.	If bag stoppers are used, the gas pressure shall not exceed 100 mbar (10 kPa).
Jointed on top of main.		By means of a saddle.

5.4.5 Backfilling

Unless otherwise specified, buried pipelines and casings shall have a minimum soil cover of 0,6 m. Exceptions may be made for pipes entering metering or regulating boxes, but such pipes shall be protected against external interference. Greater soil cover shall be provided in areas of deep ploughing, drainage, roads with heavy traffic, railway or waterway crossings.

Excavated materials may be used as backfill provided that they are free from stones and sharp objects likely to damage the pipe. If not, imported backfill may be used.

The PVC-HI pipe shall be uniformly supported;

Material around the pipe shall be compacted so as to avoid excessive pipe out-of-roundness and shall be done layer by layer.

5.5 Pressure testing and commissioning

5.5.1 General

Pressure testing and commissioning shall be in accordance with EN 12327.

Consideration shall be given to the need for any special precautions to be taken to protect persons and property if air or inert gas is used as the test medium. During the pressure test, when the pipe is subjected to the test pressure in an open trench, end caps and bends shall be secured.

5.5.2 Testing requirements — For MOP ⩽ 20 kPa

The pipe shall be tested using air or an inert gas. During the strength test the pipe is subjected to a test pressure of 1 bar for at least 30 min. After the strength test, the pipe is subjected to a soundness test with a test pressure of 200 mbar to be applied for at least 1 hour.

5.5.3 Testing requirements — For MOP > 20 kPa ⩽ 100 kPa

The test pressure shall be appropriate to the MOP of the pipe system. It could be necessary to take into account national regulations.