BRITISH STANDARD

BS EN
15001-1:2009

Gas Infrastructure — Gas installation pipework with an operating pressure greater than 0,5 bar for industrial installations and greater than 5 bar for industrial and non-industrial installations

Part 1: Detailed functional requirements for design, materials, construction, inspection and testing

ICS 23.040.01; 91.140.40

BSI
British Standards

National foreword

This British Standard is the UK implementation of EN 15001-1:2009.

The UK participation in its preparation was entrusted to Technical Committee GSE/33, Gas supply.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 October 2009

ISBN 978 0 580 54498 9

Amendments/corrigenda issued since publication

Date	Comments

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 15001-1

July 2009

ICS 23.040.01

English Version

Gas Infrastructure - Gas installation pipework with an operating pressure greater than 0,5 bar for industrial installations and greater than 5 bar for industrial and non-industrial installations - Part 1: Detailed functional requirements for design, materials, construction, inspection and testing

Infrastructures gazières - Canalisations d'installations de gaz avec une pression de service supérieure à 0,5 bar pour les installations industrielles et supérieures à 5 bar pour les installations industrielles et non industrielles (domestiques et commerciales) - Partie 1: Exigences fonctionnelles détaillées relative à la conception, aux matériaux, à la construction, à l'inspection et aux essais

Gasinfrastruktur - Gas-Leitungsanlagen mit einem Betriebsdruck größer 0,5 bar für industrielle Installationen und größer 5 bar für industrielle und nicht-industrielle Installationen - Teil 1: Detaillierte funktionale Anforderungen an Planung, Material, Bau, Inspektion und Prüfung

This European Standard was approved by CEN on 16 May 2009.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 15001-1:2009: E

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Foreword

This document (EN 15001-1:2009) has been prepared by Technical Committee CEN/TC 234 “Gas Infrastructure”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2010, and conflicting national standards shall be withdrawn at the latest by January 2010.

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

Annexes A to D are informative.

The normative Annex E of this document lists some suitable materials for pipework, in addition to the materials listed in Clause 5.

This standard includes requirements concerning current design practice and reflects the state of the art at the time of publication. It provides clear solutions for users of the standard. Other design solutions and construction materials, as well as new developments, may be used if equal or greater safety than that required by this EN can be demonstrated or established.

There is a complete suite of functional standards prepared by CEN/TC 234 “Gas infrastructure” to cover all parts of the gas supply system from the input of gas to the transmission system up to the inlet connection of the gas appliances, whether for residential, commercial or industrial purposes.

In preparing this standard, a basic understanding of gas supply by the user has been assumed.

Gas supply systems are complex and the importance on safety of their construction and use has led to the development of very detailed codes of practice and operating manuals in the member countries. These detailed statements embrace recognised standards of gas engineering and the specific requirements imposed by the legal structures of the member countries.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies detailed functional requirements for the design, selection of materials, construction, inspection and testing of

— industrial gas installation pipework and assemblies with an operating pressure greater than 0,5 bar, and

— non-industrial gas installation pipework (residential and commercial) with an operating pressure greater than 5 bar in buildings,

starting from the outlet of the network operator's point of delivery up to the inlet connection to the gas appliance; normally the inlet isolation valve. This standard also covers the inlet connection to the gas appliance comprising of the pipework that does not fall within the scope of the appliance standard.

NOTE The use of the term installation and pipework is interchangeable.

This standard applies to gas installations operating at ambient temperatures between - 20 °C and 40 °C and operating pressures up to and including 60 bar. For operating conditions outside these limitations, reference should additionally be made to EN 13480 for metallic pipework.

For industrial gas installations up to and including 0,5 bar and for non-industrial (residential and commercial) gas installations up to and including 5 bar in buildings, EN 1775 applies.

For gas installations that do not fall within the scope of EN 1775 or other European Standards, this standard applies.

In this standard, the term "gas" refers to combustible gases, which are gaseous at 15 °C and 1 013 mbar absolute atmospheric pressure (normal conditions). These gases are commonly referred to as manufactured gas, natural gas or Liquefied Petroleum Gas (LPG). They are also referred to as first, second or third family gases (see Table 1 of EN 437:2003). The given values are considered as normal conditions for all volumes given in this standard.

LPG storage vessels (including all ancillaries fitted directly to storage vessels) are excluded. Also excluded are LPG installations and sections of LPG installations operating at vapour pressure in the liquid state (e.g. between the storage vessel and any pressure regulator).

In this standard, all pressures are gauge pressures unless otherwise stated.

This standard has been harmonised to address the essential safety requirements of the Pressure Equipment Directive (PED, 97/23/EC) relevant for the joining of gas installation pipework (assemblies) falling within the scope of the PED. These are listed in Annex ZA. However, "this Directive does not cover the assembly of pressure equipment on the site and under the responsibility of the user, as in the case of industrial installations" (PED, Preamble, 5th recital, last paragraph).

Although in this respect, the standard takes into account the essential safety requirements of the PED, no inference can be drawn from this as to whether or not the installation or parts of the installation falls within the scope of the PED. Reference should be made to the PED and national legislation.

This European Standard specifies common basic principles for gas supply systems. Users of this European Standard should be aware that more detailed national standards and/or code of practice may exist in the CEN member countries.

This European Standard is intended to be applied in association with these national standards and/or codes of practice setting out the above-mentioned basic principles.

In the event of conflicts in terms of more restrictive requirements in national legislation/regulation with the requirements of this standard, the national legislation/regulation shall take precedence as illustrated in CR 13737.

This provision does not apply to requirements that are harmonised to directive 97/23/EC (see Annex ZA).

This CR 13737 gives:

— clarification of all legislations/regulations applicable in a country;

— if appropriate, more restrictive national requirements thereof;

— a national contact point for the latest information.

Functional requirements for commissioning, operation and maintenance of industrial gas installations and assemblies with an operating pressure greater than 0,5 bar and of gas installations greater than 5 bar in buildings and areas intended for non-industrial installations greater than 5 bar are described in EN 15001-2.

Generally, additional safety precautions may be necessary where non-odorized gas is used. For non industrial purposes, the gas should be odorized.

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.

EN 287-1, *Qualification test of welders — Fusion welding — Part 1: Steels*

EN 331:1998, *Manually operated ball valves and closed bottom taper plug valves for gas installations for buildings*

EN 334:2005, *Gas pressure regulators for inlet pressures up to 100 bar*

EN 571-1, *Non destructive testing — Penetrant testing — Part 1: General principles*

EN 583-1:1998, *Non-destructive testing — Ultrasonic examination — Part 1: General principles*

EN 751-1:1996, *Sealing materials for metallic threaded joints in contact with 1st, 2nd and 3rd family gases and hot water — Part 1: Anaerobic jointing compounds*

EN 751-2:1996, *Sealing materials for metallic threaded joints in contact with 1st, 2nd and 3rd family gases and hot water — Part 2: Non-hardening jointing compounds*

EN 751-3:1996, *Sealing materials for metallic threaded joints in contact with 1st, 2nd and 3rd family gases and hot water — Part 3: Unsintered PTFE tapes*

EN 764-5:2002, *Pressure equipment — Part 5: Compliance and Inspection Documentation of Materials*

EN 970:1997, *Non-destructive examination of fusion welds — Visual examination*

EN 1044:1999, *Brazing — Filler metals*

EN 1057:2006, *Copper and copper alloys — Seamless, round copper tubes for water and gas in sanitary and heating applications*

EN 1092-1:2007, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 1: Steel flanges*

EN 1092-3:2003, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 3: Copper alloy flanges*

EN 1254-1:1998, *Copper and copper alloys — Plumbing fittings — Part 1: Fittings with ends for capillary soldering or capillary brazing to copper tubes*

EN 1254-2:1998, *Copper and copper alloys — Plumbing fittings — Part 2: Fittings with compression ends for use with copper tubes*

EN 1254-5:1998, *Copper and copper alloys — Plumbing fittings — Part 5: Fittings with short ends for capillary brazing to copper tubes*

EN 1290, *Non-destructive examination of welds — Magnetic particle examination of welds*

EN 1435:1997, *Non-destructive examination of welds — Radiographic examination of welded joints*

EN 1514-1:1997, *Flanges and their joints — Dimensions of gaskets for PN-designated flanges — Part 1: Non-metallic flat gaskets with or without inserts*

EN 1514-2:2005, *Flanges and their joints — Gaskets for PN-designated flanges — Part 2: Spiral wound gaskets for use with steel flanges*

EN 1515-1:1999, *Flanges and their joints — Bolting — Part 1: Selection of bolting*

EN 1515-2:2001, *Flanges and their joints — Bolting — Part 2: Classification of bolt materials for steel flanges, PN designated*

EN 1555-1:2002, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 1: General*

EN 1555-2:2002, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 2: Pipes*

EN 1555-3:2002, *Plastic piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 3: Fittings*

EN 1555-4:2002, *Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) — Part 4: Valves*

EN 1555-5:2002, *Plastic piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 5: Fitness for purpose of the system*

EN 1563:1997, *Founding — Spheroidal graphite cast irons*

EN 1594:2009, *Gas supply systems — Pipelines for maximum operating pressure over 16 bar — Functional requirements*

EN 1714:1997, *Non-destructive examination of welds — Ultrasonic examination of welded joints*

EN 1759-1:2004, *Flanges and their joint – Circular flanges for pipes,valves, fittings and accessories, Class designated - Part 1: Steel flanges, NPS 1/2 to 24*

EN 1775:2007, *Gas supply- Gas pipework for buildings — Maximum operating pressure less than or equal to 5 bar — Functional recommendations*

EN 10002-1, *Metallic materials — Tensile testing — Part 1: Method of test at ambient temperature*

EN 10045-1:1990, *Metallic materials — Charpy impact test — Part 1: Test method*

EN 10087:1998, *Free-cutting steels — Technical delivery conditions for semi-finished products, hot-rolled bars and rods*

EN 10088-1:2005, *Stainless steels — Part 1: List of stainless steels*

EN 10088-3:2005, *Stainless steels — Part 3: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes*

EN 10204:2004, *Metallic products — Types of inspection documents*

EN 10208-1:2009, *Steel pipes for pipelines for combustible fluids — Technical delivery conditions — Part 1: Pipes of requirement class A*

EN 10208-2, *Steel pipes for pipe lines for combustible fluids — Technical delivery conditions — Part 2: Pipes of requirement class B*

EN 10216-1:2002, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 1: Non-alloy steel tubes with specified room temperature properties*

EN 10216-5:2004, *Seamless steel tubes for pressure purpose — Technical delivery conditions — Part 5: Stainless steel tubes*

EN 10217-1:2002, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 1: Non-alloy steel tubes with specified room temperature properties*

EN 10217-7:2005, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 7: Stainless steel tubes*

EN 10220:2002, *Seamless and welded steel tubes — Dimensions and masses per unit length*

EN 10226-1:2004, *Pipe threads where pressure tight joints are made on the threads — Part 1: Taper external threads and parallel internal threads — Dimensions, tolerances and designation*

EN 10240:1997, *Internal and/or external protective coatings for steel tubes — Specification for hot dip galvanized coatings applied in automatic plants*

EN 10253-2:2007, *Butt-welding pipe fittings — Part 2: Non alloy and ferritic alloy steels with specific inspection requirements*

EN 10255:2004, *Non-alloy steel tubes suitable for welding and threading — Technical delivery conditions*

EN 10289:2002, *Steel tubes and fittings for onshore and offshore pipelines — External liquid applied epoxy and epoxy-modified coatings*

EN 10290:2002, *Steel tubes and fittings for onshore and offshore pipelines — External liquid applied polyurethane and polyurethane-modified coatings*

EN 12007-2:2000, *Gas supply systems — Gas pipelines for maximum operating pressure up to and including 16 bar — Part 2: Specific functional recommendations for polyethylene (MOP up to and including 10 bar)*

EN 12007-3:2000, *Gas supply systems — Pipelines for maximum operating pressure up to and including 16 bar – Part 3: Specific functional recommendations for steel*

EN 12068:1998, *Cathodic protection — External organic coatings for the corrosion protection of buried or immersed steel pipelines used in conjunction with cathodic protection — Tapes and shrinkable materials*

EN 12186:2000, *Gas supply systems — Gas pressure regulating stations for transmission and distribution — Functional requirements*

EN 12266-1:2003, *Industrial valves — Testing of valves — Part 1: Pressure tests, test procedures and acceptance criteria - Mandatory requirements*

EN 12279:2000, *Gas supply systems — Gas pressure regulating installations on service lines — Functional requirements*

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

EN 12560-1:2001, *Flanges and their joints — Gaskets for Class-designated flanges — Part 1: Non-metallic flat gaskets with or without inserts*

EN 12560-2:2001, *Flanges and their joints — Gaskets for Class-designated flanges — Part 2: Spiral wound gaskets for use with steel flanges*

EN 12732:2000, *Gas supply systems — Welding steel pipework — Functional requirements*

EN 12799:2000, *Brazing — Non-destructive examination of brazed joints*

EN 12954:2001, *Cathodic protection of buried or immersed metallic structures — General principles and application for pipelines*

EN 13100-1:1999, *Non destructive testing of welded joints of thermoplastics semi-finished products — Part 1: Visual examination*

EN 13134:2000, *Brazing — Procedure approval*

EN 13445-6, *Unfired pressure vessels — Part 6: Requirements for the design and fabrication of pressure vessels and pressure parts constructed from spheroidal graphite cast iron*

EN 13480-2:2002, *Metallic industrial piping — Part 2: Materials*

EN 13480-3:2002, *Metallic industrial piping — Part 3: Design and calculation*

EN 13480-5:2002, *Metallic industrial piping — Part 5: Inspection and testing*

EN 13480-6:2004, *Metallic industrial piping — Part 6: Additional requirements for buried piping*

EN 13774:2003, *Valves for gas distribution systems with maximum operating pressure less than or equal to 16 bar — Performance requirements*

EN 13785:2005, *Regulators with a capacity of up to and including 100 kg/h, having a maximum nominal outlet pressure of up to and including 4 bar, other than those covered by EN 12864 and their associated safety devices for butane, propane or their mixtures*

EN 13786:2004, *Automatic change-over valves having a maximum outlet pressure of up to and including 4 bar with a capacity of up to and including 100 kg/h, and their associated safety devices for butane, propane or their mixtures*

EN 14141:2003, *Valves for natural gas transportation in pipelines — Performance requirements and tests*

EN 14291:2004, *Foam producing solutions for leak detection on gas installations*

EN 14382:2005, *Safety devices for gas pressure regulating stations and installations — Gas safety shut-off devices for inlet pressures up to 100 bar*

EN 20898-2:1993, *Mechanical properties of fasteners — Part 2: Nuts with specified proof load values — Coarse thread (ISO 898-2:1992)*

EN 60529:1991, *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989)*

EN 60079-10:2003, *Electrical apparatus for explosive gas atmospheres — Part 10: Classification of hazardous areas (IEC 60079-10:2002)*

EN 60079-14, *Explosive atmospheres — Part 14: Electrical installations design, selection and erection (IEC 60079-14:2007)*

EN ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation (ISO 228-1:2000)*

EN ISO 898-1:2009, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread (ISO 898-1:2009)*

EN ISO 3506-1:1997, *Mechanical properties of corrosion-resistant stainless-steel fasteners — Part 1: Bolts, screws and studs (ISO 3506-1:1997)*

EN ISO 3506-2:1997, *Mechanical properties of corrosion-resistant stainless-steel fasteners — Part 2: Nuts (ISO 3506-2:1997)*

EN ISO 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections (ISO 5817:2003, corrected version:2005, including Technical Corrigendum 1:2006)*

EN ISO 10380:2003, *Pipework — Corrugated metal hoses and hose assemblies (ISO 10380:2003)*

EN ISO 10806:2003, *Pipework — Fittings for corrugated metal hoses (ISO 10806:2003)*

EN ISO 12944-1:1998, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems –Part 1: General introduction (ISO 12944-1:1998)*

EN ISO 15607:2003, *Specification and qualification of welding procedures for metallic materials — General rules (ISO 15607:2003)*

EN ISO 15609-1:2004, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding (ISO 15609-1:2004)*

EN ISO 15610:2003, *Specification and qualification of welding procedures for metallic materials — Qualification based on tested welding consumables (ISO 15610:2003)*

EN ISO 15612:2004, *Specification and qualification of welding procedures for metallic materials — Qualification by adoption for a standard welding procedure (ISO 15612:2004)*

EN ISO 15614-1:2004, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2004)*

ISO 9329-2, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 2: Unalloyed and alloyed steels with specified elevated temperature properties*

ISO 15348, *Pipework — Metal bellows expansion joints — General*

3 Terms and definitions

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

3.1 Definitions relating to pressure

3.1.1
pressure
gauge pressure of the fluid inside the system, measured in static conditions

3.1.2
design pressure
DP
pressure at which the design calculations are based; this is equivalent to the maximum allowable pressure (PS) as given in the PED

3.1.3
maximum allowable pressure
PS
maximum pressure for which pipework is designed in accordance with the strength requirements in this document

NOTE For this standard, PS is equivalent to the design pressure (DP).

3.1.4
maximum incidental pressure
MIP
maximum pressure which a system can experience during a short time, limited by the safety devices

3.1.5
operating pressure
OP
pressure which occurs within a system under normal operating conditions

3.1.6
maximum operating pressure
MOP
maximum pressure at which a system can be operated continuously under normal operating conditions

NOTE Normal conditions are: no fault in any device or stream.

3.1.7
tightness test pressure
TTP
pressure applied to a system during tightness testing

3.1.8
strength test pressure
STP
pressure applied to a system during strength testing

3.1.9
combined test pressure
CTP
pressure applied to a system during combined testing

3.2 Definitions relating to the gas installation

3.2.1
components
any item from which a gas supply system or installation is constructed; a distinction is drawn between the following groups of components:

— ancillaries (for example: pressure regulators, valves, safety devices, expansion joints and insulating joints)

— pipes, including bends made from pipe

— instrumentation pipework

— fittings (for example: reducers, tees, factory-made elbows, flanges, dome ends, welding stubs and mechanical joints)

3.2.2
flexible appliance connector
fitting of flexible pipe to be fitted between the end of fixed pipework and the appliance inlet connection

3.2.3
point of delivery
point where the gas is transferred to the user

NOTE This can be at a means of isolation or at the meter outlet connection and is normally at the point of transfer of ownership.

3.2.4
user(s)
person(s) responsible for the safety of the gas installation and associated risks on a site

NOTE Normally the user will be the site occupier or owner. It should be assumed that every user has a responsibility for work performed on their site, whether or not the work is performed directly for the user or not. This does not mean that they cannot take advice from an independent specialist.

3.2.5
pipework
assembly of pipes and fittings

3.2.6
installation pipework
pipework including components and stations downstream of the point of delivery terminating at the appliance inlet connection

NOTE This pipework is normally the property of the customer.

3.2.7
ventilated space
space where the air is continuously changed by natural or mechanical means

3.2.8
safety zone
area around the pipework from which persons who are not involved in the strength test are excluded during testing

3.2.9
equipotential bond
means of ensuring that metallic gas pipework and other metallic parts of the building are at the same electrical potential

NOTE For safety reasons, this equipotential bonding is connected to earth.

3.2.10
duct
space specifically designed and constructed for the passage of building services

EXAMPLE Building services include gas pipework, water systems, power and telecommunication cables.

3.2.11
ventilation duct
duct forming part of the structure of the building and intended exclusively for ventilation purposes

3.3 Definition relating to means of isolation

3.3.1
means of isolation
device which is intended to interrupt the gas flow in pipework

EXAMPLE Manually operable valve.

3.4 Definitions relating to jointing methods

3.4.1
joint
means of connecting elements of a gas installation

3.4.2
flanged joint
joint in which gas tightness is achieved by compression of a gasket between the faces of two flanges

3.4.3
threaded joint
joint in which gas tightness is achieved by metal-to-metal contact within threads with the assistance of a sealant

3.4.4
mechanical joint
joint in which gas tightness is achieved by compression, with or without a seal and which can be disassembled and reassembled

NOTE This definition includes twin ferrule type joints.

3.4.5
pressed joint
joint in which tightness is achieved by using a specific tool for either compressing a fitting to form the joint or expanding a pipe to enable forming the joint

3.4.6
brazed joint
joint formed by brazing

3.4.7
welded joint
joint formed by welding

3.4.8
electro fusion joint
joint formed between polyethylene components using fittings which have an integrated electric heating element

3.4.9
butt fusion joint
joint formed between polyethylene components where the two pipe ends are heated and brought together to be fused directly without the use of a separate fitting or filler material

3.4.10
compression joint
type of joint in which gas tightness is achieved by compression within a socket with or without a seal

3.5 Definitions relating to components

3.5.1
regulator
device which reduces the gas pressure to a set value and maintains it within prescribed limits

3.5.2
appliance connection
flexible pipe or length of rigid pipework connecting an appliance's means of isolation with the appliance inlet connection

3.5.3
insulating joint
fitting installed to insulate electrically one section of pipework from another

3.5.4
sleeve
protective pipe through which a gas pipe passes

3.5.5
vent pipe
pipework connected to a safety or control device to release gas at a safe location

3.5.6
creep relief valve
device designed to release a limited flow of gas in the event of an unacceptable pressure being detected within the system it protects

3.5.7
safety slam-shut device
device designed to quickly shut off the gas flow in the event of an unacceptable pressure being detected within the system it protects

3.5.8
instrumentation pipework
pipework required for the proper functioning of the ancillaries installed within the pressure regulating installation

EXAMPLE Sensing, measuring, auxiliary and sampling lines.

3.5.9
DN
alphanumeric designation of size for components of a pipework system, which is used for reference purposes; it comprises the letters DN followed by a dimensionless whole number, which is directly related to the physical size, in millimetres, of the bore or outside diameter of the end connections

NOTE 1 The number following the letters DN does not represent a measurable value and should not be used for calculation purposes except where specified.

NOTE 2 Where DN designation is used, any relationship between DN and component dimensions are given, e.g. DN/OD or DN/ID.

3.5.10
safety system
system which ensures, independent of the pressure regulating system, that the outlet pressure of that system does not exceed the safety limits

3.6 Definitions relating to tests

3.6.1
strength test
specific procedure intended to verify that the pipework meets the requirements for mechanical strength

3.6.2
tightness test
specific procedure intended to verify that the pipework meets the requirements for tightness

3.6.3
combined test
specific procedure to verify that the pipework and/or installation meets the requirements for mechanical strength and tightness

3.6.4
leak detection fluid
specially formulated fluid and foaming product that gives a clear indication that a leak exists when applied to an element of pipework

3.7 Definition relating to testing and inspection

3.7.1
competent person
person who is trained, experienced and approved to perform activities relating to gas pipework

NOTE Means of approval are determined within each country.

3.8 Definitions relating to assembly processes for metallic materials

3.8.1
welding
joining (union) of two or more parts by heat or pressure or a combination of both (fusion, arc or oxy-acetylene), such that the materials form a continuity; a filler metal having a melting point similar to that of the materials to be welded may be used

3.8.2
brazing
operation in which metal parts are joined by means of capillary action of a filler metal in the liquid state with a melting temperature, higher than 450 °C, lower than that of the parts to be joined and wetting the parent metal(s), which does not participate in the making of the joint

NOTE This is often referred to as hard soldering.

3.8.3
hot tapping
procedure involving the safe use of heat, e.g. welding or fusion, to affix an attachment to a section of pipework containing gas at pressure

3.9 Definitions relating to pressure regulating and metering

3.9.1
compressors
a complete unit for raising the gas pressure within installation pipework above 0,5 bar to an OP greater than 5 bar

3.9.2
station
gas pressure regulating and/or metering system including (where applicable) the housing, the odorisation facilities and the fenced site

3.9.3
gas pressure regulating and metering system
system comprising all equipment, together with inlet and outlet pipework up to and including the isolating valves, which together performs the functions of pressure regulation, pressure safety and/or quantitative gas measurement, whether or not including pressure boosting and/or gas mixing facilities

3.9.4
monitor
second regulator used as a safety device in series with the active regulator which assumes control of the pressure at a higher set value in the event of the active regulator failing open

4 General

4.1 Quality system

The life of a gas installation can be divided into four phases:

— design;

— construction and testing;

— commissioning;

— operation and maintenance.

A quality system shall be applied to the design, construction, and testing activities in accordance with this standard also considering the requirements for commissioning, operation and maintenance in EN 15001-2. Reference may be made to the EN ISO 9000 series of standards or to equivalent quality system standards.

NOTE After the gas installation has been put into operation, the integrity should be maintained by the programme of operation, maintenance and condition monitoring in accordance with EN 15001-2.

4.2 Selection of materials

4.2.1 Specification

Materials shall be selected to be compatible with anticipated fabrication and to be suitable for the internal fluid and external environment. Both normal operating conditions and transient conditions occurring during fabrication, transport, testing, commissioning and decommissioning shall be taken into account when specifying the materials.

4.2.2 CE marking

Wherever relevant, components shall be CE marked.

4.3 Protection against hazards

4.3.1 Resistance to fire

Pipework including supports shall be designed and constructed to limit the release of gas in case of damage caused by a fire; so as to minimise the possibility of an explosion or a significant increase in the fire.

4.3.2 Resistance to corrosive substances and atmosphere

Pipework including supports in contact with soil or building materials, which can be expected to contain corrosive substances, or in contact with corrosive atmosphere shall be resistant to or protected against these substances.

4.3.3 Protection against variations in the operating pressure

The specifiers and designers of pipework shall ensure that the supply pressure conditions are suitable for the safe operation of the appliances.

4.3.4 Protection against gas hazards

4.3.4.1 General

Gas escaping through apertures in ancillaries can result in a flammable mixture in an enclosed space or in small building areas.

To avoid this, the following provisions may be used:

— the apertures are fitted with vent pipes terminating in a safe location;

— the fitting of restrictions in breather connections, provided the operational performance is not impaired;

— providing extra ventilation to the room.

The above apertures also include breather holes serving diaphragms in pressure regulators and safety devices.

Consideration should also be given to the heavier than air properties of LPG.

4.3.4.2 Zone classification

A risk assessment shall be performed to verify if a hazardous area classification has to be established.

NOTE 1 See Directive 1999/92/EC of the European Parliament and of the Council of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres (15th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC). All mechanical and electrical equipment will need to conform with 94/9/EC ATEX when within the scope of this Directive. Reference can also be made to EN 60079-10.

NOTE 2 Normally, pipework designed and constructed to this standard and subsequently maintained in accordance with EN 15001-2, should not leak during its service life.

However, where gas detection systems are to be installed, they shall not be considered as an alternative to good ventilation.

NOTE 3 Gas detection systems should be in compliance with EN 61779-1 to EN 61779-5. They are only reliable when maintained regularly.

4.3.5 Electrical installation

4.3.5.1 Voltage fluctuation

The safety of the gas installation shall not be impaired by the failure or restoration of electric power or by a voltage fluctuation or by overload (flash of lightning).

4.3.5.2 Installation in hazardous area

Electrical installations in hazardous areas shall comply with EN 60079-14.

4.4 Accommodation and location of gas pressure regulating and metering systems, gas pressure compressors and gas mixing systems

4.4.1 Installation in a separate space

4.4.1.1 Requirements for the enclosure of installations

If a gas pressure regulating and metering system for DP upstream greater than 5 bar or a gas mixing system is installed in an isolated enclosed space, the enclosure shall comply with the relevant requirements of EN 12186.

The information contained within EN 12186 may be considered for compressors in the absence of specific recognized standards or information from the manufacturer.

4.4.1.2 Layout of the site and site security

The relevant requirements of EN 12186 shall be met. Compressors shall comply with the manufacturer's indications and/or the national legislation/regulation.

4.4.2 Installation in an appliance room

A gas pressure regulating and metering system for one or more gas appliances may be installed in the same room as the appliance(s) provided there is adequate ventilation and a DP upstream is equal to or less than 5 bar. In this case, the construction, layout, facilities and location of the room shall be subject to the requirements applicable to the gas appliances concerned. For examples, see Figure A.1 and Figure A.2.

Where compressors and/or gas mixing systems are installed, additional safety precautions may be necessary.

An external means of isolation shall be provided.

4.4.3 Protection against adverse influences

Gas pressure regulating and metering systems, gas pressure boosters/compressors and/or gas mixing systems in appliance rooms as referred to in 4.4.2 shall, where necessary, be protected against adverse influences such as corrosion, heat and vibration.

5 Materials

5.1 Standards and specifications for pipes and pipe fittings

5.1.1 General

Pipes and fittings shall be constructed of:

— materials complying with the restrictions given in Tables 1 to 4, 7 and 8; or

— materials given in Annex E.

5.1.2 Carbon steel

5.1.2.1 Pipes

Longitudinally and spiral welded pipes and seamless pipes are permitted:

— steel threaded pipes to a design pressure of 5 bar and nominal diameter of 50 mm;

— welded steel pipes and seamless steel pipes in accordance with EN 10220 with nominal external diameter greater than or equal to 17,2 mm.

As a minimum, the pipe material shall be in conformance with Table 1. They may also be in compliance with EN 13480-2.

Table 1 — Standards for carbon steel pipes

DP	Standard	Steel grade	Elongation (%)	Charpy V (J) >	Operating Temperature - 20 °C to + 40 °C	Upper Yield strength T ≤ 16 mm N/mm²
≤ 5 bar	EN 10255	L195*	20		X	195
≤ 16 bar	EN 10208-1	L210GA*	25		X	210
		L235GA*	23		X	235
	EN 10217-1	P 235 T1*	23		X	235
	EN 10216-1	P 235 T1*	23		X	235
> 16 bar	EN 10208-2	L245 NB	22	40	X	245
		L290 NB	21	40	X	290
	ISO 9329-2	PH 26	19	27	X	265
	EN 10216-1	P 235 T2	23	27	X	235
		P 265 T2	19	27	X	265
	EN 10217-1	P 235 T2	23	27	X	235
		P 265 T2	19	27	X	265

* Materials listed in Annex E.

5.1.2.2 Pipe fittings

As a minimum, pipe fittings shall be in conformance with Table 2.

Table 2 — Standards and steel grades for pipe fittings

	Dimensions defined in	Steel grade (defined in)	Ductility according to the standard	
			Charpy V (J)>	Elongation (%)>
Tee Bend or elbow Reducer Cap	EN 10253-2	P235 (EN 10253-2)	27	23
		P265 (EN 10253-2)	27	19
Flange	EN 1092-1	S235JR (EN 10025),	27	26
		P245GH (EN 10222-2),		23
		GP240 GH (EN 10213-2)		22

5.1.2.3 Test certificate

5.1.2.3.1 DP greater than 5 bar

Carbon steel pipes and pipe fittings shall, as a minimum, be certificated on the basis of EN 10204 and in accordance with EN 764-5.

5.1.2.3.2 DP less than or equal to 5 bar

Carbon steel pipe and pipe fittings for use with MOP up to and including 5 bar shall be certificated by an inspection document 2.2 in accordance with EN 10204.

For pipework falling in PED, Table 6, Category II or Category III, the certificate shall be in accordance with EN 764-5.

5.1.3 Stainless steel

5.1.3.1 Pipes and pipe fittings (including flanges and valves)

As a minimum, the material shall be in accordance with Table 3.

5.1.3.2 Test certificate

Materials for pressure containing parts compliant with the requirements of this European Standard shall be certified on the basis of EN 10204.

NOTE The certification should be in accordance with EN 764-5.

Table 3 — Standards and EN material numbers for stainless steel

Component	Standards	Material		
		EN material number (EN 10088-3, EN 13480-2)	Ductility according to the EN material number	
			Charpy V (J) >	Elongation (%)
Welded pipe	EN 10217-7	1.4301 1.4306 1.4311 1.4401 1.4404 1.4571	100 100 100 100 100 100	45 45 40 40 40 40
Seamless pipes	EN 10216-5			
Tee	EN 10253-2			
Bend				
Reducer				
Convex bottom				
Welding stub	None			
Flange	EN 1092-1			
Valve	EN 13774 EN 14141			

5.1.4 Copper

As a minimum, copper pipes and pipe fittings intended for use with copper pipes shall be in accordance with Table 4.

For pressure limits and wall thickness of copper pipes, see 6.4.2.2.

Table 4 — Standards and material type for copper pipework and pipe fittings

	Standards	Material type
Pipes	EN 1057	R250 (half hard, elongation 20 %, hardness 75 N/mm² to 100 N/mm²)
Flanges	EN 1092-3	
Soldered fittings*	EN 1254-1 and EN 1254-5	Bronze or brass
Compression fittings*	EN 1254-2	

* Materials listed in Annex E.

5.1.5 Polyethylene

PE 80* (MRS 8 N/mm²) and PE 100* (MRS 10 N/mm²) pipes and fittings of series SDR 17,6 or SDR 11 shall be in accordance with EN 1555-1 to EN 1555-3.

* Materials listed in Annex E.

5.1.6 Flange types, dimensions and drilling patterns

The pressure class of a flange depends on the type of material, the maximum allowable pressure, and the operating temperature as defined in EN 1092-1 and EN 1759-1.

5.1.7 Threaded joint sealants

A sealant in accordance with EN 751-1, EN 751-2 or EN 751-3 shall be used in combination with the self-sealing thread.

5.1.8 Requirements for prevention of cracking and control of elongation

5.1.8.1 Weldability

Where the material standard is not listed in Table 1, the chemical composition of steels intended for welding or forming shall not exceed the values in Table 5. Exceptions shall be technically justified (weldability test) and agreed between the parties involved.

Table 5 — Maximum carbon, phosphorus and sulphur content of steel for welding and forming

Steel group	Maximum content of cast analysis		
	% C	% P	% S
Carbon steel	0,21	0,035	0,030
Stainless steel	0,08	0,045	0,015

For stainless steel products to be machined, a controlled sulphur content of 0,015 % to 0,030 % may be permitted by agreement provided the resistance to corrosion is satisfied for the intended purpose.

For carbon steel products the sum of sulphur and phosphorus as a total of the ladle analysis shall be less than, or equal to 0,050 %.

To meet the weldability criteria, the value of the carbon equivalent (CE) of carbon steels shall be less than or equal to 0,45 for grades with specified minimum yield strength (SMYS) not exceeding 360 N/mm^2, unless otherwise agreed between the parties involved. This value shall be guaranteed by the manufacturer.

Carbon equivalent is given by the formula:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Cu + Ni}{15}$$

where

CE is the carbon equivalent;

C is the weight percentage of carbon content;

Mn is the weight percentage of manganese content;

Cr is the weight percentage of chromium content;

Mo is the weight percentage of molybdenum content;

V is the weight percentage of vanadium content;

Cu is the weight percentage of copper content;

Ni is the weight percentage of nickel content.

5.1.8.2 Notch impact strength and elongation

Steels for pipework for a MOP greater than 16 bar and with a wall thickness greater than 5 mm shall have specified minimum impact energy measured on Charpy V notch test specimen (EN 10045-1) that is:

— ≥ 27 J for carbon steel;

— ≥ 40 J for stainless steel;

at a temperature not higher than 20 °C. The test temperature and the requirements of EN 13480-2, Annex B, shall apply.

Carbon steel materials shall be subjected to a tensile test carried out by a standard procedure, its elongation after rupture shall be no less than 14 % and its bending rupture energy measured on an ISO V test-piece shall be less than 27 J, at a temperature not greater than 20 °C but not higher than the lowest scheduled operating temperature.

5.2 Ancillaries

5.2.1 Pressure and materials

Minimum material requirements for ancillaries not otherwise specified in this standard shall be at least in accordance with Table 6.

Table 6 — Materials for ancillaries

Design Pressure	Above-ground	Buried
< 5 bar	Brass; Aluminium alloy[a]; Steel; Nodular/spheroidal graphite cast iron in accordance with Table 7[b]	Steel; Nodular/spheroidal graphite cast iron in accordance with Table 7; Approved plastic and suitable for purpose.
≥ 5 bar to 16 bar	Steel Nodular/spheroidal graphite cast iron grade EN-GJS-400-18-LT[c]	

[a] Not to be used for appliance isolation.

[b] Appliance isolating valve EN-GJS-400-18-LT or equivalent.

[c] Standards equivalent in terms of their mechanical properties (tensile strength, yield limit and elongation over 10 %) are also acceptable.

Table 7 — Nodular/spheroidal graphite cast iron grades with elongation over 14 %

Standard	Ductility according to the standard		Designation	Required safety factor EN 13445-6
	Charpy V (J) >	Elongation (%)		
EN 1563	12 (at – 40 °C ± 2 °C)	22	EN-GJS-350-22-LT*	2,4
	12 (at – 20 °C ± 2 °C)	18	EN-GJS-400-18-LT*	2,4
	17 (at 23 °C ± 5 °C)	22	EN-GJS-350-22-RT*	3,5
		22	EN-GJS-350-22*	3,5
	14 (at 23 °C ± 5°C)	18	EN-GJS-400-18-RT*	3,5
		18	EN-GJS-400-18*	3,5
		15	EN-GJS-400-15*	3,5

* Materials listed in Annex E.

5.2.2 Valves

Valves, if applicable, shall meet the requirements of EN 331, EN 1555-4, EN 12266-1, EN 13774 and/or EN 14141 (see Annex E).

5.3 Gas pressure regulating and safety systems

5.3.1 Pipe materials, pipe fittings and ancillaries

Materials for instrumentation pipes shall be in accordance with EN 1057 and EN 10088-1.

Materials for connectors (compression fittings) shall be in accordance with Table 8.

Materials for bolts, screws, studs and nuts shall be in accordance with Table 8.

All other metallic materials for pipes, fittings and joints in regulating and metering systems, other than instrumentation pipework, shall meet the requirements of Clause 5 of this Standard.

Gas pressure regulators shall meet the requirements of EN 334 for natural gas, manufactured gas and EN 13785 or EN 13786 for LPG.

Safety slam shut devices shall meet the requirements of EN 14382.

Creep relief valves shall meet the requirements of EN 334.

Table 8 — Materials for compression fittings, bolts, nuts, etc.

Materials			Restrictions
Description	**Type**	**Relevant standard**	**DP** bar
Compression* fittings	11 SMnPb30/1.0718 and 11 SMnPb37/1.0737 both with a min 8 % and $5 \leq d \leq 100$	EN 10087	60[a]
	All steel designations	EN 10088-3	
Bolts, screws, studs and nuts*	Class 10.9	EN ISO 898-1	50
	Class 10 for nuts	EN 20898-2	
	Class 4.6, 5.6, 8.8	EN ISO 898-1	60[a]
	Grade A2ss, A4ss	EN ISO 3506-1 EN ISO 3506-2	
	Classes 5, 8, 9 for nuts	EN 20898-2	

[a] These materials are generally applicable up to 100 bar.

* Materials listed in Annex E.

6 Design of pipework

6.1 General

6.1.1 Installation drawings and technical file

The user shall ensure that a technical file is available and that it contains the following information (with parts lists where appropriate):

— the manufacturers technical file under PED;

— the location (route) of the installation pipework;

— the pipe diameters, MIP, DP, OP, materials and coatings;

— the location and design of supports;

— the location and design of wall and floor transits, points where pipework crosses or runs parallel with other systems, etc.;

— location of ancillaries, stating the make, type, connection sizes and type of material;

— joints, gaskets, bolts, etc.;

— location and layout of internal gas pressure regulating systems, stating the required settings for regulators and safety devices;

— the location and sizes of valved points for testing and purging;

— maximum flow in pipework sections including any extension, expressed in m^3/h under normal conditions of gas;

— cathodic protection system, where fitted.

The gas appliances to be connected to the system shall be specified separately, stating:

— supplier/make and type;

— maximum flow, in m^3/h under normal conditions of gas;

— minimum and maximum operating pressure.

6.1.2 Measuring and test instruments

Gas installations shall incorporate such measuring instruments and test points as are necessary for its safe operation.

A threaded valve with integral means of depressurisation, having a 15 mm connection in accordance with EN 10226-1 shall be provided at an accessible and appropriate point of the pipework for pressure measurement and sampling.

6.1.3 Properties of gas

If a gas is toxic or corrosive or contains moisture, then this shall be taken into account. Condensation of gas is not permissible.

NOTE Some manufactured or process gases can be toxic, corrosive or ‘wet’. Higher hydrocarbon gases can be heavier than air.

In case of possible exceeding the temperature limits of - 20 °C and + 40 °C, a temperature monitoring device shall be provided.

6.2 Layout

6.2.1 Limits of the pipework location

Pipework shall be laid, if possible, within the property for which the gas installation is intended.

6.2.2 Above-ground pipework

Whether installed in a building or above ground within the site, gas pipework shall:

— be able to absorb expansion;

— be well supported;

— not be exposed to mechanical damage;

— not be of PE-pipe unless encased in a steel sleeve, see 6.6.6.1.

The design shall take into account the adverse effects of stray currents, lightning and differing electrical potentials between nearby metallic components.

6.2.3 Buried pipework

The pipework design shall take account of any future requirements for inspection and repair.

Buried pipework shall not impair the building's construction and shall be protected against movement of the building (such as through the use of a protective sleeve), see 8.3.1. Above 5 bar, buried pipework below buildings is not permitted. For systems up to 5 bar, it may be permissible to locate pipework under buildings on the completion of a risk assessment to determine any additional safety precautions or constructional requirements.

6.2.4 Distance between buried pipework and buildings

Except at the point where the pipe enters a building, pipework should be located at least 1 m away from any building or structure.

6.2.5 Unacceptable locations for gas pipework in buildings

Pipework shall not be laid in:

— wall cavities, walls or ceilings except for pipe transits employing a pipe sleeve;

— chimneys, flue ducts or ventilation ducts and ducts forming part of an air conditioning system;

— garbage chutes, fuel chutes or lift shafts;

— immediately adjacent to hot or refrigerated services or high voltage cables unless taken into account in the design.

6.3 Dimensioning

6.3.1 Pressure loss

At maximum flow, the pressure drop shall not exceed 10 % of the OP in the case of gas appliances without pressure regulators.

In the case of appliances with pressure regulators, the pressure shall not be outside that specified for the safe operation of all connected appliances under all operating and flow conditions.

6.3.2 Gas velocity

In the metering and regulating systems, the design shall be limited to 20 m/s to prevent erosion and flow-induced pulsation, the velocity of the gas in the pipe should not exceed 25 m/s. For higher velocities flow-induced pulsation calculations shall be made and noise and erosion aspects should be taken into account.

NOTE VDI 3733 may be consulted for designs based on noise criteria.

6.4 Pressure and wall thickness

6.4.1 DP and test pressure

DP and STP of the gas installation are based on the MOP of the point of delivery. **DP is equivalent to the maximum allowable pressure (PS) as given in PED.** The MIP at the point of delivery shall be less than or equal to 1,1 times the DP. Components shall be chosen in such a way that they are leak tight at a pressure at least equal to the MIP.

Table 9 — Required STP/CTP in relation to DP

DP bar	**STP/CTP** bar
> 40	≥ 1,43 DP
16 < DP ≤ 40	≥ 1,43 DP
5 < DP ≤ 16	≥ 1,43 DP
2 < DP ≤ 5	≥ 1,43 DP
0,5 < DP ≤ 2	> 1,75 DP

6.4.2 Pipe wall thickness

6.4.2.1 Steel pipe

6.4.2.1.1 General

The wall thickness of carbon steel pipes shall be at least equal to the relevant value given in Table 10 below.

The wall thickness as stated in Table 10 for carbon steel is the calculated minimum wall thickness plus the absolute value of the negative tolerance taken from the material standards or as provided by the pipe manufacturer and the corrosion allowance. Site conditions can alter the corrosion allowance.

The dimensions have been rounded off to standard pipe sizes, taking into account ease of handling and weldability.

6.4.2.1.2 Straight pipe wall thickness determination

If no additional requirements are imposed, for straight pipe the minimum wall thickness to withstand the internal pressure is calculated as follows:

$$T_{\text{min}} = \frac{DP \times D}{20\ \sigma_{\text{p}} \times z}$$

with the requirement that:

$$\sigma_{\text{p}} \leq f_0 \times R_{\text{t0,5}}(\theta)$$

where

T_{min} is the calculated minimum wall thickness, in millimetres (mm);

DP is the design pressure, in bar;

D is the outside diameter of the pipe, in millimetres (mm);
if D_i is preset, D shall equal D_i + 2 T_{min}, D_i being the inside diameter in millimetres (mm);

σ_{p} is the hoop stress, in Newton per square millimetre (N/mm^2);

f_0 is the design factor;

$R_{t0,5}(\theta)$ is the specified minimum yield strength at the design temperature, in Newton per square millimetre (N/mm^2);

$R_{t0,5}$ is the specified minimum yield strength at ambient temperature, in Newton per square millimetre (N/mm^2) (see EN 10002-1);

z joint coefficient.

NOTE If temperature less than or equal to 60 °C, $R_{t0,5}(\theta)$ *is equal to* $R_{t0,5}$.

If the temperature is over 60 °C, the value of the specified minimum yield strength has to be corrected for the temperature.

6.4.2.1.3 Calculation conditions for Table 10

The wall thicknesses shown in the table are calculated using the following:

— maximum design factor f_o shall be 0,45;

— z is taken as 1 for equipment subject to destructive and non destructive testing which confirm that the whole series of joints show no significant defects;

  — for equipment subject to random non destructive testing, z is taken as 0,85;

  — for equipment not subject to non-destructive testing other than visual inspection, z is taken as 0,7;

— $R_{t0,5}$ is taken as 240 N/mm^2 (from material specification);

— external corrosion allowance taken as:

  — carbon steel 2 mm;

  — stainless steel 0 mm;

— supported in accordance with 6.6.6, or else laid in an open trench;

— measures to prevent additional loads affecting the pipe, for example crossings with roads and railway tracks;

— service temperature between - 20 °C and 40 °C;

— no other loads other than those in the note in Table 17, and the depth of cover is not to exceed 3 m;

— no corrosive components in the gas;

— no pipe bends made on the user's site with a radius smaller than 20 D_0 (outside diameter), nor any such bends where DP exceeds 10 bar.

In other cases, the wall thickness shall be calculated in accordance with EN 1594 or EN 12007-3 or EN 13480-6 for buried pipes and in accordance with EN 13480-3 for above-ground pipework. In all cases the design factor of 0,45 is recommended for use.

Table 10 — Minimum wall thickness of steel pipes as a function of diameter and DP

Nominal pipe diameter (DN)	**Outside diameter** mm	**Minimum wall thickness** mm											
		DP bar											
		≤ 1	≤ 10	≤ 16	≤ 25	≤ 40	≤ 50	≤ 60	≤ 16	≤ 25	≤ 40	≤ 50	≤ 60
		Material											
		Carbon steel welded and seamless							Stainless steel welded and seamless				
		Smooth (threaded)	Smooth (threaded ≤ 5 bar)	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth				
15	21,3	2,6 (3,2)	2,6 (3,2)	2,6	3,6	3,6	3,7	3,7	2,6	2,6	2,6	2,6	2,6
20	26,9	2,6 (3,2)	2,6 (3,2)	2,6	3,6	3,6	3,9	3,9	2,6	2,6	2,6	2,9	2,9
25	33,7	2,6 (3,2)	2,6 (3,2)	2,6	3,6	3,6	4,5	4,5	2,6	2,6	2,6	3,2	3,2
40	48,3	2,6 (3,2)	2,6 (3,2)	2,6	3,6	3,6	5,0	5,0	2,6	3,6	3,6	3,6	3,6
50	60,3	2,9 (3,6)	2,9 (3,6)	2,9	3,6	3,6	5,6	5,6	2,9	3,6	3,6	4,0	4,0
65	76,1	2,9	2,9	2,9	3,6	3,6	5,2	5,6	2,9	3,6	3,6	5,0	5,0
80	88,9	3,2	3,2	3,2	3,6	4,0	5,6	5,6	3,2	3,6	3,6	5,6	5,6
100	114,3	3,6	3,6	3,6	3,6	4,5	6,3	6,3	3,2	3,6	3,6	6,3	6,3
125	139,7	4,0	4,0	4,0	4,0	5,6	6,6	6,6	3,6	4,0	4,0	6,3	6,3
150	168,3	4,5	4,5	4,5	4,5	5,6	7,1	7,1	4	4,5	5,0	7,1	7,1
200	219,1	5,9	5,9	6,3	6,3	7,1	8,0		4,5	6,0	6,3	8,0	
250	273,0	6.3	6,3	7,1	7,1	8,0	10,0		5	6,3	8,2	10,0	
300	323,9	7,1	7,1	8,0	8,0	8,8	-		5,6	6,3	9,5	-	

Table 10 *(continued)*

Nominal pipe diameter (DN)	**Outside diameter** mm	**Minimum wall thickness** mm											
		DP bar											
		≤ 1	≤ 10	≤ 16	≤ 25	≤ 40	≤ 50	≤ 60	≤ 16	≤ 25	≤ 40	≤ 50	≤ 60
		Material											
		Carbon steel welded and seamless							Stainless steel welded and seamless				
		Smooth (threaded)	Smooth (threaded)	Smooth (threaded)	Smooth	Smooth	Smooth	Smooth	Smooth				
350	355,6	7,1	7,1	8,0	8,0	10,0	-		-	-	-	-	
400	406,4	7,1	7,1	8,8	8,8	-	-		-	-	-	-	
450	457,2	7,1	7,1	10,0	-	-	-		-	-	-	-	
500	508,0	7,1	7,1	10,0	-	-	-		-	-	-	-	

6.4.2.2 Copper pipes

6.4.2.2.1 General

The wall thickness and DP of copper pipes shall be in accordance with Table 11.

Table 11 — Wall thickness for copper pipework

DP ≤ 10 bar	
Outside diameter[a] mm	**Wall thickness** mm
12/15/18/22	1,0
28/42	1,5
54/64/76,1/88,9	2,0
[a] For tolerance, see EN 1057.	

6.4.2.2.2 Calculation of the wall thickness

The minimum wall thickness is calculated as follows:

$$T_{\text{min}} = \frac{DP \times D_{\text{a}}}{1\,000 + DP}$$

where

T_{min} is the calculated minimum wall thickness, in millimetres (mm);

DP is the design pressure, in bar;

D_{a} is the average diameter of the pipe, in millimetres (mm);

1 000 is factor resulting from calculation constant 20 (bar $\times$ mm^2), from special tensile strength, R = 200 N/mm^2 and a safety factor of 4.

6.4.2.2.3 Limits for using copper pipework given in Table 11

The wall thicknesses shown in the table are calculated using the following:

— supported according to 6.6.6.3;

— only above-ground;

— no internal and external corrosion allowance;

— bends made at the user's site shall be made according to the pipe manufacturer's instructions;

— no external loadings.

6.4.2.3 PE pipes

6.4.2.3.1 General

The DP corresponding to the wall thickness and the material shall be selected according to Table 12.

Table 12 — DP for PE pipe

	PE 80 bar	**PE 100** bar
SDR 11	8	10
SDR 17,6	5	6

NOTE At the time of publication of this standard, PE 80 products are only available up to 5 bar.

6.4.2.3.2 Selection of the standard dimension rate (SDR)

The SDR ratio shall be calculated according to the following formulae:

$$\text{SDR} = \frac{20\ MRS + DP \times C \times D_F}{DP \times C \times D_F}$$

where

DP is the design pressure, in bar;

MRS is the minimum required strength, in N/mm^2;

C is overall service (design) coefficient;

SDR is standard dimension ratio $\approx \frac{D}{T}$;

D is the nominal outside diameter;

T is the nominal wall thickness;

D_F is the derating factor.

NOTE The derating factor is a coefficient, which takes into account the influence of the operating temperature. Temperature derating coefficients are given in Table 13.

Table 13 — Temperature derating coefficients

Temperature °C	**Derating coefficient**
Up to/including 20	1,0
20 to 30	1,1
30 to 40	1,3

PE pipes are available in a standardised SDR series. In order to select the right standardised SDR series, the first value of SDR series lower than the calculated value shall be selected.

EXAMPLE Calculated value of SDR is 17,2. The first lower series is SDR 11 (see Table 12).

6.4.2.3.3 Limits for using PE pipe in the SDR Series

The conditions that apply to the standard SDR series are:

— The overall design coefficient shall be greater than or equal to 2 based on the DP of the SDR series.

— The ratio of critical RCP pressure (P_{RCP}) to DP shall be greater than or equal to 1,5. P_{RCP} is the critical pressure level at which a rapid crack propagation (RCP) can occur in a pipe, defined at a reference temperature. The critical RCP pressure is based on a temperature of 0 °C (see EN 12007-2).

NOTE Where the pipe temperature is below 0 °C, the P_{RCP}/DP ratio should be recalculated in accordance with EN 1555-5 using a value of RCP pressure determined from the minimum expected operating temperature of the pipe. If necessary, the value of DP should be reduced so as to maintain the P_{RCP}/DP ratio at a value greater than or equal to 1,5.

— Bending on site shall be in accordance with 8.10.2.

— Pipe trench filling should be in accordance with 8.9.4.

— Pipework is normally to be buried.

6.5 Safety engineering

6.5.1 Principles of pipework

The pipework design shall take account of any future requirements for inspection and repair.

Above ground pipework shall be protected against mechanical damage.

The number of joints shall be kept to a minimum.

Where pipes are subject to vibration, flexible hoses shall be used unless other means of removing the effects of the vibration are employed. Flexible connections and fittings shall be in accordance with EN ISO 10806 or EN ISO 10380.

Gas pipework which is subject to temperature variations that could lead to excessive stresses shall incorporate means such as bellows or other expansion joints to remove those stresses. This is not normally needed where the temperature variation is less than 60 K. Bellows shall be in accordance with ISO 15348.

Compression joints shall be suitable for the application and should not be used as part of the main supply pipework. However, PE to steel transition fittings may be used.

Twin ferrule type joints may be used for applications above 5 bar for steel instrumentation and ancillary pipework.

6.5.2 Isolation of the gas supply

6.5.2.1 Isolation in an emergency

A quick-acting manual isolating valve shall be installed in the pipework at a readily accessible position for use in an emergency.

The isolating valve shall be fitted in the pipework at one of the following readily-accessible locations and its location visibly indicated:

— before the point of entry into a building – in this case, it shall be possible to operate the valve at a distance of;

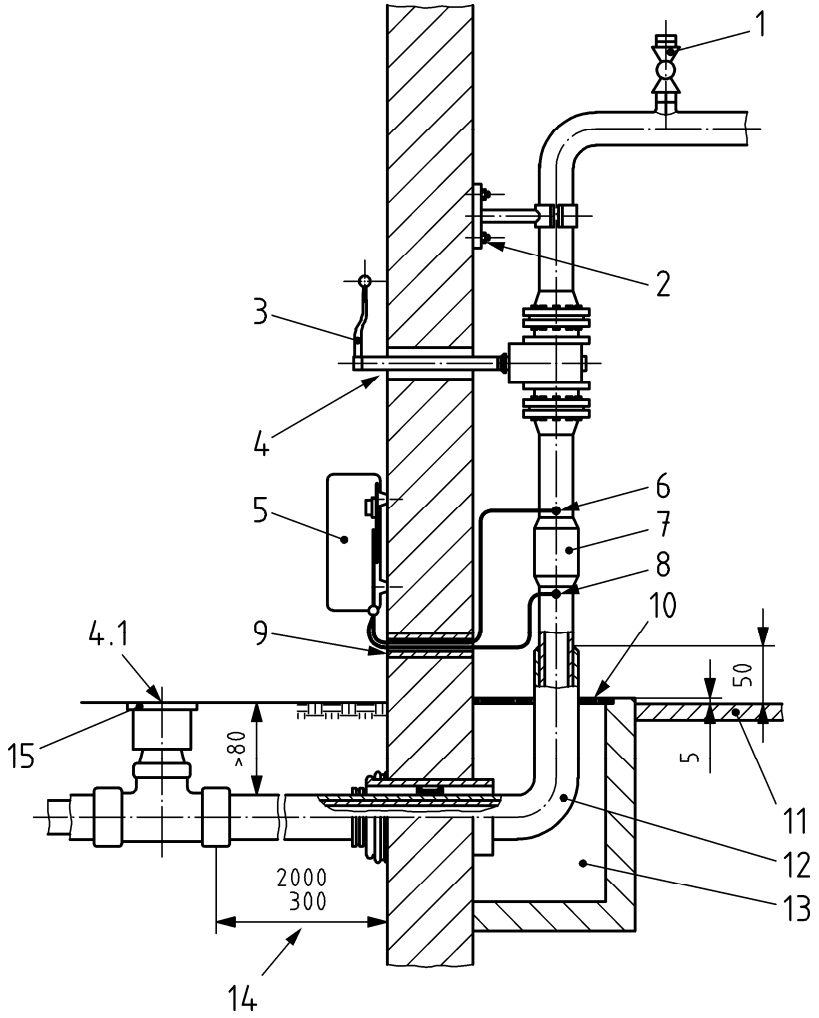
  — for buried valves, no more than 20 m and preferably more than 1 m from the building or installation; consideration should be given to the potential for gas leakage from joints near to buildings;

  — for above ground valves, no more than 20 m from the building or installation;

— immediately after the point of entry in a building – in this case, it shall be possible to operate the valve close to the entrance on the outside of the building.

Buried valves shall not be located in any area where vehicular parking can occur.

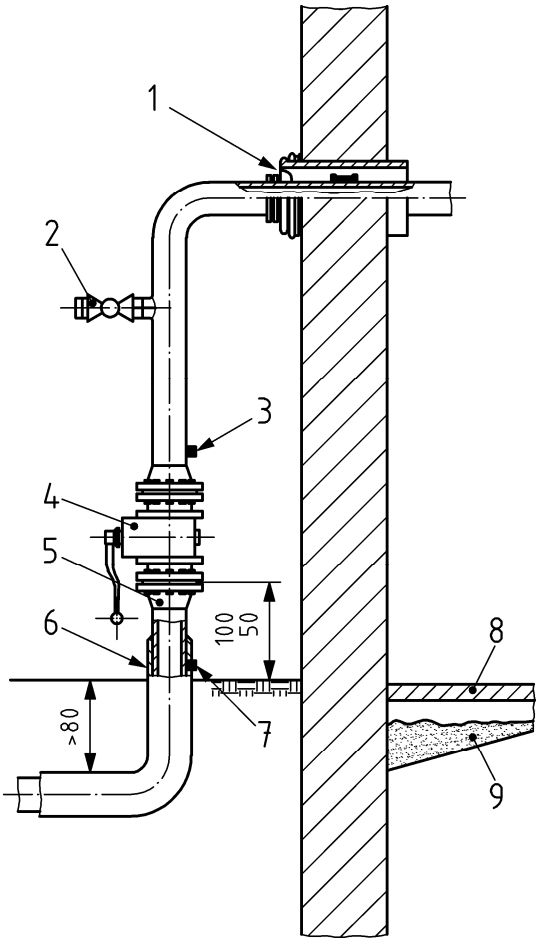
Examples are given in Figure 1 and Figure 2.



Key

1 Discharge valve
2 Wedge bolts
3 Lever
4 Quick-closing valve within hand reach
4.1 Buried valve with assembly components
5 Synthetic terminal box (watertight)
6 Cathodic protection (CP) measuring point
7 Insulating joint
8 CP measuring point
9 PVC pipe sleeve
10 Ventilating cover
11 Floor
12 Coating to be extended
13 Pit
14 Centred plastic pipe sleeve with gastight wall passage
15 Surface box

Figure 1 — Example of an underground pipe transit entering a building



Key

1	Wall passage with watertight pipe sleeve	6	Coating to be extended
2	Discharge valve	7	Measuring point
3	Measuring point	8	Floor
4	Manually operated valve	9	Clean sand
5	Ebonited insulation flange (single) combined with valve		

Figure 2 — Example of an above-ground pipe transit entering a building

6.5.2.2 Isolation to enable work to be performed

Manually operated valves shall be fitted in gas installation to enable the installation to be operated and inspected, and to allow maintenance work to be performed safely.

A means shall be provided to verify the isolating valves are gas tight before any pipework is removed. The use of blind flanges, spectacle flanges or double block valve seats should be considered.

The use of lockable valves should be considered.

6.5.2.3 Reverse flow

Where more than one gaseous media is employed in pipework, a means of protection of reverse flow of extraneous gases into the pipework shall be provided.

6.5.3 Location of pipework

All spaces containing pipework with joints (other than welds) and components shall be adequately ventilated. Particular attention shall be paid to the low level ventilation of spaces where gases heavier than air are being distributed.

Where gas pipework is installed in unventilated spaces and it is totally welded or is a radiographic/non destructive examination of the welds shall be performed on all welded joints of nominal diameter DN equal to or greater than 50 and OP greater than 2 bar.

6.5.4 Supporting structures

Pipes shall not be used as an active part of supporting structures or as a reinforcement for such structures.

6.5.5 Depressurising and purging

For systems greater than 50 DN and above 1 bar, provision shall be made for depressurising and purging, via temporary or permanent vent pipe. For this purpose, the pipe or pipe section shall be provided with a connection at both ends, one for evacuating the fuel gas and the other for introducing the purge gas. It is preferable for the connections to be arranged such that the purge gas flows in the opposite direction to the normal flow of fuel gas.

The connections shall be suitably sized to permit the correct purge rate. For information on purging criteria see EN 12327.

Specific valves for purging and testing shall be sealed with a purpose made fitting.

6.6 Detail engineering

6.6.1 Pipe transits

Pipework which passes through walls or floors shall be protected by pipe sleeves. The pipe sleeve shall:

— be made of suitable material e.g. PE, steel or copper;

— be passively protected internally and externally against corrosion, if made from steel;

— not make metal-to-metal contact with the pipe;

— protrude beyond the finish of a wall by at least 25 mm or of a floor by at least 50 mm to avoid the admittance of moisture and flushing water;

— not impair the fire resistance of the structure; where the spaces have requirements for fire resistance, sleeves shall be suitably sealed to the structure and the pipe to prevent the transmission of fire or smoke;

— whether above or below ground, be designed to permanently insulate the pipe electrically from conductive elements in the structure, such as concrete reinforcement.

No special provisions are required for pipe transits through solid interior walls, provided the pipe is not bricked-in and a gap of approximately 30 mm is left around the pipe, unless the wall has a fire protection function.

No joints, other than welded joints shall be located within pipe sleeves.

6.6.2 Branches in steel pipes

Branches should preferably be formed using tees with dimensions in accordance with EN 10253-2.

Branches constructed using preformed manufactured fittings shall comply with Table 14. Examples of such fittings are shown in Figure 3.

A branch not constructed using a preformed manufactured fitting can be up to half the diameter of the main pipe, with a maximum of DN 25 if executed without reinforcement as shown in Figure 5 and a maximum of DN 50 if executed with reinforcement as shown in Figure 6 or using a weldolet fitting.

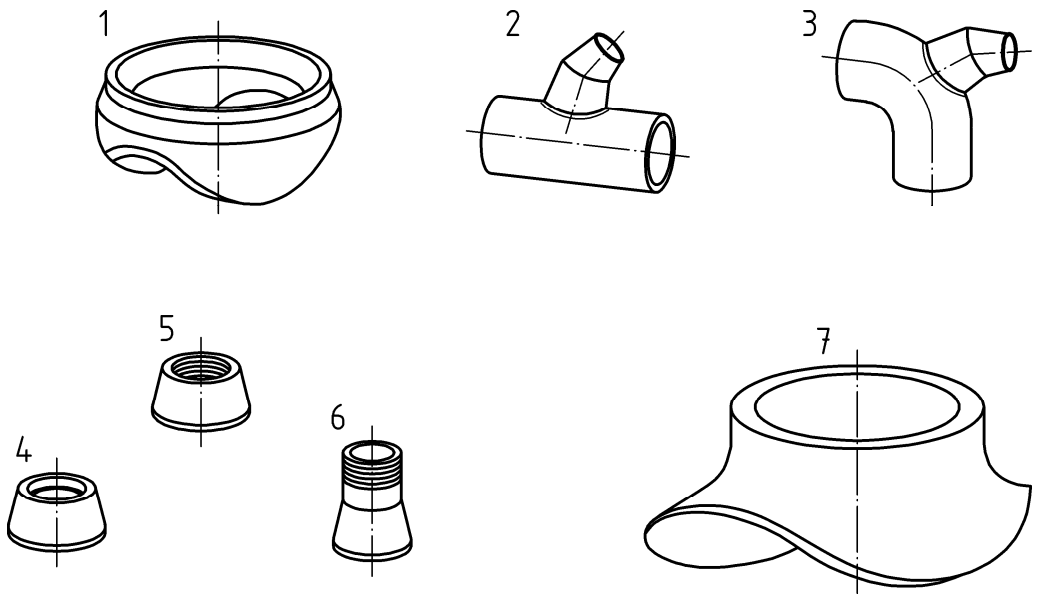
Branches made on existing pipework which cannot be taken out of service shall be made with a split tee, branch or welding stub. The construction of such branches is covered by the hot-tapping procedure described in 6.7.

Table 14 — Standardised branches for carbon steel pipes

Main pipe diameter DN mm	**Branch pipe diameter** mm												
	15	20	25	40	50	80	100	150	200	250	300	350	400
400	c	c	c	c	d	d	d	d	b	b	b	b	a
350	c	c	c	c	d	d	d	d	b	b	b	a	
300	c	c	c	c	d	d	d	b	b	b	a		
250	c	c	c	c	d	d	d	b	b	a			
200	c	c	c	c	d	d	b	b	a				
150	c	c	c	c	d	b	b	a					
100	c	c	c	c	b	b	a						
80	c	c	c	c	b	a							
50	c	c	c	c	a								
40	b	b	b	a									
25	b	b	a										
20	b	a											
15	a												

a = Tee
b = Reducing tee
c = Nipolet, threadolet, sockolet, elbowlet
d = Weldolet, sweepolet

See Figure 3 for examples of standard carbon steel pipe fittings.

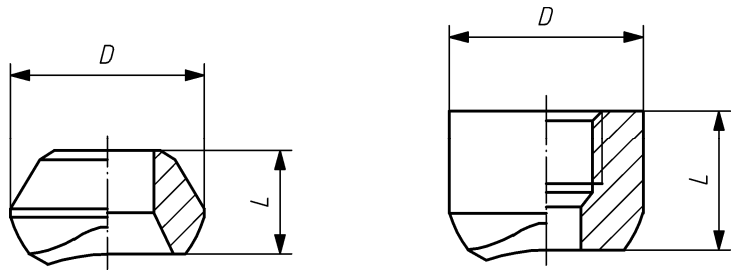


Key

1 Weldolet
2 Latrolet
3 Elbolet
4 Sockolet
5 Thredolet
6 Nipolet
7 Sweepolet

Figure 3 — Examples of standard carbon steel branch fittings

For DP's over 16 bar, only welding stubs which are suitable for the diameter of the main pipe shall be used. For dimensions, see Figure 4.

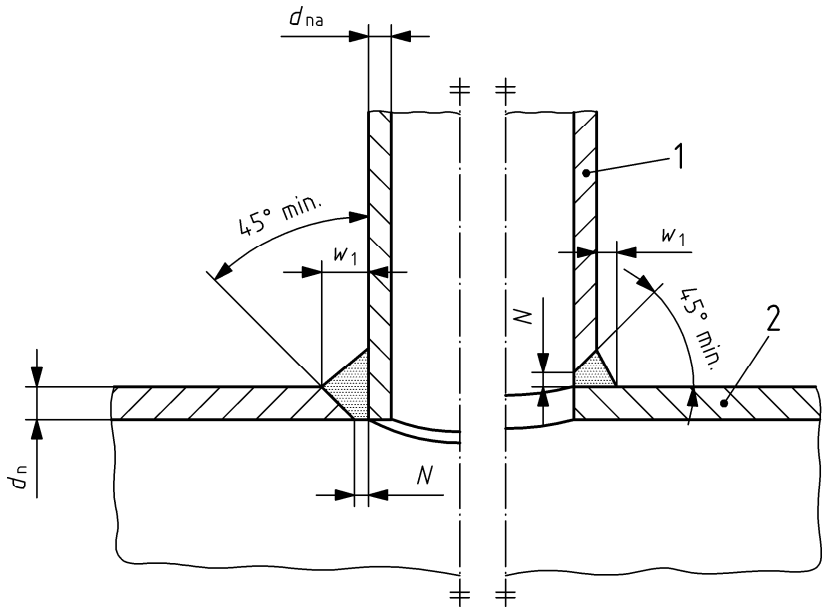


	Weldolet						Threaddolet		
DN	15	20	25	50	80	100	15	20	25
Diameter D (mm)	34,2	40,8	54,7	90,5	127,9	158,3	34,2	40,8	54,7
Length L (mm)	25,7	29,7	39,9	60,5	80,3	94,6	44,8	49,9	60,9

Figure 4 — Branch fittings

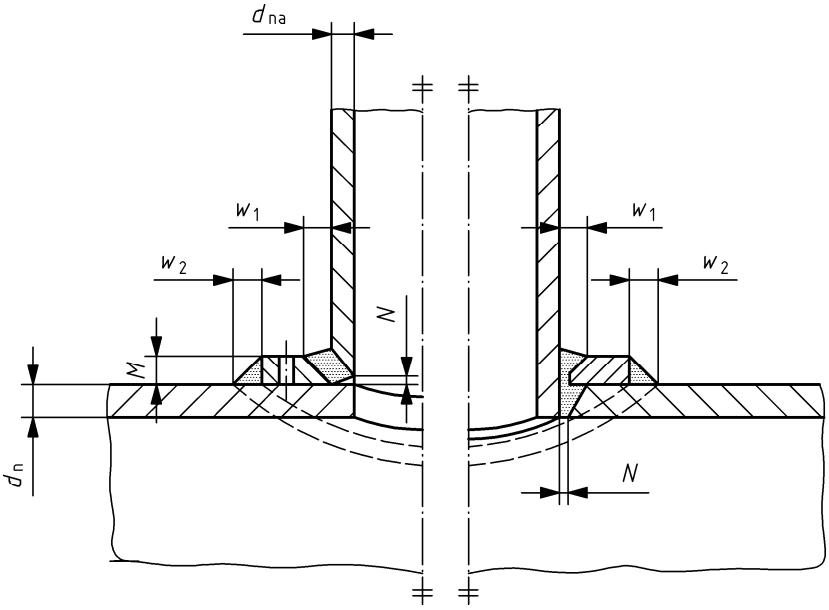
If the manufacturer guarantees the strength of standardised branches in accordance with Table 14 and Figure 4 for the desired minimum DP, a strength calculation is not required.

For strength calculations, EN 13480-3 shall be used.



Key
1 Branch
2 Continuing pipe (header)
w_1 = 0,38 d_{na} with a minimum of 6 mm
N = 1,6 mm to 3,2 mm (except where a backing weld or backing strip is used)

Figure 5 — Alternative weld configurations for branches without reinforcement other than that provided by the wall thickness of the through pipe and the branch



Key
w_1 = 0,38 d_{na} with a minimum of 6 mm
w_2 = 0,5 M with a minimum of 6 mm
N = 1,6 mm to 3,2 mm (except where a backing weld or backing strip is used)
All weld profiles shall be isosceles triangles with a minimum throat dimension of at least 0,7 times the length of the sides.
If M is thicker than d_n, the thickness of the reinforcement shall be reduced to the wall thickness d_n of the through pipe.

A small hole shall be provided in the reinforcement to facilitate detection of leakage through the weld during the pressure test and to allow venting during welding and, where applicable, heat treatment.
If the reinforcement consists of two pieces, the welded fitting shall be at right angles to the axis of the through pipe.

Figure 6 — Alternative weld profiles for branches with local reinforcement

6.6.2.1 Branches in Copper Pipes

Branches in copper pipes shall be constructed using appropriate fittings (EN 1254 i.e.).

6.6.3 Off-take connections made of straight pipes for DP up to and including 16 bar

Fabricated off-take connections made of straight pipes with nominal wall thickness equal to those given in Table 10 do not require any further design calculation, where the nominal diameter of the off-take does not exceed the appropriate value given in Table 15 and where the main pipe and off-take are of the same material specification. In all other cases, design calculations shall be undertaken.

Table 15 — Maximum nominal flange diameter of pipes for off-takes

	Nominal diameter DN								
Main pipes	100	125	150	200	250	300	350	400	500
DP	5 bar								
Material	EN 10208-1- L210, L240, L290,L360								
Off-take branch	100	125	150	200	250	300	350	400	500
DP	16 bar								
Material	EN 10208-1- L210								
Off-take branch	100	125	150	200	150	150	125	150	80
Material	EN 10208-1- L240								
Off-take branch	100	125	150	200	250	250	200	200	125
Material	EN 10208-1- L290								
Off-take branch	100	125	150	200	250	300	350	400	200
Material	EN 10208-1-L360								
Off-take branch	100	125	150	200	250	300	350	400	400

6.6.4 Joints

6.6.4.1 General requirements for joints

The number of mechanical joints in pipework shall be kept to a minimum.

The following are preferred:

— all-welded pipe joints for steel;

— butt fusion/electrofusion for PE;

— all brazed for copper joints;

— flanged and threaded joints for ancillaries;

— ancillaries with welding ends.

6.6.4.2 Flanged joints

6.6.4.2.1 Use of flanged joints

Flanges shall be welded in accordance with 8.5.1.10.

Slip-on steel flanges are permitted up to DN 150 and 16 bar. They shall be welded at both ends and inspected visually.

Flanges on PE-pipes shall be made using the appropriate jointing material.

6.6.4.2.2 Nuts and bolts

Nuts and bolts for carbon steel and PE flanges shall be selected in accordance with Table 16. For stainless steel flanges, EN 1515-2 shall be considered. Nuts and bolts for flanges of other materials shall have the normal commercial quality.

In situations where vibration can occur, the nuts shall be effectively locked.

Table 16 — Nuts and bolts for carbon steel and PE flanged joints

Standard	DP bar	Nominal diameter mm	Bolt/stud grade	Nuts
EN 1515-1 and EN 1515-2, EN ISO 898-1 EN 20898-2	≤ 1	> 150	≥ 5,6	Nuts may be one grade lower to prevent thread pick-up.
	≤ 4	> 125		
	≤ 6	> 125		
	≤ 10	> 100		
	≤ 16	> 65		
	> 16	All	≥ 8,8	

In exceptional cases where smaller diameter bolts are used for insulating flanges, they shall be of sufficiently higher grade so that at least the same force can be applied.

6.6.4.2.3 Flange gaskets

Gaskets in flanged joints shall be used according to EN 1514-1, EN 1514-2, EN 12560-1 and EN 12560-2.

Metal gaskets shall not be used on nodular/spheroidal graphite cast iron flanges.

6.6.4.3 Threaded joints

Threaded joints in steel pipe shall be minimised and are only permitted up to DN 50 for pressures up to 5 bar and DN 25 for pressures above 5 bar. The type and quality of the thread shall be suitable for the DP rating of the pipework.

6.6.4.4 Joints between different materials

Pipe sections of different materials should preferably be connected with a flanged joint. PE to steel connections shall be performed using transition fittings.

6.6.5 Ancillaries

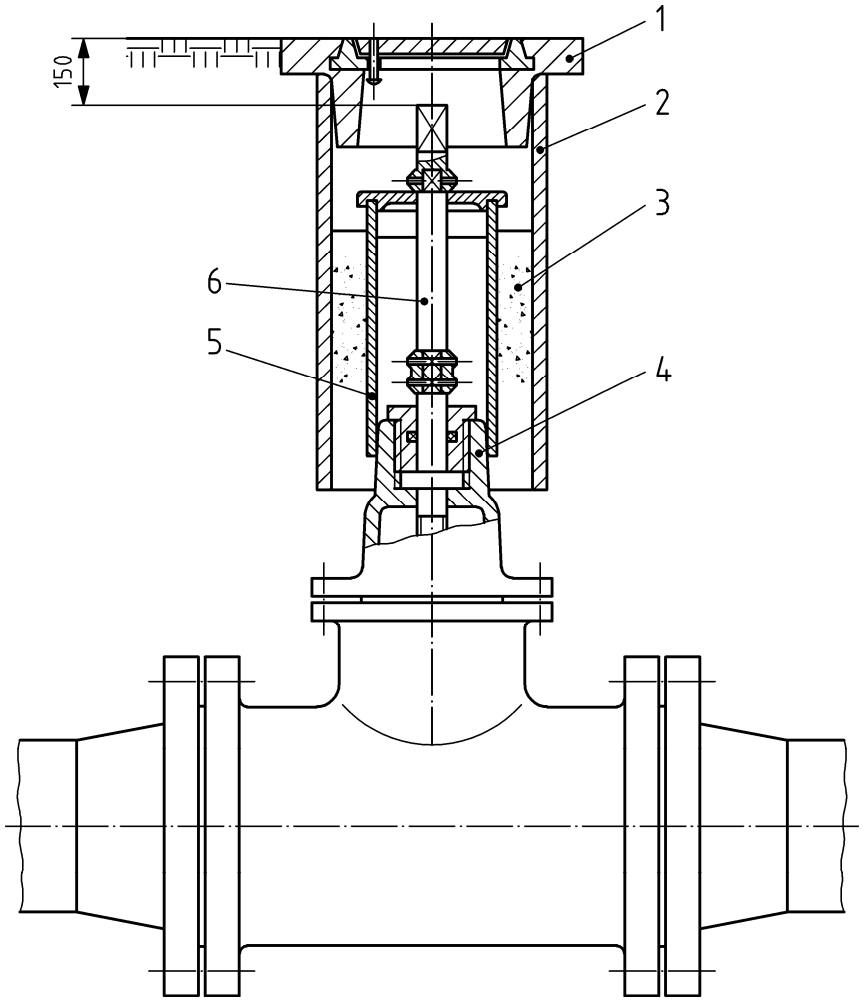
6.6.5.1 Spheroidal graphite/nodular iron

No welding shall be performed on these materials.

6.6.5.2 Underground isolating valves

Underground isolating valves shall be fitted with an extension shaft accessible from a surface box in accordance with Figure 7.

An identification plate shall be placed in an appropriate position, and as near as practicable, to identify the position of the surface box. Surface boxes should be identifiable e.g. by colour yellow.



Key

1	Surface box	4	Valve cover
2	Thick-walled plastic pipe	5	Plastic protection pipe
3	Clean sand	6	Extension spindle

The sealing between 4 and 5 is water tight.

Figure 7 — Underground isolating valve with surface box

6.6.5.3 Above ground isolating valves

Above ground isolating valves shall be located in a safe and accessible location, near to the buildings they serve, see also 6.5.2.1.

6.6.5.4 Appliance isolating valves

It shall be possible to shut off each gas appliance with its own quick-acting isolating valve.

6.6.6 Above ground pipework inside and outside buildings

6.6.6.1 General

Pipe supports shall be provided throughout the length of above-ground pipework and in such a manner as will permit thermal movement without causing damage to any applied corrosion protection.

NOTE The linear coefficient of expansion of carbon steel is approximately 0,011 mm/m per K or 0,017 mm/m per K for copper.

Where PE pipe outside a building is not buried, horizontal sections shall be continuously supported throughout their length and vertical sections shall be adequately supported. PE pipes, fittings and valves installed above ground shall be protected against mechanical interference and UV degradation. Incoming and outgoing PE pipes for connection to steel pipe shall be placed within a fire resistant sealed sleeve when above ground.

Pipe support shall be able to withstand the full weight of the pipe, any end thrusts and any water used when in-situ hydrostatic testing is envisaged.

In above-ground pipe transits through outside walls, the above-ground section of the pipe shall be supported, if necessary.

Some typical pipe supports are shown in the figures in Annex D.

6.6.6.2 Stress calculations for metallic pipes

If necessary, stress analysis shall be carried out according to the properties of the specific materials, reference may be made to EN 13480-3.

According to EN 13480-3, no formal analysis of adequate flexibility is required for pipework which meets one of the following criteria:

— duplicates or replaces without significant change a system operating with a satisfactory service record;

— can readily be judged adequate by comparison with previously analysed systems;

— is of uniform size, has no more than two anchors and no intermediate restraints or other movement controlling devices, and is designed for a service of not more than 1 000 full cycles and satisfies the following empirical equation:

$$\frac{D_0 Y}{(L-l)^2} \leq 208{,}3 \qquad \text{[EN 13480-3:2002, 12.2.10.1, for steel]}$$

where

D_0 is the nominal outside diameter of the pipe (mm);

Y is the resultant of movements to be absorbed by pipework;

L is the developed length of pipework between anchors (m).

NOTE For example, L would be the total length of a 'U' shaped expansion loop l is the anchor distance (length of straight line joining anchors) (m).

The formula given is an example of an acceptable simplified method of analysis.

No general proof can be offered that this equation will yield accurate or consistently conservative results. It was developed for ferrous materials and is not applicable to systems used under severe cyclic conditions. It should be used with caution in configurations such as unequal leg U-bends ($L/l > 2,5$), or near straight "saw-tooth" runs, or for large diameter thin-wall pipe, or where extraneous displacements (not in the direction connecting anchor points) constitute a large part of the total displacement. There is no assurance that terminal reactions will be acceptably low, even if the pipework falls within the above limitations.

6.6.6.3 Supporting horizontal metallic pipework

Pipework shall be secured by brackets in a stress-free condition. To this end, the pipework shall be supported in particular at valves, bends and expansion areas. Where the pipework is flexibly suspended, lateral support shall be provided at regular intervals. Corrosion of the pipe at supports shall be prevented.

The maximum distance between the supports for horizontal steel pipes is given in Table 17. If the permissible support spacing is exceeded, it shall be demonstrated by calculation that this is acceptable.

For diameters of less than 25 mm and copper pipes of up to 28 mm, the distance between the supports shall be less than 60 times the outside diameter. For copper pipes over 28 mm, the distance between the supports shall be less than 40 times the outside diameter.

Table 17 — Maximum support spacing for steel pipes

Nominal pipe diameter mm	**Maximum support spacing** m	**Load per support** N
≤ 25	1,5	500
40	3,0	1000
50	4,0	1250
65	4,5	1 500
80	5,0	2 000
100	6,0	3 000
125	7,5	4 500
150	8,5	7 000
200	10,0	15 000
250–500	12,0	20 000

NOTE 1 This table takes no account of the load imposed by ancillaries.

NOTE 2 The following loads have been used as the basis for calculating the support distances:

a) weight of pipe;
b) weight of water filling, where appropriate (i.e. where hydraulic testing is expected);
c) load given by a and b multiplied by a factor of 2 for snow loading and load imposed by insulating material;
d) body weight of a person centrally between two supports. This load is included from a nominal pipe diameter of 80 mm upwards:
   - thermal load, ambient temperature, temperature difference 40 °C
   - bending stress in the pipe wall ≤ 110 N/mm^2
   - deflection ≤ $\frac{L}{300}$, where L is the distance between supports

NOTE 3 When calculated, other support spacing may be used. Closer spacing will reduce load per support.

6.6.6.4 Supporting vertical metallic pipework

The weight of the vertical section shall be carried by the supports and fasteners which can be in the vertical or horizontal sections.

6.6.6.5 Positioning adjacent to floors

Pipework shall be located at least 50 mm above any finished surface to permit safe access for maintenance.

6.6.6.6 Appliance Connection

The following shall be used to connect gas appliances, compressors, engines, etc:

— threaded steel pipe up to DN 50 and up to 5 bar OP;

— seamless or welded steel pipe;

— copper tube;

— a short length of flexible connection [flexible appliance connector].

Flexible appliance connectors may be incorporated:

— to accommodate movement of gas appliances;

— to connect movable appliances;

— to connect appliances that can generate vibrations.

Where flexible connectors are used, a nearby upstream means of isolation shall be provided. This may be the appliance isolation valve.

Reference should also be made to relevant appliance standards.

6.6.6.7 Electrical interference

The pipework shall be protected against effects of stray currents by appropriate measures.

EXAMPLE 1 Stray currents caused by railways.

Influences associated with the proximity of high-voltage power transmission cables shall be taken into account because of safety reasons.

EXAMPLE 2 For the protection of the pipeline and the safety of individuals.

6.6.7 Buried pipework

6.6.7.1 Distance between gas pipework and other buried systems

The distance between gas pipework and other systems in Table 18 shall be complied with. Smaller distances may be acceptable if other precautions are taken.

If the prescribed minimum distance cannot be achieved at an intersection, measures shall be taken to prevent mutual contact (through settlement or subsidence) and consequent damage of any protective coating. Also, to prevent interference at the point where the gas pipe crosses another metallic conductor, an insulating plate shall be placed halfway between the two systems. The insulating plate, each side of which shall be equal to the diameter of the conductors plus 1 m, shall be made of non-absorbent plastic approximately 10 mm thick.

Where the gas pipe crosses non-gas tight systems (such as sewers) measures shall be taken to prevent leaking gas penetrating them. If an adequate spacing cannot be obtained buried, a protecting sleeve shall be employed or the pipe shall be carried on a pipe bridge. In the case of cathodic protected pipework, the requirements of EN 12954 shall be met.

The distance between a PE gas pipe and a hot pipework shall be sufficient to ensure that the surface temperature of the gas pipe cannot exceed 20 °C. At temperatures above 20 °C, the DP rating of PE pipe is reduced (see EN 1555-5).

Special consideration shall be given to the distances of metallic pipework from other hot pipework.

Table 18 — Minimum distances between buried gas pipework and other systems

Crossing or running in parallel with	Preferred crossing configuration	Minimum distance m
Low-voltage electric cables	No preference	0,25
Sewers, pipework or tanks containing corrosive media	Gas pipe above	Crossing: 0,25 Parallel: 1,5 PE pipe may be 0,3 where solvents are not present
Metal pipes	Gas pipe above	Crossing: 0,25 Parallel: 0,5
Plastic pipes (other than sewers or pipes carrying corrosive media)	Gas pipe above	Crossing: 0,25 Parallel: 0,3
Ditches and other open systems	No preference	Crossing: 0,25 Parallel: 0,5 Underwater crossing: minimum cover 0,6
Other buried structures except buildings	No preference	0,5
High-voltage power transmission cables	No preference	Crossing 0,5 Parallel 0,5 [Consideration should be given to induced currents for buried and overhead power cables]
Insulated high temperature steam/water pipes [see text above for temperature affects].	Gas pipe above	Crossing 0,3 Parallel 0,3

6.6.7.2 Support for valves and other ancillaries in buried pipework

Where necessary, valves and pipe fittings in buried pipework shall be anchored such that no unacceptable stresses can be transmitted to the pipework during normal operation or actuation of valves or other ancillaries.

6.6.7.3 Depth of cover

The depth of cover shall be at least 0,5 m. For pressures above 5 bar DP, increased depths of cover shall be considered. The depth of cover may be reduced provided that measures are taken to limit the risk of external mechanical damage to the pipe and any protective coating.

6.6.7.4 Precautions at crossings with on-site roads and on-site rail tracks

Depending on the situation, at least one of the requirements below shall be met at crossings with site roads or site rail tracks:

— depth of cover over the pipework of at least 1 m;

— a row of concrete slabs approximately 1 m wide laid above the pipework at 0,3 m to 0,5 m below ground level;

— increased pipe wall thickness to accommodate increased external loading calculated in accordance with EN 1594.

Alternatively, the pipe crossing may be installed in a protecting sleeve, taking due consideration of any cathodic protection requirements for the pipework, see EN 12954.

6.6.7.5 Protection of stainless steel pipework

Stainless steel pipes and fittings shall be sufficiently protected, see 8.8.3.1.2.

6.6.7.6 Insulating joints

The buried and above-ground sections of metal (copper, carbon steel and stainless steel) pipework shall be galvanic isolated from each other by insulating joints or ebonited insulating flanges. This separation should be made above-ground at no more than 0,5 m above ground level or at the point of entry into a building in accordance with 8.3. Electrical test points shall be provided on both sides of the insulator. Care shall be taken to ensure that no unintended bridging of insulating joints is possible.

To avoid damage to insulating joints resulting from high voltage due to lightning or earth currents caused by electric power lines, installing protective devices (e.g. an appropriate spark arrestor) should be considered.

If an insulating joint is to be installed in areas classified as hazardous in accordance with EN 60079-10, it is essential that it conforms to the certification and operational requirements of the zone.

6.6.7.7 Support for buried pipework

Buried pipework shall be supported in such a way that, during his lifetime, the pipework will not move with respect to its initial installed position, except for foreseen permitted displacements.

6.6.7.8 Impermeable surfaces

Facilities can be required in finished surfaces for gas leakage monitoring.

6.6.8 Wall thickness related to bending of steel pipes

The minimum required wall thickness (without allowances and tolerances) of bends shall be calculated by the following:

— On the inside surface of the bend

$$t_{\text{int}} = t\frac{(R/D_0) - 0{,}25}{(R/D_0) - 0{,}5}$$

— On the outside surface of the bend

$$t_{ext} = t\frac{(R/D_0)+0{,}25}{(R/D_0)+0{,}5}$$

where

t is the minimum required thickness (without allowances and tolerances);

D_0 is the outside diameter;

R is the bend radius;

t_{int} is the minimum required thickness (without allowances and tolerances) for a bend on the inside surface of the bend;

t_{ext} is the minimum required thickness (without allowances and tolerances) for a bend on the outside surface of the bend.

6.6.9 Provision for expansion and flexibility

The use of flexible hoses and bellows shall be kept to a minimum in view of their vulnerability and the risk of leakage which they present.

Provision for expansion shall be considered:

— in buried pipework if there is a risk of subsidence;

— in buildings and external pipework if the pipework is not sufficiently flexible to accommodate thermal movement.

Where there is a risk of mechanical loading exceeding the manufacturer's specifications, expansion joints of the bellows type shall be fitted with anchor points to limit expansion in the intended direction. If necessary, rubber and plastic elements shall be protected from local thermal radiation and/or mechanical damage by a metal shield.

6.7 Hot tapping carbon steel pipe

6.7.1 General

Hot tapping shall be performed in accordance with EN 12732.

6.7.2 Principles

Hot tapping is a process requiring specialist skills, experience and equipment to ensure the safety of the operation and it is used for new extensions to existing pipework under pressure.

Hot tapping is permitted on main pipe diameters from DN 50 up to and including DN 500 within the scope of EN 12732.

The minimum wall thickness of the existing pipe shall be 3,6 mm.

Ancillaries of cast iron or nodular cast iron shall not be used.

The welder shall be in possession of a valid identity card and a copy of the welder's certification.

6.7.3 Conditions

The following precautions shall be taken so that the tapping operation can be performed correctly:

— the minimum distance between the hot tapping location and any other welded joint shall be 75 mm, or $1{,}5 \times D_o$, where D_o is the outside diameter;

— the minimum distance between the hot tapping location and any other threaded or flanged joint shall 150 mm;

— the pipe wall shall be free of inclusions and/or material defects;

— if a welding stub is used, the ratio between the diameter of the gas-carrying pipe and that of the branch at the welding stub shall not exceed 2:1;

— if a split tee is used, the ratio between the diameter of the gas-carrying pipe and that of the branch at the tee shall be 1:1;

— the gas flow shall be reduced to a minimum, but not less than 0,4 m/s;

— the temperature of the flowing gas shall not exceed 40 °C.

6.7.4 Design evaluation

The design shall be submitted in advance and shall at least include:

— a construction drawing of the pipework indicating the location of the tapping;

— details of the materials to be used;

— the Welding Procedure Specification (WPS) and the Welding Procedure Approval Record (WPAR) for the welds;

— Non Destructive Testing record(s) of:

  — wall thickness measurements;

  — examination for faults due to rolling;

  — dye penetrant examination of the pipe material to detect cracks;

The evaluation procedure is as follows:

— the WPS and the WPAR for the welds are first evaluated by the welding expert;

— the design is then evaluated.

7 Design of pressure control systems

7.1 General

The pressure control system shall maintain the pressure in the downstream system within the required limits and shall ensure that this pressure does not exceed the permitted level, see Figure 8. The downstream system includes all pipework up to the next pressure boundary.

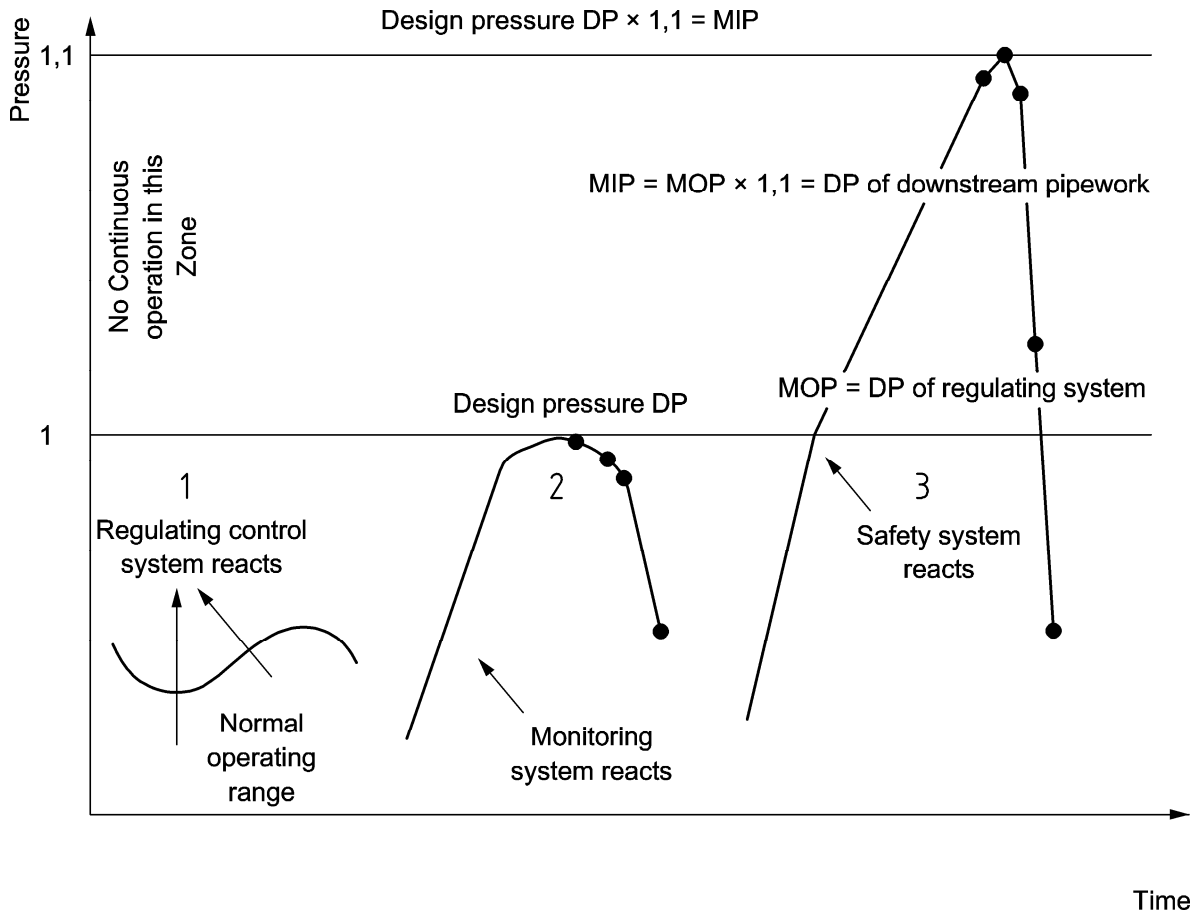


Figure 8 — Response of regulating, monitoring and safety systems in relation to DP of regulating system

Where appropriate, the functional requirements of EN 12186 or EN 12279 shall apply.

Consideration shall be given to any necessary requirements for site security to prevent unauthorised interference.

7.2 Pressure regulating system

The pressure regulating system shall maintain the pressure within limits which are acceptable for the downstream system. The set value shall not exceed the DP. However, the OP may exceed the set value due to the dynamic nature of the system. The pressure regulating system shall not allow the downstream pressure to exceed the DP of the downstream pipework, see Figure 8.

Appropriate measures by means of gas pressure safeguards shall be taken to prevent too high or too low an outlet pressure from the pressure regulating system resulting in hazardous combustion conditions.

7.3 Instrumentation

The instrumentation employed for pressure safety systems shall comply with the following requirements:

— installation: instrumentation wiring and pipework shall be dimensioned and installed having due regard for their function. The instrumentation serving the pressure safety system shall be independent from the other instrumentation. The setting of the control system which forms part of the pressure safety system shall be fixed, where necessary.

— isolation: isolation of the pressure detection components of the pressure safety system from the system which it protects is not permitted, unless it leads to a safety action.

7.4 Permanent bypasses

7.4.1 Bypasses for equalisation or testing

If a bypass is used for the equalisation of pressure across an ancillary or for testing purposes, a valve shall be installed which shall close automatically, when not manually held open.

7.4.2 Bypasses of the safety system

Safety systems shall not be bypassed. Where it is necessary to ensure continuity of supply, a parallel system should be fitted.

7.5 Construction requirements

7.5.1 Pressure resistance

Equipment, pipes, ancillaries and gasket materials of all gas pressure regulating and metering systems, gas pressure boosters/compressors and gas mixing systems shall be capable of withstanding at least the MIP.

7.5.2 Operation

All gas pressure regulating and metering systems, gas pressure boosters/compressors and gas mixing systems shall be designed such that:

a) they can be taken out of service without difficulty, including purging to gas and to air;

b) all parts are accessible for manual operation, scheduled inspection and preventive maintenance;

c) all parts can be easily removed and refitted;

d) proper working is assured under the expected normal environmental conditions;

e) there is a facility to attach an equipotential bond to earth, where required.

7.5.3 Insulating joint/flange

If the incoming and/or outgoing pipework of a gas pressure regulating and metering system, gas pressure compressor unit or gas mixing system, installed in an enclosed space, incorporates an insulating joint or pair of insulating flanges within this space, then protection shall be provided against spark-over.

7.5.4 Gas velocity

The gas velocities in any gas pressure regulating and metering system, gas pressure compressor unit or gas mixing system shall not give rise to vibration or resonance which is harmful to the installation or causes nuisance to people in the vicinity.

7.5.5 External sensing lines

Each safety device or pressure regulator shall have individual sensing lines separately connected to the protected system. The connection of the sensing lines for safety devices should be between the regulator and the first outlet isolating valve. The sensing lines should be visible for reasons of safe operation.

A valve in the sensing lines serving pressure regulators and safety devices should not be installed when the connection of the line is upstream of the first outlet isolating valve. Provisions may be made in sensing lines for switching between sensing points with a three-way valve or two interlocked valves provided that one of the sensing points is connected at all times.

The sensing point selected for regulating and safety systems should be reasonably free from turbulence and any effect resulting from changes in the gas velocity or from high gas velocities in the installation, such that a representative pressure condition is imposed on the instrumentation at all times.

Individual sensing lines may be connected to a header welded onto the inlet or outlet pipework. To ensure strength and static pressure conditions, the diameter of the header and the connection to the pipework shall be at least 40 mm or equal to the diameter of the inlet or outlet pipework.

7.5.6 Breather and vent pipes

7.5.6.1 Pressure resistance

Permanent breather and vent pipes shall be designed on the basis of the DP for the section to which the line is connected, except where restriction of the amount of gas to be vented justifies a lower DP. Breather and vent pipes shall be sized to pass the design flow, taking into account the installation conditions.

7.5.6.2 Combination of breather and vent pipes

Combined vent and breathers are not normally recommended. However, any combined system shall ensure that no interaction can occur that leads to unsafe conditions.

Vent pipes working at the same pressure may be combined provided that leakage through one or more does not affect the operation of any equipment.

Dedicated vent and depressurising pipework shall not be combined with breather pipework in a manifold. If manifolds are used for a type of vent pipe, this shall not impair the proper functioning of the connected units.

Precautions shall be taken to prevent blockage of the outlet and to protect it against the ingress of foreign material, such as water, dirt and insects.

Vent pipes for gas shall not be combined with vent pipes for air or oxygen.

Consideration should be given to the use of flow indicators on pressure relief valve vent pipes for condition monitoring in order to minimise uncontrolled release and environmental damage.

7.5.6.3 Isolation of instrumentation, breather and vent pipes

No isolating valves or high-pressure shut-off valves shall be installed in instrumentation, breather or vent pipes from pressure regulators or inlet or outlet lines from creep relief valves.

7.5.6.4 Vent and breather termination

The termination of vent pipes shall be designed to encourage the safe dispersion of the escaping gas, and prevent the ingress of water, rain, snow, etc.

The termination of breather lines shall prevent the ingress of water, rain, etc.

Terminations of vents and breathers shall be located in a safe place.

The use of a flame arrestor is not recommended.

The terminations of vents shall be considered for classification as a hazardous area.

7.5.7 Isolating valves

Manually operated isolating valves shall be fitted on the inlet to and outlet from a gas pressure regulating system or gas pressure compressor unit. The valve on regulating system outlets is optional for DN 50 or less where the flow is also less than 200 m^3/h.

7.5.8 Filter, separators

If there is a possibility of dust or liquid being entrained in the gas stream impairing the proper functioning of the equipment, consideration shall be given to a dust or liquid extraction system. The systems shall have adequate capacity based on the maximum gas flow at minimum pressure.

A strainer with a mesh not exceeding 0,6 mm should be fitted.

Filters and liquid extraction systems shall be constructed in such a way that they can be opened without risk. For liquids, a manual or automatic discharge device, if necessary with collector, should be provided.

Where fitted, filters shall:

— be installed such that contaminated filter elements are easy to replace and the filter housing is positioned such that no debris can fall back into the pipework;

— incorporate pressure tappings to enable measurement of the pressure drop across the filter.

For filters, a differential pressure gauge should be considered.

NOTE Special applications may require higher levels of filtration.

7.5.9 Pressure gauges

Pressure gauges shall be fitted at the inlet and the outlet of gas pressure regulating and metering streams operating above 5 bar inlet, gas pressure boosters/compressors and gas mixing systems. In all cases tappings shall be provided to measure inlet and outlet pressures. The pressure gauge connection shall be fitted with a pressure relieving/three port isolating valve, except for pressure regulating streams of 5 bar or less.

Pressure gauges or pressure gauge connections shall be sized appropriately, taking account of the pressure in order to limit the escape of gas in the event of breakage of the gauge. If necessary (depending on gauge design), consideration shall be given to the need for safety glass on pressure gauges for pressures above 5 bar.

7.5.10 Pressure tappings and purge connections

Pressure tappings and purge connections shall be fitted with valves or other means of preventing gas leakage to enable safe testing and purging to take place during commissioning and maintenance.

NOTE Capped or plugged ends can lead to danger to personnel when removed from high pressure systems.

7.6 Low gas temperature

7.6.1 Functional requirements

Any drop in temperature due to pressure reduction shall not lead to adverse effects on the operation of the pressure regulating system.

7.6.2 Design temperature effects

Any drop in temperature shall not adversely affect the design temperature conditions of the downstream pipework. Pre-heating of the gas can be required.

7.6.3 Condensation

Condensation or freezing of atmospheric moisture on the gas pressure regulating and safety equipment due to the low temperatures resulting from a pressure drop across it shall have no adverse effect on the proper functioning of the equipment. Alternatively, the gas or the equipment shall be heated.

7.7 Gas compressors

7.7.1 Construction

The gas pressure compressor unit shall be designed for the compression of flammable gases.

7.7.2 Temperature rise

Appropriate measures shall be taken where necessary to prevent the gas temperature at the outlet rising too high.

NOTE The limit value for the temperature rise is a function, amongst others, of the design of the pressure compressor unit and gas installation.

7.7.3 Pressure variation

The system shall be designed such that during the operation, start-up and shut down of the compressor/ booster unit, it shall not lead to adverse effects on the operation of downstream appliances or upstream regulator/meter installations.

7.8 Safety systems

7.8.1 Pressure safety system

7.8.1.1 General

The pressure safety system shall operate automatically to prevent the pressure in the downstream system exceeding permitted levels, taking setting tolerances into account, in the event of failure of the pressure regulating system.

For upper pressure limits, see Figure 8. Lower pressure limits shall be defined by the owner or operator, if applicable.

The pressure settings of regulators and safety devices shall be detailed in the Operating Manual.

7.8.1.2 Operating principles of pressure safety systems

Pressure safety systems shall be designed on the principle of non-venting using overpressure slam shut with active regulator or active and monitor regulators.

It may be permissible to use other systems provided that safety is assured and that the release of gas from creep relief valves is minimised. A risk assessment shall be performed to ensure safety.

The following principles shall be applied for pressure safety systems in pressure regulating systems:

— non-venting: this can be an over-pressure slam-shut device or a monitor in the case of 7.8.1.4.3. The amount of gas vented to the atmosphere from creep relief valves should be minimised;

— the chosen operating principle shall provide adequate protection against pressure rises in excess of the permitted level in all situations.

The permitted level for monitors shall be related to the DP, the permitted level for other safety devices shall be related to the MIP.

The reaction time of the system shall be considered when determining the set value of the safety system to ensure the MIP is not exceeded.

In the event of operation of the high pressure slam shut device, the gas supply to the control/pilot system to the pressure regulator(s) shall also be shut off.

7.8.1.3 Applications

7.8.1.3.1 General

A single pressure safety system shall be installed if:

$$MOP_u > MIP_d$$

A single pressure safety system plus a second device shall be installed if:

$$MOP_u - MOP_d > 16 \text{ bar and } MOP_u > STP_d$$

where

MOP_u maximum upstream operating pressure;

MOP_d maximum downstream operating pressure;

MIP_d maximum downstream incidental pressure;

STP_d downstream strength test pressure.

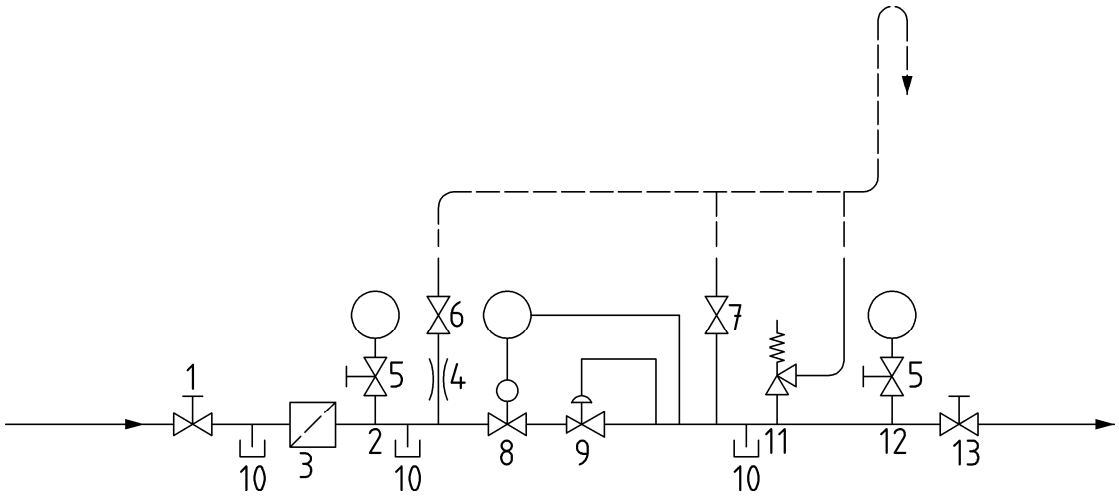
The function of the second device is to increase the safety level.

7.8.1.3.2 Example of a single pressure safety system

A high-pressure slam shut device (8) in combination with a creep relief valve (11) with a capacity of between 2 % and 5 % of that of the pressure regulator (9) may be fitted as shown in Figure 9.

7.8.1.3.3 Reverse flow due to excessive outlet pressure

Where no outlet pressure safeguard is required, but appliances and/or separate burners are connected to the pipework which is also fed with another piped gaseous medium, including air or oxygen, a high-pressure slam shut device (DA) or some other equal effective devices shall be installed.



Key

1 Inlet valve
2 Inlet pressure gauge
3 Filter
4 Restrictor (optional)
5 Pressure gauge tap
6 Valve (DA reset)
7 Vent valve
8 High-pressure slam shut device
9 Pressure regulator
10 Testpoint
11 Creep relief valve
12 Outlet pressure gauge
13 Outlet isolating valve

Figure 9 — Layout of gas pressure regulating and metering system

7.8.1.4 Non-venting pressure safety devices

7.8.1.4.1 Safety slam shut devices

Where non-venting pressure safety devices are used, each individual device shall comply with the following requirements:

— the highest set value for the pressure safety devices shall be MIP minus the positive tolerance corresponding to the accuracy group of the safety device;

— if an overpressure safety slam-shut device is activated, it shall remain in the closed position until opened by local manual intervention. However, if it is necessary to maintain supplies in the event of more than one stream failing, consideration shall be given to the inclusion of a control system which allows for the automatic opening and closing of the safety device between set pressure limits.

For indirect-acting slam shut devices, failure of auxiliary power shall result in a safety action. Exceptions to this requirement are permitted if:

— pressurised gas from the system itself is used as auxiliary power and the supply of this gas is continuous;

— auxiliary power (such as electricity, air or hydraulic fluid) from an external source is supported by gas from the system as auxiliary back-up power, and the supply of this gas is continuous.

If instruments such as transmitters or control instruments are used without a back-up, loss of signal shall result in a safety action.

7.8.1.4.2 Over-pressure slam shut device employing auxiliary energy

A combination of an electrical or pneumatic slam shut device and an electrical or pneumatic pressure switch is considered equivalent to an over pressure slam shut device.

NOTE 1 Pneumatic energy includes compressed air, gas or nitrogen.

If the auxiliary energy fails, the slam shut device shall close and require manual resetting. Loss of auxiliary power shall lead to a safe condition.

In the event of fluctuations in the level of the auxiliary energy, the slam shut device shall either remain fully open or else close and require manual resetting.

If gas pressure is used as auxiliary energy, this gas shall not be continuously vented (i.e. a “permanent bleed” is not permitted).

NOTE 2 Over pressure protection can be provided by a direct acting valve or one using auxiliary power and a pressure switch or transducer.

7.8.1.4.3 Monitors

A monitor used as a pressure safety device shall comply with the following requirements:

— the set value for the monitor shall be selected such that the DP cannot be exceeded. If, by means of an alarm system or frequent inspection of the station, the situation where a monitor has taken over control from the active pressure regulator can be detected within a short time period, MIP (instead of DP) may be taken into account for the determination of the set value;

— failure of auxiliary power shall result in a safety action, but exceptions to this requirement are permitted if:

  a) pressurised gas from the system itself is used as auxiliary power and the supply of this gas is continuous;

  b) auxiliary power (electricity, air or hydraulic fluid) from an external source is supported by gas from the system as auxiliary back-up power and the supply of this gas is continuous;

— if instruments such as transmitters or control instruments are used without a back-up, loss of signal shall result in a safety action;

— a failure of the active regulator shall not impair the proper functioning of the pressure safety system.

7.8.2 Pressure warning system

If, in a pressure control system, the settings of the safety devices are in the range between DP and MIP, measures should be taken to ensure that entering this range is incidental in both frequency and duration.

7.8.3 Gas pressure boosters/compressors

7.8.3.1 Reverse flow

If there is any risk of a shut-down causing unacceptable reverse flow, a non-return valve or equivalent safety device shall be fitted. See 7.8.1.4.2.

7.8.3.2 Low inlet pressure

A safety device shall be fitted to the inlet of a gas pressure compressor unit which automatically turns off the compressor unit and requires manual resetting if the upstream pressure falls below a minimum value. A single automatic attempt to restart is permitted after a defined time period.

7.8.3.3 High outlet pressure

If the pressure compressor unit is able to deliver an outlet pressure which exceeds the MOP for the downstream section of the pipework and the appliances connected to this section, a safety device shall be fitted which automatically turns off the compressor unit when the delivery pressure rises too high and then requires manual restarting.

7.8.4 Gas mixing systems

Where extraneous gases are mixed with the gas, protection against variations in mixture composition, shall be provided by a control system. This system shall:

— prevent the mixture moving outside 'safe limits', and

— prevent the mixture from being transmitted into the upstream pipework.

This will normally require the use of a control device and at least one independent limiting device.

8 Construction

8.1 Identification of the installation

8.1.1 Installation drawings

When an existing installation is to be extended or modified, details of the existing sections of gas pipework that are to be modified shall be available before work starts.

When a new gas installation is to be constructed or new sections are to be added to existing pipework, installation drawings shall be available which shall state:

— names and addresses of the contractor/manufacturers;

— details of the property/building where the installation is being constructed.

8.1.2 Identification of the components

8.1.2.1 Pipes and pieces of pipes

Unless established documentation is available proving that only certified materials are used, all components shall be marked for identification. The markings shall be by means of paint, stamping or tags. This identification shall remain visible throughout the installation process.

8.1.2.2 Fittings

All fittings shall be marked externally according to the relevant standards.

8.1.3 Weld identification

Unless the contractor/manufacturer can prove through documentation that he is employing only welders qualified for the task and that the welders are using only qualified welding procedures, the welds or the sections thereof shall be identified by the welder's symbol close to the weld.

The welder identification may be replaced by corresponding details in the fabrication documents.

8.2 External hazards

8.2.1 Mechanical loads

Equipment shall not be exposed to mechanical load, impacts, vibrations, etc., greater than those permitted in accordance with the equipment specifications or which could affect its safety. Gas installation pipework shall be laid out and constructed to avoid unnecessary mechanical loads.

8.2.2 Electric currents

8.2.2.1 Protective conductor

The above ground installation pipework shall be earthed and equipotentially bonded according to national requirements or, where no national requirements exist, in accordance with IEC 60364.

8.2.2.2 Stray currents

Gas installations shall be designed and built such as to minimise the risk of their becoming part of a stray current circuit as a result of multiple earthing.

8.2.2.3 Insulating joint

Aboveground and underground transits of pipework into a building through outside walls shall be fitted with a insulating joint or ebonited insulating flange immediately behind the wall.

8.2.3 Environmental influences

Pipework shall be protected from or resistant to corrosion, see 8.8.

Plastic-coated pipes and polyethylene pipes shall not be exposed, during storage or use, to direct sunlight unless protected from or resistant to its effects.

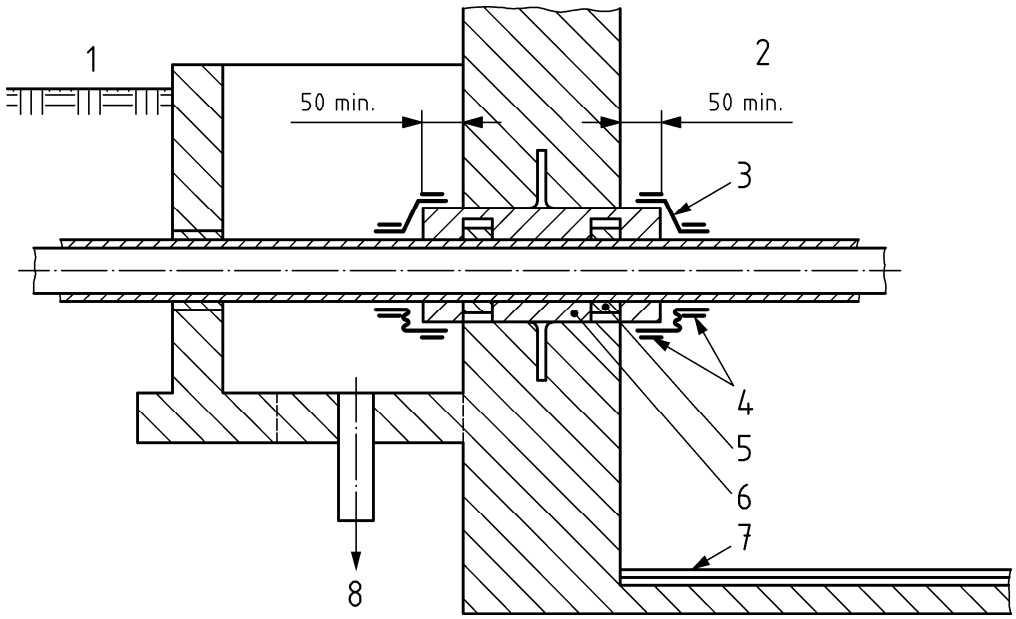
8.3 Gas pipework passing through exterior walls

8.3.1 Buried pipe transits

Buried pipe transits through outside walls passages shall be executed separately, and shall be gas tight and watertight when necessary.

EXAMPLE See Figure 10.

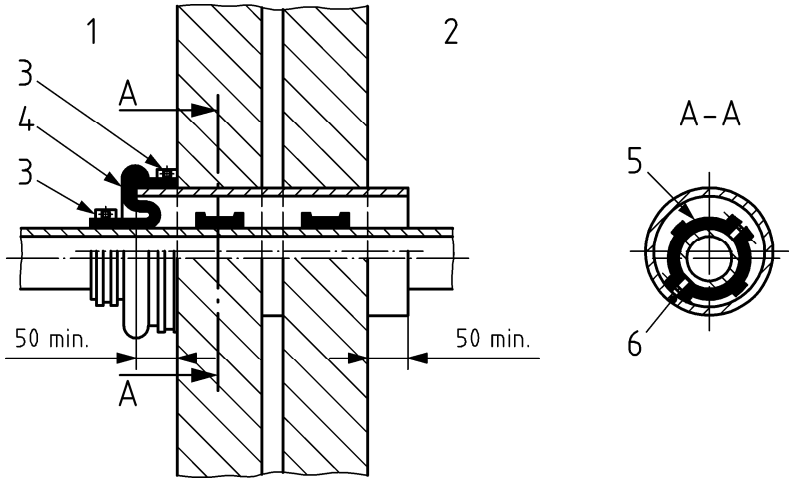
Unused buried transits through exterior walls and unused cut-outs shall be sealed.



Key

1 Outside
2 Inside
3 Rubber collar
4 Clamping band
5 Synthetic centring ring
6 Pipe
7 Floor
8 To sewer (if gravel, then sewer connection not required)

a) Example buried pipe transit



Key

1 Outside
2 Inside
3 Clamping band, corrosion-resistant steel
4 Rubber sealing collar
5 Clamping band, corrosion-resistant steel
6 Plastic spacer or centring rings

b) Example of gas-tight pipe transit

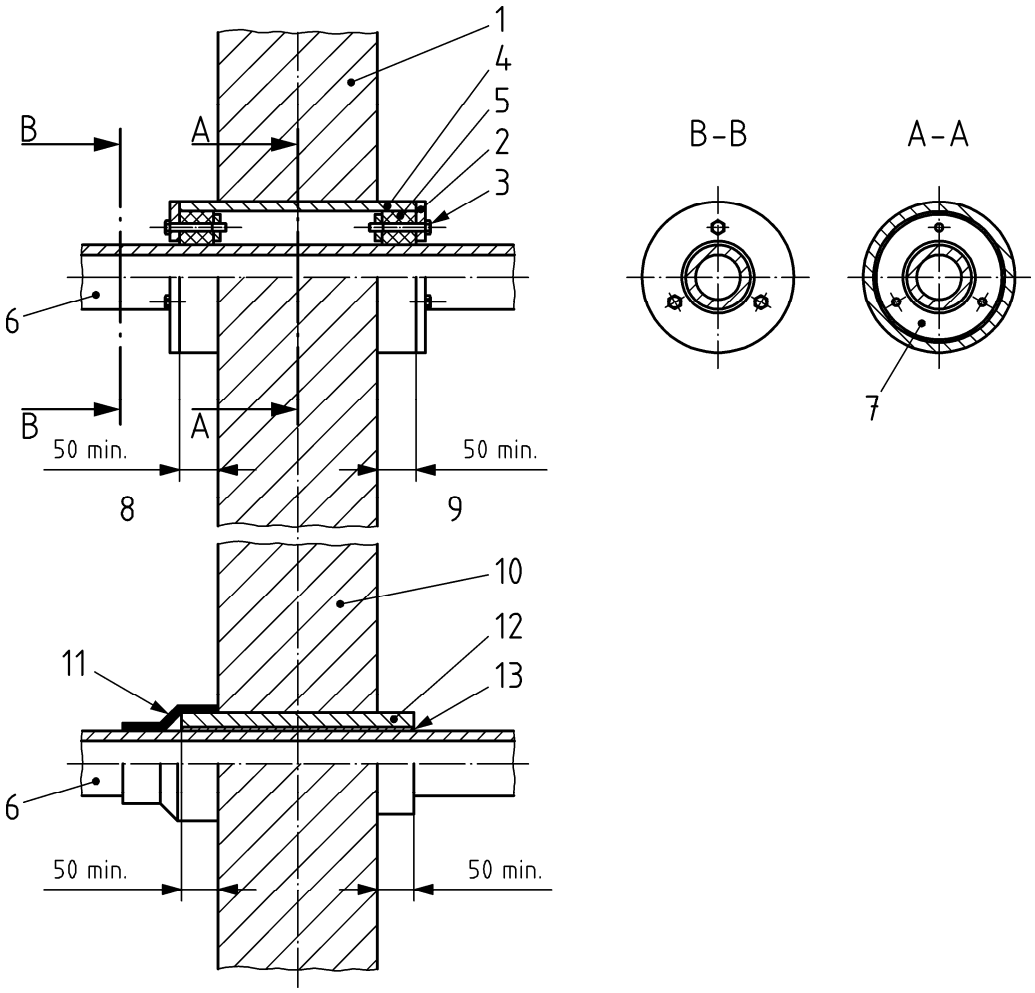
Figure 10 — Pipe transits

8.3.2 Aboveground pipe transits

Aboveground pipe transits through cavity walls shall incorporate a pipe sleeve. The pipe shall be installed centrally within the sleeve; this can require the use of a centering facility. The pipe transit shall be watertight, preferably on the outside, unless there is sufficient space around the pipe for maintenance and inspection.

In aboveground pipe transits, a free space around the pipe shall be provided; supports and pipe brackets shall be fitted on a sufficient distance of the pipe sleeve.

National regulations and Code of Practice required for fire and smoke protection with regard to pipe transits shall be taken into account.



Key

1 Wall
2 Metal ring
3 Hexagon bolt
4 Steel pipe sleeve
5 Rubber ring
6 Gas pipe
7 Metal ring
8 Outside
9 Inside
10 Wall
11 Corrosion proof collar
12 Plastic pipe sleeve
13 Sealing compound

Figure 11 — Examples of gas-tight above-ground pipe transits

8.4 Identification of pipework

8.4.1 Identification of above-ground pipework

Gas pipework shall be identified by a yellow colour which can be applied by painting or through the use of suitable marking.

If several piped media are distributed, the gas pipework shall be recognisable from the other media. In the case of appliances which are fed with more than one (gaseous) medium, another colour identification system may be used for pipework downstream of the appliance isolating valves.

Inscriptions should be carried on tags at the isolating valves.

Consideration shall be given to the display, at intervals, on the pipework of the maximum operating gas pressure [MOP].

8.4.2 Identification of buried pipework

Where the pipework is being laid in open trenches, the pipe location shall be marked by a yellow warning marker tape laid at a minimum of 0,30 m above the pipe. See also 6.6.7.

8.5 Specifications and requirements for joints

8.5.1 Welded joints and pipe fittings in carbon steel and stainless steel pipes

8.5.1.1 General

Pipes and fittings should be checked to be in good condition before use.

Welding fittings should preferably be used in steel pipework for branches, bends and reducers. Welded joints in pipes are permitted only by the arc welding process, and only used on steel pipes and appliance connections made of rolled, forged or cast steel. If the appliances are provided with welding edges making them suitable for direct welding to pipework, they shall be designed, constructed, welded and heat-treated, where applicable, such that no damage or detrimental effect is caused by welding or annealing.

Clause 8.5.1 relates to manual arc-welding processes. The quality of welds made with other welding processes, whether automatic or manual, shall be at least equal to that specified in this clause.

8.5.1.2 Heat treatment

There is no post weld heat treatment (PWHT) required for carbon steel materials according to Clause 5 (unalloyed steels with $R_{EH} \leq 360$ N/mm^2) and a wall thickness < 35 mm.

For the austenitic steels specified in Clause 5, the need for PWHT shall be given individual consideration by the manufacturer.

8.5.1.3 Welding procedures and welding procedure specification for pressure less than or equal to 5 bar

Welding shall be carried out in accordance with this standard or EN 12732.

For wall thickness up to 3,6 mm, and DN less than or equal to 100, provided the material is suitable, oxy-acetylene welding is permitted.

8.5.1.4 Welding procedures and welding procedure specification for pipework falling in PED, Table 6

Welding shall be carried out in accordance with 8.5.1.4 up to and including 8.5.1.11.

Describing the method adopted for the test welds in accordance with EN ISO 15609-1 shall specify the appropriate welding procedure. This procedure shall be complied with in the execution of the welding. Reports on the suitability of the welding procedure shall be kept for as long as this procedure is used for the project.

Welding procedures shall be evaluated and approved in accordance with EN ISO 15609-1, EN ISO 15614-1, EN ISO 15610, EN ISO 15612, EN ISO 5817 and qualified by methods given in EN ISO 15607.

8.5.1.5 Welder's competence

The project supervisor shall be able to demonstrate at all times that the competence of the welder(s) carrying out the work has been rated as satisfactory in accordance with EN 287-1. If the competence of a welder is found to be unsatisfactory during the course of work, a decision shall be made on the extent to which his competence and the acceptability of the welding work requires more detailed investigation.

8.5.1.6 Preparation

The welding faces shall be mechanically cleaned and shall be free of materials which might impair the quality of the weld. The root gap shall be determined in accordance with the requirements set forth in the qualified welding procedure specification. Precautions shall be taken to prevent stray arcs.

8.5.1.7 Alignment of pipes

The pipe ends shall be aligned as accurately as possible with one another and with pipe fittings, allowing for the tolerances on the diameter, the wall thickness and the out-of-roundness of the pipes. The elements shall be aligned to give the most advantageous distribution of tolerances for the application of the root bead. No change in this position shall occur during the welding.

Welds on longitudinally and spirally welded pipes shall be staggered by not less than 10 times the pipe wall thickness, subject to a 50 mm minimum, with the welds in a "9 o'clock to 3 o'clock" position.

8.5.1.8 Weather conditions

If there is a risk of the quality of the weld being impaired due to the prevailing weather conditions, such as frost, fog, rain or blown sand, no welding work shall be carried out unless effective preventative measures are taken.

The welding faces shall be preheated before welding if necessary, to drive off any moisture present.

8.5.1.9 Electrodes

The electrodes, as prescribed by the welding procedure specification, shall be kept dry and protected from damage during storage and use.

8.5.1.10 Weld details

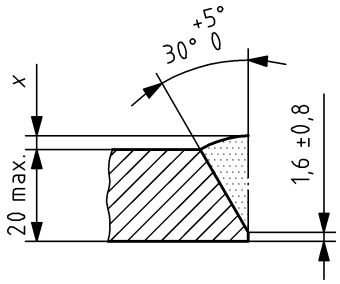
Weld details shall comply with those permitted in the qualified welding procedure.

Examples of weld details are given in the Figure 12 to Figure 15.

Overfill dimensions (x) are given in Table 19.

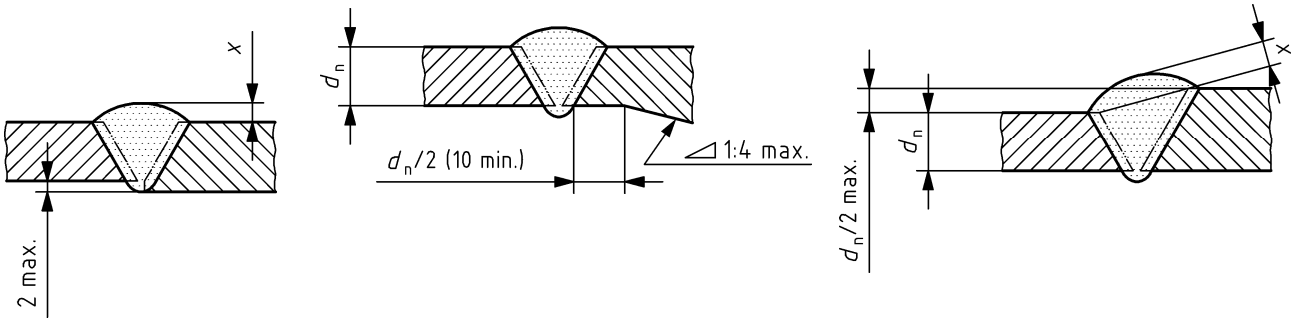
Table 19 — Overfill dimensions

d_n = wall thickness		x = overfill max.
Over	Up to and including	
—	12	2
12	20	3
25	—	4



NOTE The root opening must be 1 mm to 4 mm.

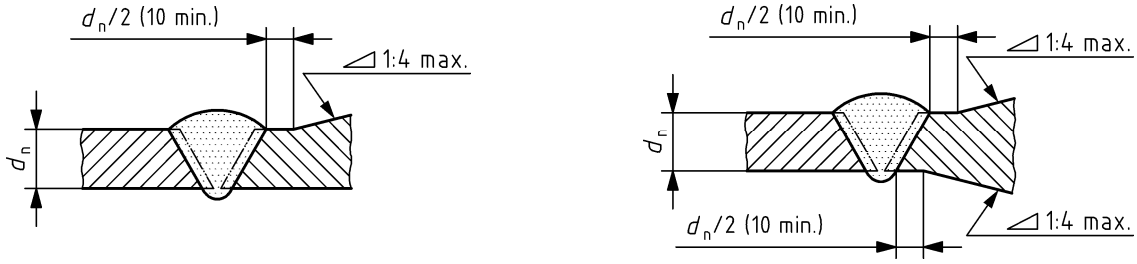
Figure 12 — Standard weld profile for pipes and pipe fittings



I. Difference in wall thickness up to 2 mm for same outside diameters

II. Difference in wall thickness over 2 mm for same outside diameters

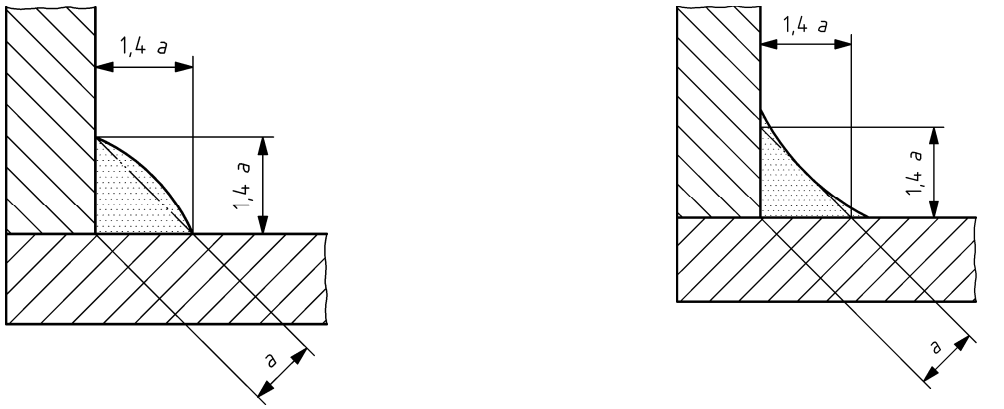
III. Difference in wall thickness up to 0,5 d_n for same inside diameters



IV. Difference in wall thickness over 0,5 d_n for same inside diameters

V. As IV with greater wall thickness and smaller inside diameter

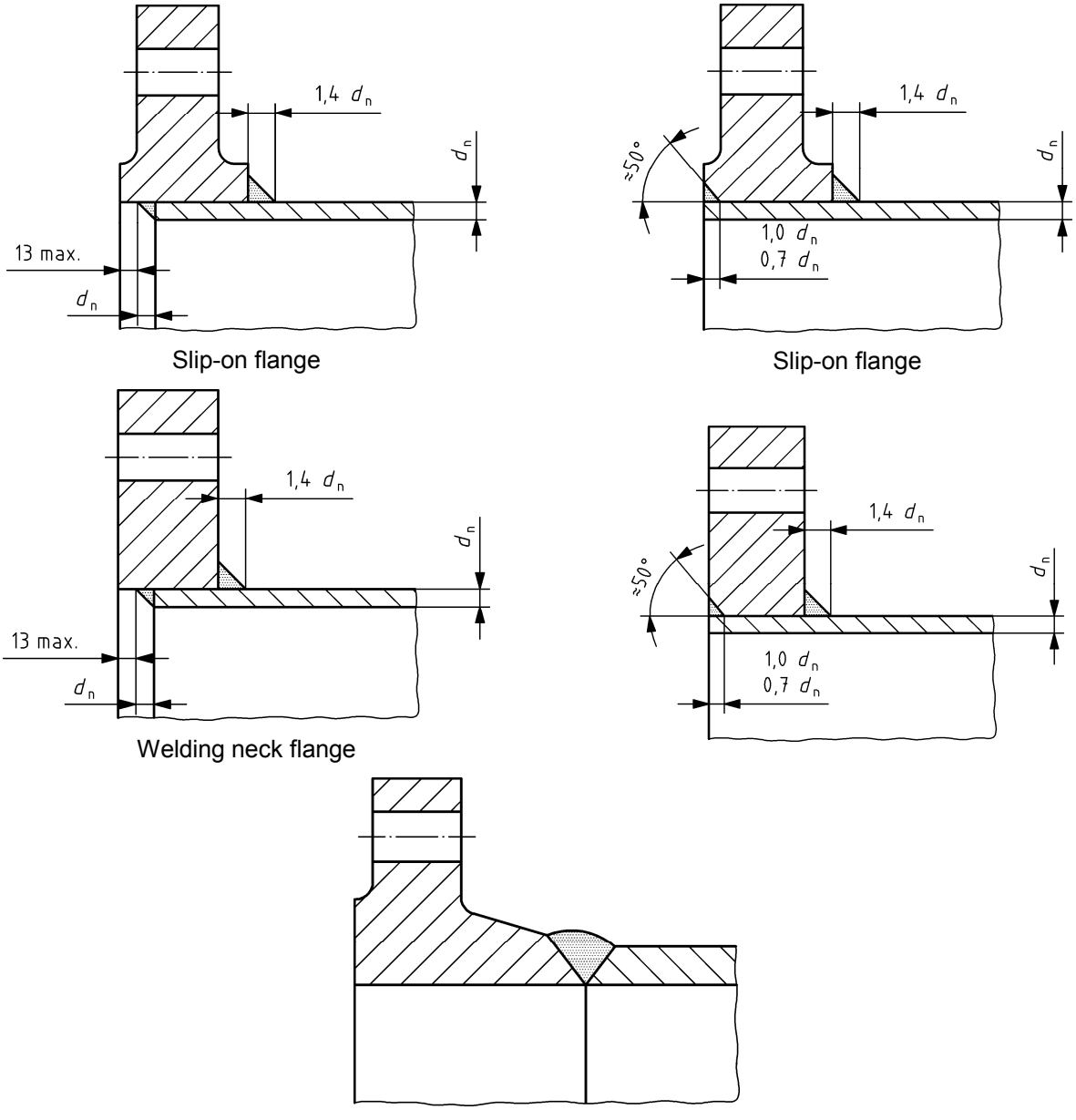
Figure 13 — Permissible combinations of weld profiles for pipes and pipe fittings with unequal wall thicknesses



a. Convex fillet weld

b. Concave fillet weld

Figure 14 — Fillet weld dimensions



Slip-on flange

Slip-on flange

Welding neck flange

Figure 15 — Recommended weld profiles for flanges

8.5.1.11 Special welding fittings

A special type of welded joint, in the form of a forged steel socket with annular welding spaces, may be used in steel pipes up to a DN 50. The permitted tolerances on the outside diameter of the pipe and the inside diameter of the welding socket shall not be exceeded.

8.5.2 Joints in copper pipework

Brazing shall be carried out according to EN 1775 using filler metals in accordance with EN 1044.

8.5.2.1 Brazing procedure approval

Procedure approval shall be in accordance with EN 13134.

8.5.3 Fusion joints in plastic pipes

Butt fusion joints in PE pipes shall be made in accordance with EN 12007-2.

Electro fusion joints shall be made in accordance with the manufacturer's instructions.

8.5.4 Flange joints

The flange diameter shall correspond to the pipe diameter. Designs in accordance with equivalent standards and suitable for higher DP are permitted.

The flange sealing faces shall be raised, and the finish of the sealing faces shall be suitable for the gasket and the operating conditions.

For nuts, bolts and gaskets, see 6.6.4.2.

8.5.5 Compression joints

Compression joints shall not be used for pipes of DN greater than 50 nor for a DP greater than 5 bar.

Compression joints shall conform to appropriate standards and shall be resistant to end loadings. If no standard is available, they shall conform to the manufacturer's instructions and shall be type-tested.

8.5.6 Threaded joints

Threaded joints shall be made in accordance with EN 10226-1. Male and female threads shall be compatible. Where the equipment has a parallel threaded connection, this thread shall comply with EN ISO 228-1. In this case, care shall be taken to ensure an adequate seal.

8.6 Joint suitability

For above-ground pipework the following joints shall be used.

— For steel:

  — welded flanges in accordance with EN 1092-1;

  — welded joints;

  — tees and socket weld fittings;

  - threaded and mechanical joints. Threaded joints shall not be used in above ground pipe runs exceeding 50 m.

- For copper:
  - brazing neck flanges in accordance with EN 1092-3;
  - brazed copper or bronze pipe fittings;
  - mechanical fittings;
  - compression fittings;
  - up to and including 5 bar pressed joints in accordance with EN 1775.

For buried pipework the following joints shall be used.

- For steel:
  - welding neck flanges in accordance with EN 1092-1 (valves and PE transition fittings only);
  - welded joints.

NOTE End load resistant mechanical joints may be used up to 5 bar.

- For copper:
  - brazing neck flanges in accordance with EN 1092-3 (valves only);
  - brazed joints with copper or bronze pipe fittings.
- For PE:
  - butt-fusion joints in accordance with EN 12007-2;
  - electro fusion joints in accordance with EN 12007-2;
  - end-load-resistant mechanical joints in accordance with EN 12007-2;
  - transition fittings in accordance with EN 1555-3.

8.7 Connections

8.7.1 Connection points/pipe ends

Unused connection points and fixed pipe ends, whether or not fitted with an appliance isolating valve, shall be terminated with a suitable component such as:

- a welded cap;
- a blind flange in accordance with EN 1092-1;
- a threaded cap;
- a threaded plug.

Where future extensions to pipework are planned, consideration should be given to the fitting of valves (with sealed outlets as above) to pipe ends during initial construction.

8.7.2 Appliance isolating valves

Appliance isolating valves shall be fitted such that they are readily accessible for use and maintenance; and located in environments where the valve temperature cannot exceed its design rating or 60 °C, whichever is the lower.

8.8 Corrosion protection

8.8.1 Metal-to-metal contact

To prevent galvanic corrosion, pipework shall not make metal-to-metal contact with other pipework or cables, except for connections at gas appliances and joints with equipotential bonding conductors in accordance with IEC 60364.

Special attention shall be given to the prevention of corrosion at pipe supports. See Annex D for examples of pipe supports.

8.8.2 Above-ground protection of pipework

8.8.2.1 General

The choice of protection system shall take account of the required level of protection against harmful influences and also of the capital cost compared with the maintenance cost.

The effectiveness of a protection system relies upon:

— preparation (degreasing, cleaning, removal of rust and mill scale);

— application of one or more anti-corrosion primer coats;

— application of a sealing (and, where necessary, a weatherproof) finish coat. Paint manufacturers may advise on protection systems.

Special attention shall be paid to the protection of the pipework at flanges, suspension points at supports and in wall transits.

NOTE Spaces between flanges are difficult to protect. One means of preventing corrosion between flanges is to inject a corrosion preventing fluid (tectyl) into the space and to then seal the gap between the flanges with tape. Corrosion can also be prevented by packing the gap with mastic. In the case of flanges which have to be parted regularly, a non-setting mastic (butylene) may be used. In other cases, a very durable seal can be obtained with more flexible substances, such as polysulphide, polyurethane or silicone mastics. In the interests of corrosion prevention, the use of hot dipped galvanised or stainless steel nuts, bolts and washers is recommended. Flanges can be galvanised or plastic coated for corrosion protection.

Pipework shall not be laid below other pipework or structures which contain corrosive media or on which water vapour can condense, unless the pipework is suitably protected in accordance with EN ISO 12944-1.

8.8.2.2 Protection systems in corrosive environments

Corrosive environments in damp spaces shall be taken into account. The choice of protection system shall be made taking into account the expected level of corrosion in accordance with EN ISO 12944-1.

A distinction may be drawn between light to moderate and highly corrosive environments as follows:

Light to moderately corrosive environments:

— Indoors: shower rooms, dairy product plants, potato flour plants, laundries, toilets;

— Open-air installations.

Highly corrosive environments:

— Indoors: chemical plants, pickling shops, tin-plating shops, galvanising shops, permanently damp cellars, crawl spaces;

— Open-air installations in the vicinity of sulphuric acid plants, ammonia plants, or fertiliser plants.

Examples of effective protection for above-ground pipes are as follows:

Non-corrosive environments

a) Steel pipework: painted or galvanised;

b) Copper pipework: no protection necessary.

Light to moderately corrosive environments

a) Steel pipework:

   1) rust primer and two coats of paint (undercoat and topcoat);

   2) coating with polyethylene or wrapped in accordance with EN 12068, and the joints covered with pipe wrapping or shrinkable material in accordance with EN 12068;

   3) hot-dip galvanised in accordance with EN 10240 (zinc coating thickness at least 56 μm), damage made good.

b) Copper pipework:

   1) etching primer and one topcoat of paint;

   2) plastic coating.

Highly corrosive environment

a) Carbon steel pipework:

   1) rust primer and two coats of epoxy paint (undercoat and topcoat);

   2) coating with polyethylene and the joints covered with pipe wrapping or shrinkable material in accordance with EN 12068;

   3) hot-dip galvanised in accordance with EN 10240 (zinc coating thickness at least 56 μm), and coated with chlorinated rubber paint.

b) Copper pipework:

   1) etching primer and two coats of epoxy paint (undercoat and topcoat);

   2) plastic coating as applied by the manufacturer.

c) Stainless steel:

1) wrapping or shrinkable material in accordance with EN 12068.

8.8.2.3 Harmful effects to pipe coatings

Pipes with a polyethylene coating or wrapped with tape shall not be exposed to direct sunlight. An exception is made for polyethylene stabilised with carbon-black, which can be identified by its black colour, but pipes coated with this material shall be protected against long-term solar irradiation.

8.8.2.4 Pipework with thermal and/or acoustic insulation

If insulation is to be applied, the following protective measures against corrosion of the pipework shall be taken:

a) waterproof/corrosion coating to the pipe;

b) insulation by materials around the pipework;

c) covering with a vapour barrier, paying particular attention to the ends; and

d) protection of coating against mechanical damage if necessary.

NOTE It is preferable to avoid the need for insulation by making an appropriate choice of location or taking other measures because it has been found in practice that pipe can corrode severely under its insulating coating, if the insulation has been carelessly applied at initial installation or after repair work. This is all the more dangerous because the corrosion is not directly visible.

8.8.3 Protection of buried pipework

8.8.3.1 Protection respecting materials

8.8.3.1.1 Carbon steel pipework

Pipes, joints and fittings made of steel shall be provided with an external coating. The pipe coating can be:

— an epoxy and polyurethane-based coating in accordance with EN 10289 and EN 10290;

— wrapping or shrinkable material in accordance with EN 12068.

Carbon steel pipework shall be cathodically protected according to 8.8.3.3.

8.8.3.1.2 Stainless steel pipework

Stainless steel pipes and fittings may only be used buried if:

— the pipes and fittings are provided with an external PE coating and wrapping or shrinkable material in accordance with EN 12068;

— the soil conditions are such that cathodic protection is not required, pursuant to 8.8.3.3, and no such system has been installed.

8.8.3.1.3 Copper pipework

The use of buried copper pipework systems is not recommended. In copper pipework systems, where used, the pipework and fittings shall be protected against corrosion by the application of a suitable coating.

8.8.3.2 Protection of ancillaries and joints

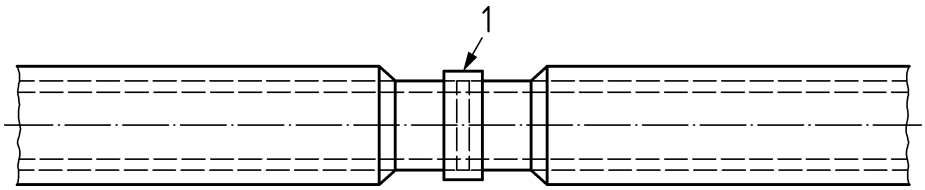
Ancillaries should be pre-coated by the manufacturer with materials as given in 8.8.3.1. Where this is not possible, a wrapping material such as one of those detailed in EN 12068 shall be applied.

Special attention shall be given, for example, to items such as valve spindles, greasing lines and vent/pressure pipes where an adhesive insulating coating can be applied. The use of a protective sleeve over the valve spindle shall be considered.

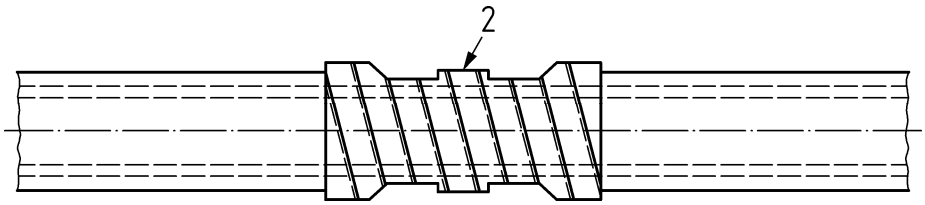
8.8.3.2.1 Wrapping and shrinkable materials

Pipe wrapping or shrinkable material for coating welded joints and pipe fittings shall be in accordance with EN 12068.

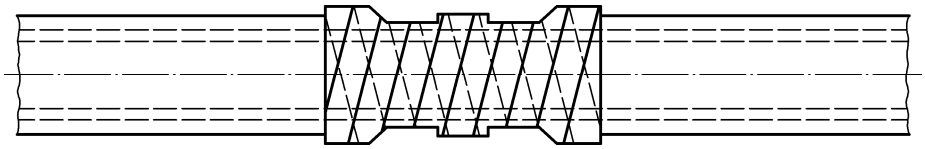
The application of the material shall be performed in accordance with Figure 16 and/or the instructions of the manufacturer.



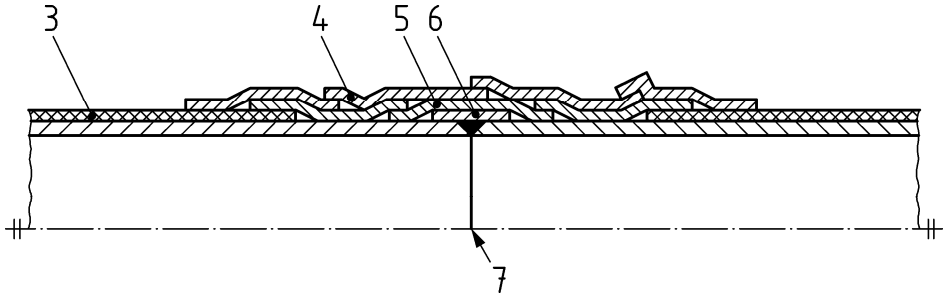
A – Wrapping tape locally off the weld



B – First layer of the wrapping tape on the joint



C – Second layer of the wrapping tape on the joint



D – Wrapping tape on a joint with pipe diameter above 500 mm

Key

1 Wrapping tape (width 50 mm)
2 Wrapping tape 50 % overlap
3 Factory coating
4 2nd layer, 4 wrapping tapes (width 200 mm), 12 mm to 25 mm overlap in tape width; 100 mm overlap in tape length
5 1st layer, 3 wrapping tapes (width 200 mm), 12 mm to 25 mm overlap in tape width; 100 mm overlap in tape length
6 Wrapping tape (width 100 mm)
7 Pre-treatment circumferential weld

Figure 16 — Application of wrapping tape

8.8.3.3 Cathodic protection for carbon steel pipework

8.8.3.3.1 General

Carbon steel pipework shall be cathodically protected in accordance with EN 12954. Short lengths of steel pipework may not need the application of cathodic protection provided it is coated with a double wrapping or a shrinkable material to EN 12068.

Cathodic protection is not required if all the following conditions are met:

— the specific resistance of the environment is over 100 Ωm;

— the acidity is low (pH > 6);

— the influence of any stray currents is below the level permitted under the cathodic interference criteria;

— the environment is not anaerobic.

If high contact resistances can occur between components of the pipework which require cathodic protection (for example at flanged joints) the components shall be electrically connected.

To enable the cathodic protection system to function effectively, gas pipes shall be galvanically isolated from their supports by insulating shells.

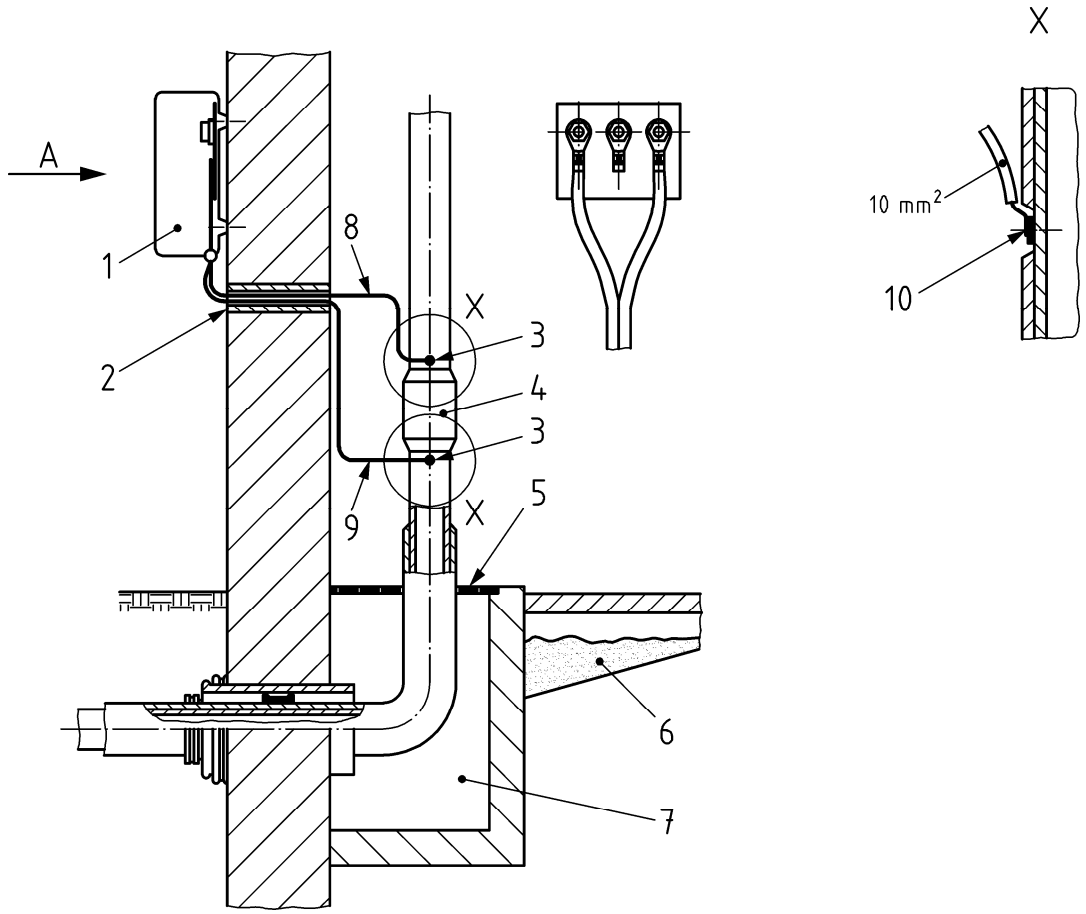
To ensure galvanic isolation of the pipework, care shall be taken to ensure that valves are insulated from the earth.

8.8.3.3.2 Insulating joints

If the insulating joint or ebonited insulating flanges are located inside the building, it shall be possible to test the efficiency of the joint. Where applicable, test points shall be connected by insulated cables to a measuring cabinet located above ground and readily accessible. The cabinet shall be at least to IP54 according to EN 60529 and lockable (see Figure 17). All test points and bare wires shall be covered by an insulating material.

8.8.3.3.3 Attachment of test cables to carbon steel pipes

Test cables shall be connected to the pipe using 10 mm^2 copper cable having coloured PVC insulation, see Figure 17. The cable should be attached to the pipework using an appropriate method, e.g. exothermic welding, according to the relevant instructions. The connection procedure shall not damage or weaken the pipe surface. On completion of the work, the pipe coatings shall be repaired.



Key
1 Synthetic test box (watertight)
2 PVC cable transit (watertight)
3 Test point (see Detail)
4 Insulating joint
5 Ventilated cover
6 Clean sand
7 Pit
8 Copper cable (10 mm²) with PVC isolation (red)
9 Copper cable (10 mm²) with PVC isolation (black)
10 Cadweld type F 33

Figure 17 — Example of configuration of test points

8.8.3.3.4 Attachment of cathodic protection connections

Attachment of cathodic protection connections may be carried out in accordance with EN 12732.

8.8.4 Corrosion at pipe supports

The method of restraining pipes within their supports shall not encourage corrosion or lead to failure of any pipework corrosion protection, pipes or supports.

NOTE This can require the addition of a flexible layer of non-absorbent material between the support and the surface of the pipe or of its corrosion protection.

8.9 Handling and installation of pipework

8.9.1 PE pipework

8.9.1.1 Surface condition

Pipes and fittings shall be inspected before use and those with surface defects deeper than 10 % of the nominal wall thickness shall not be used.

8.9.1.2 Storage, handling and transportation

Care shall be taken during the transport, handling and storage of pipes, fittings and other components to ensure at all stages that their specified properties and conditions, which can be affected by environmental factors, are preserved and that physical damage and distortion is avoided.

EXAMPLE At low temperatures, flexibility and fracture resistance are reduced.

PE pipes and fittings stored outside are subjected to UV degradation when exposed to direct daylight. PE materials are stabilized to give protection for a UV radiation level of 3,5 GJ/m^2.

Pipes shall not be used where it is considered that they have exceeded the maximum UV exposure limit, unless they have been tested to demonstrate acceptable performance in accordance with existing standards.

Further guidance on storage, handling and transportation of PE pipes and fittings is given in EN 12007-2.

8.9.1.3 Installation and laying

Care shall be taken to prevent damage to the pipes and fittings during the whole process of laying.

When tightening or loosening a mechanical joint, it is essential that movement is not transmitted to the pipe.

Consideration shall be given during the laying process to the potential effects on the pipe of relative movements of the ground due to adjacent construction activities or from temperature variations.

Pipes shall not be overstressed during construction, laying, testing or removal of any temporary supports.

During construction, after final assembly, and after a pressure test, the installer shall ensure that all temporary supports are removed.

Stresses caused by different temperatures between laying and operation shall be considered.

Valves shall be installed so that they do not expose the PE pipes to unnecessary stress during opening and closing cycles.

8.9.2 Steel pipework

8.9.2.1 Surface condition

There shall be no visible damage to the metal pipe surface.

Coating shall be repaired before installing.

8.9.2.2 Storage, handling and transportation

Handling, transport and storage of the pipework shall be performed with care so that the pipe, its external coating and any bevels are not damaged.

During storage, the pipes shall be protected against corrosion and be suitably supported.

Measures shall be taken to prevent rolling and to ensure the pipe is stable when in storage.

Further guidance is given in EN 12007-3.

8.9.2.3 Installation and laying

Where necessary, during assembly of pipework, the installer shall use temporary supports to ensure that no unacceptable stress or deformation occurs in the pipework as a consequence of any cantilever effect of unsupported weight distribution.

Temporary supports for pipes larger than DN 50 shall not be located more than 1 pipe diameter from the specified position on the pipework.

After final assembly, and after a pressure test, the installer shall ensure that all temporary supports are removed.

Pipework shall not be distorted during alignment when assembling joints and installing/removing supports.

Equipment used for lifting and lowering the pipework shall not damage the pipe or its coating. The pipe shall be inspected after such equipment has been in contact with the pipework.

Care shall be taken to ensure that overstressing of the pipework does not occur during lifting or lowering operations and that, after lowering, the pipework is not left in an overstressed condition.

8.9.3 Copper pipework

8.9.3.1 Surface condition

There shall be no visible damage to the copper pipe and any surface coating.

8.9.3.2 Storage, handling and transportation

Handling, transport and storage of the copper pipework shall be performed with care so that the pipes and the fittings are not damaged.

During storage, the pipes shall be suitably supported.

8.9.3.3 Installation

Where necessary, during assembly of pipework, the installer shall use temporary supports to ensure that no unacceptable stress or deformation occurs in the pipework as a consequence of any cantilever effect of unsupported weight distribution.

Pipework shall not be distorted during alignment when assembling joints.

After final assembly, and after any hydrostatic pressure test, the installer shall ensure that all temporary supports are removed.

8.9.4 Pipe trench filling

To avoid any damage to the pipe and the coating a pre-backfill should be placed over the pipe immediately after the pipe is laid in the trench. This pre-backfill and the pipe trench bottom should contain no materials likely to damage the pipe coating.

Backfilling shall be carried out as soon as possible after lowering to prevent damage.

The trench shall be filled such that the pipe is evenly and firmly supported on all sides over its entire length.

No structures, such as slabs and beams, shall be laid under the pipe without taking suitable precautions to prevent damage. These precautions can include the use of plastic pads, special coatings of polyethylene or reinforced coatings.

For PE pipe, backfill material shall be selected to prevent damage to the pipe from contact with sharp edges during and after compaction. It shall be compacted layer by layer so as to avoid excessive pipe ellipticity.

8.10 Bending of pipes

8.10.1 Steel pipe bending

8.10.1.1 Carbon steel grade L195 less than or equal to 10 bar

Pipes in accordance with EN 10255 may be bent cold, using appropriate hydraulic bending equipment and formers, up to 90° and to a minimum inside bend radius in accordance with Table 20.

Table 20 — Minimum bend radius as a function of DN (dimensions in mm)

DN	15	20	25	32	40	50
Bend radius	95	120	150	200	230	280

If present, longitudinal seams shall lie on the outside of the bend. Bending shall not cause ellipticity or corrugation of the pipe.

8.10.1.2 Other steel grades

Cold bending of other steel grades shall only be performed according to the appropriate manufacturing standard and to the advice and limitations given by the material supplier or manufacturer.

Other advice can be obtained from 6.6.8 and from EN 12007-3.

8.10.1.3 Heat treatment

There is no heat treatment required after cold forming of pipes for carbon and stainless steel pipe materials according to Clause 5 and having a mean bending radius of not less than 2,5 d_o for the outside diameter d_o.

NOTE Carbon steel formers should not be used for cold bending stainless steel pipes.

8.10.2 PE pipe bending

Changes of direction of PE pipework shall be achieved by means of preformed bends or elbow fittings or by the natural flexibility of the PE pipe within the allowable limits. Natural flexing may be used for bend radii greater than or equal to $25 \times d_n$ (d_n = nominal outside diameter), and for smaller radii dependant upon the SDR, ambient temperature and material properties based on operational experience and good engineering practice, see also EN 12007-2.

Machine bending of pipes or bending using the application of heat shall not be used.

8.10.3 Copper pipe bending

Copper pipes shall be bent according to Table 21 and to the manufacturer's instructions hard copper over 18 mm shall not be bent.

Table 21 — Minimum bend radius as a function of D (outside diameter)

Outside diameter D mm	**Material type**	**Minimum bend radius, neutral axis** mm
12	soft/half hard/hard	45
15	soft/half hard/hard	55
18	soft/half hard/hard	70
22	soft/half hard	77
28	half hard	114

8.11 Welding of supports and anchor points to carbon steel pipework

Where supports and anchor points are welded to pipework the following shall apply:

— the material shall be suitable for welding to the pipework;

— the stresses occurring shall be investigated and found to be within acceptable limits;

— tubular supports shall have an open connection to atmosphere;

— welds shall be inspected and meet quality requirements at least equal to those for branches/fillet welds in accordance with Table 22.

In addition, for pipework with a DP exceeding 16 bar, the following requirements shall also apply:

— the material shall be accompanied by an inspection document 2.2 in accordance with EN 10204;

— the required welding procedure qualifications for attaching the support or anchor to the pipework shall comply with EN ISO 15614-1;

— the welder’s qualification shall comply with EN 287-1.

If there is a risk of the stress on the pipe exceeding permitted limits, additional measures shall be taken, for example:

— a tie plate with a length and width of at least the nominal diameter of the pipework. The tie plate shall be attached to the pipe all round (to prevent corrosion);

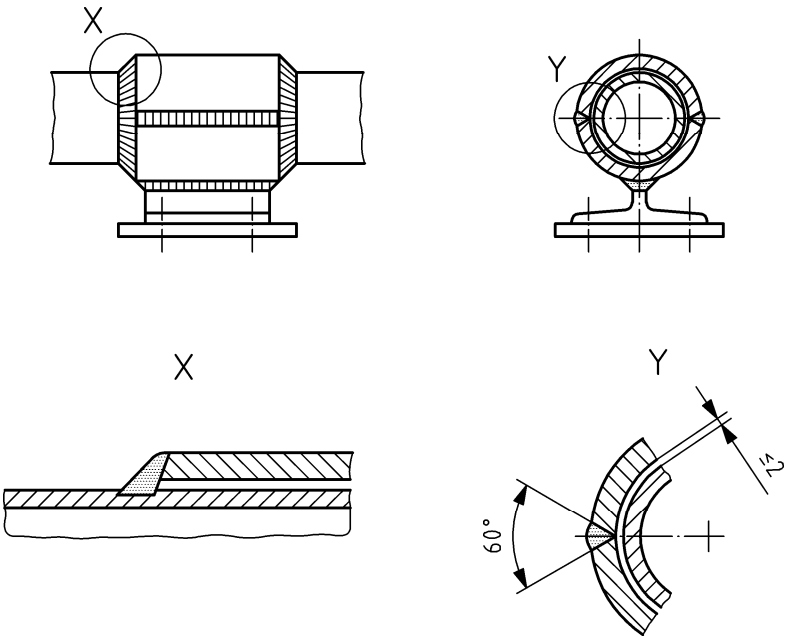
— a steel sleeve, at points where the pipework has to be fixed in a particular direction. The sleeve shall be attached to the pipe with girth welds (see Figure 18);

  — any longitudinal welds shall be made first; the sleeve shall still be free to turn round the pipe after this operation;

  — the first end fillet weld shall be made after the longitudinal welds have cooled; this weld shall be allowed to cool before the second end fillet weld is made;

  — the supports or anchors shall then be welded on;

  — the gap between pipework and sleeve shall not exceed 2 mm.



Key
X Detail A
Y Detail B

Figure 18 — Steel fixing sleeve around pipework

8.12 Installation of pressure regulating systems

8.12.1 Protection of the installation space

8.12.1.1 Breather apertures

Where gas can escape from apertures in ancillaries with a diameter exceeding 1 mm it shall be conveyed to a safe place, with or without a flame arrester.

Gas escaping through apertures in ancillaries can result in a flammable mixture in an enclosed space. To avoid this, at least one of the following provisions should be used:

— the apertures are fitted with vent pipes outside the room;

— restrictions added to breather connections, provided the operational performance in not impaired;

— extra ventilation added to the room.

The above apertures also include breather holes serving diaphragms in pressure regulators and safety devices. If vent pipes are fitted to these apertures, they shall be of sufficient capacity so that gas can escape freely and the functioning of any pressure regulators and safety devices is not adversely affected by pressure build-up in the line.

8.12.1.2 Location of outlets from vent pipes

Gas escaping from outlets outside enclosed spaces can lead to a hazardous area depending on operational and environmental conditions which should be taken into account. Therefore, generally in this area there shall not be any sources of ignition and be in safe distance from any doors or windows.

8.12.1.3 Discharge opening of creep relief valve

Gas escaping from a creep relief valve shall be conveyed to a safe place. Flame arrestors shall not be fitted to relief valve vent pipes.

8.12.2 Construction requirements

8.12.2.1 Precautions

Suitable precautions shall be taken to prevent unauthorised and/or accidental manual operation or alteration of the settings of gas pressure regulating and metering systems, gas pressure boosters/compressors and gas mixers.

8.12.2.2 Pressure balancing

Where necessary, a means shall be provided to balance the pressure across a high pressure slam shut device, to allow it to be reset.

EXAMPLE Two facilities are generally required to enable resetting of the high-pressure slam shut device after lock-out, each comprising a manual vent valve and ventline:

a) one with a vent valve (K2) fitted between the filter (F) and the high-pressure slam shut device (DA) in Figure 9, except where the supplier states that it is possible and permissible to open the high-pressure slam shut device in the prescribed manner at the prevailing differential pressure between inlet and outlet;

b) one with a vent valve (K3) fitted between the pressure regulator (DR) and the outlet valve (A2) in Figure 9.

8.12.2.3 Combined control and safety devices

Where control and/or safety functions are incorporated in a single unit, each function shall operate independently.

9 Documentation, inspection and testing

9.1 General

Prior to strength and tightness testing, the pipework shall be inspected for compliance with the design requirements. Inspection shall also ensure that the pipework is safe for subsequent purging and placing into operation. It is essential that the technical file and operating manual is available for those involved in the process of inspection. The inspection shall comprise at least the following items:

— examination of joints;

— verification of materials and components;

— checking the route and construction of pipework;

— checking for the correct use of safety markings and signs;

— verification of corrosion protecting measurements.

The results of the inspections and associated operations shall be recorded.

9.2 Documentation

9.2.1 General

The designer of the system shall produce sufficient written information concerning its design, construction, examination, operation and maintenance in form of a technical file. This has to be appropriate for the size and complexity of the system in order that the system may be used and maintained by the user in a safe condition.

9.2.2 Technical file

The technical file shall contain at least the following information:

1) a diagram of the installation pipework;

2) details of design standards used, evidence of testing of materials and components together with any certificates issued by test bodies/manufacturers;

3) DP and temperatures, maximum and minimum;

4) flow rates and discharge capacities;

5) function and duty of protective controls;

6) corrosion allowances;

7) material wall thicknesses of pipes;

8) materials of construction and design calculations, where performed;

9) welding standards and test procedures;

10) commissioning procedures;

11) testing and retesting procedures;

12) purging procedures or methodology;

13) setting of pressure regulators and safety devices;

14) operating manual;

15) decommissioning and maintenance procedures including in-service inspections.

After inspection and testing, the technical file shall be completed by the recorded results of inspection and testing.

9.3 Inspection

9.3.1 Joint inspection

9.3.1.1 Welding of steel

9.3.1.1.1 Inspection criteria of welded joints

Adequate weld quality shall be assured by visual inspection and non-destructive and/or destructive examination.

The results shall be recorded in writing.

Welding on pipework shall be inspected such that the quality of each welder's work can be adequately evaluated.

The minimum extent of non-destructive examination shall be in accordance with Table 22, with a minimum of three welds.

The number of welds examined by non destructive examination shall be spread evenly over the different diameters.

Reports on weld quality shall be available for the welds examined non destructive examination.

No radiographic examination is required in the following cases:

— if DN is less than or equal to 50 and the OP is less than or equal to 2 bar;

— if DN is less than or equal to 25.

Table 22 — Minimum extent of non-destructive examination

Quality category on the basis of DP and parent metal	Type/position of weld	Visual examination by welding expert	Radiographic and/or ultrasonic examination	Surface crack test
DP: ≤ 5 bar and parent metal: Group 1 as per EN ISO 15614-1 Yield strength: $R_{t0,5} \leq 360$ N/mm^2	Circumferential welds on pipes and pipe fittings $R_{t0,5} \leq 360$ N/mm^2	10 %	10 %	
	Branches, fillet welds	10 %		10 %
	Longitudinal welds	100 %	10 %	
DP: 5 bar to 16 bar and parent metal: Group 1 as per EN ISO 15614-1 Yield strength: $R_{t0,5} \leq 360$ N/mm^2	Circumferential welds on pipework and pipe fittings $R_{t0,5} \leq 360$ N/mm^2	20 %	10 %	
	Pipework in built-up areas	20 %	10 %	
	Branches, fillet welds	100 %		10 %
	Longitudinal welds	100 %	100 %	
	Welds which cannot be tested hydrostatically	100 %	100 %	
DP: > 16 bar or parent metal: unalloyed steel or low-alloy steel Groups 1-3 as per EN ISO 15614-1 Yield strength: $R_{t0,5} \leq 360$ N/mm^2	Circumferential welds on pipes and pipe fittings $R_{t0,5} \leq 360$ N/mm^2	100 %	20 %	
	Circumferential welds on pipes and pipe fittings $R_{t0,5} \geq 360$ N/mm^2	100 %	20 %	
	Branches, fillet welds	100 %		20 %
	Longitudinal welds Sweepolets	100 %	100 %	
	Welds which cannot be tested hydrostatically	100 %	100 %	
	Pipework/units (appliances) installed in built-up areas	100 %	100 %	

9.3.1.1.2 Examination and testing of welds

The quality of the welding shall be inspected visually as far as possible as work progresses. The application of equivalent acceptability standards for other non-destructive examination procedures shall require advance approval on a case-by-case basis.

The welds shall be examined radiographically and/or to enable the quality of the welding, and the competence of the welders, to be assessed. If one or more unacceptable welds are found in the random sample, another 10 % of the unexamined welds and the repaired welds shall be examined.

All welds in pipework at crossings with civil engineering works (roads, railway tracks, watercourses) and all tie-in welds and weld repairs shall be subjected to full (100 %) non-destructive examination.

Non-destructive examination shall be carried out in accordance with following standards:

— visual inspection of joints: EN 970, EN 12732;

— ultrasonic examination: EN 583-1, EN 1714 EN 12732;

— radiographic examination: EN 1435;

— magnetic testing: EN 1290;

— penetrant testing: EN 571-1.

9.3.1.1.3 Non-destructive examination — Acceptance requirements for welds

Quality levels for imperfections shall be in accordance with EN ISO 5817.

9.3.1.1.4 Repairing welds

Before proceeding with a repair, consideration shall be given to whether the repair can reasonably be expected to improve the quality of the weld. If not, the weld shall be rejected. Rejected parts of welds shall be cut out of the pipe and re-welded and then re-inspected.

Parts of welds containing unacceptable defects shall be removed by grinding or cutting down to sound metal before proceeding with repair. Slag and oxide deposits shall be removed. Repairs shall be carried out in accordance with an approved procedure. No further repairs are permitted on repaired parts of a weld. All repairs shall be examined.

9.3.1.1.5 Testing personnel

Destructive testing and non destructive testing shall be carried out by competent persons who are appropriately qualified for the duties they are to perform according to an appropriate recognised international or national standard. Non destructive examination personnel shall at least be qualified to level 2 of EN 473.

NOTE All companies providing such personnel should be certificated according to an appropriate standard (e.g. EN ISO/IEC 17020).

9.3.1.2 Brazing of copper

Non-destructive examination of brazed joints shall be in accordance with EN 12799. See also EN 1775.

9.3.1.3 Welding of Thermoplastic

Joints shall be inspected according to EN 13100-1 and EN 12007-2.

9.3.2 Corrosion protection

9.3.2.1 Coatings on buried pipework

After pipe joints, bends and fittings have been site coated, and any visible coating damage has been repaired, the coating shall be checked for defects with a spark tester (holiday detection).

If air is trapped under the wrapping, this shall be removed.

NOTE If required, the peeling force can be measured in accordance with EN 12068.

9.3.2.2 Above ground protection

Protection shall be in accordance with 8.8.2 and applied in accordance with the instructions of the paint supplier.

9.3.3 Recording of test results

Each inspected component shall be indicated in a sketch or logbook and in the technical file and shall be clearly traceable in the examination and radiographic reports (see also EN 12327).

9.4 Testing

9.4.1 General

Pipework shall be strength and leak tightness tested prior to purging.

Testing procedures can use hydrostatic or pneumatic means according to size, pressure and materials in accordance with EN 12327. A range of methods is available for performing these tests, some of which are detailed in informative Annex B.

NOTE 1 National legislations may prohibit some test procedures.

NOTE 2 Pneumatic testing is normally acceptable for systems with an MOP less than or equal to 5 bar.

NOTE 3 In some cases, pneumatic strength and leak tightness testing can be combined.

All joints in accessible pipework installed after pressure testing shall be bubble tested with a foaming agent, using nitrogen or air as the test medium.

Leak detection fluids shall comply with EN 14291. Leak detection fluids shall be selected so as not to cause corrosion or failure of pressure parts and the fluid should always be removed by washing, drying, etc.

NOTE 4 For components made of stainless steel, the level of Chloride (Cl-) in the leak detection fluid should be below 30 mg/l.

9.4.2 Instrumentation

Pressure testing instruments and pressure recorders shall have valid calibration certificates. Instruments shall be selected such that:

— the range shall be suitable for the test pressure. The test pressure should preferably be within 60 % to 100 % of the full scale reading of the instrument. The instrument shall be able to display the reading [resolution] to better than 1 % of the full scale reading within 1 second;

— the accuracy of the instrument shall be better than 2 % of full scale;

— the repeatability shall be better than 0,6 % of full scale at ambient conditions;

— the instrument shall be able to withstand an overpressure of not less than 10 % of full scale without failure;

— electronic instruments shall stabilise within 15 minutes under ambient conditions;

— electronic instruments shall have low battery indication and shall perform within specification;

— the instrument need not be of a type intended for use in flammable environments unless used in explosive environments.

Reference may be made to EN 12327 for additional information.

Instrumentation used for test periods in excess of 30 minutes should preferably be insensitive to atmospheric pressure changes, i.e. they should incorporate absolute pressure transducers.

Connections from test instrumentation shall incorporate a minimum number of joints.

Where hydrostatic testing is used, the instruments shall be suitable for the application and/or protected against water ingress.

9.4.3 Test Media

Pneumatic testing shall be performed with dry and oil free air or inert gas. Hydrostatic testing shall be performed with uncontaminated water at a temperature not less than 4 °C. Where stainless or austenitic steels are employed, the water shall have a halogen content of less than 30 ppm.

NOTE Above 30 ppm damage can occur to some steels and components.

Fuel gas shall not be used as a test media for strength tests on new installations.

9.4.4 Strength testing

A pneumatic or hydrostatic strength test shall be applied prior to the tightness test. However, pneumatic strength testing can occur concurrently with the tightness test.

The test safety distance around the exposed pipework should not be less than that given in Table 23 for metallic pipe or 5 m for PE pipe. Otherwise appropriate precautions shall be taken. Only authorized and experienced test personnel shall be permitted to enter the safety distance during testing above 5 bar.

NOTE Hydrostatic testing is not always a practical option, particularly in those cases where the pipework contains installed pre-tested components, e.g. valves, meters, or where it is impossible to vent air from high points or where it is impossible to drain and dry the system.

Table 23 — Test safety distance

Test pressure (STP/CTP) bar	**Nominal pipe size** DN	**Pneumatic test**	**Hydrostatic test**
		M	
		Minimum safety distance (L_{vg})	Advised free safety distance
≤ 5	≤ 50	0	0
≤ 5	> 50 ≤ 600	5	5
≤ 20	≤ 300	5	5
≤ 20	> 300 ≤ 600	15	5
> 20	≤ 400	see formula	5

The safety distances in Table 23 above are calculated for pneumatic testing from:

$$L_{\mathrm{vg}} \geq 3 \times 10^{-4} \times D \sqrt{D(p_{\mathrm{t}} - p_{\mathrm{t}}^{0,714})}$$

where

L_{vg} is the safety distance for the pneumatic test, in m;

p_t is the *STP*, in bar (*STP* > 1 bar);

D is the nominal pipe size, in mm.

Pre-tested or certified components can be removed during a strength test.

The minimum STP shall be in accordance with Table 9. It shall be verified that all components are designed for this pressure.

The test duration shall be such as will reliably expose any defects in the construction that might lead to failure of the pressurised parts. Any defects shall be rectified.

The minimum temperature stabilisation and test periods for hydrostatic testing of metallic pipework shall be 15 minutes up to and including an STP of 5 bar, and 30 minutes for an STP above 5 bar.

Pipework with an STP above 5 bar should be hydrostatically tested.

9.4.5 Tightness testing

Prior to purging, a tightness test shall be performed. The test duration shall be such as will reliably expose any defects in the construction that might lead to gas leakage. The pipework shall be allowed to stabilise to ambient temperature before the tightness test commences.

The tightness test pressure shall be not less than the OP.

Where a leak is discovered, it shall be investigated and then repaired after reducing the pressure.

An exception is made for components within the pipework which cannot be included in the tightness test. These components shall be tested at the prevailing gas pressure immediately after commissioning.

9.4.6 Procedure for strength and tightness testing

If the test pressure exceeds 5 bar, a test procedure shall be drawn up in advance. This procedure shall as a minimum define:

a) the final test pressure and the way in which it is achieved;

b) the test medium;

c) practical preparations;

d) functioning and use of the test equipment;

e) any additional measures to be taken at critical points in the pipework.

Sudden changes in pressure within the pipework shall not be permitted. When performing pneumatic testing, the increase and decrease of pressure above 5 bar should be in increments of 10 % of STP.

On completion of hydrostatic testing, the water shall be immediately drained and the system dried to a dewpoint of - 20 ºC, or a vacuum of less than 100 mbar absolute.

9.4.7 Safety during tests

A test safety distances (see 9.4.4) shall be maintained during strength and tightness testing, within which no other work shall be performed while the tests are in progress.

The following measures shall be taken before and during testing:

— during pressurisation and testing, only individuals involved in the testing shall be allowed access to the test area; access to the area shall be restricted to a minimum;

— the necessary instructions shall be given to individuals working in the immediate vicinity of the test area but not involved in the testing; the area shall be marked if required.

While testing with gaseous media, the pressure in the pipework shall be increased and reduced gradually in accordance with the testing procedure.

9.4.8 Hot tapping

In hot tapping procedures, the strength and tightness of the branch shall be tested with air or an inert gas after installation of the isolating valve and before perforating the pipe wall.

9.4.9 Pressure regulating systems and ancillaries

Pressure regulating installations including all components shall either be pressure tested [strength and tightness as appropriate] by the manufacturer or be included within the testing procedure for the pipework.

NOTE It can be dangerous to introduce water to certain components on site such as pressure regulators, safety valves, gas meters, etc.

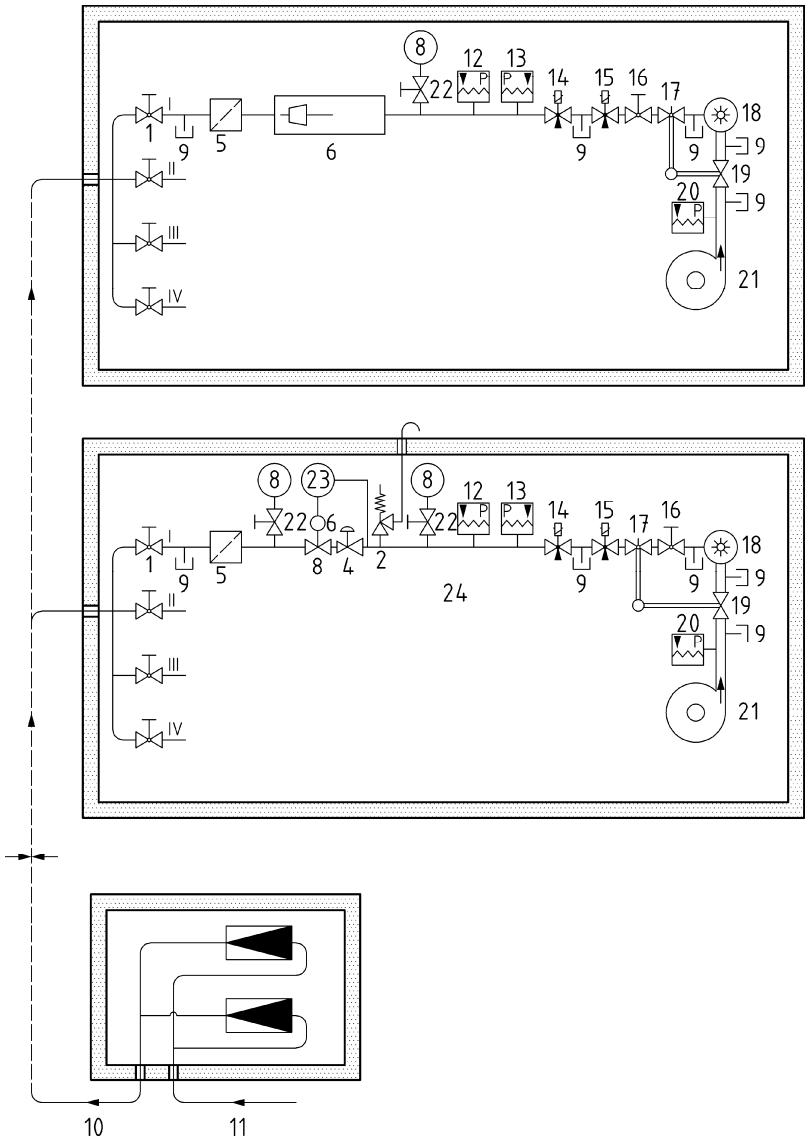
Equipment, pipes, ancillaries and gasket materials of all gas pressure regulating and metering systems, gas pressure boosters/compressors and gas mixing systems shall be capable of withstanding at least the DP associated with the MOP. This is specified in Table 9, together with the test pressure.

For outlet sections after a protected gas pressure regulating system with a DP not given in Table 9, the STP shall be 1,43 times the MIP.

9.4.10 Recording of test results

Each tested component shall be indicated in a sketch or logbook and in the technical file and shall be clearly traceable in the examination and radiographic reports (see EN 12327).

Annex A
(informative)
Example schematic diagrams of installation options for gas pressure regulating systems

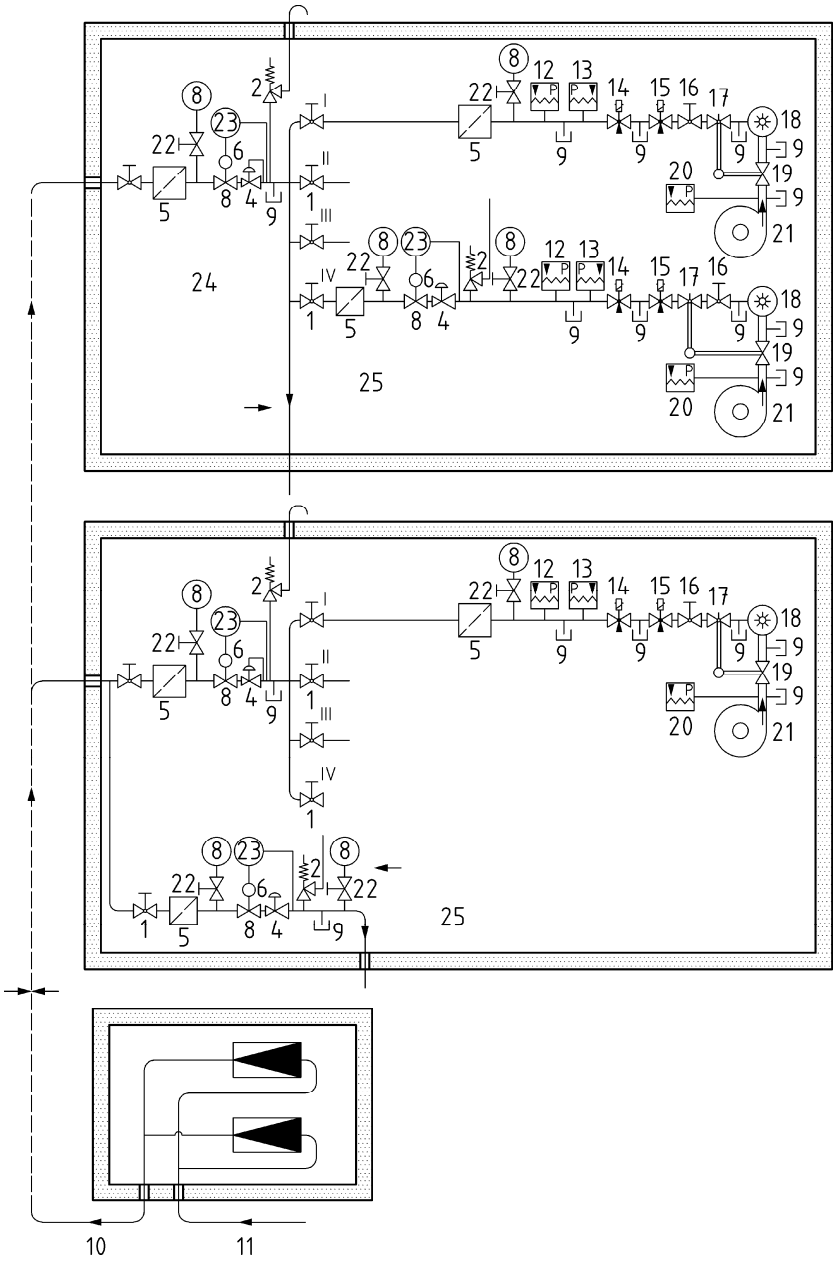


Key

1	Isolating valve	2	Creep relief valve
3	Slam shut device	4	Gas pressure regulator
5	Filter/strainer	6	Turbine gas meter
7	Gauge valve	8	Pressure gauge
9	Measuring point	10	High gas pressure switch
11	Low gas pressure switch	12	Low air pressure switch
13	Safety valve	14	Gas flow regulator
15	Air flow regulator	16	Ventilator
		17	Burner

NOTE Location of the gas delivery station will be specified in consultation between the consumer and the gas suppler.

Figure A.1 — Examples 1 and 2



Key

1	Isolating valve	2	Creep relief valve
3	Slam shut device	4	Gas pressure regulator
5	Filter/strainer	6	Turbine gas meter
7	Gauge valve	8	Pressure gauge
9	Measuring point	10	High gas pressure switch
11	Low gas pressure switch	12	Low air pressure switch
13	Safety valve	14	Gas flow regulator
15	Air flow regulator	16	Ventilator
		17	Burner

NOTE Location of the gas delivery station will be specified in consultation between the consumer and the gas suppler.

Figure A.2 — Examples 3 and 4

Annex B
(informative)

Examples of methods for testing

B.1 General

Further information about testing can be obtained from below or from the following standards:

EN 1775, *Gas supply — Gas pipework for buildings — Maximum operating pressure less than or equal to 5 bar — Functional recommendations*

EN 1779, *Non destructive testing — Leak testing — Criteria for method and technique selection*

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

EN 13184, *Non-destructive testing — Leak testing — Pressure change method*

EN 13185, *Non-destructive testing — Leak test — Tracer gas method*

EN 13480-5, *Metallic industrial piping — Part 5: Inspection and testing*

EN 13625, *Non-destructive testing — Leak test — Guide to the selection of instrumentation for the measurement of gas leakage*

B.2 Strength test on metallic pipework

B.2.1 Duration

The duration of the strength test is given in 9.4.4.

NOTE At pressures below 2 bar, shorter durations may be acceptable.

B.2.2 Conditions

The following conditions shall apply:

— valves, if installed, in a section under test should be set in the half-open position, so that the valve body is also tested;

— pressure should not be applied to a valve carrying gas on one side. With flanged joints, a spectacle blind of sufficient strength shall be fitted;

— sensitive instruments, such as pressure stats, pressure transmitters, etc., shall be disconnected during the strength test, if the bodies of these instruments are not capable of withstanding the prescribed MIP, but impulse lines, measuring lines, buffer vessels, etc., should be subjected to strength testing;

— to prevent damage to gas pressure regulators, control valves, etc., during the pressure testing, they can be removed or isolated (where necessary by fitting a spectacle blind) during the strength test. In such

cases, test certificates issued by the manufacturer or supplier are required. In the absence of a certificate, the equipment concerned can be subjected to a separate strength test;

— where pipework consists of different materials, each section should be tested separately;

— where the pipework includes expansion bellows these should be removed or isolated prior to strength or pneumatic testing.

B.2.3 Pneumatic testing

Nobody should be allowed inside the safety zone during pressurisation, unless they are involved in carrying out the test.

Nobody should be allowed inside the safety zone during the “waiting time”, which commences once the pressure is raised to a higher level. The waiting time is the time, which should be allowed before raising the pressure to the next level. Waiting time is calculated as follows:

Waiting time (in seconds) = 10 $\times$ safety distance L_{vg} (with a minimum of 300 s).

This pressure should be maintained during the waiting time. The joints (including welds) should then be checked for leaks using a foaming liquid.

Any leaks detected should be repaired after depressurising the pipe and the test should be repeated.

The test commences by increasing the pressure to a value of 0,5 times STP. The procedure should then be repeated in steps of 0,1 times STP until pressure p_t is reached, but without checking for leakage.

The strength test pressure should be maintained for a duration of at least 0,5 h and then reduced to below the DP.

The objective of tightness testing of new pipework should be to ensure it is leak free. The test duration should reflect this objective. It has to be accepted however that some components such as valve stem seals can have a small leakage.

B.2.4 Hydrostatic testing

Where there is a difference in height between the highest and lowest points of more than 20 m, a check should be made to ensure that the DP of the lowest section is adequate to accommodate the increase in pressure due to the liquid column. If necessary, the pipework should be tested in sections.

The pressure gauge for reading the test pressure should be fitted at the highest point.

The pipework should be vented during filling.

Care should be taken to prevent the test pressure rising to an excessive level due to temperature effects.

In this test, the pressure in the pipework should be recorded every half hour to an accuracy of 0,5 bar.

The joints should be checked for leaks at the beginning, during, and at the end of the minimum test period.

No additional water shall be pumped into the pipework during the test.

There should be no leakage from any part. The system should be depressurised before any repair.

After the test, the pipework should be drained and dried as necessary.

B.2.5 Pressure assessment

The pressure should be read at the beginning and end of the test.

Loss of pressure during the test should not exceed 5 % of the test pressure.

NOTE Compensation for pressure loss due to leakage by the addition of test medium is permitted during the strength test. It should be decided on the basis of the type of leak (to be determined in the tightness test) whether a repeat of the strength test is necessary.

B.3 Tightness test on metallic pipework

B.3.1 General

A tightness test should be preceded by a strength test or combined with a pneumatic strength test.

If a difference in pressure during the test cannot be explained by changes in temperature and/or atmospheric pressure, even after significant extension of the test period, appropriate measures should be taken.

The duration of the tightness test depends on the test procedure used.

The test procedure to be used depends on whether all, part, or none of the pipework can be inspected visually during the test.

NOTE The dynamic viscosity and density of gases are considerably lower than those of liquids. Smaller leakage sources can therefore be detected when testing with gases. For large volume installations it is more practical to use liquid, see B.2.4.

B.3.2 Pipework which can be inspected visually

B.3.2.1 Conditions

All sensitive equipment previously removed for the strength test should be reinstalled.

Underground steel pipework should not be covered.

Joints (welds and flanges) and ancillaries should not be coated.

Access to the complete pipework should be such that it can be inspected in safety. Scaffolding and retaining walls should not be removed until the inspection has been completed.

Joints should be protected from rain when necessary.

B.3.2.2 Tightness test using a pressure gauge

Where this test method is used, special care should be taken with any sensitive measuring instruments.

The pressure gauge should at least comply with the requirements of accuracy class 0,6. See EN 837-1.

The joints should be checked for leaks at the beginning, during, and at the end of the minimum test period.

The duration of the test should be between 2 h and 6 h. The duration should be 6 h for pipework incorporating flanged and threaded joints.

B.3.2.3 Locating of leaks

B.3.2.3.1 Flanged and threaded joints and gaskets

Leaks at flanged and threaded joints should be checked at the test pressure using for example foaming liquid, see 9.4.1.

Any leaks detected should be repaired and the tightness test should be repeated. Depending on the nature of the leak, the repeat test at the prevailing gas pressure may be performed at a later time.

B.3.2.3.2 Welded joints

Leaks at welded joints should be checked for using a foaming liquid at a pressure of approximately 1 bar, or lower if this is necessary in connection with the DP. A higher pressure can be necessary in some cases.

The test duration should be as long as necessary for proper inspection.

B.3.3 Pipework which cannot be inspected fully by visual means

B.3.3.1 Conditions

All sensitive equipment previously removed for the strength test should be reinstalled.

The quality of the coating on steel pipework should be checked before any trench is back-filled.

When testing pipework or a section of pipework still to be buried it should be covered with soil as far as possible to minimise temperature effects.

The test duration should not commence until the pressure in the pipework has stabilised.

B.3.3.2 Differential manometer and reference vessel (using air or inert gas as test medium)

B.3.3.2.1 General

This test is intended for large volume buried high pressure installations.

B.3.3.2.2 Procedure

The pipework under test should be connected to a reference vessel and raised to the test pressure. After the stabilisation period, of at least 1 h/bar, to allow the temperature of the pipework and vessel to equalise, the connection between the pipework and vessel should be broken and a differential manometer should be interposed.

The reference vessel should be buried at a sufficient depth or connected to the pipe in such a way that its temperature follows that of the pipework under test as closely as possible.

The volume of the reference vessel should be at least 1 500 times the volume of the connecting hose between the reference vessel and the differential manometer plus the volume of the manometer leg to which it is connected.

The test should commence after the stabilisation period and as a general rule should continue for 24 h.

The differential manometer should be readable to an accuracy of 0,1 mbar.

The test pressure should be equal to the DP.

At the end of the test period the difference between the pressure in the pipework under test and that in the reference vessel should be determined.

B.3.3.3 Pressure balance test

B.3.3.3.1 Test medium

Water

B.3.3.3.2 Test procedure

The test relies on the principle that a given quantity of enclosed water of constant volume does not change in pressure if the volume of the 'vessel' remains constant. This method requires accurate measurement of the pressure, the temperature and the volumes of water required for filling and pressurising. In view of its complexity, this method is not dealt with in detail in this standard. The test procedure is shown in Figure B.1.

B.3.3.3.3 Test pressures

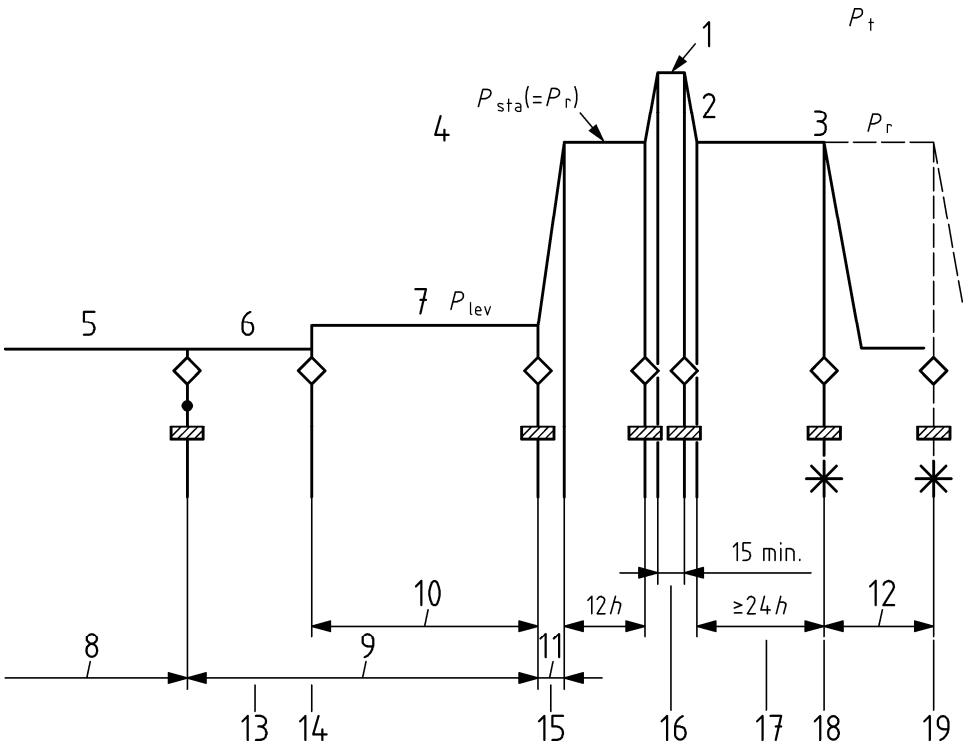
For the strength test, the pressure should be determined in accordance with Table 9.

For the tightness test, a lower pressure may be agreed.

B.3.3.3.4 Duration of test and result of calculations

The test should commence after the stabilisation period and as a general rule, should continue for 24 h.

Depending on the result, the test should be extended or repeated in full.



Key

1 Strength test
2 Draining
3 Tightness test
4 Stabilising
5 Preparation
6 Filling
7 Levelling
8 > 2 weeks
9 > 6 working days
10 Levelling time
11 pressure limit for stabilised condition
12 Possible extension
13 Stopping drainage by well points
14 Filling results
15 Levelling results
16 Possible “air check”
17 Results of measurements of the strength testand draining
18 Results of the tightness calculation
19 Results of the tightness calculation of the extended test

Figure B.1 — Hydrostatic test procedure (water)

B.3.3.3.5 Evaluation of test result

Pipework can be considered gas tight if the pressure loss during a 24-hour test period is less than 50 mbar.

B.4 Strength and tightness test on PE pipework

PE pipework should be gas tight with inlet(s) and outlet(s) capped after strength testing. Pipework or pipework sections should be tested with air, inert gas or water in accordance with Table B.1 or Table B.2.

A tightness test should be carried out after a hydrostatic strength test, as indicated in Table B.1 or Table B.2.

Hydrostatic strength testing should be performed with a continuously recording manometer with an accuracy of 0,1 bar.

A tolerance of $^{+0}_{-1}$ bar is permitted on the stated pressures for hydrostatic strength testing.

Pneumatic strength and tightness testing within a built-up area should not be performed unless there is a clear need for doing so and additional precautions are taken at the welds in the pipework.

Pneumatic strength and tightness testing should be performed only with a continuously recording differential pressure gauge with an accuracy of 1 mbar.

A tolerance of $^{+0}_{-0,5}$ bar is permitted on the stated pressures for strength and tightness testing with air or inert gas.

If a reference vessel is to be used both the pipework and the vessel should be conditioned.

The pipework and reference vessel should be kept at test pressure for 24 hours before tightness measurements commence.

When pneumatic testing, precautions should be taken to prevent oil from the compressor entering the pipework. The temperature of the air at the point where it enters the pipe should not exceed 40 °C.

The pipework is approved if any pressure rise or fall during testing can be satisfactorily attributed in its entirety to temperature differences or other natural phenomena occurring during testing. If the test is run for 24 hours, a constant fall in pressure invariably indicates a leak.

Any leak or other defect revealed by the test should be repaired. After repair, the test should be repeated to demonstrate that the pipe is sound.

Table B.1 — Testing PE pipes in accordance with 12007-2

Material	**PE 80**	**PE 100**	**PE 80**	**PE 100**
DP	**100 mbar**	**1 bar**	**6 bar**	**10 bar**
Strength test[a]				
Medium Subject to OP	Air, inert gas	Air, water, inert gas	See Table B.2	Air, water, inert gas
Test pressure	1 bar	2 bar	See Table B.2	1,43 × DP
Minimum duration	½ hour	8 hours	See Table B.2	24 hours
Tightness test[b]				
Medium	Air, inert gas	Air, inert gas	See Table B.2	Air, inert gas
Test pressure	200 mbar	1,1 × DP	See Table B.2	1,1 × DP
Minimum duration	1 hour	1 hour	See Table B.2	After conditioning 6 hours

[a] Weakest points can be detected during strength testing such as incorrectly assembled joints.

[b] The application of foaming liquids on PE pipes should be limited and should be done with products recommended by the manufacturer of the PE pipe. After using foaming liquids, the PE pipe should be well cleaned.

Table B.2 — Testing PE 80 pipes with a DP of 6 bar

Pressure class in accordance with	Description of test method	Type of test	Test method for diameters	
			≤ 160 mm	> 160 mm
SDR 17,6[c]	Hydrostatic strength test[a] followed by pneumatic tightness test	Strength test	6 bar for 24 h	
		Tightness test	Conditioning at 6 bar for 24 h followed by measurement at 6 bar for 6 h	
	Pneumatic strength test[a] followed by pneumatic tightness test	Strength test	6 bar for 24 h (also conditioning)	Not applicable[b]
		Tightness test	6 bar for 6 h	
SDR 11[c]	Hydrostatic strength test[a] followed by pneumatic tightness test	Strength test	10 bar for 24 h	
		Tightness test	Conditioning at 10 bar for 24 h followed by measurement at 10 bar for 6 h	
	Pneumatic strength test[a] followed by pneumatic tightness test	Strength test	10 bar for 24 h (also conditioning)	Not applicable[b]
		Tightness test	10 bar for 6 h	

[a] In this case, strength testing does not imply verification of the long-term (50 year) strength of the joints.

[b] In this range, it is uncertain whether a crack will stop, and there is a risk that a crack will continue to propagate over a considerable length. Pneumatic pressure testing should be preceded by detailed analysis by an expert.

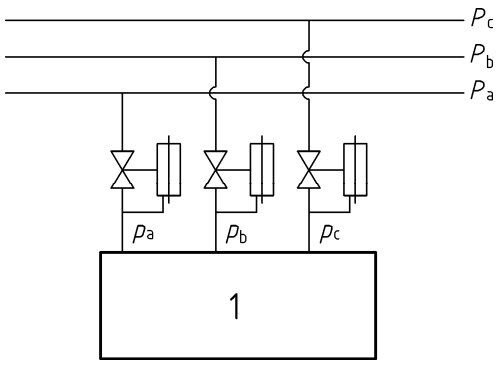
[c] Where a class SDR 17,6 pipe incorporates a class SDR 11 section, the pipe should be regarded as being entirely class SDR 17,6 for test purposes. If there are isolating valves at both ends of the SDR 11 section, the section should be tested in accordance with SDR 11.

Annex C
(informative)

Flammable gases mixing systems

C.1 Reverse flow

Reverse flow of one gaseous medium into the pipework of the other via the gas mixing system shall be prevented, for example by using a separate pressure regulating system for each of the component gases, as shown in Figure C.1, whereby in principle the pressure of each component entering the gas mixer and the pressure of the mixture itself is lower than the pressure in the line supplying each individual component.



$p_a < P_a$	$p_b < P_a$	$p_c < P_a$
$p_a < P_b$	$p_b < P_b$	$p_c < P_b$
$p_a < P_c$	$p_c < P_c$	$p_c < P_c$

Key

1 Appliance

Figure C.1 — Preventing reverse flow by ensuring that the supply pressures (P) are higher than gas mixer regulator outlet pressures (p)

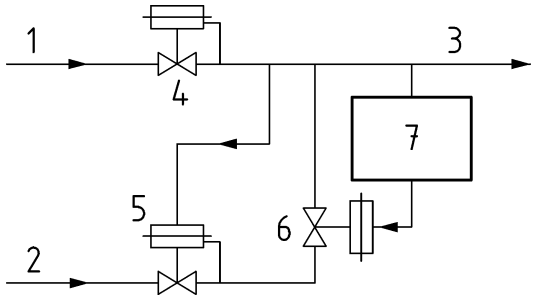
C.2 Control of mixture composition

Three examples of control systems are shown in Figure C.2, Figure C.3 and Figure C.4.

A feedback system in accordance with Figure C.2 may be used alone to control the composition of the mixture, provided that the response of the gas analyser, including the sampling line and any sample preparation steps, is sufficiently fast to accommodate possible changes in the volume flow of gas mixture.

If this requirement cannot be met, ratio control in accordance with Figure C.3 can be applied to the measured volume flows of the components for mixing, with ratio correction on the basis of the measured composition of the mixture.

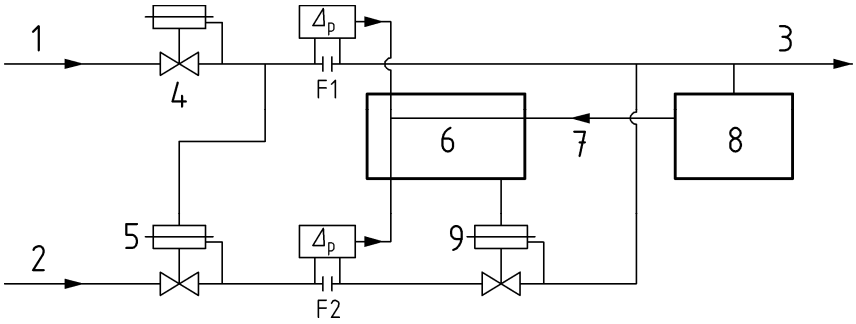
Instead of ratio control of the measured volume flow, ratio control can also be applied by means of an injector in accordance with Figure C.4.



Key

1	Component 1	4	DR1
2	Component 2	5	DR2
3	Mixture	6	RK
		7	Analyser + controller

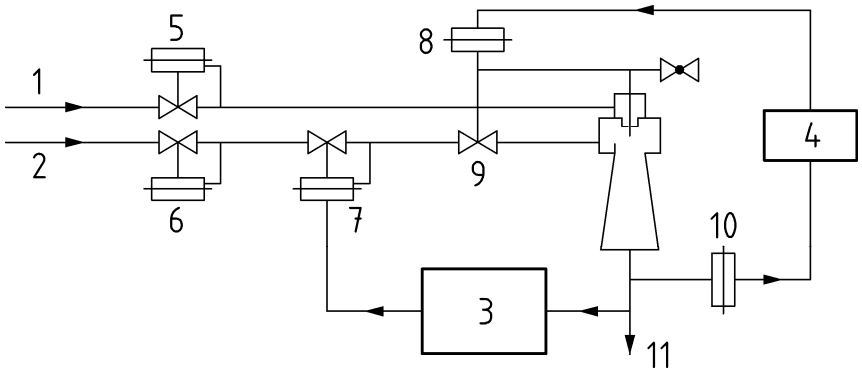
Figure C.2 —Gas mixing system based on equal-pressure mixing



Key

1	Component 1	5	DR2
2	Component 2	6	Ratio Controller
3	Mixture	7	Set point
4	DR1	8	Analyser + controller
		9	RK

Figure C.3 —Gas mixing system based on ratio control of volume flows



Key

1	Component 1	6	DR2
2	Component 2	7	DR3
3	Analyser + controller	8	PKM
4	Controller	9	TK
5	DR1	10	P-transmitter
		11	Mixture

Figure C.4 — Gas mixing system based on pressurised injector

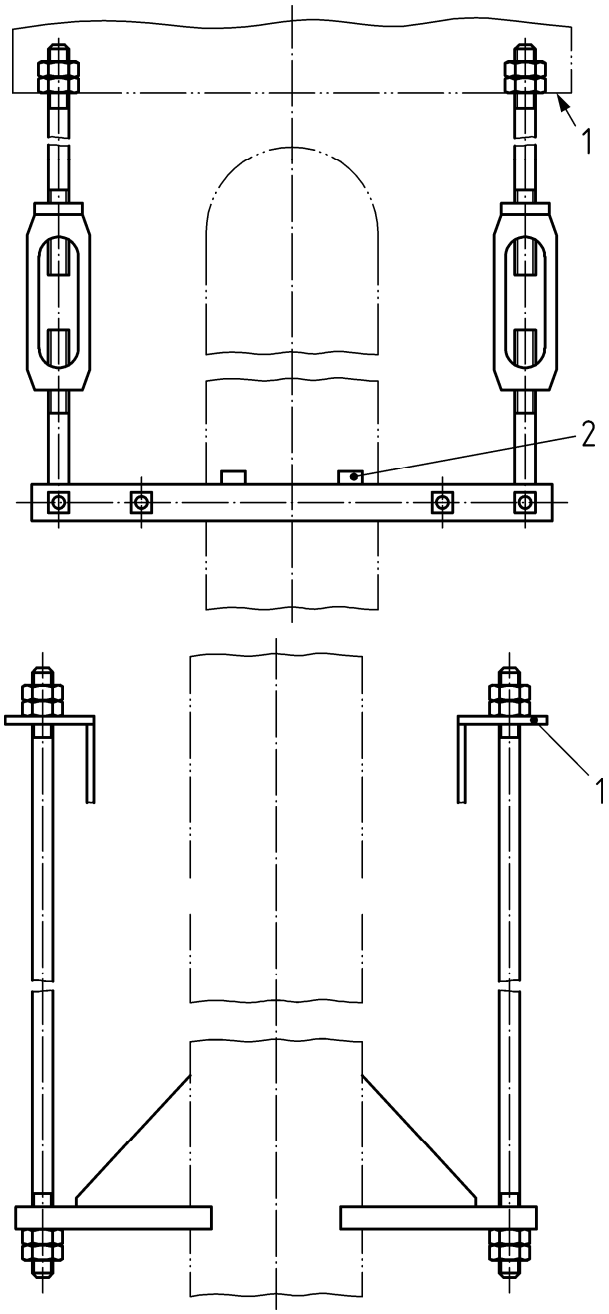
C.3 Matching pressures of components for mixing

In order to match the pressures of the components at the point of mixing, which is necessary for control of the mixture composition, and ensure a constant pressure drop across the control valve, the pressure of one component shall be controlled by the pressure of the other, as shown in Figure C.2, Figure C.3 and Figure C.4.

The pressure of any risk-creating gas shall be controlled as a function of any non-hazardous gas.

Annex D
(informative)

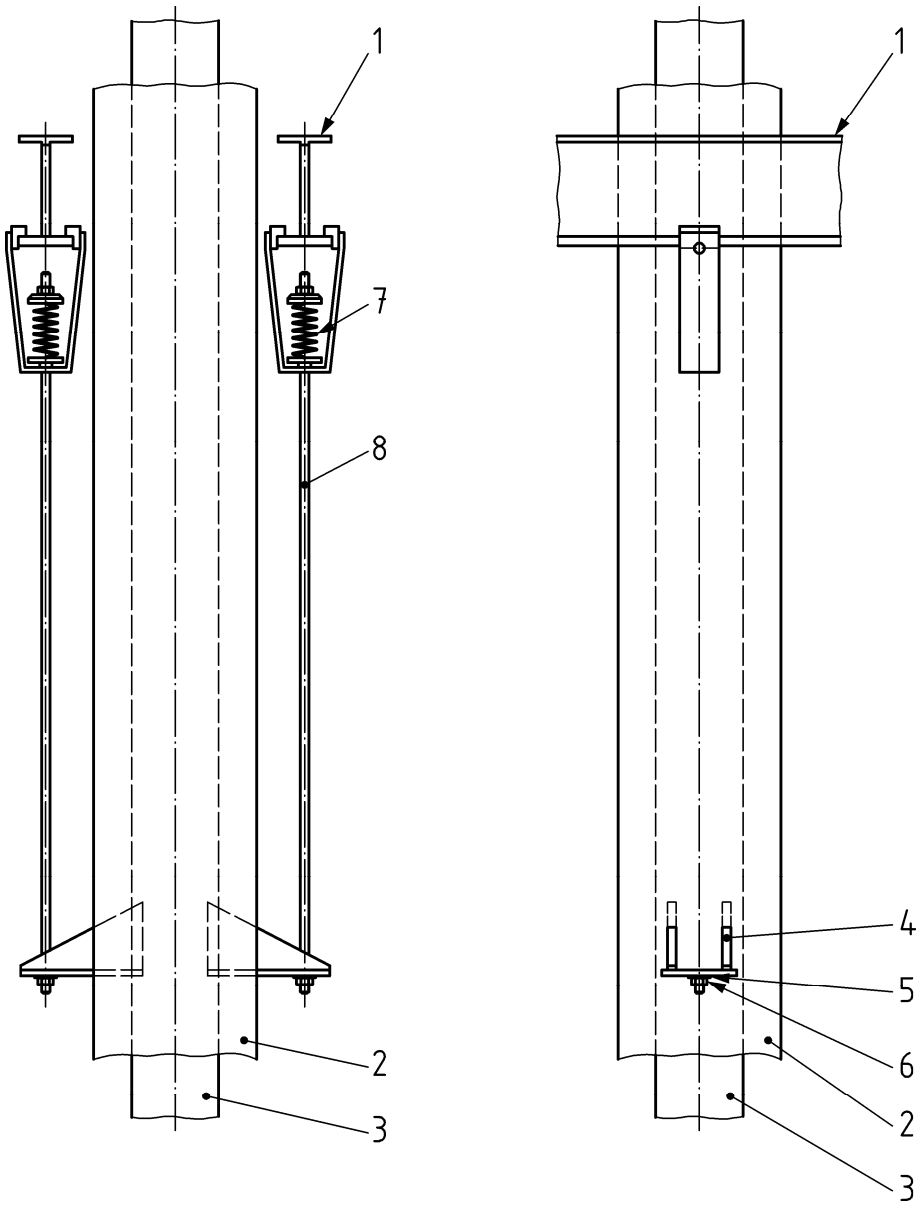
Examples of supports



Key
1 Supporting structure
2 Stop lugs

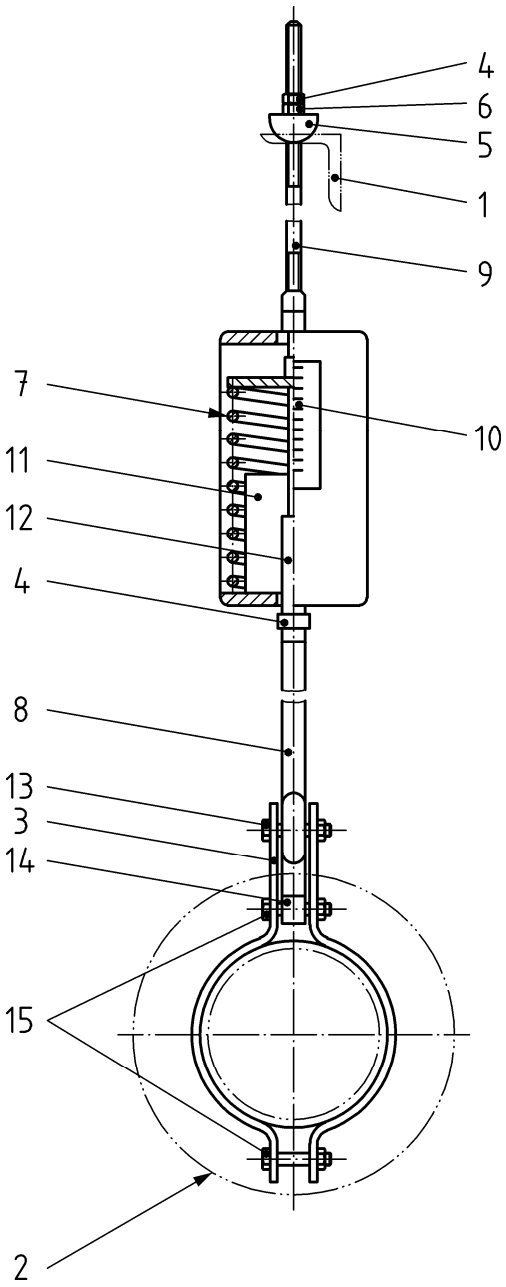
NOTE Alternative methods of supporting vertical runs of pipework, where some free movement is desirable. They are suitable for use with insulated or un-insulated pipework. Figure b is generally for heavier applications. Where multiple supports are necessary on the same run of piping, consideration should be given of spring hangers.

Figure D.1 — Hangers for vertical pipes



Key
1 Supporting structure
2 Wrapping
3 Pipe
4 Fabricated brackets welded to pipe
5 Spherical washer
6 Nut and locknut
7 Spring
8 Sling rod

Figure D.2 — Spring hanger for vertical pipes

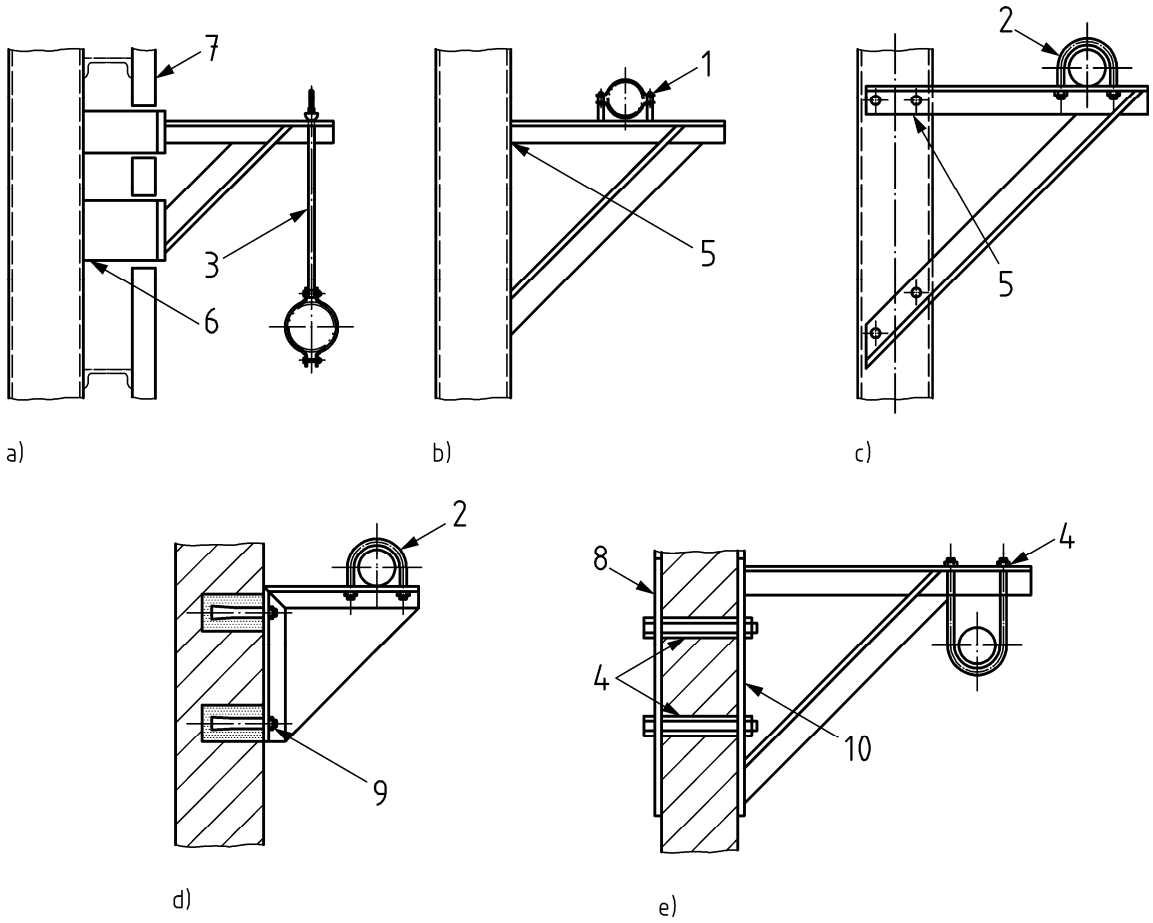


Key

1	Supporting structure	9	Spring rod
2	Wrapping	10	Load travel scale
3	Pipe clip	11	Travel stop
4	Lock nut	12	Screwed coupling
5	Spherical washer	13	Load bolt
6	Nut	14	Distance piece
7	Spring assembly	15	Clip bolt
8	Sling rod		

NOTE A variable load – spring type support used to accommodate positional changes of pipework resulting from thermal expansion, but it should only be used where load changes are relatively small. The spring housing carries the full load on the hanger.

Figure D.3 — Typical springs hanger assembly

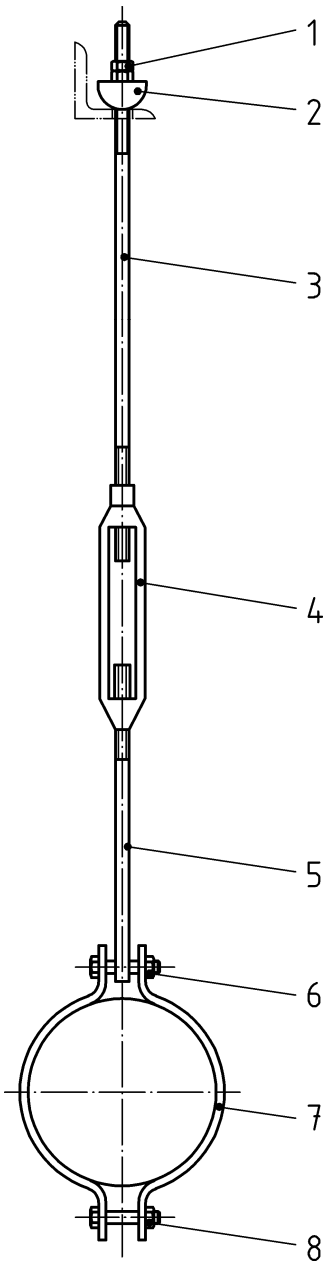


Key

1	Guides	6	Bolt or weld to steel column
2	U-bolt	7	Corrugated sheeting
3	Hanger	8	Backing plate
4	Tubular sleeves	9	Bolt to brick to concrete wall using masonry bolts
5	Bolt or weld to steel column	10	Bolt to brick to concrete wall

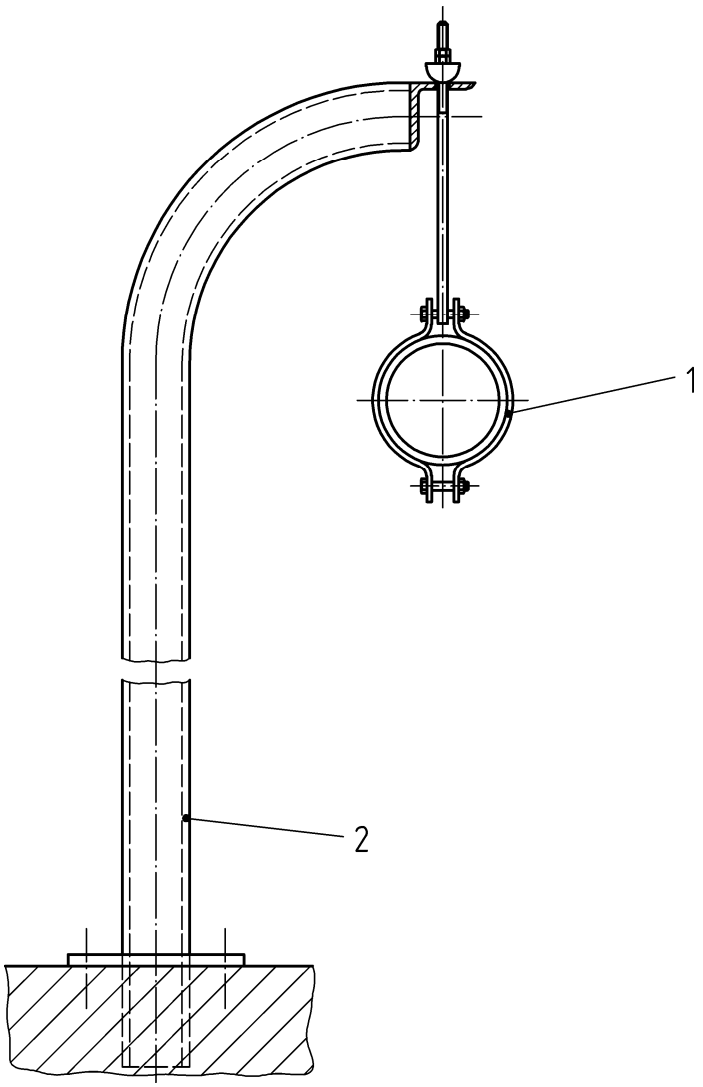
NOTE For attachment to structures or buildings to carry single or multiple runs of pipes.

Figure D.4 — Typical pipe support brackets



Key
1 Nut and locknut
2 Spherical washer
3 Sling rod
4 Turnbuckle (optional)
5 Sling rod
6 Load bolt
7 Pipe clip
8 Clip bolt

Figure D.5 — Hanger for un-insulated pipes

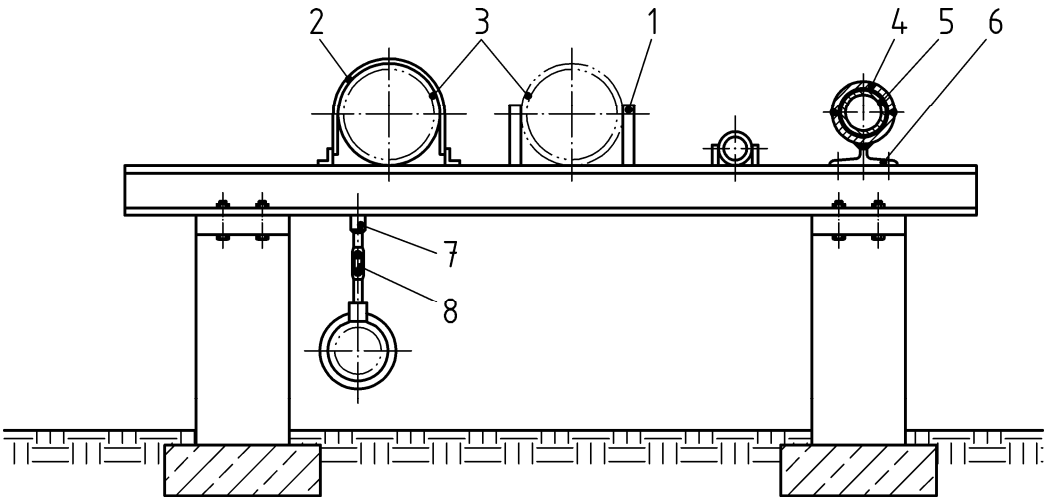


Key

1 Hanger
2 Tube

NOTE For suspending elevated runs of single pipe.

Figure D.6 — Tubular support for a single pipe

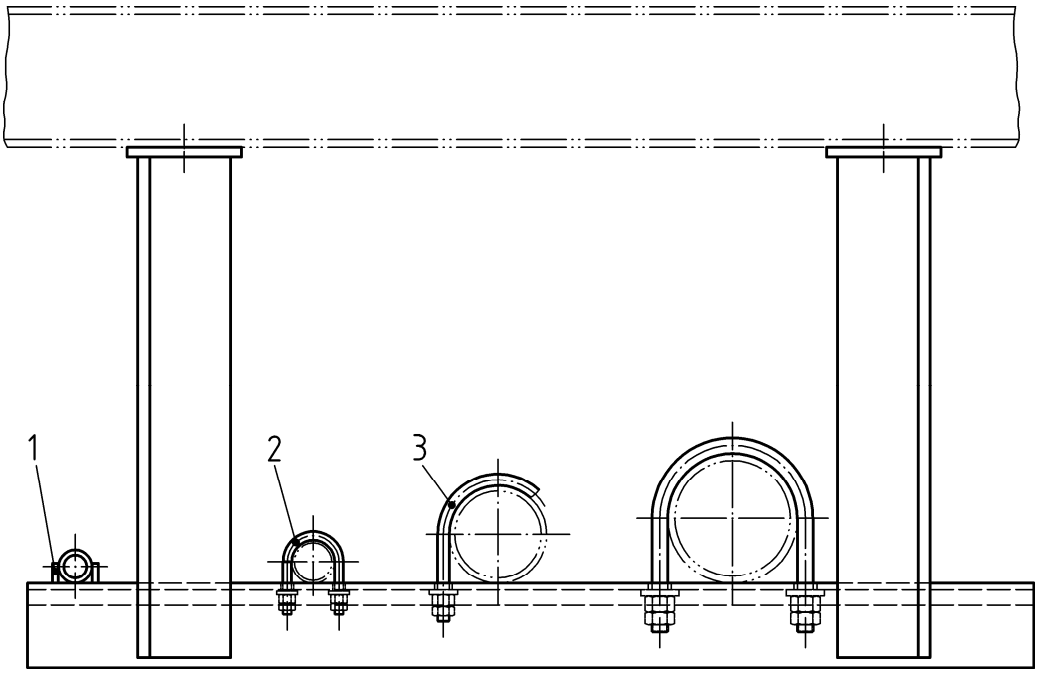


Key

1 Guides
2 Guides
3 Un-insulated pipes
4 Wrapped pipes elevated on slider or hung as shown
5 Sliders
6 Guides
7 Joist attachment
8 Hanger

NOTE For carrying multiple runs of pipelines at low levels.

Figure D.7 — Low-level trestle for multiple pipes



Key

1 Guides
2 U-bolt
3 Hook bolt

NOTE This simple form of support, attached below another structure, enables banks of pipes to be carried in the horizontal plane.

Figure D.8 — Suspended support for multiple pipes

Annex E
(normative)

Materials

E.1 General

The materials listed in the tables with relevant restrictions are suitable for the design of pressure containing parts complying with this document.

Table E.1 — Standards for carbon steel pipes

DP	Standard	Steel grade	Elongation (%)	Charpy V (J)>	Operating Temperature - 20 ºC to + 40 ºC	Upper Yield strength T≤ 16 mm N/mm²
≤ 5 bar	EN 10255	L195	20		x	195
≤ 16 bar	EN 10208-1	L210GA	25		x	210
		L235GA	23		x	235
	EN 10217-1	P 235 T1	23		x	235
	EN 10216-1	P 235 T1	23		x	235
> 16 bar	ISO 9329-2	PH 26	19	27	x	265

Table E.2 — Standards and material type for copper pipework and pipe fittings

	Standards	Material type
Soldered fittings	EN 1254-1 and EN 1254-5	Bronze or brass
Compression fittings	EN 1254-2	

Table E.3 — Nodular/Spheroidal graphite cast iron grades with elongation over 10 %

Standard	Ductility according to the standard		Designation	Required safety factor EN 13445-6
	Charpy V (J)>	Elongation (%)		
EN 1563	12 (at – 40 °C ± 2 °C)	22	EN-GJS-350-22-LT	2,4
	12 (at – 20 °C ± 2 °C)	18	EN-GJS-400-18-LT	2,4
	17 (at 23 °C ± 5 °C)	22	EN-GJS-350-22-RT	3,5
		22	EN-GJS-350-22	3,5
	14 (at 23 °C ± 5 °C)	18	EN-GJS-400-18-RT	3,5
		18	EN-GJS-400-18	3,5
		15	EN-GJS-400-15	3,5

Table E.4 — Materials for compression fittings, bolts, nuts, etc.

Materials			Restrictions	
Description	**Type**	**Relevant standard**		**DP** bar
Compression fittings	11 SMnPb30/1.0718 and 11 SMnPb37/1.0737 both with a min 8 % and $5 \leq d \leq 100$	EN 10087		60[a]
	All steel designations	EN 10088-3		
Bolts, screws, studs and nuts	Class 10.9	EN ISO 898-1		50
	Class 10 for nuts	EN 20898-2		
	Class 4.6, 5.6, 8.8	EN ISO 898-1		60[a]
	Grade A2ss, A4ss	EN ISO 3506-1 EN ISO 3506-2		
	Classes 5, 8, 9 for nuts	EN 20898-2		

[a] These materials are generally applicable up to 100 bar.

Table E.5 — Materials for plastic pipes, fittings and valves

Materials		
Description	**Type**	**Relevant standard**
Pipes	PE 80 and PE 100	EN 1555- 2
Fittings	Various materials	EN 1555- 3
Valves	PE 80 and 100	EN 1555- 4
NOTE EN 1555 -1 and 5 apply to all components of the plastic pipe system.		

Valves, if applicable, shall meet the requirements of EN 331, EN 12266-1, EN 13774 and/or EN 14141.

E.2 Materials with a demonstrated safe history of application in this type of equipment

The materials in Table E.1 to E.5 are listed in Table E.6, which specifies the standards, regulations and codes of practices providing reliable examples of materials which have not been harmonised with PED but which have been used within the gas installation pipework over many years and which are recognised as being safe to use:

— with well-known characteristics, and

— with a well-established history of safe use in the pressure equipment field.

PED, Annex I, Clause 7 allows the application of these materials non-harmonised with PED if the "equivalent overall level of safety" is given.

Table E.6 — Materials not harmonised with PED but recognised as safe in use in relation to current and former national standards and codes and practices

European standard on materials referred to in prEN 15001-1	Steel grade referred to in the European standard	Corresponding national standard proofing the safe and appropriate use of the materials exemplified in …			
		Netherlands	France	Germany	United Kingdom
EN 10255	L195	NEN 2078, 1997	NF A49-145:1978	DIN 2440:1978 DIN 2441:1978	BS 1387
EN 1254-1	Bronze or brass	NEN 2078, 1997	NF E29-591:1980	DVGW GW 2:1997	BS 864-2,1983
EN 1254-5	Bronze or brass	NEN 2078, 1997	NF E29-591:1980		
EN 1254-2	Copper	NEN 2078, 1997	NF E29-591:1980		BS 864-2,1983
EN 1563	EN-GJS-350-22-LT EN-GJS-400-18-LT EN-GJS-350-22-RT EN-GJS-350-22 EN-GJS-400-18RT EN-GJS-400-18 EN-GJS-400-15	NEN 2078, 1997	NF A32-201:1987	DIN EN 1563:1977	BS 2789,1985
EN 10087	11SMnPb30/1.0718 and 11 SMnPb37/1.0737 both with a min 8 % and 5 ≤ d ≤ 100		NF A35-561:1992		BS 970-1,1996 BS EN 10083-1:1991 BS EN 10084:1998
EN10088-3	All steel designations	NEN 2078, 1997	NF A35-574:1990	DIN 17440:1985	BS 970-1,1991

Table E.6 *(continued)*

European standard on materials referred to in prEN 15001-1	Steel grade referred to in the European standard	Corresponding national standard proofing the safe and appropriate use of the materials exemplified in …			
		Netherlands	**France**	**Germany**	**United Kingdom**
EN ISO 898-1	Class 4.6,5.6,8.8,10.9	NEN 2078, 1997	NF E25-100:1985	DIN EN ISO 898-1:1997	BS 6104-1:1981 Replaced by BS EN 20898-1:1992, ISO 898-1:1988
EN 20898-2	Class 5,8,9,10 for nuts	NEN 2078, 1997	NF E25-005:1984 NF E25-400	DIN 267-4:1983	BS 6104-2:1983
EN- ISO 3506-1	Grade A2ss, A4ss	NEN 2078, 1997		DIN EN ISO 3506-1:1995	
EN-ISO 3506-2	Grade A2ss, A4ss	NEN 2078, 1997		DIN EN ISO 3506-2:1995	BS 6105,1981
EN 1555-2	PE 80 and PE 100	NEN 2078, 1997	NF T54-065:1987	DIN 8074:1987 DIN 8075:1987 DVGW VP 608:1995 DVGW G 477:1983	
EN 1555-3	Various materials	NEN 2078, 1997	NF T54-066:1987	DVGW VP 308:1995 DVGW VP 607:1994	
EN 1555-4	PE 80 and PE 100	NEN 2078, 1997	NF T54-067:1987	DVGW VP 302:1993	
EN 331				DIN 3537-1:1990	
EN 13774				DIN 3547-1:1990	
EN 14141	EN 1515-1 and EN 1515-2	EN 1594 and NEN 3650	EN 1594	DIN 3437:1990	

NOTE The European Standards indicated are implemented in the given Member States according to the Date of Availability. Therefore, they are not specially indicated in the national lists.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 97/23/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission to provide a means of conforming to Essential Requirements of the New Approach Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Directive 97/23/EC

Clause(s)/ sub-clause(s) of this EN	Essential requirements (ERs) of Directive 97/23/EC Annex I	Qualifying remarks/Notes
7.1, 7.8	2.1	General design safety systems
6.4	2.1	Proper design using relevant factors Safety coefficients and margins
6.6.6.1	2.2.1	Simultaneous occurrence of loading
6.4.2	2.2.1, 2.2.2, 2.2.3	Design for adequate strength
6.5.2, 7.5, 8.12	2.3	Safe handling and operation
6.5.5, 7.5.6	2.5	Means of draining and venting
4.4.3, 6.1.3, 8.8	2.6	Corrosion or other chemical attack
6.3.2	2.7	Wear
7.8.1.2	2.11.1, 2.11.2	Safety accessories
7	2.11.2, 7.3	Pressure limitation
4.3.1, 6.5.2.1	2.12	External fire
8.10	3.1	Bending and other forming
8.5.1.1, 8.5.1.6, 8.5.1.7	3.1.1	Preparation of component parts
8.5.1.4, 8.5.2, 8.5.3	3.1.2	Permanent joining

Table ZA.1 *(continued)*

Clause(s)/ sub-clause(s) of this EN	Essential requirements (ERs) of Directive 97/23/EC Annex I	Qualifying remarks/Notes
9.3.1.1.5	3.1.3	Personnel for non-destructive
8.5.1.2	3.1.4	Heat Treatment
8.1	3.1.5	Tracebility
9.4	3.2.2	Proof testing
9.2	3.4	Documentation
5	4.1(a); 4.2(a, b); 4.3	Provision and consideration of appropriate material properties
6.6.6.3, 6.6.6.4	6(a)	Protection against exceeding the allowable limits

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

[1] ASME B 16.11:2005, *Forged steel fittings, socket-welding and threaded*

[2] ASTM A269: 2001, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service*

[3] ASTM F 593: 2002, *Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs*

[4] ASTM F 594: 2002, *Standard Specification for Stainless Steel Nuts*

[5] BS 864-2:1983, *Capillary and compression tube fittings of copper and copper alloy. Part 2: Specification for capillary and compression fittings for copper tubes*

[6] BS 970-1:1996, *Specification for wrought steels for mechanical and allied engineering purposes. General inspection and testing procedures and specific requirements for carbon, carbon manganese, alloy and stainless steels (withdrawn)*

[7] BS 1387, *Specification for screwed and socketed steel tubes and tubulars and for plain end steel tubes suitable for welding or for screwing to BS 21 pipe threads (withdrawn)*

[8] BS 2789:1985 *Specification for spheroidal graphite or nodular graphite cast iron (withdrawn)*

[9] BS 6104-1:1981, *Mechanical properties of fasteners. Specification for bolts, screws and studs (withdrawn)*

[10] BS 6104-2:1983, *Mechanical properties of fasteners. Specification for nuts with specified proof load values (withdrawn)*

[11] BS 6105:1981 *Specification for corrosion-resistant stainless steel fasteners (withdrawn)*

[12] CEN/TR 13480-7, *Metallic industrial piping — Part 7: Guidance on the use of conformity assessment procedures*

[13] DIN 1630:1984, *High performance seamless circular unalloyed steel tubes; technical delivery conditions*

[14] DIN 267-4:1983:08, *Fasteners; technical delivery conditions; property classes for nuts (previous classes) - Mechanische Verbindungselemente; Technische Lieferbedingungen; Festigkeitsklassen für Muttern (bisherige Klassen) (withdrawn)*

[15] DIN 2391-2:1994, *Seamless precision steel tubes — Part 2: Technical delivery conditions*

[16] DIN 2440:1978:06, *Steel Tubes; Medium-Weight Suitable for Screwing - Stahlrohre; Mittelschwere Gewinderohre (withdrawn)*

[17] DIN 2441:1978:06, *Steel Tubes; Medium-Weight Suitable for Screwing – Stahlrohre; Mittelschwere Gewinderohre (withdrawn)*

[18] DIN 3437:1990:06 revised 1996:07; *Gas stop valves rated for pressures over 16 bar; requirements and acceptance testing- Gasabsperrarmaturen über PN 16; Anforderungen und Anerkennungsprüfung (withdrawn)*

[19] DIN 3537-1:1990:06; *Gas stop valves rated for pressures up to 4 bar; requirements and acceptance testing / Note: To be replaced by DIN 3537-1 (2005-05) - Gasabsperrarmaturen bis PN 4; Anforderungen und Anerkennungsprüfung*

[20] DIN 3547-1:1990:06; *PN 4 to PN 16 gas and water stop valves; requirements and acceptance testing - Gas- und Wasser-Absperrarmaturen PN 4 bis PN 16; Anforderungen und Anerkennungsprüfung (withdrawn)*

[21] DIN 8074:1987-09, *High-density polyethylene (PE-HD) pipes; dimensions - Rohre aus Polyethylen hoher Dichte (PE-HD); Maße (withdrawn)*

[22] DIN 8074:1999-08, *Polyethylene (PE) - Pipes PE 63, PE 80, PE 100, PE-HD - Dimensions - Rohre aus Polyethylen (PE) - PE 63, PE 80, PE 100, PE-HD – Maße*

[23] DIN 8075:1987-05, High-*density polyethylene (HDPE) pipes; general quality requirements; testing - Rohre aus Polyethylen hoher Dichte (PE-HD); Allgemeine Anforderungen (withdrawn)*

[24] DIN 8075:1999-08*, Polyethylene (PE) pipes - PE 63, PE 80, PE 100, PE-HD - General quality requirements, testing - Rohre aus Polyethylen (PE) - PE 63, PE 80, PE 100, PE-HD - Allgemeine Güteanforderungen, Prüfungen*

[25] DIN 17440:1985-07, *Stainless steels; technical delivery conditions for plate and sheet, hot rolled strip, wire rod, drawn wire, steel bars, forgings and semi-finished products - Nichtrostende Stähle; Technische Lieferbedingungen für Blech, Warmband, Walzdraht, gezogenen Draht, Stabstahl, Schmiedestücke und Halbzeug (withdrawn)*

[26] DIN 17440:1996-09, *Stainless steels - Technical delivery conditions for plates, hot rolled strip and bars for pressure purposes, drawn wire and forgings - Nichtrostende Stähle - Technische Lieferbedingungen für Blech, Warmband und gewalzte Stäbe für Druckbehälter, gezogenen Draht und Schmiedestücke (withdrawn)*

[27] DIN 17458:1985, *Seamless circular austenitic stainless steel tubes subject to special requirements — Technical delivery conditions*

[28] DVGW G 477:1983-04, *Manufacture, quality assurance and testing of pipes of PVC rigid (polyvinyl chloride rigid) and HDPE (polyethylene rigid) for gas lines and requirements on pipe couplings and pipeline parts - Herstellung, Gütesicherung und Prüfung von Rohren aus PVC hart (Polyvinylchlorid hart) und HDPE (Polyethylen hart) für Gasleitungen und Anforderungen an Rohrverbindungen und Rohrleitungsteile (withdrawn)*

[29] DVGW GW 2:1996-01, *Joining of copper pipes for gas and water installation within properties and premises - Verbinden von Kupferrohren für die Gas- und Wasserinstallation innerhalb von Grundstücken und Gebäuden (withdrawn)*

[30] DVGW-VP 302:1993:01, *Absperrarmaturen aus Polyethylen hoher Dichte (PE-HD); Anforderungen und Prüfungen (withdrawn)*

[31] DVGW VP 308:1995, *Gas-Absperrarmaturen für Manometer (einschließlich Überdruckschutzvorrichtungen) und Steuerleitungen; Prüfgrundlage*

[32] DVGW VP 607:1994:01, *Vorläufige Prüfgrundlage für Formteile aus Polyethylen (PE-HD) für Gas- und Trinkwasserleitungen - Anforderungen und Prüfungen Note: Applies in conjunction with DVGW G 477 (1983-04), DVGW W 320 (1981-09).*

[33] DVGW VP 608:1995-12, *Pipes of polyethylen (PE 80 and PE 100) for gas- and waterpipelines - Requirements and testing / Note: Applies in conjunction with DVGW G 477 (1983-04), DVGW W 320 (1981-09) - Rohre aus Polyethylen (PE 80 und PE 100) für Gas- und Trinkwasserleitungen - Anforderungen und Prüfungen (withdrawn)*

[34] EN ISO 9000, *Quality management systems – Fundamentals and vocabulary (ISO 9000:2005)*

[35] EN 837-1, *Pressure gauges — Part 1: Bourdon tube pressure gauges — Dimensions, metrology, requirements and testing*

[36] EN 10083-1:2006, *Steels for quenching and tempering - Part 1: General technical delivery conditions*

[37] EN 10084:2008, *Case hardening steels - Technical delivery conditions*

[38] EN 13480-1, *Metallic industrial piping — Part 1: General*

[39] EN 12449, *Copper and copper alloys — Seamless, round tubes for general purposes*

[40] EN 25817, *Arc welded joints in steel — Guidance on quality levels for imperfections (ISO 5817:1992)*

[41] IEC 60364:2001, *Electrical installations of buildings — Part 1: Fundamental principles, assessment of general characteristics, definitions*

[42] IIW Doc. SCXI-E 17/1999, *International Institute of Welding — Welding of Hot-Tap fittings on pipelines under pressure*

[43] MSS SP 97:1995, *Integrally reinforced forged branch outlet fittings — Socket welding, threaded and butt-welding ends*

[44] NEN 2078, *Eisen voor industriële gasinstallaties (Requirements for industrial gas installations)*

[45] NEN 3650, *Eisen voor buisleidingsystemen (Requirements for pipeline systems)*

[46] NF A49-145:1978, *Tubes en acier - Tubes soudés filetables finis à chaud (dimensions - Conditions techniques de livraison)*

[47] NF E29-591:1980, *Tuyauteries en cuivre - Raccords en cuivre et alliage de cuivre, à braser par capillarité, utilisés sous pression*

[48] NF A32-201:1987, *Produits de fonderie - Pièces moulées en fonte à graphite sphéroïdal*.

[49] NF A35-561:1992, *Produits sidérurgiques - Barres, fil machine en acier de décolletage d'usage général - Conditions techniques de livraison*

[50] NF A35-574:1990, *Produits sidérurgiques. Aciers inoxydables d'usage général. Demi-produits, barres et fil machine.*

[51] NF E25-100:1985, *Éléments de fixation - Norme de famille des vis à métaux*

[52] NF E25-005:1984, *Éléments de fixation - Méthodes d'essai*

[53] NF E25-400:1985, *Éléments de fixation. Norme de famille des écrous.*

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