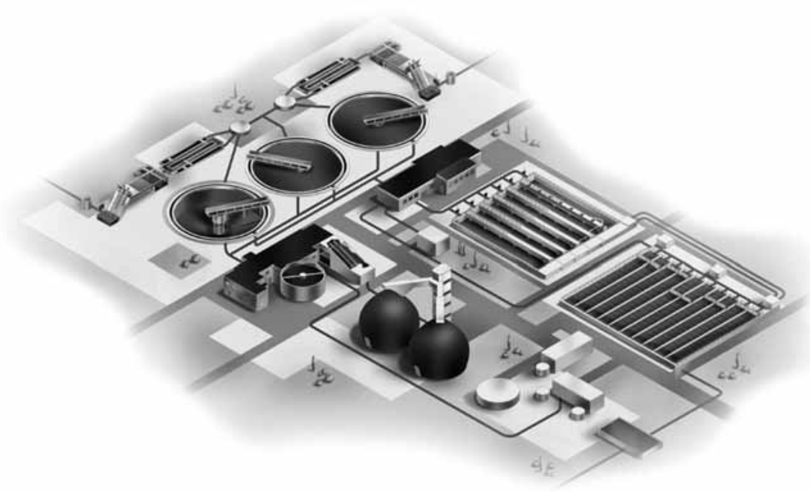
General foreword: Application of Akatherm PE pressure fittings

Akatherm PE pressure fittings have been used for more than 40 years in areas of application where the pipe system has to meet high standards of durability and reliability. These standards are met by combining the excellent material properties of PE with homogeneous welded joints.



Water treatment installations
Their high impact resistance, wide temperature range and outstanding chemical resistance make PE pressure pipe systems extremely suitable for the transport of waste water in water treatment installations. As well as standard fittings for this application, special fabricated fittings, dismantling joints and wall ducts are available.

Waste water transport
Good flexibility, high impact resistance and wide temperature range make PE pressure pipe systems extremely suitable for the use in pressure sewage systems such as public sewers, culverts etc. As well as standard fittings for this area of application, long radius bends made from pipe, special electrofusion couplers and customer made inspection chambers and pump pits are available.

Swimming pool constructions
The already mentioned properties high impact resistance, wide temperature range and excellent chemical resistance make PE pressure pipe systems extremely suitable for application in high quality swimming pool installations. As well as standard fittings for this application, special fabricated fittings, dismantling joints and wall ducts are available.

Industrial process pipe systems
The outstanding chemical resistance and wide temperature range make PE pressure pipe systems extremely suitable for installations in e.g. the process and food process industry. As well as standard fittings for this area of application, screw couplings and union ends for connection to valves and pumps are available.

Transport of solids
The high wear resistance, good flexibility and the smooth internal wall make PE pressure systems extremely suitable for the transportation of solids in amongst others sand & gravel dredging and mining industry. As well as standard fittings for this area of application, long radius bends made from pipe, flanged joints and electrofusion sockets are available.

General foreword: Application of Akatherm PE pressure fittings

Specification Manual PE pressure fittings

Price list 2011

Jointing techniques

Appendices

General foreword

Table of contents

Specification Manual PE pressure fittings

Foreword

1 "Plastic" material

2 Material properties of PE

3 Planning criteria

4 Standards

5 Installation

6 Planning and construction guidelines and stress types

7 Basic calculations

8 Jointing

Price list 2011

Foreword

PE100 pressure fittings

Short fittings for butt-welding

Long fittings for butt-welding and electrofusion

Fittings made from pipe

Backing rings and gaskets

GOEMA pipe clips

GOEMA pipe clips

Jointing techniques

9 Welding polyolefins

10 Quality

Appendices

Specification Manual
PE pressure fittings

Foreword

Foreword Specification Manual

The economic and technical advantages of plastic as opposed to conventional materials (such as steel) have caused builders and project developers to become strongly interested in the applications of such materials. For this reason, thermoplastics are an increasingly more frequent component of many community and industrial facilities. High demands on quality and comparatively low costs are therefore factors that cause planners and fabricators to use plastics in projects with ever increasing frequency. Nowadays, plastic has become an indispensable substance employed in all areas of modern life. Associated with the term "plastic" is a variety of synthetic polymers that, due to their different qualities, are used in many sectors, such as engineering, medicine, clothing industry and the building trades. This list of industries is only meant to have an exemplary character and does not represent any indication of value, as the industrial areas in which plastic is an essential material could be lengthened in any number of ways. However, when mention is made of plastic in this Specification Manual, it is primarily the PE100 (polyethylene) polymer employed by Akatherm BV that is meant.

This Specification Manual is a useful tool providing extensive information for both the engineer and contractor.
Extensive planning and fabrication requires users to be sufficiently familiar with material-specific qualities, have this information clearly and comprehensively presented to them and have a variety of possibilities indicated. Based on the more than 40-year experience of Akatherm BV with PE and PP pipe systems, Akatherm is able to present with pride an up-to-date Specification Manual for PE100. This is a revised version of the Akatherm Technical Manual for PE/PP Pipe Systems compiled under the technical and editorial supervision of Dipl.-Ing. (FH) Jürgen Thielen (Akatherm FIP GmbH) in collaboration with PM Engineering in Leimen, a firm involved in polymer engineering and the design of industrial facilities. The process has yielded a manual in which tables, diagrams, variables, guidelines and installation tips are partly reprinted and partly are reformulated, always in compliance with all the NEN, EN, ISO and other national and international standards that were important and valid at the time of printing in March 2011, while also taking other guidelines and regulations applicable to pipe construction into account.

The result is a Specification Manual that provides the engineer and contractor with the appropriate calculation and dimensioning principles, as well as installation instructions applicable from the beginning of the planning stage to the completion of a pipe system.

This Specification Manual is to be viewed as a contribution to customer service in association with the wish to standardise the use of plastic materials and to make their applications generally understandable. For cases involving special applications, as experienced Akatherm BV employee will always be placed at your disposal. The data contained in various chapters corresponds to the current state of our knowledge and is essentially based on standards involving plastics or pipe construction. Nevertheless, the content of the Specification Manual is only of an informative nature, and its use does not entail any legal obligation.

There are no claims concerning certain product qualities or their appropriateness for a specific requirement connected with the data in the Specification Manual. All liability for deviations from existing standards, deficiencies or errors, as well as infringement of third party industrial rights is excluded. The responsibility of and warranties offered by users for proper planning and construction of thermoplastic components and facilities are not limited by the use of this manual. For its part, Akatherm BV guarantees the faultless quality of its own products in accordance with its terms of delivery and sale. Reproduction and copying even of extracts of this Specification Manual can only occur with the written consent of Akatherm BV.

1 "Plastic" material

Plastic is a familiar term and a frequently-used material both in engineering and in daily life. Since this material is employed in almost all areas of our everyday lives, it has become indispensable. Although we use it on a daily basis, most people are forced to admit that they actually know little about the substance itself.
Planners and manufacturers in the fields of pipe construction, mechanical engineering and the manufacture of special parts are also increasingly confronted with plastic materials. It is at this point that questions of the following type arise:
What is plastic? How do I handle the material? What advantages does the material have over conventional materials such as concrete, ductile iron, etc.?
To lighten the introduction to plastics we have compiled the most important information about plastics and polymer processing machinery. As a result, this chapter is purely informative.

1.1 Classification of plastics

Plastics are subdivided into three large groups. Figure 1.1 provides an overview of the polymer groups and figure 1.2 presents their structural models.

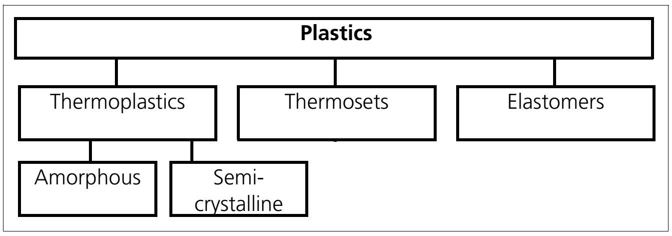


Figure 1.1 Classification of plastics into main categories: thermoplastics, thermosets and elastomers

1.2 Thermosets and elastomers

Thermosets and elastomers play a rather secondary role in plastic pipe construction and are therefore only discussed briefly in this Specification Manual.

Thermosetting plastics have a close-meshed macromolecular structure (figure 1.2). As a consequence, these plastics are usually hard, brittle and no longer meltable. For this reason manufacturers mix the molten mass with fillers that not only have a "filler" (i.e. material saving) function but are primarily added to improve material properties.
Areas of application relating to pipe construction are plant engineering (fibre-glass reinforced containers, flanges, etc.).
Elastomers (better known as "vulcanised rubber") are made from natural or synthetic rubber by means of an interlinking reaction (vulcanisation). The vulcanisation of rubber creates a broad-meshed, loose interweaving, which gives the material its typical rubbery qualities under the normal conditions of its use. Elastomers are used in pipe construction as seals (O-rings, flat gaskets, etc.) between connected elements.

1.3 Thermoplastics

Thermoplastics are by far and away the most important for pipe construction. The plastic often used in pipe fabrication is polyolefin, of which the most important representatives are polyethylene and polypropylene. They belong to the category of semi-crystalline thermoplastics. As a rule, thermoplastics are produced by one of the three following processes:
- Polymerisation
- Polyaddition
- Polycondensation

The different processes produce various plastics with various properties. Within each individual manufacturing process, there are special procedures that influence the appearance and characteristics of the specific plastics. Thermoplastics can be further subdivided into two groups: a distinction is made between amorphous and semi-crystalline thermoplastics. It should be further mentioned that plastics are seldom used in their pure form but usually as mixtures in what are known as blends or compounds. The composition of which depends on their purpose and area of application. Blends allow new or altered characteristics (mechanical, physical or chemical properties) to be produced.
It is however not possible to combine just any type of plastic with any other type. Very often, bonding agents or other additives are needed to create any bond at all.

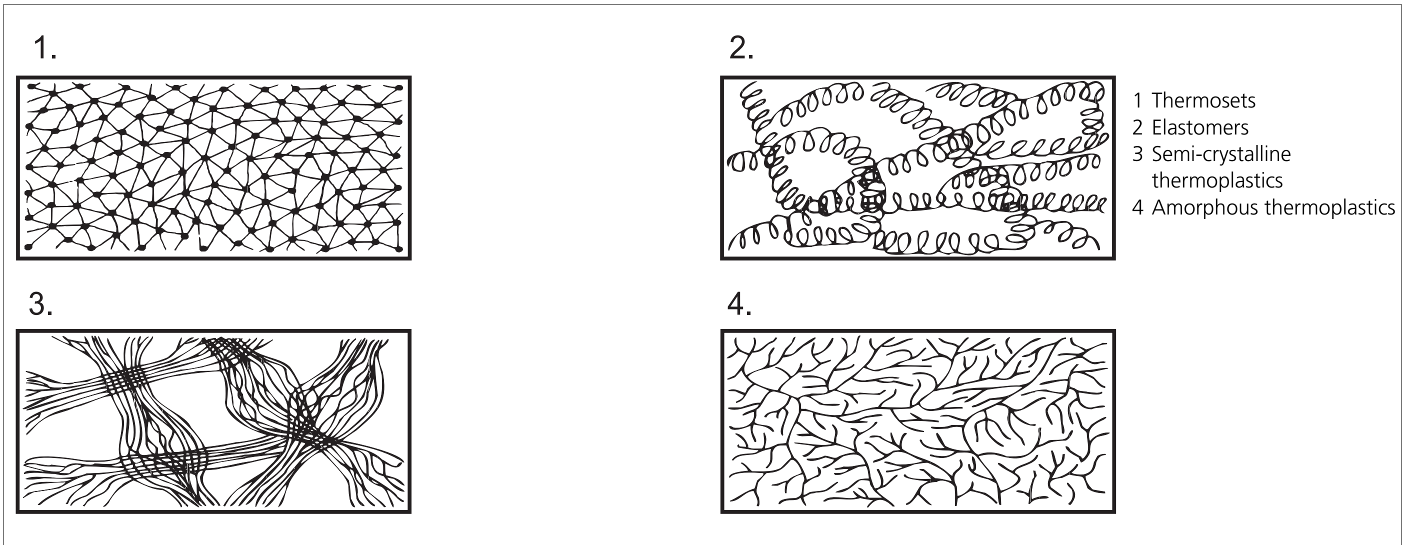


Figure 1.2 Structural model of thermosets, elastomers and semi-crystalline and amorphous thermoplastics

"Plastic" material

1.3.1 Amorphous thermoplastics
The arrangement of the molecular bond depends on several factors. Especially important is the chemical structure of the chain molecule (or the macro-molecular structure). An ordered spatial structure is impeded by long and cumbersome lateral chains. Since the molecular bond occurs amidst what amounts to perfect disorder, the structure resembles the structure that of a cotton wad. The best known representatives of the group are:
- polystyrene (PS)
- polycarbonate (PC)
- polymethyl methacrylate (PMMA -> plexiglas)
- polyvinyl chloride (PVC)

In uncoloured state, amorphous thermoplastics are as clear as glass.

1.3.2 Semi-crystalline thermoplastics
Semi-crystalline thermoplastics develop both chemically-uniform as well as geometrically-structured regions (figure 1.2), which means that there are regions in which crystals form. Crystals are understood to be parallel groupings of molecular segments or folds in molecular chains. Some chain molecules can therefore partly traverse the crystalline and amorphous regions, or they can even belong to several crystallites at the same time. Semi-crystalline thermoplastics are white in colour. Due to the dense arrangement of molecules in crystalline bonds, crystallites refract light.
The degree of crystallisation greatly influences the properties and transparency of plastic in its uncoloured state. The use of an accelerated cooling rate significantly affects the crystallisation tendency of the material. Important types of semi-crystalline thermoplastic are:
- polyethylene (PE)
- polypropylene (PP)
- polyoxymethylene (POM)

1.4 Characteristics of amorphous and semi-crystalline thermoplastics

A comparison of amorphous and semi-crystalline thermoplastics reveals a few distinctive properties. The most important qualitative distinctions are contrasted below.
In contrast to semi-crystalline thermoplastics, amorphous thermoplastics display:
- greater strength
- greater rigidity
- greater surface hardness
- better surface quality
- less thermal expansion
- less distortion

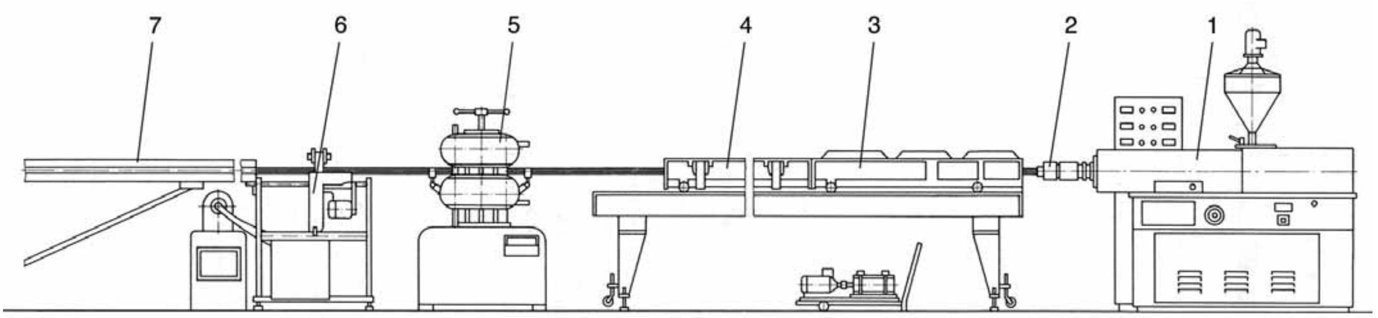
In contrast to amorphous thermoplastics, semi-crystalline thermoplastics display:
- greater resilience
- less impact sensitivity
- greater flexibility and elasticity

1.5 Plastic processing machines

Plastic processing machines are used to transform raw plastic (mostly in granular form) into semi-finished products. The following section briefly sketches the most important plastic processing machines and explains their functions and applications in simple terms. Emphasis will be placed on machines that are important for the manufacture of plastic pipes and fittings.

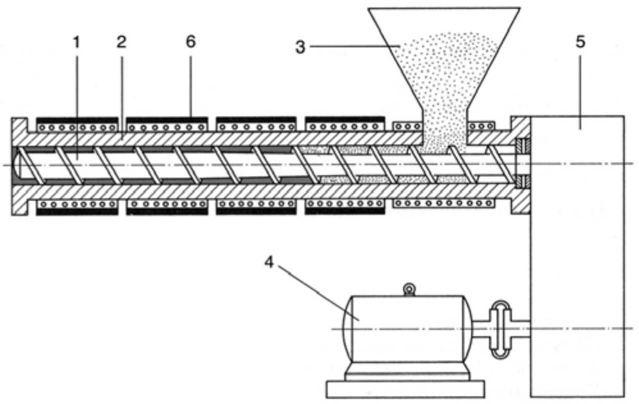
1.5.1 Extruder
Extruders are used to manufacture pipes, along with associated dies, cooling units, extractor units and cutters. Due to increased quality standards, a modern extrusion installation now includes connected inline measuring systems (e.g. wall thickness metres) that enable immediate responses to irregularities during the production process. The functional principle of the extruder involves melting (i.e. plasticising) raw material (e.g. granulate) and shaping it into a new form by pressing it through a die linked to a cooling unit.

An extruder (figure 1.4) can be equipped with one, two or several screws (also known as worm shafts). Depending on the material being processed and the semi-finished product being manufacture, special extruders are individually made to suit the needs of the production process. Especially important for the actual plasticising processes (i.e. the melting of the supplied raw material) are the screws, the screw geometry and the temperature of the heated cylinders. Due to the shear force in the material, it is plasticised at the corresponding cylinder temperature and pressure build-up by the extruder screw geometry and the die, and then transported further along the screw channels. Material to be plasticised (melted) is fed into the extruder, usually in granular form. Often, three-section screws are used in standardised single-screw extruders, along with barrier screws. The plasticised material is pressed through the die and cooled in a sizing and cooling section. The fitting (e.g. pipe, profile, solid bar) is fixed in the sizing unit. As a result of this process, the plastic, specifically the macromolecule chains, are forced into an arrangement and alignment. In technical terminology, this is called "orientation". Extrusion involves a continuous process (i.e. the process is uninterrupted unless the machine is switched off or not supplied with new material).



1 Extruder
2 Die head
3 Sizer
4 Water bath
5 Caterpillar
6 Cutting saw
7 Tip unit

Figure 1.3 Principle layout of a pipe extrusion installation



1 Screw
2 Cylinder
3 Hopper
4 Motor
5 Drive
6 Heater

Figure 1.4 Layout of an extruder

1.5.2 Injection moulding machine

The layout of an injection moulding machine (figure 1.5) resembles the extruder in its structure. The most important distinction between the two machines involves the motion of the screw. In addition to the rotary motion already described for the extruder, it also makes an axial movement.
In contrast to extruders, the injection moulding machine is involved in a discontinuous process. A discontinuous production process makes special demands on the machine, the mould and the associated and necessary mould cooling. There are three important parameters for the manufacture of an injection moulded part.
- temperature
- time
- pressure

These three parameters have an extremely important impact on the injection moulding process, which is organised into three functional steps:
- plasticisation
- injection
- cooling

The plastic to be processed is plasticised while moving along the screw through the heated cylinder. The actual plasticising process corresponds essentially to extrusion. The plasticising material is moved forward by the screw in the direction of the screw tip.

The plasticising material is simultaneously pre-compressed. Once there is sufficient material in the "accumulator", which is at the end of the plasticising unit, the material is squeezed through an injector into the mould. To prevent material shrinkage, plasticised material is compressed for a certain time during the cooling phase. The machine parameters depend on the material being worked and the fitting being manufactured. At the end of the injection cycle, the process begins again.

1.6 Mechanical properties

1.6.1 Assessing creep behaviour

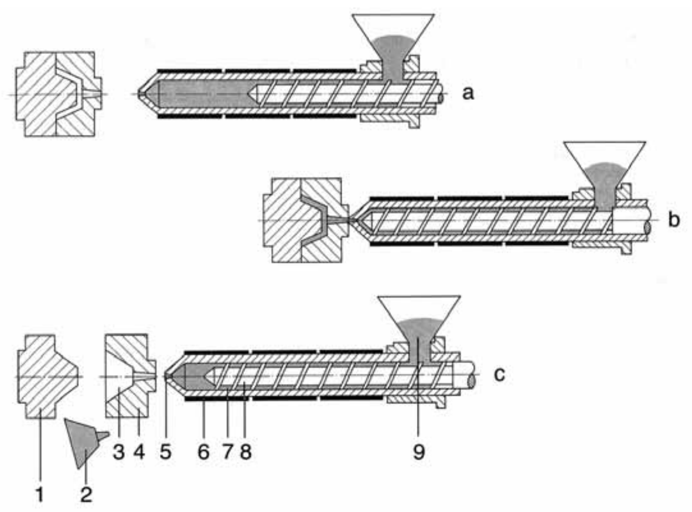
Creep behaviour is among the most important tested factors for pipes and fittings. It indicates the life expectancy possessed by the plastic pipe or fitting when it is subject to internal pressure. The internal pressure involved generates stress in the pipe wall. An appropriate reference stress (σ_r) is based on the relationship of internal pressure (ρ_i), the safety coefficient (SF) and the diameter - wall thickness ratio (SDR). The reference stress (σ_r) can be calculated using the well-known boiler formula. It reads:

$$\sigma_{acc} = p_i \cdot \frac{(SDR - 1)}{20} \quad \text{with } \sigma_{acc} = \frac{\sigma_r}{SF}$$

Equation 1.1

σ_{ref} = Reference stress (N/mm^2)
σ_{acc} = Acceptable stress (N/mm^2)
ρ_i = Internal pressure (bar)
SDR = Standard dimension ratio
SF = Safety factor = General design coefficient "C"

The reference stress (σ_r) conforms, in practice, to the stress on the circumference of the internal pipe surfaces. In contrast to this stress, the stress in the axial direction of the pipe is only half as large. In applying the boiler formula, the acceptable stress (σ_{acc}) of the corresponding material provides the basis for dimensioning the plastic pipe. Additionally extremely important is the fact that the stress at break has a very large dependence on the thermal load and period of load. Usually, tests are



a) The turning screw takes extracted granulate from the bulk hopper and feeds it along the screw channel to the screw tip.
b) The mould is closed, the injection unit moves against the feed bush, the screw operates as a piston to press plasticised moulding material into the mould.
c) The cooled injected material drops out of the opened mould, the screw moves new moulding material to the screw tip, the injection unit withdraws from the tip.

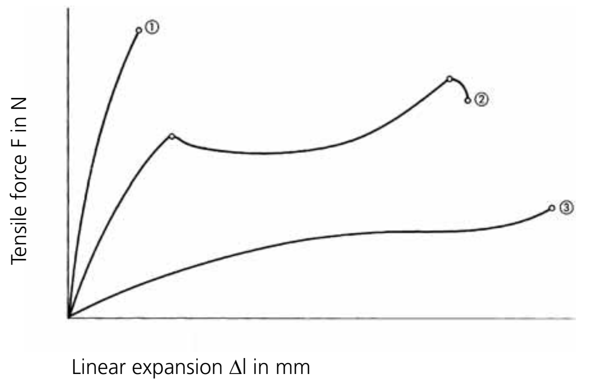
1 Movable mould part
2 Injection-formed component
3 Mould cavity
4 Fixed part of the mould
5 Nozzle
6 Heating band
7 Material cylinder
8 Screw
9 Bulk material hopper

Figure 1.5 Functional principle of a injection moulding machine conducted on water-filled sections of standardised pipe. During the tests, the test sample is placed in a water bath.

Special applications require the testing of pipe sections filled with the intended flow medium. The results of such tests are shown on a double-logarithm diagram in which the reference stress is plotted over time. The tests are conducted at various temperatures. The bend in the curve indicates when pipe failure is to be expected. Results of the tests at higher temperatures allows an interpolation of the creep behaviour for a pipe at lower temperatures. This provides an indication of the life expectancy of a pipe under certain conditions. Time curves for PE100 are displayed in appendix A1.

1.6.2 Assessing the mechanical variables

The tensile test is described in NEN-EN-ISO 527-1, NEN-EN-ISO 527-2 and NEN-EN-ISO 527-3.
In the tensile test, precisely defined samples are stretched to the breaking point and the required force measured. This usually involves a 1-axial load on the sample. The force used for this purpose is applied in a time-dependent manner. An adjustment screw on the tensile testing machine is used to plot the relationship between force and length change in the test, enabling a force-linear expansion diagram to be made, which can be converted into a stress-elongation diagram.



Curve 1: hard brittle plastic without yield range, e.g. polystyrene (PS)
Curve 2: ough hard plastic, e.g. polyethylene (PE)
Curve 3: flexible elastic plastic, e.g. plasticised polyvynil chloride (PVC-P)

Figure 1.6 Force-linear expansion diagram (tensile force)

The diagram provides information on the following characteristic variables:

- Elongation (ε) - linear expansion (Δl) as a percentage of the initial length (l_0) at each time interval in the test.
- Tensile strength (σ_B) - which is the tensile stress at maximum load.
- Breaking strength (σ_B) - which is the tensile stress at the moment of breakage.
- Yield stress (σ_Y) - which is the stress at which the increase in the stress-elongation curve is first equal to null.

The mechanical variables are very strongly dependent on the test conditions. The tests are therefore conducted under normal climate conditions (23°C and 50% relative humidity). The tensile test is one of the short-term tests and the knowledge gained does not indicate anything about the behaviour of material under a long-term mechanical load. Semi-crystalline materials such as PP and PE mostly display a distinct yield stress and a high degree of elongation (figure 1.6).

1.6.3 Assessing the elasticity modulus (creep modulus)

Short-term values

The elasticity modulus (E-modulus) is the ratio of stress (σ) to elongation (ε):

$$E = \frac{\sigma}{\varepsilon} \qquad E = \frac{\sigma_1 - \sigma_2}{\varepsilon_1 - \varepsilon_2}$$

$$\sigma = \frac{F}{A_0} \qquad \varepsilon = \frac{\Delta l}{l_0}$$

Equation 1.2

σ_1 = Normal stress at 0.05% elongation (N/mm^2)
σ_2 = Normal stress at 0.25% elongation (N/mm^2)
ε_1 = Elongation of 0.05 (%)
ε_2 = Elongation of 0.25 (%)
F = Force (N)
A_0 = Starting section (mm^2)
Δl = Change of length due to force (F) (mm)
l_0 = Starting length (mm)
E = E-modulus (N/mm^2)

DIN 53457 describes the determination of the E-modulus from the tensile test (E_t), the compressive test (E_d), from the 3-point flexural test (E_{F3}) and the 4-point flexural test (E_{F4}).

Long-term values

The E-modulus under tensile load is determined by means of the creep tensile test specified in NEN-EN-ISO 899-1. The creep tensile test allows calculation of the creep modulus (E_{cR}). In general, the tensile test is given preference over the flexural or compressive tests, as its performance is usually easier. The test items are non-axially stressed in a controlled test environment by a force that remains constant throughout the test period. If these tests are conducted at temperatures resembling the subsequent application temperature range, the diagram provides the engineer with important data to assess the behaviour of the corresponding material.

1.6.4 Impact resistance

The procedures for the impact flexural and notched impact flexural tests are described in DIN 53453 and DIN 53753. The tests are used to determine impact behaviour, otherwise known as the resilience of the plastic. The variable measured is the quantity of absorbed impact energy in relation to the cross-sectional areas that results in breakage of the bar or plate-shaped test specimen, which may be notched. Force is generated by a pendulum impact tester, which strikes the specimen at high speed. In Europe, two test procedures (notched and unnotched) are most commonly performed: one known as "Charpy" uses a pendulum impact tester as specified in NEN-EN-ISO 179 and the other, which is called "Izod", uses a Dynstat apparatus as specified in NEN-EN-ISO 180. Three defined notch types are used to determine notched impact resistance.

1.6.5 Surface hardness

Surface hardness indicates the resistance that a defined specimen displays in order to prevent it from being penetrated. The Shore test, specified in NEN-EN-ISO 868, may make use of two procedures to determine Shore hardness: these are known as Shore A and Shore D. The two procedures differ in the geometry of the test specimen used (test needle). Figure 1.7 shows the two different test objects. Shore hardness is dimensionless, and the range of hardness varies between values of 0 and 100. The Shore A procedure is predominantly applied to soft plastics, while Shore D is used with hard ones.
In addition to the Shore hardness test, the hardness of a material can be determined as specified in NEN-EN-ISO 2039-1 in terms of its ball indentation hardness. This method is mostly used when the hardness of a material can no longer be established by the Shore procedure. A ball with a 5 mm diameter serves as the test object, which is subject to a defined load for 30 seconds.

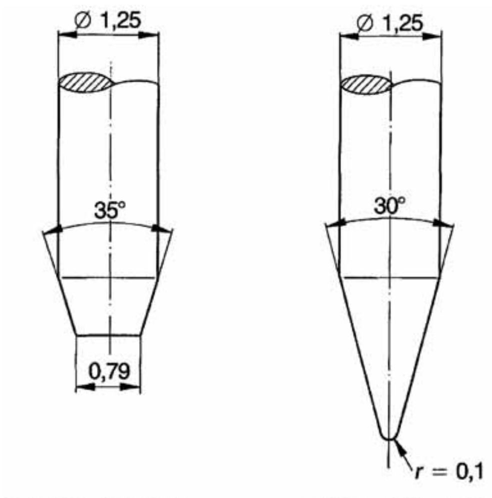


Figure 1.7 Test objects for Shore A and Shore D hardness tests

1.7 Thermal properties

1.7.1 Heat expansion coefficient

In determining the heat expansion coefficient, a distinction is made between the linear expansion coefficient (thermal length expansion coefficient (a_9)) and the cubic expansion coefficient (spatial expansion coefficient (β_9)). The linear expansion coefficient (α_9) indicates the amount that a material with a standard length of one metre will lengthen or shorten under a temperature change of 1 K. The spatial expansion coefficient (β_9) indicates the amount that a cubic meter of material will lengthen or shorten under a temperature change of 1 K. DIN 53752 describes the tests for the linear and cubic expansion coefficients. The unit of the expansion coefficient is (1/K), (K^{-1}) or (mm/mK).

1.7.2 Deformation resistance to heat

All property changes are important to the engineer and especially behaviours in response to heat effects. For this reason, various tests are conducted to ascertain the approximate boundary temperatures below which deformation does not occur. NEN-EN-ISO 75-1 and NEN-EN-ISO 75-2 describe methods of determining heat resistance.

Three procedures are used to determine deformation resistance:
1. Martens (DIN 53462)
2. Vicat
3. ISO/R 75 (ASTM D 640)

The determined variables do not, however, permit any conclusions to be drawn about the working temperature of the tested plastics. Values ascertained for plastics are only comparable when they are tested under identical conditions and procedures. The outside temperature effects of air or fluid as well as the form and manufacturing method of the samples have a large influence on the measured results.

1.7.3 Heat conductivity

The heat conductivity or the heat coefficient (λ), measured as (W/mK), is a temperature dependent material characteristic that indicates something about the capacity of a material to conduct heat. An indication of heat conductivity or insulation capacity (negative thermal conductivity) of a material can be provided by tests specified in DIN 52612-1 or DIN 52613 (ISO/DIS 8497-1988). The heat conductivity of a substance can be significantly influenced by the filling, reinforcements, auxiliary materials, and colouring.

1.7.4 Heat transfer coefficient

The Heat transfer coefficient (α_ω) is an important factor needed to calculate the heat transition coefficient (λ) as well as specific heat conductivity (l) of a material. The heat conductivity, like the heat transfer coefficient, is strongly dependent on other influences, such as separation plane, geometry and flow rate of the medium.

1.7.5 Heat transition coefficient

The heat transition coefficient (k) provides information about the insulation capacity of a material. The unit is (W/m^2K). The smaller the k-value is, the higher the insulation capacity of the material. The heat transition coefficient is computed with the equation:

$$k = \frac{1}{\frac{1}{\alpha_{w1}} + \frac{d_w}{\lambda} + \frac{1}{\alpha_{w2}}}$$

Equation 1.3

k = Heat transition coefficient (-)
α_{w1} = Heat transition coefficient of medium 1 to the wall (W/m^2K)
α_{w2} = Heat transition coefficient of the wall to medium 2 (W/m^2K)
λ = Heat conductivity of the wall (W/mK)
d_w = Thickness of the separation wall (m)

1.7.6 Burning behaviour

Plastics are organic compounds that are, by their nature, combustible. The European standard NEN-EN 13501-1 defines a classification system for material burning behaviour for building products and building structures. The burning behaviour of finished products (in the manner that they are used) must be described in terms of the extent to which the material contribute to the development and spread of fire and smoke in an area or environment. In the case of fire, building products are exposed to a fire ignited in a given area. This fire can then grow (increase) and

Stage 1: Combustibility

Class	Fire tests	Spreading of flames	Contribution	Practice
F	Not tested or does not meet class E	Unclassified	Undefined	Extremely combustible
E	EN-ISO 11925-2 (15 sec-Fs<150 mm-20 sec)	Spreading of flames 100 kW <2 min.	Very high contribution	Very combustible
D	EN 13823, Figra <750 W/sEN-ISO 11925-2 (30 sec-Fs<150 mm-60 sec)	Spreading of flames 100 kW >2 min.	High contribution	Quite combustible
C	EN 13823, Figra <120 W/s + Thr <15 MJEN-ISO 11925-2 (30 sec-Fs<150 mm-60 sec)	Spreading of flames 100 kW >10 min.	Large contribution	Combustible
B	EN 13823, Figra <120 W/s + Thr <7.5 MJEN-ISO 11925-2 (30 sec-Fs<150 mm-60 sec)	No spreading of flames	Very limited contribution	Very difficult to combust
A2	EN ISO 1182 of EN-ISO 1716 plusEN 13823, Figra <120 W/s+ Thr <7,5 MJ	No spreading of flames	Hardly any contribution	Practically incombustible
A1	EN ISO 1182 = IncombustibleEN-ISO 1716 = Caloric values	No spreading of flames	No contribution	Incombustible

Table 1.1

finally spread. The scenario contains three components of fires that correspond the stages in the development of a fire:

- Combustibility: the starting of a fire by ignition using a small flame on a small surface/product.
- Smoke production: development and potential spread of fire.
- Burning drops/fragments: outbreak of fire when all combustible material contribute to the fire potential.

Combustion classification

Stage 2: Smoke production

Class	Description
s3	Great deal of smoke production
s2	Average smoke production
s1	Little smoke production

Table 1.2

Stage 3: Burning drops/ fragments

Class	Description
d2	Fragments burning longer than 10 sec.
d1	Fragments burning shorter than 10 sec.
d0	No production of burning fragments

Table 1.3

Fire safety
The required fire safety level of a building is not the same in all European member states. Every member state may make its own regulations to determine the products that may be used and the combustion class that is suitable for the circumstances.

Level of fire safety in the Netherlands
The fire-safety level in the Netherlands is specified in the Netherlands Buildings Decree (Bouwbesluit), which only applies to aboveground pipe systems. Burning behaviour can be disregarded for underground pipe systems.

1.8 Chemical properties

1.8.1 Chemical resistance
The chemical resistance of PE to contacting media will be treated in detail in Chapter 2 (table 2.3).

1.8.2 Permeation
Permeation is regarded as the diffusion of a medium through a plastic (e.g. container wall, shaft wall or pipe wall). Contact between plastic and chemical medium can, under certain circumstances, result in moisture expansion or dissolution. Problems can also result from the dislodging of material by softening and processing agents, as well as from the bleeding of colouring. Practical testing procedures are presented in DIN 53405 (dislodging) and NEN-EN-ISO 183 (bleeding of colouring).

1.8.3 Water absorption
Many plastics tend to absorb water. Due to swelling the dimensional stability changes. PE is water-repellent, which means that it cannot be damaged by swelling. The test procedure is described in NEN-EN-ISO 62.

1.9 Processing characteristic: Melt index

Determination of the melt-mass flow rate (MFR) as specified in NEN-EN-ISO 1133, also known as the melt flow index (MFI), is a standardised testing method for obtaining a relatively quick and quantitative indication of a plastic's flow behaviour. The MFR value indicates the amount of thermoplastic molten mass pressed through a standardized nozzle during 10 minutes of steady piston force and constant melt temperature. Table 1.4 indicates the test conditions:

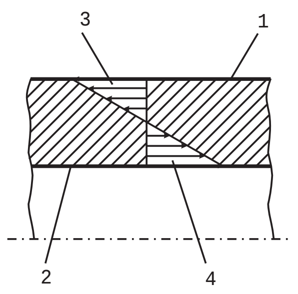
Test specification	Test conditions	
ISO 1133	Temperature (°C)	Load (kg)
1	190	2.16
6	190	10.00
12	230	2.16
18	190	5.00
20	230	5.00

Table 1.4 Test specifications and conditions for determining the MFR value

The melt volume flow rate (MVR), also known as the melt volume index (MVI) is used to test the flow behaviour of a molten mass at constant piston force and defined temperature. The unit of the MRV is $cm^3/10$ min.

1.10 Physics of plastics

1.10.1 Residual stress
All plastic components possess a certain residual stress potential, which is not attributable to external forces but exists on account of manufacturing and cooling conditions. In the process of extruding plates, pipes and profiles, molten mass is pressed through a die, causing the macromolecule to be stretched. Subsequently, it is cooled and fixed in a sizing unit. Since the pipe is cooled from the outside in, the pipe wall cools at substantially different rates.
This cooling behaviour has consequently effects on the structure and/or thickness of the pipe shell.
In the pipe wall results at the initially cooled side residual compressive stress (δ_D) and at the subsequently cooled side residual tensile stress (δ_T) (figure 1.8). These stresses may be significantly reduced by means of tempering (i.e. reheating the pipe to a defined temperature). The subsequent heating reduces the existing residual stresses, which have substantial effects on the dimensional stability, retraction, shrinkage and service life of the pipe. Dimensional stability is extremely important for pipes and components, since a change in diameter can have negative consequences for the leak tightness of connections. Usually, PE pipes are tempered.



1 Pipe wall exterior
2 Pipe wall interior
3 δ_D = compressive stress
4 δ_T = tensile stress

Figure 1.8 Stress in the pipe wall

The stresses normally equally offset each other. If external or internal influences cause the stresses to fall into disequilibrium, the component can be deformed.
However, the cooling procedure is not the only cause of residual stresses in a plastic component. The following sections describe other types of stress that have residual effects on a pipe or fitting.

- Residual orientation stress
This strongly depends on cooling patterns. The speed with which the orientation in longitudinal and transverse directions is fixed ("frozen" in the technical terminology), which is to say the strength with which heat dissipation acts on both orientation states, raises or lowers the level of orientation, causing stresses to be increased or decreased.

- Residual after-pressure stress
Residual after-pressure stress mostly occurs in injection-moulding components, although it can also be caused by extrusion processes. For example, an extrusion process is typically involved in the manufacture of solid bars, which have to be subject to after-pressure in order to prevent cavities (holes) or bubbles (empty spaces) from forming. If the pressure during cooling of the fittings is too high, a residual pressure remains in the fitting that can lead to its deformation.

- Residual crystallisation stress
This stress originates in the crystallisation phase of semi-crystalline thermoplastics. Crystallites forming when the molten mass is cooling are subject to contraction (volume change). Cooling that occurs in an uneven manner and results in a temporarily irregular crystallisation process can cause structural strains.

- Stress reduction
A remedial measure to abate frozen stresses (residual stresses) is the tempering of the pipe. Besides reducing residual stress, tempering can instigate an after-crystallisation process (in semi-crystalline plastics), which can have a positive effect on the properties of plastic.
Tempering is a special temperature control or heat treatment, the parameters of which depend on the plastic involved. During tempering, care must be taken not to set the heat high enough to generate reset forces and cause deformation. As a rule, the parameters depend on the thickness of the tempered fittings and the level of the stress profile.
It is important that the products are slowly cooled after storage to prevent stresses from recurring as a result of local temperature differences.

1.10.2 Flexural, thermal, tensile and compressive stresses
These types of stress are discussed in detail in chapter 6, as they represent important criteria in planning and constructing pipe systems. They are basic elements in the construction and manufacture of plastic building supplies.

1.10.3 Orientation
Orientation designates the arrangement of macromolecules in a plastic component.
Initially, the macromolecules of a plastic are in a disordered state ("knotted ball"). The processing procedures (e.g. extrusion or injection moulding) force the macromolecules through dies, moulds, extractor units, cooling processes, etc., aligning them in a certain direction. They can be arranged both longitudinally (in the case of extrusion in the direction that the fitting is extracted) or transversely to the centre line. The nature and alignment of the orientations have very great effects on the mechanical properties and stability of the product. Orientation results from shear and expansion forces.
Shear forces are created in both injection moulding and extrusion processes. They are produced by the shear strain of adjacent strata of molten material flowing at different velocities, for example when molten material is clinging to the wall of the mould. Expansion forces are caused by the flow of molten material through constrictions or flow channels, such as nozzles. In extruded semi-finished products (e.g. plates, pipes, profiles), the preferred orientation is longitudinal to the extrusion direction and less optimally in the transverse direction. In opposition to the pressed semi-finished products in which no distinct orientation is the result, the properties of extruded semi-finished products are anisotropic, which means strongly dependent on orientation. Mechanical properties such as strength, impact resistance and impact strength are better in anisotropic semi-finished products oriented in the direction of extrusion and poorer in the case of transverse orientation such as isotropic semi-finished products. Since thermal elasticity is only utilised in temperatures above freezing (or crystallite melting temperature), it is not possible to remedy orientation by tempering.

1.10.4 Retraction
The term "retraction" is understood as a change in the fitting as a result of forced length changes of the macromolecule. This process occurs especially in extrusion procedures. The molecule is consequently stretched by the extrusion die and/or extractor unit, usually in a axial (i.e. longitudinal) direction. As soon as the macromolecule again has the opportunity to resume its original shape, a length change counteracts the stretching orientation. This is called the "memory effect". Rapid cooling of the molten plastic fixes it in a given (frozen) state. Heating the plastic above the "freezing temperature" activates the above-mentioned "memory effect" and the macromolecule attempts to return to its original ("knotted") state. Retraction is therefore a pure contraction in length (length change) as a consequence of orientation of the macromolecule in the fitting.

1.10.5 Contraction
The term shrinkage designates a volume contraction of the plastic fittings. Like other materials, a volume increase occurs when plastic is exposed to a temperature rise.
The cooling of the material instigates the inverse process. Since this effect is well-known, this phenomenon must be considered when constructing tools and fittings if a manufacturer wishes to produce technically high-grade products. There are two kinds of shrinkage:
- processing shrinkage
- after-shrinkage

1.10.6 Notch effect
The calculation of component stresses is ideally based on tensile and flexural stresses. The stresses that actually occur are however influenced by a number of factors (e.g. scratches, material inhomogeneities, structural composition of the fitting, etc.), all of which result in deviation from the ideal state. The size of notches, the radius of notch bases and the types of load have important effects on the strength of a fitting. The deeper and sharper that a notch is formed, the higher the stress peak at the notch base and, consequently, the greater the danger of damage to the component. It is therefore advisable to make the smallest possible notches that are round (circular) shaped.

"Plastic" material

1.11 Chapter summary

Plastic	Plastic is divisible into three main groups: thermoplastics, thermosets and elastomers.
Elastomers	Elastomers are better known as rubber. They are wide-meshed, spaciously interlinked synthetic or natural rubber compounds. Interlinking is enhanced by vulcanisation.
Thermosets	Thermosets possess a close-meshed interlinked macromolecular structure. They are hard, brittle and no longer plasticisable (meltable).
Thermoplastics	Thermoplastics can be divided into amorphous and semi-crystalline thermoplastics.
Polyolefin	This compound belongs to the group of semi-crystalline thermoplastics. Its most important representatives are polyethylene (PE) and polypropylene (PP).
Plastic processing machines	Extruders, injection moulding machines and calendars (not discussed in this manual) are machines used to manufacture plastic semi-finished products.
Extruder	An extruder is responsible for plasticising raw materials. Used, for example, in the manufacture of pipes, profiles and plates. Continuous process.
Injection moulding machine	Injection moulding involves a discontinuous manufacturing process. The screw performs both a rotational and an axial motion. Important parameters for injection moulding are: temperature, time and pressure. Process steps are: plasticisation, injection and cooling.
Internal pressure creep test	Simulates the life expectancy of a plastic pipe under an internal pressure load. The associated reference stress (σ_{ref}) is a function of the internal pressure, mean pipe diameter and wall thickness. It is calculated using the boiler formula.
Short-term tensile test	The short-term tensile test involves stretching a sample bar to the breaking point. The result provides an indication of the mechanical values of the tested material. The most important mechanical values are: expansion, tensile strength, breaking strength and breaking strain.
Elasticity modulus (Creep modulus)	The elasticity modulus is the ratio of stress to expansion.
Creep tensile test	The creep tensile test is used to determine the creep modulus.
Impact resistance	Impact resistance is determined by means of the impact flexural test and the notched impact flexural test (the latter involving defined notches in the sample). Most important test methods are the "Charpy" and "Izod" tests.
Surface hardness	Designates the resistance against the penetration of the test specimen. Most important procedures are Shore A, Shore D and ball indentation hardness.
Heat expansion coefficient	The heat expansion coefficient is an important parameter in plastics. A statement of this mechanical value is usually accompanied by an indication of the linear expansion coefficient (α_ϑ) (in literature, this is mostly expressed as the mean linear longitudinal expansion coefficient α).
Heat resistance	This term designates the temperature limits of thermoplastics under the effects of heat. Testing procedures are Martens, Vicat and ISO/R 75. No conclusions about working temperatures are possible.
Heat conductivity	Variable indicating the capacity of a material to conduct heat. Filling, reinforcements, auxiliary material and colouring affect heat conductivity.
Heat transfer coefficient	This variable is used to calculate the heat transition coefficient. It depends on the separation plane, geometry and flow speed of the medium.
Heat transition coefficient	The heat transition coefficient (k) provides information about the insulating capacity of a material.
Burning behaviour	Plastics are organic compounds and therefore combustible by nature.
Permeation	Diffusion tendency of a material, which is the permeability of fluids or gaseous elements through the plastic.
Water absorption	Many plastics tend to absorb water (swelling). This means that the stability of the plastic is no longer assured. PE has hardly any tendency to absorb water.
Melt index	The melt index indicates the flow capacity of a plasticised plastic. Previously known as the MFI value, it is now referred to as the MFR value.
Residual stress	During an extrusion process, residual stresses build up in pipes as a result of cooling procedures at high extraction speeds, for example. These stresses can be reduced in pipes by adopting special temperature controls or heat treatments (tempering).
Residual orientation stress	Dependent on cooling conditions. Increasing cooling speed raises the stress potential in pipes.
Residual after-pressure stress	Phenomenon in injection moulding components. Residual after-pressure stress can also occur in extrusion components when, for example, after pressure has to be used in manufacturing solid bars to prevent bubbles and cavities.
Residual crystallisation stress	This occurs in semi-crystalline plastics (e.g. PE) due to crystallite formation during the cooling phase.
Tempering	Heat treatment to reduce or eliminate residual stress potentials.
Orientation	Alignment of the macromolecules by external forces (e.g. extraction speed).
Retraction	Retraction designates a longitudinal contraction (negative length change) in the direction in which the macromolecules are oriented.
Shrinkage	In contrast to retraction, shrinkage designates a volume contraction (negative volume change) as a result of cooling processes. In contrast to retraction, a volume change is discernible in every plastic component. These volume changes are seen in the fitting structure and in the die or mould structure.
Notch effect	The notch effect affects the strength of the component. Grooves, scratches, inhomogenities or a component's structural form can have adverse affects on the fittings.

2 Material properties of PE

2.1 General material properties of polyethylene (PE)

Thermoplastics are sub-divisible into two groups: amorphous and semi-crystalline thermoplastics. Polyethylene is a polyolefin, which forms a separate group among the semi-crystalline thermoplastics. Polyethylene, abbreviated PE, is an umbrella term for a group on individually distinctive PE types.
In specific, the following PE types are distinguished:
- PE-LD (Density: 0.9 - 0.91 g/cm^3)
- PE-LLD (Density: 0.91 - 0.93 g/cm^3)
- PE-MD (Density: 0.93 - 0.94 g/cm^3)
- PE-HD (Density: 0.94 - 0.965 g/cm^3)

It is PE-HD that is of primary interest for use in plastic pipe construction, although PE-MD is also used in the gas-pipe sector. The characteristics of PE-MD will, however, not be further detailed in this Specification Manual.
PE-HD (high density) has a high density with an average molar mass (MM) between 40,000 and 400,000 g/mol (depending on the manufacturing process and the process parameters). In comparison, PE-LD (low density) has a lower density and therefore a molar mass of up to 600,000 g/mol. PE-HD is manufactured as a polymer either by using a medium pressure procedure (Phillips) or a low pressure procedure (Ziegler). Polymers based on ethylene offer semi-finished product manufacturers a great deal of latitude in making modifications. For pipe and fitting manufacture, it is the mechanical properties of PE that are foregrounded (elastic stiffness).
As mentioned at the beginning of this chapter, PE is to be understood as an umbrella term for a thermoplastic group. For instance, PE includes the substance PE100.

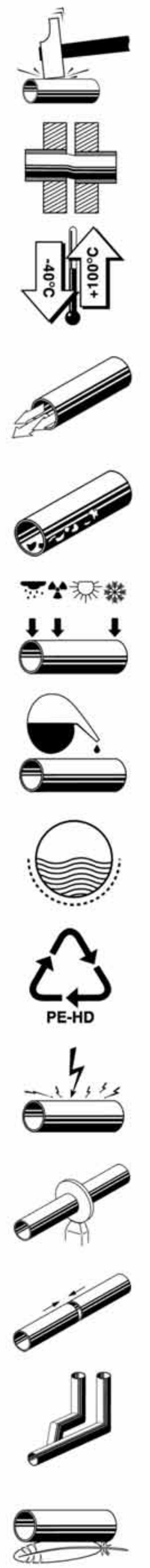
More attention will be paid to the significance of the numerical values (e.g. PE100) in the course of chapter 4. For the sake of simplification, the label "PE" will be used throughout the rest of this manual to designate PE-HD. PE is resistant to acids, bases, saline solutions, water, alcohol and oil. Under 60°C, it is practically insoluble in nearly all organic solvents. PE can readily withstand ionised rays if they are not too strong and will not become radioactive itself. It is furthermore readily weldable, although there are problems involved in gluing and decorating PE. The surfaces will allow imprinting or painting to adhere only after physical or chemical pre-treatment. Bonding can only be done with the help of contact glue, although such adhesive bonds cannot be subject to very high mechanical loads.

2.2 Properties of PE100

	Unit	Test method	Value
Density at 23°C	g/cm^3	ISO 1183	0.958
Elasticity modulus	N/mm^2	ISO 527	900
Tensile creep modulus	N/mm^2	ISO 899	850
Bending creep modulus	N/mm^2	DIN 54852-Z4	1200
Tensile strength at 23°C	N/mm^2	ISO 527	23
Elongation at break	%	ISO R 527	>600
Linear expansion coefficient	mm/mK	DIN 53752	0.13 - 0.19
Indentation hardness	N/mm^2	ISO 2039	36 - 46
Ignition temperature	°C	-	~350
Thermal conductivity	W/m . K	DIN 52612	0.23
Shore hardness		ISO 868	65
Crystallite melting range	°C		~130
Operational temperature range	°C	-	-40 - +100
Melt flow rate MFR 190/5	g/10min	ISO 1133	0.43

Table 2.1

Material properties of PE



Properties PE	Benefits
Impact-resistant and tough	Unbreakable at temperatures > 5°C
Elastic	Suitable for underground pipes through adjustment to local ground movement
Thermal resistant	Application possible between -40°C and 100°C
Smooth internal wall	Low blockage risk due to low deposit/residue effects
Wear resistant	Lower costs due to relatively long life
Weather-resistant / UV resistant	Application in open air unrestricted through colouring with carbon black
Chemical Resistance	Suitable for the transport of polluted waste water
Poor heat conductivity	No condensation during short periods of cooling
Non-toxic	Environmentally friendly
Insulating	Non-conductive
Highly suitable for welding	Easy installation using butt-welding and electrofusion techniques
Homogeneous welded joints	End load resistant and leak proof
Prefabrication	Reduces on-site installation times
Light in weight	Cost-saving in transport and handling

Table 2.2

2.3 Chemical resistance

Table 2.3 indicates the chemical resistance of PE to various media at a number of temperatures.

In transporting chemicals, consideration needs to be given to the following factors:
- the medium
- concentration of the medium
- temperature
- duration of the load
- flow volume

The elastomer resistance list is intended as an aid for determining the suitability of a given seal. The indicated values refer to the volume of swelling for the rubber compound, which is only one of the indications concerning resistance. Chemical damage to the polymer chain can also lead to changes in mechanical properties such as tensile strength, elasticity at break, etc. The most commonly indicated values are measured at a temperature of 20°C. A longer exposure to a higher temperature can create more aggressive conditions that reduce the life-span of elastomers.

Explanation of symbols used for PE pipes and fittings:	
+	Resistant: based on performed tests, PE is in general a suitable material for this application
/	Limited resistance: further research required
-	Non-resistant

Empty field = The material has not been tested on this medium at this temperature.

1 Little of no effect: volume change <10%, the elastomer can display slight swelling and/or loss of physical characteristics under heavy conditions.
2 Possible change of physical qualities: volume change of 10-20%, the elastomer can display swelling and a change of physical characteristics, can be suitable for structural applications.
3 Substantial change in physical characteristics: the elastomer displays a substantial change in volume and physical qualities.
4 Excessive change: elastomer is unsuitable.

Empty field = The elastomer has not been tested on this medium.

Abbreviations used:
PE = polyethylene
NBR = acrylonitrile butadiene
EPDM = ethylene propylene
FPM = fluorocarbon
SBR = styrol butadiene

Material properties of PE

Component			Concentration	Pipe and fittings			Elastomeric seals			
					HDPE		NBR	EPDM	FPM	SBR
Name	Formula	Remark			°C		°C	°C	°C	°C
				20	40	60	20	20	20	20
Acetaldehyde	CH_3CHO	Aqueous solution	40%	+	+	/	4	2	4	3
Acetaldehyde	CH_3CHO	Technically pure	100%	+	/	/	4	2	4	3
Acetic Acid	CH_3COOH	Aqueous solution	10%	+	+	+	4	3/4	4	4
Acetic Acid	CH_3COOH	Aqueous solution	30%	+	+	+	4	4	4	4
Acetic Acid	CH_3COOH	Aqueous solution	60%	+	+	+	4	4	4	4
Acetic Acid	CH_3COOH	Aqueous solution	80%	/	/	-	4	4	4	4
Acetic Acid	CH_3COOH	Technically pure	100%	+	+	/	4	4	4	4
Acetic Acid Anhydride	$(CH_3CO)_2O$	Technically pure	100%	+	/		4	2	4	2
Acetone	CH_3COCH_3	Aqueous solution	10%	+	+	+	4	1	4	2/3
Acetone	CH_3COCH_3	Technically pure	100%	/	/		4	1	4	2/4
Acetophenone	$CH_3COC_6H_5$	Technically pure	Indetermined	+	+	+	4	1	4	4
Acrylonitrile	$CH_2{=}CH{-}CN$	Technically pure	100%	+	+	+	4	4	4	3
Adipic Acid	$HOOC(CH_2)_4COOH$	Aqueous solution	Saturated	+	+	+	1	1	1	1
Alcohol			40%	+						
Alcoholic Spirits			Comm. Comp.	+	+					
Allyl Alcohol	$CH_2{=}CH{-}CH_2OH$	Aqueous solution	96%	+	+	+				
Alum	$Al_2(SO_4)_3K_2SO_4\ _4H_2O$	Aqueous solution	Solution	+	+	+	2	1	1	1
Alum	$Al_2(SO_4)_3K_2SO_4\ _4H_2O$	Aqueous solution	Saturated	+	+	+	2	1	1	1
Aluminium Acetate	$(CH_3COO)_3Al$	Aqueous solution	Saturated	+	+	+	2	1	4	4
Aluminium Bromide	$AlBr_3$	Aqueous solution	Saturated	+	+	+	1	1	1	1
Aluminium Chloride	$AlCl_3$	Aqueous solution	All	+	+	+	2	1	1	1
Aluminium Fluoride	AlF_3	Aqueous solution	Saturated	+	+	+	2	1	1	1
Aluminium Nitrate	$Al(NO_3)_3$	Aqueous solution	Saturated	+			1	1	1	1
Aluminium Sulfate	$Al_2(SO_4)_3$	Aqueous solution	10%	+	+	+	2	1	1	1
Aluminium Sulfate	$Al_2(SO_4)_3$	Aqueous solution	Saturated	+	+	+	2	1	1	1
Ammonia	NH_3	Aqueous solution	Solution	+	+	+	2	1	3	2
Ammonia Gas	NH_3	Aqueous solution	Saturated	+	+	+	2	1	3	2
Ammonia Gas	NH_3	Technically pure	100%	+	+	+	2	1	3	2
Ammonium Acetate	CH_3COONH_4	Aqueous solution	Saturated	+	+	+				
Ammonium Bifluoride	NH_4FHF	Aqueous solution	Saturated	+	+	+				
Ammonium Carbonate	$(NH_4)_2CO_3$	Aqueous solution	100%	+	+	+	2	1	2	2
Ammonium Chloride	NH_4Cl	Aqueous solution	Saturated	+	+	+	1	1	1	1
Ammonium Fluoride	NH_4F	Aqueous solution	25%	+	+	+	1	1	1	1
Ammonium Fosfate	$(NH_4)_3PO_4$ X H_2O		All	+	+	+	1	1	1	1
Ammonium Hydroxide	NH_4OH	Aqueous solution	Solution	+	+	+	4	1	2	4
Ammonium Hydroxide	NH_4OH	Aqueous solution	Saturated	+	+	+	4	1	2	4
Ammonium Nitrate	NH_4NO_3	Aqueous solution	Saturated	+	+	/	2	1	1	1
Ammonium Sulfate	$(NH_4)_2SO_4$	Aqueous solution	All	+	+	+	1	1	1	1
Ammonium Sulfhydrate	$NH_4OH(NH_4)_2SO_4$	Aqueous solution	Solution	+						
Ammonium Sulfhydrate	$NH_4OH(NH_4)_2SO_3$	Aqueous solution	Saturated	+						
Ammonium Sulfide	$(NH_4)_2S$	Aqueous solution	10%	+	+	+	1	1	1	1
Ammonium Sulfide	$(NH_4)_2S$	Aqueous solution	Saturated	+	+	+	1	1	1	1
Amyl Acetate	$CH_3COO(CH_2)_4CH_3$	Technically pure	100%	+	+	+	4	2	4	3
Amyl Alcohol	$CH_3(CH_2)_3CH_2OH$		100%	+	+	/	2	2	2	1
Amyl Chloride	$CH_3(CH_2)_4Cl$	Technically pure	100%	-				4	1	4
Aniline	$C_6H_5NH_2$	Technically pure	100%	/			4	2/3	1	3
Aniline Chlorhydrate	$C_6H_5NH2HCl$	Aqueous solution	Saturated	/	/	/	2	2	1	1
Anthraquinone Sulfonic Acid			Solution	+						
Antimony Trichloride	$SbCl_3$	Aqueous solution	90%	+	+	+	1	1	1	1
Aqua Regia	$_3HCl+_1HNO_3$		100%	-	-	-	4	4	2/3	4
Arsenic Acid	H_3AsO_4		Saturated	+	+					
Barium Carbonate	$BaCO_3$	Aqueous solution	All	+	+	+				
Barium Chloride	BaCl2	Aqueous solution	All	+	+	+	1	1	1	1
Barium Hydroxide	$Ba(OH)_2$	Aqueous solution	Saturated	+	+	+	1	1	1	1
Barium Nitrate	$Ba(NO_3)_2$	Aqueous solution	Saturated	+	+	+				
Barium Sulfate	$BaSO_4$	Aqueous solution	Saturated	+	+	+	1	1	1	1
Barium Sulfide	BaS	Aqueous solution	Saturated	+	+	+	1	1	1	2
Beer			100%	+	+	+	1	1	1	1
Benzaldehyde	C_6H_5CHO	Aqueous solution	Saturated	+	+	+	4	2	4	3
Benzene	C_6H_6	Technically pure	100%	/	-	-	4	4	3	4
Benzene + Benzine			20/80%	/	-	-	2/3	4	2	4

Material properties of PE

Component			Concentration	Pipe and fittings			Elastomeric seals			
					HDPE		NBR	EPDM	FPM	SBR
Name	Formula	Remark			°C		°C	°C	°C	°C
				20	40	60	20	20	20	20
Benzene Sulfonic Acid	$C_6H_5SO_3H$	Aqueous solution	10%	-			4	4	1	4
Benzine (Free Of Pb And Aromatic)	$C_5H_{12}÷C_{12}H_{26}$	Technically pure	100%	+	+	/	4	4	1	4
Benzoic Acid	C_6H_5COOH	Aqueous solution	Saturated	+	+	+	4	4	1	4
Benzyl Alcohol	$C_6H_5CH_2OH$	Technically pure	100%	+	+	/	4	1	1	4
Bleaching Lye	$NaClO+NaCl$		12,5% Cl	/	/		4	1	1	4
Borax	$Na2B_4O_7$	Aqueous solution	All	+	+	+	1	1	1	1
Boric Acid	H_3BO_3	Aqueous solution	Saturated	+	+	+	1	1	1	1
Brine			Comm. Comp.	+						
Bromic Acid	$HBrO_3$		10%	+	+	+	4	1	1	4
Bromine,Liquid	Br_2	Technically pure	100%	-			4	3	2	4
Bromine,Liquid	Br_2		High	-			4	4	1	4
Butadiene	$CH_2=CH-CH=CH_2$	Gas	100%	+			3	4	2	4
Butane Gas	$CH_3CH_2CH_2CH_3$		100%	+	+	+	2	4	2	4
Butanediol	$OHCH_2CH_2CH_2CH_2OH$	Aqueous solution	10%	+	+	+				
Butanediol	$OHCH_2CH_2CH_2CH_2OH$	Aqueous solution	Concentrated	/	-	-				
Butyl Acetate	$CH_3COOCH_2CH_2CH_2CH_3$	Technically pure	100%	/	/	/	4	2	4	4
Butyl Alcohol	$CH_3(CH_2)_3OH$	Technically pure	100%	+	+	+	1	2	1	1
Butyl Ether	$(CH_3(CH_2)_3)2O$	Technically pure	100%	/	-	-	4	3	4	4
Butyl Phenol	$C_4H_9C_6H_4OH$	Technically pure	100%	-			4	4	2	4
Butyl Phthalate	$HOOCC_6H_4COOC_4H_9$	Technically pure	100%	+	/	/				
Butylene	$CH_2=CH-CH_2CH_4$	Liquid	100%	-			2	4	1	4
Butylene Glycol	$OHCH_2-CH=CH-CH_2OH$	Technically pure	100%	+	+	+	1	1	1	1
Butylene	$CH_2=CH-CH_2CH_3$	Technically pure	100%	-			2	4	1	4
Butyric Acid	$CH_3CH_2CH_2COOH$	Aqueous solution	20%	+	+	/				
Butyric Acid	$CH_3CH_2CH_2COOH$	Technically pure	100%	+	+	/				
Calcium Acetate	$Ca(CH_3COO)_2$	Aqueous solution	Saturated	+	+	+	2	1	4	4
Calcium Bisulfite	$Ca(HSO_3)_2$	Aqueous solution	Saturated	+	+	+	2	1	2	2
Calcium Carbonate	$CaCO_3$	Aqueous solution	All	+	+	+	1	1	1	1
Calcium Chlorate	$Ca(ClO_3)_2$	Aqueous solution	Saturated	+	+	+	1	1	1	1
Calcium Chloride	$CaCl_2$	Aqueous solution	All	+	+	+	1	1	1	1
Calcium Hydroxide	$Ca(OH)_2$	Aqueous solution	All	+	+	+	1	1	1	1
Calcium Hypochloride	$Ca(ClO)_2$	Aqueous solution	Saturated	+	+	+	4	1	1	4
Calcium Nitrate	$Ca(NO_3)_2$	Aqueous solution	50%	+	+	+	1	1	1	1
Calcium Sulfate	$CaSO_4$	Aqueous solution	Saturated	+	+	+				
Calcium Sulfide	CaS	Aqueous solution	Saturated	/	/	/	1	1	1	2
Camphor Oil			Comm. Comp.	-	-					
Carbon Dioxide	CO_2+H_2O	Aqueous solution	Indetermined	+	+	+	1	1	1	1
Carbon Dioxide	CO_2	Gas	100%	+	+	+	1	1	1	1
Carbon Disulfide	CS_2	Technically pure	100%	/	-		4	4	1	4
Carbon Monoxid	CO	Gas	100%	+	+	+	2	2	1	2
Carbon Tetrachloride	CCl_4	Technically pure	100%	-						
Carbonic Acid	H_2CO_3	Aqueous solution	Saturated	+	+	+				
Chloramine	$C_6H_5SO_2NNaCl$	Aqueous solution	Solution	+						
Chloric Acid	$HClO_3$	Aqueous solution	20%	/						
Chlorine	Cl_2	Wet	All	/	-		4	3	1	4
Chlorine	Cl_2	Gas	100%	/	/	-	4	2	4	4
Chlorine	Cl_2	Technically pure	100%	-						
Chlorine Water	Cl_2+H_2O		Saturated	/	/					
Chloro Benzene	C_6H_5Cl	Technically pure	100%	/	-	-				
Chloro Sulfonic Acid	$HClSO_3$	Technically pure	100%	-	-	-				
Chloroform	$CHCl_3$	Technically pure	100%	-			4	4	2	4
Chrome Alum	$KCr(SO_4)_2$	Aqueous solution	Saturated	+	+	+				
Chrome Alum	$KCr(SO_4)_2$		Indetermined	+	+	+				
Chromic Acid	CrO_3+H_2O	Aqueous solution	10%	/	-	-	4	2/3	1	4
Chromic Acid	CrO_3+H_2O	Aqueous solution	30%	/	-	-	4	2/3	1	4
Chromic Acid	CrO_3+H_2O	Aqueous solution	50%	/	-	-	4	2/3	1	4
Citric Acid	$C_3H_4(OH)(COOH)_3$	Aqueous solution	50%	+	+	+	2	1	1	2
Compressed Air with Oil			100%	+	+					
Copper Acetate	$Cu(COOCH_3)_2$		Saturated	+			2	1	4	4
Copper Chloride	$CuCl_2$	Aqueous solution	Saturated	+	+	+	1	1	1	1
Copper Fluoride	CuF_2	Aqueous solution	All	+	+	+	2	1	1	1
Copper Nitrate	$Cu(NO_3)_2$	Aqueous solution	Indetermined	+	+	+	2	1	1	1

Material properties of PE

Component			Concentration	Pipe and fittings			Elastomeric seals			
					HDPE		NBR	EPDM	FPM	SBR
Name	Formula	Remark			°C		°C	°C	°C	°C
				20	40	60	20	20	20	20
Copper Sulfate	$CuSO_4$	Aqueous solution	Solution	+	+	+	1	1	1	1
Copper Sulfate	$CuSO_4$	Aqueous solution	Saturated	+	+	+	1	1	1	1
Cresol	$CH_3C_6H_4OH$	Aqueous solution	>=90%	+	+	/				
Cresol	$CH_3C_6H_4OH$	Aqueous solution	Solution	+	+	/				
Croton Aldehyde	CH_3-CH=CH-CHO	Technically pure	100%	/						
Cryolite	Na_3AlF_6	Aqueous solution	Saturated	/	/	-				
Cyclohexane	C_6H12	Technically pure	100%	+	+	+	2	4	1	4
Cyclohexanol	C_6H11OH	Technically pure	100%	+	/	/	2	4	2	3
Cyclohexanone	$C_6H_{10}O$	Technically pure	100%	+	/	/	4	3	4	4
Decalin (Decahydronaftalene)	$C_{10}H_{18}$	Technically pure	100%	+	/	/				
Detergents		Aqueous solution	Comm. Comp.	+	+	+				
Dextrine			Comm. Comp.	+	+	+				
Dextrose	$C_6H_{12}O_6$	Aqueous solution	All	+	+	+				
Dextrose	$C_6H_{12}O_6$	Aqueous solution	Saturated	+	+	+				
Dextrose	$C_6H_{12}O_6$	Aqueous solution	All	+	+	+	1	1	1	1
Dibutyl Phthalate	$C_6H_4(COOC_4H_9)_2$	Technically pure	100%	-			4	2	2	4
Dibutyl Sebacate	$C8H_{16}(COOC_4H_9)_2$	Technically pure	100%	+			4	2	2	4
Dichloro Benzene	$C_6H_4Cl_2$	Technically pure	100%	/			4	4	2	4
Dichloroacetic Acid	$Cl_2CHCOOH$	Aqueous solution	50%	+	+	+	2	2	2	2
Dichloroacetic Acid	$Cl_2CHCOOH$	Technically pure	100%	+	+	/	3	2	3	3
Dichloroacetic Acid Methyl Ester	$Cl_2CHCOOCH_3$	Technically pure	100%	+	+	+				
Dichloroethylene	CHCl=CHCl	Technically pure	100%	-			2		2	4
Diesel Oil			100%	+	/	/	1	4	1	4
Diethylether	$C_2H_5OC2H_5$	Technically pure	100%	-	-		4	4	4	4
Diglycolic Acid	$HOOCCH_2OCH_2COOH$	Aqueous solution	Saturated	+						
Di-Isobutyl Ketone	$(CH_3)_2CHCH_2COCH_2CH(CH_3)_2$	Technically pure	100%	+	/	-	4	2	4	2/3
Dimethyl Amine	$(CH_3)_2NH$	Technically pure	100%	/	-					
Dimethyl Formamide	$HCON(CH_3)_2$	Technically pure	100%	+	+	/	4	2	4	3
Dioctyl Phthalate	$C_6H_4(COOC_8H_{17})_2$	Technically pure	100%	+	/	/	4	2	2	4
Dioxane	$(CH_2)_4O2$	Technically pure	100%	+	+	+	4	2/3	4	4
Ethyl Acetate	$CH_3COOCH_2CH_3$	Technically pure	100%	+	/	-	4	2/3	4	4
Ethyl Alcohol	CH_3CH_2OH	Aqueous solution	96%	+	+	/	2	1	2	1
Ethyl Benzene	$C_6H_5C_2H_5$	Technically pure	100%	/	/	/	4	4	2	4
Ethyl Chloride	CH_3CH_2Cl	Technically pure	100%	/	-		2/3	4	2	4
Ethyl Ether	$CH_3CH_2OCH_2CH_3$	Technically pure	100%	/			3	3	4	4
Ethylene Chlorohydrin	$ClCH_2CH_2OH$	Technically pure	100%	+	+	/	4	2	2	2
Ethylene Diamina	$NH_2CH_2CH2NH_2$	Technically pure	100%	-	-	-	2	1	4	2
Ethylene Dichloride	CH_2ClCH_2Cl	Technically pure	100%	/	/		4	4	2/3	4
Ethylene Glycol	$HOCH_2$-CH_2OH	Technically pure	100%	+	+	+	1	1	1	1
Ethylene Oxide	C_2H_4O	Technically pure	100%	-			3	3	4	4
Exhaust fumes			Traces	+	+	+				
Fatty Acids	$R>C_6$	Technically pure	100%	+	+	/				
Ferric Chloride	$FeCl_3$	Aqueous solution	Saturated	+	+	+	2	1	1	2
Ferric Nitrate	$Fe(NO_3)_3$		Indetermined	+	+	+				
Ferric Sulfate	$Fe_2(SO_4)_3$	Aqueous solution	Saturated	+	+	+				
Ferrous Chloride	$FeCl_2$	Aqueous solution	Saturated	+	+	+	2	1	1	2
Ferrous Nitrate	$Fe(NO_3)_2$	Aqueous solution	Saturated	+	+	+				
Ferrous Sulfate	$FeSO_4$	Aqueous solution	Saturated	+	+	+	2	1	1	2
Fertilizer Salts		Aqueous solution	10%	+	+	+				
Fertilizer Salts		Aqueous solution	Saturated	+	+	+				
Fluoboric Acid	HBF_4	Technically pure	100%	+	+	+	1	1		1
Fluorine Gas Dry	F_2		100%	-			4		1	4
Fluosilicic Acid	H2SiF6	Aqueous solution	32%	+	+	+				
Formaldehyde	CH_2O	Aqueous solution	37%	+	+	+	1	1	1	1
Formamide	$HCONH_2$	Technically pure	100%	+	+	+	2	2	1	1
Formic Acid	HCOOH	Aqueous solution	50%	+	+	+	4	2	4	2
Formic Acid	HCOOH	Technically pure	100%	+	+	+	4	2	4	2
Freon F-12	CCl_2F_2	Technically pure	100%	-			2	2/3	2	4
Fruit pulp and juice			Comm. Comp.	+						
Furfuryl Alcohol	$C_5H_6O_2$	Technically pure	100%	+	+	/	4	2		4

Material properties of PE

Component			Concentration	Pipe and fittings			Elastomeric seals			
					HDPE		NBR	EPDM	FPM	SBR
Name	Formula	Remark			°C		°C	°C	°C	°C
				20	40	60	20	20	20	20
Gelatine			100%	+	+	+	1	1	1	1
Glycerine	$C_3H_5(OH)_3$	Aqueous solution	All	+	+	+	1	1	2	1
Glycocoll	NH_2CH_2COOH	Aqueous solution	10%	+	+					
Glycolic Acid	$HOCH_2COOH$	Aqueous solution	37%	+	+	+				
Gas containing:										
- Carbon Dioxide	CO_2	Gas	All	+	+	+				
- Carbon Monoxid	CO	Gas	All	+	+	+				
- Hydrochloric Acid	HCL	Gas	All	+	+	+				
- Hydrochloric Acid	HCL	Gas	All	+	+	+				
- Hydrofluoric Acid	HF	Gas	< 0,1 %	+	+	+				
- Nitrous Vapours	NO, NO_2, $N2O_3$, NOx	Gas	< 0,1 %	+	+	+				
- Nitrous Vapours	NO, NO_2, $N2O_3$, NOx	Gas	5%	+	+	+				
- Oleum	$H_2SO_4 + SO_3$	Gas	< 0,1 %	-	-	-				
- Oleum	$H_2SO_4 + SO_3$	Gas	5%	-	-	-				
- Sulphur Dioxide Liquid	SO_2	Gas	All	+	+	+				
- Sulphur Trioxide	SO_3	Gas	< 0,1 %	-	-	-				
- Sulphuric Acid	H_2SO_4	Gas	All	+	+	+				
Heptane	C_7H_{16}	Technically pure	100%	+	/	-	1	4	1	4
Hexane	C_6H_{14}	Technically pure	100%	+	/	/	1	4	1	4
Hydrazine Hydrate	NH_2-NH_2 H_2O	Aqueous solution	Solution	+	+	+	2	1	1	
Hydrobromic Acid	HBr		10%	+	+	+	3	2	1	3
Hydrobromic Acid	HBr		48%	+	+	+	4	1	1	4
Hydrochloric Acid	HCl	Aqueous solution	10%	+	+	+				
Hydrochloric Acid	HCl	Aqueous solution	30%	+	+	+	2/3	1	2	2/3
Hydrochloric Acid	HCl	Aqueous solution	5%	+	+	+				
Hydrochloric Acid	HCl	Aqueous solution	Saturated	+	+	+				
Hydrocyanic Acid	HCN	Aqueous solution	Solution	+	+	+	2	2	1	2
Hydrocyanic Acid	HCN	Technically pure		+	+	+	2	2	1	2
Hydrofluoric Acid	HF	Aqueous solution	10%	+	+	/	4	3	2/3	3
Hydrofluoric Acid	HF	Aqueous solution	40%	+	/	/	4	3	2/3	3
Hydrofluoric Acid	HF	Aqueous solution	70%	+	/	/	4	3	2/3	3
Hydrogen Gas	H_2		100%	+	+	+	2	1	1	4
Hydrogen Peroxide	H_2O_2	Aqueous solution	10%	+	+	+	2	1	1	2
Hydrogen Peroxide	H_2O_2	Aqueous solution	50%	+	+	/	2	1	1	2
Hydrogen Peroxide	H_2O_2	Aqueous solution	90%	+	-	-	2	1	1	2
Hydrogen Sulfide	H_2S	Aqueous solution	Saturated	+	+	+				
Hydrogen Sulfide	H_2S		100%	+	+	/				
Hydroquinone	$C_6H_4O_2$	Aqueous solution	Saturated	+	+	+	3	4	2	4
Hydroxylamine Sulphate	$(NH_2OH)_2$-H_2SO_4	Aqueous solution	All	+	+	+				
Iodine Dry And Wet	I_2		3%	/	-		1	2	1	1
Iso-Octane	C_8H_{18}		100%	/	/	-	1	4	1	4
Isopropyl Alcohol	$(CH_3)_2CHOH$	Technically pure	100%	+	+	+	2	1	1	2
Isopropyl Ether	$(CH_3)_2CHOCH(CH_3)_2$	Technically pure	100%	/	-	-	2/3	3	4	4
Lactic Acid	$CH_3CHOHCOOH$	Aqueous solution	<=28%	+	+	+	2	1	1	3
Lanoline			Comm. Comp.	+	+	+	1	4	1	4
Lard Oil			Comm. Comp.	+						
Lead Acetate	$Pb(CH_3COO)_2$	Aqueous solution	Saturated	+	+	+	1	1	4	4
Lead Chloride	$PbCl_2$	Aqueous solution	Saturated	+	+					
Lead Nitrate	$Pb(NO_3)_2$	Aqueous solution	Saturated	+			1	1	1	1
Lead Sulfate	$PbSO_4$	Aqueous solution	Saturated	+	+	+				
Linseed Oil			Comm. Comp.			/	1	3	1	4
Lubricating Oils			Comm. Comp.	-			2	4	1	4
Lubricating Oils,Free Of Aromatic			Comm. Comp.	+	+	/	1	4	1	4
Magnesium Carbonate	$MgCO_3$	Aqueous solution	All	+	+	+	1	1	1	1
Magnesium Chloride	$MgCl_2$	Aqueous solution	Saturated	+	+	+	2	1	1	1
Magnesium Nitrate	$Mg(NO_3)_2$	Aqueous solution	Indetermined	+	+	+				
Magnesium Sulfate	$MgSO_4$		Saturated	+	+	+	2	1	1	1
Maize Oil			Comm. Comp.	+	+	/	1	1	1	4
Maleic Acid	HOOC-CH=CH-COOH	Aqueous solution	Saturated	+	+	+	1	1	1	1
Malic Acid	$HOOCCH_2CHOHCOOH$	Aqueous solution	Saturated	+			1	4	1	2
Mercuric Chloride	$HgCl_2$	Aqueous solution	Saturated	+	+	+	1	1	1	1

Material properties of PE

Component			Concentration	Pipe and fittings			Elastomeric seals			
					HDPE		NBR	EPDM	FPM	SBR
Name	Formula	Remark			°C		°C	°C	°C	°C
				20	40	60	20	20	20	20
Mercuric Cyanide	$Hg(CN)_2$	Aqueous solution	All	+	+	+				
Mercuric Sulfate	$HgSO_4$	Aqueous solution	Saturated	+	+	+				
Mercurous Nitrate	$HgNO_3$	Aqueous solution	Saturated	+	+	+				
Mercury	Hg	Technically pure	100%	+	+	+	1	1	1	1
Methane	CH_4		100%	+			1	3	1	3
Methanesulfonic Acid	CH_3SO_3H	Aqueous solution	50%	/	/					
Methanesulfonic Acid	CH_3SO_3H	Technically pure	100%	-	-					
Methyl Acetate	CH_3COOCH_3	Technically pure	100%	+			4	2	4	4
Methyl Alcohol	CH_3OH	Technically pure	100%	+	+	+				
Methyl Amine	CH_3NH_2	Aqueous solution	32%	/			4	1	4	2
Methyl Bromide	CH_3Br	Technically pure	100%	/			4	4	1	4
Methyl Chloride	CH2Cl	Technically pure	100%	/			4	3	1	4
Methyl Ethyl Ketone	$CH_3COCH2CH_3$		100%	+	/	-	4	2	4	4
Methylene Chloride	CH_2Cl_2		100%	/			4	4	3	4
Milk			100%	+	+	+	1	1	1	1
Mineral oil			Comm. Comp.	/	/	-	1	4	1	4
Mixed Acids (Chromic, Sulphuric)	$H_2CrO_4/H_2SO_4/H_2O$		50/15/35%	-						
Mixed Acids (Sulphuric, Nitric)	$H_2SO_4/HNO_3/H_2O$		10/20/70%	/	/	/				
Mixed Acids (Sulphuric, Nitric)	$H_2SO_4/HNO_3/H_2O$		48/49/3	-	-	-				
Mixed Acids (Sulphuric, Nitric)	$H_2SO_4/HNO_3/H_2O$		50/50%	-	-	-				
Mixed Acids (Sulphuric, Phosphoric)	$H_2SO_4/H_3PO_4/H_2O$		30/60/10%	+	/					
Molasses			Comm. Comp.	+	/	/	1	1	1	1
Monochloracetic Acid	$ClCH_2COOH$	Aqueous solution	50%	+	/	/	4	2		4
Monochloroacetic Acid Ethyl Ester	$ClCH_2COOCH_2CH_3$	Technically pure	100%	+	+	+				
Naphthalene	C10H8	Technically pure	100%	+	/	/				
Nickel Chloride	$NiCl_2$	Aqueous solution	All	+	+	+	1	1	1	1
Nickel Nitrate	$Ni(NO_3)_2$	Aqueous solution	Saturated	+	+	+				
Nickel Sulfate	$NiSO_4$	Aqueous solution	Solution	+	+	/	1	1	1	1
Nickel Sulfate	NiSO4	Aqueous solution	Saturated	+	+	+	1	1	1	1
Nicotine	$C_{10}H1_4N_2$		Indetermined	+	+	+				
Nitric Acid	HNO_3	Aqueous solution	20%	+	/	/	4	4	2/3	4
Nitric Acid	HNO_3	Aqueous solution	40%	/	-	-	4	4	2/3	4
Nitric Acid	HNO_3	Aqueous solution	70%	-	-	-	4	4	2/3	4
Nitric Acid	HNO_3	Technically pure	100%	-			4	4	2/3	4
Nitrobenzene	$C_6H_5NO_2$		100%	+	/	/				
Nitroethane	$CH_3CH_2NO_2$	Technically pure	100%	+	/	/	4	2	4	2
Nitromethane	CH_3NO_2	Technically pure	100%	+	/	/	4	2	4	2
Nitrotoluene	$CH_3C_6H_4NO_2$	Technically pure	100%	+	+	/				
Nitrous Gases	NOx	Anhydrous	Solution	+	+	+	1	1	1	1
Oleic Acid	$C_{17}H_{33}COOH$	Technically pure	100%	+	+	/	2	3	1	4
Oleum	$H_2SO_4+SO_3$		10%	-			4	4	1	4
Oleum	$H_2SO_4+SO_3$		High	-			4	4	1	4
Oleum	$H_2SO_4+SO_3$		Traces	-			4	4	1	4
Olive Oil			Comm. Comp.	+	+	/	1	4	1	4
Oxalic Acid	HOOCCOOH	Aqueous solution	10%	+	+	+	1	1	1	1
Oxalic Acid	HOOCCOOH	Aqueous solution	Saturated	+	+	+	1	1	1	1
Oxygen	O_2		All	+	+	/	2	1	1	4
Ozone Gas	O_3	Aqueous solution	Saturated	/	-		4	1	1	4
Ozone Gas	O_3		>2%	/	-		4	1	1	4
Palmitic Acid	$CH_3(CH_2)1_4COOH$		70%	/	-	-				
Paraffin Emulsion		Water-emulsie	Comm. Comp.	/	/	/	1	4	1	4
Paraffin Oil			Comm. Comp.	+	+	+	1	4	1	4
Peanut Oil			Comm. Comp.	+			1	3	1	4
Perchloric Acid	$HClO_4$	Aqueous solution	10%	+	+	+	4	1	1	4
Perchloric Acid	$HClO_4$	Aqueous solution	70%	+	/	-	4	1	1	4
Perchloric Acid	$HClO_4$	Aqueous solution	10%	+	+		4	1	2	4

Component			Concentration	Pipe and fittings			Elastomeric seals			
					HDPE		NBR	EPDM	FPM	SBR
Name	Formula	Remark			°C		°C	°C	°C	°C
				20	40	60	20	20	20	20
Petroleum		Technically pure	100%	+	+	/	1	4	1	4
Petroleum Ether		Technically pure	100%	+	/	/	1	4	1	4
Phenol	C_6H_5OH	Aqueous solution	1%	+	/		4	4	2	4
Phenol	C_6H_5OH	Aqueous solution	90%	+	+		4	4	1	4
Phenylhydrazine	$C_6H_5NHNH_2$	Technically pure	100%	/	/	/	3	3	2	4
Phenylhydrazine Hydrochloride	$C_6H_5NHNH_2HCl$	Aqueous solution	Saturated	+						
Phosphoric Acid	H_3PO_4	Aqueous solution	25%	+	+	+	1	1	1	1
Phosphoric Acid	H_3PO_4	Aqueous solution	50%	+	+	+	1	1	1	1
Phosphoric Acid	H_3PO_4	Aqueous solution	85%	+	+	/	1	1	1	1
Phosphorous Penta-Trichloride	PCl_5-PCl_3	Technically pure	100%	+	/	/				
Phosphorous Pentoxide	P_2O_5	Technically pure	100%	+	+	+				
Photographic Developer			Comm. Comp.	+			1	2	1	2
Photographic Emulsion			Comm. Comp.	+	+					
Phthalic Acid	$C_6H_4(COOH)_2$	Aqueous solution	50%	+	+	+				
Picric Acid	$C_6H_2(OH)(NO_2)_3$	Aqueous solution	1%	+	+	/	2	1	1	2
Potassium Acetate	CH_3COOK	Aqueous solution	Saturated	+	+	+	1	1	2	4
Potassium Bicarbonate	$KHCO_3$	Aqueous solution	Saturated	+	+	+	1	1	1	1
Potassium Bichromate	$K_2Cr_2O_7$	Aqueous solution	Saturated	+	+		2	1	1	2
Potassium Bisulfate	$KHSO_4$	Aqueous solution	Indetermined	+	+	+	1	1	1	1
Potassium Borate	K_3BO_3	Aqueous solution	Saturated	+	+	+				
Potassium Bromate	$KBrO_3$	Aqueous solution	Saturated	+	+	/	1	1	1	1
Potassium Bromide	KBr	Aqueous solution	Saturated	+	+	+	1	1	1	1
Potassium Carbonate	K_2CO_3	Aqueous solution	Saturated	+	+	+	1	1	1	1
Potassium Chlorate	$KClO_3$	Aqueous solution	Saturated	+	+	+	4	1	1	2
Potassium Chloride	KCl	Aqueous solution	Saturated	+	+	+	1	1	1	1
Potassium Chromate	K_2CrO_4	Aqueous solution	Saturated	+	+		2	1	1	2
Potassium Cyanide	KCN	Aqueous solution	Saturated	+	+	+	1	1	1	1
Potassium Ferricyanide	$K_4Fe(CN)_{63}H_2O$	Aqueous solution	Saturated	+	+	+				
Potassium Fluoride	KF	Aqueous solution	Saturated	+	+	+				
Potassium Hydroxide	KOH	Aqueous solution	<=60%	+	+	+	2	1	2/3	1
Potassium Hypochlorite	KClO	Aqueous solution	Indetermined	+	/	/				
Potassium Iodide	KI	Aqueous solution	Saturated	+	+	+				
Potassium Nitrate	KNO_3	Aqueous solution	Saturated	+	+	+	1	1	1	1
Potassium Perborate	KBO_3	Aqueous solution	Indetermined	+	+	+				
Potassium Perchlorate	$KClO_4$	Aqueous solution	Saturated	+	+	+	3	1	1	3
Potassium Permanganate	$KMnO_4$	Aqueous solution	10%	+	+	+				
Potassium Permanganate	$KMnO_4$	Aqueous solution	Saturated	+	+	/				
Potassium Persulfate	K_2S_2O8	Aqueous solution	Saturated	+	+	+				
Potassium Phosphates Acids	K_2HPO_4 KH_2PO_4	Aqueous solution	All	+	+	+				
Potassium Sulfate	K_2SO_4	Aqueous solution	Saturated	+	+	+	1	1	1	1
Propane Gas	$CH_3CH_2CH_3$		100%	+			1	4	1	4
Propane Gas	$CH_3CH_2CH_3$		100%	+			1	4	1	4
Propionic Acid	CH_3CH_2COOH	Aqueous solution	50%	+	+	+	2	4	1	4
Propyl Alcohol	C_3H_7OH	Aqueous solution	97%	+	+	+				
Propylene Glycol	$CH_3CHOHCH_2OH$	Technically pure	100%	+	+	+	2	1	1	1
Propylene Oxid		Technically pure	100%	+			4	1	4	4
Pyridine	C_5H_5N	Technically pure	100%	+	/	/	4	4	4	4
Silicic Acid	H_2SiO_3	Aqueous solution	All	+	+	+				
Silicone Oil			Comm. Comp.	+	+	/	1	1	1	1
Silver Cyanide	AgCN	Aqueous solution	All	+	+	+				
Silver Nitrate	$AgNO_3$	Aqueous solution	Saturated	+	+	+	1	1	1	1
Silver Sulfate	Ag_2SO_4	Aqueous solution	Saturated	+	+	+				
Soap		Aqueous solution	All	+	+	+	1	1	1	2
Sodium Acetate	CH_3COONa	Aqueous solution	Saturated	+	+	+	2	1	4	4
Sodium Alum	$NaAl(SO_4)_2$	Aqueous solution	Saturated	+	+	+				
Sodium Benzoate	C_6H_5COONa		Saturated	+	+	+				
Sodium Bicarbonate	$NaHCO_3$	Aqueous solution	Saturated	+	+	+	2	1	1	1
Sodium Bichromate	Na_2Cr_2O7	Aqueous solution	Saturated	+	+	+				

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Material properties of PE

Component			Concentration	Pipe and fittings			Elastomeric seals			
					HDPE		NBR	EPDM	FPM	SBR
Name	Formula	Remark			°C		°C	°C	°C	°C
				20	40	60	20	20	20	20
Sodium Bisulfate	$NaHSO_4$	Aqueous solution	10%	+	+	+	1	1	1	2
Sodium Bisulfite	$NaHSO_3$	Aqueous solution	100%	+	+	+	1	1	1	2
Sodium Bromate	$NaBrO_3$	Aqueous solution	All	+	/					
Sodium Bromide	NaBr	Aqueous solution	Saturated	+	+	+				
Sodium Carbonate (Soda)	Na_2CO_3	Aqueous solution	Saturated	+	+	+	2	1	1	1
Sodium Chlorate	$NaClO_3$	Aqueous solution	All	+	+	+	2/3	2	1	4
Sodium Chloride	NaCl	Aqueous solution	Solution	+	+	+	1	1	1	1
Sodium Chloride	NaCl	Aqueous solution	Saturated	+	+	+	1	1	1	1
Sodium Chromate	Na_2CrO_4	Aqueous solution	Solution	+						
Sodium Cyanide	NaCN	Aqueous solution	All	+	+	+	2	1	1	1
Sodium Disulphite	$Na_2S_2O_5$	Aqueous solution	All	+			1	1	1	2
Sodium Ferrocyanide	Na_4FeCN_6	Aqueous solution	Saturated	+	+					
Sodium Fluoride	NaF	Aqueous solution	Saturated	+						
Sodium Hydroxide	NaOH	Aqueous solution	10%	+	+	+	3	1	2	2
Sodium Hydroxide	NaOH	Aqueous solution	30%	+	+	+	4	1	3	2
Sodium Hydroxide	NaOH	Aqueous solution	50%	+	+	+	1	1	3	2
Sodium Hypochlorite	NaClO	Aqueous solution	12,50%	/	-		4	1	1	4
Sodium Hypochlorite	NaClO	Aqueous solution	3%	+	/	/	4	1	1	4
Sodium Iodide	NaI	Aqueous solution	All	+						
Sodium Metasilicate	Na_2SiO_3	Aqueous solution	<5%	+	+	+				
Sodium Metasilicate	Na_2SiO_3	Aqueous solution	Saturated	+	+	+	1	1	1	1
Sodium Nitrate	$NaNO_3$	Aqueous solution	Saturated	+	+	+	1	1	1	1
Sodium Nitrite	$NaNO_2$	Aqueous solution	Saturated	+						
Sodium Oxalate	$Na_2C_2O_4$	Aqueous solution	Saturated	+						
Sodium Perborate	$NaBO_3$	Aqueous solution	All	+			2	1	1	2
Sodium Perchlorate	$NaClO_4$	Aqueous solution	Indetermined	+						
Sodium Peroxide	Na_2O_2		Solution	+			2	1	1	2
Sodium Persulphate	Na_2S_2O8	Aqueous solution	Saturated	+	+	+				
Sodium Phosphate	Na_3PO_4	Aqueous solution	Saturated	+	+	+	1	1	1	1
Sodium Phosphate Monoacid	Na_2HPO_4	Aqueous solution	Saturated	+	+		1	1	1	
Sodium Sulfate	Na_2SO_4	Aqueous solution	Saturated	+	+	+	1	1	1	1
Sodium Sulfide	Na_2S	Aqueous solution	Solution	+	+	+	2	1	1	3
Sodium Sulfide	Na_2S	Aqueous solution	Saturated	+	+	+	2	1	1	3
Sodium Sulfite	Na_2SO_3	Aqueous solution	Saturated	+	+	+				
Sodium Thiocyanate	NaSCN	Aqueous solution	Indetermined	+	+	+				
Sodium Thiosulphate	$Na_2S_2O_3$	Aqueous solution	Saturated	+	+	+	3	1	1	2
Stannic Chloride	$SnCl_4$	Aqueous solution	Saturated	+	+	+	1	1	1	2
Stannous Chloride	$SnCl_2$	Aqueous solution	Saturated	+	+	+	1	1	1	1
Stearic Acid	$C_{17}H_{35}COOH$	Technically pure	100%	+		/	1	1	1	1
Styrene	$C_6H_5CH=CH_2$		100%	/	-	-	4	4	1	4
Sugar Syrup			Saturated	+	+	+	1	1	1	1
Sulfamic Acid	HSO_3NH_2	Aqueous solution	20%	-						
Sulphur	S		100%	+	+	+				
Sulphur Dioxide Liquid	SO_2	Aqueous solution	Saturated	+	+	+				
Sulphur Dioxide Liquid	SO_2	Technically pure	100%	-						
Sulphur Dioxide Liquid	SO_2	Technically pure	100%	+	+	+				
Sulphur Trioxide	SO_3		100%	-						
Sulphuric Acid	H_2SO_4	Aqueous solution	10%	+	+	+	2	1	2	2
Sulphuric Acid	H_2SO_4	Aqueous solution	50%	+	+	+	4	1	2	4
Sulphuric Acid	H_2SO_4	Aqueous solution	80%	+	+	/	4	2	2	4
Sulphuric Acid	H_2SO_4	Aqueous solution	90%	/	/	-				
Sulphuric Acid	H_2SO_4	Aqueous solution	96%	-	-	-	4	4	2	4
Sulphuric Acid	H_2SO_4	Aqueous solution	98%	-	-	-				
		indetermined								
Sulphuric Acid	H_2SO_4	Technically pure	100%	-	-	-				
Sulphurous Acid	H_2SO_3	Aqueous solution	Saturated	+	+	+	2	2	1	2
Tallow Emulsion			Comm. Comp.	+	/	/	2	2	1	4
Tannic Acid	$C_{76}H_{52}O_{46}$	Aqueous solution	All	+	+	+	2	2	2	2
Tartaric Acid	$COOH(CHOH)_2COOH$	Aqueous solution	All	+	+	+				
Tetrachloroethane	$CHCl_2CHCl_2$		100%	/	-		4	4	1	4

Material properties of PE

Component			Concentration	Pipe and fittings			Elastomeric seals			
					HDPE		NBR	EPDM	FPM	SBR
Name	Formula	Remark			°C		°C	°C	°C	°C
				20	40	60	20	20	20	20
Tetrachloroethylene	$Cl_2C{=}CCl_2$		100%	/	-		4	4	2	4
Tetraethyl Lead	$Pb(C_2H_5)_4$	Technically pure	100%	+			2	4	1	4
Tetrahydrofurane	$(CH_2)_4O$		100%	/	-		4	4	4	4
Tetrahydronaphthalene	$C_{10}H_{12}$		100%	/						
Thionyl Chloride	$SOCl_2$	Technically pure	100%	-			2/3	1	1	2/3
Thiophene	C_4H_8S		100%	/	/	/	4	4	4	4
Toluene	$C6H_5CH_3$	Technically pure	100%	/	-	-	4	4	2	4
Toluic Acid	CH_3C6H_4COOH		50%	/						
Transformer Oil			Comm. Comp.	+	/	/	2	4	2	4
Tributylphosphate	$(C_4H_9)_3PO_4$	Technically pure	100%	+	+	+	4	2	3	4
Trichlorethylene	$ClCH{=}CCl_2$	Technically pure	100%	-	-	-	4	4	2	4
Trichloroacetic Acid	CCl_3COOH	Aqueous solution	50%	+	/	/	2	2	4	4
Trichloroacetic Acid	CCl_3COOH	Technically pure	100%	+	/	-	2	2	4	4
Trichloroethane	CH_3CCl_3	Technically pure	100%	/			4	4	1	4
Tricresylphosphate	$(CH_3C6H_4O)_3PO_4$	Technically pure	100%	+	+	+	4	2	2	4
Triethanolamine	$N(CH_2CH_2OH)_3$	Technically pure	100%	+	+	/	3	1	4	2
Trioctylphosphate	$(C_8H_{17})_3PO_4$	Technically pure	100%	/			4	1	2	4
Turpentine Oil		Technically pure	100%	/	-	-	2	4	1	4
Urea	NH_2CONH_2	Aqueous solution	<=10%	+	+	+	1	1	1	1
Urea	NH_2CONH_2	Aqueous solution	33%	+	+	+	1	1	1	1
Urine			Indetermined	+	+	+				
Vaseline Oil			Comm. Comp.	+	+	/	1		1	4
Vegetable Oils and fats			Comm. Comp.	+	/		1	4	1	3
Water	H_2O		100%	+	+	+	1	1	1	1
Water	H_2O		100%	+	+	+	1	1	1	1
Water	H_2O		100%	+	+	+	1	1	1	1
Water	H_2O		100%	+	+	+	2	1	2	2
Water	H2O		100%	+	+	+	2	1	2	2
Water, Rain	H_2O		100%	+	+	+	1	1	1	1
Water, Salt	$H_2O{+}NaCl$		Saturated	+	+	+	1	1	1	1
Water, Sea			100%	+	+	+	1	1	1	1
Wine			Comm. Comp.	+	+	+	1	1	1	1
Wine Vinegar		Technically pure	Comm. Comp.	+	+	+				
Xylene	$C_6H_4(CH_3)_2$		100%	-			4	4	2	4
Zinc Acetate	$Zn(CH_3COO)_2$		Indetermined	+	+	+	2	1	4	4
Zinc Chloride	$ZnCl_2$	Aqueous solution	Solution	+	+	+	2	1	1	2
Zinc Chloride	$ZnCl_2$	Aqueous solution	Saturated	+	+	+	2	1	1	2
Zinc Chromate	$ZnCrO_4$	Aqueous solution	Indetermined	+	+	+				
Zinc Cyanide	$Zn(CN)_2$	Aqueous solution	All	+	+	+				
Zinc Nitrate	$Zn(NO_3)_2$	Aqueous solution	Indetermined	+	+	+				
Zinc Sulfate	$ZnSO_4$	Aqueous solution	Solution	+	+	+	1	1	1	1
Zinc Sulfate	$ZnSO_4$	Aqueous solution	Saturated	+	+	+	1	1	1	1

Table 2.3 Chemical resistance. The data is based on the latest knowledge. When in doubt please contact Technical Support.

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Material properties of PE

2.4 Health assessment of PE

Physiological assessment

General product safety
The European General Product Safety Directive (GPSD) has been incorporated in the Netherlands Commodities Act and the General Product Safety (Commodities Act) Decree. The core of the GPSD is the obligation of companies only to sell safe products.

Legislation on hygiene
New European legislation on food and feed hygiene came into effect on 1 January 2006. The EC General Food Law (GFL) lays the groundwork for food safety. Further elaboration occurs in an EC Food Hygiene Regulation, an EC Feed Hygiene Regulation and a Control Regulation for government. Within this hygiene package, the Netherlands Food and Consumer Product Safety Authority (Voedsel en Waren Autoriteit, abbreviated VWA) has a central role. The VWA is the governmental organisation that investigates and monitors the safety of food and consumer products.

Packaging and Consumer Product Regulation
The Netherlands Packaging and Consumer Product (Commodities Act) Regulation (Regeling Verpakkingen en Gebruiksartikelen, abbreviated RVG) consists of a list of authorised materials that may be used to produce and package foodstuffs. The authorised RVG list gives values to a number of substances indicating the quantities that may be present in the end product as long as Article 2 Paragraph 1 Item c RVG (Commodities Act) is complied with. In addition, the regulation contains a large number of (migration) limits for the end product. Polyolefins, such as PE, are frequently used as packaging material.

National regulation of the water supply in the Netherlands
The Netherlands Water Supply Act (Waterleidingwet) has the principle role in protecting public health against the risk associated with the delivery or supply of tap water. Formulated in 1980, the first European Drinking Water Directive imposed very strict requirements on the quality of the water meant for human consumption. This EU directive was implemented in the Netherlands in the Water Supply Decree (Waterleidingbesluit), which stipulates that tap water must meet certain legal quality requirements. Materials used in obtaining, preparing, treating, storing, transporting or distributing tap water may not have adverse consequences for public health.

Certificate for toxicological elements
An important instrument for protecting the quality of drinking water in the Netherlands is the Water Supply (Materials and Chemicals) Regulation (Regeling materialen en chemicaliën leidingwatervoorziening). This regulation imposes requirements on the materials and chemicals used in the preparation and distribution of drinking water and that therefore come into contact with the drinking water. Under this regulation, products that satisfy the stated requirements are given an official quality certificate by the Minister of Housing, Spatial Development and the Environment: the KIWA ATA (Certificate for Toxicological Elements).
The requirements governing the quality of drinking water in the Netherlands are laid down in the Water Supply Decree. To enable testing of all the materials and chemicals used in the drinking water sector, KIWA has established Authorised Lists containing precise statements of the requirements that chemicals and materials must satisfy to be toxicologically permissible. There is an Authorised List for all plastic pipe materials, such as PE100 and rubber products.

2.5 Chapter summary

Polyethylene	Polyethylene is abbreviated "PE". PE is a semi-crystalline thermoplastic belonging to the polyolefin group. Depending on the average molar mass, the compound produced may be PE-LD (low density PE), PE-LLD (linear low density PE), PE-MD (medium density PE) and PE-HD (high density PE).
Health assessment of PE	The health assessment of plastic is laid down in food legislation and differs from country to country, making it necessary for manufacturers to inquire further. In the Netherlands, regulations have been established to govern substance quantities that can be present in end products. Authorised Lists have been formulated containing the materials that meet imposed requirements. PE is found on these Authorised Lists.

3 Planning criteria

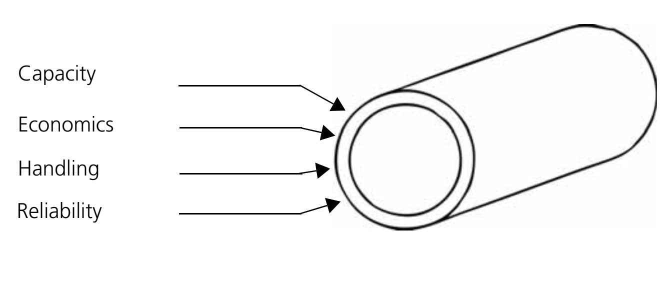


Figure 3.1

3.1 Selection criteria for PE pipe systems

For a professional and economic construction of plastic pipe systems a series of parameters and criteria have to be considered in planning. To employ plastic pipe systems made of PE the following has therefore to be included in the general considerations.

Economics
Economics is one of the most important factors that tip the balance concerning the use of materials in planned applications. The question of price is not the only crucial factor included under the term "economics", but equally decisive in assessing economic considerations are life-span, flexibility, ease of installation, handling and increasingly stronger concerns about environmental impact as well. A cost comparison of pipe installations usually involves facilities made from plastic with those made from other materials such as metal, concrete or clay. Due to shortened installation times and ease of handling, plastic pipe systems enable important cost savings.
A further factor involving economic considerations of using PE plastic pipe systems is the reduced maintenance with respect to corrosion protection. The costs of preserving and maintaining an installation are regarded as a cost-intensive part of an overall project and therefore affect the investment decision after the fact.

The advantages and disadvantages of PE in pipe and equipment construction will be discussed on the basis of some practical applications. The potential of PE as a problem solutions will be indicated in subsequent parts of this Specification Manual. Based on more than 40 years of experience with PE, Akatherm BV possesses fundamental knowledge about installation techniques and solutions to the problems that arise in plastic pipe construction.
We are pleased to share this expertise with our customers. Akatherm will, however, restrict itself in this Specification Manual to application techniques and resulting problem solutions involving the use of PE in plastic pipe systems.

Capacity
There are many requirements in industrial pipe construction, and process-related details frequently necessitate the manufacture of components of various geometries and configurations.
Akatherm places a great deal of value on the continuous contact with its customers in order to maintain regular exchanges of information. Years of experience with our products as well as their continuous adaptation to the needs of our customers has led to steady development and expansion of our product range. We have a large range of injection moulding components from our own production facility at disposal. The product range PE100 spigot fittings consists of:
- Short spigot fittings for butt-weld
- Elongated fittings for butt-weld and electrofusion
- Fittings made from pipe
- Flanges and gaskets

On account of these components, Akatherm is capable of offering a solution for every connection of PE pressure pipes.

Reliability
Every malfunction, if only of short duration, incurs costs and reduces confidence in the reliability of facilities. Users should therefore make sure ahead of time that their decisions in choosing the right materials involve sufficient attention to quality assurance. The demands of operational reliability begin in the earliest project stage and must be comprehensively realised in compliance with rules and regulations as well as the available testing methods. Incisive knowledge, professional advice and optimal processing are important pre-requisites for reliable and proper-functioning plastic pipe systems.

Handling
In employing PE materials, attention must always be paid to the fact that, beside all the advantages over conventional materials, there are also some disadvantages and therefore certain rules have to be followed. Just as in processes involving other materials, the use of plastic in pipe systems requires appropriate expertise and care. In contrast with conventional materials, the mechanical factors of PE are significantly affected by internal and external influences (e.g. medium and environmental temperatures). In contrast to concrete or other materials employed in pipe construction, PE pipe systems possess a comparably small surface hardness, which is compensated by high flexibility and long life-span. A positive property worth mentioning is the good chemical resistance of PE against many aggressive media. Conventional pipe materials such as concrete are unsuitable. Unlike conventionally employed materials, appropriate exploitation of the offered advantages yields more technical possibilities for solving numerous problems during installation. In most cases resolved in an uncomplicated manner. The handling of plastic materials is relatively easy to learn, but basic manual training is nevertheless beneficial.

The following rules are to be observed when working with PE pipes:
- Pipes are to be transported in appropriate vehicles and carefully loaded and unloaded.
- During transport, they should not be exposed to impact loads.
- Surfaces are to be protected against mechanical influences and their effects (such as grooves, scratches, notches and the like).
- Storage should occur in such a manner that the products are not exposed to the effects of heat, solar radiation, UV radiation or other adverse atmospheric and/or environmental influences for any length of time.
- The products should not be soiled any more than is necessary. The supporting surfaces for the pipes and fittings must remain free of stones and level under all conditions.
- Deformations of the pipes can be prevented by restricting stacking heights. As a rule, do not stack PE pipes higher than 1 metre.

3.2 User instructions

Loads to which pipe systems are exposed during installation or operations are indispensable variables for the engineer. The reasons for this information need involve the behaviour of plastic, which is directly affected by external and internal parameters such as internal pressures as well as temperature fluctuations of the environmental and the flow medium.
These influences have a great deal of significance for the life expectancy of a plastic pipe system. The necessary information about the expected loads that could affect the pipe system have therefore to be considered even in the planning phase.
For this purpose a selection of recurring considerations regarding material application and processing is gathered into the form of a checklist.

Planning criteria

3.3 Checklist for pipe and equipment contractors

What is to be considered?	Pipework	Equipment
Are the dimensions of the pipes and fittings (connecting dimensions) as well as the material data clear and complete?	x	x
Are the requirements of the fittings appropriately indicated (dimensions, load, chemical resistance)?	x	x
Is the standard length of pipe sufficient or are custom lengths possibly more economical?	x	
Given the component dimensions based on the indicated catalogue sizes, is a prefabricated part more appropriate?	x	
Does the external and internal pipe diameter conform to the chosen nominal size?	x	x
Is statistic evidence to be provided? Should or must an engineer be brought in?	x	x
Do the flanged connecting dimensions indicated in DIN 2501 or ASTM correspond to the pressure ratings for armatures and components?	x	
Are special product requirements demanded by the operator, agency or authorities?	x	x
Are acceptance tests required or must test reports be issued in accordance with EN 10204?	x	x
When are the delivered fittings required on the construction site? Are there adequate storage facilities or are on-demand deliveries to be agreed?	x	x
What are the possibilities for transport to the construction site? Is packaging of products required or possible?	x	
During installation work, is there surveillance by a neutral agency?	x	x
Are there certified welders for the welding work and are they available?	x	x
Does the welding and auxiliary equipment meet the requirements of current standards?	x	x
What are the local conditions?		x
If applicable, do the components have to be manufactured on site?	x	x
Are facilities available for a final pressure or leakage test?	x	x
Must these be documented?	x	x
Are suppliers and/or manufacturers aware of the operating conditions?	x	x
Important information includes:		
- the medium or nature of the flow substance in order to determine the chemical resistance (if applicable, additional information must be obtained from the pipe manufacturer!)	x	x
- the temperature limits ($T_{i\ min}$) and ($T_{i\ max}$), the load duration, and the medium that loads the pipe or fitting	x	x
- the environmental temperature ($T_{i\ min}$) and ($T_{i\ max}$)	x	x
- the internal pressure ($p_{i\ min}$) and ($p_{i\ max}$)	x	x
- the negative pressure (p_u)	x	x
- the external pressure (p_a) (e.g. soil loads, etc.)	x	x
- does the data involve conditions of continuous load or intermittent operation?	x	x
- does the system to be installed involve an aboveground or an underground system?	x	x
- could there be long periods of disuse with unfilled pipes?	x	
- are pressure surges resulting from pump operation to be expected? Size?	x	x
- are the respective weld parameters known?	x	x
- must special manufacturing guidelines or instructions be followed as well?	x	x

Table 3.1

4 Standards

4.1 General

Harmonisation of European standards for plastic piping systems is an ongoing process. Plastic pressure pipe systems are subject to:

prEN 15014 Pressure Drainage & Sewerage
This harmonised European standard contains only the performance characteristics needed to meet the essential requirements of EU Directive(s). It does not cover all the characteristics of the products. These are specified in the product standards listed in table 4.1 "European product standards for PE pipe systems" and other appropriate product specifications. This listing represents the situation at the time this document was published and may be changed if new standards are developed.

The harmonised European standard belongs to a family or cluster of standards aimed at plastic pipe systems. The relationship is shown in figure 4.1.

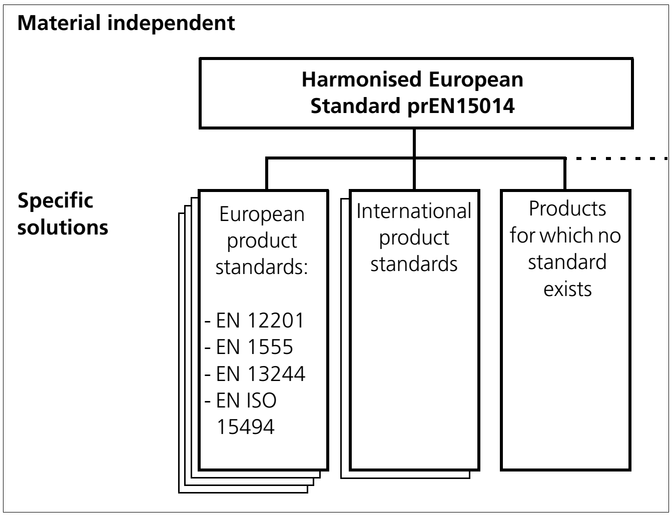


Figure 4.1

For the harmonisation of pressure plastic pipe systems figure 4.2 applies:

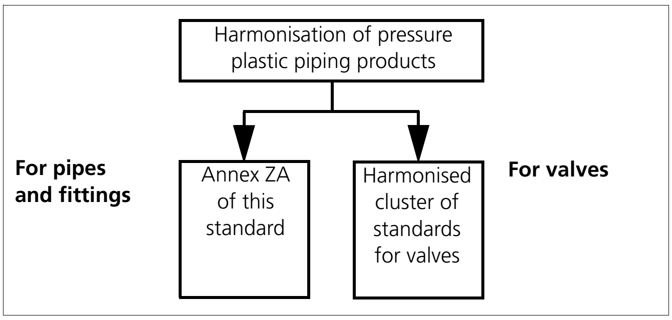


Figure 4.2

The harmonised European standard prEN 15014 specifies performance requirements for plastic pipes, fittings and their joints for buried or above ground pressure applications involving general purpose water, drainage, sewerage and irrigation, as well as for any other pressure application with other fluids covered by the Construction Products Directive, with the exception of drinking water for human consumption. It gives associated test methods for verification and evaluation of compliance with this standard.

European product standards for PE pipe systems	
EN 12201	Plastic pipe systems for water supply - Polyethylene (PE)
EN 1555	Plastic pipe systems for the supply of gaseous fuels - Polyethylene (PE)
EN 13244	Plastic pipe systems for buried and aboveground pressure systems for general purpose water, drainage and sewerage - Polyethylene (PE) - Part 1: General
EN ISO 15494	Plastic pipe systems for industrial applications - Polybutene (PB), Polyethylene (PE), Polypropylene (PP) - Specifications for components and the system - Metric series

Table 4.1

4.2 Minimum required strength (MRS)

As mentioned in section 1.6.1, the internal pressure creep test is one of the most important indicators of a thermoplastic pipe's capacity. The ISO DIS 12162 classification system was created to classify pipe material in a meaningful manner. The basis for this classification is formed by the measurement and analysis of creep rupture curves according to the standard extrapolation method specified in ISO/TR 9080. For the circumferential stress (measured at a temperature of 20°C, a life-span of 50 years and using water as test medium), this enables us to determine:

- the expectation value for long terms hydrostatic strength (LTHS)
- the 97.5% lower confidence level (LCL)

The LCL value is categorised according to the Renard 10 number series (R10). This standard number series (DIN 323, ISO 30) involves the subdivision of a decade into 10 equal parts, plotted on a logarithmic scale. This produces the following series $(\sqrt[10]{10})^n$ with n = 1, 2, 3, ..., n.
Rounding these values produces the following number series: 1 - 1.25 - 1.6 - 2 - 3.2 - 4 - 5 - 6.3 - 8 - 10. The smooth values result from the fact that these results are rounded down to the next lowest R10 number. The outcome is viewed as the minimum required strength (MRS). The significance of the MRS values will be illustrated using an example involving PE:
MRS 6.3 = σ_{ref} = 6.3 MPa (Mega Pascal) and corresponds to PE63.
MRS 8 = σ_{ref} = 8 MPa and corresponds to PE80.
MRS 10 = σ_{ref} = 10 MPa and corresponds to PE100.

4.3 Pipe series number (ISO-S)

To calculate wall thickness, material-specific variables are reinforced by a safety factor in order to guarantee the permissible internal pressure load for the pipe.
For the transport of water through a pipe system, calculations are performed using an aggregate pipe coefficient (C) = safety factor (SF) $\geq$ 1.25. For the transport of gas in pipe systems an aggregate pipe coeffcient (c) = Safety Factor (SF) > 2.0 is used. The aggregate pipe coefficient is comparable to the safety factor (SF) in its size and significance, as it comprises the safety reserves required under certain circumstances when additional loads affect the pipe. For instance, pressure surges, heat stresses during temperature changes, agitations and ground subsidences can reduce internal pressure load capacity. In contrast to the calculation of minimum values when sizing pipes, which are determined simply by running tests, the calculation of pipe safety factors must resort to empirical values. Dividing the MRS value by the aggregate pipe coefficient (C) yields the reference stress (σ_{ref}), and the acceptable stress (σ_{acc}) is produced by dividing the reference stress (σ_{ref}) by the aggregate pipe coefficient (C) (equation 4.1).

Standards

$$\sigma_{ref} = \frac{MRS}{C} \quad \text{c.q.} \quad \sigma_{acc} = \frac{\sigma_v}{C}$$

Equation 4.1

MRS = Minimum required stress (-)
σ_{ref} = Reference stress (N/mm^2)
σ_{acc} = Acceptable stress (N/mm^2)
C = SF = Aggregate pipe coefficient (safety factor) (-)

The safety factor underlying calculations for an entire pipe system has to be established in the context of individual applications (consideration is first given to the weakest pipe elements, such as branches, tees, etc.). The values of the safety coefficient for an entire pipe system are normally always larger than the values indicated in the DIN, which only apply to a straight pipe

4.4 Maximum operating pressure (MOP)

Before introduction of the European standard the internal pressure load capacity of PE pressure pipes and fittings was indicate by the nominal pressure stages of a pipe in terms of a PN rating. For instance, pipes rated PN 6 meant that the permissible internal pressure load capacity of the pipe was 6 bar for water at a temperature of 20°C over a lifespan of 50 years.
According to the present European standard, the designation (PN) is replaced by the designations (SDR) or (ISO-S), whereby:

$$(ISO - S = \frac{SDR - 1}{2})$$

Equation 4.2

The permissible internal pressure load capacity or maximun operating pressure of PE pipes (PE80, PE100) are based on variable safety factors SF = 1.25 (for water supply pipes) and SF = 2.0 (for gas pipes). The significance of these specifications will be investigated further in the rest of this chapter.

4.5 Standard dimension ratio (SDR)

In European standards the notion of nominal pressure "PN" is being largely abandoned. Instead, the previously used pipe series number "ISO-S" and the standard dimension ratio "SDR" are being emphasised. The relationship between ISO-S and SDR is shown in equation 4.3.
This ratio is indicated in the form of an SDR mark (standard dimension ratio). Within a pipe series, this SDR number is constant and corresponds to the value of the rounded outside diameter of the pipe divided by the wall thickness of the pipe.

$$SDR = \frac{d_e}{e}$$

Equation 4.3

SDR = standard dimension ratio (-)
d_e = rounded outside diameter of the pipe (mm)
e = pipe wall thickness (mm)

Application		**Drinking water**	**Gas**
Material		PE100	PE100
Standards		**E DIN 8074**	**E DIN 8074**
σ_{ref} (Water 20°C, 50 years)		10	10
Aggregate pipe coefficient C		**1.25**	**2.0**
σ_{acc} (Water 20°C, 50 years)		8	5
SDR	**ISO-S**		
41	20	4	
33	16	5	
26	12.5	6.3	
17.6	8.3	9.6	
17	8	10	5
11	5	16	10
9	4	20	-
7.4	3.2	25	-

Table 4.2 Internal pressure load capacity for PE100 drinking water and gas pipes

Table 4.2 shows the maximum permissible operating pressure (according to DVGW VP for drinking water and G 472 for gas), the current pipe series as specified in DIN 8074, and their standard dimension ratios (SDR) for the PE100 material classes.

Note on table 4.2
If PE pipes and fittings are used to supply drinking water (e.g. table water, mineral water), an additional test must be conducted regarding any adverse effect on taste. In transporting chemical flow materials (not including gas or tap water), special consideration must be given to the appropriateness of PE with regard to the indicated media. The choice of the appropriate pipe series is fundamentally linked to a consideration of stress reduction factors. Black coloured PE pipes are storable in central European climate zones for 25 years.

4.6 The polyethylene (PE) mark

The continuous development and improvement of plastic also influences its mechanical properties and variables. These are continuously improved due to years of practical experience, as well as efforts in the research departments of pipe manufacturers in improving the capacity of plastic. Improvements in the mechanical properties of the polyolefin used in plastic pipe construction primarily involve PE compounds.
Associated with changes in material characteristics are corresponding changes in material designations. In plastic pipe construction, reference is no longer made to PE-HD but to the PE types PE63, PE80 and PE100.
It must, however, be noted that only PE100 is, in fact, used in this field. The digits indicate the long-term stability of the material, a conventional practice in labelling metal materials. The long-term stability for PE100 is calculated as follows: σ_{ref} = 100/10 = 10 MPa = 10 N/mm^2 and applies to situations where the flow medium is water at 20°C and the load period 50 years. Both German and European standards incorporate the new PE types by adopting the following classification:

- PE63 -> MRS 6,3
- PE80 -> MRS 8,0
- PE100 -> MRS 10,0

Since PE63 has smaller creep strength than PE80 and PE100, it has only limited applications in pressure pipe systems. In terms of strength values, PE80 largely corresponds to PE-HD with partial improvements of material properties.
Due to its greater strength, the use of PE100 is increasingly more common in pipe construction, especially in areas involving high pressure. Initial suspicions with regard to welding have been dispelled, so that manufacturers and contractors can widely benefit from the advantages of PE100.

Standards and application guidelines have been updated so that any impediments in them no longer exist. The new bimodular types of PE80 and PE100 demonstrate, in addition to improvements in strength properties, greater resilience than PE-HD, a quality improvement that yields the following benefits:

- greater creep strength at higher temperatures
- greater resistance to rapid crack growth
- reduced susceptibility to notching

In terms of the service life of the bimodular types, evidence to support assuming it to be 100 years is provided by the standard extrapolation method specified in ISO/TR 9080. Based on years of positive experience, the minimum safety factor (SF) has been established on 1.25 (gas pipe SF = 2.0). The creep rupture curve for calculating strength values can be derived from appendix A1. The important properties and variables of PE are discussed in chapter 2.

4.7 Load capacity of welded PE100 pipe and fittings

PE100 can be welded without restriction. Welding of PE100 onto PE80 components can also be performed unrestricted.
The butt-weld process according to NEN 7200 is specified in chapter 9.
The electrofusion process according to NIL weld practice recomandation VM 102 is also specified in chapter 9. In case of application of welded fittings, a reduced pressure load made from pipe has to be taken in account. Please consult Akatherm BV about the internal pressure load capacity.

4.8 Wall thicknesses and acceptable internal pressure load capacity for PE100 pipes

		Wall thicknesses of PE100 pipes and fittings of the corresponding SDR series													
PE100 (SF = 1.25)	**MOP**	**40**	**(31.9)**	**25**	**20**	**16**	**12.5**	**10**	**(9.7)**	**8**	**(7.5)**	**6.3**	**5**	**4**	**3.2**
	ISO-S	**2**	**2.5**	**3.2**	**4**	**5**	**6.3**	**8**	**8.3**	**10**	**10.5**	**12.5**	**16**	**20**	**25**
	SDR	**5**	**6**	**7.4**	**9**	**11**	**13.6**	**17**	**17.6**	**21**	**22**	**26**	**33**	**41**	**51**
d_e		Wall thickness (e) (mm)													
10		2.0	1.8												
12		2.4	2.0	1.8											
16		3.3	2.7	2.2	1.8										
20		4.1	3.4	2.8	2.3	1.9	1.8								
25		5.1	4.2	3.5	2.8	2.3	1.9	1.8							
32		6.5	5.4	4.4	3.6	2.9	2.4	1.9	1.8						
40		8.1	6.7	5.5	4.5	3.7	3.0	2.4	2.3	1.9	1.9	1.8			
50		10.1	8.3	6.9	5.6	4.6	3.7	3.0	2.9	2.4	2.3	2.0	1.8		
63		12.7	10.5	8.6	7.1	5.8	4.7	3.8	3.6	3.0	2.9	2.5	2.0	1.8	
75		15.1	12.5	10.3	8.4	6.8	5.6	4.5	4.3	3.6	3.5	2.9	2.3	1.9	1.8
90		18.1	15.0	12.3	10.1	8.2	6.7	5.4	5.1	4.3	4.1	3.5	2.8	2.2	1.8
110		22.1	18.3	15.1	12.3	10.0	8.1	6.6	6.3	5.3	5.0	4.2	3.4	2.7	2.2
125		25.1	20.8	17.1	14.0	11.4	9.2	7.4	7.1	6.0	5.7	4.8	3.9	3.1	2.5
140		28.1	23.3	19.2	15.7	12.7	10.3	8.3	8.0	6.7	6.4	5.4	4.3	3.5	2.8
160		32.1	26.6	21.9	17.9	14.6	11.8	9.5	9.1	7.7	7.3	6.2	4.9	4.0	3.2
180		36.1	29.9	24.6	20.1	16.4	13.3	10.7	10.2	8.6	8.2	6.9	5.5	4.4	3.6
200		40.1	33.2	27.4	22.4	18.2	14.7	11.9	11.4	9.6	9.1	7.7	6.2	4.9	3.9
225		45.1	37.4	30.8	25.2	20.5	16.6	13.4	12.8	10.8	10.3	8.6	6.9	5.5	4.4
250		50.1	41.6	34.2	27.9	22.7	18.4	14.8	14.2	11.9	11.4	9.6	7.7	6.2	4.9
280		56.2	46.5	38.3	31.3	25.4	20.6	16.6	15.9	13.4	12.8	10.7	8.6	6.9	5.5
315		63.2	52.3	43.1	35.2	28.6	23.2	18.7	17.9	15.0	14.4	12.1	9.7	7.7	6.2
355			59.0	48.5	39.7	32.2	26.1	21.1	20.1	16.9	16.2	13.6	10.9	8.7	7.0
400			66.5	54.7	44.7	36.3	29.4	23.7	22.7	19.1	18.2	15.3	12.3	9.8	7.9
450				61.5	50.3	40.9	33.1	26.7	25.5	21.5	20.5	17.2	13.8	11.0	8.8
500				68.3	55.8	45.4	36.8	29.7	28.4	23.9	22.8	19.1	15.3	12.3	9.8
560					62.5	50.8	41.2	33.2	31.7	26.7	25.5	21.4	17.2	13.7	11.0
630						57.2	46.3	37.4	35.7	30.0	28.7	24.1	19.3	15.4	12.3
710						64.5	52.2	42.1	40.2	33.9	32.3	27.2	21.8	17.4	13.9
800							58.8	47.4	45.3	38.1	36.4	30.6	24.5	19.6	15.7
900							66.1	53.3	51.0	42.9	41.0	34.4	27.6	22.0	17.6
1000								59.3	56.7	47.7	45.5	38.2	30.6	24.5	19.6
1200									68.0	57.2	54.6	45.9	36.7	29.4	23.5
1400										66.7	63.7	53.5	42.9	34.4	27.4
1600												61.2	49.0	39.2	31.3

SF = Safety factor (valid for water at 20°C)

Table 4.3 Classification criteria for pressure pipes: PE100 / DIN 8074: 1999-08

Standards

Temperature (°C)	Years of service	SDR	51	41	33	26	22	21	17.6	17	13.6	11	9	7.4	6	5
		ISO-S	25	20	16	12.5	10.5	10	8.3	8	6.3	5	4	3.2	2.5	2
			Maximum operating pressure (bar)													
10	5		4.0	5.0	6.3	7.9	9.4	10.1	12.1	12.6	15.7	20.2	25.2	31.5	40.4	50.5
	10		3.9	4.9	6.2	7.8	9.3	9.9	11.9	12.4	15.5	19.8	24.8	31.0	39.7	49.6
	25		3.8	4.8	6.0	7.6	9.0	9.6	11.6	12.1	15.1	19.3	24.2	30.2	38.7	48.4
	50		3.8	4.7	5.9	7.5	8.9	9.5	11.4	11.9	14.8	19.0	23.8	29.7	38.0	47.6
	100		3.7	4.6	5.8	7.3	8.7	9.3	11.2	11.6	14.6	18.7	23.3	29.2	37.4	46.7
20	5		3.3	4.2	5.3	6.6	7.9	8.4	10.2	10.6	13.2	16.9	21.2	26.5	33.9	42.4
	10		3.3	4.1	5.2	6.5	7.8	8.3	10.0	10.4	13.0	16.6	20.8	26.0	33.3	41.6
	25		3.2	4.0	5.0	6.4	7.6	8.1	9.8	10.1	12.7	16.2	20.3	25.4	32.5	40.7
	50		3.2	4.0	5.0	6.3	7.5	8.0	9.6	10.0	12.5	16.0	20.0	25.0	32.0	40.0
	100		3.1	3.9	4.9	6.1	7.3	7.8	9.4	9.8	12.2	15.7	19.6	24.5	31.4	39.2
30	5		2.8	3.6	4.5	5.6	6.7	7.2	8.6	9.0	11.2	14.4	18.0	22.5	28.8	36.0
	10		2.8	3.5	4.4	5.5	6.6	7.0	8.5	8.8	11.0	14.1	17.7	22.1	28.3	35.4
	25		2.7	3.4	4.3	5.4	6.4	6.9	8.3	8.6	10.8	13.8	17.2	21.6	27.6	34.5
	50		2.7	3.3	4.2	5.3	6.3	6.7	8.1	8.4	10.6	13.5	16.9	21.2	27.1	33.9
40	5		2.4	3.0	3.8	4.8	5.8	6.1	7.4	7.7	9.6	12.3	15.4	19.3	24.7	30.9
	10		2.4	3.0	3.8	4.7	5.7	6.0	7.3	7.6	9.5	12.1	15.2	19.0	24.3	30.4
	25		2.3	2.9	3.7	4.6	5.5	5.9	7.1	7.4	9.2	11.8	14.8	18.5	23.7	29.7
	50		2.3	2.9	3.6	4.5	5.4	5.8	7.0	7.2	9.1	11.6	14.5	18.2	23.3	29.1
50	5		2.1	2.6	3.3	4.2	5.0	5.3	6.4	6.7	8.3	10.7	13.4	16.7	21.4	26.8
	10		2.0	2.6	3.2	4.0	4.8	5.2	6.2	6.5	8.1	10.4	13.0	16.2	20.3	26.0
	15		1.9	2.3	2.9	3.7	4.4	4.7	5.7	5.9	7.4	9.5	11.8	14.8	19.0	23.7
60	5		1.5	1.9	2.4	3.0	3.6	3.8	4.6	4.8	6.0	7.7	9.7	12.1	15.5	19.4
70	2		1.2	1.5	1.9	2.4	2.9	3.1	3.7	3.9	4.9	6.2	7.8	9.8	12.5	15.7

Table 4.4 Acceptable operating overpressures for pressure pipes: PE100 with SF = 1.25 (flow medium: water) / DIN 8074: 1999-08

Note to tables 4.3 and 4.4:
The stated values do not apply to pipes exposed to the effects of UV and pressureless drainage and sewerage pipes with maximum operating pressures <1 bar and are not included in the tables.

4.9 Chapter summary

European standards	prEN 15014 Pressure Drainage & Sewerage is the harmonised European standard for buried or aboveground pressure facilities for general purpose water, drainage, sewerage and irrigation, as well as for any other pressure applications involving other fluids. National standards have been revised in order to comply with European standards.
Minimum required strength (MRS)	The minimum required strength corresponds to the reference stress (σ_{ref}) of water at 20°C and a service life of 50 years.
Maximum operating pressure (MOP)	The internal pressure load capacity was formerly used to designate the nominal pressure "PN" of pipes and fittings. In the European standards, the designation has been abandoned and replaced by (SDR) or (ISO-S).
Standard dimension ratio (SDR)	The standard dimension ratio indicates the relationship of the pipe outside diameter to wall thickness.
Pipe series number (ISO-S)	The pipe series number (ISO-S) indicates the internal pressure load capacity of a pipe, while taking a safety factor into account.
Aggregate pipe coefficient (C)	The aggregate pipe coefficient (C) is a safety buffer (safety reserve) to allow for the additional loads that occur in pipe systems. It corresponds to the safety factor (SF). 1.25 for water and 2.0 for gas.
Safety factor (SF)	The safety factor (SF) corresponds to the aggregate pipe coefficient (C).
Welding property of PE100	Demonstrated by extensive research: no problems have been shown to arise in welding PE80 to PE100 pipe elements of identical SDR values. Welding can therefore be done without restriction.

5 Installation

5.1 Pre-requisites

Principle pre-requisites for a professionally designed pipe system are good technical knowledge coupled with many years of experience in application and production techniques. Customers now expect that both the engineering (planning) firm and construction company possesses the appropriate theoretical basis and the correspondingly qualified professional personnel. In addition, they must be able to offer an environmentally-friendly, low-maintenance, economical and long-lasting pipe system, features that a plastic system can provide.

5.2 General

The references to corresponding chapters of the Specification Manual indicated in the figures will serve as guides to passages in which the relevant subjects are discussed in detail and should facilitate the use of this Specification Manual in specific applications.

5.3 Classification criteria

In the project planning and installation of thermoplastic pipe systems, consideration must always be given to material-specific properties. The applicability of general principles to specific applications is only possible when material variables and behaviours display similarities (to the requirements of the given situation). In the age of the PC, modern computer programmes are used to design reliable pipe systems, and graphical planning occurs with the support of modern CAD applications. But these are not sufficient to guarantee the operational reliability of pipes, which still depends on the professional processing and use of plastic. The following instructions should be used, especially in planning, as a guide for the design and construction of PE pipe systems. A general distinction in the classification of plastic pipe systems is based on the method of installation. In general, there are three main groups, which are shown in figure 5.1.

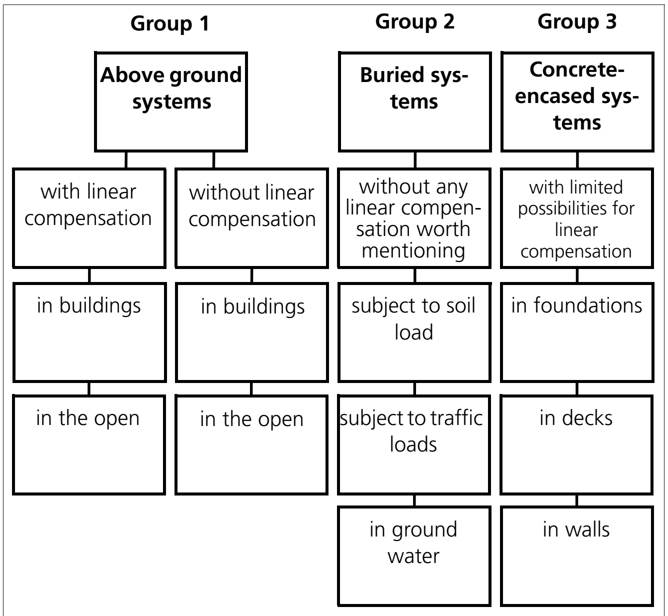


Figure 5.1 Pipe system applications

Group 1 consists of pipe systems with and without linear compensation. These systems require a bracket construction and are predominantly found in chemical or sewage plants, as well as in swimming pool construction. They generally require the largest project outlays. Planning aids and discernible influential factors for these pipe systems can be seen in figures 5.2 and 5.3.

Groups 2 pipe installations are exemplified by the parts of a communal water supply network. They are, however, also frequently used in the area of industrial waste water technology. Due to the flexibility of PE pipes, the costs of groundwork are lower than they are when laying steel, ductile iron or concrete pipes. PE also has distinctive advantages over less flexible plastic pipes (such as PVC). Planning aids and discernible influential factors are shown in figure 5.4.

Group 3 pipe systems constitute exceptional cases, especially as the accessibility for maintenance is limited. If possible, a pipeline should be installed according to the principles of groups 1 or 2, and direct integration into structures be reserved for open channels or discharge pipes, which are subject to lower stress. Planning aids and discernible influential factors are shown in figure 5.5.

5.4 Influence of operating conditions

The influence of pressure and temperature fluctuations depends on the individual system.
Since the possibility of thermal linear compensation is not always available, this limitation must be taken into account when calculating load effects. Stress due to internal pressure, bending, external loads, etc can collectively occur and make it necessary for the individual pipe system to be sized in a system-dependent manner.

5.5 Structural analysis

Depending on the nature of the load, various tests can be run on buried pipe systems. In one design, it is the stress and deformation calculation that is important. In another, it is a stability test. A summary of the relevant considerations in this respect is presented in chapters 5.5.1 and 5.5.2. The principles underlying the calculations for buried plastic pipe installations are provide in ATVA 127 (calculations specific to the Netherlands are reported in NEN 3650, NEN 3651 and NPR 3659).

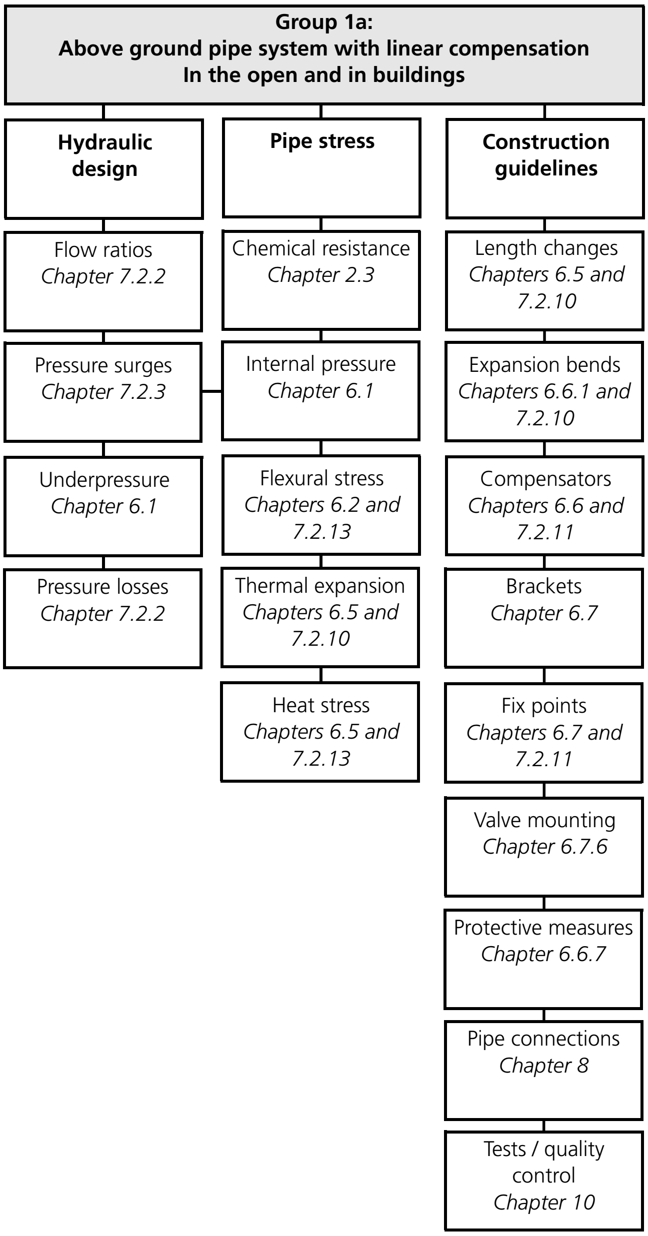
5.5.1 The stress and deformation calculation

Soil loads and traffic loads give rise to pipe cross-section tensile and compressive stresses. The extent of the stress is influenced by the elasticity of the pipe. In general, increasing the elasticity of the pipe will reduce tension. The testing for stress is therefore to be conducted while considering all inner and outer influential factors (e.g. soil stress, traffic load, water, ground water, chemical resistance internal over- or underpressure). The manner of embedding in the ground is particularly responsible for degrees of pipe deformation. The higher the compression ratio of the surrounding ground, the smaller the deformation. The requirement of locating the pipe zone in compactable soil is derived from this observation. The acceptable vertical deformation of a PE pipe is currently 6% and is based on the average pipe diameter. Stress and deformation calculations are always performed in parallel.

5.5.2 Stability test

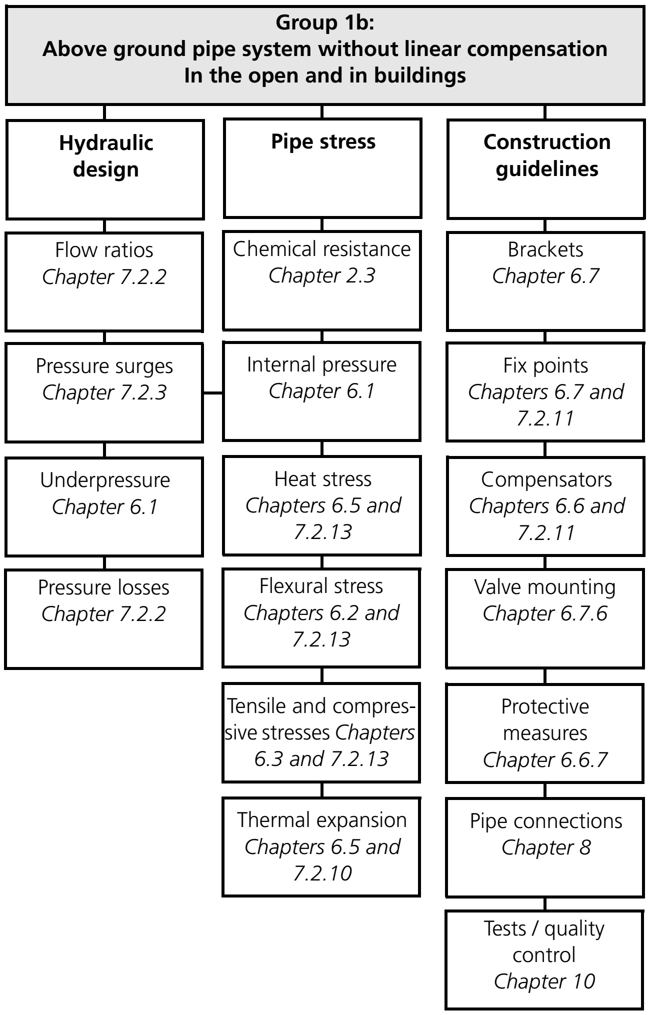
In a PE pipe susceptible to deformation, exceeding a critical load will cause the pipe cross section to buckle. This occurs as a result of increased external (external overpressure due to the effects of groundwater, depth of the covering soil, etc) or internal (underpressure) stresses. The stability test is used to document the safety clearance between the critical and actually occurring load. Details and instructions for the calculation and the installation of the pipe systems are provided in the following chapter.

Installation



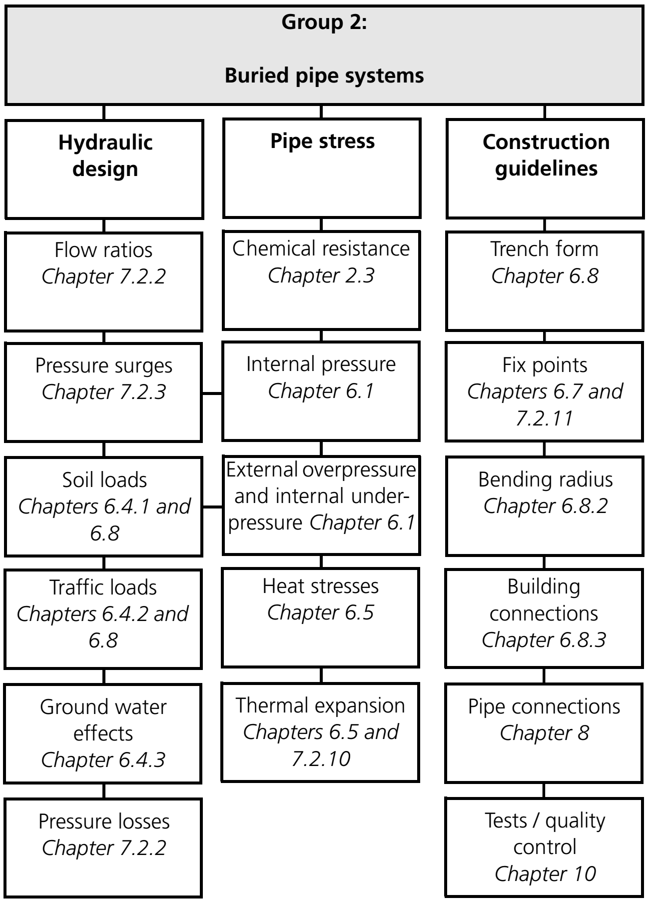
Pipe systems are usually installed so that the pipelines can elongate under the effects of heat. The latitude of movement can be provided by the installations own compensation elements (e.g. expansion bends and compensators) and by properly positioned sliding and guiding brackets. Special consideration needs to be given to ensure adherence to the acceptable support distances and the limiting of flexural loads in pipe bends and branches.

Figure 5.2 Above ground pipe systems with linear compensation



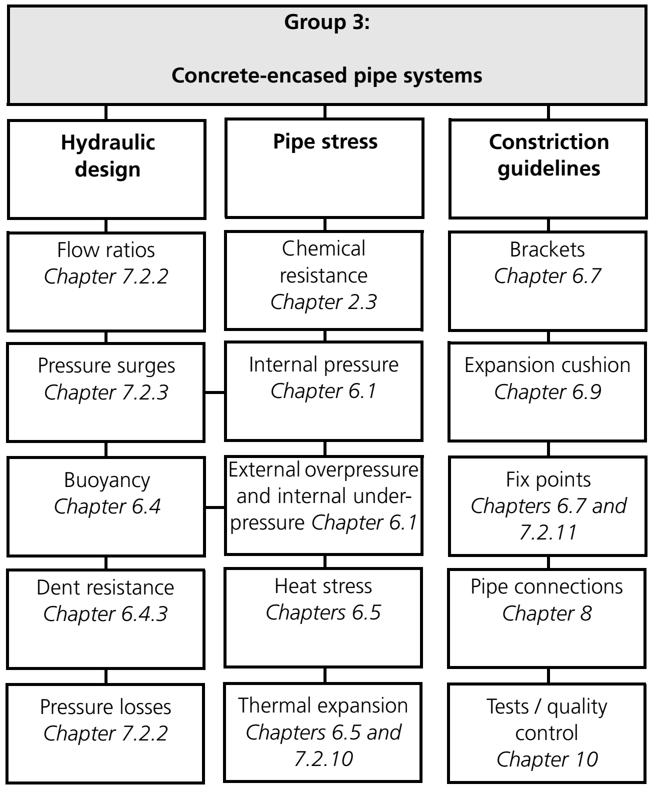
Pipe systems can also be installed without special thermal linear compensation. Pipe systems in which linear movement is impeded must pay special attention to the tensile and compressive stresses that occur, as well as to forces at fixed points. Exposed plastic pipes that are rigidly or firmly clamped (e.g. on a pipe bridge) can be exposed to large temperature variations. For this reason, calculations can be used in individual cases to test the expected stresses in order to determine if linear compensation can be excluded.

Figure 5.3 Above ground pipe systems without linear compensation



Buried pipe systems are subject to other load characteristics than above ground pipe systems. In designing pipelines, emphasis is placed on determining the largest possible load capacity of the pipe under the effects of external forces and the testing of stability.

Figure 5.4 Buried pipe systems



Pipe systems can also be installed so that an encasement in concrete walls, decks, foundations, etc is possible after completion of the installation. The concrete surrounding the pipe impedes length changes resulting from temperature fluctuations (e.g. due to the temperature of the flow medium or the effects of external temperature). Since no friction-type connection exists between the plastic pipe and the concrete, measures must be taken to protect individual pipe elements.

Figure 5.5 Concrete-encased pipe systems

Installation

6 Planning and construction guidelines and stress types

In principle, several internal and/or external stresses can affect a pipe system. This especially applies to buried pipe systems. Potential types of stress will be discussed below.

6.1 Internal and external pressure loads

In a pressure pipe system, principal stresses occur in various directions under the effects of compressive loads (internal and external overpressure, or internal underpressure). In principle, the below-listed types of stress can be distinguished:
- Radial stress (σ_r)
- Axial stress, longitudinal stress (σ_a)
- Tangential stress, circumferential stress (σ_t)

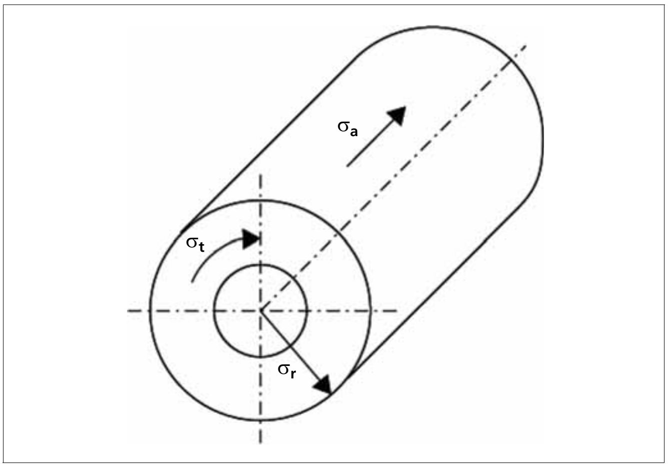


Figure 6.1 Stresses as function of the direction of their effects

The size of the respective stress can be calculated using the equations in chapter 7. The diagrams in appendix B are also aids for determining pressure load capacity.

6.1.1 Internal overpressure

An overload of a pressure pipe system due to internal overpressure results, especially in association with additional heat effects, to a continuous expansion of the pipe until it breaks.
The danger of an expansion arises as a result of too small wall thicknesses, in which an indiscriminate wall thickness increase is not justifiable. In the presence of heat expansion, a wall thickness enlargement also increases the reactive forces on the pipe fixed points. The engineer must ensure that the wall thickness is designed to meet requirements while the pipe remains elastic in response to any length changes that might arise. A sudden change in structural operating conditions due to internal pressure leads to pressure surges. The distinctive elasticity of the plastic pipe has the advantage that the extreme values of pressure waves are significantly lower than in steel pipes. Despite this fact, pipe systems operated by pumps or containing rapidly closing shut-off valves must be tested for any foreseeable effects of pressure surges.

6.1.2 Internal underpressure and/or external overpressure

Thin-walled pipes can dent as a result of internal underpressure or external overpressure, which is to say that they can lose their circular shape. To guard against possible instability, the critical dent pressure of a pipe must be calculated in relation to the standard dimension ratio. The critical dent pressure (ρ_{crit}) must display a safety factor SF = 2.0 against underpressure (according to ATV A 127, a safety factor of 2.0 to 2.5 is to be incorporated). In professional literature, the denotation "N" is used to designate the safety factor (SF).

6.2 Stress due to pipe deflection

Usually, deflection occurs in a pipe length as a result of the filled pipe's dead weight, including the weights of valves. The flexural stress resulting from a bend depends on the weight and span of the pipe between two support points.
In establishing support distances (LD) in compliance with appendix B4, the flexural stresses are so small that no overload or strain on the outer surface can occur. It must be noted that support distances have to be reduced when other components (e.g. valves) are present, or else additional support has to be provided. Especially notable are the significantly higher flexural stresses created by deformation of pipe branches and bends in connection with changes in direction.
Experienced has shown that, depending on the installation temperature and the standard dimension ratio, the bending of pipe strings that might predominantly occur in buried installations does not have any effect on the service life and operational reliability of the pipe. Temperature loads in a plastic pipe system affect strength values. Varying temperature loads can produce heat stresses if pipe expansion is restricted or prevented. Heat stresses are also created by temperature differences between the inner and outer wall of the pipe.

The stresses created by constricted conditions (e.g. impeded thermal expansion between two fixed points) are absorbed by the visco-elastic behaviour of the plastic pipe until a tension/expansion equilibrium is created. This process is also termed relaxation. Critical operating conditions arise when varying loads are involved, and the periods of high temperature grow longer than the periods of low temperature. In particular, tensile stresses with long-term effects can, after frequent load changes, result in fatigue fractures. Stress peaks occur when an initial temperature variation affects an installation condition. If the temperature level remains nearly constant over a longer period, the heat stresses are reduced by relaxation to level = 0.50% of the maximum value. Heat stress generated by a varying thermal load and tensile stress having a long-term relaxing effect can be calculated according to the equations in chapter 7.

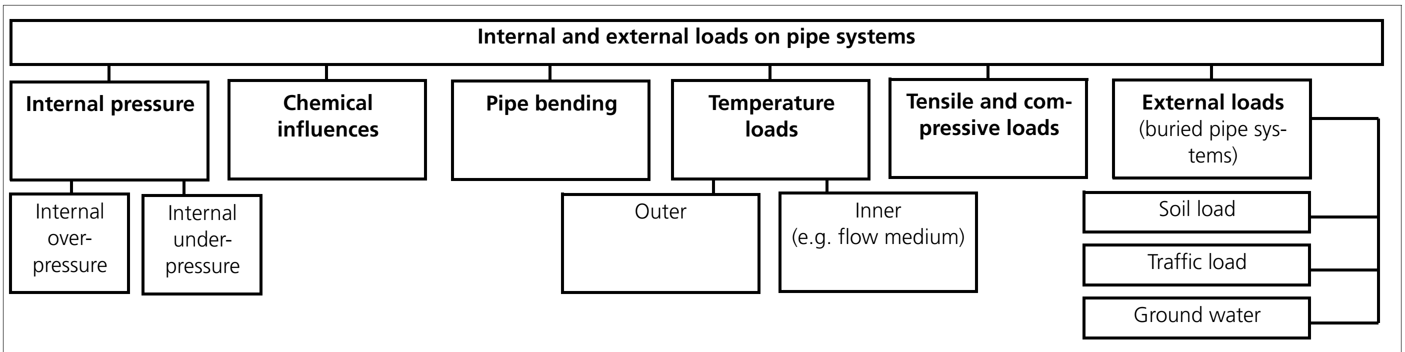


Figure 6.2 Internal and external loads on pipe systems

Planning and construction guidelines and stress types

6.3 Tensile and compressive loads

As a result of differing thermal expansions in the inner and outer wall of a pipe, compressive stresses develop on the warmer side and tensile stresses on the colder side. At the same time, these stresses interact with the internal pressure. Stress values can be calculated using the equations in chapter 7. Compressive and tensile stresses do not only arise in connection with constricted thermal expansion but also due to the internal pressure itself. In particular, length changes related to short-term stress peaks can be observed in pressure tests involving increased internal pressure. It should also be noted that the effects of notches in the pipe wall are significantly strengthened by tensile loads.

6.4 Loads on buried pipe systems

6.4.1 Soil load

The bearing capacity of buried plastic pipes depends on the combined effects of pipe and soil. The top of the pipe is pressed down under soil load and the sides of the pipe are pushed out into the surrounding soil.
The reaction pressure that a lateral force exercises on the pipe causes a large cross-section deformation (support effect). The form of the trench, the nature of the pipe embedding and the backfill for the trench substantially determine the bearing capacity and stability of a buried plastic pipe system. The load must be evenly spread over the entire pipe length. It is also necessary to design pipe brackets that eliminate longitudinal bending and point loading. The acceptable installation depth (i.e. the bearable soil load (p_E)) is calculated using the following equation:

$$p_E = \gamma_B \cdot h$$

Equation 6.1

p_E = external soil pressure (kN/m^2)
γ_B = specific weight of the soil (kN/m^3)
(soil groups 1-3 -> γ_B = 20)
h = height of the soil layer above the top of the pipe

The acceptable installation depth (i.e. the bearable soil load) essentially depends on:
- pipe wall thickness
- pipe and soil stiffness
- form of the trench
- pipe embedding and trench backfill

6.4.2 Traffic load

Pressure dispersals resulting from traffic loads due to road and rail transport are assumed to be an evenly distributed surface load (p = surface load). The soil stress (p_{soil}) resulting from traffic loads is calculated in the following equation:

$$p_{soil} = a_F \cdot p_F$$

Equation 6.2

p_{soil} = soil stress (kN/m2) (acc. to ATV A 127, there designated "ρ")
a_F = correction factor for road-traffic loads (-)
p_F = soil stress resulting from traffic loads (kN/m^2)
(acc. to ATV A 127)

The stresses derived from the above-indicated equation are multiplied by a shock factor (φ), which takes the nature of traffic load into consideration.
Generally, the following shock factors are employed:

$$\left.\begin{array}{l} 1.2 \text{ for SLW 60} \\ 1.4 \text{ for SLW 30} \\ 1.5 \text{ for SLW 12} \end{array}\right\} \text{road traffic}$$

Inserting the calculated stresses and corresponding shock factors in the following equation 6.3 yields the actual effective traffic load.

$$p_V = \varphi \cdot p_{soil}$$

Equation 6.3

p_{soil} = soil stress (kN/m^2) (acc. to ATV A 127)
φ = shock factor for road-traffic loads (-)
p_v = soil stress resulting from traffic loads (kN/m^2)
(acc. to ATV A 127)

For pipes under railways, the following applies:
$\varphi = 1.4 - (0.1 \cdot (H - 0.5)) \geq 1$
With burial depth ≥ 4.00 m, general experience indicates that all stress differences between dead soil load and percussive traffic load completely disappear. With diminishing burial depths, the influence of the traffic load above soil load grows larger. The minimum height of the soil layer H_{min} for railway traffic loads is:

$$H_{min} = 1{,}50 \text{ m}$$

Equation 6.4

Under certain conditions, a minimum soil layer $H_{min} \leq 1.50$ m make it necessary to invoke special measures (e.g. use of protective pipe). The guidelines from Bahn AG are to be observed when manufacturing railway crossings. The vertical aggregate stress on buried pipes is composed of both soil and traffic loads. The horizontal stresses produced by traffic load can be ignored.

6.4.3 Ground water

Buried pipes can be exposed to external overpressure (this especially applies to areas with high ground-water tables). Similarly, a pipe encased in concrete, if only for a short time, is subject to an external pressure. A dent resistance test is required for buried pipe systems that are burdened by additional external pressure.
The effects of the external pressure load correspond to the hydrostatic pressure on the pipe axis.

$$p_w = \gamma_W \cdot \left(h_W + \frac{d_e}{2}\right)$$

Equation 6.5

p_W = external water pressure (bar)
γ_W = specific weight of the fluid (for water = 1.00) (kN/m^3)
h_W = height of the water column above the top of the pipe

The critical dent pressure (p_K) of a circular PE pipe as a result of water pressure is:

$$p_k = \frac{2 \cdot E_{C_R}}{1-\mu^2} \cdot \left(\frac{e}{d_e}\right)^3 \cdot 10$$

Equation 6.6

E_{CR} = creep modulus for the pipe material as a factor of temperature and load period (N/mm^2)
e = pipe wall thickness (mm)
d_e = outside diameter of the pipe (mm)
p_k = critical dent pressure (bar)
μ = transverse contraction value (for PE μ = 0.38-0.40) (-)

The safety factor (SF ≥ 2.0) usually used in the stability test (according to ATV A 127, a security factor designated there as "N" of 2.0 to 2.5 is to be taken into account) makes it necessary to undertake the following verification:

$$p_{W_{acc}} \leq \frac{p_k}{SF}$$

Equation 6.7

$p_{w\ acc}$ = acceptable external water pressure (bar)
p = critical dent pressure (bar)
SF = safety factor (-)

Note:
The soil surrounding a buried pipe has a supporting effect. It is therefore possible to derive support factors that enable the critical and, consequently, the acceptable external pressures to be increased. Technical literature provides the support factor values indicated in table 6.1.

Nominal pressure (bar)	Support factors fsup (-) with compaction	without compaction
SDR 17	2.3	1
SDR 11	1.2	1

Table 6.1 Support factors for buried pipe systems

Appendix B11 can be consulted to roughly estimate the external pressure stability.

Example applying appendix B11
Invoking three examples, we can clarify the use of appendix B11 for potential pressure loads created by external overpressure or internal underpressure.

Case 1: External overpressure alone
Operating conditions:
Material: PE100, SDR 11
Operating temperature: 25°C
Internal underpressure (p_u) 0 bar (no underpressure)

Result:
Maximum pressure load ($p_{ex\ tot}$) from external overpressure (p_{ex}) (maximum height of the water column (h_w) above the top of the pipe) and no underpressure (p_u) in the pipe system:

Read from appendix B11:
$p_{ex\ tot}$ = 1.0 bar à 10 mWs
-> $p_{ex\ tot}$ = $p_{ex} + p_u$
-> p_{ex} = $p_{ex\ tot} - p_u$ = 1.0 bar - 0 bar = 1.0 bar
à p_{ex} = $p_{ex\ tot}$ = 1.0 bar

Case 2: Internal underpressure alone
Operating conditions:
Material: PE100, SDR 11
Operating temperature (T_{O1}): 25°C
Operating temperature (T_{O2}): 50°C
External over pressure (p_{ex}): 0 bar (no external overpressure)

Result:
Maximum pressure load (pex tot) from internal underpressure (pu) and no outside overpressure (pex):

Read from appendix B11:
for T_{O1} = $p_{ex\ tot1}$ = 1.0 bar
for T_{O2} = $p_{ex\ tot2}$ = 0.6 bar

For T_{O1}, the following holds:
-> $p_{ex\ tot1}$ = $p_{ex} + p_u$
-> p_u = $p_{ex\ tot1}$ - pex = 1.0 bar - 0 bar = 1.0 bar
-> p = $p_{ex\ tot1}$ = 1.0 bar
-> The selected pipe system is vacuum stable.

For T_{O2}, the following holds:
-> $p_{ex\ tot2}$ = $p_{ex} + p_u$
-> p = $p_{ex\ tot2}$ - p = 0.5 bar - 0 bar = 0.5 bar
-> p_u = p $_{tot2}$ = 0.6 bar
-> p_{atm} = 1 bar ; $p_{abs} = p_{atm} - p_u$ = 1 bar - 0.6 bar = 0.4 bar absolute pressure
-> The selected pipe system is not vacuum stable under these operatingconditions, as $\rho_{u\ max}$ = 0.6 bar!

Case 3: Internal underpressure and external overpressure
Operating conditions:
Material: PE100, SDR 11
Operating temperature (T_{O1}): 25°C
Operating temperature (T_{O2}): 50°C
Maximum water column above the top of the pipe = p_{ex}: 7 m
Maximum underpressure (p_u) in pipe system: 0.2 bar

Result:
Maximum pressure load ($p_{ex\ tot}$) from external overpressure (p_{ex}) (maximum height of the water column (h_w) above the top of the pipe) and internal underpressure (p_u) in the pipe system:

Read from appendix B11:
for T_{O1} = p $_{tot1}$= 1.0 bar
for T_{O2} = p $_{tot2}$= 0.6 bar

For T_{O1}, the following holds:
-> p $_{tot}$ = $p_{ex} + p_u$
-> $p_{ex\ tot}$ = $p_{ex} + p_u$ = 0.7 bar + 0.2 bar = 0.9 bar
-> $p_{ex\ tot} = p_{ex\ tot\ 1}$
-> selected pipe is suitable!

For T_{O2} , the following holds:
-> $p_{ex\ tot}$ = $p_{ex} + p_u$
-> $p_{ex\ tot}$ = $p_{ex} + p_u$ = 0.7 bar + 0.2 bar = 0.9 bar
-> p_{ex} = $p_{ex\ tot2}$
-> Since $p_{ex\ tot} > p_{ex\ tot2}$, the total pressure load for the pipe system selected in the example is too large, which means that the selected pipe is unsuitable for this load.

T_O = operating temperature (°C)
T_{O1}, T_{O2} = selected operating temperature (°C)
p_{ex} = external over pressure (bar)
p_{abs} = absolute pressure (bar)
p_{atm} = atmospheric pressure ≈ 1 bar (bar)
$p_{ex\ max}$ = maximum external overpressure (bar)
p_u = internal underpressure (bar)
$p_{u\ max}$ = maximum internal underpressure (bar)
$p_{ex\ tot}$ = pressure difference between external overpressure and internal underpressure (bar)
$p_{ex\ tot1}$ = pressure load read from appendix B11 for t_{O1} (bar)
$p_{ex\ tot2}$ = pressure load read from appendix B11 for t_{O2} (bar)
h_w = height of the water column above the top of the pipe (m)

6.4.4 Superposition of loads
According to appendix B11, the simultaneous effects of soil pressure and external water pressure can reduce additional load values.
In practice, the superposition of several internal and external influences can occur and have adverse effects on a pipe system. This means that, besides external loads, internal loads arising from internal pressure and/or impeded thermal expansion can affect the pipe system. In addition, buoyancy in ground water can cause flexural stress along the pipe axis.
The multiplicity of superposed loads requires careful and extensive planning of buried plastic pipe systems.

6.4.5 Structural analysis
Buried pipe systems must be regarded as special cases on account of their external loads.
They always require a differentiated analysis based on the installation guideline ATV A127 (on the standards NEN 3650, NEN 3651 and NPR

3559 in the Netherlands). Most equations and data on the preceding pages are established on the basis of this ATV guideline. A generalisation of the calculation methods is not possible due to the extent of the factors involved, making it necessary to abandon any simple overview of the equations.

6.5 Causes of length change

Plastic pipe systems are subject to discernible length changes even under small temperature variations on account of their high thermal length expansion coefficient (α_ϑ). As a result, the pipe system is constantly in motion in order to compensate for any temperature differences that arise. Length changes and associated linear expansions in pressure pipe systems mostly occur due to the superposition of several influential factors. The largest role in this regard is played by the additional occurrence of internal pressure loads.

6.5.1 Length change due to internal pressure load
Consideration must be given to pressure tests on pipe systems in which the test pressure can be 1.5 times larger than the nominal pressure. Test and/or operating pressures create axial stresses in the pipe that can result in longitudinal deformation on account of the low creep modulus of thermoplastics. The actual length change will often turn out to be smaller than the mathematically calculated one, since the expansion of the pipe system is impeded by friction. This difference is, however, irrelevant to the mathematical analysis of length changes and their effects.

6.5.2 Length change due to chemical effects
Besides the frequently mentioned good to very good resistance of polyolefin to a large number of chemicals, there are cases when chemical interaction is to be anticipated. In such cases, the appropriateness of the pipe material should be tested on the expected chemicals to be transported early in the planning stage. Various chemicals can cause length changes in pipe systems. Under certain circumstances, the chemicals being used can instigate swelling of the pipe or fitting. In such cases, the pipe wall absorbs more or less of the fluid contacting the pipe wall and consequently increases in volume. This expansion occurs both in a horizontal and in a radial direction to the pipe axis. The action of chemical compounds can, under certain conditions, result in reactions that have a detrimental effect on operating temperature. These temperature changes can subsequently produce thermal length changes that are unwanted and harmful to the pipe system.

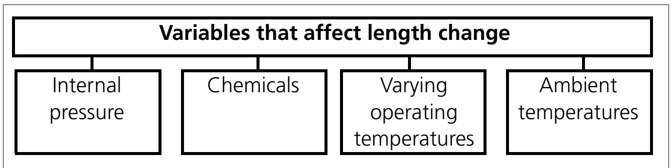


Figure 6.3 Variables that affect length change

6.5.3 Length change due to varying operating temperatures
In only considering the effects of operating temperature, it is possible to detect that the condition of the pipe changes after initial use in accordance with the operating temperature involved.
Decisive for the size of the length change is the temperature difference ($\Delta\vartheta$) that comes into effect. It is therefore advisable to test the effects of the length change at various operating temperatures at least once. After initial operation, a check should be made to see if the shifting of individual pipe lengths has damaged or might damage the pipe fixed points.

6.5.4 Length change due to ambient temperatures
Not only temperature differences of the medium but also outside temperature differences caused by changes between day and night as well as summer and winder periods are partly associated with large length changes. In particular, empty pipe systems exposed to solar radiation or the effects of frost must contain sufficiently designed compensation elements. The risk potential results from high flexural stresses in expansion bends and large forces on clamp positions (pipe fixed points).

6.6 Compensation for length changes

Plastic pipe systems are generally installed so that a compensation device absorbs any length change. There are also various design options, which will be dealt with in the following chapters.

6.6.1 Elbows
Usually, the site-specific pipe layout can be segmented by a given fixed-point design enabling length changes to be absorbed by pipe strings running at right angles to the direction of expansion.
This requires the smallest expenditure and the pipe system remains, in itself, closed.
The compensation pipe lengths created by this installation method have L, Z or U forms, or are geometrically interconnected with each other in the indicated forms.
Consideration has to be given to the fact that length changes in one pipe string lead to bends in others.
Since the resulting flexural stresses are transmitted to the expansion bend, it is recommended that these do not exceed the minimum length calculated in appendices B5 to B8.
The mathematical determination of expansion bends as compensation for length changes will be discussed in detail in chapters 7.2.10.

6.6.2 Compensators
If linear compensation by means of expansion bends is not or only partly possible, compensators must be incorporated in the system. These are also required at connection points with smaller load capacities, such as pump and tank supports.
In addition, compensators serve to reduce vibrations and their transmission to building structures. The design and construction of compensators is based on operating pressure and temperature.

- Axial compensators
Axial compensators are predominantly used to absorb length changes along the pipe axis. They can only absorb longitudinal forces by using tension bars, but not any transverse forces.

- Lateral compensators
Lateral compensators serve to absorb movement in both axial and transverse directions to the pipe axis. Since tension rods are involved in their construction, they constitute a force-locking element in the axial direction.

- Angular compensators
Angular compensators are also called lateral expansion joints. They provide suitable compensation for large length changes in both level and three-dimensional pipe systems. A length change is compensated in the expansion joint by bending pipe sections.

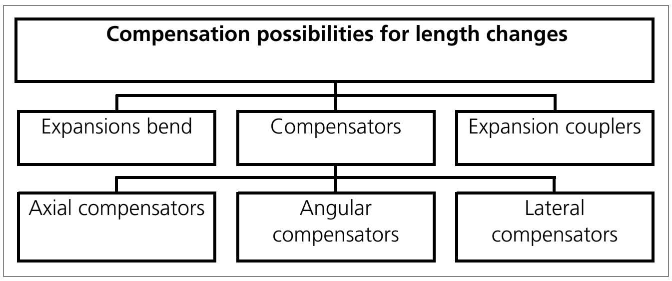


Figure 6.4 Length change compensation

- Forces in pipe lengths with compensators

Each length change in pipe systems generates a resistance of which the size is influenced by the nature of the compensation elements. The smaller that this resistance is, the smaller the reaction forces are and the larger the length change (Δl). The length change of the pipe causes the compensator to be pressed together or deformed and exercises, as a result, a reaction force.

The reaction force (= fixed point load) is composed of the deformation resistance of the compensator and the longitudinal force produced by the internal pressure, based on the effective cross-sectional area of the compensator.

The possibility cannot be excluded that the load on the fixed point is made larger by incorporating an compensator than it would be using expansion bends. In planning fixed point constructions, special attention should be paid to this fact.

- General remarks on compensators

The following rules need to be followed when making use of compensators:

- To function effectively, compensators must be mounted between two fixed points.
- The distance from one guide bracket (guide saddle) should not be any larger than 3x the pipe diameter.
- Only one compensator can be fitted between two fixed points.

6.6.3 Expansion couplers

Expansion couplers are suitable for absorbing axial length changes. Moreover, expansion couplers are only to be used in pipe systems in which no load produced by underpressure is to be expected (leakage in the sealing part of the coupler). If abrasive media are being transported (e.g. hydraulic transport of solids such as quartz sand water mixtures), Akatherm will certainly not be allowed to employ expansion couplers. Details on function, specifications and areas of application for expansion couplers can be found in chapter 8. By arranging guide brackets (guide saddles) in the immediate proximity of couplers, care needs to be taken to prevent the pipe from kinking on the side. The expansion coupler is not longitudinally force-locked and must also be installed between two fixed points. The resulting load on fixed points is smaller than the fixed-point that occur when compensators are used. A typical application for expansion couplers involves linear compensation in a rigid connecting piece between or more tanks.

6.7 Brackets

Brackets, also called pipe bearings, pipe saddles or pipe fixings, have the task of safely transferring all the loads arising in an pipe system to the building structure or infrastructure. Pre-requisite for the combined effects of pipes and brackets is the functional construction and design of the fixing elements. Examples of various arrangements of brackets in a pipe system are presented in figure 7.13.

6.7.1 Sliding and hanging brackets

Sliding and hanging brackets (sliding and hanging bracket saddles) can only absorb vertical forces and will only provide limited resistance to any operating movement. In incorporating sliding and hanging brackets, care must be taken that both longitudinal and a lateral movement of the pipe is given some play. The nature of this type of fixing is extremely susceptible to vibration, so their use in pipe systems powered by pumps is not recommended or only permissible along with guide brackets (guide saddles).

6.7.2 Guide brackets

Guide brackets (guide saddles) have to prevent any lateral deflection of the pipe. Due to their construction, they are therefore able to absorb transverse forces. The incorporation of guide brackets ensures that a pipe string cannot kink as a result of axial restraint.

6.7.3 Criteria for using brackets

The most important criteria for the correct application of brackets in a plastic pipe system are:

- If possible, pipes should be equipped at the bracket points with saddles. If there is no provision for the sliding of pipes in the saddles, plastic or rubber inserts can be used. The pipe may, however, not be crimped at the fixed point.
- If the pipe is to have the possibility of moving freely and uninhibitedly in brackets (saddles), the inside diameter of the bracket must be larger than the outside diameter of the pipe.
- Brackets may not be sharp-edged or linear. Point supports are also not acceptable.
- Pipes with large diameters are frequently equipped with saddle shaped supports. The angle of contact of the pipe must be at least 90°. At the same time, it must ensure suitable lift protection.
- The expansion of the pipe string must not be impeded by the bracket construction. The structure of the sliding surfaces must be corrosion resistant and offer sufficient room for shifting. Under certain circumstances, a final limit is provided.
- In a pipe installation without linear compensation (axially constricted), the acceptable support intervals (L_S) is, according to appendix B4, comparable with the critical buckling length $L_K = L_F$ (guide distance) indicated in appendix B10.

The smallest value indicated in this comparison is to be used as the actual value, which is $L_{act} = L_x$ (with $L_x \leq f\ (L_s, L_K, L_F)$. The acceptable fixing distance is:

$$L_{act} \leq L_K \text{ by which } L_K \leq L_F < L_A$$

Equation 6.8

This especially applies to pipes of small diameter.

- At positions in which the bracket distances must have very large designs for structural reasons, additional or movable supports (e.g. installation rails) must be provided. A support also serves to stabilise small pipes and prevent larger flexural deflections in pipe systems under constantly high operating temperatures. The support is connected to the pipe by means of a strap. Care must also be taken to ensure that , despite the additional supports, unimpeded sliding in brackets and/or expansion couplings can occur.
- If heat expansion gives rise to the danger of the pipe being lifted off its supports, or if vertically hanging brackets are attached to vertically inclined pipe sections, the inclusion of additional spring elements can be required (constant support).
- Sliding and hanging brackets (sliding and hanging bracket saddles) are provided if movement might occur in any direction. The pipe supported in this manner is however very susceptible to damage from vibration and must have a few intermediate brackets for cushioning effect.
- Concrete applications for sliding and hanging brackets (sliding and hanging bracket saddles) occur as fixed points involving expansion bends. Their design ensures that the acceptable support distances are not exceeded even in cases of large expansion bends.
- Radial guide brackets (guide saddles) are predominantly used with inclined pipes. They should be constructed In such a way that movements along the pipe axis are possible while the pipe axis is prevented from kinking. In addition, reaction forces due to vibrations of the radial guide brackets can be dissipated.

6.7.4 Fixed points

Fixed points will prevent shifting or movement of the pipe in any direction. They also serve to absorb reaction forces (e.g. when compensators or expansion couplers are used).

If a pipe system is constructed so that linear compensation cannot occur (axially constricted), the fixed-point design must be given special attention. The mathematical calculation of loads on fixed points will be discussed in chapter 7.2.11.

Planning and construction guidelines and stress types

6.7.5 Principles for the layout and construction of fixed points

- Fixed points are to be arranged so that direction changes in the pipe route can be used to absorb length changes.
- They are also to be designed in considering all the loads that might arise. In addition to reaction forces from friction at bracket contact points and deformation of bends, large forces are produced by fixed restraints of pipe lengths.
- The pipe must have the appropriate retainer rings to transfer the forces to the construction of the fixed point. Insufficient consideration of the restraint of the pipe in the bracket alone will, in many cases, cause deformation of the pipe cross section or damage to the pipe surface.
- Fixing pipe systems at fixed points should, if possible, be done at low ambient temperatures, giving rise to predominantly compressive stresses when heated (operating state).
- If flange connections occur in pipe lengths between fixed points, tensile stresses can cause the joint pre-tension forces to decrease, resulting in leakage at the flange connections.
- In inclining pipe segments, fixed points are employed to absorb dead weight and dynamic loads. The design has to ensure that vertical length changes do not produce any unacceptable tensile loads on the horizontal connections.

6.7.6 Valve mounting

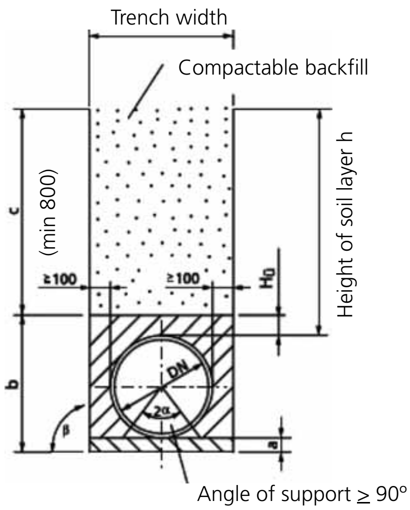
Locations in which valves or other heavy equipment encumber the pipe system have to be provided with an additional support structure. Supporting valves not only serves to bear weight but also prevents the transfer of large actuating forces to the pipe system.
The design features must be arranged to enable replacement of the valves without simultaneous disassembly of the entire fixing. If the valve mount corresponds to a fixed point, consideration must be given to the consequences of the restricted length change.

6.7.7 Protective measures

Protective measures for above ground pipe systems outside buildings (e.g. on pipe bridges) include insulation against loss of heat or cooling, concomitant heating and UV light blinding. Protected pipes are no longer exposed to extreme ambient temperatures that can result in such effects as a reduction in length change. In establishing the bracket distances in accordance with appendix A8 to A15, B4 and B10, it should be noted that the dead weight of the insulation will cause increased deflection. Protective measures can also be used to limit maximum pipe wall temperatures and therefore broaden the range of internal pressure loads for which the pipes are suitable. DVS 2210 Part 1 provides the following information on the UV stability of PE:
"Thermoplastic pipes treated with stabilising additives can be used in the open without any lasting effects from ultraviolet radiation (UV rays). Despite coating the thermoplastic with lightfast pigments, longer exposure to intensive UV light can cause discolouration (bleaching of the original colour). Reduced impact resistance is also not to be excluded."

6.8 Construction and installation of buried pipe systems (figure 6.5)

Following is based on German directions.



A = Pipe bed (in pipe zone)
100 mm for normal soil composition
150 mm on rocks or hard soils

B = Pipe zone with height of soil layer H_o

C= Backfill with a soil layer over the pipe zone that has a height of at least 800 mm

(stone-free sand, compacted)

Figure 6.5 Design of the trench

The height of the soil layer over the pipe is:
H_{min} (*) + H_{max} = mathematical calculation for the individual case in accordance with ATV guideline A 127.

(*) Note on H_{min}:
The KRV installation guideline for "pressure pipes" recommends that, in designing pipe trenches, all pipe elements are to be placed at a frost-free depth. Depending on the climate zone, the minimum height of the soil layer over the pipe must lie between 0.80 and 1.80 m. The standards for trench design are NEN-EN 1610, DIN 4124 and DIN 19630.

Trench bottom - Area a
The form and consistency of the trench bottom affects the mechanical properties of thermoplastic pipes. The already present or prepared bed must consist of stone-free sand and be easy to compact using appropriate equipment. The pipe must be laid so that a suitable supporting surface with an angle of at least 90° is formed. The depth of the trench can be calculated using equation 6.9, which is frequently employed in practice:

$$H_{Tr} = minimum\ 100\ mm + \frac{DN}{10}$$

Equation 6.9

H_{Tr} = depth of the trench (mm)
DN = Nominal diameter of the pipe (mm)

The above-cited equation 6.9 is given the same form in NEN-EN 1610. NEN-EN 1610 provides the following minimum values that, unless otherwise indicated, should not be exceeded:
- normal soil composition -> 100 mm
- rocks or hard soils -> 150 mm

Pipe embedding - Area b

The fill for the embedding of pipe systems must be stone-free soil, sand or similar material that must be capable of proper soil compaction. The embedding procedure significantly determines the soil pressure and soil-load distribution, as well as the formation of a stress-relieving, lateral soil pressure on the pipe.
The height of the embedding layer over the pipe (H_o) is:
H_0 = min. 150 mm over the top of the pipe and 100 mm over connecting elements (as stated in NEN-EN 1610)

Backfill - Area c

The backfilling and compacting of the trench occurs in layers. Soil types and materials that can result in settling at a later time may not be used to backfill the trench (e.g. ash, slag, stones). The compression ratio of backfill material is measure in %Proctor (%D_{pr}). The use of heavy compacting or compression equipment for soil compaction is not permitted when the soil layer over the pipe is <1.0 m.

6.8.1 Construction principles

The design (i.e. the form of the trench), the backfill and the corresponding compaction of materials have important effects on the service life of plastic pipe systems.
The following construction principles should therefore be observed:
- The pipe trench is shaped so that all pipe parts are covered by the prescribed soil layer.
- In laying plastic pipes on the prepared trench bottom and in subsequently embedding them, stones must be prevented from contacting the plastic pipe (danger of notching that leads to cracking).
- In rocky or stony subsoil, the trench bottom is to be excavated 0.15 m deeper and the additional excavation filled by a stone-free support layer.
- Sand and fine gravel (grit size <20 mm) are the most suitable materials for embedding pipes and compacting the pipe zone.
- All soil types occurring in nature are classified in DIN 18196 "Soil classification for construction purposes and methods of recognising soil groups". Soils are divided into:
  Group 1: non-cohesive coarse soils (sandy, gritty soils)
  Group 2: cohesive, fine soils (coarse clay, clay)
  Group 3: cohesive, fine and coarse mixed soils (cohesive sandy soils, gritty soils, cohesive stony weathered soils).
- The compactability of individual soils and, consequently, the quality of the compaction depend on the granulometric composition, the grain shape and water content. The method of compaction with regard to the equipment used is shown in table 6.2.
- Concrete or clay bar must, in certain circumstances, be incorporated in slopes in order to prevent the sandy pipe bed from being washed away. In some cases, drainage must be provided.
- In the case of bearing capacity changes of the trench bottom due to differing soil layers, a sufficiently long fine-gravel or sand fill is applied at the transitions.

The following instructions sheets are important for pipe trench design:
- DIN 4124 "Excavations and trenches"
- Din 19630 "Guidelines for the construction of water pipes: DVGW Technical Regulations"
- NEN-EN 1610 "Laying and testing drainage pipes and canals: Dutch Version EN 1610:1997"

Type of equipment			Soil group								
		Service weight (kg)	I Coarse (non-cohesive)			II Fine (cohesive)			III Mixed grained (cohesive)		
			Appropriate	Layer height (cm)	Number Trans.	Appropriate	Layer height (cm)	Number Trans.	Appropriate	Layer height (cm)	Number Trans.
1. Light compacting equipment (predominantly for the pipe zone)											
Tamper	**light**	≤ 25	+	≤ 15	2 - 4	+	≤ 10	2 - 4	+	≤ 15	2 - 4
Frogrammer	**medium**	25 - 60	+	20 - 40	2 - 4	+	10 - 30	2 - 4	+	15 - 30	3 - 4
	light	≤ 100	o	20 - 30	3 - 4	+	20 - 30	3 - 5	+	15 - 25	3 - 5
Vibrating plate	**light**	≤ 100	+	≤ 20	3 - 5	-	-	-	o	≤ 15	4 - 6
Vibrating roller	**medium**	100 - 300	+	20 - 30	3 - 5	-	-	-	o	15 - 25	4 - 6
	light	≤ 600	+	20 - 30	4 - 6	-	-	-	o	15 - 25	5 - 6
2. Medium and heavy compacting equipment (above the pipe zone)											
Tamper	**medium**	25 - 60	+	20 - 40	2 - 4	+	10 - 30	2 - 4	+	15 - 30	2 - 4
	heavy	60 - 200	+	40 - 50	2 - 4	+	20 - 30	2 - 4	+	20 - 40	2 - 4
Frogrammer	**medium**	100 - 500	o	20 - 40	3 - 4	+	20 - 30	3 - 5	+	25 - 35	3 - 4
Vibrating plate	**heavy**	500	o	30 - 50	3 - 4	+	30 - 40	3 - 5	+	30 - 50	3 - 4
	medium	300 - 750	+	30 - 50	3 - 5	-	-	-	o	20 - 40	3 - 5
Vibrating roller	**heavy**	750	+	40 - 70	3 - 5	-	-	-	o	30 - 50	3 - 5
		600 - 8000	+	20 - 50	4 - 6	-	-	-	+	20 - 40	5 - 6

+ = recommended o = most suitable

Table 6.2 Type of compaction

* The above-stated data represents average performance data. In unfavourable conditions (e.g. high water content, sheet lining, the indicated layer heights have to be decreased, while they can be increased in especially favourable conditions. Precise values are only ascertained by means of trial compaction. If no trial compaction is run (except in cases involving steel and ductile iron pipes), only use the highest values for the layer heights indicated in the table.

Planning and construction guidelines and stress types

6.8.2 Bending radius

Route direction changes can be followed by bending the pipe.
To avoid the risk of buckling and overstraining the outside surface, it is recommended that the minimum bending radius not be exceeded (table 6.3).

Material	Bending radius at various installation temperatures				
	ISO-S	SDR	0°C	10°C	20°C
PE100	8	17	50 x d_e	35 x d_e	20 x d_e
	5	11	50 x d_e	35 x d_e	20 x d_e

Table 6.3 Bending radius

Note to table 6.3:
The safety factor (SF) for the indicated SDR and ISO-S values of PE is 1.6. The bending radius at an installation temperature of 20°C were mathematically calculated. To calculate the bending radius at an installation temperature of 0°C, the mathematically calculated values for an installation temperature of 20°C were multiplied by a factor of 2.5. The bending radius at an installation temperature of 10°C were interpolated (mean values).

6.8.3 Building connections

When buried pipes connect to buildings, the possibility of settling has to be taken into account. The elastic plastic pipe, due to the deformation capacity zone (figure 6.6) over the length DZ (elbow length) ensures that no overload can occur in the area of settlement.

6.9 Principles of constructing and installing concrete-encased pipe systems

Plastic pipes encased in concrete after installation represent a special case. Their handling in connection with the technical application guidelines in for pressure pipes in this manual is therefore limited to important or critical details. The instructions may be applied to other similar circumstances.

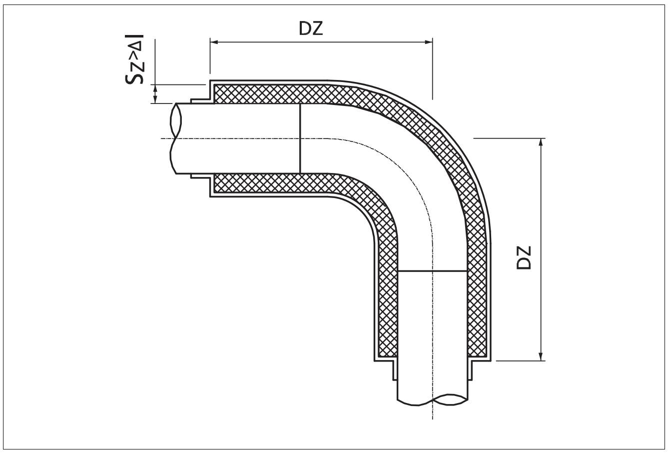


Figure 6.6 Expansion zones in pipe bends

6.9.1 Behaviour of pipe systems under temperature loads

Once a pipe system is encased in concrete, no movement can any longer occur. A pipe system without linear compensation is created, meaning that increased heat stresses have to be taken into account. Since no friction-lock connection is formed between the straight pipe and surrounding concrete, the fittings constitute fixed points and are correspondingly subjected to stress. In installing pipe systems, measures need to be taken to limit the load on the fittings. Examples of such practices are described below.

6.9.2 Load on pipe bend

If extreme temperature differences can arise, pipe bends have to be protected against overstress. For this purpose, an expansion zone using deformable material is incorporated. The chosen thickness of the expansion cushions must be at least as large as Δl. The length of the expansion zone corresponds to the dimensions of the expansion bends in appendices B5 to B8.

6.9.3 Load on tee

Due to varying temperatures, fittings are subject to surface pressure. This adverse load concentrates on tee sections, as additional shear forces are created at outgoing connections.

If a load limiting element is placed directly beside the fitting, an electrofusion coupler is the most suitable connection piece. The longitudinal force (force on a fixed point) (F_{Fp}) remains equally large, but the deformation due to the significantly smaller Δl is clearly less. Another option for protection against overloading is the incorporation of an expansion zone (expansion cushion).

6.9.4 Fixing pipe systems

In comparison with brackets, the installation of a concrete-encased pipe system does not require any special measures. The fixing during installation only serves as float protection and is to be regarded as provisional attachment prior to encasement with concrete.

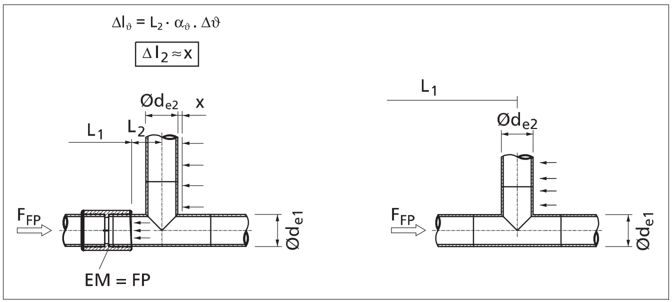


Figure 6.7 Shear and fixed-point forces on tees and 45° branches

6.10 Chapter summary

Internal pressure loads	Internal pressure loads create stresses in various directions. Radial stresses, axial stresses and tangential stresses can occur.
Internal overpressure	Internal overpressure can result in pipe expansion, especially under the effects of heat. Sudden changes in operation conditions can cause pressure surges.
Internal underpressure / external overpressure	Exposed to internal underpressure or external overpressure, a pipe will tend to buckle, which means it deviates for its ideal form (circular cross section). The critical buckle pressure should be calculated with regard to stability.
Pipe bending	Pipe bending is usually caused by the dead weight of the pipe and/or additionally incorporated valves and pipe fill. The relevant bracket distances (support distances) must therefore be determined and the suitable pipe brackets incorporated.
Temperature loads	Temperature loads have a very large effect on the mechanical properties of plastic pipe. Attention is first of all to be paid to the relatively large thermal length change.
Tensile and compressive stresses on the pipe wall	They are created during pipe manufacture due to differing cooling conditions. Compressive stresses arise in the outer wall of the pie (usually the first surface to cool) and tensile stresses on the warmer inner wall of the pipe.
Soil load	The soil layer on top of the pipe loads weight on the pipe and can cause it to deform. This load therefore has a significant effect on the pipe structure and the service life of the pipe.
Trench form, pipe embedding and backfill	Pipe trench design substantially influences the bearing capacity and stability of a pipe system, and therefore has a large influence on the service life of the system.
Traffic loads	Traffic loads are additional external loads that can affect the pipe system. They require special protective measures. If the prescribed minimum soil layer over the pipe is not maintained, protective pipes may have to be installed.
Railway traffic loads (railway crossings)	The installation guidelines from ProRAil are important for installation under railways and railway facilities as well as for railway crossings.
Ground water	Areas having a high ground water table can load external overpressure on the pipe system. The same holds true for concrete-encased pipe systems, which are exposed to short-term heightened overpressures. Both cases require the calculation of dent resistance.
Length change	The length change of a pipe system is caused by varying operating temperatures, varying ambient temperatures or internal pressure loads. Frequently, several of these influences are superposed.
Compensation for length changes	The inclusion of elbows, expansion couplers or compensators can compensate for length changes.
Elbow	Elbows (expansion bends) absorb length changes by moving laterally perpendicular to the expansion direction. Depending on structural and spatial conditions, they can be U, L or Z shaped.
Compensators	Compensators are used if other compensation options cannot or can only be partially applied. The design depends on operating pressure and temperature. Axial, lateral and angular compensators are used.
Expansion couplers	Expansion couplers are predominantly employed in pressureless systems as connection elements and compensation for length changes.
Brackets	Brackets have the task of transferring the effective loads on the pipe system to the building structure or infrastructure.
Sliding and hanging brackets (sliding and hanging bracket sleeves)	They are only able to absorb vertical forces.
Guide brackets (Guide saddles)	They serve to absorb both vertical and horizontal forces.
Fixed points	Fixed points in association with suitable bracket concepts prevent shifting or movement of pipe systems.
Valve fixing	Valve fixings not only serve as support for valves but prevent the transfer of reaction forces.
Protective measures for above ground pipe systems	They are used to improve the insulation properties of pipe systems. The use of concomitant heating is necessary in many cases. Protective measure may also be taken against UV radiation.
Bending radius	In bending pipe, certain bending radius should not be exceeded (table 6.3).
Building connections	Connections of building can be exposed to settling, which can be compensated by creating deformable zones.
Concrete-encased pipe systems	Concrete-encased pipe systems function as a fixed restraint. Fittings behave in concrete as fixed points and are therefore also subject to the same stresses, which means that any heat stresses must be absorbed and compensated for in the pipe system.

Planning and construction guidelines and stress types

7 Basic calculations

7.1 Factors influencing pipe system design

Type of influence	Short symbol	Unit
Outside diameter	d_e	mm
Inside diameter	d_i	mm
Internal pressure	p_i	bar
External pressure	p_{ex}	bar
Underpressure	p_u	bar
Reference stress	σ_{ref}	N/mm^2
Creep modulus	E_{cR}	N/mm^2
Operating temperatures		
Lowest operating temperature	$T_{i\ min}$	°C
Highest operating temperature	$T_{i\ max}$	°C
Highest ambient temperature	$T_{a\ max}$	°C
Average installation temperature	T_{ins}	°C
Safety factor		
for load class I = 1.3	S	
for load class II = 1.8	S	
for load class III = 2.0	S	
for stability N = 2.0	S	
Calculated pipe wall temperature		
$T_W = 0{,}9 \cdot T_{Flow\ medium}$	$T_{W\ min}$ $T_{W\ max}$	°C
Maximum occurring temperature difference		
max $\Delta\vartheta = T_u - T_i$	$\Delta\vartheta$	K
T_0 = upper maximum value		
T_u = lower maximum value		
Load period:		
Load h/a (= hours per annum)		
for min T_W	-	h/a
for max T_W	-	h/a
for ρ_i	-	h/a
for ρ_a	-	h/a
Calculated service life for	t_{SL}	h
calculation of creep strength	t_{SL}	a
Reduction factors		
Time dependence (if applying appendix A1, this factor has already been taken into account)	A_1	-
Reduction factor		
(influence of ambient medium) according to DVS 2205 - Part 1	A_2	-
Reduction factor		
Temperature dependence (if applying appendix A1, this factor has already been taken into account!)	A_3	-
Reduction factor		
(influence of specific resilience) DVS 2205 - Part 1 (*See table 7.12*)	A_4	-
Flow medium		
Pressure loss per m pipe	Δp	bar/m
Flow velocity	w	m/s
Flow volume	$\dot{V}$	m^3/h

Type of influence	Short symbol	Unit
Pressure Surge	p_{surge}	
Welding factors		
Short-term welding factor	f_s	-
Long-term welding factor	f_l	-
(The abbreviations f_s and f_l indicated here have been freely chosen by Akatherm. In the DVS 2205 Part 1 guideline they are shown as f_z (short-term welding factor) and f_l (long-term welding factor)!		
Connection method		
- *detachable connection*		
- unions		
- couplings		
- plug-in connections		
- flange connections		
- compression connections		
- *permanently attached connections*		
- welding		
o electrofusion	EF	
o butt-welding	BW	
o hot gas extrusion welding	HE	
o hot gas hand welding	HW	
o hot gas speed welding	HR	
Types of installation		
- above ground with linear compensation	☐	
- above ground without linear compensation	☐	
- concrete encased	☐	
- buried	☐	
- installation in the open	☐	
- installation in buildings	☐	
Additional influences		

Table 7.1

The listed data is meant to guide compilation of important data and variables important for the construction of a pipe installation.

Note:
The listed mathematical operations and relations have been simplified as much as possible. Plastic-specific parameters and generally valid factors are partly already integrated into calculation formulae. We have abstained from detailing the derivation or reproduction of single values to abbreviate this section.

7.2 Calculating pipe parameters

7.2.1 Explanation

The calculation of thermoplastic pipe systems is especially important for the engineer undertaking a project. This chapter presents the basic principles required for designing plastic pipe systems. However, the practitioner (user) should also be able to acquire the necessary data and standard variables for internally pressure-loaded pipe in a relatively simple manner without spending a lot of time. The mathematical operations are supported by diagrams in the appendices from which most values and data can be read off. Thermoplastic pipe calculations basically occur on the basis of long-term values. The reference stress (σ_{ref}) and mechanical (creep) strength (i.e. creep modulus (E_{cR})) of a pipe system in relation to temperature can be derived from the creep diagram in appendix A1 and the creep modulus curve diagram in appendix A2. The creep rupture curves are based on internal pressure tests on pipe samples filled with water and represent minimum values. If pipe systems are not intended for water but for other flow media, their effects on creep strength properties must be given special consideration.

Basic calculations

7.2.2 Hydraulic principles

- Calculating flow velocity

$$w = 354 \cdot \frac{\dot{V}'}{d_i^2} \quad \text{resp.} \quad w = 1275 \cdot \frac{\dot{V}''}{d_i^2}$$

Equation 7.1

d_i = inside diameter -> $d_s = d_e - 2 \cdot e$ (mm)
$\dot{V}'$ = flow volume (flow rate) (m^3/h)
$\dot{V}''$ = flow volume (flow rate) (l/s)
w = flow velocity (m/s)
Standard values for fluids:
w ≈ 0.5 - 1.0 m/s -> intake side
w ≈ 1.0 - 3.0 m/s -> pressure side

- Calculating the flow volume

The required pipe size is derived from the flow velocity of the medium and the clear cross-section of the pipe. The flow rate of fluids is calculated as follows:

$$\dot{V} = A \cdot w = const.$$
$$A = \frac{d_i^2 \cdot \pi}{4} \qquad d_i = d_e - 2 \cdot e$$

Equation 7.2

d_i = inside diameter of the pipe (mm)
d_e = outside diameter of the pipe (mm)
e = pipe wall thickness (mm)
A = cross-sectional area of flow channel (mm^2)
w = flow velocity (m/s)
$\dot{V}$ = flow volume (m^3/h, l/s)

- Calculating the inside diameter of the pipe

If the flow rate (flow volume) is known and the constants in the above-stated equations have been compiled, this yields a conventionally-sued formula for calculating the inside diameter of the pipe:

$$d_i = 18{,}8 \cdot \sqrt{\frac{\dot{V}'}{w}} \quad \text{resp.} \quad d_i = 35{,}7 \cdot \sqrt{\frac{\dot{V}''}{w}}$$

Equation 7.3

d_i = inside diameter of the pipe (mm)
w = flow velocity (m/s)
V' = flow volume (m^3/h)
V'' = flow volume (l/s)

The tomogram presented in the appendix A16 (along with the associated tables A16a, A16b and A16c) can be used to directly calculate the appropriate dimensions.

- Calculating the Reynolds number (Re)

The Reynolds number (Re) indicates the relationship of the inert forces affecting the flow particles to the forces of viscosity. The Reynolds number is dimensionless and is calculated as follows:

$$Re = \frac{w \cdot d_i}{10^3 \cdot \nu}$$

Equation 7.4

Re = Reynolds number (-)
ν = kinematic viscosity (m^2/s)
w = flow velocity (m/s)
d_i = inside diameter of the pipe (mm)

- Determining the pipe friction number (λ_P)

The dimensionless pipe friction number (λ_P) is required to calculate the hydraulic loss in the pipe. For laminar flows (Re < 2320) in circular cross-sections, the following holds:

$$\lambda_P = \frac{64}{Re}$$

Equation 7.5

Re = Reynolds number (-)
λ_P = pipe friction number (-)

In most cases, turbulent flows are created in pipes (Re > 2320).
The pipe friction number (λ_P) for turbulent flows can be determined with the aid of appendix A3. The pipe roughness value (k), which is crucial for the calculation, can be considered to be 0.01. In practice, λ_P = 0.02 can be used to make rough estimates of hydraulic loss.

- Equivalent pipe length

$$L_{tot} = L_{Pipe} + L_{Fitting} + L_{Valve}$$

Equation 7.6

$$L_{Pipe} = \text{total pipe length (straight pipe)}$$
$$L_{Fitting} = \frac{d_i}{10^3} \cdot \Sigma\xi_F$$
$$L_{Valve} = \frac{d_i}{10^3 \cdot \lambda_P} \cdot \Sigma\xi_A$$

Equation 7.7

L_{tot} = total pipe length (m)
ΣL_{Pipe} = sum of all pipe lengths in the system (m)
$\Sigma L_{Fitting}$ = sum of all fitting lengths in the system (m)
ΣL_{Valve} = sum of all valve lengths in the system (m)
d_i = inside diameter of the pipe (mm)
λ_P = pipe friction number (-)
$\Sigma\zeta_F$ = sum of the individual resistances of fittings (-)
$\Sigma\zeta_A$ = sum of the individual resistances of valves (-)

An exact indication of pressure loss at connections (welding joints, flange connections, unions) is not possible because the nature and manner of the connections vary. An overall addition of 10% to the calculated total loss would appear to be appropriate.

- Calculating total pressure loss

In calculating the total pressure loss, the sum of the respective individual pressure losses must be computed. The sum of the individual pressure losses is calculated by:

$$\Delta p_{tot} = \Sigma\Delta p_{RP} + \Sigma\Delta p_{RF} + \Sigma\Delta p_{RV} + \Sigma\Delta p_{RC}$$

Equation 7.8

$\Sigma\Delta p_{tot}$ = sum of the individual losses (bar)
$\Sigma\Delta p_{RP}$ = sum of the pressure losses in straight pipe lengths (bar)
$\Sigma\Delta p_{RF}$ = sum of the pressure losses in fittings (bar)
$\Sigma\Delta p_{RV}$ = sum of the pressure losses in valves (bar)
$\Sigma\Delta p_{RC}$ = sum of the pressure losses in connections (bar)

- Pressure loss in straight pipe sections

The pressure loss in straight pipe sections is calculated using the following equation:

$$\Delta p_{RP} = \lambda_R \cdot \frac{L_P}{d_i} \cdot \frac{\rho_F}{2 \cdot 10^2} \cdot w^2$$

Equation 7.9

$\Delta\rho_{RP}$ = pressure loss in individual pipe sections (bar)
λ_R = pipe friction number (-)
L_P = length of the pipe sections (m)
d_i = inside diameter of the pipe (mm)
ρ_F = density of the flow (kg/m^3)
w = flow velocity (m/s)

- Pressure loss in pipe fittings

Given that substantial losses result from friction, changes of direction and transfer loss, these individual losses represent a significant portion of the total pressure loss in a pipe system. The pressure loss is calculated with the following formula:

$$\Delta\rho_{RF} = \zeta_{RF} \cdot \frac{\rho_F}{2 \cdot 10^5} \cdot w^2$$

Equation 7.10

$\Delta\rho_{RF}$ = pressure loss in individual pipe fittings (bar)
ρ_F = density of the flow (kg/m^3)
w = flow velocity (m/s)
ζ_{RF} = resistance factors for pipe fittings (-)

The resistance factors for fittings will be identified in tables 7.2 to 7.7.

- Pressure loss in pipe connections

Pressure loss also occurs in pipe connections, although it cannot be precisely characterised, as the geometric dimensions vary a great deal (e.g. welding beads). DVS 2210 Part 1 recommends basing pressure loss calculations for connections in plastic pipe systems (such as butt, sleeve and flange joints) on a resistance factor of ζ_{RF} = 0.1 (-) . For pressures losses in connections, this means:

$$\Delta\rho_{RC} = \zeta_{RC} \cdot \frac{\rho_F}{2 \cdot 10^5} \cdot w^2$$

Equation 7.11

$\Delta\rho_{RC}$ = pressure loss in connections (bar)
ρ_F = density of the flow (kg/m^3)
w = flow velocity (m/s)
ζ_{RC} = resistance factor for pipe connections = 0.1 (-)

To obtain a rough estimate of the pressure loss in connections, it is sufficient to consider an addition of 15% to the pressure loss in straight sections ζ_P and fittings ζ_{PF}.

- Pressure loss in valves

The pressure loss in valves can be determined using the following equation:

$$\Delta\rho_{RV} = \zeta_{RA} \cdot \frac{\rho_F}{2 \cdot 10^5} \cdot w^2$$

Equation 7.12

Δp_{RV} = pressure loss in valves (bar)
ρ_F = density of the flow (kg/m^3)
w = flow velocity (m/s)
ζ_{RA} = resistance factors for pipe valves (-)

The resistance factors for valves are shown in table 7.10.

- Resistance factors

The pressure loss in a pipe system is caused by friction, changes of direction and transfer loss. To determine the variables involving total pressure loss in a pipe system requires knowledge of the resistance factors (ζ_F) for fittings, pipe connections and valves. The most important resistance factors are indicated below.

- ζ_F - values for seamless pipe bends

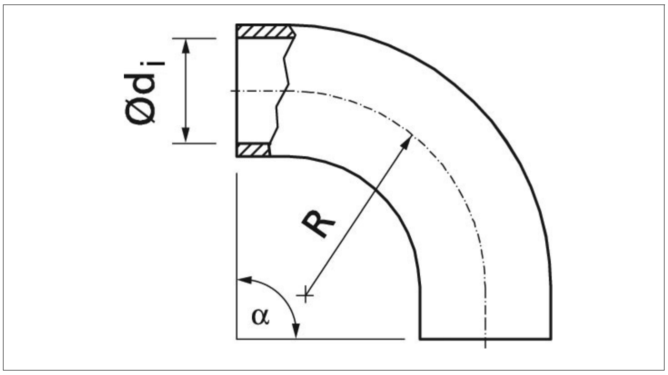


Figure 7.1 Seamless pipe bends

α \ R/d_i	1	1.5	2	4
30°	0.23	0.19	0.14	0.11
45°	0.34	0.27	0.20	0.15
60°	0.41	0.33	0.24	0.19
90°	0.51	0.41	0.34	0.23

Table 7.2 ζ_F value for seamless bends

- ζ_F values for segmented pipe bends

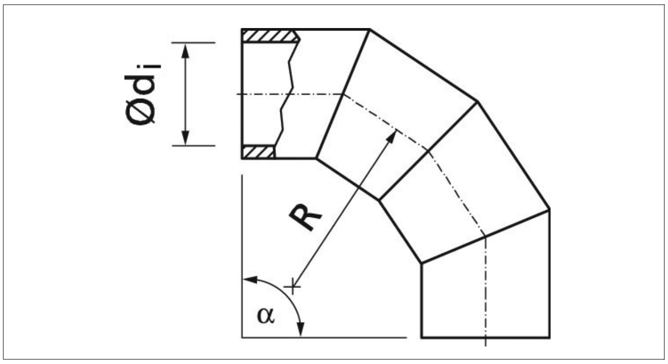


Figure 7.2 Segmented pipe bends

α \ R/d_i	1.5	3	4	6
30°	0.10	0.10	0.11	0.11
45°	0.14	0.15	0.16	0.17
60°	0.19	0.20	0.22	0.23
90°	0.24	0.26	0.28	0.29

Table 7.3 ζ_F values for segmented pipe bends

Basic calculations

- ζ_F values for segmented pipe bends

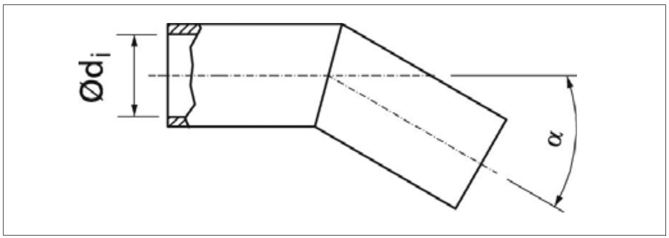


Figure 7.3 Elbows

α	10°	15°	20°	30°	45°
ζ_F	0.04	0.05	0.05	0.14	0.30

Table 7.4 ζ_F values for segmented pipe bends

- ζ_F values for tee sections

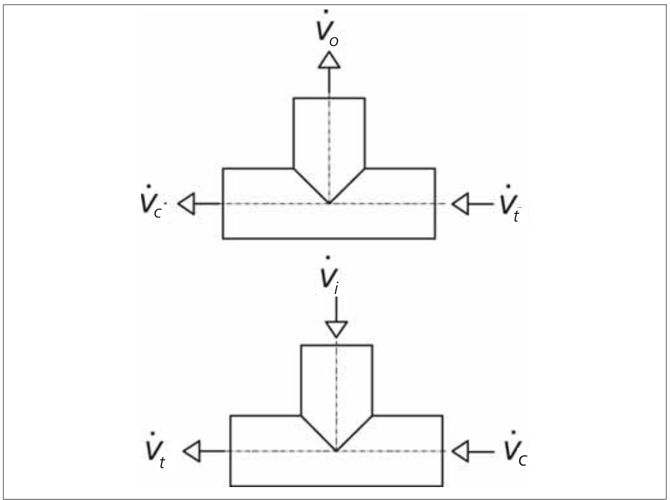


Figure 7.4 Tee for dividing and uniting flows

$\dot{V}_i/\dot{V}_t$	Uniting flows $\dot{V}_t=\dot{V}_o+\dot{V}_i$		$\dot{V}_o/\dot{V}_t$	Dividing flows $\dot{V}_t=\dot{V}_o+\dot{V}_c$	
	ζ_z	ζ_d		ζ_a	ζ_s
0.0	-1.20	0.06	0.0	0.97	0.10
0.2	-0.40	0.20	0.2	0.90	-0.10
0.4	0.10	0.30	0.4	0.90	-0.05
0.6	0.50	0.40	0.6	0.97	0.10
0.8	0.70	0.50	0.8	1.10	0.20
1.0	0.90	0.60	1.0	1.30	0.35

Table 7.5 ζ_F values for tees

$\dot{V}_t$ -> total flow volume (l/s - m^3/h)
$\dot{V}_c$ -> total continuous volume (l/s - m^3/h)
$\dot{V}_o$ -> outgoing volume (l/s - m^3/h)
$\dot{V}_i$ -> incoming volume (l/s - m^3/h)

Positive values indicate pressure loss, negative values pressure increases.

- ζ_F values for tanks and tank outlets

overlying -> ζ_F = 2.0
flush -> ζ_F = 0.3
rounded -> ζ_F = 0.05

- ζ_F values for cross-section changes

a) Pipe enlargement, perpendicular

d_{e1} / d_{e2}	1.2	1.4	1.6	1.8	2.0
ζ_F	0.07	0.15	0.24	0.46	0.56

Table 7.6 Pipe enlargement, perpendicular

b) Pipe constriction, perpendicular

d_{e1} / d_{e2}	1.2	1.4	1.6	1.8	2.0
ζ_F	0.10	0.22	0.29	0.33	0.35

Table 7.7 Pipe enlargement, perpendicular

c) Pipe enlargement, conical ζ value for λ_P = 0.025

	ζ_F values for angle of enlargement α_E		
d_{e2}/d_{e1}	4 - 8°	16°	24°
1.2	0.10	0.15	0.20
1.4	0.20	0.30	0.50
1.6	0.50	0.80	1.50
1.8	1.20	1.80	3.00
2.0	1.90	3.10	5.30

Table 7.8 Pipe enlargement, conical

α_E is the angle of enlargement. The ζ values are related to velocity (w_2). The conical length (l) is derived from the angle of enlargement (α_E) and the diameter ratio d_{e2}/d_{e1}. The best angle of enlargement in which the stream of the inflowing medium still does not lose contact with the pipe is about 7 to 8°.

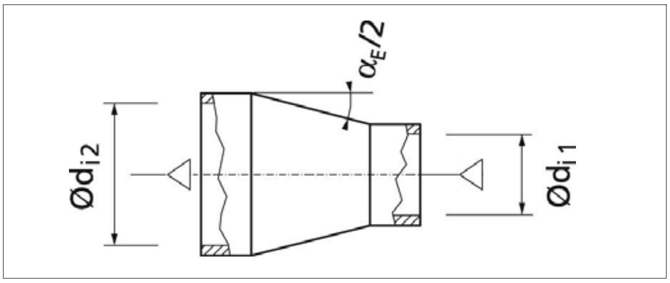


Figure 7.5 Conical enlargement of the flow cross section

d) Pipe enlargement, conical ζ value for λ_P = 0.025

	ζ_F values for angle of enlargement α_E		
d_{e2}/d_{e1}	4°	8°	24°
1.2	0.046	0.023	0.210
1.4	0.067	0.033	0.013
1.6	0.076	0.038	0.015
1.8	0.031	0.041	0.016
2.0	0.034	0.042	0.017

Table 7.9 Pipe enlargement, conical

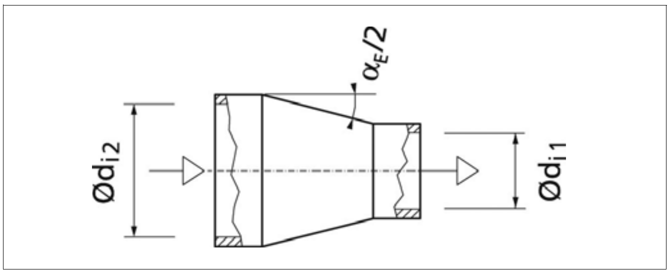


Figure 7.6 Conical enlargement of the flow cross section

- ζ_V values for valves

nominal diameter DN	diaphragm valve	flat-seat valve	ball valve	inclined seat valve valve without constriction	ball valve	butterfly valve	free-flow check valve	check valve
	Resistance factor (ζ)							
25	4.0	2.1	3.0	0.1...0.3	0.1...0.15	0.3...0.6	2,5	1,9
32	4.2	2.2	3.0	0.1...0.3	0.1...0.15	0.3...0.6	2.4	1.6
40	4.4	2.3	3.0	0.1...0.3	0.1...0.15	0.3...0.6	2.3	1.5
50	4.5	2.3	2.9	0.1...0.3	0.1...0.15	0.3...0.6	2.0	1.4
65	4.7	2.4	2.9	0.1...0.3	0.1...0.15	0.3...0.6	2.0	1.4
80	4.8	2.5	2.8	0.1...0.3	0.1...0.15	0.3...0.6	2.0	1.3
100	4.8	2.4	2.7	0.1...0.3	0.1...0.15	0.3...0.6	1.6	1.2
125	4.5	2.3	2.3	0.1...0.3	0.1...0.15	0.3...0.6	1.6	1.0
150	4.1	2.1	2.0	0.1...0.3	0.1...0.15	0.3...0.6	2.0	0.9
200	3.6	2.0	2.4	0.1...0.3	0.1...0.15	0.3...0.6	2.5	0.8

Table 7.10 ζ-values for valves

- ζ values for compensators

Surge suppressors : $\zeta = 2.0$ per surge
Expansion joints : $\zeta = 3.0$

- ζ values for welding seams

Electrofusion : $\zeta = 0.05$
Butt-welding : $\zeta = 0.1$

- ζ values for pipe bends in succession

180° bends : $\zeta = 2.0 \cdot \zeta\,90°$
Stage of 2 x 90° bends : $\zeta = 2.5 \cdot \zeta\,90°$
Expansion stage of 2 x 90° bends : $\zeta = 3.0 \cdot \zeta\,90°$

7.2.3 Investigating pressure surges

The change in the stationary conditions of a pipe system (e.g. due to activation of a butterfly valve or the failure of a pump) creates a pressure wave producing superpositions due to reflections in bends, reducers, etc. that can amount to many times the operating pressure. The largest pressure increase occurs when the closure procedure or stop command following pump failure falls under the so-called reflection time. If a pipe system contains externally controlled valves or trip mechanisms, it must be ensured that their closure time is larger than the reflection time.
If a pressure surge occurs, its effects must be investigated by means of a short-term stress analysis and a stability test.

Note:
The pressure surge is not always sufficiently expressed by the following equations. In particular, more precise investigations must be employed in longer or complexly branched pipe systems in order to consider and evaluate all the significant factors.

Significant factors are:
Operating pressure, pump pressure = p_O (bar)
Flow velocity = w_o (m/s)
E modulus of the pipe material = E_{cR} (N/mm²)
(short-term E modulus = creep modulus between 1 and 10 min)
E modulus of the flow medium = E_F (N/mm²)
(for water at 20°C -> $E_F \approx 2100$ N/mm²)
Density of the flow medium = ρ_F (g/cm³)

- Calculating pressure wave velocity (a)

$$a = \frac{a_0}{\sqrt{1 + 2 \cdot \frac{E_F}{E_{C_R}} \cdot \frac{\eta^2 + 1}{\eta^2 - 1}}}$$

Equation 7.13

The indicated resistance factors are reference values and are used in rough pressure loss calculations. Object related calculations are based on the data of the respected valve manufacturers.

$$a_0 = 31{,}3 \cdot \sqrt{\frac{E_F}{\rho_F}}$$

Equation 7.14

$$\eta = \frac{d_e}{d_i}$$

Equation 7.15

a = pressure wave velocity (m/s)
a_0 = speed of sound (m/s)
d_e = outside diameter of the pipe (mm)
d_i = inside diameter of the pipe (mm)
η = correction factor (-)
E_{cR} = creep modulus of the pipe material (N/mm²)
E_F = E modulus of the flow medium (N/mm²)
ρ_F = density of the flow medium (kg/m³)

- Maximum pressure surge for $\Delta w = w_0$

$$p_{Surge} = p_0 \pm \frac{a}{100} \cdot \Delta w$$

Equation 7.16

a = pressure wave velocity (m/s)
p_{Surge} = pressure surge (bar)
p_O = pump pressure, operating pressure (bar)
Δw = $w_0 - w_1$ (with w_1 = flow velocity at the reflection position) (m/s)

For short pipes of a single length can be assumed that a surge degradation occurs.

$$L_{Pipe} \leq \frac{a \cdot t_s}{2}$$

Equation 7.17

t_s = closing time of the butterfly valve or delay of the pump stop command after failure (c)
L_{Pipe} = pipe length (m)
a = pressure wave velocity (m/s)

The surge degradation factor is:

$$Z_s = \frac{2 \cdot L_{Pipe}}{a \cdot t_s} \geq 1$$

Equation 7.18

Z_s = surge degradation factor (-)
L_{Pipe} = pipe length between valve mechanism or pump and reflection position (m)
t_s = closing time of the butterfly valve or delay for the pump stop command after failure (c)
a = pressure wave velocity (m/s)

Basic calculations

The complete pressure change ($\Delta\rho$) corresponding to the velocity change (Δ_w) velocity when the closing time (t_c) is smaller than the reflection time (t_R). The reflection time (t_R) is calculated by:

$$t_R = \frac{2 \cdot L_{Pipe}}{a}$$

Equation 7.19

t_R = reflection time (c)
L_{Pipe} = pipe length between valve mechanism or pump and reflection position (m)
a = pressure wave velocity (m/s)

The rough estimate of a pressure surge hazard can draw on the following rule of thumb:

$$K_s = \frac{L_{Pipe} \cdot w_0}{\sqrt{H_P}}$$

Equation 7.20

H_P = delivery height of the pump (m)
K_s = pressure wave size (-)
L_{Pipe} = pipe length between valve mechanism or pump and reflection position (m)
w_o = flow velocity (m/s)

For K_s > 70 and with simultaneous use of rapidly closing valves, a special pressure surge calculation is recommended.

- Calculating the pressure surge for the section involved $L_{Pipe} \leq 500 \cdot de$

Equation 7.21 is an empirical calculation formula. It should therefore only be used when rough estimates are to be made for simple pipe systems without fittings.

$$p_{Surge} = p_0 \cdot \left[1 + \frac{100 \cdot w \cdot p_F}{\varphi \cdot p_s} \cdot \left(1 + 0{,}2 \cdot \sqrt{p_0} \right) \right]$$

Equation 7.21

p_{Surge} = pressure surge (bar)
p = pump pressure, operating pressure (bar)
w = flow velocity (m/s)
ρ_F = density of the flow medium (g/cm^3)
φ = surge factor (-)

In general, the following values can be selected for φ:
φ = 25 for rapidly closing valves
φ = 50 for normally closing valves
φ = 75 for slowly closing valves

The loads often arising along with pressure surges due to vacuums can, under certain conditions, cause buckling of the pipe in specific situations. The stability (i.e. buckling resistance) of the pipe series in question must be verified in every case.

$$p_{Crit} = 2{,}9 \cdot E_{C_R} \cdot \left(\frac{2 \cdot e}{d_i} \right)^3$$

Equation 7.22

p_{Crit} = critical underpressure (bar)
E_{cR} = elasticity modulus (between 1…10 min) (N/mm^2), see appendix A2.
e = pipe wall thickness (mm)
d_i = inside diameter of the pipe (mm)

From this, it follows:

$$SF = \frac{p_{Crit}}{p_u} \geq 2$$

Equation 7.23

p_u = under pressure from pressure surge calculation (bar)
p_{Crit} = critical underpressure (bar)
SF = safety factor (-)

Note:
Appendices B9 to B10 indicate the acceptable external pressure load (p_{ex}) or the underpressure load (p_u) in short-term observations (t = 100 h) and long-term observations (t = 25a) for PE at various SDR levels.

7.2.4 Calculating acceptable stress

Calculation of acceptable stress requires the inclusion of various reduction factors. The significance of individual reduction factors will be discussed in section 7.2.6. The acceptable stress is determined by the following formula.

$$\sigma_{acc} = \frac{\sigma_{ref} \cdot f_{s,l}}{R_2 \cdot R_4 \cdot SF}$$

Equation 7.24

σ_{acc} = acceptable stress (N/mm^2)
σ_{ref} = reference stress (N/mm^2), see appendix A2.
f_l = long-term welding factor (-)
f_s = short-term welding factor (max. 1h) (-)
R_2 = reduction factor for the influence of the flow medium (see table 2.3) (-)
R_4 = reduction factor for the influence of the specific resilience of the material (-)
SF = safety factor for the respective loads (see table 7.13) (-)

7.2.5 Welding factors

The size of the welding factors depends on the specific welding procedures. There is also a distinction made between short-term (f_s) and long-term welding factors (f_l). Only long-term factors may be used in component calculations. The calculation of welding factors is performed in DVS 2203 part 2.
Table 7.11 contains the relevant factors for PE butt-weld (DVS 2203 part 1) and electrofusion (DVS 2212 part 1).
The original abbreviations f_s and f_l have been freely chosen by Akatherm.

Material	Welding factor	PE
Butt-welding	f_s	0.9
(BW)	f_l	0.8
Electro-fusion	f_s	0.9
(EF)	f_l	0.8

Table 7.11 Welding factors f_s and f_l

7.2.6 Reduction factors

- Reduction factor R_1

The reduction factor R_1 (time dependent) accounts for the dependence of material strength on stress duration. This value is displayed in the creep rupture curves (appendix A1). Use of this diagram supplants direct observation.

- Reduction factor R_2

This reduction factor designates the influence of the flow medium (chemical resistance factor) on the creep strength of thermoplastic. Relevant values can be taken from table 2.3 in chapter 2.

- Reduction factor R_3
The dependence of strength on the operating temperature is accounted for in reduction factor (R_3). This value is also displayed in the creep rupture curves (appendix A1). Use of this diagram supplants direct observation.

- Reduction factor R_4
This factor accounts for the specific resilience of the material as a function of the operating temperature and is therefore derived from impact strength values. The corresponding values for reduction factor (R_4) are found in table 7.12.

Material	Pipe wall temperature			
	-10°C	20°C	40°C	60°C
PE100	1.2	1	1	1

Table 7.12 Reduction factor R_4

Factors can be interpolated for intermediary temperatures.

7.2.7 Safety factor (SF)

Load Class		
I	Even load on the pipe in installations in building. If damage occurs, no possible danger to people, property and the environment.	1.3
II	Load on the pipe under changing operating conditions in installations outside buildings. If damage occurs, no damage to people is expected. Effects on property and the environment limited. (*)	1.8
III	Load on the pipe under changing operating conditions in installations inside and outside buildings. If damage occurs, there are possible hazards for people, property and the environment. Applied for monitoring and inspection facilities.	≥2.0

Table 7.13 Safety factors (SF) for various loads

(*) In contrast to general references in the technical literature (e.g. DVS 2205 part 1) in which only two loads are distinguished, Akatherm has introduced this additional load class for larger loads that could affect a pipe system in an installation outside buildings.

7.2.8 Minimum wall thickness

- Straight pipes

$$e_0 = \frac{d_e \cdot p_i}{20 \cdot \sigma_{acc} + p_i}$$

Equation 7.25

e_0 = minimum wall thickness (mm)
d_e = outside diameter of the pipe (mm)
p_i = Internal pressure (bar)
σ_{acc} = acceptable stress (N/mm^2)

- Seamless and welded segmented pipe bends
For the inside of bends, the following holds:

$$e_i = \frac{d_e \cdot p_i}{20 \cdot \sigma_{acc} + p_i} \cdot f_{Bi}$$

Equation 7.26

e_i = wall thickness on the inside of the bend (mm)
f_{Bi} = factor for the inside of the bend from table 7.14 (-)
p_i = Internal pressure (bar)
d_e = outside diameter of the pipe (mm)
σ_{acc} = acceptable stress (N/mm^2)

For the outside of bends, the following holds:

$$e_o = \frac{d_e \cdot p_i}{20 \cdot \sigma_{acc} + p_i} \cdot f_{Bo}$$

Equation 7.27

e_o = wall thickness on the outside of the bend (mm)
f_{Bo} = factor for the outside of the bend from table 7.14 (-)
p_i = internal pressure (bar)
d_e = outside diameter of the pipe (mm)
σ_{acc} = acceptable stress (N/mm^2)

- Factors (f_{Bi}) and (f_{Bo}) for determining wall thicknesses of bends

		Radius R			
		$1,0 \cdot d_e$	$1,5 \cdot d_e$	$2,0 \cdot d_e$	$2,5 \cdot d_e$
Seamless pipe-bends	f_{Bi}	1,27	1,22	1,15	1,12
	f_{Bo}	0,92	0,93	0,95	0,96
Segmented bends	f_{Bi}	1,59	1,50	1,44	1,40
	f_{Bo}	1,15	1,16	1,19	1,20

Table 7.14 Factors for determining wall thicknesses for bends

- Welded branches (tees)
In principle, branches in pipes represent weaknesses.
This condition has the consequence that unreinforced welded tee sections do not correspond to the nominal pressure of the pipe. Welded tees can only be exposed to a reduced pressure load. An improvement of the internal load capacity is achieved by increasing the wall thickness of the connection or by a corresponding strengthening of welded joints.

- Wall thickness of branch pipes:

$$e_0 = \frac{d_e \cdot p_i}{(20 \cdot \sigma_{acc} + p_i) \cdot W_{RF}}$$

Equation 7.28

e_o = wall thickness (mm)
d_e = outside diameter of the pipe (mm)
p_i = internal pressure (bar)
σ_{acc} = acceptable stress (N/mm^2)
W_{RF} = weakening factor of the fitting (-)

Values for the weakening factor (WRF) can be interpreted from appendix B2.

The reduced internal loads for fittings welded on pipe segments is shown in appendix B2.

7.2.9 Internal pressure capacity of welded and injection-moulded fittings.

- Moulded fittings
Moulded fittings do not generally require any restrictions regarding a minimum internal pressure load capacity. They therefore withstand the same internal pressure load as a pipe of the same SDR level.

- Segment-welded tee sections
The inclusion of unreinforced welded tees in any pipe system reduces the tolerable operating pressure. The corresponding reduction factor is strongly temperature-dependent, which means that the internal pressure capacity is lowered by rising operating temperatures. Information about the internal pressure load capacity of segment-welded tees is provided by appendix B2.

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Basic calculations

- Segment-welded bends

Like the mentioned segment-welded tees, segment-welded bends (angle >30º) have a reduced internal pressure load capacity in comparison with a straight pipe. The weakening effect of butt-welded segmented bends is also dependent on the same temperature conditions affecting segment-welded tees. The actual internal pressure load capacities can be seen in appendix B2.

7.2.10 Length changes due to heating and internal pressure

- Thermal-conditioned length change

Exposing a pipe system to varying temperatures (e.g. ambient and operating temperatures) changes its status with regard to the expansion capacities of individual pipe sections. Pipe sections designate the distances between the system point in question to the relevant fixed point. The thermally conditioned length change (Δl_ϑ) of individual pipe sections is calculated as follows:

$$\Delta l_\vartheta = L_{Pipe} \cdot \alpha_\vartheta \cdot \Delta\vartheta_{max} \cdot 10^3$$

Equation 7.29

Δl_ϑ = thermal length change (mm)
L_{Pipe} = pipe length (m)
α_ϑ = thermal expansion coefficient (K-1)
$\Delta\vartheta_{max}$ = max. temperature difference (K)

Examples for the calculation of $\Delta\vartheta_{max}$:
$\Delta\vartheta_{max}$ = $T_{W\,max}$ - $T_{W\,min}$
or
$\Delta\vartheta_{max}$ = $T_{W\,max}$ - T_M
or
$\Delta\vartheta_{max}$ = $T_{W\,max}$ - T_a
$\Delta\vartheta_{max}$ = temperature difference (K)
$T_{W\,min}$ = minimum pipe wall temperature (°C)
T_M = average installation temperature (°C)
$T_{W\,max}$ = maximum pipe wall temperature (°C)
T_a = lowest ambient temperature (°C)

- Length change due to internal pressure loads

In any closed pipe string, a longitudinal expansion is produced by the occurrence of internal pressure loads as follows:

$$\Delta l_\rho = \frac{0{,}1 \cdot p_i}{E_{c_R}} \cdot \frac{(1-2\cdot\mu)}{\left(\frac{d_e}{d_i}\right) - 1} \cdot L_{Pipe}$$

Equation 7.30

Δl_ρ = length change due to internal pressure (mm)
p_i = internal pressure (bar)
E_{cR} = creep modulus of the pipe material (N/mm^2)
d_e = outside diameter of the pipe (mm)
d_i = inside diameter of the pipe (mm)
L_{Pipe} = pipe length (L_1, L_2,···, L_x) (mm)
μ = transverse contraction number (-)

- Determining expansion bend dimensions

Length change (Δl_ϑ):

$$\Delta l_\vartheta = L_{Pipe} \cdot \alpha_\vartheta \cdot \Delta\vartheta \cdot 10^3$$

Equation 7.31

L_{Pipe} = pipe length (m)
α_ϑ = thermal expansion coefficient (K-^{1})
Δ_ϑ = temperature difference (K)
Δl_ϑ = thermal length change (mm)

In calculating temperature difference ($\Delta\vartheta$), care should be taken that the lowest and highest temperatures (installation, operating and stationary) are used in the calculation. Approximations usually take just flow medium and ambient temperatures into account. They simplest type of compensation for length changes in thermoplastic pipe installations involves using L-form expansion bends (90° changes of direction). L-bends are also referred to as elbows. The minimum dimensions of an elbow as illustrated in figure 7.7 is indicated by the following equation:

$$L_{B1,2} = \sqrt{\frac{3 \cdot d_e \cdot L_{1,2} \cdot \varepsilon \cdot E_{c_R}}{\sigma_{sf\,acc}}}$$

Equation 7.32

L_B = length of the expansion bend (mm)
$L_{1,2}$ = system lengths of expansion bends (mm)
d_e = outside diameter of the pipe (mm)
ε = expansion (-)
E_{cR} = (average) bending creep modulus of the pipe material for t = 25a (N/mm2)
$\sigma_{sf\,acc}$ = acceptable flexural stress share for t = 25a (N/mm^2)

Expansion bend lengths for L, Z and U bends are illustrated in appendices B5 to B8, and the corresponding values can be read from these diagrams.

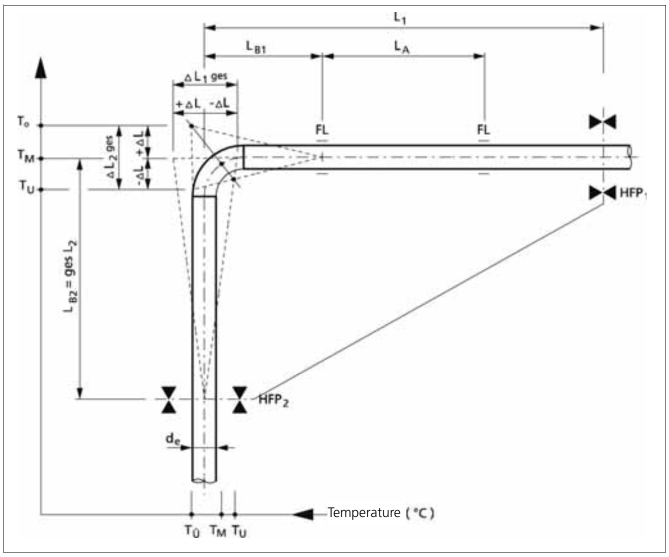


Figure 7.7 Elbow (L-bend)

- Pipe sections for absorbing length changes

As shown in figure 7.8, length changes subject pipe sections to bending. The dimensions of expansion bends (L_B) are established by the relationship:

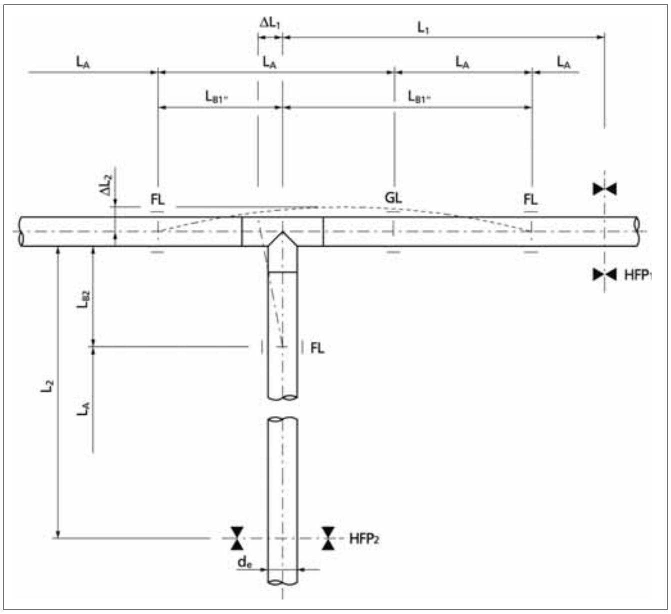


Figure 7.8 Pipe section for absorbing length changes

$$L_B = \sqrt{\frac{3 \cdot d_e \cdot L_{1,2} \cdot \varepsilon \cdot E_{C_R}}{\sigma_{f\,acc}}}$$

Equation 7.33

L_B = length of the expansion bend (mm)
d_e = outside diameter of the pipe (mm)
ε = expansion (-)
$L_{1,2}$ = system lengths of expansion bends (mm)
E_{cR} = (average) bending creep modulus of the pipe material for t = 25a (N/mm^2)
$\sigma_{f\,acc}$ = acceptable flexural stress (N/mm^2)

- Branch connections

In pipe sections subject to axial movement, it is also important to ensure that branching pipe strings are not exposed to high flexural tensions. The minimum distance between a tee section and the nearest guide bracket corresponds to the expansion bend length (L_B). With the aid of appendices B5 to B8, the required expansion bend lengths are visually illustrated.

7.2.11 Calculating forces at fixed points

Fixed points in pipe installations are brackets that fix the pipe in x, y and z directions. The forces at these points depend on the nature of individual pipe system. The "slacker" the pipe running between two fixed points is, the smaller the reaction forces generated by deformation effects. The exact calculation of the force components in any given pipe system is laborious. The calculation is made easier by employing the correspondingly suitable PC software for thermoplastic pipe systems.

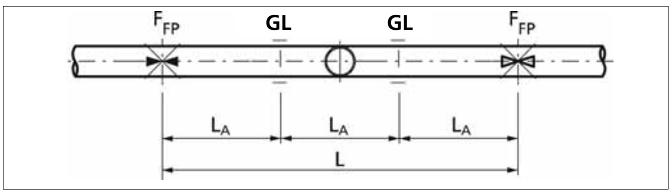


Figure 7.9 Firmly fastened pipe string

- Maximum force at fixed-points without compensation for length change

The largest fixed-point load occurs on a firmly fastened pipe string. It is calculated as follows:

$$F_{FP} = A_p \cdot \varepsilon \cdot E_{C_R}$$

Equation 7.34

Load from termal expansion: $\varepsilon = \alpha_\vartheta \cdot \Delta\vartheta$ (35)

Load from internal pressure: $\varepsilon = \dfrac{0{,}1 \cdot p_i \cdot (1-2 \cdot \mu)}{E_{C_R} \cdot \left(\dfrac{d_e^2}{d_i^2} - 1\right)}$ (36)

Load from swelling: $\varepsilon = 0{,}025 \ldots 0{,}040$ (37)

Equation 7.35-7.37

Explanation of symbols in equations 7.34 to 7.37
F_{FP} = force at fixed points in a firmly fastened pipe string (N)
A_P = area of pipe annular surface (mm^2)
ε = constricted length expansion (-)
α_ϑ = thermal expansion coefficient (K-1)
$\Delta\vartheta$ = maximum temperature difference between TL and TU (K)
p_i = internal pressure (bar)
E_{cR} = (average) creep modulus of the pipe material for t = 100 min (N/mm^2)
d_e = outside diameter of the pipe (mm)
d_i = inside diameter of the pipe (mm)
μ = transverse contraction number (-)

Since the creep modulus is dependent on time, temperature and stress, an average load period of 100 min is adopted for the calculations. The corresponding values can be derived from appendix A2. The forces at fixed points can also be interpolated from the appendix B9.

- System-dependent fixed-point force

Thermoplastic pipes are usually installed so that the compensation capacity of direction changes can be used to absorb length changes.
The resulting fixed-point forces are therefore system-specific. In most cases, they are smaller than the fixed-point load calculated in section 7.2.14. In practice however, the procedure is simplified by adopting the largest possible load to design the fixed-point structure. If, due to the load compensation parameters, the forces are prevented from being large enough (e.g. for pipe bridges, brickwork, containers, pump supports), a system-specific calculation is an essential part of a structural calculation. The PC calculation program can again serve this purpose.

Basic calculations

- Forms of compensation in level pipe systems

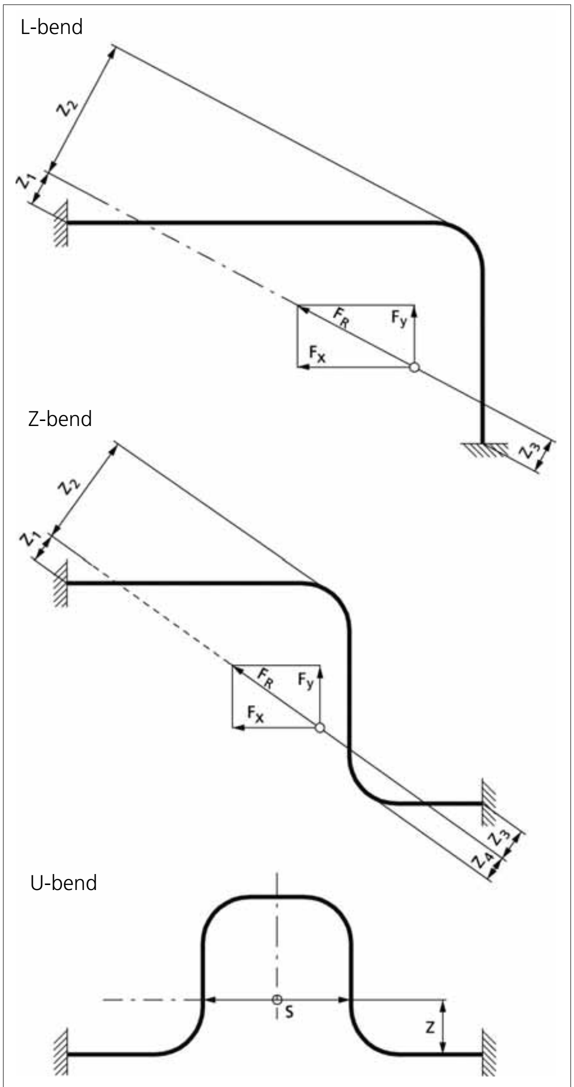


Figure 7.10 Forms of compensation in level pipe systems

Explanation of figure 7.10:

F_x , F_y , F_z = force components
F_y, F_x = F_T at fixed points "A" und "B"
F_T = transverse force
F_R = resulting total force
Z_1 , Z_2 , Z_3 = distances of the system points from the line of action
S = system centre of mass

The distance (Z) (lever) and the resulting total force (F_R) produces the moment (M)

$$M = F_R \cdot Z$$

Equation 7.38

at a given position of the individual pipe system

M = moment of torque (Nm)
F_R = resulting force (N)
Z = lever (m)

- Rough calculation of fixed-point forces in L-bends:

$$F_{LB} = \frac{12 \cdot \Delta l \cdot E_{c_R} \cdot J_P}{L_B^3}$$

Equation 7.39

F_{LB} = fixed-point load at (L, Z, U) bends -> F_y or F_x (N)
Δl = length change (mm)
E_{cR} = (average) creep modulus of the pipe material for t = 100 min (N/mm^2)
J_P = pipe moment of inertia (mm^4)
L_B = length of the expansion bend (mm)

$$J_P \approx \frac{d_e^4 - d_i^4}{20}$$

Equation 7.40

J_P = pipe moment of inertia (mm^4)
d_e = outside diameter of the pipe (mm)
d_i = inside diameter of the pipe (mm)

- Fixed-point force in cases of constricted length change due to internal pressure load

$$F_{FP} = A_P \cdot \sigma_a \quad \text{with} \quad A_P = \frac{\left(d_e^2 - d_i^2\right) \cdot \pi}{4}$$

Equation 7.41

σ_a = axial stress (N/mm^2)
A_P = area of pipe annular surface (mm^2)
F_{FP} = force at fixed point (N)
d_e = outside diameter of the pipe (mm)
d_i = inside diameter of the pipe (mm)

- Fixed-point force in cases involving compensators or expansion couplers

$$F_{FP} = 0{,}1 \cdot A_K \cdot p_i \quad \text{with} \quad A_K = \frac{d_i^2 \cdot \pi}{4}$$

Equation 7.42

A_K = surface subject to pressure (mm^2)
p_i = internal pressure (bar)
d_i = inside diameter of the pipe (mm)
F_{FP} = force at fixed point (N)

- Resulting force at fixed point

Brackets are subject to both horizontal and vertical loads. Simultaneous loads in both directions produce a resulting total force (F_R).

$$F_R = \sqrt{F_B^2 + F_V^2}$$

Equation 7.43

F_B = axial fixed-point force (F_{FP}) or friction force (F_μ) as a result of a length change in the pipe string
F_V = transverse force (F_{TV}) for fixed-point load and/or pipe weight (F_W) between two brackets with or without additional load.

7.2.12 Elasticity test

Elasticity tests on pipe systems serve predominantly to calculate force actions and stresses.
Stresses are created by:
- internal pressure loads
- constricted longitudinal movement under temperature change
- bending of bend sections when absorbing length changes

The forces affecting fixed points do not only cause bending moments in the bend sections but also in the firmly fastened pieces. In 3-D systems, the pipe string is also subject to torsion (twisting).
For facilities corresponding to load classes II and III (table 7.13) or requiring testing or monitoring in general, the elasticity calculation is not only a criterion for careful project planning but also partly prescribed.

7.2.13 Calculating the stresses arising in a pipe system

Pipe systems are usually exposed to a multi-axial state of stress. The mechanical stress measured in the internal pressure creep test (appendix A1) provides the basis for designing thermoplastic pipe systems. The layout of pipes is generally based on the internal pressure load, which corresponds to the load in the internal pressure creep test.

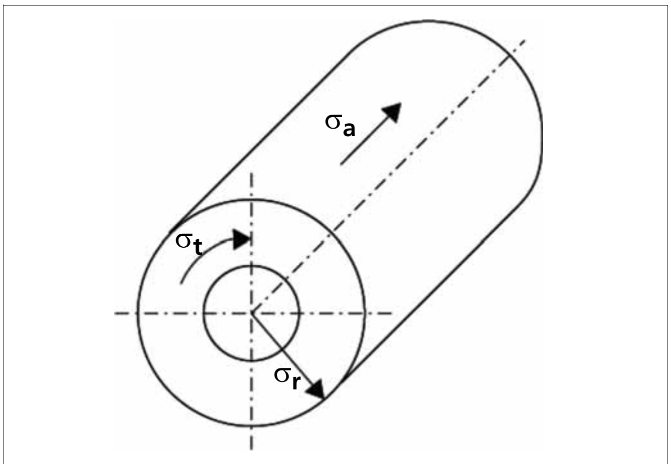


Figure 7.11 Radial (σ_r), Axial (σ_a) or Tangential (σ_t) stress

However, in addition to the mentioned stresses in axial, radial and tangential directions to the pipe axis, which are usually caused by heat or internal pressure loads, there are other stresses (e.g. flexural stresses) created in a pipe system, making it necessary to investigate all the stress components as part of a structural analysis. To establish the multi-axial state of stress requires calculation of the resulting stress (σ_{res}) and comparison with the value for (σ_{acc}). In particular, failure to account for flexural stresses around expansion bends and the tensile stresses resulting from impeded thermal expansion can result in failure of a pipe that is, otherwise, subject to a small internal pressure load.

- Axial stress (X axis) due to internal pressure

$$\sigma_a = \frac{p_i}{10} \cdot \frac{1}{\left(\frac{d_e}{d_i}\right)^2 - 1} \triangleq \sigma_1$$

Equation 7.44

- Tangential stress (Y axis) due to internal overpressure

$$\sigma_t = \frac{p_i}{10} \cdot \frac{\left(\frac{d_e}{d_i}\right)^2 + 1}{\left(\frac{d_e}{d_i}\right)^2 - 1} \triangleq \sigma_y$$

Equation 7.45

- Radial stress (Z axis due to inner over pressure)

$$\sigma_r = -\frac{p_i}{10} \triangleq \sigma_z$$

Equation 7.46

- Flexural axial stress (x axis) in a straight pipe between brackets

$$\sigma_f = \frac{q \cdot L_B^2}{8 \cdot W_R} \triangleq \sigma_x$$

Equation 7.47

- Flexural stress in bends

$$\sigma_f = \sigma_0 \cdot \frac{2}{1+12 \cdot \lambda_B^2} \cdot \left[9 \cdot \lambda_B + (1+6 \cdot \lambda_B^2) \cdot \frac{r_a}{R} \right]$$

Equation 7.48

M_b from the elasticy test

$$\sigma_0 = \frac{M_b \cdot d_e}{20 \cdot J_P}$$

Equation 7.49

$$\lambda_B = \frac{R \cdot e}{r_a^2}$$

Equation 7.50

$$r_m = \frac{d_e - e}{2}$$

Equation 7.51

- Stresses due to constricted thermal expansion

maximum stress value in a short-term perspective:

$$\sigma_{\vartheta max} = \pm\, \alpha_\vartheta \cdot \Delta\vartheta \cdot E_{C_R} \triangleq \sigma_x$$

Equation 7.52

in a long-term perspective:
Stress for temperature = constant

$$\sigma_\vartheta = 0{,}5 \cdot \sigma_{\vartheta max}$$

Equation 7.53

Basic calculations

stress for temperature = variable

$$\sigma_{\vartheta} = 0{,}67 \cdot \sigma_{\vartheta max}$$

Equation 7.54

Tensile stress arises when the period of low operating temperature(t_{cold}) is shorter than the period of high operating temperature (t_{warm}) , i.e. $t_{cold} < t_{warm}$

$$\sigma_z = -0{,}33 \cdot \sigma_{\vartheta max}$$

Equation 7.55

- Residual stress due to temperature differences between inner pipe wall and outer pipe wall

$$\sigma_{\vartheta} = 0{,}81 \cdot E_{C_R} \cdot \alpha_{\vartheta} \cdot (T_{S_P} - T_{e_P})$$

Equation 7.56

- Calculating the resulting stress

$$\sigma_{res} = 0{,}71 \cdot \sqrt{(\sigma_x - \sigma_y)^2 + (\sigma_y - \sigma_z)^2 + (\sigma_z - \sigma_x)^2}$$

Equation 7.57

$$\sigma_x \leq \sigma_{acc} = \sigma_a + \sigma_f \pm \sigma_{\vartheta}$$

Equation 7.58

$$\sigma_y \leq \sigma_{acc} = \sigma_u$$

Equation 7.59

$$\sigma_y \leq \sigma_{acc} = \sigma_r$$

Equation 7.60

$$\sigma_{res} \leq \sigma_{acc}$$

Equation 7.61

Explanation of symbols in equations 7.44 - 7.61

R_p	=	moment of resistance of the pipe (cm^3)
M_b	=	bending moment due to the tensile or compressive forces affecting branch sections
L_B	=	bracket distance (m)
J_P	=	pipe moment of inertia (cm^4)
R	=	bending radius of bends (mm)
r_a	=	average pipe radius (mm)
q	=	weight of the full pipes (N/m)
e	=	pipe wall thickness (mm)
d_e	=	outside diameter of the pipe (mm)
d_i	=	inside diameter of the pipe
E_{cR}	=	average creep modulus of the pipe material (N/mm^2)
ρ_i	=	internal pressure (bar)
σ_0	=	stress in straight pipe (N/mm^2)
σ_a	=	axial stress (N/mm^2)
σ_t	=	tangential stress (N/mm^2)
σ_r	=	radial stress (N/mm^2)
σ_f	=	flexural stress (N/mm^2)
σ_ϑ	=	axial stress due to constricted thermal expansion (N/mm^2)
$\sigma_{\vartheta max}$	=	maximum axial stress due to constricted thermal expansion (N/mm^2)
σ_{res}	=	resulting stress (N/mm^2)
$\sigma_{x,\,y,\,z}$	=	direction-dependent stress (N/mm^2)
σ_{acc}	=	acceptable stress (N/mm^2)
T_{sP}	=	inner pipe wall temperature (°C)
T_{eP}	=	outer pipe wall temperature (°C)
λ_B	=	bend factor (-)
a_ϑ	=	thermal expansion coefficient (K-1)

7.2.14 Expansions

If pipe deformation exceeds certain creep limits, flow zones and microscopic cracks are created across the direction of expansion. For usual applications, pipe deformation is calculated in the following manner.

$$\varepsilon_{\sigma x} = \frac{100}{E_{C_R}} \cdot \left[\sigma_x - \mu \cdot (\sigma_y - \sigma_z)\right]$$

Equation 7.62

$$\varepsilon_{\sigma y} = \frac{100}{E_{C_R}} \cdot \left[\sigma_y - \mu \cdot (\sigma_x + \sigma_z)\right]$$

Equation 7.63

$\varepsilon_{\sigma x}$, $\varepsilon_{\sigma y}$	=	expansion along the x and y axes of stress in a multi-axial load (-)
σ_x, σ_y, σ_z	=	stress along the x, y and z axes (N/mm^2)
E_{cR}	=	average creep modulus of the pipe material (N/mm^2)
μ	=	transverse contraction number = 0.38 (-)

The largest expansion is calculated on each occasion and compared with the threshold value (ε_F) in table 7.15. The requirement reads:

$$\frac{\varepsilon_F}{\varepsilon_{max}} \geq 1{,}3$$

Equation 7.64

ε_F = expansion threshold value
ε_{max} = $\varepsilon_{\sigma x}$ or $\varepsilon_{\sigma y}$ (-)

Material	PE
expansion threshold value ε_F	3%

Table 7.15 Expansion threshold value for PE

Should the correlation between stress and expansion be expressed, it can also be included in the following relationship:

$$\sigma_0 = \varepsilon \cdot E_{C_R} \text{ resp. } \varepsilon = \frac{\sigma_0}{E_{C_R}} \cdot 100\%$$

Equation 7.65

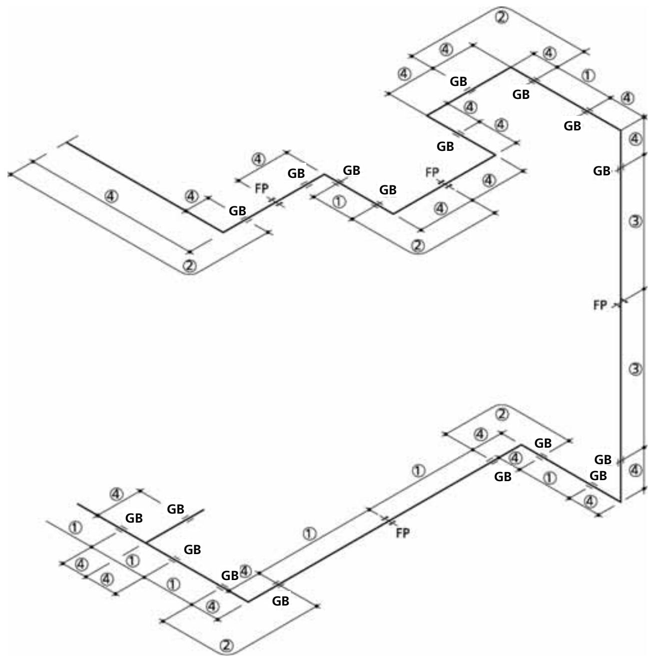
E_{cR} = average creep modulus of the pipe material (N/mm^2)
ε = expansion (-)
σ_0 = stress (N/mm^2)

7.2.15 Estimating service life

If the calculation variables, temperatures and their reaction time in relation to the assumed total load period are all available, the expected service life (life-span) can then be determined. The calculation of the service life however requires a large amount of mathematical complexity. For this reason, closer examination of the mathematical determination of a pipe system's service life will be set aside. In calculating service life, it should be noted that the life-span of the pipe system is also affected by chemical and/or physical conditions. A detailed treatment of the topic of service-life, complete with examples, is contained in the DVS 2205-1 guideline. The calculation of service lives involving varying loads requires firm knowledge about the handling of plastics. Valuable aids are PC calculating programmes, which can also provide support for less frequently used calculations.

7.2.16 Sample calculation

A number of values will be calculated for the isometric pipe system illustrated below.



GB = guide bracket (guide saddle), which is a fixing with an axial pipe guide
FP = fixed point, which is a fixing without any possibility for movement
① L_M = support distance for the middle of a continuous pipe
② L_E = support distance for a separate or end piece, as well as the self-supporting total pipe length of an L bend. If both bending lengths are, in total, longer than the acceptable support distance (L_F), an additional SB is to be placed between the pipe bend and the GB
③ L_V = guide bracket distance for an inclined pipe string. To absorb weight, a fixed point or bearing fixed point or support ring is to be provided for each string
④ L_B = bending lengths for absorbing length changes and operating conditions

Figure 7.12 Pipe isometrics

Explanation of terms ① ② ③ ④ for equations 7.66 to 7.73. The numbering and short symbols provide information about the variables being calculated and where their location in the isometric diagram. The illustration is therefore a guide and helps the user to obtain an overview of a pipe system and its calculations.

1. Load on brackets

Brackets are subject to both horizontal and vertical loads. Simultaneous loads produce a resulting total force (F_R), which can be calculated using the following equation 7.66. Figure 7.13 shows a bracket with the effective forces and the calculated bracket distance (B_d).

$$F_R = \sqrt{F_B^{\,2} + F_V^{\,2}}$$

Equation 7.66

FB = axial fixed-point force (F_{FP}) or friction force (F_μ) as a result of a length change in the pipe string
FV = transverse force (F_{TV}) for fixed-point load and/or pipe weight (F_W) between two brackets with or without additional load

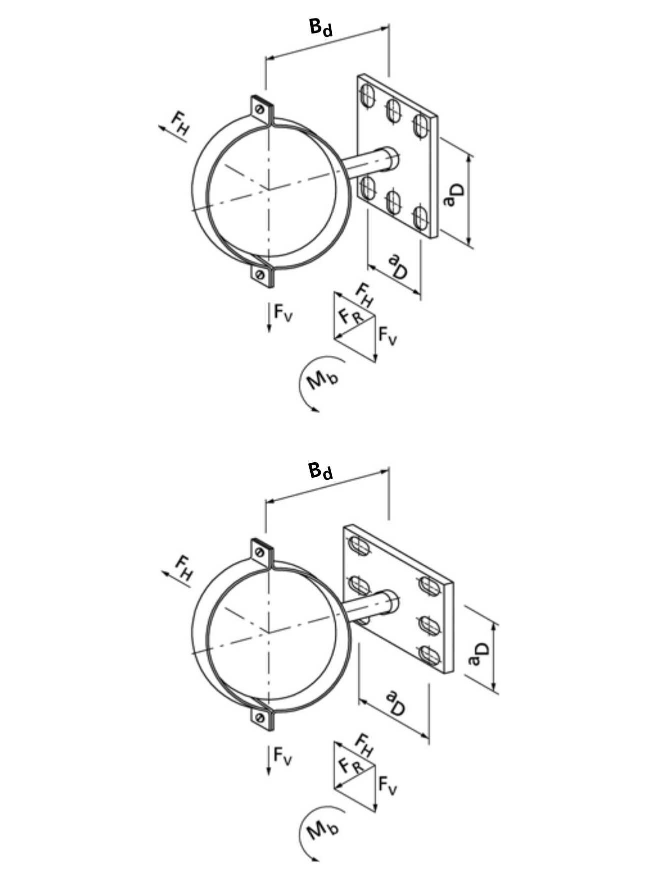


Figure 7.13 Pipe saddle load

Determination of the force components

F_{FP} = see equation 7.34

F_μ = $F_W \cdot \mu$

F_{TV} = based on system calculation

$F_W = F_{W\,(Pipe)} + F_{W\,(Fill\ med)} + F_{W\,(Add\ load)}$

Equation 7.67

μ_F	=	friction coefficient usually between 0.3 and 0.5
F_{FP}	=	force at fixed point (N)
F_W	=	weight (N)
F_{TV}	=	transverse force (N)
$F_{w\,(Pipe)}$	=	weight (pipe weight) (N)
$F_{W\,(Fill\ med)}$	=	weight (weight of fill medium) (N)
$F_{W\,(Add\ load)}$	=	weight (additional weight) (N)

2. Bracket distances (B_d)

The fixing distances of a plastic pipe are to be determined in such a way that no excessive stresses arise both under operating conditions and during testing. Similarly, consideration is also to be given to the deflection limits of the pipe. The arrangement of various brackets and their distances from each other can be seen in the illustrated example (figure 7.12) of pipe isometrics.

Basic calculations

3. Calculating acceptable bracket distances

$$L_M = 1{,}86 \cdot \sqrt[4]{\frac{E_{C_R} \cdot f_{acc} \cdot \left(d_e^4 - d_i^4\right) \cdot 10^5}{\left(d_e - d_i\right) \cdot e \cdot \rho_P + \frac{d_i^2}{2} \cdot \rho_F}}$$

Equation 7.68

L_M = support distance for the middle of a continuous pipe (mm)
E_{cR} = creep modulus of the pipe material for t = 25a (N/mm^2)
f_{acc} = acceptable pipe deflection according to the recommendations in table 7.16 (mm)
d_e = outside diameter of the pipe (mm)
d_i = inside diameter of the pipe (mm)
e = pipe wall thickness (mm)
ρ_P = density of the pipe medium (g/cm^3)
ρ_F = density of the flow medium (g/cm^3)

$$L_E = 0{,}67 \cdot L_M$$

Equation 7.69

$$L_V = Y \cdot L_M$$

Equation 7.70

Values for Y: $\leq Ø\, d_e$ 110 mm -> Y=1,1
$Ø\, d_e$125 - 200 mm -> Y=1,2
$\leq Ø\, d_e$ 225 mm -> Y=1,3

L_B = mathematical definition in equation 7.28 respectively with appendices B3 to B7

Equation 7.71

Explanation of symbols in equations 7.69 to 7.71:
L_M = support distance for the middle of a continuous pipe (mm)
L_E = support distance for a separate and end piece, as well as the self-supporting total pipe length of an L bend.
L_V = guide distance for an inclined pipe string (mm)
L_B = length of the expansion bend (mm)
Y = factor (dependent on pipe dimensions) (-)

To calculate the support distances, the following deflections are recommended as acceptable values:

Ø d_e	20 - 110	125 - 200	225 - 355	400 - 600
f_{acc}	2 -3 mm	3 - 5 mm	5 - 7 mm	7 - 10 mm

Table 7.16 Deflection f_{acc} for pipes

If larger deflections are permitted, the pipe should not be axially constricted.

4. Verifying the acceptable buckling length

If pipes are installed so that axial expansion of all or individual strings is no longer possible (axial constriction), the calculated fixing distance must be tested for its buckling resistance. To avoid the risk of buckling due to constricted thermal expansion, the length of pipe between two brackets must be no more than L_K .

$$L_{K_{acc}} \leq 1{,}12 \cdot \sqrt{\frac{d_e^2 - d_i^2}{\alpha_\vartheta \cdot \Delta\vartheta}}$$

Equation 7.72

See appendix B10.

$L_{K\,acc}$ = acceptable buckling length between two brackets (mm)
α_ϑ = thermal expansion coefficient (K-^{1})
Δ_ϑ = temperature difference (K)
d_e = outside diameter of the pipe (mm)
d_i = inside diameter of the pipe (mm)

The following applies to all pipe systems without linear compensation:

$$L_{B_{acc}} \leq L_{S_{acc}}$$

Equation 7.73

Values for LB are found in appendix B10:
$L_{B\,acc}$ = acceptable pipe length between two brackets (mm)
$L_{S\,acc}$ = available or calculated support distance according to equations ① ② ③ (equations 7.68 to 7.70)
d_e = outside diameter of the pipe (mm)
d_i = inside diameter of the pipe (mm)
α_ϑ = thermal expansion coefficient (K-^{1})
Δ_ϑ = temperature difference (K)

Note to equations 7.72 and 7.73:
Axially constricted pipe systems operated at raised temperatures or an expected reduction of the creep modulus (E_{cR}) as a result of chemical effects will both give rise to risks of buckling.
Raised operating temperatures are:
PE -> $T_{crit} \geq 45$°C
PP -> $T_{crit} \geq 60$°C
The buckling risk is strengthened due to bending along the pipe axis or insufficient pipe storage practices. Bending can result from too long support distances, improper storage of pipe and lasting pipe impacts during welding.
In such case, it is recommended that the buckling distances either calculated or interpolated from appendix B10 are reduced by a factor of 0.8. Pipe systems with $d_e \leq 50$ mm should be equipped with continuous support for economic reasons.

5. Determining pipe deflection for calculated support distances

Pipe deflection for the calculated support distance (L_M) (from equation 7.68) is determined by means of the following equation.

Pipe deflection for the calculated support distance (L_E) (from equation 7.69) is also determined by means of equation 7.74.

$$① \quad f_D = \frac{2{,}6 \cdot q \cdot L_M^4}{E_{C_R} \cdot J_P} \qquad ② \quad f_D = \frac{5{,}4 \cdot q \cdot L_E^4}{E_{C_R} \cdot J_P}$$

Equation 7.74

q = weight of the filled pipe along with any insulation (N/mm^2)
E_{cR} = creep modulus of the pipe material (N/mm^2)
L_M, L_E = bracket distance (m)
L_B = acceptable bracket distance (m)
J_P = pipe moment of inertia (mm^4)
f_D = deflection (mm)

At position 3, the pipe is not subject to deflection but to buckling.

8 Jointing

8.1 General

In planning and installing PE pipe systems, the planning and/or installation organisations can select a series of different jointing techniques. The nature of the load, the type of installation, the economics and the local conditions have large influences on the choice of appropriate connecting method. The nature of the pipe connection can have lasting positive and negative consequences for the manufacturing costs of a pipe system. Criteria for selecting the most appropriate jointing technique are:
- operational reliability
- accessibility
- level of sealing
- effects of the medium to which it will be exposed
- cost outlay
- internal pressure load of the pipe system

The planner and fitter of plastic pipe systems can choose between a detachable and non-detachable connecting technique. Various procedures are available for possible solutions. The detachable connection contains elements that generally enable non-destructive disassembly and reassembly without large additional expense.

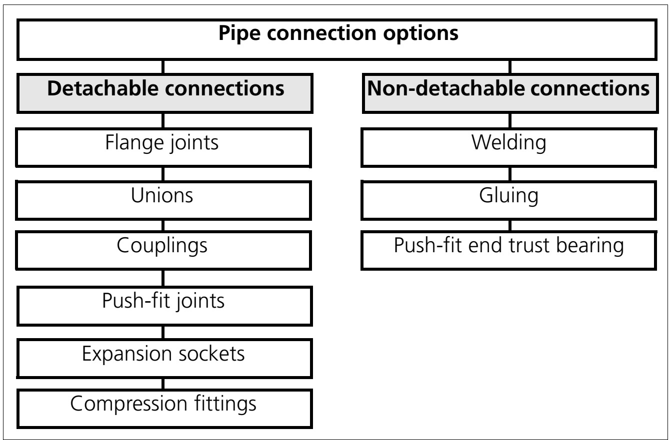


Figure 8.1 Detachable and non-detachable pipe connections

8.2 Detachable connections

8.2.1 General

In general, the group of detachable connecting elements for PE pipe systems consists of:
- flanges
- push-fit connections
- unions
- compression fittings

The individual jointing techniques in this group will be discussed below.

8.2.2 Flange joints

Connections to such components as pumps or valves are normally made by means of flange joints. The elements of the flange joint used in plastic pipe construction are the stub flange, backing ring, gasket and bolts with washers (possibly lock washers) and hex nuts. Flange joints can be either backing ring connections or blind flange joints. A blind flange joint is usually used to seal the end of a pipe. The fixed flange variant is generally ruled out due to higher costs. A backing ring connection is, in most cases, the substantially less expensive variant whenever a direct comparison is made, and therefore fixed flange joints are only of limited significance in the choice of flange joints.

The backing rings used as connecting elements in the plastic pipe construction are constructed from metal materials (e.g. steel, aluminium), fibre glass reinforced plastic or a combination of plastic and metal. The ease of assembly involved in their use and especially the higher operating reliability give backing ring connections definite advantages over fixed flange joints.

Figure 8.2 Flange joint

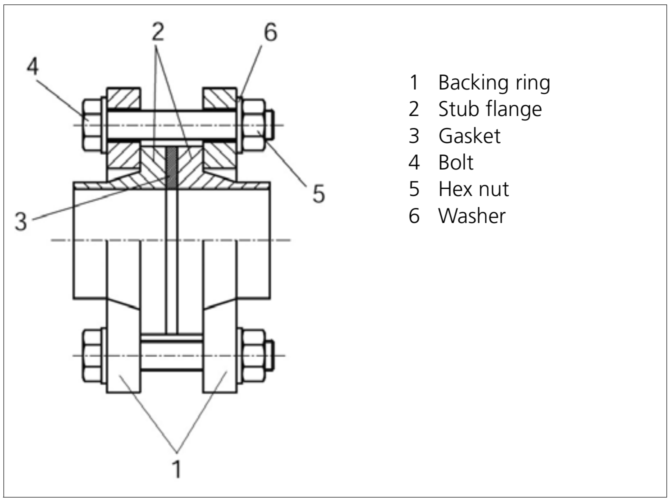


Figure 8.3 Cross-section of a flange joint

The gasket, nearly always in the form of a flat ring gasket, is available in various material and material qualities. Use is often made of gaskets composed of elastomers or elastomer compounds, such as neoprene, hypalon or viton. Hard gaskets have proven to be less suited or even unsuitable on account of their limited formability. The use of elastomer flat gaskets without steel inlays frequently results in leakage at higher internal pressures (e.g. during pressure testing). It is therefore recommended for use to be made of armoured gaskets with a convex cross-section. Their use is especially advisable when the internal pressure (operating pressure) comes close to the pipe's pressure rating. An additional improvement in the level of sealing is obtained when the inside of the gasket has the form of an O-ring. O-rings, double chamber gaskets, etc. are to be used in cases involving high internal pressures, especially when vacuums are involved as well. Gasket sizes are to be chosen so that the inside pipe diameter is not reduced by any excess gasket material, or that fissures can occur allowing fluid to penetrate the seal (with risk of sedimentation in the fissure!). During assembly, care must also be taken to ensure that the bolts are tightened evenly and the gasket and sealing surfaces are clean. Table 8.1 shows the standard values for the bolt torques in flange joints.

Jointing

Standard bolt torques in flange joints of thermoplastic pipes (DVS 2210 Part 1)

d_e (mm)	DN (mm)	Bolt tightening torque (Nm) Flat ring gasket ($p_{acc} \le 10$ bar)	Profile gasket ($p_{acc} \le 16$ bar)	O-ring gasket ($p_{acc} \le 16$ bar)
20	15	15	10	10
25	20	15	15	15
32	25	15	15	15
40	32	20	15	15
50	40	30	15	15
63	50	35	20	20
75	65	40	20	20
90	80	40	20	20
110	100	40	20	20
125	100	40	20	20
140	125	50	30	30
160	150	60	40	35
180	150	60	40	35
200	200	70 (1)	50	40
225	200	70 (1)	50	40
250	250	80 (1)	55	50
280	250	80 (1)	55	50
315	300	100 (1)	60	55
355	350	100 (1)	70	60
400	400	120 (1)	80	65
450	500	190 (1)	90	70
500	500	190 (1)	90	70
560	600	220 (1)	100	80
630	600	220 (1)	100	80

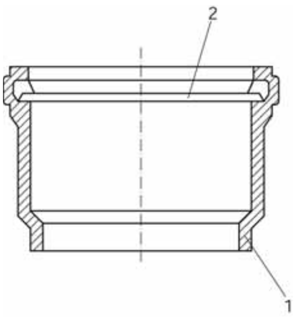
(1) for $P_{acc} \le 6$ bar

Table 8.1 Bolt tightening torques for flat, profile and O-ring gaskets

8.2.3 Push-fit connection

A push-fit connection is the general name given to all spigot and socket connections. The push-fit socket to be used will be explained in the following section.

Figure 8.4 Push-fit spigot



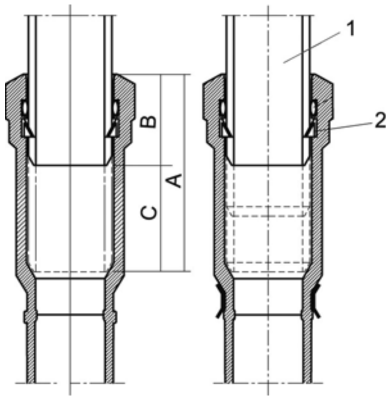
1 Socket
2 Seal

Figure 8.5 Cross-section of a connection with a push-fit socket

Push-fit and expansion sockets

The leak-tightness of a pipe connection with a push-fit and/or expansion socket is essentially achieved by applying the forces of a sealing element to the connecting pipe and/or fitting. In addition, the existing internal pressure helps to strengthen the radial sealing force. Small pipe deflections can be tolerated, as well as longitudinal movements corresponding to the distance that can be absorbed between the socket and seal seat.

Socket connections should only be used in pressure applications involving pipe systems that are free of underpressure. In principle, use is to be entirely avoided in pipe systems subject to internal pressure and another jointing technique chosen.



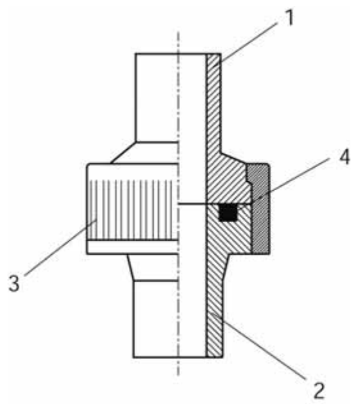
1 Plug
2 Lip seal ring

A Total insertion depth
B Minimum insertion depth
C Expansion capacity

Figure 8.6 Functional principle of the expansion socket

8.2.4 Unions

Figure 8.7 Screw-thread joint



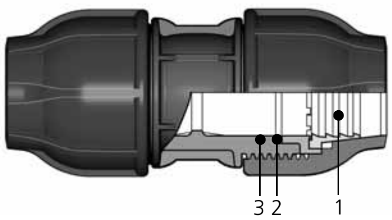
1 Section to be inserted
2 Section to be screwed on
3 Ring nut
4 O-ring

Figure 8.8 Cross-section of a union

These types of connecting elements are used in water lines as well as in transitions from plastic to other materials. The ease of assembly make them an especially valued connecting technique for small pipe sizes. Temperature effects can restrict application in pipe systems due to the flow behaviour of plastic. Each application must be carefully tested.

8.2.5 Compression fitting

Compression fittings are used to connect pipes in a quick and easy manner. A pressure chamber contains a sealing ring. Screwing in the fitting causes the sealing ring to be clamped against the pipe. NBR O-rings are used to connect the PE pipes. Special compression rings can be adopted to connect PE pipes with other types of material, such as PVC-U, PVC-C, PP, PE-X copper, lead and steel. Compression fittings are used in swimming-pool systems, for (drinking) water distribution, irrigation and telecommunications as well as in the mining industry and horticulture.



1 Clamp ring
2 Compression ring
3 Sealing system with limited size tolerance

Figure 8.9 Compression fitting

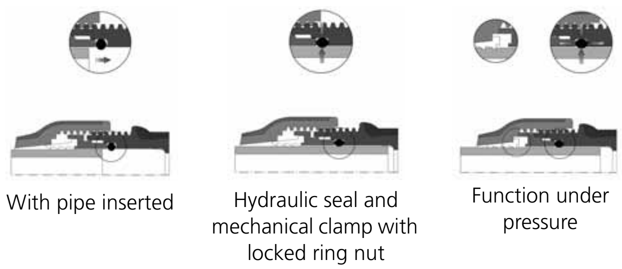


Figure 8.10 Compression principle

8.3 Non-detachable connections

8.3.1 General

Non-detachable jointing techniques are the most commonly used connection techniques in PE pipe construction. Welding is an extremely important form of connection used for PE fitting in plastic pipe construction. For this reason, welding has been made the focus of this Specification Manual and, on account of its importance, will be discussed in a separate chapter.

8.3.2 Welding

Welding has a special significance in pipe installation as well as in the production of PE shafts, tanks and special welded components. Many of the welding techniques described in chapter 9 are based on the principles in the DVS guidelines and have been adopted either directly or in analogous forms.

8.3.3 Gluing

Up to now, gluing has not been used in PE pipe construction. The characteristics of the plastics in question (polyolefin) make them unsuitable for glued connections (due to their "waxiness"), as their surfaces are not softened by adhesives. Special multi-component adhesives allow only limited connections to be formed that cannot be subject to mechanical loads and that are technically insignificant.

8.3.4 Push-fit socket end thrust bearing

Push-Fast is a unique spigot and socket type water jointing system, which combines the benefits of PE pipe with the ease of conventional push-fit joints. Unlike most spigot and socket type systems, Push-Fast has a specially designed and patented socket, which incorporates a tough thermoplastic 'grip' ring located in a tapered groove. This allows the joint to resist end-thrust generated by the internal pressure and eliminates the need for anchors or thrust blocks.

Figure 8.11 Section through assembled Push-Fast Joint showing grab ring and sealing

Push-Fast heads can easily be butt-welded to pipe lengths and coils. It is quick and easy to install. Suitable for underground pipe systems in subsidence areas and to limited space installation. The pipe system is immediately serviceable after assembly.

The performance of the Push-Fast joint depends on the efficiency of the seal between the elastromeric sealing ring, the pipe and the socket. Damage to the pipe or fittings or the presence of dirt or grit will adversely affect the performance of the joint.

akatherm

Jointing

8.4 Chapter summary

Connection method	In plastic pipe construction, there are two types of connecting techniques: detachable and non-detachable.
Detachable connection technique	Detachable connections can be easily disassembled and re-assembled without destroying the connection.
Non-detachable connection technique	Disassembly usually involves destruction of at least one of the connecting elements.
Flange connections	Can be fixed or backing ring connections. Backing ring connections consist of the components: stub flange, backing ring and gasket. A combination of stub flange, backing ring, blind flange and gasket can be used to seal pipes. At higher loads, backing ring connections are preferable to fixed flange connections.
Seals	Seals are needed to seal connections between two connecting elements. In the flange connections used in plastic pipe construction, flat gaskets (with and without steel inlays) and O-rings are mostly used. The material of the seal is adaptable to the flow medium.
Push-fit and expansion sockets	These are simple detachable connections. However, they should only be used in pressureless (under and overpressure free) pipe systems. They are therefore appropriate for pressureless drainage and/or sewerage systems.
Unions	Unions are quick connection devices. They are detachable connections and enable simple assembly, disassembly and re-assembly without special implements and tools.
Welding	Welding is one of the most commonly used jointing techniques in plastic pipe construction. Various plastic welding procedures are used to manufacture fittings from pipes and pipe segments, joints made of pieces of pipe, as well as plastic shafts, tanks and other special components. Welding processes non-detachable connection techniques.
Gluing	Gluing is only very conditionally meaningful and possible as an appropriate jointing technique for polyolefin materials. A bond is produced only with special multi-component adhesives. These glued connections are not at all capable of withstanding mechanical loads.
Push-fit socket end thrust bearing	Plug and socket type water jointing system with push fit joints. A tough thermoplastic 'grip' ring located in a tapered groove allows the joint to resist end-thrust. It is quick and easy to install. No anchors or thrust blocks required. Suitable for ground subsidence areas and to limited space installation. Immediately serviceable.

Price list 2011

Foreword

Foreword price list

Technical data
All data complies with the actual technical data at time of print of this publication. All dimensions are in mm, unless otherwise stated. Akatherm cannot be held responsible for printing errors and temporary changes in this price list.
For more information contact our Technical Support.

Approvals
The Akatherm product range has the following approvals and certificates:
- Akatherm spigot fittings: Kiwa and DVGW
- Electrofusion fittings: Kiwa and DV
- Akatherm BV: ISO 9001 and ISO 14001

Assembly instructions
The following guidelines are applicable for the jointing of the different product ranges:
- Akatherm spigot fittings according NEN7200 or the appicable (inter)national standard
- Electrofusion fittings according FRIALEN assembly instruction or the applicable (inter)national standard.

Price and delivery conditions
- Prices are in euro, excluding VAT.
- Our general terms and conditions are applicable.

Article group
Every article in this price list is given an article group (AG) which refers to a discount group given in the Akatherm terms and conditions.

Packing quantity
In this price list packing quantities (q) are clearly marked.

Inspection certificate
Inspection certificates can be issued and have to be requested at time of ordering. Akatherm will charge €15,- handling fee per position.

Electronic price list
This price list is also in digital form available as an Excel-version for electronic ordering systems and a pdf-version for PC use.

Distribution
The Akatherm pressure system is sold through a network of distributors. The contact details of the distributor in your country can be requested at the Customer Service department or can be found on our website: www.akatherm.com

Storage
Fittings and electrofusion couplers need to be stored in a dry environment. We recommand to keep the fittings and couplers as long as possible in the original packing to prevent corrosion and pollution.

Return goods
Products can only be returned after Akatherm has expressly given its consent in writing. A 25% handling fee will be charged.

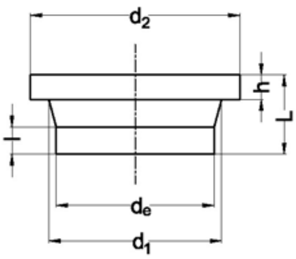
Service
Realising dureable and reliable joints request more than just good products. By giving training, supplying product information and site support we try to inform contractors, consultants, end-users and distributors about the properties, applications and assembly of PE pressure pipe systems. We do this with only one goal:
Safe and reliable jointings!

ABBREVIATONS	
AG	article group
Art. Nr.	article number
DN	nominal size
d_e	outside diameter
e	wall thickness of a pipe
G	cilindrical pipe threads where pressure-tight joints are not made on the threads ISO 228
L	length of fitting
l	length of spigot
q	package quantity
R	male pipe threads where pressure-tight joints are made on the threads ISO 7
R_p	cilindrical female pipe threads where pressure-tight joints are made on the threads ISO 7
R_c	conical female pipe threads where pressure-tight joints are made on the threads ISO 7
SDR	ratio between outer diameter / wall thickness
NEN	national standard in The Netherlands
EN	European standard
ISO	international standard
DIN	national standard in Germany
ASTM	American standard
S	class indication ISO-S = (SDR-1)/2
o.r.	on request

Stub flange short SDR 33

for butt-welding

PE100
SDR 33
water 3,2 bar



d_e	Art. Nr.	q	€	AG		h	l	d_1	d_2	L
110	**47 11 02 533**	**1**	**12,63**	**EB**		18	34	125	158	80
125	**47 12 02 533**	**1**	**15,53**	**EB**		18	38	132	158	80
140	**47 14 02 533**	**1**	**18,02**	**EB**		18	32	155	188	80
160	**47 16 02 533**	**1**	**22,32**	**EB**		18	26	175	212	80
180	**47 18 02 533**	**1**	**32,59**	**EB**		18	31	183	212	80
200	**47 20 02 533**	**1**	**39,14**	**EB**		18	34	232	268	100
225	**47 22 02 533**	**1**	**43,89**	**EB**		18	46	235	268	100
250	**47 25 02 533**	**1**	**61,92**	**EB**		20	71	285	320	132
280	**47 28 02 533**	**1**	**66,79**	**EB**		20	62	291	320	128
315	**47 31 02 533**	**1**	**80,00**	**EB**		20	71	335	370	136
355	**47 35 02 533**	**1**	**136,85**	**EB**		23	57	373	430	120
400	**47 40 02 533**	**1**	**284,30**	**EB**		26	49	427	482	120
450	**47 45 02 533**	**1**	**332,91**	**EB**		33	27	514	585	120
500	**47 50 02 533**	**1**	**404,33**	**EB**		33	37	530	585	120
560	**47 56 02 533**	**1**	**478,44**	**EB**		35	25	615	685	120
630	**47 63 02 533**	**1**	**551,08**	**EB**		35	45	642	685	120
710	**47 71 02 533**	**1**	**646,64**	**EL**	*	35	35	737	800	120
800	**47 80 02 533**	**1**	**1051,56**	**EL**	*	36	34	840	905	120
900	**47 90 02 533**	**1**	**1319,23**	**EL**	*	40	30	944	1005	120
1000	**47 91 02 533**	**1**	**1654,88**	**EL**	*	42	28	1047	1110	140
1200	**47 92 02 533**	**1**	**2179,32**	**EL**	*	50	20	1245	1330	140

* *fabrication on order, returning not possible*

With grooved jointing face.

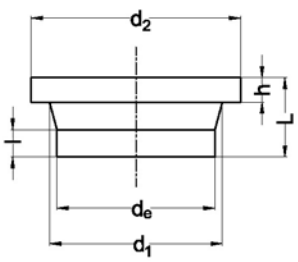
PE100 pressure fittings

Stub flange short SDR 17

PE100
SDR 17

for butt-welding

water 10 bar/gas 5 bar



d_e	Art. Nr.	q	€	AG		h	l	d_1	d_2	L
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50	**47 05 02 517**	**25**	**4,08**	**EA**		12	21	61	88	50
63	**47 06 02 517**	**15**	**5,00**	**EA**		14	16	75	102	50
75	**47 07 02 517**	**10**	**5,90**	**EA**		16	14	89	122	50
90	**47 09 02 517**	**5**	**8,64**	**EA**		17	33	105	138	80
110	**47 11 02 517**	**5**	**10,97**	**EA**		18	27	125	158	80
125	**47 12 02 517**	**5**	**13,49**	**EA**		18	42	132	158	80
140	**47 14 02 517**	**4**	**15,69**	**EA**		18	34	155	188	80
160	**47 16 02 517**	**4**	**19,39**	**EA**		18	34	175	212	80
180	**47 18 02 517**	**3**	**28,34**	**EA**		20	60	182	212	80
200	**47 20 02 517**	**2**	**35,41**	**EA**		24	36	232	268	100
225	**47 22 02 517**	**2**	**39,69**	**EA**		24	46	235	268	100
250	**47 25 02 517**	**1**	**56,72**	**EA**		25	35	285	320	100
280	**47 28 02 517**	**1**	**62,31**	**EA**		25	45	291	320	100
315	**47 31 02 517**	**1**	**76,07**	**EA**		25	35	335	370	100
355	**47 35 02 517**	**1**	**149,93**	**EB**		30	30	373	430	120
400	**47 40 02 517**	**1**	**303,01**	**EB**		33	42	427	482	120
450	**47 45 02 517**	**1**	**357,07**	**EB**		46	14	514	585	120
500	**47 50 02 517**	**1**	**440,21**	**EB**		46	24	530	585	120
560	**47 56 02 517**	**1**	**526,93**	**EB**		50	10	615	685	120
630	**47 63 02 517**	**1**	**610,24**	**EB**		50	30	642	685	120
710	**47 71 02 517**	**1**	**684,04**	**EL**	*	50	20	737	800	120
800	**47 80 02 517**	**1**	**1229,35**	**EL**	*	52	18	840	905	120
900	**47 90 02 517**	**1**	**1516,65**	**EL**	*	55	15	944	1005	120
1000	**47 91 02 517**	**1**	**1975,65**	**EL**	*	60	10	1047	1110	140

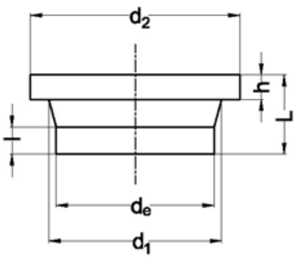
* *fabrication on order, returning not possible*

With grooved jointing face.

Stub flange short SDR 11

for butt-welding

PE100
SDR 11
water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG		h	l	d_1	d_2	L
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25	**47 02 02 511**	**30**	**2,57**	**EA**		9	26	33	58	50
32	**47 03 02 511**	**30**	**3,05**	**EA**		10	25	40	68	50
40	**47 04 02 511**	**30**	**3,63**	**EA**		11	24	50	78	50
50	**47 05 02 511**	**25**	**4,47**	**EA**		12	21	61	88	50
63	**47 06 02 511**	**15**	**5,57**	**EA**		14	16	75	102	50
75	**47 07 02 511**	**10**	**6,59**	**EA**		16	14	89	122	50
90	**47 09 02 511**	**5**	**9,43**	**EA**		17	33	105	138	80
110	**47 11 02 511**	**5**	**12,14**	**EA**		18	27	125	158	80
125	**47 12 02 511**	**5**	**14,64**	**EA**		25	25	132	158	80
140	**47 14 02 511**	**4**	**17,09**	**EA**		25	27	155	188	80
160	**47 16 02 511**	**4**	**21,55**	**EA**		25	34	175	212	80
180	**47 18 02 511**	**3**	**33,47**	**EA**		30	60	182	212	80
200	**47 20 02 511**	**2**	**36,84**	**EA**		32	36	232	268	100
225	**47 22 02 511**	**2**	**41,06**	**EA**		32	46	235	268	100
250	**47 25 02 511**	**1**	**62,31**	**EA**		35	35	285	320	100
280	**47 28 02 511**	**1**	**68,07**	**EA**		35	45	291	320	100
315	**47 31 02 511**	**1**	**80,20**	**EA**		35	35	335	370	100
355	**47 35 02 511**	**1**	**163,73**	**EB**		40	30	373	430	120
400	**47 40 02 511**	**1**	**322,56**	**EB**		46	42	427	482	120
450	**47 45 02 511**	**1**	**377,82**	**EB**		60	14	514	585	120
500	**47 50 02 511**	**1**	**478,44**	**EB**		60	24	530	585	120
560	**47 56 02 511**	**1**	**591,18**	**EB**		60	10	615	685	120
630	**47 63 02 511**	**1**	**704,19**	**EB**		60	30	642	685	120
710	**47 71 02 511**	**1**	**1482,27**	**EL**	*	67	20	737	800	120

* *fabrication on order, returning not possible*

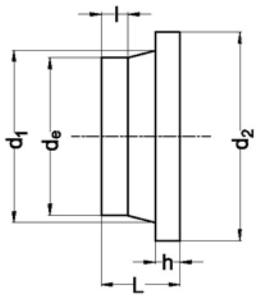
With grooved jointing face.

PE100 pressure fittings

Stub flange short SDR 17 for FIP butterfly valve type FE and FK

PE100
SDR 17
water 10 bar

for butt-welding



d_e/DN	Art. Nr.	q	€	AG		h	l	d_1	d_2	L
50/40	47 05 72 517	1	5,15	EB		12	21	61	88	50
63/50	47 06 72 517	1	6,28	EB		14	16	75	102	50
75/65	47 07 72 517	1	7,42	EB		16	14	89	122	50
90/80	47 09 72 517	1	10,85	EB		17	33	105	138	80
110/100	47 11 72 517	1	13,81	EB		18	27	125	158	80
125/100	47 12 72 517	1	16,88	EB		18	42	132	158	80
140/125	47 14 72 517	1	19,62	EB		18	34	155	188	80
160/150	47 16 72 517	1	24,31	EB		18	34	175	212	80
180/150	47 18 72 517	1	35,49	EB		20	60	182	212	80
200/200	47 20 73 517	1	44,28	EB	*	24	36	232	268	100
225/200	47 22 72 517	1	49,64	EB		24	46	235	268	100
250/250	47 25 73 517	1	70,98	EB	*	25	35	285	320	100
280/250	47 28 72 517	1	77,94	EB		25	45	291	320	100
315/300	47 31 73 517	1	95,16	EB	*	25	35	335	370	100

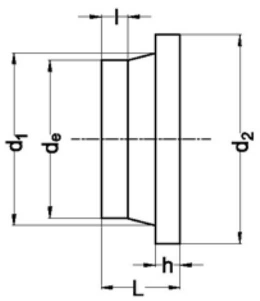
* *machined for free movement of disc*

With flat jointing face.
Suitable for installation on both sides of the butterfly valve.
Dimensions are adapted to the profile backing ring for stub flange.

Stub flange short SDR 11 for FIP butterfly valve type FE and FK

PE100
SDR 11
water 16 bar

for butt-welding



d_e/DN	Art. Nr.	q	€	AG		h	l	d_1	d_2	L
50/40	47 05 72 511	1	5,60	EB		12	21	61	88	50
63/50	47 06 72 511	1	6,96	EB		14	16	75	102	50
75/65	47 07 72 511	1	8,34	EB		16	14	89	122	50
90/80	47 09 72 511	1	11,87	EB		17	33	105	138	80
110/100	47 11 72 511	1	15,75	EB		18	27	125	158	80
125/100	47 12 72 511	1	18,38	EB		25	25	132	158	80
140/125	47 14 72 511	1	21,45	EB		25	27	155	188	80
160/150	47 16 73 511	1	27,05	EB	*	25	34	175	212	80
180/150	47 18 72 511	1	41,88	EB		30	60	182	212	80
200/200	47 20 73 511	1	46,10	EB	*	32	36	232	268	100
225/200	47 22 73 511	1	51,35	EB	*	32	46	235	268	100
250/250	47 25 73 511	1	77,94	EB	*	35	35	285	320	100
280/250	47 28 73 511	1	85,12	EB	*	35	45	291	320	100
315/300	47 31 73 511	1	100,31	EB	*	35	35	335	370	100

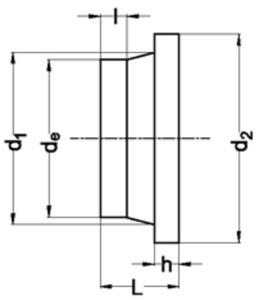
* *machined for free movement of disc*

With flat jointing face.
Suitable for installation on both sides of the butterfly valve.
Dimensions are adapted to the profile backing ring for stub flange.

Stub flange short SDR 17 for entrance side FIP check valve type CR and FR

PE100
SDR 17
water 10 bar

for butt-welding



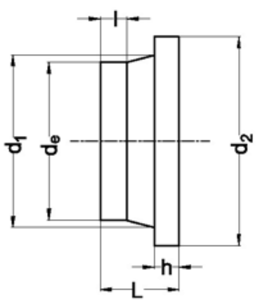
d_e/DN	Art. Nr.	q	€	AG	h	l	d_1	d_2	L
50/40	**47 05 72 517**	**1**	**5,15**	**EB**	12	21	61	88	50
63/50	**47 06 72 517**	**1**	**6,28**	**EB**	14	16	75	102	50
75/65	**47 07 72 517**	**1**	**7,42**	**EB**	16	14	89	122	50
90/80	**47 09 72 517**	**1**	**10,85**	**EB**	17	33	105	138	80
110/100	**47 11 72 517**	**1**	**13,81**	**EB**	18	27	125	158	80
125/100	**47 12 72 517**	**1**	**16,88**	**EB**	18	42	132	158	80
140/125	**47 14 72 517**	**1**	**19,62**	**EB**	18	34	155	188	80
160/150	**47 16 72 517**	**1**	**24,31**	**EB**	18	34	175	212	80
180/150	**47 18 72 517**	**1**	**35,49**	**EB**	20	60	182	212	80
200/200	**47 20 72 517**	**1**	**44,28**	**EB**	24	36	232	268	100
225/200	**47 22 72 517**	**1**	**49,64**	**EB**	24	46	235	268	100
250/250	**47 25 72 517**	**1**	**70,98**	**EB**	25	35	285	320	100
280/250	**47 28 72 517**	**1**	**77,94**	**EB**	25	45	291	320	100
315/300	**47 31 72 517**	**1**	**95,16**	**EB**	25	35	335	370	100

With flat jointing face.
Suitable for installation on entrance side. Install stub flange extended short CR/FR on exit side.
Dimensions are adapted to the profile backing ring for stub flange.

Stub flange short SDR 11 for entrance side FIP check valve type CR and FR

PE100
SDR 11
water 16 bar

for butt-welding



d_e/DN	Art. Nr.	q	€	AG	h	l	d_1	d_2	L
50/40	**47 05 72 511**	**1**	**5,60**	**EB**	12	21	61	88	50
63/50	**47 06 72 511**	**1**	**6,96**	**EB**	14	16	75	102	50
75/65	**47 07 72 511**	**1**	**8,34**	**EB**	16	14	89	122	50
90/80	**47 09 72 511**	**1**	**11,87**	**EB**	17	33	105	138	80
110/100	**47 11 72 511**	**1**	**15,75**	**EB**	18	27	125	158	80
125/100	**47 12 72 511**	**1**	**18,38**	**EB**	25	25	132	158	80
140/125	**47 14 72 511**	**1**	**21,45**	**EB**	25	27	155	188	80
160/150	**47 16 72 511**	**1**	**27,05**	**EB**	25	34	175	212	80
180/150	**47 18 72 511**	**1**	**41,88**	**EB**	30	60	182	212	80
200/200	**47 20 72 511**	**1**	**46,10**	**EB**	32	36	232	268	100
225/200	**47 22 72 511**	**1**	**51,35**	**EB**	32	46	235	268	100
250/250	**47 25 72 511**	**1**	**77,94**	**EB**	35	35	285	320	100
280/250	**47 28 72 511**	**1**	**85,12**	**EB**	35	45	291	320	100
315/300	**47 31 72 511**	**1**	**100,31**	**EB**	35	35	335	370	100

With flat jointing face.
Suitable for installation on entrance side. Install stub flange extended short CR/FR on exit side. Dimensions are adapted to the profile backing ring for stub flange.

akatherm

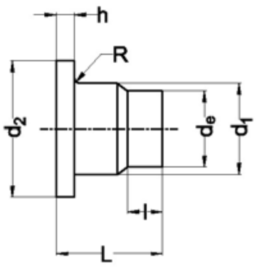
PE100 pressure fittings

Stub flange extended short SDR 17 for exit side FIP check valve type CR and FR

PE100
SDR 17
water 10 bar

for butt-welding

d_e/DN	Art. Nr.	q	€	AG	h	l	d_1	d_2	L	R
50/40	**47 05 71 517**	**1**	**42,00**	**EC**	12	20	61	90	50	3
63/50	**47 06 71 517**	**1**	**48,71**	**EC**	14	20	75	105	54	4
75/65	**47 07 71 517**	**1**	**60,31**	**EC**	16	20	89	125	58	4
90/80	**47 09 71 517**	**1**	**63,98**	**EC**	17	40	105	138	92	4
110/100	**47 11 71 517**	**1**	**80,22**	**EC**	18	40	125	160	92	4
140/125	**47 14 71 517**	**1**	**119,53**	**EC**	18	40	155	190	100	4
160/150	**47 16 71 517**	**1**	**151,53**	**EC**	18	40	175	215	120	4
225/200	**47 22 71 517**	**1**	**256,41**	**EC**	24	40	235	270	165	4
280/250	**47 28 71 517**	**1**	**381,66**	**EC**	25	40	291	325	195	6
315/300	**47 31 71 517**	**1**	**602,92**	**EC**	25	40	335	375	250	6



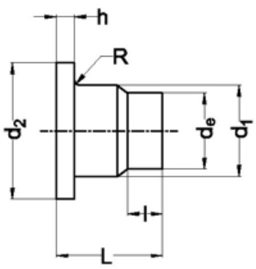
With flat jointing face. Extended for free movement of disc.
Suitable for installation on exit side. Install stub flange short CR/FR on entrance side.
Dimensions are adapted to the profile backing ring for stub flange.
Fabrication on order.

Stub flange extended short SDR 11 for exit side FIP check valve type CR and FR

PE100
SDR 11
water 16 bar

for butt-welding

d_e/DN	Art. Nr.	q	€	AG	h	l	d_1	d_2	L	R
50/40	**47 05 71 511**	**1**	**42,00**	**EC**	12	20	61	90	50	3
63/50	**47 06 71 511**	**1**	**48,71**	**EC**	14	20	75	105	56	4
75/65	**47 07 71 511**	**1**	**60,31**	**EC**	16	20	89	125	65	4
90/80	**47 09 71 511**	**1**	**63,98**	**EC**	17	35	105	138	92	4
110/100	**47 11 71 511**	**1**	**80,22**	**EC**	18	35	125	160	92	4
140/125	**47 14 71 511**	**1**	**119,53**	**EC**	18	40	155	190	110	4
160/150	**47 16 71 511**	**1**	**151,53**	**EC**	18	40	175	215	120	4
225/200	**47 22 71 511**	**1**	**256,41**	**EC**	26	56	235	270	180	4
280/250	**47 28 71 511**	**1**	**381,66**	**EC**	35	40	291	325	220	6
315/300	**47 31 71 511**	**1**	**602,92**	**EC**	35	40	335	375	270	6

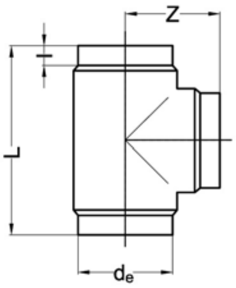


With flat jointing face. Extended for free movement of disc.
Suitable for installation on exit side. Install stub flange short CR/FR on entrance side.
Dimensions are adapted to the profile backing ring for stub flange.
Fabrication on order.

Tee 90° short SDR 33

for butt-welding

PE100
SDR 33
water 3,2 bar

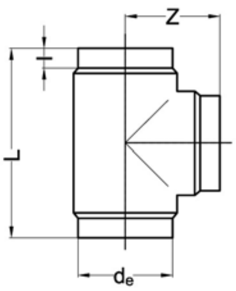


d_e	Art. Nr.	q	€	AG	L	Z	l
110	39 11 01 533	1	27,34	EB	249	121	50
125	39 12 01 533	1	32,32	EB	262	132	47
140	39 14 01 533	1	37,32	EB	293	145	48
160	39 16 01 533	1	62,29	EB	318	160	55
180	39 18 01 533	1	73,82	EB	356	175	59
200	39 20 01 533	1	91,14	EB	385	194	55
225	39 22 01 533	1	170,89	EB	442	212	59
250	39 25 01 533	1	264,24	EB	465	232	70
280	39 28 01 533	1	336,17	EB	536	268	80
315	39 31 01 533	1	424,41	EB	530	263	75
355	39 35 01 533	1	594,28	EB	658	330	95
400	39 40 01 533	1	871,26	EB	690	345	104
450	39 45 01 533	1	1176,29	EB	890	450	130
500	39 50 01 533	1	1527,05	EB	895	450	130

Tee 90° short SDR 17

for butt-welding

PE100
SDR 17
water 10 bar/gas 5 bar



d_e	Art. Nr.	q	€	AG	L	Z	l
40	39 04 01 517	10	3,40	EA	88	44	16
50	39 05 01 517	10	5,42	EA	116	58	21
63	39 06 01 517	10	7,39	EA	146	73	24
75	39 07 01 517	10	15,09	EA	170	85	28
90	39 09 01 517	10	21,53	EA	200	100	23
110	39 11 01 517	5	35,74	EA	240	120	43
125	39 12 01 517	5	49,52	EA	250	125	26
140	39 14 01 517	4	58,46	EA	280	140	32
160	39 16 01 517	2	109,92	EA	320	160	40
180	39 18 01 517	1	135,03	EA	390	195	73
200	39 20 01 517	1	184,38	EA	430	215	64
225	39 22 01 517	1	216,47	EA	490	245	72
250	39 25 01 517	1	287,27	EA	550	275	86
280	39 28 01 517	1	324,69	EA	620	310	105
315	39 31 01 517	1	431,87	EA	700	350	111
355	39 35 01 517	1	746,78	EB	680	340	101
400	39 40 01 517	1	1020,68	EB	680	338	95
450	39 45 01 517	1	1419,43	EB	900	450	130
500	39 50 01 517	1	1826,66	EB	900	450	130

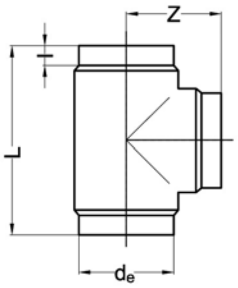
akatherm

PE100 pressure fittings

Tee 90° short SDR 11

for butt-welding

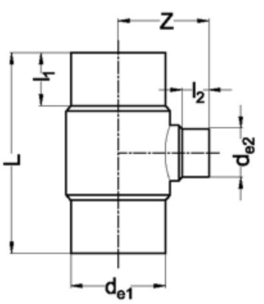
PE100
SDR 11
water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG	L	Z	l
20	39 01 01 511	30	2,27	EA	50	25	8
25	39 02 01 511	30	2,27	EA	60	30	10
32	39 03 01 511	20	2,86	EA	80	40	12
40	39 04 01 511	10	4,55	EA	88	44	16
50	39 05 01 511	10	6,13	EA	116	58	21
63	39 06 01 511	10	9,51	EA	146	73	24
75	39 07 01 511	10	19,15	EA	170	85	28
90	39 09 01 511	10	28,61	EA	200	100	23
110	39 11 01 511	5	42,01	EA	240	120	43
125	39 12 01 511	5	57,87	EA	250	125	26
140	39 14 01 511	4	73,32	EA	280	140	32
160	39 16 01 511	2	123,32	EA	320	160	40
180	39 18 01 511	1	158,07	EA	390	195	73
200	39 20 01 511	1	226,52	EA	430	215	64
225	39 22 01 511	1	269,40	EA	490	245	72
250	39 25 01 511	1	342,73	EA	550	275	86
280	39 28 01 511	1	463,37	EA	620	310	105
315	39 31 01 511	1	658,23	EA	700	350	111
355	39 35 01 511	1	884,67	EB	680	340	101
400	39 40 01 511	1	1320,97	EB	680	338	95
450	39 45 01 511	1	1745,21	EB	900	450	130
500	39 50 01 511	1	2230,49	EB	900	450	130

Tee 90° reduced short SDR 17
with reduced branch
for butt-welding

PE100
SDR 17
water 10 bar/gas 5 bar



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z	l_1	l_2
90/32	28 09 03 517	10	22,89	EB	213	85	53	23
90/50	28 09 05 517	10	23,51	EB	214	93	53	28
110/32	28 11 03 517	5	38,34	EB	244	94	66	22
110/50	28 11 05 517	5	36,02	EB	238	103	66	27
110/63	28 11 06 517	5	46,87	EB	240	105	48	32
110/90	28 11 09 517	5	46,87	EB	240	115	48	38
125/63	28 12 06 517	5	54,13	EB	264	110	70	31
125/90	28 12 09 517	5	54,13	EB	265	124	72	32
140/63	28 14 06 517	4	62,62	EB	300	120	83	32
140/75	28 14 07 517	4	62,90	EB	300	130	81	35
140/90	28 14 09 517	4	63,92	EB	300	130	81	41
140/110	28 14 11 517	4	65,24	EB	300	137	50	47
160/110	28 16 11 517	2	127,67	EB	320	145	56	38
160/125	28 16 12 517	2	127,67	EB	315	150	58	47
180/63	28 18 06 517	1	144,41	EB	358	134	125	30
180/75	28 18 07 517	1	144,41	EB	360	140	112	30
180/110	28 18 11 517	1	148,82	EB	365	158	106	48
180/125	28 18 12 517	1	148,82	EB	358	160	92	50
200/63	28 20 06 517	1	181,35	EB	382	145	143	31
200/125	28 20 12 517	1	203,54	EB	390	165	114	43
200/160	28 20 16 517	1	206,07	EB	390	165	98	60
225/110	28 22 11 517	1	255,40	EB	440	264	89	89

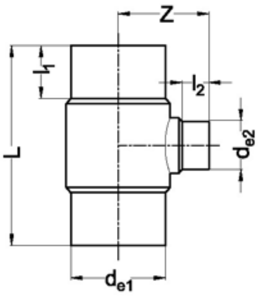
-- to be continued --

Tee 90° reduced short SDR 17 - continuation -

d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z	l_1	l_2
225/125	**28 22 12 517**	**1**	**255,40**	**EB**	445	180	135	40
225/160	**28 22 16 517**	**1**	**255,40**	**EB**	470	200	89	60
250/110	**28 25 11 517**	**1**	**310,47**	**EB**	455	197	135	38
250/160	**28 25 16 517**	**1**	**316,75**	**EB**	455	219	110	58

Tee 90° reduced short SDR 11
with reduced branch
for butt-welding

PE100
SDR 11
water 16 bar/gas 10 bar

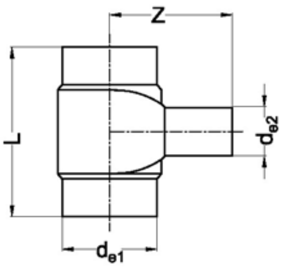


d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z	l_1	l_2
90/32	**28 09 03 511**	**10**	**30,50**	**EB**	213	85	53	23
90/50	**28 09 05 511**	**10**	**31,33**	**EB**	213	90	53	28
110/32	**28 11 03 511**	**5**	**45,01**	**EB**	244	94	66	22
110/50	**28 11 05 511**	**5**	**45,94**	**EB**	244	103	66	27
110/63	**28 11 06 511**	**5**	**64,05**	**EB**	240	105	48	32
110/90	**28 11 09 511**	**5**	**64,05**	**EB**	240	115	48	38
125/63	**28 12 06 511**	**5**	**64,28**	**EB**	278	112	70	31
125/90	**28 12 09 511**	**5**	**64,28**	**EB**	265	124	72	32
140/63	**28 14 06 511**	**4**	**80,65**	**EB**	305	120	83	32
140/75	**28 14 07 511**	**4**	**80,65**	**EB**	305	130	81	35
140/90	**28 14 09 511**	**4**	**81,95**	**EB**	305	130	81	41
140/110	**28 14 11 511**	**4**	**81,95**	**EB**	305	140	50	47
160/110	**28 16 11 511**	**2**	**144,25**	**EB**	320	145	56	38
160/125	**28 16 12 511**	**2**	**144,25**	**EB**	325	150	58	47
180/63	**28 18 06 511**	**1**	**168,86**	**EB**	358	134	125	30
180/75	**28 18 07 511**	**1**	**168,86**	**EB**	352	140	112	30
180/110	**28 18 11 511**	**1**	**174,27**	**EB**	365	158	106	48
180/125	**28 18 12 511**	**1**	**174,27**	**EB**	366	166	92	50
200/63	**28 20 06 511**	**1**	**242,12**	**EB**	382	145	143	31
200/125	**28 20 12 511**	**1**	**258,70**	**EB**	390	165	114	43
200/160	**28 20 16 511**	**1**	**252,67**	**EB**	390	180	98	60
225/110	**28 22 11 511**	**1**	**306,19**	**EB**	440	264	89	88
225/125	**28 22 12 511**	**1**	**306,19**	**EB**	456	178	135	40
225/160	**28 22 16 511**	**1**	**318,27**	**EB**	470	200	89	60
250/110	**28 25 11 511**	**1**	**401,60**	**EB**	463	197	135	38
250/160	**28 25 16 511**	**1**	**396,00**	**EB**	458	219	110	58

PE100 pressure fittings

Tee 90° reduced machined short SDR17 - pressure class conform
with reduced branch
for butt-welding

PE100
SDR 17
water 10 bar/gas 5 bar



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
280/63	40 28 06 517	1	650,86	EC	270	365
280/75	40 28 07 517	1	667,12	EC	280	365
280/90	40 28 09 517	1	694,16	EC	295	365
280/110	40 28 11 517	1	728,29	EC	315	365
280/125	40 28 12 517	1	766,29	EC	330	365
280/140	40 28 14 517	1	802,15	EC	345	365
280/160	40 28 16 517	1	923,98	EC	365	365
280/180	40 28 18 517	1	1008,71	EC	385	365
280/200	40 28 20 517	1	1092,54	EC	405	365
280/225	40 28 22 517	1	1349,19	EC	430	365
315/75	40 31 07 517	1	712,14	EC	280	380
315/90	40 31 09 517	1	734,67	EC	295	380
315/110	40 31 11 517	1	937,59	EC	315	380
315/125	40 31 12 517	1	980,88	EC	330	380
315/140	40 31 14 517	1	914,01	EC	345	380
315/160	40 31 16 517	1	1087,04	EC	365	380
315/180	40 31 18 517	1	1151,06	EC	385	380
315/200	40 31 20 517	1	1207,86	EC	405	380
315/225	40 31 22 517	1	1577,17	EC	430	380
315/250	40 31 25 517	1	1703,27	EC	455	380
355/90	40 35 09 517	1	861,68	EC	305	400
355/110	40 35 11 517	1	943,59	EC	325	400
355/125	40 35 12 517	1	980,56	EC	340	400
355/140	40 35 14 517	1	1039,59	EC	355	400
355/160	40 35 16 517	1	1277,14	EC	375	400
355/180	40 35 18 517	1	1350,20	EC	395	400
355/200	40 35 20 517	1	1431,29	EC	415	400
355/225	40 35 22 517	1	1525,99	EC	440	400
355/250	40 35 25 517	1	1643,92	EC	465	400
355/280	40 35 28 517	1	2088,35	EC	500	400
400/110	40 40 11 517	1	1132,06	EC	325	425
400/125	40 40 12 517	1	1183,57	EC	340	425
400/140	40 40 14 517	1	1233,14	EC	355	425
400/160	40 40 16 517	1	1279,98	EC	375	425
400/180	40 40 18 517	1	1589,07	EC	395	425
400/200	40 40 20 517	1	1676,52	EC	415	425
400/225	40 40 22 517	1	1770,12	EC	440	425
400/250	40 40 25 517	1	1906,26	EC	465	425
400/280	40 40 28 517	1	2361,44	EC	500	425
400/315	40 40 31 517	1	2589,44	EC	535	425
450/125	40 45 12 517	1	1220,34	EC	340	450
450/140	40 45 14 517	1	1271,98	EC	355	450
450/160	40 45 16 517	1	1342,17	EC	375	450
450/180	40 45 18 517	1	1607,96	EC	395	450
450/200	40 45 20 517	1	1692,71	EC	415	450
450/225	40 45 22 517	1	1773,78	EC	440	450
450/250	40 45 25 517	1	2152,35	EC	465	450
450/280	40 45 28 517	1	2317,14	EC	500	450
450/315	40 45 31 517	1	2538,94	EC	535	450
450/355	40 45 35 517	1	3360,71	EC	575	450
500/140	40 50 14 517	1	1533,99	EC	355	475
500/160	40 50 16 517	1	1595,45	EC	375	475
500/180	40 50 18 517	1	1681,82	EC	395	475
500/200	40 50 20 517	1	1770,12	EC	415	475
500/225	40 50 22 517	1	2555,10	EC	440	475
500/250	40 50 25 517	1	2743,36	EC	465	475

-- to be continued --

Tee 90° reduced machined short SDR17 - pressure class conform - continuation -

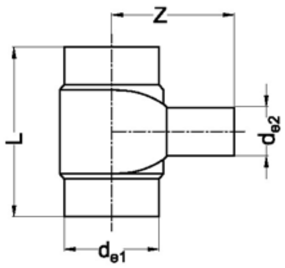
d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
500/280	**40 50 28 517**	**1**	**2767,96**	**EC**	500	475
500/315	**40 50 31 517**	**1**	**3195,60**	**EC**	535	475
500/355	**40 50 35 517**	**1**	**3480,30**	**EC**	575	475
500/400	**40 50 40 517**	**1**	**3967,07**	**EC**	620	475
560/160	**40 56 16 517**	**1**	**2038,66**	**EC**	375	500
560/180	**40 56 18 517**	**1**	**2153,97**	**EC**	395	500
560/200	**40 56 20 517**	**1**	**2238,51**	**EC**	415	500
560/225	**40 56 22 517**	**1**	**2427,18**	**EC**	440	500
560/250	**40 56 25 517**	**1**	**2504,50**	**EC**	465	500
560/280	**40 56 28 517**	**1**	**2727,01**	**EC**	500	500
560/315	**40 56 31 517**	**1**	**2099,11**	**EC**	535	500
560/355	**40 56 35 517**	**1**	**3820,05**	**EC**	575	500
560/400	**40 56 40 517**	**1**	**4319,43**	**EC**	620	500
560/450	**40 56 45 517**	**1**	**5508,78**	**EC**	670	500
560/560	**40 56 56 517**	**1**	**8500,36**	**EC**	780	500
630/180	**40 63 18 517**	**1**	**2314,41**	**EC**	395	540
630/200	**40 63 20 517**	**1**	**2407,26**	**EC**	415	540
630/225	**40 63 22 517**	**1**	**2556,73**	**EC**	440	540
630/250	**40 63 25 517**	**1**	**2759,42**	**EC**	465	540
630/280	**40 63 28 517**	**1**	**2963,95**	**EC**	500	540
630/315	**40 63 31 517**	**1**	**3906,82**	**EC**	535	540
630/355	**40 63 35 517**	**1**	**4232,05**	**EC**	575	540
630/400	**40 63 40 517**	**1**	**4789,84**	**EC**	620	540
630/450	**40 63 45 517**	**1**	**5757,61**	**EC**	670	540
630/500	**40 63 50 517**	**1**	**7398,59**	**EC**	720	540
630/630	**40 63 63 517**	**1**	**13153,14**	**EC**	850	540
710/180	**40 71 18 517**	**1**	**3406,13**	**EC**	395	620
710/200	**40 71 20 517**	**1**	**3522,26**	**EC**	415	620
710/225	**40 71 22 517**	**1**	**3635,12**	**EC**	440	620
710/250	**40 71 25 517**	**1**	**3850,22**	**EC**	465	620
710/280	**40 71 28 517**	**1**	**4033,10**	**EC**	500	620
710/315	**40 71 31 517**	**1**	**4517,05**	**EC**	535	620
710/355	**40 71 35 517**	**1**	**4840,75**	**EC**	575	620
710/400	**40 71 40 517**	**1**	**5293,59**	**EC**	620	620
710/450	**40 71 45 517**	**1**	**6142,17**	**EC**	670	620
710/500	**40 71 50 517**	**1**	**7195,07**	**EC**	720	620
710/560	**40 71 56 517**	**1**	**8369,50**	**EC**	780	620
710/710	**40 71 71 517**	**1**	**15261,18**	**EC**	950	650

Pressure rating guaranteed, branch extended with pipe.
Fabrication on order, returning not possible.

PE100 pressure fittings

Tee 90° reduced machined short SDR11 - pressure class conform
with reduced branch
for butt-welding

PE100
SDR 11
water 16 bar/gas 10 bar



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
280/63	40 28 06 511	1	676,37	EC	270	365
280/75	40 28 07 511	1	693,24	EC	280	365
280/90	40 28 09 511	1	721,29	EC	295	365
280/110	40 28 11 511	1	756,83	EC	315	365
280/125	40 28 12 511	1	796,35	EC	330	365
280/140	40 28 14 511	1	833,55	EC	345	365
280/160	40 28 16 511	1	960,14	EC	365	365
280/180	40 28 18 511	1	1048,24	EC	385	365
280/200	40 28 20 511	1	1135,31	EC	405	365
280/225	40 28 22 511	1	1402,12	EC	430	365
315/75	40 31 07 511	1	739,97	EC	280	380
315/90	40 31 09 511	1	763,44	EC	295	380
315/110	40 31 11 511	1	974,27	EC	315	380
315/125	40 31 12 511	1	1019,17	EC	330	380
315/140	40 31 14 511	1	1066,01	EC	345	380
315/160	40 31 16 511	1	1129,61	EC	365	380
315/180	40 31 18 511	1	1196,16	EC	385	380
315/200	40 31 20 511	1	1255,10	EC	405	380
315/225	40 31 22 511	1	1639,06	EC	430	380
315/250	40 31 25 511	1	1770,02	EC	455	380
355/90	40 35 09 511	1	895,52	EC	305	400
355/110	40 35 11 511	1	980,56	EC	325	400
355/125	40 35 12 511	1	1019,07	EC	340	400
355/140	40 35 14 511	1	1080,33	EC	355	400
355/160	40 35 16 511	1	1327,24	EC	375	400
355/180	40 35 18 511	1	1403,04	EC	395	400
355/200	40 35 20 511	1	1487,36	EC	415	400
355/225	40 35 22 511	1	1585,71	EC	440	400
355/250	40 35 25 511	1	1708,35	EC	465	400
355/280	40 35 28 511	1	2170,13	EC	500	400
400/110	40 40 11 511	1	1176,46	EC	325	425
400/125	40 40 12 511	1	1229,80	EC	340	425
400/140	40 40 14 511	1	1281,50	EC	355	425
400/160	40 40 16 511	1	1330,08	EC	375	425
400/180	40 40 18 511	1	1651,35	EC	395	425
400/200	40 40 20 511	1	1742,18	EC	415	425
400/225	40 40 22 511	1	1839,41	EC	440	425
400/250	40 40 25 511	1	1980,85	EC	465	425
400/280	40 40 28 511	1	2454,00	EC	500	425
400/315	40 40 31 511	1	2690,93	EC	535	425
450/125	40 45 12 511	1	1268,20	EC	340	450
450/140	40 45 14 511	1	1321,85	EC	355	450
450/160	40 45 16 511	1	1394,69	EC	375	450
450/180	40 45 18 511	1	1670,95	EC	395	450
450/200	40 45 20 511	1	1759,04	EC	415	450
450/225	40 45 22 511	1	1843,16	EC	440	450
450/250	40 45 25 511	1	2236,68	EC	465	450
450/280	40 45 28 511	1	2408,07	EC	500	450
450/315	40 45 31 511	1	2638,41	EC	535	450
450/355	40 45 35 511	1	3492,38	EC	575	450
500/140	40 50 14 511	1	1593,93	EC	355	475
500/160	40 50 16 511	1	1657,85	EC	375	475
500/180	40 50 18 511	1	1747,66	EC	395	475
500/200	40 50 20 511	1	1839,41	EC	415	475
500/225	40 50 22 511	1	2655,29	EC	440	475
500/250	40 50 25 511	1	2850,88	EC	465	475

-- to be continued --

Tee 90° reduced machined short SDR11 - pressure class conform - continuation -

d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
500/280	**40 50 28 511**	**1**	**2876,37**	**EC**	500	475
500/315	**40 50 31 511**	**1**	**3320,78**	**EC**	535	475
500/355	**40 50 35 511**	**1**	**3616,63**	**EC**	575	475
500/400	**40 50 40 511**	**1**	**4122,43**	**EC**	620	475
560/160	**40 56 16 511**	**1**	**2118,51**	**EC**	375	500
560/180	**40 56 18 511**	**1**	**2238,40**	**EC**	395	500
560/200	**40 56 20 511**	**1**	**2326,19**	**EC**	415	500
560/225	**40 56 22 511**	**1**	**2522,18**	**EC**	440	500
560/250	**40 56 25 511**	**1**	**2602,64**	**EC**	465	500
560/280	**40 56 28 511**	**1**	**2833,91**	**EC**	500	500
560/315	**40 56 31 511**	**1**	**3237,26**	**EC**	535	500
560/355	**40 56 35 511**	**1**	**3969,81**	**EC**	575	500
560/400	**40 56 40 511**	**1**	**4488,70**	**EC**	620	500
560/450	**40 56 45 511**	**1**	**5724,59**	**EC**	670	500
560/560	**40 56 56 511**	**1**	**8833,41**	**EC**	780	500
630/180	**40 63 18 511**	**1**	**2405,03**	**EC**	395	540
630/200	**40 63 20 511**	**1**	**2501,55**	**EC**	415	540
630/225	**40 63 22 511**	**1**	**2656,91**	**EC**	440	540
630/250	**40 63 25 511**	**1**	**2867,52**	**EC**	465	540
630/280	**40 63 28 511**	**1**	**3080,08**	**EC**	500	540
630/315	**40 63 31 511**	**1**	**4059,83**	**EC**	535	540
630/355	**40 63 35 511**	**1**	**4397,76**	**EC**	575	540
630/400	**40 63 40 511**	**1**	**4977,50**	**EC**	620	540
630/450	**40 63 45 511**	**1**	**5983,27**	**EC**	670	540
630/500	**40 63 50 511**	**1**	**7688,47**	**EC**	720	540
630/630	**40 63 63 511**	**1**	**13668,48**	**EC**	850	540
710/180	**40 71 18 511**	**1**	**3539,52**	**EC**	395	620
710/200	**40 71 20 511**	**1**	**3660,23**	**EC**	415	620
710/225	**40 71 22 511**	**1**	**3777,59**	**EC**	440	620
710/250	**40 71 25 511**	**1**	**4001,11**	**EC**	465	620
710/280	**40 71 28 511**	**1**	**4191,11**	**EC**	500	620
710/315	**40 71 31 511**	**1**	**4694,04**	**EC**	535	620
710/355	**40 71 35 511**	**1**	**5030,43**	**EC**	575	620
710/400	**40 71 40 511**	**1**	**5500,96**	**EC**	620	620
710/450	**40 71 45 511**	**1**	**5366,74**	**EC**	670	620
710/500	**40 71 50 511**	**1**	**7476,91**	**EC**	720	620
710/560	**40 71 56 511**	**1**	**8697,37**	**EC**	780	620
710/710	**40 71 71 511**	**1**	**15859,12**	**EC**	950	650

Pressure rating guaranteed, branch extended with pipe.
Fabrication on order, returning not possible.

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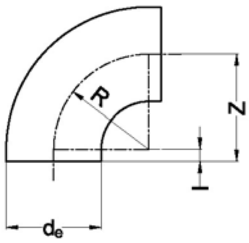
PE100 pressure fittings

Bend 90° short SDR 33 | PE100
SDR 33

for butt-welding | water 3,2 bar

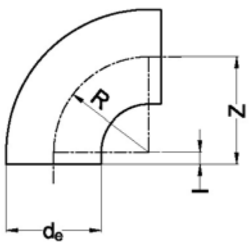


d_e	Art. Nr.	q	€	AG	Z	l	R
110	11 11 91 533	1	20,88	EB	120	10	110
125	11 12 91 533	1	23,51	EB	140	15	125
140	11 14 91 533	1	30,39	EB	150	10	140
160	11 16 91 533	1	39,70	EB	180	25	155
180	11 18 91 533	1	48,38	EB	200	25	175
200	11 20 91 533	1	60,02	EB	220	23	197
225	11 22 91 533	1	73,88	EB	250	20	230
250	11 25 91 533	1	90,75	EB	290	25	265
280	11 28 91 533	1	112,27	EB	290	10	280
315	11 31 91 533	1	159,31	EB	340	40	300
355	11 35 91 533	1	425,76	EB	340	40	300
400	11 40 91 533	1	595,47	EB	345	45	300
450	11 45 91 533	1	802,21	EB	450	50	400
500	11 50 91 533	1	1118,11	EB	450	50	400

R ≈ 1 x d_e

Bend 90° short SDR 17 | PE100
SDR 17

for butt-welding | water 10 bar/gas 5 bar



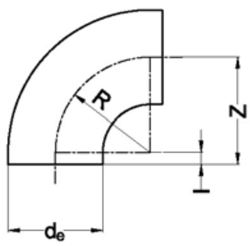
d_e	Art. Nr.	q	€	AG	Z	l	R
40	11 04 91 517	50	3,79	EA	51	7	44
50	11 05 91 517	30	4,75	EA	62	7	55
63	11 06 91 517	15	6,59	EA	77	8	69
75	11 07 91 517	10	9,65	EA	85	10	75
90	11 09 91 517	10	12,59	EA	100	10	90
110	11 11 91 517	10	26,52	EA	120	10	110
125	11 12 91 517	5	33,72	EA	140	15	125
140	11 14 91 517	5	48,97	EA	155	15	140
160	11 16 91 517	5	54,01	EA	175	15	160
180	11 18 91 517	2	66,77	EA	195	15	180
200	11 20 91 517	1	82,69	EA	215	15	200
225	11 22 91 517	1	101,92	EA	245	20	225
250	11 25 91 517	1	172,12	EA	275	25	250
280	11 28 91 517	1	223,69	EA	310	30	280
315	11 31 91 517	1	309,03	EA	350	35	315
355	11 35 91 517	1	563,15	EB	340	40	300
400	11 40 91 517	1	784,19	EB	350	50	300
450	11 45 91 517	1	1025,14	EB	450	50	400
500	11 50 91 517	1	1293,62	EB	450	50	400

R ≈ 1 x d_e

Bend 90° short SDR 11

for butt-welding

PE100
SDR 11
water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG	Z	l	R
20	11 01 91 511	100	2,84	EA	27	3	24
25	11 02 91 511	80	2,97	EA	32	5	27
32	11 03 91 511	50	3,06	EA	40	5	35
40	11 04 91 511	50	3,98	EA	51	7	44
50	11 05 91 511	30	5,00	EA	62	7	55
63	11 06 91 511	15	7,14	EA	77	8	69
75	11 07 91 511	10	9,86	EA	85	10	75
90	11 09 91 511	10	14,30	EA	100	10	90
110	11 11 91 511	10	27,22	EA	120	10	110
125	11 12 91 511	5	38,36	EA	140	15	125
140	11 14 91 511	5	51,28	EA	155	15	140
160	11 16 91 511	5	62,48	EA	175	15	160
180	11 18 91 511	2	73,97	EA	195	15	180
200	11 20 91 511	1	110,25	EA	215	15	200
225	11 22 91 511	1	131,50	EA	245	20	225
250	11 25 91 511	1	253,13	EA	275	25	250
280	11 28 91 511	1	329,13	EA	310	30	280
315	11 31 91 511	1	454,37	EA	350	35	315
355	11 35 91 511	1	764,32	EB	340	40	300
400	11 40 91 511	1	1049,61	EB	350	50	300
450	11 45 91 511	1	1377,27	EB	450	50	400
500	11 50 91 511	1	1776,68	EB	450	50	400

$R \approx 1 \times d_e$

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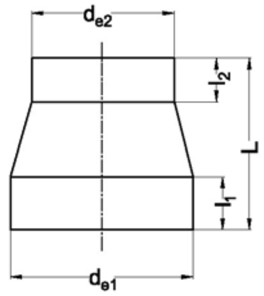
PE100 pressure fittings

Reducer concentric DIN short SDR 33

PE100
SDR 33

for butt-welding

water 3,2 bar



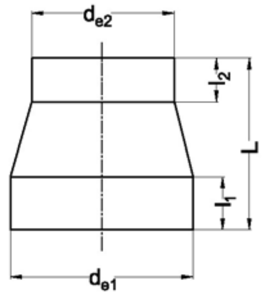
d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	l_1	l_2
200/140	17 20 14 533	1	66,85	EC	154	50	35
200/160	17 20 16 533	1	59,13	EC	151	50	40
200/180	17 20 18 533	1	52,95	EC	151	50	45
225/140	17 22 14 533	1	79,86	EC	160	60	50
225/160	17 22 16 533	1	68,53	EC	171	55	40
225/180	17 22 18 533	1	65,25	EC	171	55	45
225/200	17 22 20 533	1	57,49	EC	171	55	50
250/160	17 25 16 533	1	91,52	EC	194	60	40
250/180	17 25 18 533	1	84,70	EC	182	60	45
250/200	17 25 20 533	1	77,94	EC	182	60	50
250/225	17 25 22 533	1	73,84	EC	182	60	55
280/200	17 28 20 533	1	101,96	EC	200	80	65
280/225	17 28 22 533	1	95,04	EC	200	80	75
280/250	17 28 25 533	1	91,52	EC	200	80	85
315/200	17 31 20 533	1	130,10	EC	230	95	85
315/225	17 31 22 533	1	115,10	EC	230	95	88
315/250	17 31 25 533	1	104,83	EC	230	95	95
315/280	17 31 28 533	1	98,22	EC	230	95	107

Reducer concentric DIN short SDR 17

PE100
SDR 17

for butt-welding

water 10 bar/gas 5 bar



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	l_1	l_2
50/32	17 05 03 517	25	5,02	EV	55	12	12
50/40	17 05 04 517	25	5,02	EV	55	12	12
63/32	17 06 03 517	15	6,03	EV	65	16	12
63/40	17 06 04 517	15	6,03	EV	65	16	12
63/50	17 06 05 517	15	6,03	EV	65	16	12
75/32	17 07 03 517	5	7,79	EV	80	19	12
75/40	17 07 04 517	5	7,79	EV	71	19	12
75/50	17 07 05 517	5	7,79	EV	71	19	12
75/63	17 07 06 517	5	7,79	EV	71	19	16
90/50	17 09 05 517	5	8,69	EV	80	22	12
90/63	17 09 06 517	5	8,69	EV	80	22	16
90/75	17 09 07 517	5	8,69	EV	80	22	19
110/50	17 11 05 517	5	11,06	EV	105	28	12
110/63	17 11 06 517	5	11,06	EV	97	28	16
110/75	17 11 07 517	5	11,06	EV	97	28	19
110/90	17 11 09 517	5	11,06	EV	97	28	22
125/63	17 12 06 517	5	14,20	EV	112	30	16
125/75	17 12 07 517	5	14,20	EV	108	32	19
125/90	17 12 09 517	5	14,20	EV	108	32	22
125/110	17 12 11 517	5	14,20	EV	108	32	28
140/75	17 14 07 517	4	17,19	EV	123	35	19
140/90	17 14 09 517	4	17,19	EV	115	35	22
140/110	17 14 11 517	4	17,19	EV	115	35	28
140/125	17 14 12 517	4	17,19	EV	115	35	32
160/90	17 16 09 517	4	20,09	EV	135	40	22
160/110	17 16 11 517	4	20,09	EV	124	40	28
160/125	17 16 12 517	4	20,09	EV	124	40	32

-- to be continued --

Reducer concentric DIN short SDR 17 - continuation -

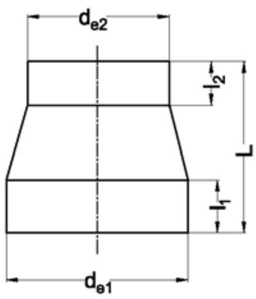
d_{e1}/d_{e2}	Art. Nr.	q	€	AG		L	l_1	l_2
160/140	**17 16 14 517**	**4**	**20,09**	**EV**		124	40	35
180/90	**17 18 09 517**	**2**	**31,54**	**EV**		157	45	22
180/110	**17 18 11 517**	**2**	**29,70**	**EV**		157	45	28
180/125	**17 18 12 517**	**2**	**27,42**	**EV**		136	45	32
180/140	**17 18 14 517**	**2**	**26,00**	**EV**		136	45	35
180/160	**17 18 16 517**	**2**	**24,80**	**EV**		136	45	40
200/140	**17 20 14 517**	**2**	**71,13**	**EV**		154	50	35
200/160	**17 20 16 517**	**2**	**62,90**	**EV**		151	50	40
200/180	**17 20 18 517**	**2**	**56,26**	**EV**		151	50	45
225/140	**17 22 14 517**	**2**	**84,90**	**EV**		160	60	50
225/160	**17 22 16 517**	**2**	**72,89**	**EV**		171	55	40
225/180	**17 22 18 517**	**2**	**69,41**	**EV**		171	55	45
225/200	**17 22 20 517**	**2**	**61,13**	**EV**		171	55	50
250/160	**17 25 16 517**	**1**	**97,36**	**EV**		194	60	40
250/180	**17 25 18 517**	**1**	**90,05**	**EV**		182	60	45
250/200	**17 25 20 517**	**1**	**82,86**	**EV**		182	60	50
250/225	**17 25 22 517**	**1**	**78,57**	**EV**		182	60	55
280/200	**17 28 20 517**	**1**	**108,37**	**EV**	*	200	85	70
280/225	**17 28 22 517**	**1**	**101,05**	**EV**	*	200	85	72
280/250	**17 28 25 517**	**1**	**98,39**	**EV**	*	200	85	80
315/200	**17 31 20 517**	**1**	**138,31**	**EV**	*	230	95	85
315/225	**17 31 22 517**	**1**	**122,36**	**EV**	*	230	95	88
315/250	**17 31 25 517**	**1**	**111,51**	**EV**	*	230	95	95
315/280	**17 31 28 517**	**1**	**104,42**	**EV**	*	230	95	107

* *machined version*

Reducer concentric DIN short SDR 11

for butt-welding

PE100
SDR 11
water 16 bar/gas 10 bar



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	l_1	l_2
25/20	**17 02 01 511**	**30**	**3,78**	**EV**	37	12	12
32/20	**17 03 01 511**	**30**	**4,39**	**EV**	43	12	12
32/25	**17 03 02 511**	**30**	**4,39**	**EV**	43	12	12
40/20	**17 04 01 511**	**25**	**5,02**	**EV**	50	12	12
40/25	**17 04 02 511**	**25**	**5,02**	**EV**	50	12	12
40/32	**17 04 03 511**	**25**	**5,02**	**EV**	50	12	12
50/25	**17 05 02 511**	**25**	**5,25**	**EV**	55	12	12
50/32	**17 05 03 511**	**25**	**5,25**	**EV**	55	12	12
50/40	**17 05 04 511**	**25**	**5,25**	**EV**	55	12	12
63/32	**17 06 03 511**	**15**	**6,37**	**EV**	65	16	12
63/40	**17 06 04 511**	**15**	**6,37**	**EV**	65	16	12
63/50	**17 06 05 511**	**15**	**6,37**	**EV**	65	16	12
75/32	**17 07 03 511**	**5**	**8,17**	**EV**	80	19	12
75/40	**17 07 04 511**	**5**	**8,17**	**EV**	71	19	12
75/50	**17 07 05 511**	**5**	**8,17**	**EV**	71	19	12
75/63	**17 07 06 511**	**5**	**8,17**	**EV**	71	19	16
90/50	**17 09 05 511**	**5**	**9,06**	**EV**	80	22	12
90/63	**17 09 06 511**	**5**	**9,06**	**EV**	80	22	16
90/75	**17 09 07 511**	**5**	**9,06**	**EV**	80	22	19
110/50	**17 11 05 511**	**5**	**11,57**	**EV**	105	28	12
110/63	**17 11 06 511**	**5**	**11,57**	**EV**	97	28	16
110/75	**17 11 07 511**	**5**	**11,57**	**EV**	97	28	19
110/90	**17 11 09 511**	**5**	**11,57**	**EV**	97	28	22
125/63	**17 12 06 511**	**5**	**14,88**	**EV**	112	30	16
125/75	**17 12 07 511**	**5**	**14,88**	**EV**	108	32	19
125/90	**17 12 09 511**	**5**	**14,88**	**EV**	108	32	22
125/110	**17 12 11 511**	**5**	**14,88**	**EV**	108	32	28

-- to be continued --

PE100 pressure fittings

Reducer concentric DIN short SDR 11 - continuation -

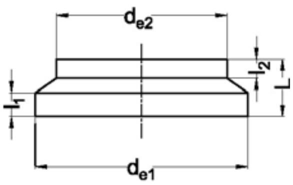
d_{e1}/d_{e2}	Art. Nr.	q	€	AG		L	l_1	l_2
140/75	**17 14 07 511**	**4**	**18,01**	**EV**		123	35	19
140/90	**17 14 09 511**	**4**	**18,01**	**EV**		115	35	22
140/110	**17 14 11 511**	**4**	**18,01**	**EV**		115	35	28
140/125	**17 14 12 511**	**4**	**18,01**	**EV**		115	35	32
160/90	**17 16 09 511**	**4**	**21,13**	**EV**		135	40	22
160/110	**17 16 11 511**	**4**	**21,13**	**EV**		124	40	28
160/125	**17 16 12 511**	**4**	**21,13**	**EV**		124	40	32
160/140	**17 16 14 511**	**4**	**21,13**	**EV**		124	40	35
180/90	**17 18 09 511**	**2**	**33,15**	**EV**		157	45	22
180/110	**17 18 11 511**	**2**	**31,20**	**EV**		157	45	28
180/125	**17 18 12 511**	**2**	**28,77**	**EV**		136	45	32
180/140	**17 18 14 511**	**2**	**27,30**	**EV**		136	45	35
180/160	**17 18 16 511**	**2**	**26,07**	**EV**		136	45	40
200/140	**17 20 14 511**	**2**	**74,64**	**EV**		154	50	35
200/160	**17 20 16 511**	**2**	**66,03**	**EV**		151	50	40
200/180	**17 20 18 511**	**2**	**59,10**	**EV**		151	50	45
225/140	**17 22 14 511**	**2**	**89,18**	**EV**		160	60	50
225/160	**17 22 16 511**	**2**	**76,51**	**EV**		171	55	40
225/180	**17 22 18 511**	**2**	**72,84**	**EV**		171	55	45
225/200	**17 22 20 511**	**2**	**64,19**	**EV**		171	55	50
250/160	**17 25 16 511**	**1**	**102,19**	**EV**		194	60	40
250/180	**17 25 18 511**	**1**	**94,52**	**EV**		182	60	45
250/200	**17 25 20 511**	**1**	**87,00**	**EV**		182	60	50
250/225	**17 25 22 511**	**1**	**82,43**	**EV**		182	60	55
280/200	**17 28 20 511**	**1**	**113,84**	**EV**	*	200	85	70
280/225	**17 28 22 511**	**1**	**106,11**	**EV**	*	200	85	72
280/250	**17 28 25 511**	**1**	**102,19**	**EV**	*	200	85	80
315/200	**17 31 20 511**	**1**	**145,27**	**EV**	*	230	95	85
315/225	**17 31 22 511**	**1**	**128,50**	**EV**	*	230	95	88
315/250	**17 31 25 511**	**1**	**117,05**	**EV**	*	230	95	95
315/280	**17 31 28 511**	**1**	**109,67**	**EV**	*	230	95	107

* *machined version*

Reducer concentric short SDR 33

for butt-welding

PE100
SDR 33
water 3,2 bar



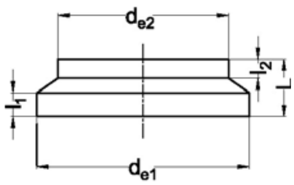
d_{e1}/d_{e2}	Art. Nr.	q	€	AG		L	l_1	l_2
355/200	**15 35 20 533**	**1**	**150,36**	**EC**		160	57	40
355/225	**15 35 22 533**	**1**	**144,56**	**EC**		140	57	40
355/250	**15 35 25 533**	**1**	**138,69**	**EC**		130	54	40
355/280	**15 35 28 533**	**1**	**128,66**	**EC**		120	53	40
355/315	**15 35 31 533**	**1**	**124,76**	**EC**		110	53	40
400/225	**15 40 22 533**	**1**	**533,24**	**EC**		160	64	40
400/250	**15 40 25 533**	**1**	**500,24**	**EC**		150	61	40
400/280	**15 40 28 533**	**1**	**443,68**	**EC**		140	60	40
400/315	**15 40 31 533**	**1**	**343,54**	**EC**		120	50	40
400/355	**15 40 35 533**	**1**	**250,38**	**EC**		110	51	40
450/280	**15 45 28 533**	**1**	**634,39**	**EC**		160	65	40
450/315	**15 45 31 533**	**1**	**563,04**	**EC**		140	55	40
450/355	**15 45 35 533**	**1**	**383,15**	**EC**		130	57	40
450/400	**15 45 40 533**	**1**	**316,28**	**EC**		120	60	40
500/280	**15 50 28 533**	**1**	**1110,21**	**EC**		180	80	40
500/315	**15 50 31 533**	**1**	**774,15**	**EC**		170	71	40
500/355	**15 50 35 533**	**1**	**676,65**	**EC**		150	62	40
500/400	**15 50 40 533**	**1**	**574,28**	**EC**		140	65	40
500/450	**15 50 45 533**	**1**	**511,44**	**EC**		120	60	40
560/355	**15 56 35 533**	**1**	**1263,99**	**EC**		170	75	40
560/400	**15 56 40 533**	**1**	**715,70**	**EC**		160	68	40
560/450	**15 56 45 533**	**1**	**518,49**	**EC**		140	62	40
560/500	**15 56 50 533**	**1**	**439,06**	**EC**		130	67	40
630/355	**15 63 35 533**	**1**	**1419,88**	**EC**		200	80	40
630/400	**15 63 40 533**	**1**	**1282,49**	**EC**		190	78	40
630/450	**15 63 45 533**	**1**	**1030,63**	**EC**		170	72	40
630/500	**15 63 50 533**	**1**	**617,39**	**EC**		150	67	40
630/560	**15 63 56 533**	**1**	**572,55**	**EC**		130	64	40
710/500	**15 71 50 533**	**1**	**1073,69**	**EC**	*	130	84	40
710/560	**15 71 56 533**	**1**	**959,77**	**EC**	*	170	81	40
710/630	**15 71 63 533**	**1**	**1708,84**	**EC**	*	140	71	40
800/560	**15 80 56 533**	**1**	**1708,84**	**EC**	*	200	85	40
800/630	**15 80 63 533**	**1**	**1211,99**	**EC**	*	180	85	40
800/710	**15 80 71 533**	**1**	**1093,12**	**EC**	*	150	78	40
900/630	**15 90 63 533**	**1**	**2522,28**	**EC**	*	220	96	40
900/710	**15 90 71 533**	**1**	**2185,09**	**EC**	*	190	89	40
900/800	**15 90 80 533**	**1**	**1737,79**	**EC**	*	160	85	40
1000/710	**15 91 71 533**	**1**	**3441,27**	**EC**	*	220	101	40
1000/800	**15 91 80 533**	**1**	**2891,09**	**EC**	*	180	86	40
1000/900	**15 91 90 533**	**1**	**2339,79**	**EC**	*	140	75	40
1200/1000	**15 92 91 533**	**1**	**3406,22**	**EC**	*	190	92	40

* *fabrication on order, returning not possible*

akatherm

PE100 pressure fittings

Reducer concentric short SDR 17 PE100
SDR 17
for butt-welding water 10 bar/gas 5 bar



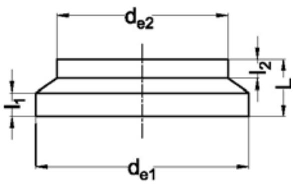
d_{e1}/d_{e2}	Art. Nr.	q	€	AG		L	l_1	l_2
355/200	**15 35 20 517**	**1**	**150,36**	**EC**		160	57	40
355/225	**15 35 22 517**	**1**	**144,56**	**EC**		140	57	40
355/250	**15 35 25 517**	**1**	**138,69**	**EC**		130	54	40
355/280	**15 35 28 517**	**1**	**128,66**	**EC**		120	53	40
355/315	**15 35 31 517**	**1**	**124,76**	**EC**		110	53	40
400/225	**15 40 22 517**	**1**	**533,24**	**EC**		160	64	40
400/250	**15 40 25 517**	**1**	**500,24**	**EC**		150	61	40
400/280	**15 40 28 517**	**1**	**443,68**	**EC**		140	60	40
400/315	**15 40 31 517**	**1**	**343,54**	**EC**		120	50	40
400/355	**15 40 35 517**	**1**	**250,38**	**EC**		110	51	40
450/280	**15 45 28 517**	**1**	**634,39**	**EC**		160	65	40
450/315	**15 45 31 517**	**1**	**563,04**	**EC**		140	55	40
450/355	**15 45 35 517**	**1**	**383,15**	**EC**		130	57	40
450/400	**15 45 40 517**	**1**	**316,28**	**EC**		120	60	40
500/280	**15 50 28 517**	**1**	**1110,21**	**EC**		180	80	40
500/315	**15 50 31 517**	**1**	**774,15**	**EC**		170	71	40
500/355	**15 50 35 517**	**1**	**676,65**	**EC**		150	62	40
500/400	**15 50 40 517**	**1**	**574,28**	**EC**		140	65	40
500/450	**15 50 45 517**	**1**	**511,44**	**EC**		120	60	40
560/355	**15 56 35 517**	**1**	**1445,55**	**EC**		170	75	40
560/400	**15 56 40 517**	**1**	**906,52**	**EC**		160	68	40
560/450	**15 56 45 517**	**1**	**565,28**	**EC**		140	62	40
560/500	**15 56 50 517**	**1**	**461,73**	**EC**		130	67	40
630/355	**15 63 35 517**	**1**	**1561,82**	**EC**		200	80	40
630/400	**15 63 40 517**	**1**	**1465,70**	**EC**		190	78	40
630/450	**15 63 45 517**	**1**	**1216,66**	**EC**		170	72	40
630/500	**15 63 50 517**	**1**	**801,58**	**EC**		150	67	40
630/560	**15 63 56 517**	**1**	**620,25**	**EC**		130	64	40
710/500	**15 71 50 517**	**1**	**2013,26**	**EC**	*	130	84	40
710/560	**15 71 56 517**	**1**	**1109,13**	**EC**	*	170	81	40
710/630	**15 71 63 517**	**1**	**1011,20**	**EC**	*	140	71	40
800/560	**15 80 56 517**	**1**	**1708,84**	**EC**	*	200	85	40
800/630	**15 80 63 517**	**1**	**1211,99**	**EC**	*	180	85	40
800/710	**15 80 71 517**	**1**	**1093,12**	**EC**	*	150	78	40
900/630	**15 90 63 517**	**1**	**2661,73**	**EC**	*	220	96	40
900/710	**15 90 71 517**	**1**	**2359,59**	**EC**	*	190	89	40
900/800	**15 90 80 517**	**1**	**1917,99**	**EC**	*	160	85	40
1000/710	**15 91 71 517**	**1**	**3651,60**	**EC**	*	220	101	40
1000/800	**15 91 80 517**	**1**	**3071,32**	**EC**	*	180	86	40
1000/900	**15 91 90 517**	**1**	**2507,81**	**EC**	*	140	75	40

* *fabrication on order, returning not possible*

Reducer concentric short SDR 11

for butt-welding

PE100
SDR 11
water 16 bar/gas 10 bar



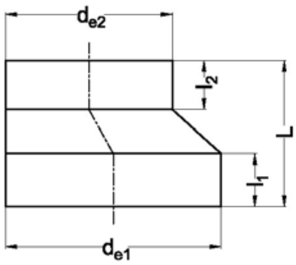
d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	l_1	l_2
355/200	**15 35 20 511**	**1**	**157,84**	**EC**	160	57	40
355/225	**15 35 22 511**	**1**	**151,77**	**EC**	140	57	40
355/250	**15 35 25 511**	**1**	**145,59**	**EC**	130	54	40
355/280	**15 35 28 511**	**1**	**135,10**	**EC**	120	53	40
355/315	**15 35 31 511**	**1**	**130,99**	**EC**	110	53	40
400/225	**15 40 22 511**	**1**	**612,35**	**EC**	160	64	40
400/250	**15 40 25 511**	**1**	**516,84**	**EC**	150	61	40
400/280	**15 40 28 511**	**1**	**443,68**	**EC**	140	60	40
400/315	**15 40 31 511**	**1**	**343,54**	**EC**	120	50	40
400/355	**15 40 35 511**	**1**	**250,38**	**EC**	110	51	40
450/280	**15 45 28 511**	**1**	**634,39**	**EC**	160	65	40
450/315	**15 45 31 511**	**1**	**563,04**	**EC**	140	55	40
450/355	**15 45 35 511**	**1**	**405,92**	**EC**	130	57	40
450/400	**15 45 40 511**	**1**	**316,28**	**EC**	120	60	40
500/280	**15 50 28 511**	**1**	**1110,21**	**EC**	180	80	40
500/315	**15 50 31 511**	**1**	**774,15**	**EC**	170	71	40
500/355	**15 50 35 511**	**1**	**740,80**	**EC**	150	62	40
500/400	**15 50 40 511**	**1**	**618,73**	**EC**	140	65	40
500/450	**15 50 45 511**	**1**	**560,50**	**EC**	120	60	40
560/355	**15 56 35 511**	**1**	**1283,47**	**EC**	170	75	40
560/400	**15 56 40 511**	**1**	**968,53**	**EC**	160	68	40
560/450	**15 56 45 511**	**1**	**589,98**	**EC**	140	62	40
560/500	**15 56 50 511**	**1**	**503,87**	**EC**	130	67	40
630/355	**15 63 35 511**	**1**	**1786,33**	**EC**	200	80	40
630/400	**15 63 40 511**	**1**	**1648,90**	**EC**	190	78	40
630/450	**15 63 45 511**	**1**	**1309,20**	**EC**	170	72	40
630/500	**15 63 50 511**	**1**	**892,24**	**EC**	150	67	40
630/560	**15 63 56 511**	**1**	**706,17**	**EC**	130	64	40

PE100 pressure fittings

Reducer eccentric short SDR 33

for butt-welding

PE100
SDR 33
water 3,2 bar



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	l_1	l_2
160/90	**31 16 09 533**	**1**	**139,67**	**EC**	140	54	40
160/110	**31 16 11 533**	**1**	**121,33**	**EC**	120	45	40
160/125	**31 16 12 533**	**1**	**110,43**	**EC**	110	44	40
160/140	**31 16 14 533**	**1**	**98,25**	**EC**	90	33	40
180/110	**31 18 11 533**	**1**	**165,83**	**EC**	140	54	40
180/125	**31 18 12 533**	**1**	**147,13**	**EC**	130	52	40
180/140	**31 18 14 533**	**1**	**134,04**	**EC**	110	41	40
180/160	**31 18 16 533**	**1**	**123,15**	**EC**	90	33	40
200/125	**31 20 12 533**	**1**	**178,72**	**EC**	150	61	40
200/140	**31 20 14 533**	**1**	**161,47**	**EC**	130	50	40
200/160	**31 20 16 533**	**1**	**142,39**	**EC**	110	41	40
200/180	**31 20 18 533**	**1**	**134,22**	**EC**	90	33	40
225/140	**31 22 14 533**	**1**	**224,30**	**EC**	160	65	40
225/160	**31 22 16 533**	**1**	**209,94**	**EC**	140	57	40
225/180	**31 22 18 533**	**1**	**183,25**	**EC**	120	48	40
225/200	**31 22 20 533**	**1**	**164,55**	**EC**	100	40	40
250/160	**31 25 16 533**	**1**	**266,27**	**EC**	160	62	40
250/180	**31 25 18 533**	**1**	**256,81**	**EC**	140	54	40
250/200	**31 25 20 533**	**1**	**234,64**	**EC**	120	45	40
250/225	**31 25 22 533**	**1**	**195,41**	**EC**	100	40	40
280/180	**31 28 18 533**	**1**	**299,13**	**EC**	170	66	40
280/200	**31 28 20 533**	**1**	**275,16**	**EC**	150	58	40
280/225	**31 28 22 533**	**1**	**247,72**	**EC**	130	52	40
280/250	**31 28 25 533**	**1**	**212,31**	**EC**	110	47	40
315/200	**31 31 20 533**	**1**	**331,26**	**EC**	190	78	40
315/225	**31 31 22 533**	**1**	**293,32**	**EC**	160	62	40
315/250	**31 31 25 533**	**1**	**256,61**	**EC**	140	57	40
315/280	**31 31 28 533**	**1**	**233,02**	**EC**	110	44	40

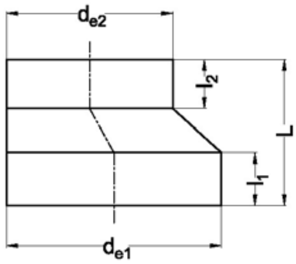
Larger diameters on request.

Reducer eccentric short SDR 17

PE100
SDR 17

for butt-welding

water 10 bar/gas 5 bar



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	l_1	l_2
160/90	**31 16 09 517**	**1**	**139,70**	**EC**	140	54	40
160/110	**31 16 11 517**	**1**	**121,33**	**EC**	120	45	40
160/125	**31 16 12 517**	**1**	**110,43**	**EC**	110	44	40
160/140	**31 16 14 517**	**1**	**98,25**	**EC**	90	33	40
180/110	**31 18 11 517**	**1**	**165,83**	**EC**	140	54	40
180/125	**31 18 12 517**	**1**	**147,13**	**EC**	130	52	40
180/140	**31 18 14 517**	**1**	**134,04**	**EC**	110	41	40
180/160	**31 18 16 517**	**1**	**123,15**	**EC**	90	33	40
200/125	**31 20 12 517**	**1**	**178,72**	**EC**	150	61	40
200/140	**31 20 14 517**	**1**	**161,47**	**EC**	130	50	40
200/160	**31 20 16 517**	**1**	**142,39**	**EC**	110	41	40
200/180	**31 20 18 517**	**1**	**134,22**	**EC**	100	43	40
225/140	**31 22 14 517**	**1**	**224,30**	**EC**	160	65	40
225/160	**31 22 16 517**	**1**	**209,94**	**EC**	140	57	40
225/180	**31 22 18 517**	**1**	**183,25**	**EC**	120	48	40
225/200	**31 22 20 517**	**1**	**164,55**	**EC**	100	40	40
250/160	**31 25 16 517**	**1**	**266,27**	**EC**	160	62	40
250/180	**31 25 18 517**	**1**	**256,08**	**EC**	140	54	40
250/200	**31 25 20 517**	**1**	**234,64**	**EC**	130	55	40
250/225	**31 25 22 517**	**1**	**195,41**	**EC**	100	40	40
280/180	**31 28 18 517**	**1**	**299,13**	**EC**	170	66	40
280/200	**31 28 20 517**	**1**	**275,16**	**EC**	150	58	40
280/225	**31 28 22 517**	**1**	**247,72**	**EC**	130	52	40
280/250	**31 28 25 517**	**1**	**212,31**	**EC**	110	47	40
315/200	**31 31 20 517**	**1**	**331,26**	**EC**	190	78	40
315/225	**31 31 22 517**	**1**	**293,32**	**EC**	160	62	40
315/250	**31 31 25 517**	**1**	**256,61**	**EC**	140	57	40
315/280	**31 31 28 517**	**1**	**233,02**	**EC**	120	54	40

Larger diameters on request.

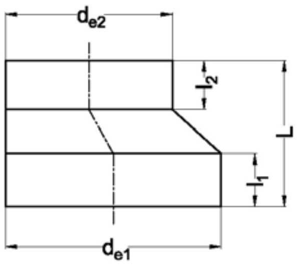
akatherm

PE100 pressure fittings

Reducer eccentric short SDR 11

for butt-welding

PE100
SDR 11
water 16 bar/gas 10 bar



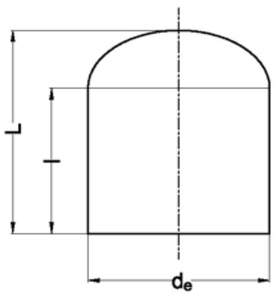
d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	l_1	l_2
160/90	**31 16 09 511**	**1**	**146,75**	**EC**	140	54	40
160/110	**31 16 11 511**	**1**	**131,67**	**EC**	120	45	40
160/125	**31 16 12 511**	**1**	**117,69**	**EC**	110	44	40
160/140	**31 16 14 511**	**1**	**103,70**	**EC**	100	43	40
180/110	**31 18 11 511**	**1**	**173,99**	**EC**	140	54	40
180/125	**31 18 12 511**	**1**	**154,57**	**EC**	130	52	40
180/140	**31 18 14 511**	**1**	**143,30**	**EC**	120	51	40
180/160	**31 18 16 511**	**1**	**131,86**	**EC**	100	43	40
200/125	**31 20 12 511**	**1**	**187,61**	**EC**	150	61	40
200/140	**31 20 14 511**	**1**	**170,54**	**EC**	130	50	40
200/160	**31 20 16 511**	**1**	**151,47**	**EC**	120	51	40
200/180	**31 20 18 511**	**1**	**143,30**	**EC**	100	43	40
225/140	**31 22 14 511**	**1**	**235,74**	**EC**	160	65	40
225/160	**31 22 16 511**	**1**	**218,12**	**EC**	140	57	40
225/180	**31 22 18 511**	**1**	**189,79**	**EC**	120	48	40
225/200	**31 22 20 511**	**1**	**172,73**	**EC**	110	50	40
250/160	**31 25 16 511**	**1**	**279,34**	**EC**	170	72	40
250/180	**31 25 18 511**	**1**	**269,34**	**EC**	150	64	40
250/200	**31 25 20 511**	**1**	**243,93**	**EC**	130	55	40
250/225	**31 25 22 511**	**1**	**210,14**	**EC**	110	50	40
280/180	**31 28 18 511**	**1**	**314,20**	**EC**	180	76	40
280/200	**31 28 20 511**	**1**	**280,41**	**EC**	160	68	40
280/225	**31 28 22 511**	**1**	**255,36**	**EC**	140	62	40
280/250	**31 28 25 511**	**1**	**226,49**	**EC**	120	57	40
315/200	**31 31 20 511**	**1**	**347,80**	**EC**	190	78	40
315/225	**31 31 22 511**	**1**	**307,47**	**EC**	170	72	40
315/250	**31 31 25 511**	**1**	**266,62**	**EC**	150	67	40
315/280	**31 31 28 511**	**1**	**241,36**	**EC**	130	64	40

Larger diameters on request.

End cap long/short SDR 17

for butt-welding

PE100
SDR 17
water 10 bar/gas 5 bar



d_e	Art. Nr.	q	€	AG		L	l
63	67 06 08 517	1	10,92	EF	*	85	62
75	67 07 08 517	1	16,92	EF	*	95	63
90	67 09 08 517	1	25,69	EF	*	110	79
110	67 11 08 517	1	34,84	EF	*	127	88
125	67 12 08 517	1	37,64	EF	*	124	95
140	67 14 08 517	1	47,08	EF	*	140	110
160	67 16 08 517	1	52,75	EF	*	152	121
180	67 18 08 517	1	68,59	EF	*	169	134
200	67 20 08 517	1	85,44	EF	*	184	140
225	67 22 08 517	1	101,99	EF	*	200	160
250	67 25 08 517	1	137,49	EG	*	230	152
280	67 28 08 517	1	195,28	EG	*	257	162
315	67 31 08 517	1	261,15	EG	*	262	167
355	67 35 08 517	1	405,26	EG	*	270	250
400	67 40 08 517	1	711,34	EG	*	275	250
450	67 45 09 517	1	471,32	EC	**	85	-
500	67 50 09 517	1	656,90	EC	**	90	-
560	67 56 09 517	1	1523,75	EC	**	100	-
630	67 63 09 517	1	1739,45	EC	**	110	-
710	67 71 09 517	1	3809,12	EC	**	110	-
800	67 80 09 517	1	4172,26	EC	**	120	-

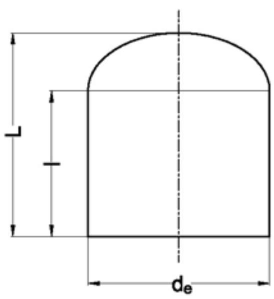
* *long version*

** *short version, machined*
fabrication on order, returning not possible

End cap long/short SDR 11

for butt-welding

PE100
SDR 11
water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG		L	l
20	67 01 08 511	1	3,69	EF	*	45	35
25	67 02 08 511	1	4,05	EF	*	52	40
32	67 03 08 511	1	5,11	EF	*	58	44
40	67 04 08 511	1	6,33	EF	*	67	50
50	67 05 08 511	1	8,28	EF	*	75	55
63	67 06 08 511	1	10,92	EF	*	85	62
75	67 07 08 511	1	16,92	EF	*	95	63
90	67 09 08 511	1	25,69	EF	*	110	79
110	67 11 08 511	1	34,84	EF	*	127	88
125	67 12 08 511	1	37,64	EF	*	124	95
140	67 14 08 511	1	47,08	EF	*	140	110
160	67 16 08 511	1	52,75	EF	*	152	121
180	67 18 08 511	1	68,59	EF	*	169	134
200	67 20 08 511	1	85,44	EF	*	184	140
225	67 22 08 511	1	101,99	EF	*	200	160
250	67 25 08 511	1	152,84	EG	*	230	152
280	67 28 08 511	1	217,09	EG	*	257	162
315	67 31 08 511	1	291,87	EG	*	262	167
355	67 35 08 511	1	405,26	EG	*	280	250
400	67 40 08 511	1	711,34	EG	*	285	250

-- to be continued --

PE100 pressure fittings

End cap long/short SDR 11 - continuation -

d_e	Art. Nr.	q	€	AG		L	l
450	**67 45 09 511**	**1**	**573,88**	**EC**	**	95	-
500	**67 50 09 511**	**1**	**712,70**	**EC**	**	105	-
560	**67 56 09 511**	**1**	**1599,32**	**EC**	**	115	-
630	**67 63 09 511**	**1**	**1837,35**	**EC**	**	125	-

* *long version*

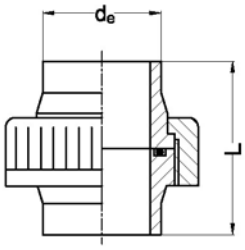
** *short version, machined*
fabrication on order, returning not possible

Union complete short SDR 11 with EPDM O-ring

PE100
SDR 11
water 6 bar

for butt-welding

d_e	Art. Nr.	q	€	AG	L
20	43 01 06 511	10	13,31	ED	110
25	43 02 06 511	10	16,52	ED	110
32	43 03 06 511	10	17,12	ED	110
40	43 04 06 511	10	24,24	ED	110
50	43 05 06 511	10	30,19	ED	110
63	43 06 06 511	5	39,71	ED	110
75	43 07 06 511	1	65,91	ED	110
90	43 09 06 511	1	82,73	ED	180
110	43 11 06 511	1	101,64	ED	180



Unions complete consist of:
- PE union end and union bush
- PVC nut
- EPDM O-ring

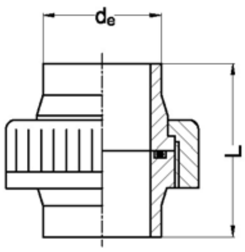
Depending on temperature change the maximum operating pressure can be reduced strongly.

Union complete short SDR 11 with FPM O-ring

PE100
SDR 11
water 6 bar

for butt-welding

d_e	Art. Nr.	q	€	AG	L
20	43 01 07 511	10	14,97	ED	110
25	43 02 07 511	10	18,67	ED	110
32	43 03 07 511	10	18,91	ED	110
40	43 04 07 511	10	28,65	ED	110
50	43 05 07 511	10	34,94	ED	110
63	43 06 07 511	5	45,17	ED	110
75	43 07 07 511	1	85,71	ED	110
90	43 09 07 511	1	107,51	ED	180
110	43 11 07 511	1	132,15	ED	180



Unions complete consist of:
- PE union end and union bush
- PVC nut
- FPM O-ring

Depending on temperature change the maximum operating pressure can be reduced strongly.
Collectioning on order.

akatherm

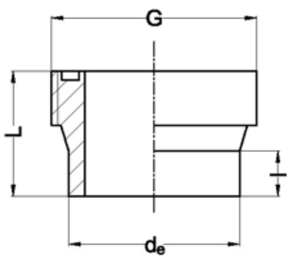
PE100 pressure fittings

Union bush short SDR 11

PE100
SDR 11

for butt-welding

d_e	Art. Nr.	q	€	AG	L	l	G
20	**83 01 01 511**	**30**	**5,68**	**ED**	55	13	1"
25	**83 02 01 511**	**30**	**5,17**	**ED**	55	13	1¼"
32	**83 03 01 511**	**30**	**5,17**	**ED**	55	14	1½"
40	**83 04 01 511**	**30**	**8,60**	**ED**	55	16	2"
50	**83 05 01 511**	**25**	**8,60**	**ED**	55	18	2¼"
63	**83 06 01 511**	**15**	**9,38**	**ED**	55	20	2¾"
75	**83 07 01 511**	**5**	**21,85**	**ED**	55	24	3½"
90	**83 09 01 511**	**5**	**28,55**	**ED**	90	25	4"
110	**83 11 01 511**	**5**	**34,86**	**ED**	90	28	5"



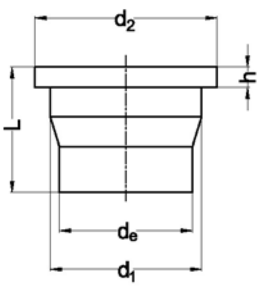
Thread according to EN-ISO 228.

Union end short SDR 11

PE100
SDR 11

for butt-welding

d_e	Art. Nr.	q	€	AG	L	h	d_1	d_2
20	**84 01 01 511**	**30**	**4,10**	**ED**	55	5	25,0	30,0
25	**84 02 01 511**	**30**	**5,17**	**ED**	55	6	33,5	38,5
32	**84 03 01 511**	**30**	**5,17**	**ED**	55	6	38,0	44,5
40	**84 04 01 511**	**30**	**8,45**	**ED**	55	7	49,5	56,2
50	**84 05 01 511**	**25**	**8,45**	**ED**	55	7	55,0	62,2
63	**84 06 01 511**	**15**	**9,38**	**ED**	55	8	70,0	78,3
75	**84 07 01 511**	**5**	**15,35**	**ED**	55	9	82,5	96,5
90	**84 09 01 511**	**5**	**20,98**	**ED**	90	10	97,5	109,5
110	**84 11 01 511**	**5**	**27,28**	**ED**	90	11	117,5	134,5

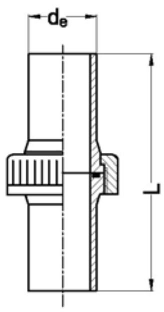


Union complete long SDR 11 with EPDM O-ring

for butt-welding and electrofusion

PE100
SDR 11
water 6 bar

d_e	Art. Nr.	q	€	AG	L
20	43 01 10 511	10	13,31	ED	190
25	43 02 10 511	10	16,52	ED	190
32	43 03 10 511	10	17,12	ED	190
40	43 04 10 511	10	24,24	ED	190
50	43 05 10 511	10	30,19	ED	190
63	43 06 10 511	5	39,71	ED	190
75	43 07 10 511	1	68,20	ED	260
90	43 09 10 511	1	85,63	ED	300
110	43 11 10 511	1	102,96	ED	340



Unions complete consist of:
- PE union end and union bush
- PVC nut
- EPDM O-ring

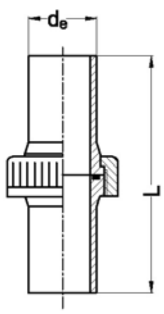
Depending on temperature change the maximum operating pressure can be reduced strongly.

Union complete long SDR 11 with FPM O-ring

for butt-welding and electrofusion

PE100
SDR 11
water 6 bar

d_e	Art. Nr.	q	€	AG	L
20	43 01 11 511	10	14,97	ED	190
25	43 02 11 511	10	18,67	ED	190
32	43 03 11 511	10	18,91	ED	190
40	43 04 11 511	10	28,65	ED	190
50	43 05 11 511	10	34,94	ED	190
63	43 06 11 511	5	45,17	ED	190
75	43 07 11 511	1	88,62	ED	260
90	43 09 11 511	1	111,32	ED	300
110	43 11 11 511	1	133,79	ED	340



Unions complete consist of:
- PE union end and union bush
- PVC nut
- FPM O-ring

Depending on temperature change the maximum operating pressure can be reduced strongly.

Collectioning on order.

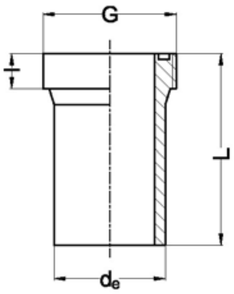
PE100 pressure fittings

Union bush long SDR 11

PE100
SDR 11

for butt-welding and electrofusion

d_e	Art. Nr.	q	€	AG	L	l	G
20	**83 01 05 511**	**30**	**6,54**	**ED**	95	13	1"
25	**83 02 05 511**	**30**	**5,92**	**ED**	95	13	1¼"
32	**83 03 05 511**	**30**	**5,92**	**ED**	95	14	1½"
40	**83 04 05 511**	**30**	**9,88**	**ED**	95	16	2"
50	**83 05 05 511**	**25**	**9,88**	**ED**	95	18	2¼"
63	**83 06 05 511**	**15**	**10,79**	**ED**	95	20	2¾"
75	**83 07 05 511**	**5**	**23,57**	**ED**	130	24	3½"
90	**83 09 05 511**	**5**	**30,17**	**ED**	150	25	4"
110	**83 11 05 511**	**5**	**34,48**	**ED**	170	28	5"



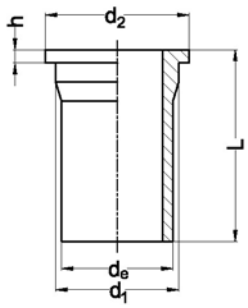
Thread according to EN-ISO 228.

Union end long SDR 11

PE100
SDR 11

for butt-welding and electrofusion

d_e	Art. Nr.	q	€	AG	L	h	d_1	d_2
20	**84 01 05 511**	**30**	**3,83**	**ED**	95	5	25,0	30,0
25	**84 02 05 511**	**30**	**4,48**	**ED**	95	6	33,5	38,5
32	**84 03 05 511**	**30**	**5,68**	**ED**	95	6	38,0	44,5
40	**84 04 05 511**	**30**	**7,27**	**ED**	95	7	49,5	56,2
50	**84 05 05 511**	**25**	**7,52**	**ED**	95	7	55,0	62,2
63	**84 06 05 511**	**15**	**10,95**	**ED**	95	8	70,0	78,3
75	**84 07 05 511**	**5**	**15,92**	**ED**	130	9	82,5	96,5
90	**84 09 05 511**	**5**	**22,23**	**ED**	150	10	97,5	109,5
110	**84 11 05 511**	**5**	**28,91**	**ED**	170	11	117,5	134,5

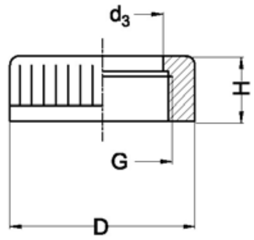


Union nut for PE union end

PVC

d_e	Art. Nr.	q	€	AG	D	G	d_3	H
20	**85 01 00 410**	**1**	**3,11**	**ED**	43	1"	27	24
25	**85 02 00 410**	**1**	**3,23**	**ED**	53	1¼"	36	27
32	**85 03 00 410**	**1**	**3,77**	**ED**	60	1½"	41	30
40	**85 04 00 410**	**1**	**5,22**	**ED**	74	2"	53	32
50	**85 05 00 410**	**1**	**7,85**	**ED**	80	2¼"	59	36
63	**85 06 00 410**	**1**	**12,68**	**ED**	103	2¾"	74	39
75	**85 07 00 410**	**1**	**25,95**	**ED**	122	3½"	83	43
90	**85 09 00 410**	**1**	**29,02**	**ED**	139	4"	98	49
110	**85 11 00 410**	**1**	**33,80**	**ED**	164	5"	118	55

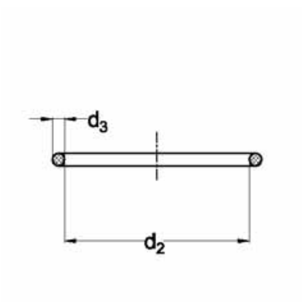
Thread according to EN-ISO 228.



O-ring for PE union bush

EPDM

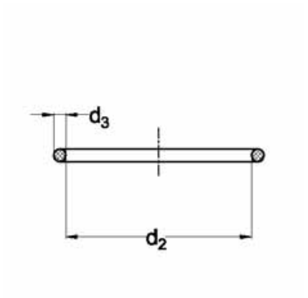
d_e	Art. Nr.	q	€	AG	d_2	d_3
20	**48 01 09 000**	**1**	**1,92**	**ED**	21,8	3,5
25	**48 02 09 000**	**1**	**1,92**	**ED**	28,2	3,5
32	**48 03 09 000**	**1**	**3,99**	**ED**	34,5	3,5
40	**48 04 09 000**	**1**	**3,99**	**ED**	43,8	5,3
50	**48 05 09 000**	**1**	**3,99**	**ED**	50,2	5,3
63	**48 06 09 000**	**1**	**4,12**	**ED**	66,1	5,3
75	**48 07 09 000**	**1**	**5,06**	**ED**	78,8	5,3
90	**48 09 09 000**	**1**	**8,64**	**ED**	94,6	5,3
110	**48 11 09 000**	**1**	**9,20**	**ED**	113,7	7,0



PE100 pressure fittings

O-ring for PE union bush FPM

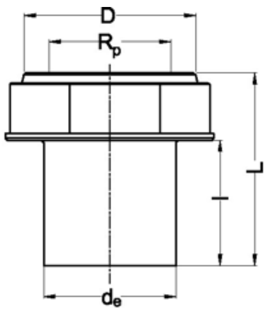
d_e	Art. Nr.	q	€	AG	d_2	d_3
20	**48 01 07 000**	**1**	**5,34**	**ED**	21,8	3,5
25	**48 02 07 000**	**1**	**6,30**	**ED**	28,2	3,5
32	**48 03 07 000**	**1**	**7,54**	**ED**	34,5	3,5
40	**48 04 07 000**	**1**	**12,20**	**ED**	43,8	5,3
50	**48 05 07 000**	**1**	**13,16**	**ED**	50,2	5,3
63	**48 06 07 000**	**1**	**14,94**	**ED**	66,1	5,3
75	**48 07 07 000**	**1**	**23,99**	**ED**	78,8	5,3
90	**48 09 07 000**	**1**	**28,52**	**ED**	94,6	5,3
110	**48 11 07 000**	**1**	**52,24**	**ED**	113,7	7,0



Adaptor long SDR 11 with female thread

PE100
SDR 11
water 10 bar

for butt-welding and electrofusion



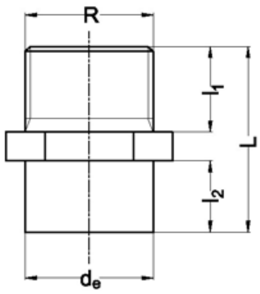
d_e/R_p	Art. Nr.	q	€	AG	L	l	D	SW
20/½"	**93 01 78 511**	**50**	**7,52**	**EA**	65	40	39	32
25/½"	**93 02 78 511**	**30**	**9,22**	**EA**	65	40	39	32
25/¾"	**93 02 79 511**	**30**	**9,74**	**EA**	66	40	49	41
32/½"	**93 03 78 511**	**30**	**10,07**	**EA**	69	44	39	32
32/¾"	**93 03 79 511**	**30**	**10,46**	**EA**	70	44	49	41
32/1"	**93 03 80 511**	**30**	**11,47**	**EA**	72	44	55	46
40/¾"	**93 04 79 511**	**30**	**11,72**	**EA**	69	45	49	41
40/1"	**93 04 80 511**	**30**	**12,65**	**EA**	76	49	55	46
40/1¼"	**93 04 81 511**	**30**	**13,42**	**EA**	80	49	66	55
50/½"	**93 05 78 511**	**25**	**13,34**	**EA**	76	55	50	32
50/1"	**93 05 80 511**	**25**	**15,05**	**EA**	78	50	55	46
50/1¼"	**93 05 81 511**	**25**	**15,92**	**EA**	85	55	66	55
50/1½"	**93 05 82 511**	**25**	**16,81**	**EA**	86	55	83	70
63/2"	**93 06 83 511**	**15**	**19,92**	**EA**	100	63	94	85

SW = size of the jaw.
Thread according to EN 10226 (ISO 7).
For sealing we advise PTFE tape.
Depending on assembly method and temperature change the maximum operating pressure can be reduced strongly.

Adaptor short SDR 11 with male thread

PE100
SDR 11
water 8 bar

for butt-welding



d_e/R	Art. Nr.	q	€	AG	L	l_1	l_2	SW
20/½"	**97 01 78 511**	**1**	**6,08**	**EB**	46	19	18	22
25/¾"	**97 02 79 511**	**1**	**7,29**	**EB**	51	22	20	27
32/1"	**97 03 80 511**	**1**	**9,21**	**EB**	61	28	24	36
40/1¼"	**97 04 81 511**	**1**	**11,08**	**EB**	66	29	26	46
50/1½"	**97 05 82 511**	**1**	**18,18**	**EB**	74	32	28	55
63/2"	**97 06 83 511**	**1**	**22,96**	**EB**	80	35	31	65

SW = size of the jaw.
Thread according to EN 10226 (ISO 7).
For sealing we advise PTFE tape.
Depending on assembly method and temperature change the maximum operating pressure can be reduced strongly. For specific applications please contact our Technical Support.

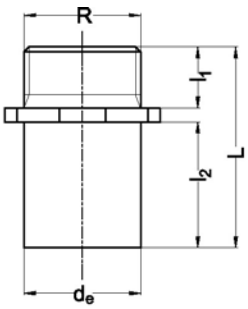
akatherm

PE100 pressure fittings

Adaptor long SDR 11 with male thread

for butt-welding and electrofusion

PE100
SDR 11
water 10 bar



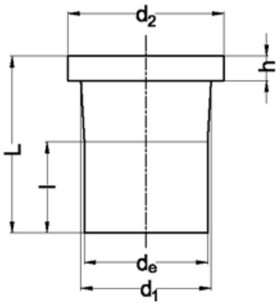
d_e/R	Art. Nr.	q	€	AG	L	l_1	l_2	SW
20/½"	**95 01 78 511**	**50**	**8,27**	**EG**	58	19	37	24
25/¾"	**95 02 79 511**	**30**	**10,10**	**EG**	61	14	40	27
32/1"	**95 03 80 511**	**30**	**12,73**	**EG**	62	18	44	35
40/1¼"	**95 04 81 511**	**30**	**14,21**	**EG**	75	19	49	46
50/1½"	**95 05 82 511**	**25**	**24,24**	**EG**	82	20	55	55
63/2"	**95 06 83 511**	**15**	**28,58**	**EG**	91	21	63	65

SW = size of the jaw.
Thread according to EN 10226 (ISO 7).
For sealing we advise PTFE tape.
Depending on assembly method and temperature change the maximum operating pressure can be reduced strongly.

Stub flange long SDR 17

for butt-welding and electrofusion

PE100
SDR 17
water 10 bar/gas 5 bar



d_e	Art. Nr.	q	€	AG		h	l	d_1	d_2	L
63	**47 06 04 517**	**15**	**8,65**	**EK**		14	66	75	102	120
75	**47 07 04 517**	**10**	**11,19**	**EK**		18	78	89	122	130
90	**47 09 04 517**	**5**	**14,58**	**EK**		18	84	105	138	145
110	**47 11 04 517**	**5**	**18,64**	**EK**		18	100	125	158	155
125	**47 12 04 517**	**4**	**22,68**	**EK**		18	108	132	158	170
140	**47 14 04 517**	**4**	**29,22**	**EK**		18	109	155	188	195
160	**47 16 04 517**	**4**	**33,42**	**EK**		18	110	175	212	195
180	**47 18 04 517**	**2**	**51,52**	**EK**		20	115	180	212	200
200	**47 20 04 517**	**1**	**58,74**	**EK**		24	127	232	268	205
225	**47 22 04 517**	**1**	**63,29**	**EK**		24	137	235	268	215
250	**47 25 04 517**	**1**	**87,62**	**EK**		25	146	285	320	205
280	**47 28 04 517**	**1**	**132,63**	**EK**		25	156	291	320	220
315	**47 31 04 517**	**1**	**173,99**	**EK**		25	160	335	370	225
355	**47 35 04 517**	**1**	**292,08**	**EG**		30	175	373	430	260
400	**47 40 04 517**	**1**	**515,51**	**EG**		33	195	427	482	285
450	**47 45 04 517**	**1**	**597,93**	**EC**	*	46	280	519	585	400
500	**47 50 04 517**	**1**	**778,22**	**EC**	*	46	280	530	585	400
560	**47 56 04 517**	**1**	**880,92**	**EC**	*	50	280	615	685	400
630	**47 63 04 517**	**1**	**1104,57**	**EC**	*	50	280	624	685	400
710	**47 71 04 517**	**1**	**2055,10**	**EC**	*	50	280	737	800	400
800	**47 80 04 517**	**1**	**2477,30**	**EC**	*	52	280	840	905	400
900	**47 90 04 517**	**1**	**3294,15**	**EC**	*	55	280	944	1005	400
1000	**47 91 04 517**	**1**	**4102,49**	**EC**	*	60	260	1047	1110	400

* *machined and extended with pipe*
fabrication on order, returning not possible

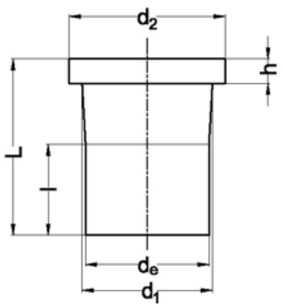
With grooved jointing face.

PE100 pressure fittings

Stub flange long SDR 11

for butt-welding and electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG		h	l	d_1	d_2	L
20	**47 01 04 511**	**50**	**3,86**	**EK**		7	64	27	45	88
25	**47 02 04 511**	**30**	**4,06**	**EK**		9	51	33	58	90
32	**47 03 04 511**	**30**	**4,77**	**EK**		11	57	40	68	95
40	**47 04 04 511**	**30**	**5,64**	**EK**		12	55	50	78	100
50	**47 05 04 511**	**25**	**6,87**	**EK**		12	63	61	88	110
63	**47 06 04 511**	**15**	**8,65**	**EK**		15	66	75	102	120
75	**47 07 04 511**	**10**	**11,19**	**EK**		17	78	89	122	130
90	**47 09 04 511**	**5**	**14,58**	**EK**		18	84	105	138	145
110	**47 11 04 511**	**5**	**18,64**	**EK**		18	115	125	158	155
125	**47 12 04 511**	**4**	**22,68**	**EK**		25	125	132	158	170
140	**47 14 04 511**	**4**	**29,22**	**EK**		25	109	155	188	195
160	**47 16 04 511**	**4**	**33,42**	**EK**		25	140	175	212	195
180	**47 18 04 511**	**2**	**51,52**	**EK**		31	115	182	212	200
200	**47 20 04 511**	**1**	**58,74**	**EK**		32	127	232	268	205
225	**47 22 04 511**	**1**	**63,29**	**EK**		33	137	235	268	215
250	**47 25 04 511**	**1**	**97,31**	**EK**		35	130	285	320	205
280	**47 28 04 511**	**1**	**147,35**	**EK**		35	156	291	320	220
315	**47 31 04 511**	**1**	**187,05**	**EK**		35	155	335	370	225
355	**47 35 04 511**	**1**	**313,95**	**EG**		40	175	373	430	255
400	**47 40 04 511**	**1**	**553,95**	**EG**		46	195	427	482	285
450	**47 45 04 511**	**1**	**665,26**	**EC**	*	60	280	514	585	400
500	**47 50 04 511**	**1**	**882,06**	**EC**	*	60	280	530	585	400
560	**47 56 04 511**	**1**	**911,73**	**EC**	*	60	280	615	685	400
630	**47 63 04 511**	**1**	**1286,01**	**EC**	*	60	280	624	685	400
710	**47 71 04 511**	**1**	**2472,79**	**EC**	*	67	280	737	800	400

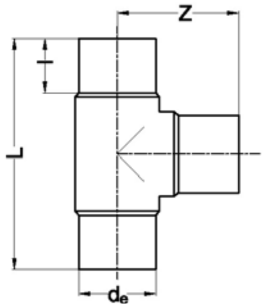
* *machined and extended with pipe*
fabrication on order, returning not possible

With grooved jointing face.

Tee 90° long SDR 17

for butt-welding and electrofusion

PE100
SDR 17
water 10 bar/gas 5 bar

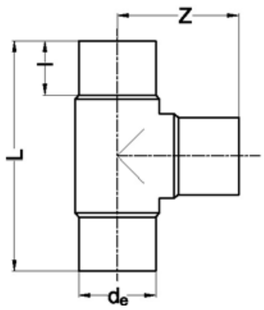


d_e	Art. Nr.	q	€	AG	L	z	l
63	39 06 05 517	1	13,37	EF	228	114	70
75	39 07 05 517	1	21,75	EF	240	120	73
90	39 09 05 517	1	31,27	EF	306	153	86
110	39 11 05 517	1	46,01	EF	336	168	95
125	39 12 05 517	1	62,95	EF	354	177	100
140	39 14 05 517	1	101,19	EF	386	193	105
160	39 16 05 517	1	131,36	EF	450	225	124
180	39 18 05 517	1	172,35	EF	466	233	119
200	39 20 05 517	1	246,79	EF	502	251	127
225	39 22 05 517	1	293,36	EF	554	272	138
250	39 25 05 517	1	374,89	EG	628	314	148
280	39 28 05 517	1	568,22	EG	692	346	160
315	39 31 05 517	1	727,50	EG	760	380	170
355	39 35 05 517	1	1065,00	EG	820	410	165
400	39 40 05 517	1	1466,03	EG	915	460	195
450	39 45 05 517	1	2146,97	EG	970	485	195
500	39 50 05 517	1	2775,93	EG	1060	530	215

Tee 90° long SDR 11

for butt-welding and electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG	L	z	l
20	39 01 05 511	1	4,78	EF	107	54	35
25	39 02 05 511	1	5,45	EF	124	62	41
32	39 03 05 511	1	6,53	EF	150	75	51
40	39 04 05 511	1	8,07	EF	164	82	55
50	39 05 05 511	1	10,70	EF	166	83	51
63	39 06 05 511	1	14,76	EF	228	114	70
75	39 07 05 511	1	24,48	EF	240	120	73
90	39 09 05 511	1	34,84	EF	306	153	86
110	39 11 05 511	1	50,98	EF	336	168	95
125	39 12 05 511	1	69,97	EF	354	177	100
140	39 14 05 511	1	112,47	EF	386	193	105
160	39 16 05 511	1	145,93	EF	450	225	124
180	39 18 05 511	1	191,50	EF	466	233	119
200	39 20 05 511	1	274,38	EF	502	251	127
225	39 22 05 511	1	326,05	EF	554	272	138
250	39 25 05 511	1	420,97	EG	628	314	148
280	39 28 05 511	1	631,26	EG	692	346	160
315	39 31 05 511	1	808,41	EG	760	380	170
355	39 35 05 511	1	1309,81	EG	820	410	165
400	39 40 05 511	1	1957,50	EG	915	460	195
450	39 45 05 511	1	2775,93	EG	970	485	195
500	39 50 05 511	1	3525,85	EG	1060	530	215

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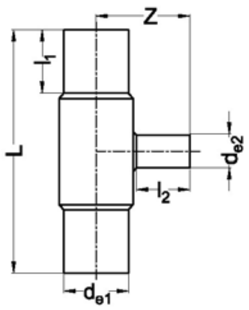
PE100 pressure fittings

Tee 90° reduced long SDR 17
with reduced branch
for butt-welding and electrofusion

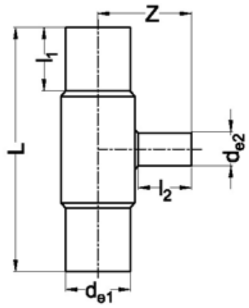
PE100
SDR 17
water 10 bar/gas 5 bar



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z	l_1	l_2
63/32	58 06 03 517	1	30,62	EG	228	91	70	46
63/50	58 06 05 517	1	14,24	EG	213	100	63	56
75/50	58 07 05 517	1	21,59	EG	253	113	70	55
75/63	58 07 06 517	1	21,95	EG	252	117	70	63
90/50	58 09 05 517	1	30,71	EG	275	117	79	55
90/63	58 09 06 517	1	30,71	EG	264	134	79	63
90/75	58 09 07 517	1	30,99	EG	272	138	74	70
110/63	58 11 06 517	1	45,55	EG	316	135	88	62
110/75	58 11 07 517	1	45,55	EG	305	148	82	70
110/90	58 11 09 517	1	46,63	EG	310	155	91	78
125/63	58 12 06 517	1	63,27	EG	358	148	100	69
125/75	58 12 07 517	1	63,27	EG	358	155	100	76
125/90	58 12 09 517	1	63,27	EG	358	164	100	85
125/110	58 12 11 517	1	63,27	EG	340	170	87	82
140/63	58 14 06 517	1	104,52	EG	386	160	105	77
140/75	58 14 07 517	1	104,52	EG	386	173	105	78
140/90	58 14 09 517	1	104,52	EG	388	182	105	87
140/110	58 14 11 517	1	108,63	EG	388	188	105	95
160/63	58 16 06 517	1	125,36	EG	424	174	110	72
160/75	58 16 07 517	1	129,21	EG	424	180	111	73
160/90	58 16 09 517	1	129,21	EG	424	190	111	84
160/110	58 16 11 517	1	130,41	EG	424	197	111	93
180/75	58 18 07 517	1	209,42	EG	460	190	116	93
180/90	58 18 09 517	1	193,14	EG	420	200	116	85
180/110	58 18 11 517	1	193,14	EG	460	210	116	95
180/125	58 18 12 517	1	209,42	EG	430	215	116	100
180/140	58 18 14 517	1	182,87	EG	460	220	116	104
180/160	58 18 16 517	1	174,31	EG	460	225	116	110
200/63	58 20 06 517	1	234,24	EG	550	225	134	80
200/75	58 20 07 517	1	215,55	EG	450	200	127	70
200/90	58 20 09 517	1	234,24	EG	550	227	134	95
200/110	58 20 11 517	1	234,24	EG	550	240	134	103
200/125	58 20 12 517	1	234,24	EG	550	240	134	110
200/160	58 20 16 517	1	234,24	EG	550	265	134	114
225/63	58 22 06 517	1	319,77	EG	540	241	130	69
225/75	58 22 07 517	1	294,17	EG	440	226	120	80
225/90	58 22 09 517	1	294,17	EG	440	224	120	80
225/110	58 22 11 517	1	295,17	EG	522	271	120	92
225/125	58 22 12 517	1	310,08	EG	522	266	120	93
225/140	58 22 14 517	1	322,86	EG	540	276	130	104
225/160	58 22 16 517	1	295,98	EG	522	252	120	109
225/180	58 22 18 517	1	296,49	EG	552	280	131	131
250/110	58 25 11 517	1	352,72	EG	575	242	130	82
250/160	58 25 16 517	1	360,60	EG	575	261	130	98
250/200	58 25 20 517	1	360,60	EG	625	290	148	116
315/90	58 31 09 517	1	818,11	EG	545	290	170	90
315/110	58 31 11 517	1	818,11	EG	546	290	170	100
315/160	58 31 16 517	1	818,11	EG	575	310	170	120
315/200	58 31 20 517	1	752,80	EG	640	330	170	130
315/225	58 31 22 517	1	855,30	EG	640	335	170	145
315/250	58 31 25 517	1	855,30	EG	638	340	170	150

Tee 90° reduced long SDR 11
with reduced branch
for butt-welding and electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z	l_1	l_2
63/32	**58 06 03 511**	**1**	**30,62**	**EG**	228	91	70	46
63/50	**58 06 05 511**	**1**	**15,39**	**EG**	213	100	63	56
75/32	**58 07 03 511**	**1**	**24,13**	**EG**	256	103	70	46
75/50	**58 07 05 511**	**1**	**24,13**	**EG**	253	113	70	55
75/63	**58 07 06 511**	**1**	**24,59**	**EG**	252	117	70	63
90/50	**58 09 05 511**	**1**	**34,36**	**EG**	275	117	79	55
90/63	**58 09 06 511**	**1**	**34,36**	**EG**	264	134	79	63
90/75	**58 09 07 511**	**1**	**34,64**	**EG**	272	138	74	70
110/63	**58 11 06 511**	**1**	**50,96**	**EG**	316	135	88	62
110/75	**58 11 07 511**	**1**	**50,96**	**EG**	305	154	82	70
110/90	**58 11 09 511**	**1**	**51,66**	**EG**	310	155	91	78
125/63	**58 12 06 511**	**1**	**70,89**	**EG**	358	148	100	63
125/75	**58 12 07 511**	**1**	**70,89**	**EG**	358	155	100	76
125/90	**58 12 09 511**	**1**	**70,89**	**EG**	330	168	110	91
125/110	**58 12 11 511**	**1**	**70,89**	**EG**	340	170	87	82
140/63	**58 14 06 511**	**1**	**122,04**	**EG**	386	160	105	77
140/75	**58 14 07 511**	**1**	**122,04**	**EG**	386	173	105	78
140/90	**58 14 09 511**	**1**	**122,04**	**EG**	388	182	105	87
140/110	**58 14 11 511**	**1**	**126,45**	**EG**	388	188	105	95
160/63	**58 16 06 511**	**1**	**139,36**	**EG**	424	174	110	72
160/75	**58 16 07 511**	**1**	**140,52**	**EG**	424	180	111	73
160/90	**58 16 09 511**	**1**	**140,52**	**EG**	424	190	111	84
160/110	**58 16 11 511**	**1**	**144,03**	**EG**	424	197	111	93
180/75	**58 18 07 511**	**1**	**209,42**	**EG**	460	190	116	93
180/90	**58 18 09 511**	**1**	**193,14**	**EG**	460	200	116	85
180/110	**58 18 11 511**	**1**	**193,14**	**EG**	420	200	116	95
180/125	**58 18 12 511**	**1**	**209,42**	**EG**	430	215	116	100
180/140	**58 18 14 511**	**1**	**203,39**	**EG**	460	220	116	104
180/160	**58 18 16 511**	**1**	**193,14**	**EG**	460	225	116	110
200/63	**58 20 06 511**	**1**	**259,85**	**EG**	550	225	134	80
200/75	**58 20 07 511**	**1**	**259,85**	**EG**	450	200	127	70
200/90	**58 20 09 511**	**1**	**259,85**	**EG**	550	227	134	95
200/110	**58 20 11 511**	**1**	**259,85**	**EG**	550	240	134	103
200/125	**58 20 12 511**	**1**	**259,85**	**EG**	550	240	134	110
200/160	**58 20 16 511**	**1**	**259,85**	**EG**	550	265	134	114
225/63	**58 22 06 511**	**1**	**341,51**	**EG**	540	241	130	69
225/75	**58 22 07 511**	**1**	**326,54**	**EG**	540	248	130	76
225/90	**58 22 09 511**	**1**	**326,54**	**EG**	440	224	120	80
225/110	**58 22 11 511**	**1**	**327,86**	**EG**	522	271	120	92
225/125	**58 22 12 511**	**1**	**344,74**	**EG**	522	266	120	93
225/140	**58 22 14 511**	**1**	**358,71**	**EG**	540	276	130	104
225/160	**58 22 16 511**	**1**	**329,02**	**EG**	522	252	120	109
225/180	**58 22 18 511**	**1**	**330,16**	**EG**	552	280	131	131
250/110	**58 25 11 511**	**1**	**436,85**	**EG**	575	242	130	82
250/160	**58 25 16 511**	**1**	**444,21**	**EG**	575	261	130	98
250/200	**58 25 20 511**	**1**	**444,21**	**EG**	625	290	148	116
315/90	**58 31 09 511**	**1**	**889,23**	**EG**	545	290	170	90
315/110	**58 31 11 511**	**1**	**929,67**	**EG**	546	290	170	100
315/160	**58 31 16 511**	**1**	**889,23**	**EG**	575	310	170	120
315/200	**58 31 20 511**	**1**	**752,80**	**EG**	640	330	170	130
315/225	**58 31 22 511**	**1**	**929,67**	**EG**	638	335	170	145
315/250	**58 31 25 511**	**1**	**929,67**	**EG**	670	333	170	150

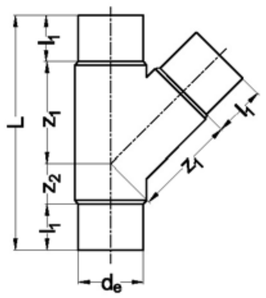
PE100 pressure fittings

Tee 45° long SDR 17

PE100
SDR 17

for butt-welding and electrofusion

water 10 bar/gas 5 bar



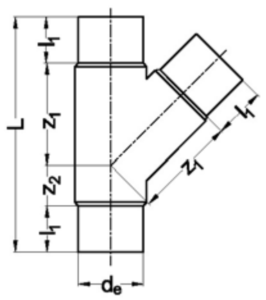
d_e	Art. Nr.	q	€	AG	L	l_1	z_1	z_2
50	**39 05 46 517**	**10**	**51,43**	**EF**	223	55	75	40
63	**39 06 46 517**	**10**	**70,37**	**EF**	245	63	93	23
75	**39 07 46 517**	**10**	**104,57**	**EF**	290	75	103	37
90	**39 09 46 517**	**5**	**184,73**	**EF**	370	85	148	51
110	**39 11 46 517**	**5**	**229,98**	**EF**	400	85	164	66
125	**39 12 46 517**	**1**	**354,38**	**EF**	440	105	185	45
160	**39 16 46 517**	**1**	**545,40**	**EF**	540	115	260	50
180	**39 18 46 517**	**1**	**687,03**	**EF**	575	116	268	75
200	**39 20 46 517**	**1**	**904,50**	**EF**	625	122	287	94
225	**39 22 46 517**	**1**	**1038,01**	**EF**	705	135	350	85

Tee 45° long SDR 11

PE100
SDR 11

for butt-welding and electrofusion

water 16 bar/gas 10 bar

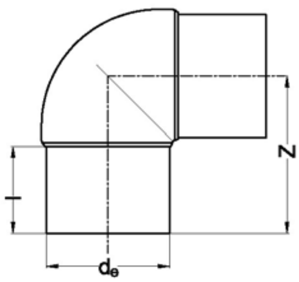


d_e	Art. Nr.	q	€	AG	L	l_1	z_1	z_2
40	**39 04 46 511**	**10**	**40,03**	**EF**	185	45	75	40
50	**39 05 46 511**	**10**	**70,83**	**EF**	223	55	90	23
63	**39 06 46 511**	**10**	**94,47**	**EF**	245	63	93	23
75	**39 07 46 511**	**10**	**143,26**	**EF**	290	75	101	37
90	**39 09 46 511**	**5**	**195,83**	**EF**	370	85	148	51
110	**39 11 46 511**	**5**	**248,72**	**EF**	400	85	164	66
125	**39 12 46 511**	**1**	**358,54**	**EF**	440	105	185	45
160	**39 16 46 511**	**1**	**747,72**	**EF**	540	110	260	50
180	**39 18 46 511**	**1**	**889,19**	**EF**	575	116	268	75
200	**39 20 46 511**	**1**	**1046,56**	**EF**	625	122	287	94
225	**39 22 46 511**	**1**	**1468,75**	**EF**	705	135	350	85

Elbow 90° long SDR 17

for butt-welding and electrofusion

PE100
SDR 17
water 10 bar/gas 5 bar

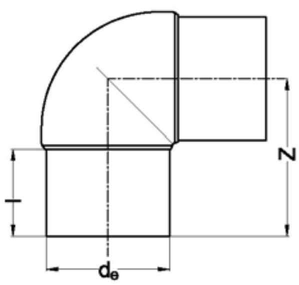


d_e	Art. Nr.	q	€	AG	z	l
63	13 06 92 517	1	14,45	EF	95	56
75	13 07 92 517	1	16,75	EF	116	72
90	13 09 92 517	1	22,50	EF	139	78
110	13 11 92 517	1	43,08	EF	158	86
125	13 12 92 517	1	53,09	EF	180	104
140	13 14 92 517	1	69,59	EF	198	119
160	13 16 92 517	1	80,52	EF	210	117
180	13 18 92 517	1	87,92	EF	222	116
200	13 20 92 517	1	120,28	EF	250	128
225	13 22 92 517	1	143,48	EF	269	136
250	13 25 92 517	1	277,66	EG	307	180
280	13 28 92 517	1	419,31	EG	340	200
315	13 31 92 517	1	521,81	EG	370	210

Elbow 90° long SDR 11

for butt-welding and electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG	z	l
20	13 01 92 511	1	4,37	EF	70	60
25	13 02 92 511	1	4,60	EF	63	42
32	13 03 92 511	1	4,92	EF	72	47
40	13 04 92 511	1	6,33	EF	69	44
50	13 05 92 511	1	8,79	EF	77	50
63	13 06 92 511	1	16,03	EF	95	56
75	13 07 92 511	1	19,56	EF	116	72
90	13 09 92 511	1	24,95	EF	139	78
110	13 11 92 511	1	47,82	EF	158	86
125	13 12 92 511	1	59,09	EF	180	104
140	13 14 92 511	1	77,29	EF	198	119
160	13 16 92 511	1	89,33	EF	210	117
180	13 18 92 511	1	97,80	EF	222	116
200	13 20 92 511	1	133,64	EF	250	128
225	13 22 92 511	1	159,31	EF	269	136
250	13 25 92 511	1	308,53	EG	307	180
280	13 28 92 511	1	465,86	EG	340	200
315	13 31 92 511	1	582,89	EG	370	210

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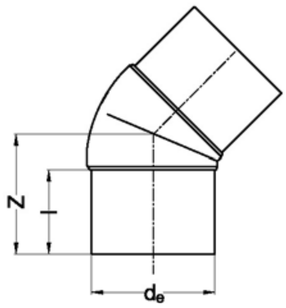
PE100 pressure fittings

Elbow 45° long SDR 17

for butt-welding and electrofusion

PE100
SDR 17
water 10 bar/gas 5 bar

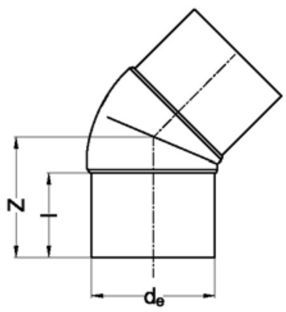


d_e	Art. Nr.	q	€	AG	Z	l
63	**13 06 46 517**	**1**	**14,45**	**EF**	82	56
75	**13 07 46 517**	**1**	**17,82**	**EF**	96	75
90	**13 09 46 517**	**1**	**22,50**	**EF**	120	84
110	**13 11 46 517**	**1**	**43,08**	**EF**	129	91
125	**13 12 46 517**	**1**	**53,09**	**EF**	147	101
140	**13 14 46 517**	**1**	**69,59**	**EF**	153	104
160	**13 16 46 517**	**1**	**80,52**	**EF**	169	113
180	**13 18 46 517**	**1**	**87,92**	**EF**	186	120
200	**13 20 46 517**	**1**	**120,28**	**EF**	201	127
225	**13 22 46 517**	**1**	**143,48**	**EF**	218	134
250	**13 25 46 517**	**1**	**277,66**	**EG**	217	155
280	**13 28 46 517**	**1**	**419,31**	**EG**	232	162
315	**13 31 46 517**	**1**	**521,81**	**EG**	251	173

Elbow 45° long SDR 11

for butt-welding and electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



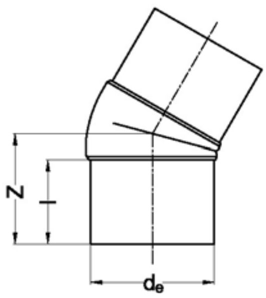
d_e	Art. Nr.	q	€	AG	Z	l
20	**13 01 46 511**	**1**	**4,77**	**EF**	44	39
25	**13 02 46 511**	**1**	**5,11**	**EF**	41	35
32	**13 03 46 511**	**1**	**6,18**	**EF**	48	47
40	**13 04 46 511**	**1**	**7,73**	**EF**	58	44
50	**13 05 46 511**	**1**	**8,79**	**EF**	74	54
63	**13 06 46 511**	**1**	**16,03**	**EF**	82	56
75	**13 07 46 511**	**1**	**19,92**	**EF**	96	75
90	**13 09 46 511**	**1**	**24,95**	**EF**	120	84
110	**13 11 46 511**	**1**	**47,82**	**EF**	129	91
125	**13 12 46 511**	**1**	**59,09**	**EF**	147	101
140	**13 14 46 511**	**1**	**77,29**	**EF**	153	104
160	**13 16 46 511**	**1**	**89,33**	**EF**	169	113
180	**13 18 46 511**	**1**	**97,80**	**EF**	186	120
200	**13 20 46 511**	**1**	**133,64**	**EF**	201	127
225	**13 22 46 511**	**1**	**159,31**	**EF**	218	134
250	**13 25 46 511**	**1**	**308,53**	**EG**	217	155
280	**13 28 46 511**	**1**	**465,86**	**EG**	232	162
315	**13 31 46 511**	**1**	**582,89**	**EG**	251	173

Elbow 30° long SDR 17

for butt-welding and electrofusion

PE100
SDR 17
water 10 bar/gas 5 bar

d_e	Art. Nr.	q	€	AG	Z	l
75	**13 07 33 517**	**1**	**48,56**	**EF**	108	77
90	**13 09 33 517**	**1**	**53,49**	**EF**	116	85
110	**13 11 33 517**	**1**	**66,39**	**EF**	130	96
125	**13 12 33 517**	**1**	**79,17**	**EF**	143	102
140	**13 14 33 517**	**1**	**97,19**	**EF**	148	110
160	**13 16 33 517**	**1**	**143,48**	**EF**	154	108
180	**13 18 33 517**	**1**	**161,50**	**EF**	160	116
200	**13 20 33 517**	**1**	**220,15**	**EF**	170	122
225	**13 22 33 517**	**1**	**263,19**	**EF**	185	129

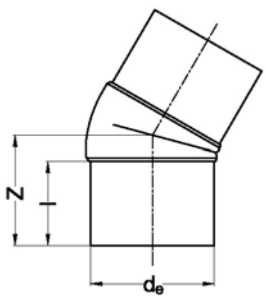


Elbow 30° long SDR 11

for butt-welding and electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar

d_e	Art. Nr.	q	€	AG	Z	l
75	**13 07 33 511**	**1**	**53,84**	**EF**	108	77
90	**13 09 33 511**	**1**	**60,27**	**EF**	116	85
110	**13 11 33 511**	**1**	**75,43**	**EF**	130	96
125	**13 12 33 511**	**1**	**94,33**	**EF**	143	102
140	**13 14 33 511**	**1**	**115,77**	**EF**	148	110
160	**13 16 33 511**	**1**	**159,95**	**EF**	154	108
180	**13 18 33 511**	**1**	**174,62**	**EF**	160	116
200	**13 20 33 511**	**1**	**238,71**	**EF**	170	122
225	**13 22 33 511**	**1**	**276,62**	**EF**	185	129



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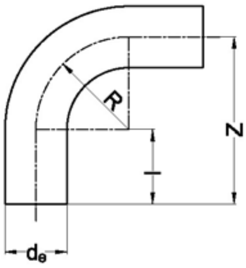
PE100 pressure fittings

Bend 90° R = 1 x d_e long SDR 17 — PE100, SDR 17

for butt-welding and electrofusion — water 10 bar/gas 5 bar

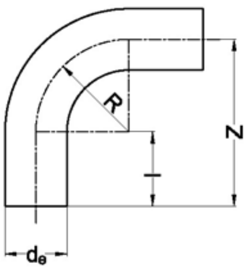
d_e	Art. Nr.	q	€	AG	l	Z	R
63	12 06 91 517	1	14,52	EG	63	128	63
75	12 07 91 517	1	21,23	EG	70	148	75
90	12 09 91 517	1	27,69	EG	71	164	90
110	12 11 91 517	1	58,38	EG	75	188	110
125	12 12 91 517	1	74,15	EG	85	213	125
140	12 14 91 517	1	107,72	EG	90	234	140
160	12 16 91 517	1	118,81	EG	90	254	160
180	12 18 91 517	1	146,90	EG	100	284	180
200	12 20 91 517	1	181,91	EG	108	312	200
225	12 22 91 517	1	224,23	EG	115	344	225



Bend 90° R = 1 x d_e long SDR 11 — PE100, SDR 11

for butt-welding and electrofusion — water 16 bar/gas 10 bar

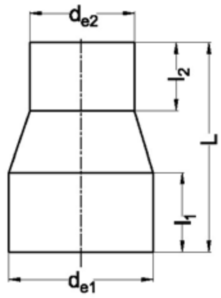
d_e	Art. Nr.	q	€	AG	l	Z	R
20	12 01 91 511	1	6,24	EG	37	59	20
25	12 02 91 511	1	6,51	EG	39	66	25
32	12 03 91 511	1	6,72	EG	44	78	32
40	12 04 91 511	1	8,73	EG	49	91	40
50	12 05 91 511	1	10,97	EG	55	107	50
63	12 06 91 511	1	15,73	EG	63	128	63
75	12 07 91 511	1	21,70	EG	70	148	75
90	12 09 91 511	1	31,47	EG	71	164	90
110	12 11 91 511	1	59,87	EG	75	188	110
125	12 12 91 511	1	84,39	EG	85	213	125
140	12 14 91 511	1	112,82	EG	90	234	140
160	12 16 91 511	1	137,46	EG	90	254	160
180	12 18 91 511	1	162,75	EG	100	284	180
200	12 20 91 511	1	242,54	EG	108	312	200
225	12 22 91 511	1	289,29	EG	115	344	225



Reducer concentric long SDR 17

for butt-welding and electrofusion

PE100
SDR 17
water 10 bar/gas 5 bar



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	l_1	l_2
50/25	45 05 02 517	1	6,53	EG	130	55	40
50/32	45 05 03 517	1	7,17	EG	132	55	44
50/40	45 05 04 517	1	7,17	EG	134	55	49
63/32	45 06 03 517	1	9,81	EG	146	63	44
63/40	45 06 04 517	1	9,81	EG	150	63	49
63/50	45 06 05 517	1	9,81	EG	150	63	55
75/63	45 07 06 517	1	13,06	EG	147	66	63
90/50	45 09 05 517	1	17,49	EG	142	64	49
90/63	45 09 06 517	1	18,29	EG	144	69	55
90/75	45 09 07 517	1	18,42	EG	163	74	65
110/63	45 11 06 517	1	24,60	EG	174	85	63
110/75	45 11 07 517	1	24,60	EG	180	85	57
110/90	45 11 09 517	1	24,60	EG	179	79	74
125/63	45 12 06 517	1	29,57	EG	187	87	61
125/75	45 12 07 517	1	27,99	EG	205	105	76
125/90	45 12 09 517	1	29,57	EG	216	99	86
125/110	45 12 11 517	1	29,63	EG	201	89	84
140/75	45 14 07 517	1	42,77	EG	230	112	70
140/90	45 14 09 517	1	42,77	EG	230	112	79
140/110	45 14 11 517	1	42,77	EG	230	112	82
140/125	45 14 12 517	1	42,54	EG	214	99	92
160/90	45 16 09 517	1	56,81	EG	216	101	72
160/110	45 16 11 517	1	56,98	EG	223	104	84
160/125	45 16 12 517	1	56,98	EG	227	95	91
160/140	45 16 14 517	1	57,28	EG	217	110	95
180/90	45 18 09 517	1	71,31	EG	237	105	79
180/110	45 18 11 517	1	71,31	EG	270	120	92
180/125	45 18 12 517	1	73,82	EG	278	116	103
180/140	45 18 14 517	1	77,46	EG	270	120	110
180/160	45 18 16 517	1	73,82	EG	277	115	114
200/125	45 20 12 517	1	76,22	EG	283	123	103
200/140	45 20 14 517	1	90,23	EG	275	120	110
200/160	45 20 16 517	1	80,91	EG	253	105	100
200/180	45 20 18 517	1	90,23	EG	272	120	115
225/110	45 22 11 517	1	122,50	EG	312	130	94
225/140	45 22 14 517	1	144,88	EG	295	130	110
225/160	45 22 16 517	1	130,14	EG	312	130	109
225/180	45 22 18 517	1	122,50	EG	310	130	111
225/200	45 22 20 517	1	144,88	EG	272	124	115
250/160	45 25 16 517	1	175,99	EG	339	138	111
250/180	45 25 18 517	1	174,20	EG	338	137	123
250/200	45 25 20 517	1	184,08	EG	337	137	127
250/225	45 25 22 517	1	184,08	EG	337	146	137
280/180	45 28 18 517	1	218,79	EG	350	146	119
280/200	45 28 20 517	1	218,79	EG	350	146	124
280/225	45 28 22 517	1	218,79	EG	350	146	129
280/250	45 28 25 517	1	245,32	EG	350	146	134
315/200	45 31 20 517	1	315,63	EG	380	180	134
315/225	45 31 22 517	1	315,63	EG	380	157	133
315/250	45 31 25 517	1	315,63	EG	380	157	138
315/280	45 31 28 517	1	298,58	EG	380	157	148
355/250	45 35 25 517	1	395,80	EG	415	172	143
355/280	45 35 28 517	1	672,54	EG	415	172	148

-- to be continued --

PE100 pressure fittings

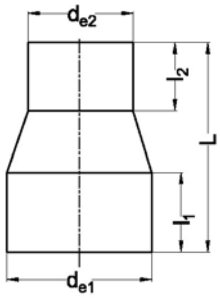
Reducer concentric long SDR 17 - continuation -

d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	l_1	l_2
355/315	**45 35 31 517**	**1**	**734,51**	**EG**	415	172	158
400/280	**45 40 28 517**	**1**	**509,39**	**EG**	450	187	153
400/315	**45 40 31 517**	**1**	**745,88**	**EG**	450	187	158
400/355	**45 40 35 517**	**1**	**794,88**	**EG**	450	187	168

Reducer concentric long SDR 11

for butt-welding and electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	l_1	l_2
25/20	**45 02 01 511**	**1**	**3,17**	**EG**	87	40	41
32/20	**45 03 01 511**	**1**	**3,55**	**EG**	92	43	39
32/25	**45 03 02 511**	**1**	**3,55**	**EG**	89	44	37
40/20	**45 04 01 511**	**1**	**5,11**	**EG**	94	45	36
40/25	**45 04 02 511**	**1**	**5,11**	**EG**	96	47	35
40/32	**45 04 03 511**	**1**	**5,11**	**EG**	93	50	39
50/25	**45 05 02 511**	**1**	**6,33**	**EG**	136	62	48
50/32	**45 05 03 511**	**1**	**6,33**	**EG**	134	61	50
50/40	**45 05 04 511**	**1**	**6,33**	**EG**	134	61	56
63/32	**45 06 03 511**	**1**	**8,43**	**EG**	150	69	50
63/40	**45 06 04 511**	**1**	**8,43**	**EG**	152	69	55
63/50	**45 06 05 511**	**1**	**8,43**	**EG**	151	69	60
75/50	**45 07 05 511**	**1**	**13,06**	**EG**	148	64	58
75/63	**45 07 06 511**	**1**	**13,06**	**EG**	149	65	59
90/50	**45 09 05 511**	**1**	**17,49**	**EG**	142	64	49
90/63	**45 09 06 511**	**1**	**18,29**	**EG**	144	69	55
90/75	**45 09 07 511**	**1**	**18,42**	**EG**	163	76	61
110/63	**45 11 06 511**	**1**	**24,60**	**EG**	174	85	63
110/75	**45 11 07 511**	**1**	**24,60**	**EG**	180	85	57
110/90	**45 11 09 511**	**1**	**24,60**	**EG**	179	99	93
125/63	**45 12 06 511**	**1**	**29,57**	**EG**	187	87	61
125/75	**45 12 07 511**	**1**	**29,57**	**EG**	205	105	76
125/90	**45 12 09 511**	**1**	**29,57**	**EG**	216	99	86
125/110	**45 12 11 511**	**1**	**29,63**	**EG**	200	90	82
140/75	**45 14 07 511**	**1**	**44,85**	**EG**	230	112	70
140/90	**45 14 09 511**	**1**	**44,85**	**EG**	230	112	79
140/110	**45 14 11 511**	**1**	**44,85**	**EG**	230	112	82
140/125	**45 14 12 511**	**1**	**44,85**	**EG**	211	96	90
160/90	**45 16 09 511**	**1**	**56,81**	**EG**	217	102	74
160/110	**45 16 11 511**	**1**	**56,98**	**EG**	223	104	84
160/125	**45 16 12 511**	**1**	**56,98**	**EG**	231	98	92
160/140	**45 16 14 511**	**1**	**57,28**	**EG**	217	110	95
180/90	**45 18 09 511**	**1**	**71,31**	**EG**	237	105	79
180/110	**45 18 11 511**	**1**	**71,30**	**EG**	270	120	92
180/125	**45 18 12 511**	**1**	**73,82**	**EG**	278	116	103
180/140	**45 18 14 511**	**1**	**73,82**	**EG**	270	120	110
180/160	**45 18 16 511**	**1**	**73,82**	**EG**	277	115	114
200/125	**45 20 12 511**	**1**	**76,22**	**EG**	283	123	103
200/140	**45 20 14 511**	**1**	**80,91**	**EG**	275	120	110
200/160	**45 20 16 511**	**1**	**80,91**	**EG**	252	105	100
200/180	**45 20 18 511**	**1**	**90,23**	**EG**	272	120	115
225/110	**45 22 11 511**	**1**	**122,50**	**EG**	312	130	94
225/140	**45 22 14 511**	**1**	**136,34**	**EG**	295	130	110
225/160	**45 22 16 511**	**1**	**130,14**	**EG**	312	130	109
225/180	**45 22 18 511**	**1**	**122,50**	**EG**	310	130	111
225/200	**45 22 20 511**	**1**	**136,34**	**EG**	272	124	115
250/160	**45 25 16 511**	**1**	**175,99**	**EG**	339	138	111
250/180	**45 25 18 511**	**1**	**174,20**	**EG**	338	137	123
250/200	**45 25 20 511**	**1**	**184,08**	**EG**	337	137	127

-- to be continued --

Reducer concentric long SDR 11 - continuation -

d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	l_1	l_2
250/225	**45 25 22 511**	**1**	**184,08**	**EG**	337	137	137
280/180	**45 28 18 511**	**1**	**218,79**	**EG**	350	146	119
280/200	**45 28 20 511**	**1**	**218,79**	**EG**	350	146	124
280/225	**45 28 22 511**	**1**	**218,79**	**EG**	350	146	129
280/250	**45 28 25 511**	**1**	**245,32**	**EG**	350	146	134
315/200	**45 31 20 511**	**1**	**315,63**	**EG**	380	180	134
315/225	**45 31 22 511**	**1**	**315,63**	**EG**	380	157	133
315/250	**45 31 25 511**	**1**	**315,63**	**EG**	380	157	138
315/280	**45 31 28 511**	**1**	**315,63**	**EG**	380	157	148
355/250	**45 35 25 511**	**1**	**480,49**	**EG**	415	172	143
355/280	**45 35 28 511**	**1**	**722,23**	**EG**	415	172	148
355/315	**45 35 31 511**	**1**	**741,65**	**EG**	415	172	158
400/280	**45 40 28 511**	**1**	**672,54**	**EG**	450	187	153
400/315	**45 40 31 511**	**1**	**734,51**	**EG**	450	187	158
400/355	**45 40 35 511**	**1**	**794,88**	**EG**	450	187	168

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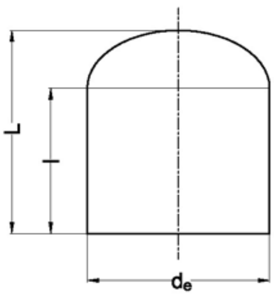
PE100 pressure fittings

End cap long SDR 17

PE100
SDR 17
for butt-welding and electrofusion
water 10 bar/gas 5 bar

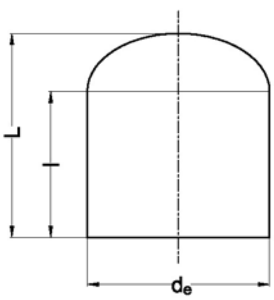


d_e	Art. Nr.	q	€	AG		L	l
63	67 06 08 517	1	10,92	EF		85	62
75	67 07 08 517	1	16,92	EF		95	63
90	67 09 08 517	1	25,69	EF		110	79
110	67 11 08 517	1	34,84	EF		127	88
125	67 12 08 517	1	37,64	EF		124	95
140	67 14 08 517	1	47,08	EF		140	110
160	67 16 08 517	1	52,75	EF		152	121
180	67 18 08 517	1	68,59	EF		169	134
200	67 20 08 517	1	85,44	EF		184	140
225	67 22 08 517	1	101,99	EF		200	160
250	67 25 08 517	1	137,49	EG		230	152
280	67 28 08 517	1	195,28	EG		257	162
315	67 31 08 517	1	261,15	EG		262	167
355	67 35 08 517	1	405,26	EG		270	250
400	67 40 08 517	1	711,34	EG		275	250
450	67 45 08 517	1	531,58	EC	*	285	250
500	67 50 08 517	1	750,05	EC	*	290	275
560	67 56 08 517	1	1518,86	EC	*	300	275
630	67 63 08 517	1	1795,22	EC	*	310	300
710	67 71 08 517	1	4272,39	EC	*	320	300
800	67 80 08 517	1	4738,74	EC	*	330	300

* *machined and extended with pipe*
fabrication on order, returning not possible

End cap long SDR 11

PE100
SDR 11
for butt-welding and electrofusion
water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG		L	l
20	67 01 08 511	1	3,69	EF		45	35
25	67 02 08 511	1	4,05	EF		52	40
32	67 03 08 511	1	5,11	EF		58	44
40	67 04 08 511	1	6,33	EF		67	50
50	67 05 08 511	1	8,28	EF		75	55
63	67 06 08 511	1	10,92	EF		85	62
75	67 07 08 511	1	16,92	EF		95	63
90	67 09 08 511	1	25,69	EF		110	79
110	67 11 08 511	1	34,84	EF		127	88
125	67 12 08 511	1	37,64	EF		124	95
140	67 14 08 511	1	47,08	EF		140	110
160	67 16 08 511	1	52,75	EF		152	121
180	67 18 08 511	1	68,59	EF		169	134
200	67 20 08 511	1	85,44	EF		184	140
225	67 22 08 511	1	101,99	EF		200	160
250	67 25 08 511	1	152,84	EG		230	152
280	67 28 08 511	1	217,09	EG		257	162
315	67 31 08 511	1	291,87	EG		262	167
355	67 35 08 511	1	405,26	EG		280	250
400	67 40 08 511	1	711,34	EG		285	250
450	67 45 08 511	1	650,16	EC	*	295	250
500	67 50 08 511	1	842,49	EC	*	305	275

-- to be continued --

End cap long SDR 11 - continuation -

d_e	Art. Nr.	q	€	AG		L	l
560	**67 56 08 511**	**1**	**1718,51**	**EC**	*****	315	275
630	**67 63 08 511**	**1**	**2032,25**	**EC**	*****	325	300
710	**67 71 08 511**	**1**	**o.r.**	**EC**	*****	320	300
800	**67 80 08 511**	**1**	**o.r.**	**EC**	*****	330	300

* *machined and extended with pipe*
fabrication on order, returning not possible

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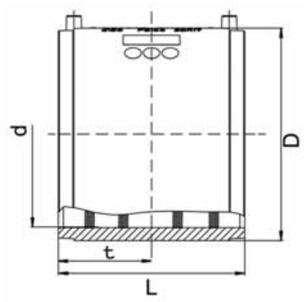
PE100 pressure fittings

Electrofusion coupler SDR 17-33
AM, without center stop
for electrofusion

PE100
SDR 17
water 10 bar



d	Art. Nr.	q	€	AG		D	L	t	kg
110	**68 00 01**	**24**	**22,17**	**FF**		128	160	80	0,60
125	**68 00 13**	**22**	**29,35**	**FF**		146	160	80	0,62
160	**68 00 02**	**12**	**35,87**	**FF**		184	180	90	1,10
180	**68 00 03**	**8**	**49,99**	**FF**		206	180	90	1,70
200	**68 00 04**	**1**	**63,03**	**FF**		229	180	90	3,20
225	**68 00 05**	**4**	**73,90**	**FF**		250	200	100	2,00
250	**68 00 06**	**4**	**105,42**	**FF**		280	200	100	2,65
280	**68 00 07**	**32**	**120,63**	**FF**		315	200	100	3,45
315	**68 00 08**	**24**	**133,68**	**FF**		355	220	110	4,90
355	**68 00 09**	**20**	**196,71**	**FF**		400	220	110	6,10
400	**68 00 10**	**12**	**249,95**	**FF**		450	220	110	7,85
450	**68 00 11**	**6**	**327,12**	**FF**		500	220	110	8,40
500	**68 00 12**	**1**	**462,96**	**FF**	*	560	270	135	14,90
560	**68 00 18**	**1**	**653,14**	**FF**	**	630	380	190	24,20
630	**68 00 19**	**1**	**967,21**	**FF**	**	710	420	210	36,80

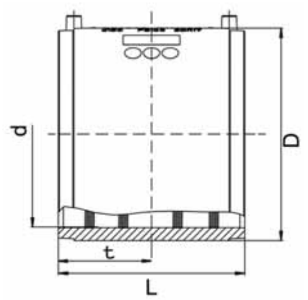
* *separate fusion zones*

** *separate fusion zones and pre-heating technique for compensation of a larger angular gap (d560-d630 compulsory)*

For PE pipes SDR 17-33.
Exposed heating coil for direct heat transmission, extra long insertion depths, wide fusion and cold zone.

Electrofusion coupler SDR 17
UB, without center stop
for electrofusion

PE100
SDR 17
water 10 bar/gas 5 bar



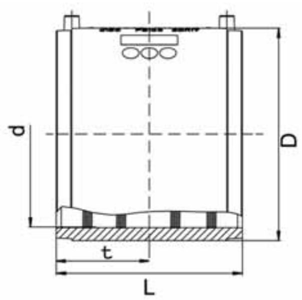
d	Art. Nr.	q	€	AG		D	L	t	kg
560	**61 57 06**	**1**	**1119,35**	**FC**	*	630	380	190	24,20
630	**61 57 26**	**1**	**1423,64**	**FC**	*	710	420	210	36,80
710	**61 59 94**	**1**	**1665,99**	**FC**	*	800	420	210	48,60
800	**61 62 90**	**1**	**3531,94**	**FC**	*	900	500	250	65,90
900	**61 63 45**	**1**	**o.r.**		*	1024	500	250	91,50

* *separate fusion zones and pre-heating technique for compensation of a larger annular gap (> 1 mm, max. 3 mm) (d500-d900 compulsory)*
d710-d900 compulsory use of hydraulic rounding clamp PWXRH

For PE pipes SDR 17-17,6. Other SDR values on request.
Exposed heating coil for direct heat transmission, extra long insertion depths, wide fusion and cold zone.

Electrofusion coupler SDR 11-17
UB, without center stop
for electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



d	Art. Nr.	q	€	AG		D	L	t	kg
20	**61 26 60**	**160**	**7,61**	**FA**		33	60	30	0,04
25	**61 26 61**	**120**	**8,91**	**FA**		38	66	33	0,04
32	**61 26 62**	**60**	**9,79**	**FA**		45	77	39	0,07
40	**61 26 63**	**42**	**10,11**	**FA**		54	86	43	0,10
50	**61 26 64**	**25**	**15,76**	**FA**		68	98	49	0,15
63	**61 26 65**	**15**	**16,52**	**FA**		82	112	56	0,21
75	**61 26 66**	**50**	**23,04**	**FA**		98	122	62	0,32
90	**61 26 67**	**30**	**30,98**	**FA**		118	138	69	0,52
110	**61 26 68**	**24**	**37,71**	**FA**		142	158	79	0,86
125	**61 26 69**	**16**	**51,51**	**FA**		160	172	86	1,20
140	**61 50 01**	**12**	**59,78**	**FA**		181	184	92	1,63
160	**61 26 71**	**8**	**68,47**	**FA**		206	202	101	2,34
180	**61 26 72**	**6**	**101,07**	**FA**		220	210	105	2,09
200	**61 26 73**	**2**	**118,46**	**FA**		247	220	110	2,80
225	**61 26 74**	**1**	**143,45**	**FA**		277	236	118	3,95
250	**61 26 75**	**1**	**202,14**	**FB**		315	246	123	6,70
280	**61 50 73**	**1**	**286,90**	**FB**	*	355	268	134	9,30
315	**61 26 70**	**1**	**326,03**	**FB**	*	400	285	142	13,75
355	**61 50 74**	**1**	**549,90**	**FB**	*	450	300	150	16,70
400	**61 50 75**	**1**	**674,88**	**FB**	*	500	320	160	20,80
450	**61 50 76**	**1**	**911,79**	**FC**	*	560	340	170	30,40
500	**61 51 24**	**1**	**983,51**	**FC**	*	630	360	180	42,50
560	**61 63 12**	**1**	**2153,55**	**FC**	*	715	380	190	56,40
630	**61 62 69**	**1**	**2438,10**	**FC**	*	810	420	210	80,60
710	**61 63 13**	**1**	**o.r.**		*	900	420	210	101,00
800	**61 63 14**	**1**	**o.r.**		*	1000	500	250	149,00

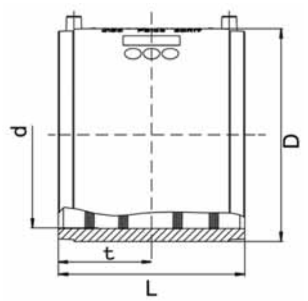
* *separate fusion zones and pre-heating technique for compensation of a larger annular gap (> 1 mm, max. 3 mm) (d280-d450 optional, d500-d900 compulsory)*
d710-d800 compulsory use of FRIATOOLS scraper, FRIAMAT welding machine and hydraulic rounding clamp PWXRH

For PE pipes SDR 11-17,6.
Exposed heating coil for direct heat transmission, extra long insertion depths, wide fusion and cold zone.

PE100 pressure fittings

Electrofusion coupler SDR 7,4-11
UB, without center stop
for electrofusion

PE100
SDR 7,4
water 25 bar



d	Art. Nr.	q	€	AG		D	L	t	kg
90	**61 62 70**	**30**	**30,98**	**FA**		117	138	69	0,53
110	**61 62 71**	**24**	**37,71**	**FA**		142	159	79	0,89
125	**61 62 72**	**16**	**51,51**	**FA**		160	172	86	1,20
140	**61 62 73**	**12**	**59,78**	**FA**		181	184	92	1,62
160	**61 62 74**	**8**	**68,47**	**FA**		206	203	95	2,36
180	**61 62 82**	**6**	**101,07**	**FA**		225	210	105	2,95
200	**61 62 83**	**2**	**118,46**	**FA**		250	224	110	3,87
225	**61 62 84**	**1**	**143,45**	**FA**		280	240	118	5,16
250	**61 62 85**	**1**	**202,14**	**FB**		315	246	123	6,84
280	**61 62 86**	**1**	**286,90**	**FB**	*	355	268	134	10,70
315	**61 62 87**	**1**	**326,03**	**FB**	**	400	285	142	13,40
355	**61 62 88**	**1**	**549,90**	**FB**	**	450	300	150	17,90

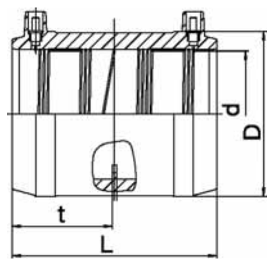
* *separate fusion zones*

** *separate fusion zones and pre-heating technique for compensation of a larger angular gap*

For PE pipes SDR 7,4-11.
Exposed heating coil for direct heat transmission, extra long insertion depths, wide fusion and cold zone.

Electrofusion coupler SDR 11-17
MB, with center stop
for electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



d	Art. Nr.	q	€	AG	D	L	t	kg
20	**61 26 80**	**160**	**7,61**	**FA**	33	60	29	0,04
25	**61 26 81**	**120**	**8,91**	**FA**	38	66	32	0,05
32	**61 26 82**	**60**	**9,79**	**FA**	45	78	38	0,07
40	**61 26 83**	**40**	**10,11**	**FA**	54	85	42	0,10
50	**61 26 84**	**25**	**15,76**	**FA**	68	98	48	0,15
63	**61 26 85**	**15**	**16,52**	**FA**	82	110	55	0,21
75	**61 26 86**	**50**	**23,04**	**FA**	98	122	60	0,32
90	**61 26 87**	**30**	**30,98**	**FA**	117	138	68	0,52
110	**61 26 88**	**24**	**37,71**	**FA**	142	158	78	0,87
125	**61 26 89**	**16**	**51,51**	**FA**	161	172	85	1,20
140	**61 26 90**	**12**	**59,78**	**FA**	181	184	91	1,64
160	**61 26 91**	**8**	**68,47**	**FA**	206	202	100	2,34

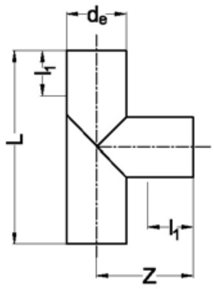
For PE pipes SDR 11-17,6.
Exposed heating coil for direct heat transmission, extra long insertion depths, wide fusion and cold zone.
Easily removable center stop.
Also suitable as repair coupler.

PE100 pressure fittings

Tee 90° welded SDR 33

PE100
SDR 33
water 2 bar

for butt-welding and electrofusion



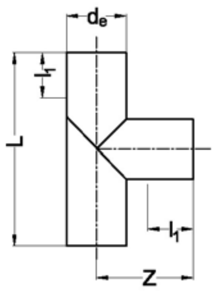
d_e	Art. Nr.	q	€	AG	L	Z	l_1
225	**39 22 02 533**	**1**	**216,42**	**EL**	530	265	150
250	**39 25 02 533**	**1**	**270,01**	**EL**	750	375	250
280	**39 28 02 533**	**1**	**309,38**	**EL**	780	390	250
315	**39 31 02 533**	**1**	**383,94**	**EL**	920	460	300
355	**39 35 02 533**	**1**	**483,00**	**EL**	960	480	300
400	**39 40 02 533**	**1**	**573,17**	**EL**	1000	500	300
450	**39 45 02 533**	**1**	**798,34**	**EL**	1050	525	300
500	**39 50 02 533**	**1**	**1137,70**	**EL**	1200	600	350
560	**39 56 02 533**	**1**	**1629,71**	**EL**	1260	630	350
630	**39 63 02 533**	**1**	**2000,18**	**EL**	1330	665	350
710	**39 71 02 533**	**1**	**2663,14**	**EL**	1410	705	350
800	**39 80 02 533**	**1**	**3160,74**	**EL**	1500	750	350
900	**39 90 02 533**	**1**	**4189,85**	**EL**	1700	850	400
1000	**39 91 02 533**	**1**	**4901,98**	**EL**	1800	900	400

Reduced pressure class, see appendix B2 "Maximum operating pressure for pipes and fittings".
Fabrication on order, returning not possible.

Tee 90° welded SDR 17

PE100
SDR 17
water 6 bar

for butt-welding and electrofusion



d_e	Art. Nr.	q	€	AG	L	Z	l_1
225	**39 22 02 517**	**1**	**240,43**	**EL**	530	265	150
250	**39 25 02 517**	**1**	**299,97**	**EL**	750	375	250
280	**39 28 02 517**	**1**	**343,79**	**EL**	780	390	250
315	**39 31 02 517**	**1**	**426,60**	**EL**	920	460	300
355	**39 35 02 517**	**1**	**536,59**	**EL**	960	480	300
400	**39 40 02 517**	**1**	**636,92**	**EL**	1000	500	300
450	**39 45 02 517**	**1**	**887,00**	**EL**	1050	525	300
500	**39 50 02 517**	**1**	**1264,06**	**EL**	1200	600	350
560	**39 56 02 517**	**1**	**1810,82**	**EL**	1260	630	350
630	**39 63 02 517**	**1**	**2222,43**	**EL**	1330	665	350
710	**39 71 02 517**	**1**	**2959,05**	**EL**	1410	705	350
800	**39 80 02 517**	**1**	**3511,88**	**EL**	1500	750	350

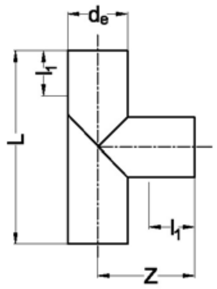
Reduced pressure class, see appendix B2 "Maximum operating pressure for pipes and fittings".
Fabrication on order, returning not possible.

PE100 pressure fittings

Tee 90° welded SDR 11

for butt-welding and electrofusion

PE100
SDR 11
water 10 bar



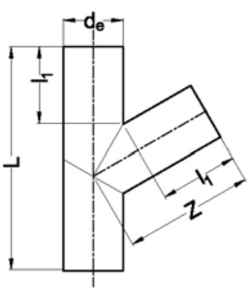
d_e	Art. Nr.	q	€	AG	L	Z	l_1
225	**39 22 02 511**	**1**	**339,61**	**EL**	530	265	150
250	**39 25 02 511**	**1**	**411,48**	**EL**	750	375	250
280	**39 28 02 511**	**1**	**501,03**	**EL**	780	390	250
315	**39 31 02 511**	**1**	**614,31**	**EL**	920	460	300
355	**39 35 02 511**	**1**	**809,77**	**EL**	960	480	300
400	**39 40 02 511**	**1**	**1012,74**	**EL**	1000	500	300
450	**39 45 02 511**	**1**	**1235,49**	**EL**	1050	525	300
500	**39 50 02 511**	**1**	**1686,09**	**EL**	1200	600	350
560	**39 56 02 511**	**1**	**3371,42**	**EL**	1260	630	350
630	**39 63 02 511**	**1**	**4088,73**	**EL**	1330	665	350

Reduced pressure class, see appendix B2 "Maximum operating pressure for pipes and fittings".
Fabrication on order, returning not possible.

Tee 60° welded SDR 33

for butt-welding and electrofusion

PE100
SDR 33
water 1,5 bar



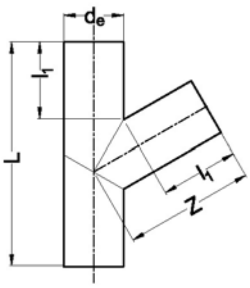
d_e	Art. Nr.	q	€	AG	L	Z	l_1
225	**35 22 02 533**	**1**	**290,80**	**EL**	760	445	250
250	**35 25 02 533**	**1**	**327,75**	**EL**	889	517	300
280	**35 28 02 533**	**1**	**407,49**	**EL**	923	543	300
315	**35 31 02 533**	**1**	**517,77**	**EL**	1064	623	350
355	**35 35 02 533**	**1**	**931,38**	**EL**	1110	658	350
400	**35 40 02 533**	**1**	**999,44**	**EL**	1162	697	350
450	**35 45 02 533**	**1**	**1141,27**	**EL**	1220	740	350
500	**35 50 02 533**	**1**	**1277,52**	**EL**	1277	783	350
560	**35 56 02 533**	**1**	**1464,19**	**EL**	1347	835	350
630	**35 63 02 533**	**1**	**1854,44**	**EL**	1427	896	350
710	**35 71 02 533**	**1**	**o.r.**	**EL**	1520	965	350
800	**35 80 02 533**	**1**	**o.r.**	**EL**	1724	1093	400
900	**35 90 02 533**	**1**	**o.r.**	**EL**	1839	1180	400
1000	**35 91 02 533**	**1**	**o.r.**	**EL**	1955	1266	400

Reduced pressure class, see appendix B2 "Maximum operating pressure for pipes and fittings".
Fabrication on order, returning not possible.

Tee 60° welded SDR 17

for butt-welding and electrofusion

PE100
SDR 17
water 5 bar



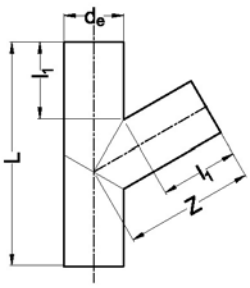
d_e	Art. Nr.	q	€	AG	L	z	l_1
225	**35 22 02 517**	**1**	**339,74**	**EL**	760	445	250
250	**35 25 02 517**	**1**	**440,20**	**EL**	889	517	300
280	**35 28 02 517**	**1**	**506,48**	**EL**	923	543	300
315	**35 31 02 517**	**1**	**622,19**	**EL**	1064	623	350
355	**35 35 02 517**	**1**	**778,16**	**EL**	1110	658	350
400	**35 40 02 517**	**1**	**956,46**	**EL**	1162	697	350
450	**35 45 02 517**	**1**	**1377,85**	**EL**	1220	740	350
500	**35 50 02 517**	**1**	**1865,92**	**EL**	1277	783	350
560	**35 56 02 517**	**1**	**2466,79**	**EL**	1347	835	350
630	**35 63 02 517**	**1**	**3141,29**	**EL**	1427	896	350
710	**35 71 02 517**	**1**	**4051,39**	**EL**	1520	965	350
800	**35 80 02 517**	**1**	**o.r.**	**EL**	1724	1093	400

Reduced pressure class, see appendix B2 "Maximum operating pressure for pipes and fittings".
Fabrication on order, returning not possible.

Tee 60° welded SDR 11

for butt-welding and electrofusion

PE100
SDR 11
water 8 bar



d_e	Art. Nr.	q	€	AG	L	z	l_1
225	**35 22 02 511**	**1**	**508,53**	**EL**	760	445	250
250	**35 25 02 511**	**1**	**660,42**	**EL**	889	517	300
280	**35 28 02 511**	**1**	**759,74**	**EL**	923	543	300
315	**35 31 02 511**	**1**	**933,22**	**EL**	1064	623	350
355	**35 35 02 511**	**1**	**1167,04**	**EL**	1110	658	350
400	**35 40 02 511**	**1**	**1435,65**	**EL**	1162	697	350
450	**35 45 02 511**	**1**	**2065,83**	**EL**	1220	740	350
500	**35 50 02 511**	**1**	**2682,44**	**EL**	1277	783	350
560	**35 56 02 511**	**1**	**3445,08**	**EL**	1347	835	350
630	**35 63 02 511**	**1**	**4416,91**	**EL**	1427	896	350

Reduced pressure class, see appendix B2 "Maximum operating pressure for pipes and fittings".
Fabrication on order, returning not possible.

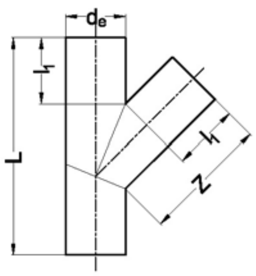
akatherm

PE100 pressure fittings

Tee 45° welded SDR 33

PE100
SDR 33
water 1,5 bar

for butt-welding and electrofusion



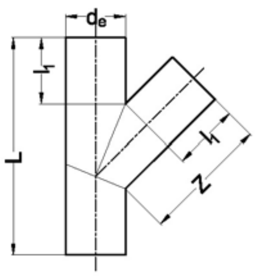
d_e	Art. Nr.	q	€	AG	L	Z	l_1
225	**30 22 02 533**	**1**	**265,23**	**EL**	818	522	250
250	**30 25 02 533**	**1**	**296,78**	**EL**	954	602	300
280	**30 28 02 533**	**1**	**374,64**	**EL**	996	638	300
315	**30 31 02 533**	**1**	**467,23**	**EL**	1145	730	350
355	**30 35 02 533**	**1**	**832,66**	**EL**	1202	779	350
400	**30 40 02 533**	**1**	**900,56**	**EL**	1266	833	350
450	**30 45 02 533**	**1**	**1036,70**	**EL**	1336	893	350
500	**30 50 02 533**	**1**	**1140,10**	**EL**	1407	954	350
560	**30 56 02 533**	**1**	**1320,31**	**EL**	1492	1026	350
630	**30 63 02 533**	**1**	**1677,27**	**EL**	1591	1110	350
710	**30 71 02 533**	**1**	**o.r.**	**EL**	1704	1207	350
800	**30 80 02 533**	**1**	**o.r.**	**EL**	1831	1316	350
900	**30 90 02 533**	**1**	**o.r.**	**EL**	2073	1486	400
1000	**30 91 02 533**	**1**	**o.r.**	**EL**	2214	1607	400

Reduced pressure class, see appendix B2 "Maximum operating pressure for pipes and fittings".
Fabrication on order, returning not possible.

Tee 45° welded SDR 17

PE100
SDR 17
water 4 bar

for butt-welding and electrofusion



d_e	Art. Nr.	q	€	AG	L	Z	l_1
225	**30 22 02 517**	**1**	**381,27**	**EL**	818	522	250
250	**30 25 02 517**	**1**	**514,11**	**EL**	954	602	300
280	**30 28 02 517**	**1**	**593,36**	**EL**	996	638	300
315	**30 31 02 517**	**1**	**730,65**	**EL**	1145	730	350
355	**30 35 02 517**	**1**	**910,61**	**EL**	1202	779	350
400	**30 40 02 517**	**1**	**1171,11**	**EL**	1266	833	350
450	**30 45 02 517**	**1**	**1547,66**	**EL**	1336	893	350
500	**30 50 02 517**	**1**	**2077,52**	**EL**	1407	954	350
560	**30 56 02 517**	**1**	**2753,17**	**EL**	1492	1026	350
630	**30 63 02 517**	**1**	**3495,75**	**EL**	1591	1110	350
710	**30 71 02 517**	**1**	**4498,45**	**EL**	1704	1207	350
800	**30 80 02 517**	**1**	**o.r.**	**EL**	1831	1316	350

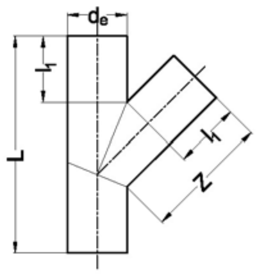
Reduced pressure class, see appendix B2 "Maximum operating pressure for pipes and fittings".
Fabrication on order, returning not possible.

PE100 pressure fittings

Tee 45° welded SDR 11

for butt-welding and electrofusion

PE100
SDR 11
water 7 bar



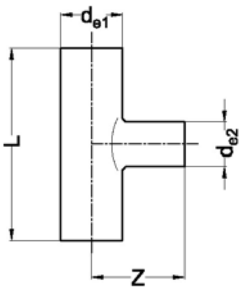
d_e	Art. Nr.	q	€	AG	L	Z	l_1
225	**30 22 02 511**	**1**	**571,89**	**EL**	818	522	250
250	**30 25 02 511**	**1**	**771,16**	**EL**	954	602	300
280	**30 28 02 511**	**1**	**890,03**	**EL**	996	638	300
315	**30 31 02 511**	**1**	**1095,52**	**EL**	1145	730	350
355	**30 35 02 511**	**1**	**1365,66**	**EL**	1202	779	350
400	**30 40 02 511**	**1**	**1757,22**	**EL**	1266	833	350
450	**30 45 02 511**	**1**	**2321,49**	**EL**	1336	893	350
500	**30 50 02 511**	**1**	**2987,24**	**EL**	1407	954	350
560	**30 56 02 511**	**1**	**3857,46**	**EL**	1492	1026	350
630	**30 63 02 511**	**1**	**4931,54**	**EL**	1591	1110	350

Reduced pressure class, see appendix B2 "Maximum operating pressure for pipes and fittings".
Fabrication on order, returning not possible.

PE100 pressure fittings

Tee 90° reduced welded SDR 17
with reduced branch
for butt-welding and electrofusion

PE100
SDR 17
water 6 bar



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
110/32	29 11 03 517	1	37,97	EL	332	180
110/40	29 11 04 517	1	43,07	EL	340	180
110/50	29 11 05 517	1	49,78	EL	350	180
110/63	29 11 06 517	1	57,28	EL	363	180
110/75	29 11 07 517	1	67,57	EL	375	180
125/32	29 12 03 517	1	41,29	EL	332	188
125/40	29 12 04 517	1	47,24	EL	340	188
125/50	29 12 05 517	1	53,47	EL	350	188
125/63	29 12 06 517	1	60,32	EL	363	188
125/75	29 12 07 517	1	71,00	EL	375	188
125/90	29 12 09 517	1	85,22	EL	390	188
140/32	29 14 03 517	1	43,82	EL	332	195
140/40	29 14 04 517	1	51,57	EL	340	195
140/50	29 14 05 517	1	57,15	EL	350	195
140/63	29 14 06 517	1	63,89	EL	363	195
140/75	29 14 07 517	1	74,17	EL	375	195
140/90	29 14 09 517	1	91,07	EL	390	195
140/110	29 14 11 517	1	105,91	EL	410	195
160/32	29 16 03 517	1	46,61	EL	332	205
160/40	29 16 04 517	1	55,50	EL	340	205
160/50	29 16 05 517	1	61,22	EL	350	205
160/63	29 16 06 517	1	66,55	EL	363	205
160/75	29 16 07 517	1	76,71	EL	375	205
160/90	29 16 09 517	1	93,48	EL	390	205
160/110	29 16 11 517	1	107,57	EL	410	205
160/125	29 16 12 517	1	120,14	EL	425	205
180/32	29 18 03 517	1	54,36	EL	332	240
180/40	29 18 04 517	1	61,47	EL	340	240
180/50	29 18 05 517	1	71,00	EL	350	240
180/63	29 18 06 517	1	73,41	EL	363	240
180/75	29 18 07 517	1	83,31	EL	375	240
180/90	29 18 09 517	1	99,32	EL	390	240
180/110	29 18 11 517	1	113,55	EL	410	240
180/125	29 18 12 517	1	126,75	EL	425	240
180/140	29 18 14 517	1	143,39	EL	440	240
200/32	29 20 03 517	1	58,67	EL	332	250
200/40	29 20 04 517	1	63,64	EL	340	250
200/50	29 20 05 517	1	70,60	EL	350	250
200/63	29 20 06 517	1	77,73	EL	363	250
200/75	29 20 07 517	1	87,77	EL	375	250
200/90	29 20 09 517	1	104,54	EL	390	250
200/110	29 20 11 517	1	118,37	EL	410	250
200/125	29 20 12 517	1	128,66	EL	425	250
200/140	29 20 14 517	1	143,26	EL	440	250
200/160	29 20 16 517	1	154,19	EL	460	250
225/63	29 22 06 517	1	86,00	EL	363	238
225/75	29 22 07 517	1	96,39	EL	375	238
225/90	29 22 09 517	1	111,89	EL	390	238
225/110	29 22 11 517	1	125,61	EL	410	238
225/125	29 22 12 517	1	138,17	EL	425	238
225/140	29 22 14 517	1	154,43	EL	440	238
225/160	29 22 16 517	1	163,84	EL	460	238
225/180	29 22 18 517	1	173,62	EL	480	263
250/75	29 25 07 517	1	100,72	EL	475	250
250/90	29 25 09 517	1	117,24	EL	490	250
250/110	29 25 11 517	1	130,96	EL	510	250

-- to be continued --

Tee 90° reduced welded SDR 17 - continuation -

d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
250/125	**29 25 12 517**	**1**	**143,51**	**EL**	525	250
250/140	**29 25 14 517**	**1**	**160,91**	**EL**	540	250
250/160	**29 25 16 517**	**1**	**170,82**	**EL**	560	250
250/180	**29 25 18 517**	**1**	**180,22**	**EL**	580	275
250/200	**29 25 20 517**	**1**	**192,16**	**EL**	600	275
280/75	**29 28 07 517**	**1**	**111,26**	**EL**	475	265
280/90	**29 28 09 517**	**1**	**128,42**	**EL**	490	265
280/110	**29 28 11 517**	**1**	**143,39**	**EL**	510	265
280/125	**29 28 12 517**	**1**	**154,43**	**EL**	525	265
280/140	**29 28 14 517**	**1**	**171,59**	**EL**	540	265
280/160	**29 28 16 517**	**1**	**181,10**	**EL**	560	265
280/180	**29 28 18 517**	**1**	**190,75**	**EL**	580	290
280/200	**29 28 20 517**	**1**	**201,18**	**EL**	600	290
280/225	**29 28 22 517**	**1**	**212,24**	**EL**	625	290
315/90	**29 31 09 517**	**1**	**139,84**	**EL**	490	283
315/110	**29 31 11 517**	**1**	**153,67**	**EL**	510	283
315/125	**29 31 12 517**	**1**	**167,38**	**EL**	525	283
315/140	**29 31 14 517**	**1**	**184,30**	**EL**	540	283
315/160	**29 31 16 517**	**1**	**198,77**	**EL**	560	283
315/180	**29 31 18 517**	**1**	**211,08**	**EL**	580	308
315/200	**29 31 20 517**	**1**	**222,13**	**EL**	600	308
315/225	**29 31 22 517**	**1**	**236,87**	**EL**	625	308
315/250	**29 31 25 517**	**1**	**256,68**	**EL**	650	358
355/110	**29 35 11 517**	**1**	**181,10**	**EL**	510	303
355/125	**29 35 12 517**	**1**	**192,16**	**EL**	525	303
355/140	**29 35 14 517**	**1**	**209,56**	**EL**	540	303
355/160	**29 35 16 517**	**1**	**224,54**	**EL**	560	303
355/180	**29 35 18 517**	**1**	**236,62**	**EL**	580	328
355/200	**29 35 20 517**	**1**	**251,73**	**EL**	600	328
355/225	**29 35 22 517**	**1**	**267,60**	**EL**	625	328
355/250	**29 35 25 517**	**1**	**288,94**	**EL**	650	378
355/280	**29 35 28 517**	**1**	**292,75**	**EL**	680	378
400/110	**29 40 11 517**	**1**	**195,08**	**EL**	510	325
400/125	**29 40 12 517**	**1**	**207,91**	**EL**	525	325
400/140	**29 40 14 517**	**1**	**224,54**	**EL**	540	325
400/160	**29 40 16 517**	**1**	**237,63**	**EL**	560	325
400/180	**29 40 18 517**	**1**	**258,07**	**EL**	580	350
400/200	**29 40 20 517**	**1**	**277,52**	**EL**	600	350
400/225	**29 40 22 517**	**1**	**301,90**	**EL**	625	350
400/250	**29 40 25 517**	**1**	**330,97**	**EL**	650	400
400/280	**29 40 28 517**	**1**	**362,34**	**EL**	680	400
400/315	**29 40 31 517**	**1**	**389,78**	**EL**	715	400
450/110	**29 45 11 517**	**1**	**231,27**	**EL**	510	350
450/125	**29 45 12 517**	**1**	**246,00**	**EL**	525	350
450/140	**29 45 14 517**	**1**	**262,90**	**EL**	540	350
450/160	**29 45 16 517**	**1**	**283,22**	**EL**	560	350
450/180	**29 45 18 517**	**1**	**303,16**	**EL**	580	375
450/200	**29 45 20 517**	**1**	**326,29**	**EL**	600	375
450/225	**29 45 22 517**	**1**	**354,72**	**EL**	625	375
450/250	**29 45 25 517**	**1**	**383,55**	**EL**	650	425
450/280	**29 45 28 517**	**1**	**419,62**	**EL**	680	425
450/315	**29 45 31 517**	**1**	**466,10**	**EL**	715	425
450/355	**29 45 35 517**	**1**	**544,58**	**EL**	755	425
500/110	**29 50 11 517**	**1**	**343,54**	**EL**	510	375
500/125	**29 50 12 517**	**1**	**367,93**	**EL**	525	375
500/140	**29 50 14 517**	**1**	**388,25**	**EL**	540	375
500/160	**29 50 16 517**	**1**	**414,42**	**EL**	560	375
500/180	**29 50 18 517**	**1**	**437,27**	**EL**	580	400
500/200	**29 50 20 517**	**1**	**469,28**	**EL**	600	400
500/225	**29 50 22 517**	**1**	**510,80**	**EL**	625	400

-- to be continued --

akatherm

PE100 pressure fittings

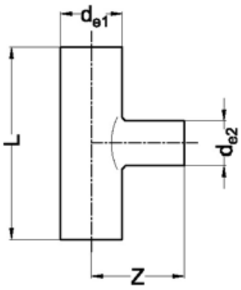
Tee 90° reduced welded SDR 17 - continuation -

d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
500/250	**29 50 25 517**	**1**	**555,51**	**EL**	650	450
500/280	**29 50 28 517**	**1**	**585,36**	**EL**	680	450
500/315	**29 50 31 517**	**1**	**617,75**	**EL**	715	450
500/355	**29 50 35 517**	**1**	**675,66**	**EL**	755	450
500/400	**29 50 40 517**	**1**	**743,47**	**EL**	800	450
560/110	**29 56 11 517**	**1**	**429,66**	**EL**	510	480
560/125	**29 56 12 517**	**1**	**472,58**	**EL**	525	480
560/140	**29 56 14 517**	**1**	**504,72**	**EL**	540	480
560/160	**29 56 16 517**	**1**	**558,30**	**EL**	560	480
560/180	**29 56 18 517**	**1**	**646,33**	**EL**	580	480
560/200	**29 56 20 517**	**1**	**674,38**	**EL**	600	480
560/225	**29 56 22 517**	**1**	**690,02**	**EL**	625	480
560/250	**29 56 25 517**	**1**	**754,15**	**EL**	650	480
560/280	**29 56 28 517**	**1**	**790,85**	**EL**	680	480
560/315	**29 56 31 517**	**1**	**835,67**	**EL**	715	480
560/355	**29 56 35 517**	**1**	**890,03**	**EL**	755	480
560/400	**29 56 40 517**	**1**	**1010,17**	**EL**	800	480
630/160	**29 63 16 517**	**1**	**635,90**	**EL**	560	520
630/180	**29 63 18 517**	**1**	**732,05**	**EL**	580	520
630/200	**29 63 20 517**	**1**	**766,98**	**EL**	600	520
630/225	**29 63 22 517**	**1**	**780,95**	**EL**	625	520
630/250	**29 63 25 517**	**1**	**853,85**	**EL**	650	520
630/280	**29 63 28 517**	**1**	**895,50**	**EL**	680	520
630/315	**29 63 31 517**	**1**	**944,40**	**EL**	715	520
630/355	**29 63 35 517**	**1**	**1007,28**	**EL**	755	520
630/400	**29 63 40 517**	**1**	**1141,38**	**EL**	800	520
630/455	**29 63 45 517**	**1**	**1325,79**	**EL**	850	520

Reduced pressure class, see appendix B2 "Maximum operating pressure for pipes and fittings".
Fabrication on order, returning not possible.

Tee 90° reduced welded SDR 11
with reduced branch
for butt-welding and electrofusion

PE100
SDR 11
water 10 bar



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
110/32	29 11 03 511	1	47,63	EL	332	180
110/40	29 11 04 511	1	53,84	EL	340	180
110/50	29 11 05 511	1	62,62	EL	350	180
110/63	29 11 06 511	1	72,14	EL	363	180
110/75	29 11 07 511	1	85,22	EL	375	180
125/32	29 12 03 511	1	51,69	EL	332	188
125/40	29 12 04 511	1	57,28	EL	340	188
125/50	29 12 05 511	1	66,69	EL	350	188
125/63	29 12 06 511	1	75,96	EL	363	188
125/75	29 12 07 511	1	89,42	EL	375	188
125/90	29 12 09 511	1	107,57	EL	390	188
140/32	29 14 03 511	1	55,88	EL	332	195
140/40	29 14 04 511	1	60,85	EL	340	195
140/50	29 14 05 511	1	70,36	EL	350	195
140/63	29 14 06 511	1	80,02	EL	363	195
140/75	29 14 07 511	1	92,59	EL	375	195
140/90	29 14 09 511	1	113,42	EL	390	195
140/110	29 14 11 511	1	131,59	EL	410	195
160/32	29 16 03 511	1	59,58	EL	332	205
160/40	29 16 04 511	1	65,78	EL	340	205
160/50	29 16 05 511	1	78,62	EL	350	205
160/63	29 16 06 511	1	89,67	EL	363	205
160/75	29 16 07 511	1	103,51	EL	375	205
160/90	29 16 09 511	1	126,13	EL	390	205
160/110	29 16 11 511	1	145,04	EL	410	205
160/125	29 16 12 511	1	162,06	EL	425	205
180/32	29 18 03 511	1	67,57	EL	332	240
180/40	29 18 04 511	1	76,35	EL	340	240
180/50	29 18 05 511	1	88,90	EL	350	240
180/63	29 18 06 511	1	98,69	EL	363	240
180/75	29 18 07 511	1	112,14	EL	375	240
180/90	29 18 09 511	1	134,24	EL	390	240
180/110	29 18 11 511	1	153,56	EL	410	240
180/125	29 18 12 511	1	171,19	EL	425	240
180/140	29 18 14 511	1	192,92	EL	440	240
200/32	29 20 03 511	1	75,57	EL	332	250
200/40	29 20 04 511	1	88,27	EL	340	250
200/50	29 20 05 511	1	101,09	EL	350	250
200/63	29 20 06 511	1	112,14	EL	363	250
200/75	29 20 07 511	1	127,13	EL	375	250
200/90	29 20 09 511	1	150,24	EL	390	250
200/110	29 20 11 511	1	170,70	EL	410	250
200/125	29 20 12 511	1	186,59	EL	425	250
200/140	29 20 14 511	1	206,77	EL	440	250
200/160	29 20 16 511	1	222,26	EL	460	250
225/63	29 22 06 511	1	122,94	EL	363	238
225/75	29 22 07 511	1	137,42	EL	375	238
225/90	29 22 09 511	1	160,80	EL	390	238
225/110	29 22 11 511	1	181,24	EL	410	238
225/125	29 22 12 511	1	199,28	EL	425	238
225/140	29 22 14 511	1	222,26	EL	440	238
225/160	29 22 16 511	1	236,48	EL	460	238
225/180	29 22 18 511	1	251,34	EL	480	263
250/75	29 25 07 511	1	145,55	EL	475	250
250/90	29 25 09 511	1	168,80	EL	490	250
250/110	29 25 11 511	1	188,98	EL	510	250

-- to be continued --

PE100 pressure fittings

Tee 90° reduced welded SDR 11 - continuation -

d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
250/125	**29 25 12 511**	**1**	**207,51**	**EL**	525	250
250/140	**29 25 14 511**	**1**	**230,27**	**EL**	540	250
250/160	**29 25 16 511**	**1**	**246,00**	**EL**	560	250
250/180	**29 25 18 511**	**1**	**259,85**	**EL**	580	275
250/200	**29 25 20 511**	**1**	**278,01**	**EL**	600	275
280/75	**29 28 07 511**	**1**	**161,68**	**EL**	475	265
280/90	**29 28 09 511**	**1**	**184,92**	**EL**	490	265
280/110	**29 28 11 511**	**1**	**205,76**	**EL**	510	265
280/125	**29 28 12 511**	**1**	**223,40**	**EL**	525	265
280/140	**29 28 14 511**	**1**	**246,77**	**EL**	540	265
280/160	**29 28 16 511**	**1**	**261,01**	**EL**	560	265
280/180	**29 28 18 511**	**1**	**276,86**	**EL**	580	290
280/200	**29 28 20 511**	**1**	**293,38**	**EL**	600	290
280/225	**29 28 22 511**	**1**	**310,01**	**EL**	625	290
315/90	**29 31 09 511**	**1**	**202,19**	**EL**	490	283
315/110	**29 31 11 511**	**1**	**222,52**	**EL**	510	283
315/125	**29 31 12 511**	**1**	**242,83**	**EL**	525	283
315/140	**29 31 14 511**	**1**	**266,33**	**EL**	540	283
315/160	**29 31 16 511**	**1**	**287,92**	**EL**	560	283
315/180	**29 31 18 511**	**1**	**305,71**	**EL**	580	308
315/200	**29 31 20 511**	**1**	**321,81**	**EL**	600	308
315/225	**29 31 22 511**	**1**	**343,30**	**EL**	625	308
315/250	**29 31 25 511**	**1**	**364,50**	**EL**	650	358
355/110	**29 35 11 511**	**1**	**258,71**	**EL**	510	303
355/125	**29 35 12 511**	**1**	**277,13**	**EL**	525	303
355/140	**29 35 14 511**	**1**	**301,39**	**EL**	540	303
355/160	**29 35 16 511**	**1**	**323,86**	**EL**	560	303
355/180	**29 35 18 511**	**1**	**341,89**	**EL**	580	328
355/200	**29 35 20 511**	**1**	**364,50**	**EL**	600	328
355/225	**29 35 22 511**	**1**	**387,10**	**EL**	625	328
355/250	**29 35 25 511**	**1**	**418,74**	**EL**	650	378
355/280	**29 35 28 511**	**1**	**427,23**	**EL**	680	378
400/110	**29 40 11 511**	**1**	**281,95**	**EL**	510	325
400/125	**29 40 12 511**	**1**	**300,12**	**EL**	525	325
400/140	**29 40 14 511**	**1**	**322,33**	**EL**	540	325
400/160	**29 40 16 511**	**1**	**343,93**	**EL**	560	325
400/180	**29 40 18 511**	**1**	**371,99**	**EL**	580	350
400/200	**29 40 20 511**	**1**	**401,34**	**EL**	600	350
400/225	**29 40 22 511**	**1**	**437,41**	**EL**	625	350
400/250	**29 40 25 511**	**1**	**478,94**	**EL**	650	400
400/280	**29 40 28 511**	**1**	**525,41**	**EL**	680	400
400/315	**29 40 31 511**	**1**	**570,75**	**EL**	715	400
450/110	**29 45 11 511**	**1**	**348,75**	**EL**	510	350
450/125	**29 45 12 511**	**1**	**358,66**	**EL**	525	350
450/140	**29 45 14 511**	**1**	**380,25**	**EL**	540	350
450/160	**29 45 16 511**	**1**	**407,31**	**EL**	560	350
450/180	**29 45 18 511**	**1**	**437,14**	**EL**	580	375
450/200	**29 45 20 511**	**1**	**471,94**	**EL**	600	375
450/225	**29 45 22 511**	**1**	**513,23**	**EL**	625	375
450/250	**29 45 25 511**	**1**	**555,90**	**EL**	650	425
450/280	**29 45 28 511**	**1**	**604,79**	**EL**	680	425
450/315	**29 45 31 511**	**1**	**673,11**	**EL**	715	425
450/355	**29 45 35 511**	**1**	**758,46**	**EL**	755	425
500/110	**29 50 11 511**	**1**	**472,70**	**EL**	510	375
500/125	**29 50 12 511**	**1**	**485,16**	**EL**	525	375
500/140	**29 50 14 511**	**1**	**497,60**	**EL**	540	375
500/160	**29 50 16 511**	**1**	**532,64**	**EL**	560	375
500/180	**29 50 18 511**	**1**	**562,11**	**EL**	580	400
500/200	**29 50 20 511**	**1**	**598,69**	**EL**	600	400
500/225	**29 50 22 511**	**1**	**633,75**	**EL**	625	400

-- to be continued --

Tee 90° reduced welded SDR 11 - continuation -

d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
500/250	**29 50 25 511**	**1**	**677,82**	**EL**	650	450
500/280	**29 50 28 511**	**1**	**732,30**	**EL**	680	450
500/315	**29 50 31 511**	**1**	**806,98**	**EL**	715	450
500/355	**29 50 35 511**	**1**	**872,26**	**EL**	755	450
500/400	**29 50 40 511**	**1**	**955,32**	**EL**	800	450
560/110	**29 56 11 511**	**1**	**549,80**	**EL**	510	480
560/125	**29 56 12 511**	**1**	**580,91**	**EL**	525	480
560/140	**29 56 14 511**	**1**	**612,03**	**EL**	540	480
560/160	**29 56 16 511**	**1**	**653,56**	**EL**	560	480
560/180	**29 56 18 511**	**1**	**798,72**	**EL**	580	480
560/200	**29 56 20 511**	**1**	**856,91**	**EL**	600	480
560/225	**29 56 22 511**	**1**	**893,60**	**EL**	625	480
560/250	**29 56 25 511**	**1**	**920,90**	**EL**	650	480
560/280	**29 56 28 511**	**1**	**981,87**	**EL**	680	480
560/315	**29 56 31 511**	**1**	**1032,68**	**EL**	715	480
560/355	**29 56 35 511**	**1**	**1095,16**	**EL**	755	480
560/400	**29 56 40 511**	**1**	**1198,03**	**EL**	800	480
630/160	**29 63 16 511**	**1**	**750,20**	**EL**	560	520
630/180	**29 63 18 511**	**1**	**912,26**	**EL**	580	520
630/200	**29 63 20 511**	**1**	**978,43**	**EL**	600	520
630/225	**29 63 22 511**	**1**	**1020,85**	**EL**	625	520
630/250	**29 63 25 511**	**1**	**920,90**	**EL**	650	520
630/280	**29 63 28 511**	**1**	**1120,30**	**EL**	680	520
630/315	**29 63 31 511**	**1**	**1177,96**	**EL**	715	520
630/355	**29 63 35 511**	**1**	**1248,94**	**EL**	755	520
630/400	**29 63 40 511**	**1**	**1365,17**	**EL**	800	520
630/455	**29 63 45 511**	**1**	**1563,29**	**EL**	850	520

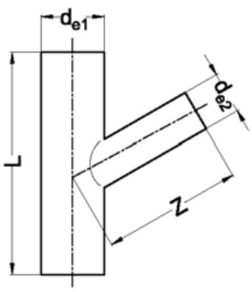
Reduced pressure class, see appendix B2 "Maximum operating pressure for pipes and fittings".
Fabrication on order, returning not possible.

akatherm

PE100 pressure fittings

Tee 60° reduced extrusion welded SDR 17
with reduced branch
for butt-welding and electrofusion

PE100
SDR 17
non pressure, gravity



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
125/110	**35 12 11 517**	**1**	**118,74**	**EL**	527	304
140/110	**35 14 11 517**	**1**	**139,45**	**EL**	527	313
160/110	**35 16 11 517**	**1**	**112,52**	**EL**	527	324
160/125	**35 16 12 517**	**1**	**128,02**	**EL**	544	329
180/110	**35 18 11 517**	**1**	**136,03**	**EL**	527	336
180/125	**35 18 12 517**	**1**	**145,30**	**EL**	544	340
180/140	**35 18 14 517**	**1**	**159,52**	**EL**	562	344
200/110	**35 20 11 517**	**1**	**155,45**	**EL**	627	397
200/125	**35 20 12 517**	**1**	**167,91**	**EL**	644	402
200/140	**35 20 14 517**	**1**	**181,10**	**EL**	662	406
200/160	**35 20 16 517**	**1**	**191,27**	**EL**	685	412
225/110	**35 22 11 517**	**1**	**163,84**	**EL**	627	412
225/125	**35 22 12 517**	**1**	**170,82**	**EL**	644	416
225/140	**35 22 14 517**	**1**	**181,10**	**EL**	662	420
225/160	**35 22 16 517**	**1**	**189,37**	**EL**	685	426
225/180	**35 22 18 517**	**1**	**213,87**	**EL**	708	432
250/110	**35 25 11 517**	**1**	**201,18**	**EL**	727	476
250/125	**35 25 12 517**	**1**	**207,91**	**EL**	744	480
250/140	**35 25 14 517**	**1**	**218,95**	**EL**	762	485
250/160	**35 25 16 517**	**1**	**259,33**	**EL**	785	491
250/180	**35 25 18 517**	**1**	**284,11**	**EL**	808	496
250/200	**35 25 20 517**	**1**	**298,71**	**EL**	831	502
280/110	**35 28 11 517**	**1**	**223,27**	**EL**	727	493
280/125	**35 28 12 517**	**1**	**238,65**	**EL**	744	498
280/140	**35 28 14 517**	**1**	**248,16**	**EL**	762	502
280/160	**35 28 16 517**	**1**	**273,82**	**EL**	785	508
280/180	**35 28 18 517**	**1**	**310,01**	**EL**	808	514
280/200	**35 28 20 517**	**1**	**361,70**	**EL**	831	519
280/225	**35 28 22 517**	**1**	**392,70**	**EL**	860	527
315/110	**35 31 11 517**	**1**	**320,44**	**EL**	827	564
315/125	**35 31 12 517**	**1**	**332,76**	**EL**	844	568
315/140	**35 31 14 517**	**1**	**349,39**	**EL**	862	572
315/160	**35 31 16 517**	**1**	**368,95**	**EL**	885	578
315/180	**35 31 18 517**	**1**	**392,70**	**EL**	908	584
315/200	**35 31 20 517**	**1**	**417,59**	**EL**	931	590
315/225	**35 31 22 517**	**1**	**441,21**	**EL**	960	597
315/250	**35 31 25 517**	**1**	**465,09**	**EL**	989	604
355/110	**35 35 11 517**	**1**	**375,31**	**EL**	827	587
355/125	**35 35 12 517**	**1**	**386,47**	**EL**	844	591
355/140	**35 35 14 517**	**1**	**399,93**	**EL**	862	595
355/160	**35 35 16 517**	**1**	**417,59**	**EL**	885	601
355/180	**35 35 18 517**	**1**	**436,01**	**EL**	908	607
355/200	**35 35 20 517**	**1**	**461,92**	**EL**	931	613
355/225	**35 35 22 517**	**1**	**480,59**	**EL**	960	620
355/250	**35 35 25 517**	**1**	**496,84**	**EL**	989	627
355/280	**35 35 28 517**	**1**	**578,51**	**EL**	1023	636
400/110	**35 40 11 517**	**1**	**474,11**	**EL**	827	613
400/125	**35 40 12 517**	**1**	**487,44**	**EL**	844	617
400/140	**35 40 14 517**	**1**	**513,73**	**EL**	862	621
400/160	**35 40 16 517**	**1**	**529,85**	**EL**	885	627
400/180	**35 40 18 517**	**1**	**543,07**	**EL**	908	633
400/200	**35 40 20 517**	**1**	**579,52**	**EL**	931	639
400/225	**35 40 22 517**	**1**	**616,10**	**EL**	960	646
400/250	**35 40 25 517**	**1**	**634,25**	**EL**	989	653
400/280	**35 40 28 517**	**1**	**662,58**	**EL**	1023	662
400/315	**35 40 31 517**	**1**	**679,85**	**EL**	1064	672

-- to be continued --

Tee 60° reduced extrusion welded SDR 17 - continuation -

d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
450/110	**35 45 11 517**	**1**	**558,30**	**EL**	827	642
450/125	**35 45 12 517**	**1**	**569,48**	**EL**	844	646
450/140	**35 45 14 517**	**1**	**578,51**	**EL**	862	650
450/160	**35 45 16 517**	**1**	**594,75**	**EL**	702	656
450/180	**35 45 18 517**	**1**	**614,95**	**EL**	908	662
450/200	**35 45 20 517**	**1**	**664,61**	**EL**	931	668
450/225	**35 45 22 517**	**1**	**692,93**	**EL**	960	675
450/250	**35 45 25 517**	**1**	**789,20**	**EL**	989	682
450/280	**35 45 28 517**	**1**	**859,18**	**EL**	1023	691
450/315	**35 45 31 517**	**1**	**1004,99**	**EL**	1064	701

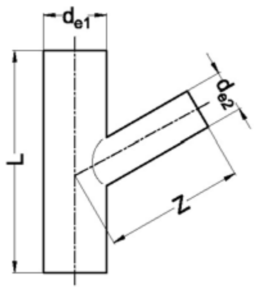
For non pressure applications.
Fabrication on order, returning not possible.

akatherm

PE100 pressure fittings

Tee 60° reduced extrusion welded SDR 11
with reduced branch
for butt-welding and electrofusion

PE100
SDR 11
non pressure, gravity



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
125/110	**35 12 11 511**	**1**	**178,45**	**EL**	527	304
140/110	**35 14 11 511**	**1**	**209,44**	**EL**	527	313
160/110	**35 16 11 511**	**1**	**168,80**	**EL**	527	324
160/125	**35 16 12 511**	**1**	**192,41**	**EL**	544	329
180/110	**35 18 11 511**	**1**	**204,87**	**EL**	527	336
180/125	**35 18 12 511**	**1**	**218,07**	**EL**	544	340
180/140	**35 18 14 511**	**1**	**240,54**	**EL**	562	344
200/110	**35 20 11 511**	**1**	**233,30**	**EL**	627	397
200/125	**35 20 12 511**	**1**	**251,59**	**EL**	644	402
200/140	**35 20 14 511**	**1**	**272,18**	**EL**	662	406
200/160	**35 20 16 511**	**1**	**287,53**	**EL**	685	412
225/110	**35 22 11 511**	**1**	**245,75**	**EL**	627	412
225/125	**35 22 12 511**	**1**	**256,80**	**EL**	644	416
225/140	**35 22 14 511**	**1**	**271,15**	**EL**	662	420
225/160	**35 22 16 511**	**1**	**283,47**	**EL**	685	426
225/180	**35 22 18 511**	**1**	**321,32**	**EL**	708	432
250/110	**35 25 11 511**	**1**	**301,25**	**EL**	727	476
250/125	**35 25 12 511**	**1**	**311,16**	**EL**	744	480
250/140	**35 25 14 511**	**1**	**327,41**	**EL**	762	485
250/160	**35 25 16 511**	**1**	**388,50**	**EL**	785	491
250/180	**35 25 18 511**	**1**	**425,84**	**EL**	808	496
250/200	**35 25 20 511**	**1**	**447,55**	**EL**	831	502
280/110	**35 28 11 511**	**1**	**334,92**	**EL**	727	493
280/125	**35 28 12 511**	**1**	**357,51**	**EL**	744	498
280/140	**35 28 14 511**	**1**	**371,10**	**EL**	762	502
280/160	**35 28 16 511**	**1**	**411,23**	**EL**	785	508
280/180	**35 28 18 511**	**1**	**463,94**	**EL**	808	514
280/200	**35 28 20 511**	**1**	**542,55**	**EL**	831	519
280/225	**35 28 22 511**	**1**	**588,03**	**EL**	860	527
315/110	**35 31 11 511**	**1**	**480,59**	**EL**	827	564
315/125	**35 31 12 511**	**1**	**499,26**	**EL**	844	568
315/140	**35 31 14 511**	**1**	**522,75**	**EL**	862	572
315/160	**35 31 16 511**	**1**	**552,84**	**EL**	885	578
315/180	**35 31 18 511**	**1**	**590,06**	**EL**	908	584
315/200	**35 31 20 511**	**1**	**626,26**	**EL**	931	590
315/225	**35 31 22 511**	**1**	**662,45**	**EL**	960	597
315/250	**35 31 25 511**	**1**	**697,49**	**EL**	989	604
355/110	**35 35 11 511**	**1**	**562,11**	**EL**	827	587
355/125	**35 35 12 511**	**1**	**579,77**	**EL**	844	591
355/140	**35 35 14 511**	**1**	**600,36**	**EL**	862	595
355/160	**35 35 16 511**	**1**	**625,25**	**EL**	885	601
355/180	**35 35 18 511**	**1**	**654,20**	**EL**	908	607
355/200	**35 35 20 511**	**1**	**693,32**	**EL**	931	613
355/225	**35 35 22 511**	**1**	**720,25**	**EL**	960	620
355/250	**35 35 25 511**	**1**	**745,40**	**EL**	989	627
355/280	**35 35 28 511**	**1**	**867,30**	**EL**	1023	636
400/110	**35 40 11 511**	**1**	**710,20**	**EL**	827	613
400/125	**35 40 12 511**	**1**	**730,53**	**EL**	844	617
400/140	**35 40 14 511**	**1**	**769,90**	**EL**	862	621
400/160	**35 40 16 511**	**1**	**795,29**	**EL**	885	627
400/180	**35 40 18 511**	**1**	**813,58**	**EL**	908	633
400/200	**35 40 20 511**	**1**	**869,34**	**EL**	931	639
400/225	**35 40 22 511**	**1**	**923,07**	**EL**	960	646
400/250	**35 40 25 511**	**1**	**951,26**	**EL**	989	653
400/280	**35 40 28 511**	**1**	**992,91**	**EL**	1023	662
400/315	**35 40 31 511**	**1**	**1020,09**	**EL**	1064	672

-- to be continued --

Tee 60° reduced extrusion welded SDR 11 - continuation -

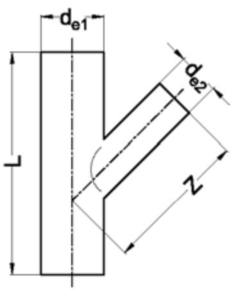
d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
450/110	**35 45 11 511**	**1**	**837,84**	**EL**	827	642
450/125	**35 45 12 511**	**1**	**854,36**	**EL**	844	646
450/140	**35 45 14 511**	**1**	**867,30**	**EL**	862	650
450/160	**35 45 16 511**	**1**	**891,57**	**EL**	702	656
450/180	**35 45 18 511**	**1**	**921,92**	**EL**	908	662
450/200	**35 45 20 511**	**1**	**997,10**	**EL**	931	668
450/225	**35 45 22 511**	**1**	**1040,54**	**EL**	960	675
450/250	**35 45 25 511**	**1**	**1184,31**	**EL**	989	682
450/280	**35 45 28 511**	**1**	**1287,69**	**EL**	1023	691
450/315	**35 45 31 511**	**1**	**1508,68**	**EL**	1064	701

For non pressure applications.
Fabrication on order, returning not possible.

PE100 pressure fittings

Tee 45° reduced extrusion welded SDR 17
with reduced branch
for butt-welding and electrofusion

PE100
SDR 17
non pressure, gravity



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
125/110	**30 12 11 517**	**1**	**154,43**	**EL**	556	343
140/110	**30 14 11 517**	**1**	**180,99**	**EL**	556	354
160/110	**30 16 11 517**	**1**	**129,42**	**EL**	556	368
160/125	**30 16 12 517**	**1**	**143,77**	**EL**	577	376
180/110	**30 18 11 517**	**1**	**136,28**	**EL**	556	382
180/125	**30 18 12 517**	**1**	**151,39**	**EL**	577	390
180/140	**30 18 14 517**	**1**	**164,48**	**EL**	598	397
200/110	**30 20 11 517**	**1**	**156,36**	**EL**	655	446
200/125	**30 20 12 517**	**1**	**171,45**	**EL**	677	454
200/140	**30 20 14 517**	**1**	**192,41**	**EL**	698	461
200/160	**30 20 16 517**	**1**	**216,93**	**EL**	726	471
225/110	**30 22 11 517**	**1**	**171,34**	**EL**	656	464
225/125	**30 22 12 517**	**1**	**186,84**	**EL**	677	472
225/140	**30 22 14 517**	**1**	**195,58**	**EL**	698	479
225/160	**30 22 16 517**	**1**	**221,12**	**EL**	726	489
225/180	**30 22 18 517**	**1**	**237,50**	**EL**	755	499
250/110	**30 25 11 517**	**1**	**205,76**	**EL**	756	532
250/125	**30 25 12 517**	**1**	**209,30**	**EL**	777	539
250/140	**30 25 14 517**	**1**	**230,77**	**EL**	798	547
250/160	**30 25 16 517**	**1**	**268,99**	**EL**	826	557
250/180	**30 25 18 517**	**1**	**294,65**	**EL**	855	567
250/200	**30 25 20 517**	**1**	**314,85**	**EL**	883	577
280/110	**30 28 11 517**	**1**	**228,61**	**EL**	756	553
280/125	**30 28 12 517**	**1**	**243,98**	**EL**	777	560
280/140	**30 28 14 517**	**1**	**252,47**	**EL**	798	568
280/160	**30 28 16 517**	**1**	**305,45**	**EL**	826	578
280/180	**30 28 18 517**	**1**	**318,02**	**EL**	855	588
280/200	**30 28 20 517**	**1**	**371,61**	**EL**	883	598
280/225	**30 28 22 517**	**1**	**406,80**	**EL**	918	610
315/110	**30 31 11 517**	**1**	**324,50**	**EL**	856	628
315/125	**30 31 12 517**	**1**	**340,25**	**EL**	877	635
315/140	**30 31 14 517**	**1**	**360,69**	**EL**	898	643
315/160	**30 31 16 517**	**1**	**383,94**	**EL**	926	653
315/180	**30 31 18 517**	**1**	**417,59**	**EL**	955	663
315/200	**30 31 20 517**	**1**	**440,32**	**EL**	983	673
315/225	**30 31 22 517**	**1**	**482,10**	**EL**	1018	685
315/250	**30 31 25 517**	**1**	**500,01**	**EL**	1054	698
355/110	**30 35 11 517**	**1**	**382,79**	**EL**	856	656
355/125	**30 35 12 517**	**1**	**399,42**	**EL**	877	664
355/140	**30 35 14 517**	**1**	**408,06**	**EL**	898	671
355/160	**30 35 16 517**	**1**	**431,56**	**EL**	926	681
355/180	**30 35 18 517**	**1**	**451,12**	**EL**	955	691
355/200	**30 35 20 517**	**1**	**483,63**	**EL**	983	701
355/225	**30 35 22 517**	**1**	**493,28**	**EL**	1018	714
355/250	**30 35 25 517**	**1**	**536,21**	**EL**	1054	726
355/280	**30 35 28 517**	**1**	**618,40**	**EL**	1096	741
400/110	**30 40 11 517**	**1**	**489,72**	**EL**	856	688
400/125	**30 40 12 517**	**1**	**505,10**	**EL**	877	695
400/140	**30 40 14 517**	**1**	**529,10**	**EL**	898	703
400/160	**30 40 16 517**	**1**	**549,16**	**EL**	926	713
400/180	**30 40 18 517**	**1**	**579,39**	**EL**	955	723
400/200	**30 40 20 517**	**1**	**603,53**	**EL**	983	733
400/225	**30 40 22 517**	**1**	**638,82**	**EL**	1018	745
400/250	**30 40 25 517**	**1**	**661,82**	**EL**	1054	758
400/280	**30 40 28 517**	**1**	**687,35**	**EL**	1096	773
400/315	**30 40 31 517**	**1**	**717,57**	**EL**	1145	790

-- to be continued --

PE100 pressure fittings

Tee 45° reduced extrusion welded SDR 17 - continuation -

d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
450/110	**30 45 11 517**	**1**	**575,97**	**EL**	856	723
450/125	**30 45 12 517**	**1**	**591,72**	**EL**	877	731
450/140	**30 45 14 517**	**1**	**600,36**	**EL**	898	738
450/160	**30 45 16 517**	**1**	**623,47**	**EL**	926	748
450/180	**30 45 18 517**	**1**	**643,90**	**EL**	955	758
450/200	**30 45 20 517**	**1**	**694,07**	**EL**	983	768
450/225	**30 45 22 517**	**1**	**729,38**	**EL**	1018	781
450/250	**30 45 25 517**	**1**	**834,40**	**EL**	1054	793
450/280	**30 45 28 517**	**1**	**901,97**	**EL**	1096	808
450/315	**30 45 31 517**	**1**	**955,07**	**EL**	1145	826

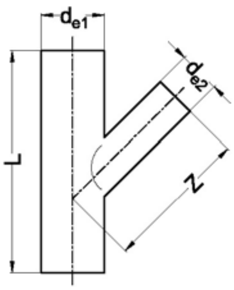
For non pressure applications.
Fabrication on order, returning not possible.

akatherm

PE100 pressure fittings

Tee 45° reduced extrusion welded SDR 11
with reduced branch
for butt-welding and electrofusion

PE100
SDR 11
non pressure, gravity



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
125/110	30 12 11 511	1	231,90	EL	556	343
140/110	30 14 11 511	1	271,29	EL	556	354
160/110	30 16 11 511	1	193,95	EL	556	368
160/125	30 16 12 511	1	215,66	EL	577	376
180/110	30 18 11 511	1	204,23	EL	556	382
180/125	30 18 12 511	1	227,34	EL	577	390
180/140	30 18 14 511	1	246,39	EL	598	397
200/110	30 20 11 511	1	234,59	EL	655	446
200/125	30 20 12 511	1	256,95	EL	677	454
200/140	30 20 14 511	1	288,81	EL	698	461
200/160	30 20 16 511	1	325,64	EL	726	471
225/110	30 22 11 511	1	256,95	EL	656	464
225/125	30 22 12 511	1	280,30	EL	677	472
225/140	30 22 14 511	1	293,51	EL	698	479
225/160	30 22 16 511	1	331,61	EL	726	489
225/180	30 22 18 511	1	356,24	EL	755	499
250/110	30 25 11 511	1	308,75	EL	756	532
250/125	30 25 12 511	1	313,95	EL	777	539
250/140	30 25 14 511	1	346,10	EL	798	547
250/160	30 25 16 511	1	403,24	EL	826	557
250/180	30 25 18 511	1	442,23	EL	855	567
250/200	30 25 20 511	1	472,46	EL	883	577
280/110	30 28 11 511	1	342,78	EL	756	553
280/125	30 28 12 511	1	365,77	EL	777	560
280/140	30 28 14 511	1	378,60	EL	798	568
280/160	30 28 16 511	1	457,98	EL	826	578
280/180	30 28 18 511	1	476,91	EL	855	588
280/200	30 28 20 511	1	557,29	EL	883	598
280/225	30 28 22 511	1	610,39	EL	918	610
315/110	30 31 11 511	1	486,68	EL	856	628
315/125	30 31 12 511	1	510,29	EL	877	635
315/140	30 31 14 511	1	540,91	EL	898	643
315/160	30 31 16 511	1	575,83	EL	926	653
315/180	30 31 18 511	1	626,63	EL	955	663
315/200	30 31 20 511	1	660,29	EL	983	673
315/225	30 31 22 511	1	723,28	EL	1018	685
315/250	30 31 25 511	1	750,20	EL	1054	698
355/110	30 35 11 511	1	574,18	EL	856	656
355/125	30 35 12 511	1	599,33	EL	877	664
355/140	30 35 14 511	1	612,03	EL	898	671
355/160	30 35 16 511	1	647,35	EL	926	681
355/180	30 35 18 511	1	676,56	EL	955	691
355/200	30 35 20 511	1	725,57	EL	983	701
355/225	30 35 22 511	1	739,91	EL	1018	714
355/250	30 35 25 511	1	804,18	EL	1054	726
355/280	30 35 28 511	1	927,38	EL	1096	741
400/110	30 40 11 511	1	734,59	EL	856	688
400/125	30 40 12 511	1	757,44	EL	877	695
400/140	30 40 14 511	1	794,42	EL	898	703
400/160	30 40 16 511	1	823,63	EL	926	713
400/180	30 40 18 511	1	869,09	EL	955	723
400/200	30 40 20 511	1	905,03	EL	983	733
400/225	30 40 22 511	1	958,11	EL	1018	745
400/250	30 40 25 511	1	989,86	EL	1054	758
400/280	30 40 28 511	1	1030,76	EL	1096	773
400/315	30 40 31 511	1	1076,23	EL	1145	790

-- to be continued --

Tee 45° reduced extrusion welded SDR 11 - continuation -

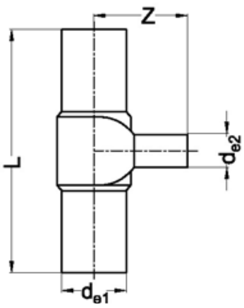
d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
450/110	**30 45 11 511**	**1**	**863,76**	**EL**	856	723
450/125	**30 45 12 511**	**1**	**887,38**	**EL**	877	731
450/140	**30 45 14 511**	**1**	**900,84**	**EL**	898	738
450/160	**30 45 16 511**	**1**	**935,63**	**EL**	926	748
450/180	**30 45 18 511**	**1**	**965,22**	**EL**	955	758
450/200	**30 45 20 511**	**1**	**1041,05**	**EL**	983	768
450/225	**30 45 22 511**	**1**	**1114,71**	**EL**	1018	781
450/250	**30 45 25 511**	**1**	**1251,87**	**EL**	1054	793
450/280	**30 45 28 511**	**1**	**1352,59**	**EL**	1096	808
450/315	**30 45 31 511**	**1**	**1432,08**	**EL**	1145	826

For non pressure applications.
Fabrication on order, returning not possible.

PE100 pressure fittings

Tee 90° reduced machined long SDR17 - pressure class conform
with reduced branch
for butt-welding and electrofusion

PE100
SDR 17
water 10 bar/gas 5 bar



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
280/63	41 28 06 517	1	915,02	EC	770	365
280/75	41 28 07 517	1	931,29	EC	780	365
280/90	41 28 09 517	1	958,31	EC	795	365
280/110	41 28 11 517	1	992,45	EC	815	365
280/125	41 28 12 517	1	1030,46	EC	830	365
280/140	41 28 14 517	1	1066,31	EC	845	365
280/160	41 28 16 517	1	1188,15	EC	865	365
280/180	41 28 18 517	1	1272,86	EC	885	365
280/200	41 28 20 517	1	1356,69	EC	905	365
280/225	41 28 22 517	1	1613,35	EC	930	365
315/75	41 31 07 517	1	1032,18	EC	780	380
315/90	41 31 09 517	1	1054,74	EC	795	380
315/110	41 31 11 517	1	1257,64	EC	815	380
315/125	41 31 12 517	1	1300,92	EC	830	380
315/140	41 31 14 517	1	1234,05	EC	845	380
315/160	41 31 16 517	1	1407,11	EC	865	380
315/180	41 31 18 517	1	1471,10	EC	885	380
315/200	41 31 20 517	1	1527,90	EC	905	380
315/225	41 31 22 517	1	1897,21	EC	930	380
315/250	41 31 25 517	1	2023,32	EC	955	380
355/90	41 35 09 517	1	1232,54	EC	805	400
355/110	41 35 11 517	1	1314,43	EC	825	400
355/125	41 35 12 517	1	1351,41	EC	840	400
355/140	41 35 14 517	1	1410,45	EC	855	400
355/160	41 35 16 517	1	1648,00	EC	875	400
355/180	41 35 18 517	1	1721,04	EC	895	400
355/200	41 35 20 517	1	1802,13	EC	915	400
355/225	41 35 22 517	1	1896,81	EC	940	400
355/250	41 35 25 517	1	2014,77	EC	965	400
355/280	41 35 28 517	1	2459,19	EC	1000	400
400/110	41 40 11 517	1	1549,64	EC	825	425
400/125	41 40 12 517	1	1601,17	EC	840	425
400/140	41 40 14 517	1	1650,74	EC	855	425
400/160	41 40 16 517	1	1697,57	EC	875	425
400/180	41 40 18 517	1	2006,66	EC	895	425
400/200	41 40 20 517	1	2094,12	EC	915	425
400/225	41 40 22 517	1	2187,71	EC	940	425
400/250	41 40 25 517	1	2323,86	EC	965	425
400/280	41 40 28 517	1	2779,02	EC	1000	425
400/315	41 40 31 517	1	3007,01	EC	1035	425
450/125	41 45 12 517	1	1753,76	EC	840	450
450/140	41 45 14 517	1	1805,38	EC	855	450
450/160	41 45 16 517	1	1875,58	EC	875	450
450/180	41 45 18 517	1	2141,37	EC	895	450
450/200	41 45 20 517	1	2226,11	EC	915	450
450/225	41 45 22 517	1	2307,20	EC	940	450
450/250	41 45 25 517	1	2685,76	EC	965	450
450/280	41 45 28 517	1	2850,56	EC	1000	450
450/315	41 45 31 517	1	3072,35	EC	1035	450
450/355	41 45 35 517	1	3894,11	EC	1075	450
500/140	41 50 14 517	1	2287,88	EC	855	475
500/160	41 50 16 517	1	2349,34	EC	875	475
500/180	41 50 18 517	1	2435,71	EC	895	475
500/200	41 50 20 517	1	2524,01	EC	915	475
500/225	41 50 22 517	1	3308,98	EC	940	475
500/250	41 50 25 517	1	3497,25	EC	965	475

-- to be continued --

Tee 90° reduced machined long SDR17 - pressure class conform - continuation -

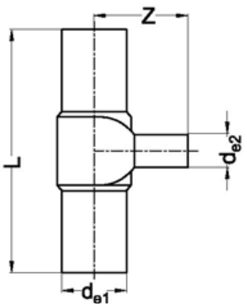
d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
500/280	**41 50 28 517**	**1**	**3521,84**	**EC**	1000	475
500/315	**41 50 31 517**	**1**	**3949,50**	**EC**	1035	475
500/355	**41 50 35 517**	**1**	**4234,19**	**EC**	1075	475
500/400	**41 50 40 517**	**1**	**4720,95**	**EC**	1120	475
560/160	**41 56 16 517**	**1**	**3025,22**	**EC**	875	500
560/180	**41 56 18 517**	**1**	**3140,53**	**EC**	895	500
560/200	**41 56 20 517**	**1**	**3225,08**	**EC**	915	500
560/225	**41 56 22 517**	**1**	**3413,74**	**EC**	940	500
560/250	**41 56 25 517**	**1**	**3491,05**	**EC**	965	500
560/280	**41 56 28 517**	**1**	**3713,57**	**EC**	1000	500
560/315	**41 56 31 517**	**1**	**4101,69**	**EC**	1035	500
560/355	**41 56 35 517**	**1**	**4806,61**	**EC**	1075	500
560/400	**41 56 40 517**	**1**	**5305,99**	**EC**	1120	500
560/450	**41 56 45 517**	**1**	**6495,34**	**EC**	1170	500
560/560	**41 56 56 517**	**1**	**9486,93**	**EC**	1280	500
630/180	**41 63 18 517**	**1**	**3649,45**	**EC**	895	540
630/200	**41 63 20 517**	**1**	**3742,33**	**EC**	915	540
630/225	**41 63 22 517**	**1**	**3891,78**	**EC**	940	540
630/250	**41 63 25 517**	**1**	**4094,49**	**EC**	965	540
630/280	**41 63 28 517**	**1**	**4298,99**	**EC**	1000	540
630/315	**41 63 31 517**	**1**	**5241,87**	**EC**	1035	540
630/355	**41 63 35 517**	**1**	**5567,10**	**EC**	1075	540
630/400	**41 63 40 517**	**1**	**6124,90**	**EC**	1120	540
630/450	**41 63 45 517**	**1**	**7092,67**	**EC**	1170	540
630/500	**41 63 50 517**	**1**	**8733,65**	**EC**	1220	540
630/630	**41 63 63 517**	**1**	**14488,20**	**EC**	1350	540
710/180	**41 71 18 517**	**1**	**5204,49**	**EC**	895	620
710/200	**41 71 20 517**	**1**	**5320,62**	**EC**	915	620
710/225	**41 71 22 517**	**1**	**5433,49**	**EC**	940	620
710/250	**41 71 25 517**	**1**	**5648,59**	**EC**	965	620
710/280	**41 71 28 517**	**1**	**5831,47**	**EC**	1000	620
710/315	**41 71 31 517**	**1**	**6315,40**	**EC**	1035	620
710/355	**41 71 35 517**	**1**	**6639,11**	**EC**	1075	620
710/400	**41 71 40 517**	**1**	**7091,94**	**EC**	1120	620
710/450	**41 71 45 517**	**1**	**7940,53**	**EC**	1170	620
710/500	**41 71 50 517**	**1**	**8993,43**	**EC**	1220	620
710/560	**41 71 56 517**	**1**	**10167,86**	**EC**	1280	620
710/710	**41 71 71 517**	**1**	**17059,55**	**EC**	1450	650

Pressure class guaranteed, all branches extended with pipe.
Fabrication on order, returning not possible.

PE100 pressure fittings

Tee 90° reduced machined long SDR11 - pressure class conform
with reduced branch
for butt-welding and electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
280/63	41 28 06 511	1	1006,58	EC	770	365
280/75	41 28 07 511	1	1023,45	EC	780	365
280/90	41 28 09 511	1	1051,48	EC	795	365
280/110	41 28 11 511	1	1087,04	EC	815	365
280/125	41 28 12 511	1	1126,56	EC	830	365
280/140	41 28 14 511	1	1163,76	EC	845	365
280/160	41 28 16 511	1	1290,36	EC	865	365
280/180	41 28 18 511	1	1347,97	EC	885	365
280/200	41 28 20 511	1	1465,53	EC	905	365
280/225	41 28 22 511	1	1732,32	EC	930	365
315/75	41 31 07 511	1	1116,91	EC	780	380
315/90	41 31 09 511	1	1140,39	EC	795	380
315/110	41 31 11 511	1	1351,22	EC	815	380
315/125	41 31 12 511	1	1396,10	EC	830	380
315/140	41 31 14 511	1	1442,96	EC	845	380
315/160	41 31 16 511	1	1506,55	EC	865	380
315/180	41 31 18 511	1	1573,10	EC	885	380
315/200	41 31 20 511	1	1632,04	EC	905	380
315/225	41 31 22 511	1	2016,00	EC	930	380
315/250	41 31 25 511	1	2146,97	EC	955	380
355/90	41 35 09 511	1	1342,58	EC	805	400
355/110	41 35 11 511	1	1427,62	EC	825	400
355/125	41 35 12 511	1	1466,13	EC	840	400
355/140	41 35 14 511	1	1527,39	EC	855	400
355/160	41 35 16 511	1	1774,28	EC	875	400
355/180	41 35 18 511	1	1850,08	EC	895	400
355/200	41 35 20 511	1	1934,42	EC	915	400
355/225	41 35 22 511	1	2032,77	EC	940	400
355/250	41 35 25 511	1	2155,08	EC	965	400
355/280	41 35 28 511	1	2617,19	EC	1000	400
400/110	41 40 11 511	1	1704,79	EC	825	425
400/125	41 40 12 511	1	1758,13	EC	840	425
400/140	41 40 14 511	1	1809,84	EC	855	425
400/160	41 40 16 511	1	1858,41	EC	875	425
400/180	41 40 18 511	1	2179,67	EC	895	425
400/200	41 40 20 511	1	2270,51	EC	915	425
400/225	41 40 22 511	1	2367,75	EC	940	425
400/250	41 40 25 511	1	2509,17	EC	965	425
400/280	41 40 28 511	1	2982,34	EC	1000	425
400/315	41 40 31 511	1	3219,27	EC	1035	425
450/125	41 45 12 511	1	1918,47	EC	840	450
450/140	41 45 14 511	1	1972,10	EC	855	450
450/160	41 45 16 511	1	2044,96	EC	875	450
450/180	41 45 18 511	1	2321,20	EC	895	450
450/200	41 45 20 511	1	2409,29	EC	915	450
450/225	41 45 22 511	1	2493,42	EC	940	450
450/250	41 45 25 511	1	2886,94	EC	965	450
450/280	41 45 28 511	1	3058,34	EC	1000	450
450/315	41 45 31 511	1	3288,65	EC	1035	450
450/355	41 45 35 511	1	4142,64	EC	1075	450
500/140	41 50 14 511	1	2493,11	EC	855	475
500/160	41 50 16 511	1	2557,02	EC	875	475
500/180	41 50 18 511	1	2646,84	EC	895	475
500/200	41 50 20 511	1	2738,60	EC	915	475
500/225	41 50 22 511	1	3554,47	EC	940	475
500/250	41 50 25 511	1	3750,04	EC	965	475

-- to be continued --

Tee 90° reduced machined long SDR11 - pressure class conform - continuation -

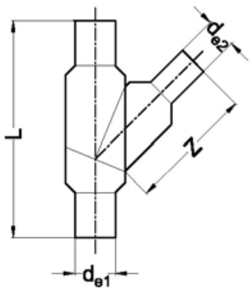
d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
500/280	**41 50 28 511**	**1**	**3775,56**	**EC**	1000	475
500/315	**41 50 31 511**	**1**	**4219,96**	**EC**	1035	475
500/355	**41 50 35 511**	**1**	**4515,82**	**EC**	1075	475
500/400	**41 50 40 511**	**1**	**5021,61**	**EC**	1120	475
560/160	**41 56 16 511**	**1**	**3307,26**	**EC**	875	500
560/180	**41 56 18 511**	**1**	**3427,14**	**EC**	895	500
560/200	**41 56 20 511**	**1**	**3514,94**	**EC**	915	500
560/225	**41 56 22 511**	**1**	**3710,93**	**EC**	940	500
560/250	**41 56 25 511**	**1**	**3791,39**	**EC**	965	500
560/280	**41 56 28 511**	**1**	**4022,63**	**EC**	1000	500
560/315	**41 56 31 511**	**1**	**4426,00**	**EC**	1035	500
560/355	**41 56 35 511**	**1**	**5158,57**	**EC**	1075	500
560/400	**41 56 40 511**	**1**	**5677,44**	**EC**	1120	500
560/450	**41 56 45 511**	**1**	**6913,34**	**EC**	1170	500
560/560	**41 56 56 511**	**1**	**10022,16**	**EC**	1280	500
630/180	**41 63 18 511**	**1**	**3969,70**	**EC**	895	540
630/200	**41 63 20 511**	**1**	**4066,23**	**EC**	915	540
630/225	**41 63 22 511**	**1**	**4221,58**	**EC**	940	540
630/250	**41 63 25 511**	**1**	**4432,20**	**EC**	965	540
630/280	**41 63 28 511**	**1**	**4644,75**	**EC**	1000	540
630/315	**41 63 31 511**	**1**	**5624,49**	**EC**	1035	540
630/355	**41 63 35 511**	**1**	**5962,45**	**EC**	1075	540
630/400	**41 63 40 511**	**1**	**6542,18**	**EC**	1120	540
630/450	**41 63 45 511**	**1**	**7547,96**	**EC**	1170	540
630/500	**41 63 50 511**	**1**	**9253,14**	**EC**	1220	540
630/630	**41 63 63 511**	**1**	**15233,15**	**EC**	1350	540
710/180	**41 71 18 511**	**1**	**5876,39**	**EC**	895	620
710/200	**41 71 20 511**	**1**	**5997,09**	**EC**	915	620
710/225	**41 71 22 511**	**1**	**6114,43**	**EC**	940	620
710/250	**41 71 25 511**	**1**	**6337,97**	**EC**	965	620
710/280	**41 71 28 511**	**1**	**6527,96**	**EC**	1000	620
710/315	**41 71 31 511**	**1**	**7030,89**	**EC**	1035	620
710/355	**41 71 35 511**	**1**	**7367,29**	**EC**	1075	620
710/400	**41 71 40 511**	**1**	**7837,83**	**EC**	1120	620
710/450	**41 71 45 511**	**1**	**8719,63**	**EC**	1170	620
710/500	**41 71 50 511**	**1**	**9813,77**	**EC**	1220	620
710/560	**41 71 56 511**	**1**	**11034,23**	**EC**	1280	620
710/710	**41 71 71 511**	**1**	**18195,98**	**EC**	1450	650

Pressure class guaranteed, all branches extended with pipe.
Fabrication on order, returning not possible.

PE100 pressure fittings

Tee 45° reduced machined long SDR17 - pressure class conform
with reduced branch
for butt-welding and electrofusion

PE100
SDR 17
water 10 bar/gas 5 bar



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
125/63	42 12 06 517	1	527,12	EC	580	350
125/75	42 12 07 517	1	527,12	EC	580	350
125/90	42 12 09 517	1	527,12	EC	580	350
125/110	42 12 11 517	1	527,12	EC	580	350
125/125	42 12 12 517	1	494,51	EC	580	350
140/75	42 14 07 517	1	638,99	EC	600	370
140/90	42 14 09 517	1	638,99	EC	600	370
140/110	42 14 11 517	1	638,99	EC	600	370
140/125	42 14 12 517	1	638,99	EC	600	370
140/140	42 14 14 517	1	592,54	EC	600	370
160/90	42 16 09 517	1	704,31	EC	540	420
160/110	42 16 11 517	1	704,31	EC	540	420
160/125	42 16 12 517	1	704,31	EC	540	420
160/140	42 16 14 517	1	704,31	EC	540	420
180/110	42 18 11 517	1	877,34	EC	660	420
180/125	42 18 12 517	1	877,34	EC	660	420
180/140	42 18 14 517	1	877,34	EC	660	420
180/160	42 18 16 517	1	877,34	EC	660	420
180/180	42 18 18 517	1	836,19	EC	660	420
200/110	42 20 11 517	1	958,31	EC	790	490
200/125	42 20 12 517	1	958,31	EC	790	490
200/140	42 20 14 517	1	958,31	EC	790	490
200/160	42 20 16 517	1	958,31	EC	790	490
200/180	42 20 18 517	1	958,31	EC	790	490
200/200	42 20 20 517	1	911,98	EC	790	490
225/110	42 22 11 517	1	1269,94	EC	702	540
225/125	42 22 12 517	1	1269,94	EC	702	540
225/140	42 22 14 517	1	1269,94	EC	702	540
225/160	42 22 16 517	1	1269,94	EC	702	540
225/180	42 22 18 517	1	1269,94	EC	702	540
225/200	42 22 20 517	1	1269,94	EC	702	540
250/110	42 25 11 517	1	1433,61	EC	960	580
250/125	42 25 12 517	1	1433,61	EC	960	580
250/140	42 25 14 517	1	1433,61	EC	960	580
250/160	42 25 16 517	1	1433,61	EC	960	580
250/180	42 25 18 517	1	1433,61	EC	960	580
250/200	42 25 20 517	1	1433,61	EC	960	580
250/225	42 25 22 517	1	1433,61	EC	960	580
250/250	42 25 25 517	1	1354,36	EC	960	580
280/160	42 28 16 517	1	1664,46	EC	1000	640
280/180	42 28 18 517	1	1664,46	EC	1000	640
280/200	42 28 20 517	1	1664,46	EC	1000	640
280/225	42 28 22 517	1	1664,46	EC	1000	640
280/250	42 28 25 517	1	1664,46	EC	1000	640
280/280	42 28 28 517	1	1580,02	EC	1000	640
315/160	42 31 16 517	1	2383,49	EC	1150	730
315/180	42 31 18 517	1	2383,49	EC	1150	730
315/200	42 31 20 517	1	2383,49	EC	1150	730
315/225	42 31 22 517	1	2383,49	EC	1150	730
315/250	42 31 25 517	1	2383,49	EC	1150	730
315/280	42 31 28 517	1	2383,49	EC	1150	730
315/315	42 31 31 517	1	2302,01	EC	1150	730
355/200	42 35 20 517	1	3923,07	EC	1210	780
355/225	42 35 22 517	1	3923,07	EC	1210	780
355/250	42 35 25 517	1	3923,07	EC	1210	780
355/280	42 35 28 517	1	3923,07	EC	1210	780

-- to be continued --

PE100 pressure fittings

Tee 45° reduced machined long SDR17 - pressure class conform - continuation -

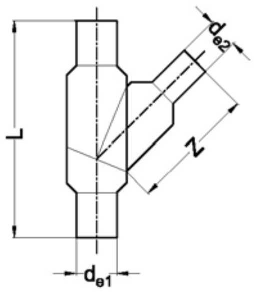
d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
355/315	**42 35 31 517**	**1**	**3923,07**	**EC**	1210	780
355/355	**42 35 35 517**	**1**	**3772,70**	**EC**	1210	780
400/200	**42 40 20 517**	**1**	**4700,64**	**EC**	1270	840
400/225	**42 40 22 517**	**1**	**4700,64**	**EC**	1270	840
400/250	**42 40 25 517**	**1**	**4700,64**	**EC**	1270	840
400/280	**42 40 28 517**	**1**	**4700,64**	**EC**	1270	840
400/315	**42 40 31 517**	**1**	**4700,64**	**EC**	1270	840
400/355	**42 40 35 517**	**1**	**4700,64**	**EC**	1270	840
400/400	**42 40 40 517**	**1**	**4517,85**	**EC**	1270	840
450/250	**42 45 25 517**	**1**	**6042,51**	**EC**	1340	900
450/280	**42 45 28 517**	**1**	**6042,51**	**EC**	1340	900
450/315	**42 45 31 517**	**1**	**6042,51**	**EC**	1340	900
450/355	**42 45 35 517**	**1**	**6042,51**	**EC**	1340	900
450/400	**42 45 40 517**	**1**	**6042,51**	**EC**	1340	900
450/450	**42 45 45 517**	**1**	**6042,51**	**EC**	1340	900
500/500	**42 50 50 517**	**1**	**7996,32**	**EC**	1410	960
560/560	**42 56 56 517**	**1**	**10298,41**	**EC**	1500	1030
630/630	**42 63 63 517**	**1**	**13137,39**	**EC**	1600	1110

60° on request.
Pressure class guaranteed, all branches extended with pipe.
Fabrication on order, returning not possible.

PE100 pressure fittings

Tee 45° reduced machined long SDR11 - pressure class conform
with reduced branch
for butt-welding and electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
125/63	42 12 06 511	1	544,58	EC	580	350
125/75	42 12 07 511	1	544,58	EC	580	350
125/90	42 12 09 511	1	544,58	EC	580	350
125/110	42 12 11 511	1	544,58	EC	580	350
125/125	42 12 12 511	1	511,98	EC	580	350
140/75	42 14 07 511	1	655,64	EC	600	370
140/90	42 14 09 511	1	655,64	EC	600	370
140/110	42 14 11 511	1	655,64	EC	600	370
140/125	42 14 12 511	1	655,64	EC	600	370
140/140	42 14 14 511	1	608,81	EC	600	370
160/90	42 16 09 511	1	742,71	EC	540	420
160/110	42 16 11 511	1	742,71	EC	540	420
160/125	42 16 12 511	1	742,71	EC	540	420
160/140	42 16 14 511	1	742,71	EC	540	420
180/110	42 18 11 511	1	922,05	EC	660	420
180/125	42 18 12 511	1	922,05	EC	660	420
180/140	42 18 14 511	1	922,05	EC	660	420
180/160	42 18 16 511	1	922,05	EC	660	420
180/180	42 18 18 511	1	880,38	EC	660	420
200/110	42 20 11 511	1	996,63	EC	790	490
200/125	42 20 12 511	1	996,63	EC	790	490
200/140	42 20 14 511	1	996,63	EC	790	490
200/160	42 20 16 511	1	996,63	EC	790	490
200/180	42 20 18 511	1	996,63	EC	790	490
200/200	42 20 20 511	1	946,43	EC	790	490
225/110	42 22 11 511	1	1315,03	EC	702	540
225/125	42 22 12 511	1	1315,03	EC	702	540
225/140	42 22 14 511	1	1315,03	EC	702	540
225/160	42 22 16 511	1	1315,03	EC	702	540
225/180	42 22 18 511	1	1315,03	EC	702	540
225/200	42 22 20 511	1	1315,03	EC	702	540
250/110	42 25 11 511	1	1486,44	EC	960	580
250/125	42 25 12 511	1	1486,44	EC	960	580
250/140	42 25 14 511	1	1486,44	EC	960	580
250/160	42 25 16 511	1	1486,44	EC	960	580
250/180	42 25 18 511	1	1486,44	EC	960	580
250/200	42 25 20 511	1	1486,44	EC	960	580
250/225	42 25 22 511	1	1486,44	EC	960	580
250/250	42 25 25 511	1	1403,34	EC	960	580
280/160	42 28 16 511	1	1726,73	EC	1000	640
280/180	42 28 18 511	1	1726,73	EC	1000	640
280/200	42 28 20 511	1	1726,73	EC	1000	640
280/225	42 28 22 511	1	1726,73	EC	1000	640
280/250	42 28 25 511	1	1726,73	EC	1000	640
280/280	42 28 28 511	1	1645,15	EC	1000	640
315/160	42 31 16 511	1	2497,59	EC	1150	730
315/180	42 31 18 511	1	2497,59	EC	1150	730
315/200	42 31 20 511	1	2497,59	EC	1150	730
315/225	42 31 22 511	1	2497,59	EC	1150	730
315/250	42 31 25 511	1	2497,59	EC	1150	730
315/280	42 31 28 511	1	2497,59	EC	1150	730
315/315	42 31 31 511	1	2423,42	EC	1150	730
355/200	42 35 20 511	1	4110,03	EC	1210	780
355/225	42 35 22 511	1	4110,03	EC	1210	780
355/250	42 35 25 511	1	4110,03	EC	1210	780
355/280	42 35 28 511	1	4110,03	EC	1210	780

-- to be continued --

Tee 45° reduced machined long SDR11 - pressure class conform - continuation -

d_{e1}/d_{e2}	Art. Nr.	q	€	AG	L	Z
355/315	**42 35 31 511**	**1**	**4110,03**	**EC**	1210	780
355/355	**42 35 35 511**	**1**	**3943,39**	**EC**	1210	780
400/200	**42 40 20 511**	**1**	**4878,95**	**EC**	1270	840
400/225	**42 40 22 511**	**1**	**4878,95**	**EC**	1270	840
400/250	**42 40 25 511**	**1**	**4878,95**	**EC**	1270	840
400/280	**42 40 28 511**	**1**	**4878,95**	**EC**	1270	840
400/315	**42 40 31 511**	**1**	**4878,95**	**EC**	1270	840
400/355	**42 40 35 511**	**1**	**4878,95**	**EC**	1270	840
400/400	**42 40 40 511**	**1**	**4734,67**	**EC**	1270	840
450/250	**42 45 25 511**	**1**	**6333,80**	**EC**	1340	900
450/280	**42 45 28 511**	**1**	**6333,80**	**EC**	1340	900
450/315	**42 45 31 511**	**1**	**6333,80**	**EC**	1340	900
450/355	**42 45 35 511**	**1**	**6333,80**	**EC**	1340	900
450/400	**42 45 40 511**	**1**	**6333,80**	**EC**	1340	900
450/450	**42 45 45 511**	**1**	**6106,31**	**EC**	1340	900
500/500	**42 50 50 511**	**1**	**8429,23**	**EC**	1410	960
560/560	**42 56 56 511**	**1**	**10769,44**	**EC**	1500	1030
630/630	**42 63 63 511**	**1**	**13707,69**	**EC**	1600	1110

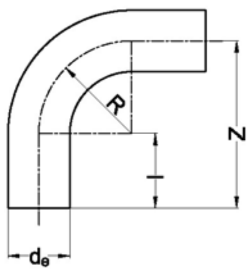
60° on request.
Pressure class guaranteed, all branches extended with pipe.
Fabrication on order, returning not possible.

PE100 pressure fittings

Bend 90° seamless formed R = 1,5 x d_e SDR 17

for butt-welding and electrofusion

PE100
SDR 17
water 10 bar/gas 5 bar



d_e	Art. Nr.	q	€	AG		Z	l	R
50	**19 05 93 517**	**1**	**33,85**	**EH**		250	120	75
63	**19 06 93 517**	**1**	**49,81**	**EH**		270	120	95
75	**19 07 93 517**	**1**	**53,28**	**EH**		300	130	113
90	**19 09 93 517**	**1**	**58,29**	**EH**		300	115	135
110	**19 11 93 517**	**1**	**72,98**	**EH**		380	150	165
125	**19 12 93 517**	**1**	**84,49**	**EH**		420	160	188
140	**19 14 93 517**	**1**	**97,52**	**EH**		450	165	210
160	**19 16 93 517**	**1**	**110,13**	**EH**		520	195	240
180	**19 18 93 517**	**1**	**174,98**	**EH**		580	215	270
200	**19 20 93 517**	**1**	**211,42**	**EH**		620	225	300
225	**19 22 93 517**	**1**	**249,42**	**EH**		700	255	338
250	**19 25 93 517**	**1**	**314,76**	**EH**		720	240	375
280	**19 28 93 517**	**1**	**354,86**	**EH**		760	235	420
315	**19 31 93 517**	**1**	**463,49**	**EH**		950	335	473
355	**19 35 93 517**	**1**	**608,58**	**EH**	*	1100	400	533
400	**19 40 93 517**	**1**	**855,50**	**EH**	*	1200	420	600
450	**19 45 93 517**	**1**	**1210,88**	**EH**	**	1350	315	900
500	**19 50 93 517**	**1**	**1737,89**	**EH**	**	1550	385	1000
560	**19 56 93 517**	**1**	**2050,20**	**EH**	**	1900	545	1120
630	**19 63 93 517**	**1**	**2558,21**	**EH**	**	2100	585	1260
710	**19 71 93 517**	**1**	**4831,05**	**EH**	**	2200	570	1440
800	**19 80 93 517**	**1**	**7598,85**	**EH**	**	2200	480	1600

* *fabrication on order, returning not possible*

** *R = 2,0 x d_e*
fabrication on order, returning not possible

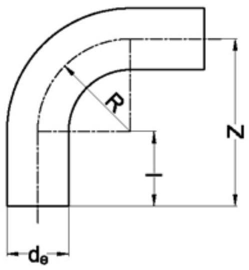
Variances of +/- 3° are possible.

Bend 90° seamless formed R = 1,5 x d_e SDR 11

PE100
SDR 11

for butt-welding and electrofusion

water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG		Z	l	R
50	19 05 93 511	1	40,98	EH		250	120	75
63	19 06 93 511	1	57,38	EH		270	120	95
75	19 07 93 511	1	63,69	EH		300	130	113
90	19 09 93 511	1	71,37	EH		300	115	135
110	19 11 93 511	1	92,62	EH		380	150	165
125	19 12 93 511	1	106,28	EH		420	160	188
140	19 14 93 511	1	122,17	EH		450	165	210
160	19 16 93 511	1	146,24	EH		520	195	240
180	19 18 93 511	1	241,50	EH		580	215	270
200	19 20 93 511	1	293,15	EH		620	225	300
225	19 22 93 511	1	347,82	EH		700	255	338
250	19 25 93 511	1	421,09	EH		720	240	375
280	19 28 93 511	1	512,32	EH		760	235	420
315	19 31 93 511	1	635,95	EH		950	335	473
355	19 35 93 511	1	915,56	EH	*	1100	400	533
400	19 40 93 511	1	1049,74	EH	*	1200	420	600
450	19 45 93 511	1	1483,40	EH	**	1350	315	900
500	19 50 93 511	1	2231,15	EH	**	1550	385	1000
560	19 56 93 511	1	2654,98	EH	**	1900	545	1120
630	19 63 93 511	1	3410,94	EH	**	2100	585	1260
710	19 71 93 511	1	6466,95	EH	**	2200	570	1440

* *fabrication on order, returning not possible*

** *R = 2,0 x d_e*
fabrication on order, returning not possible

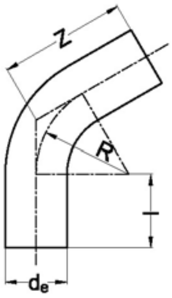
Variances of +/- 3° are possible.

PE100 pressure fittings

Bend 60° seamless formed R = 1,5 x d_e SDR 17

for butt-welding and electrofusion

PE100
SDR 17
water 10 bar/gas 5 bar



d_e	Art. Nr.	q	€	AG		Z	l	R
50	**19 05 63 517**	**1**	**33,57**	**EH**		200	110	75
63	**19 06 63 517**	**1**	**49,15**	**EH**		220	115	95
75	**19 07 63 517**	**1**	**52,28**	**EH**		240	120	113
90	**19 09 63 517**	**1**	**56,46**	**EH**		260	125	135
110	**19 11 63 517**	**1**	**70,54**	**EH**		280	150	165
125	**19 12 63 517**	**1**	**79,83**	**EH**		300	150	188
140	**19 14 63 517**	**1**	**91,06**	**EH**		400	195	210
160	**19 16 63 517**	**1**	**100,46**	**EH**		430	205	240
180	**19 18 63 517**	**1**	**160,79**	**EH**		450	205	270
200	**19 20 63 517**	**1**	**194,16**	**EH**		500	230	300
225	**19 22 63 517**	**1**	**230,66**	**EH**		550	250	338
250	**19 25 63 517**	**1**	**280,39**	**EH**		600	265	375
280	**19 28 63 517**	**1**	**312,05**	**EH**		630	270	420
315	**19 31 63 517**	**1**	**407,03**	**EH**		830	390	473
355	**19 35 63 517**	**1**	**627,77**	**EH**	*	900	415	533
400	**19 40 63 517**	**1**	**871,36**	**EH**	*	1000	455	600
450	**19 45 63 517**	**1**	**1047,46**	**EH**	**	1115	415	900
500	**19 50 63 517**	**1**	**1436,25**	**EH**	**	1300	505	1000
560	**19 56 63 517**	**1**	**1844,58**	**EH**	**	1450	560	1120
630	**19 63 63 517**	**1**	**2292,11**	**EH**	**	1600	610	1260
710	**19 71 63 517**	**1**	**4747,05**	**EH**	**	1700	570	1440
800	**19 80 63 517**	**1**	**7067,55**	**EH**	**	1700	480	1600

* *fabrication on order, returning not possible*

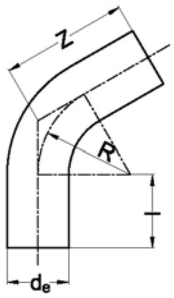
** *R = 2,0 x d_e*
fabrication on order, returning not possible

Variances of +/- 3° are possible.

Bend 60° seamless formed R = 1,5 x d_e SDR 11

for butt-welding and electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG		Z	l	R
50	**19 05 63 511**	**1**	**40,39**	**EH**		200	110	75
63	**19 06 63 511**	**1**	**56,58**	**EH**		220	115	95
75	**19 07 63 511**	**1**	**62,04**	**EH**		240	120	113
90	**19 09 63 511**	**1**	**68,72**	**EH**		260	125	135
110	**19 11 63 511**	**1**	**88,95**	**EH**		280	150	165
125	**19 12 63 511**	**1**	**99,10**	**EH**		300	150	188
140	**19 14 63 511**	**1**	**111,56**	**EH**		400	195	210
160	**19 16 63 511**	**1**	**130,95**	**EH**		430	205	240
180	**19 18 63 511**	**1**	**219,05**	**EH**		450	205	270
200	**19 20 63 511**	**1**	**265,42**	**EH**		500	230	300
225	**19 22 63 511**	**1**	**318,83**	**EH**		550	250	338
250	**19 25 63 511**	**1**	**372,36**	**EH**		600	265	375
280	**19 28 63 511**	**1**	**444,72**	**EH**		630	270	420
315	**19 31 63 511**	**1**	**542,70**	**EH**		830	390	473
355	**19 35 63 511**	**1**	**974,07**	**EH**	*	900	415	533
400	**19 40 63 511**	**1**	**1071,27**	**EH**	*	1000	455	600
450	**19 45 63 511**	**1**	**1316,46**	**EH**	**	1115	415	900
500	**19 50 63 511**	**1**	**1843,88**	**EH**	**	1300	505	1000
560	**19 56 63 511**	**1**	**2388,88**	**EH**	**	1450	560	1120
630	**19 63 63 511**	**1**	**3066,22**	**EH**	**	1600	610	1260
710	**19 71 63 511**	**1**	**6375,60**	**EH**	**	1700	570	1600

* *fabrication on order, returning not possible*

** *R = 2,0 x d_e*
fabrication on order, returning not possible

Variances of +/- 3° are possible.

akatherm

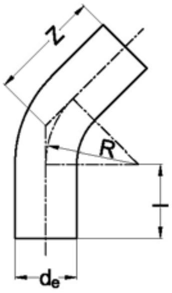
PE100 pressure fittings

Bend 45° seamless formed R = 1,5 x d_e SDR 17

PE100
SDR 17

for butt-welding and electrofusion

water 10 bar/gas 5 bar



d_e	Art. Nr.	q	€	AG		Z	l	R
50	**19 05 48 517**	**1**	**33,57**	**EH**		170	100	75
63	**19 06 48 517**	**1**	**49,15**	**EH**		180	100	95
75	**19 07 48 517**	**1**	**52,28**	**EH**		200	100	113
90	**19 09 48 517**	**1**	**56,46**	**EH**		220	100	135
110	**19 11 48 517**	**1**	**70,54**	**EH**		240	150	165
125	**19 12 48 517**	**1**	**79,83**	**EH**		270	150	188
140	**19 14 48 517**	**1**	**91,06**	**EH**		300	150	210
160	**19 16 48 517**	**1**	**100,46**	**EH**		330	180	240
180	**19 18 48 517**	**1**	**160,79**	**EH**		380	185	270
200	**19 20 48 517**	**1**	**194,16**	**EH**		430	215	300
225	**19 22 48 517**	**1**	**230,66**	**EH**		500	250	338
250	**19 25 48 517**	**1**	**280,39**	**EH**		530	260	375
280	**19 28 48 517**	**1**	**312,05**	**EH**		550	260	420
315	**19 31 48 517**	**1**	**407,03**	**EH**		650	315	473
355	**19 35 48 517**	**1**	**627,77**	**EH**	*	650	300	533
400	**19 40 48 517**	**1**	**871,36**	**EH**	*	730	335	600
450	**19 45 48 517**	**1**	**1047,46**	**EH**	**	830	320	900
500	**19 50 48 517**	**1**	**1436,25**	**EH**	**	1100	480	1000
560	**19 56 48 517**	**1**	**1835,41**	**EH**	**	1115	455	1120
630	**19 63 48 517**	**1**	**2289,41**	**EH**	**	1350	580	1260
710	**19 71 48 517**	**1**	**4469,85**	**EH**	**	1400	570	1440
800	**19 80 48 517**	**1**	**6837,60**	**EH**	**	1500	480	1600

* *fabrication on order, returning not possible*

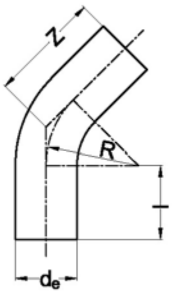
** *R = 2,0 x d_e*
fabrication on order, returning not possible

Variances of +/- 3° are possible.

Bend 45° seamless formed R = 1,5 x d_e SDR 11

for butt-welding and electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG		Z	l	R
50	19 05 48 511	1	40,39	EH		170	100	75
63	19 06 48 511	1	56,58	EH		180	100	95
75	19 07 48 511	1	62,04	EH		200	100	113
90	19 09 48 511	1	68,72	EH		220	100	135
110	19 11 48 511	1	88,95	EH		240	150	165
125	19 12 48 511	1	99,10	EH		270	150	188
140	19 14 48 511	1	111,56	EH		300	150	210
160	19 16 48 511	1	130,95	EH		330	180	240
180	19 18 48 511	1	219,05	EH		380	185	270
200	19 20 48 511	1	265,42	EH		430	215	300
225	19 22 48 511	1	318,83	EH		500	250	338
250	19 25 48 511	1	372,36	EH		530	260	375
280	19 28 48 511	1	444,72	EH		550	260	420
315	19 31 48 511	1	542,70	EH		650	315	473
355	19 35 48 511	1	974,07	EH	*	650	300	533
400	19 40 48 511	1	1071,27	EH	*	730	335	600
450	19 45 48 511	1	1316,46	EH	**	830	320	900
500	19 50 48 511	1	1843,88	EH	**	1100	480	1000
560	19 56 48 511	1	2377,58	EH	**	1115	455	1120
630	19 63 48 511	1	3055,50	EH	**	1350	580	1260
710	19 71 48 511	1	6058,50	EH	**	1400	570	1440

* *fabrication on order, returning not possible*

** *R = 2,0 x d_e*
fabrication on order, returning not possible

Variances of +/- 3° are possible.

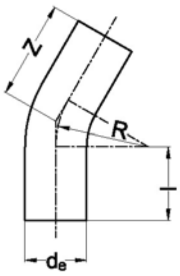
akatherm

PE100 pressure fittings

Bend 30° seamless formed R = 1,5 x d_e SDR 17

for butt-welding and electrofusion

PE100
SDR 17
water 10 bar/gas 5 bar



d_e	Art. Nr.	q	€	AG		Z	l	R
50	**19 05 33 517**	**1**	**33,57**	**EH**		170	105	75
63	**19 06 33 517**	**1**	**49,15**	**EH**		180	105	95
75	**19 07 33 517**	**1**	**52,28**	**EH**		200	120	113
90	**19 09 33 517**	**1**	**56,46**	**EH**		220	130	135
110	**19 11 33 517**	**1**	**70,54**	**EH**		230	130	165
125	**19 12 33 517**	**1**	**79,83**	**EH**		260	150	188
140	**19 14 33 517**	**1**	**91,06**	**EH**		300	170	210
160	**19 16 33 517**	**1**	**100,46**	**EH**		300	180	240
180	**19 18 33 517**	**1**	**160,79**	**EH**		330	180	270
200	**19 20 33 517**	**1**	**194,16**	**EH**		420	235	300
225	**19 22 33 517**	**1**	**230,66**	**EH**		450	250	338
250	**19 25 33 517**	**1**	**280,39**	**EH**		530	300	375
280	**19 28 33 517**	**1**	**312,05**	**EH**		530	290	420
315	**19 31 33 517**	**1**	**407,03**	**EH**		650	365	473
355	**19 35 33 517**	**1**	**627,77**	**EH**	*	650	355	533
400	**19 40 33 517**	**1**	**871,36**	**EH**	*	690	370	600
450	**19 45 33 517**	**1**	**1047,46**	**EH**	**	730	340	900
500	**19 50 33 517**	**1**	**1436,25**	**EH**	**	1100	580	1000
560	**19 56 33 517**	**1**	**1835,41**	**EH**	**	1100	560	1120
630	**19 63 33 517**	**1**	**2289,41**	**EH**	**	1250	640	1260
710	**19 71 33 517**	**1**	**4469,85**	**EH**	**	1350	570	1440
800	**19 80 33 517**	**1**	**6837,60**	**EH**	**	1450	480	1600

* *fabrication on order, returning not possible*

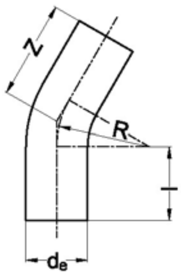
** *R = 2,0 x d_e*
fabrication on order, returning not possible

Variances of +/- 3° are possible.

Bend 30° seamless formed R = 1,5 x d_e SDR 11

for butt-welding and electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG		Z	l	R
50	**19 05 33 511**	**1**	**40,39**	**EH**		170	105	75
63	**19 06 33 511**	**1**	**56,58**	**EH**		180	105	95
75	**19 07 33 511**	**1**	**62,04**	**EH**		200	120	113
90	**19 09 33 511**	**1**	**68,72**	**EH**		220	130	135
110	**19 11 33 511**	**1**	**88,95**	**EH**		230	130	165
125	**19 12 33 511**	**1**	**99,10**	**EH**		260	150	188
140	**19 14 33 511**	**1**	**111,56**	**EH**		300	170	210
160	**19 16 33 511**	**1**	**130,95**	**EH**		300	180	240
180	**19 18 33 511**	**1**	**219,05**	**EH**		330	180	270
200	**19 20 33 511**	**1**	**265,42**	**EH**		420	235	300
225	**19 22 33 511**	**1**	**318,83**	**EH**		450	250	338
250	**19 25 33 511**	**1**	**372,36**	**EH**		530	300	375
280	**19 28 33 511**	**1**	**444,72**	**EH**		530	290	420
315	**19 31 33 511**	**1**	**542,70**	**EH**		650	365	473
355	**19 35 33 511**	**1**	**974,07**	**EH**	*	650	355	533
400	**19 40 33 511**	**1**	**1071,27**	**EH**	*	690	370	600
450	**19 45 33 511**	**1**	**1316,46**	**EH**	**	730	340	900
500	**19 50 33 511**	**1**	**1843,88**	**EH**	**	1100	580	1000
560	**19 56 33 511**	**1**	**2377,58**	**EH**	**	1100	560	1120
630	**19 63 33 511**	**1**	**3055,50**	**EH**	**	1250	640	1260
710	**19 71 33 511**	**1**	**6058,50**	**EH**	**	1350	570	1440

* *fabrication on order, returning not possible*

** *R = 2,0 x d_e*
fabrication on order, returning not possible

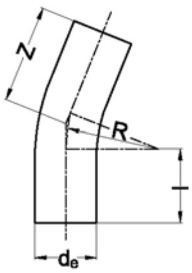
Variances of +/- 3° are possible.

PE100 pressure fittings

Bend 22° seamless formed R = 1,5 x d_e SDR 17

for butt-welding and electrofusion

PE100
SDR 17
water 10 bar/gas 5 bar



d_e	Art. Nr.	q	€	AG		Z	l	R
50	**19 05 25 517**	**1**	**33,57**	**EH**		170	110	75
63	**19 06 25 517**	**1**	**49,15**	**EH**		180	110	95
75	**19 07 25 517**	**1**	**52,28**	**EH**		200	125	113
90	**19 09 25 517**	**1**	**56,46**	**EH**		220	135	135
110	**19 11 25 517**	**1**	**70,54**	**EH**		230	150	165
125	**19 12 25 517**	**1**	**79,83**	**EH**		260	155	188
140	**19 14 25 517**	**1**	**91,06**	**EH**		300	180	210
160	**19 16 25 517**	**1**	**100,46**	**EH**		300	180	240
180	**19 18 25 517**	**1**	**160,79**	**EH**		330	195	270
200	**19 20 25 517**	**1**	**194,16**	**EH**		420	250	300
225	**19 22 25 517**	**1**	**230,66**	**EH**		450	270	338
250	**19 25 25 517**	**1**	**280,39**	**EH**		530	320	375
280	**19 28 25 517**	**1**	**312,05**	**EH**		530	315	420
315	**19 31 25 517**	**1**	**407,03**	**EH**		630	375	473
355	**19 35 25 517**	**1**	**627,77**	**EH**	*	650	380	533
400	**19 40 25 517**	**1**	**871,36**	**EH**	*	660	380	600
450	**19 45 25 517**	**1**	**1047,46**	**EH**	**	660	340	900
500	**19 50 25 517**	**1**	**1436,25**	**EH**	**	1000	565	1000
560	**19 56 25 517**	**1**	**1835,41**	**EH**	**	1000	550	1120
630	**19 63 25 517**	**1**	**2289,41**	**EH**	**	1100	600	1260
710	**19 71 25 517**	**1**	**4469,85**	**EH**	**	1300	570	1440
800	**19 80 25 517**	**1**	**6837,60**	**EH**	**	1400	480	1600

* *fabrication on order, returning not possible*

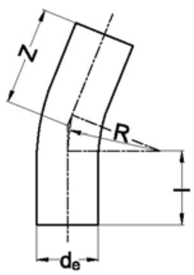
** *R = 2,0 x d_e*
fabrication on order, returning not possible

Variances of +/- 3° are possible.

Bend 22° seamless formed R = 1,5 x d_e SDR 11

for butt-welding and electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG		Z	l	R
50	**19 05 25 511**	**1**	**40,39**	**EH**		170	110	75
63	**19 06 25 511**	**1**	**56,58**	**EH**		180	110	95
75	**19 07 25 511**	**1**	**62,04**	**EH**		200	125	113
90	**19 09 25 511**	**1**	**68,72**	**EH**		220	135	135
110	**19 11 25 511**	**1**	**88,95**	**EH**		230	150	165
125	**19 12 25 511**	**1**	**99,10**	**EH**		260	155	188
140	**19 14 25 511**	**1**	**111,56**	**EH**		300	180	210
160	**19 16 25 511**	**1**	**130,95**	**EH**		300	180	240
180	**19 18 25 511**	**1**	**219,05**	**EH**		330	195	270
200	**19 20 25 511**	**1**	**265,42**	**EH**		420	250	300
225	**19 22 25 511**	**1**	**318,83**	**EH**		450	270	338
250	**19 25 25 511**	**1**	**372,36**	**EH**		530	320	375
280	**19 28 25 511**	**1**	**444,72**	**EH**		530	315	420
315	**19 31 25 511**	**1**	**542,70**	**EH**		630	375	473
355	**19 35 25 511**	**1**	**974,07**	**EH**	*	650	380	533
400	**19 40 25 511**	**1**	**1071,27**	**EH**	*	660	380	600
450	**19 45 25 511**	**1**	**1316,46**	**EH**	**	660	340	900
500	**19 50 25 511**	**1**	**1843,88**	**EH**	**	1000	565	1000
560	**19 56 25 511**	**1**	**2377,58**	**EH**	**	1000	550	1120
630	**19 63 25 511**	**1**	**3055,50**	**EH**	**	1100	600	1260
710	**19 71 25 511**	**1**	**6058,50**	**EH**	**	1300	570	1440

* *fabrication on order, returning not possible*

** *R = 2,0 x d_e*
fabrication on order, returning not possible

Variances of +/- 3° are possible.

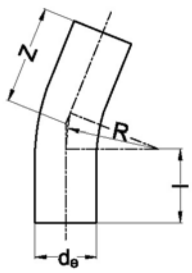
PE100 pressure fittings

Bend 11° seamless formed R = 1,5 x d_e SDR 17

PE100
SDR 17

for butt-welding and electrofusion

water 10 bar/gas 5 bar



d_e	Art. Nr.	q	€	AG		Z	l	R
50	**19 05 14 517**	**1**	**33,57**	**EH**		170	115	75
63	**19 06 14 517**	**1**	**49,15**	**EH**		180	120	95
75	**19 07 14 517**	**1**	**52,28**	**EH**		200	130	113
90	**19 09 14 517**	**1**	**56,46**	**EH**		220	145	135
110	**19 11 14 517**	**1**	**70,54**	**EH**		230	150	165
125	**19 12 14 517**	**1**	**79,83**	**EH**		260	170	188
140	**19 14 14 517**	**1**	**91,06**	**EH**		300	195	210
160	**19 16 14 517**	**1**	**100,46**	**EH**		300	195	240
180	**19 18 14 517**	**1**	**160,79**	**EH**		330	210	270
200	**19 20 14 517**	**1**	**194,16**	**EH**		420	275	300
225	**19 22 14 517**	**1**	**230,66**	**EH**		450	290	338
250	**19 25 14 517**	**1**	**280,39**	**EH**		530	345	375
280	**19 28 14 517**	**1**	**312,05**	**EH**		530	345	420
315	**19 31 14 517**	**1**	**407,03**	**EH**		630	410	473
355	**19 35 14 517**	**1**	**627,77**	**EH**	*	650	420	533
400	**19 40 14 517**	**1**	**871,36**	**EH**	*	660	420	600
450	**19 45 14 517**	**1**	**1047,46**	**EH**	**	660	400	900
500	**19 50 14 517**	**1**	**1436,25**	**EH**	**	1000	630	1000
560	**19 56 14 517**	**1**	**1835,41**	**EH**	**	1000	625	1120
630	**19 63 14 517**	**1**	**2289,41**	**EH**	**	1100	685	1260
710	**19 71 14 517**	**1**	**4469,85**	**EH**	**	1250	570	1440
800	**19 80 14 517**	**1**	**6837,60**	**EH**	**	1350	480	1600

* *fabrication on order, returning not possible*

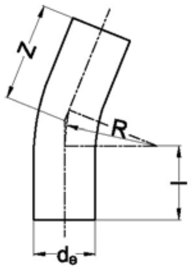
** *R = 2,0 x d_e*
fabrication on order, returning not possible

Variances of +/- 3° are possible.

Bend 11° seamless formed R = 1,5 x d_e SDR 11

for butt-welding and electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG		Z	l	R
50	**19 05 14 511**	**1**	**40,39**	**EH**		170	115	75
63	**19 06 14 511**	**1**	**56,58**	**EH**		180	120	95
75	**19 07 14 511**	**1**	**62,04**	**EH**		200	130	113
90	**19 09 14 511**	**1**	**68,72**	**EH**		220	145	135
110	**19 11 14 511**	**1**	**88,95**	**EH**		230	150	165
125	**19 12 14 511**	**1**	**99,10**	**EH**		260	170	188
140	**19 14 14 511**	**1**	**111,56**	**EH**		300	195	210
160	**19 16 14 511**	**1**	**130,95**	**EH**		300	195	240
180	**19 18 14 511**	**1**	**219,05**	**EH**		330	210	270
200	**19 20 14 511**	**1**	**265,42**	**EH**		420	275	300
225	**19 22 14 511**	**1**	**318,83**	**EH**		450	290	338
250	**19 25 14 511**	**1**	**372,36**	**EH**		530	345	375
280	**19 28 14 511**	**1**	**444,72**	**EH**		530	345	420
315	**19 31 14 511**	**1**	**542,70**	**EH**		630	410	473
355	**19 35 14 511**	**1**	**974,07**	**EH**	*	650	420	533
400	**19 40 14 511**	**1**	**1071,27**	**EH**	*	660	420	600
450	**19 45 14 511**	**1**	**1316,46**	**EH**	**	660	400	900
500	**19 50 14 511**	**1**	**1843,88**	**EH**	**	1000	630	1000
560	**19 56 14 511**	**1**	**2377,58**	**EH**	**	1000	625	1120
630	**19 63 14 511**	**1**	**3055,50**	**EH**	**	1100	685	1260
710	**19 71 14 511**	**1**	**6058,50**	**EH**	**	1250	570	1440

* *fabrication on order, returning not possible*

** *R = 2,0 x d_e*
fabrication on order, returning not possible

Variances of +/- 3° are possible.

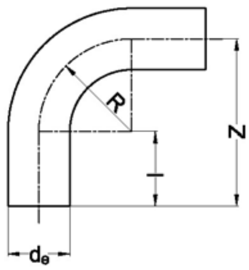
akatherm

PE100 pressure fittings

Bend 90° seamless formed R = 2,5 x d_e SDR 17

for butt-welding and electrofusion

PE100
SDR 17
water 10 bar/gas 5 bar



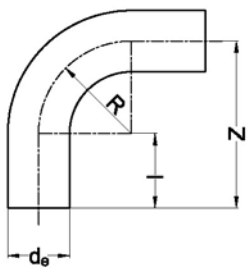
d_e	Art. Nr.	q	€	AG	Z	l	R
50	19 05 94 517	1	40,77	EL	375	250	125
63	19 06 94 517	1	43,07	EL	405	250	158
75	19 07 94 517	1	45,10	EL	435	250	188
90	19 09 94 517	1	49,28	EL	475	250	225
110	19 11 94 517	1	64,27	EL	525	250	275
125	19 12 94 517	1	77,73	EL	560	250	313
140	19 14 94 517	1	95,26	EL	600	250	350
160	19 16 94 517	1	126,88	EL	680	280	400
180	19 18 94 517	1	192,41	EL	730	280	450
200	19 20 94 517	1	236,36	EL	800	300	500
225	19 22 94 517	1	289,57	EL	890	330	563
250	19 25 94 517	1	397,95	EL	985	360	625
280	19 28 94 517	1	560,70	EL	1060	360	625
315	19 31 94 517	1	637,35	EL	1245	460	788
355	19 35 94 517	1	828,45	EL	1345	460	888
400	19 40 94 517	1	997,50	EL	1480	480	1000
450	19 45 94 517	1	1550,85	EL	1665	540	1125

Variances of +/- 3° are possible.
Fabrication on order, returning not possible.

Bend 90° seamless formed R = 2,5 x d_e SDR 11

for butt-welding and electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



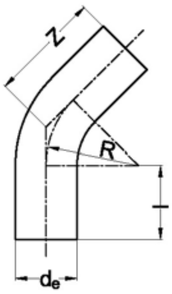
d_e	Art. Nr.	q	€	AG	Z	l	R
50	19 05 94 511	1	43,07	EL	375	250	125
63	19 06 94 511	1	45,47	EL	405	250	158
75	19 07 94 511	1	48,52	EL	435	250	188
90	19 09 94 511	1	55,38	EL	475	250	225
110	19 11 94 511	1	82,43	EL	525	250	275
125	19 12 94 511	1	101,99	EL	560	250	313
140	19 14 94 511	1	141,98	EL	600	250	350
160	19 16 94 511	1	170,56	EL	680	280	400
180	19 18 94 511	1	235,98	EL	730	280	450
200	19 20 94 511	1	305,45	EL	800	300	500
225	19 22 94 511	1	380,00	EL	890	330	563
250	19 25 94 511	1	571,20	EL	985	360	625
280	19 28 94 511	1	683,55	EL	1060	360	625
315	19 31 94 511	1	770,70	EL	1245	460	788
355	19 35 94 511	1	952,35	EL	1345	460	888
400	19 40 94 511	1	1254,75	EL	1480	480	1000
450	19 45 94 511	1	1747,20	EL	1665	540	1125

Variances of +/- 3° are possible.
Fabrication on order, returning not possible.

Bend seamless formed R = 2,5 x d_e SDR 17 60°/45°/30°/22°/11°

for butt-welding and electrofusion

PE100
SDR 17
water 10 bar/gas 5 bar



d_e	Art. Nr.	q	€	AG	Z	l	R
50	**19 05 xx 517**	**1**	**40,10**	**EL**	-	-	125
63	**19 06 xx 517**	**1**	**42,27**	**EL**	-	-	158
75	**19 07 xx 517**	**1**	**44,45**	**EL**	-	-	188
90	**19 09 xx 517**	**1**	**48,25**	**EL**	-	-	225
110	**19 11 xx 517**	**1**	**62,60**	**EL**	-	-	275
125	**19 12 xx 517**	**1**	**75,97**	**EL**	-	-	313
140	**19 14 xx 517**	**1**	**85,64**	**EL**	-	-	350
160	**19 16 xx 517**	**1**	**118,46**	**EL**	-	-	400
180	**19 18 xx 517**	**1**	**181,49**	**EL**	-	-	450
200	**19 20 xx 517**	**1**	**214,10**	**EL**	-	-	500
225	**19 22 xx 517**	**1**	**240,18**	**EL**	-	-	563
250	**19 25 xx 517**	**1**	**392,07**	**EL**	-	-	625
280	**19 28 xx 517**	**1**	**555,56**	**EL**	-	-	700
315	**19 31 xx 517**	**1**	**616,04**	**EL**	-	-	788
355	**19 35 xx 517**	**1**	**761,72**	**EL**	-	-	888
400	**19 40 xx 517**	**1**	**929,72**	**EL**	-	-	1000
450	**19 45 xx 517**	**1**	**1335,20**	**EL**	-	-	1125

Composition Art. Nr.:
xx = 64 for 60°
xx = 49 for 45°
xx = 34 for 30°
xx = 26 for 22°
xx = 15 for 11°

Dimensions apply for bend 45°, 30°, 22° and 11°.

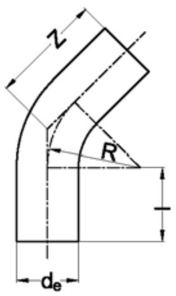
Variances of +/- 3° are possible.
Fabrication on order, returning not possible.

PE100 pressure fittings

Bend seamless formed R = 2,5 x d_e SDR 11 60°/45°/30°/22°/11°

for butt-welding and electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG	Z	l	R
50	**19 05 xx 511**	**1**	**41,95**	**EL**	-	-	125
63	**19 06 xx 511**	**1**	**44,23**	**EL**	-	-	158
75	**19 07 xx 511**	**1**	**47,39**	**EL**	-	-	188
90	**19 09 xx 511**	**1**	**54,34**	**EL**	-	-	225
110	**19 11 xx 511**	**1**	**77,60**	**EL**	-	-	275
125	**19 12 xx 511**	**1**	**89,33**	**EL**	-	-	313
140	**19 14 xx 511**	**1**	**132,58**	**EL**	-	-	350
160	**19 16 xx 511**	**1**	**158,67**	**EL**	-	-	400
180	**19 18 xx 511**	**1**	**218,44**	**EL**	-	-	450
200	**19 20 xx 511**	**1**	**286,90**	**EL**	-	-	500
225	**19 22 xx 511**	**1**	**240,18**	**EL**	-	-	563
250	**19 25 xx 511**	**1**	**560,07**	**EL**	-	-	625
280	**19 28 xx 511**	**1**	**660,87**	**EL**	-	-	700
315	**19 31 xx 511**	**1**	**734,84**	**EL**	-	-	788
355	**19 35 xx 511**	**1**	**921,90**	**EL**	-	-	888
400	**19 40 xx 511**	**1**	**1215,45**	**EL**	-	-	1000
450	**19 45 xx 511**	**1**	**1601,83**	**EL**	-	-	1125

Composition Art. Nr.:
xx = 64 for 60°
xx = 49 for 45°
xx = 34 for 30°
xx = 26 for 22°
xx = 15 for 11°

Dimensions apply for bend 45°, 30°, 22° and 11°.

Variances of +/- 3° are possible.
Fabrication on order, returning not possible.

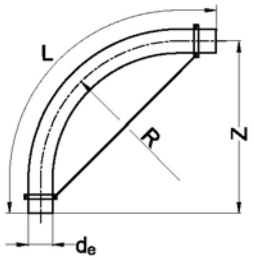
Bend seamless formed R = 3,5 x d_e SDR 17 90°

PE100
SDR 11
for butt-welding and electrofusion
water 16 bar

d_e	Art. Nr.	q	€	AG	Z	L*	R
63	**19 06 98 511**	**1**	**190,19**	**EL**	450	705	220
110	**19 11 98 511**	**1**	**249,95**	**EL**	630	1005	385
160	**19 16 98 511**	**1**	**429,27**	**EL**	800	1380	560

L is derived measure*

Will be delivered with a steel fixation.
Variances of +5°/-3° are possible.
Fabrication on order, returning not possible.

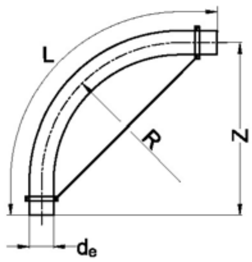


PE100 pressure fittings

Bend seamless formed Ri = 700 mm SDR 17 90°/60°

PE100
SDR 17
water 10 bar/gas 5 bar

for butt-welding and electrofusion



d_e	Art. Nr.	q	€	AG	Z	L	R
50	**19 05 xx 517**	**1**	**197,79**	**EL**	1715	3000	725
63	**19 06 xx 517**	**1**	**202,14**	**EL**	1715	3000	731
75	**19 07 xx 517**	**1**	**209,75**	**EL**	1715	3000	737
90	**19 09 xx 517**	**1**	**226,04**	**EL**	1715	3000	745
110	**19 11 xx 517**	**1**	**270,61**	**EL**	1715	3000	755
125	**19 12 xx 517**	**1**	**318,42**	**EL**	1715	3000	762
140	**19 14 xx 517**	**1**	**346,68**	**EL**	1715	3000	770
160	**19 16 xx 517**	**1**	**433,62**	**EL**	1715	3000	780
180	**19 18 xx 517**	**1**	**476,00**	**EL**	1715	3000	790
200	**19 20 xx 517**	**1**	**592,28**	**EL**	1715	3000	800
225	**19 22 xx 517**	**1**	**695,52**	**EL**	1715	3000	812
250	**19 25 xx 517**	**1**	**782,46**	**EL**	1715	3000	825
280	**19 28 xx 517**	**1**	**927,00**	**EL**	1715	3000	840

Composition Art. Nr.:
xx = 95 for 90°
xx = 65 for 60°

Dimensions apply for bend 90°.

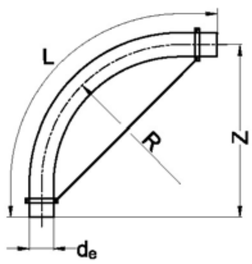
Bends 90°/60° with R > 2,5 x d_e are provided with a steel fixation.

Variances of +5°/-3° are possible.
Fabrication on order, returning not possible.

Bend seamless formed Ri = 700 mm SDR 11 90°/60°

PE100
SDR 11
water 16 bar/gas 10 bar

for butt-welding and electrofusion



d_e	Art. Nr.	q	€	AG	Z	L	R
50	**19 05 xx 511**	**1**	**202,14**	**EL**	1715	3000	725
63	**19 06 xx 511**	**1**	**213,00**	**EL**	1715	3000	731
75	**19 07 xx 511**	**1**	**221,70**	**EL**	1715	3000	737
90	**19 09 xx 511**	**1**	**245,61**	**EL**	1715	3000	745
110	**19 11 xx 511**	**1**	**277,13**	**EL**	1715	3000	755
125	**19 12 xx 511**	**1**	**344,51**	**EL**	1715	3000	762
140	**19 14 xx 511**	**1**	**373,84**	**EL**	1715	3000	770
160	**19 16 xx 511**	**1**	**478,17**	**EL**	1715	3000	780
180	**19 18 xx 511**	**1**	**529,25**	**EL**	1715	3000	790
200	**19 20 xx 511**	**1**	**631,41**	**EL**	1715	3000	800
225	**19 22 xx 511**	**1**	**735,74**	**EL**	1715	3000	812
250	**19 25 xx 511**	**1**	**811,81**	**EL**	1715	3000	825
280	**19 28 xx 511**	**1**	**986,77**	**EL**	1715	3000	840

Composition Art. Nr.:
xx = 95 for 90°
xx = 65 for 60°

Dimensions apply for bend 90°.

Bends 90°/60° with R > 2,5 x d_e are provided with a steel fixation.

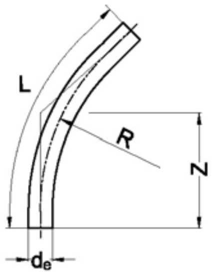
Variances of +5°/-3° are possible.
Fabrication on order, returning not possible.

Bend seamless formed Ri = 700 mm SDR 17 45°/30°/22°/11°

PE100
SDR 17

for butt-welding and electrofusion

water 10 bar/gas 5 bar



d_e	Art. Nr.	q	€	AG	Z	L	R
50	**19 05 xx 517**	**1**	**114,11**	**EL**	1500	3000	725
63	**19 06 xx 517**	**1**	**122,81**	**EL**	1500	3000	731
75	**19 07 xx 517**	**1**	**126,06**	**EL**	1500	3000	737
90	**19 09 xx 517**	**1**	**158,67**	**EL**	1500	3000	745
110	**19 11 xx 517**	**1**	**185,84**	**EL**	1500	3000	755
125	**19 12 xx 517**	**1**	**230,39**	**EL**	1500	3000	762
140	**19 14 xx 517**	**1**	**260,82**	**EL**	1500	3000	770
160	**19 16 xx 517**	**1**	**301,04**	**EL**	1500	3000	780
180	**19 18 xx 517**	**1**	**341,24**	**EL**	1500	3000	790
200	**19 20 xx 517**	**1**	**395,58**	**EL**	1500	3000	800
225	**19 22 xx 517**	**1**	**461,87**	**EL**	1500	3000	812
250	**19 25 xx 517**	**1**	**522,73**	**EL**	1500	3000	825
280	**19 28 xx 517**	**1**	**589,02**	**EL**	1500	3000	840

Composition Art. Nr.:
xx = 50 for 45°
xx = 35 for 30°
xx = 27 for 22°
xx = 16 for 11°

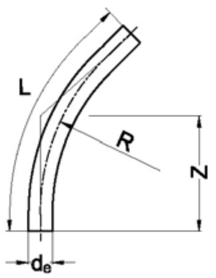
Variances of +5°/-3° are possible.
Fabrication on order, returning not possible.

Bend seamless formed Ri = 700 mm SDR 11 45°/30°/22°/11°

PE100
SDR 11

for butt-welding and electrofusion

water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG	Z	L	R
50	**19 05 xx 511**	**1**	**127,16**	**EL**	1500	3000	725
63	**19 06 xx 511**	**1**	**140,20**	**EL**	1500	3000	731
75	**19 07 xx 511**	**1**	**154,32**	**EL**	1500	3000	737
90	**19 09 xx 511**	**1**	**179,32**	**EL**	1500	3000	745
110	**19 11 xx 511**	**1**	**209,75**	**EL**	1500	3000	755
125	**19 12 xx 511**	**1**	**253,22**	**EL**	1500	3000	762
140	**19 14 xx 511**	**1**	**280,38**	**EL**	1500	3000	770
160	**19 16 xx 511**	**1**	**332,55**	**EL**	1500	3000	780
180	**19 18 xx 511**	**1**	**383,63**	**EL**	1500	3000	790
200	**19 20 xx 511**	**1**	**434,70**	**EL**	1500	3000	800
225	**19 22 xx 511**	**1**	**518,39**	**EL**	1500	3000	812
250	**19 25 xx 511**	**1**	**562,94**	**EL**	1500	3000	825
280	**19 28 xx 511**	**1**	**641,18**	**EL**	1500	3000	840

Composition Art. Nr.:
xx = 50 for 45°
xx = 35 for 30°
xx = 27 for 22°
xx = 16 for 11°

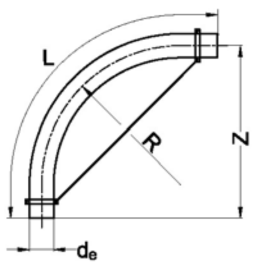
Variances of +5°/-3° are possible.
Fabrication on order, returning not possible.

PE100 pressure fittings

Bend seamless formed Ri = 1100 mm SDR 17 90°/60°

for butt-welding and electrofusion

PE100
SDR 17
water 10 bar/gas 5 bar



d_e	Art. Nr.	q	€	AG	Z	L	R
50	**19 05 xx 517**	**1**	**216,27**	**EL**	1972	3300	1125
63	**19 06 xx 517**	**1**	**221,70**	**EL**	1972	3300	1131
75	**19 07 xx 517**	**1**	**227,14**	**EL**	1972	3300	1137
90	**19 09 xx 517**	**1**	**256,47**	**EL**	1972	3300	1145
110	**19 11 xx 517**	**1**	**281,47**	**EL**	1972	3300	1155
125	**19 12 xx 517**	**1**	**318,42**	**EL**	1972	3300	1162
140	**19 14 xx 517**	**1**	**364,07**	**EL**	1972	3300	1170
160	**19 16 xx 517**	**1**	**512,95**	**EL**	1972	3300	1180
180	**19 18 xx 517**	**1**	**565,11**	**EL**	1972	3300	1190
200	**19 20 xx 517**	**1**	**659,66**	**EL**	1972	3300	1200
225	**19 22 xx 517**	**1**	**730,30**	**EL**	1972	3300	1212
250	**19 25 xx 517**	**1**	**802,02**	**EL**	1972	3300	1225
280	**19 28 xx 517**	**1**	**946,56**	**EL**	1972	3300	1240
315	**19 31 xx 517**	**1**	**1135,66**	**EL**	1972	3300	1257
355	**19 35 xx 517**	**1**	**1298,67**	**EL**	1972	3300	1277
400	**19 40 xx 517**	**1**	**1581,23**	**EL**	1972	3300	1300

Composition Art. Nr.:
xx = 96 for 90°
xx = 66 for 60°

Dimensions apply for bend 90°.

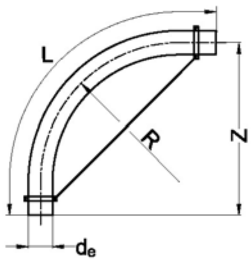
Bends 90°/60° with R > 2,5 x d_e are provided with a steel fixation.

Variances of +5°/-3° are possible.
Fabrication on order, returning not possible.

Bend seamless formed Ri = 1100 mm SDR 11 90°/60°

PE100
SDR 11
water 16 bar/gas 10 bar

for butt-welding and electrofusion



d_e	Art. Nr.	q	€	AG	Z	L	R
50	**19 05 xx 511**	**1**	**220,62**	**EL**	1972	3300	1125
63	**19 06 xx 511**	**1**	**231,48**	**EL**	1972	3300	1131
75	**19 07 xx 511**	**1**	**247,78**	**EL**	1972	3300	1137
90	**19 09 xx 511**	**1**	**273,86**	**EL**	1972	3300	1145
110	**19 11 xx 511**	**1**	**306,46**	**EL**	1972	3300	1155
125	**19 12 xx 511**	**1**	**354,28**	**EL**	1972	3300	1162
140	**19 14 xx 511**	**1**	**391,23**	**EL**	1972	3300	1170
160	**19 16 xx 511**	**1**	**545,55**	**EL**	1972	3300	1180
180	**19 18 xx 511**	**1**	**592,28**	**EL**	1972	3300	1190
200	**19 20 xx 511**	**1**	**715,08**	**EL**	1972	3300	1200
225	**19 22 xx 511**	**1**	**785,73**	**EL**	1972	3300	1212
250	**19 25 xx 511**	**1**	**829,20**	**EL**	1972	3300	1225
280	**19 28 xx 511**	**1**	**986,77**	**EL**	1972	3300	1240
315	**19 31 xx 511**	**1**	**1179,13**	**EL**	1972	3300	1257
355	**19 35 xx 511**	**1**	**1353,01**	**EL**	1972	3300	1277
400	**19 40 xx 511**	**1**	**1755,11**	**EL**	1972	3300	1300

Composition Art. Nr.:
xx = 96 for 90°
xx = 66 for 60°

Dimensions apply for bend 90°.

Bends 90°/60° with R > 2,5 x d_e are provided with a steel fixation.

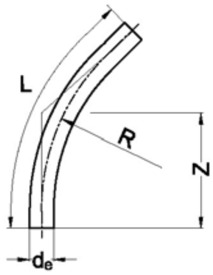
Variances of +5°/-3° are possible.
Fabrication on order, returning not possible.

PE100 pressure fittings

Bend seamless formed Ri = 1100 mm SDR 17 45°/30°/22°/11°

for butt-welding and electrofusion

PE100
SDR 17
water 10 bar/gas 5 bar



d_e	Art. Nr.	q	€	AG	Z	L	R
50	**19 05 xx 517**	**1**	**118,46**	**EL**	1650	3300	1125
63	**19 06 xx 517**	**1**	**138,02**	**EL**	1650	3300	1131
75	**19 07 xx 517**	**1**	**144,54**	**EL**	1650	3300	1137
90	**19 09 xx 517**	**1**	**160,84**	**EL**	1650	3300	1145
110	**19 11 xx 517**	**1**	**190,19**	**EL**	1650	3300	1155
125	**19 12 xx 517**	**1**	**233,66**	**EL**	1650	3300	1162
140	**19 14 xx 517**	**1**	**291,25**	**EL**	1650	3300	1170
160	**19 16 xx 517**	**1**	**312,98**	**EL**	1650	3300	1180
180	**19 18 xx 517**	**1**	**344,51**	**EL**	1650	3300	1190
200	**19 20 xx 517**	**1**	**399,92**	**EL**	1650	3300	1200
225	**19 22 xx 517**	**1**	**462,96**	**EL**	1650	3300	1212
250	**19 25 xx 517**	**1**	**525,99**	**EL**	1650	3300	1225
280	**19 28 xx 517**	**1**	**593,37**	**EL**	1650	3300	1240
315	**19 31 xx 517**	**1**	**716,17**	**EL**	1650	3300	1257
355	**19 35 xx 517**	**1**	**837,89**	**EL**	1650	3300	1277
400	**19 40 xx 517**	**1**	**1162,82**	**EL**	1650	3300	1300

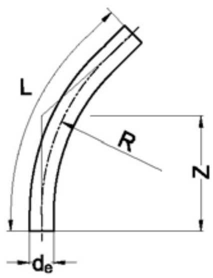
Composition Art. Nr.:
xx = 51 for 45°
xx = 36 for 30°
xx = 28 for 22°
xx = 17 for 11°

Variances of +5°/-3° are possible.
Fabrication on order, returning not possible.

Bend seamless formed Ri = 1100 mm SDR 11 45°/30°/22°/11°

for butt-welding and electrofusion

PE100
SDR 11
water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG	Z	L	R
50	**19 05 xx 511**	**1**	**130,41**	**EL**	1650	3300	1125
63	**19 06 xx 511**	**1**	**142,37**	**EL**	1650	3300	1131
75	**19 07 xx 511**	**1**	**156,49**	**EL**	1650	3300	1137
90	**19 09 xx 511**	**1**	**181,49**	**EL**	1650	3300	1145
110	**19 11 xx 511**	**1**	**221,70**	**EL**	1650	3300	1155
125	**19 12 xx 511**	**1**	**257,57**	**EL**	1650	3300	1162
140	**19 14 xx 511**	**1**	**312,98**	**EL**	1650	3300	1170
160	**19 16 xx 511**	**1**	**376,02**	**EL**	1650	3300	1180
180	**19 18 xx 511**	**1**	**407,54**	**EL**	1650	3300	1190
200	**19 20 xx 511**	**1**	**478,17**	**EL**	1650	3300	1200
225	**19 22 xx 511**	**1**	**521,64**	**EL**	1650	3300	1212
250	**19 25 xx 511**	**1**	**565,11**	**EL**	1650	3300	1225
280	**19 28 xx 511**	**1**	**644,45**	**EL**	1650	3300	1240
315	**19 31 xx 511**	**1**	**786,81**	**EL**	1650	3300	1257
355	**19 35 xx 511**	**1**	**945,47**	**EL**	1650	3300	1277
400	**19 40 xx 511**	**1**	**1266,07**	**EL**	1650	3300	1300

Composition Art. Nr.:
xx = 51 for 45°
xx = 36 for 30°
xx = 28 for 22°
xx = 17 for 11°

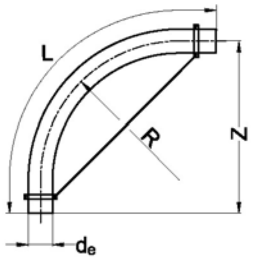
Variances of +5°/-3° are possible.
Fabrication on order, returning not possible.

Bend seamless formed Ri = 1750 mm SDR 17 90°/60°

PE100
SDR 17

for butt-welding and electrofusion

water 10 bar/gas 5 bar



d_e	Art. Nr.	q	€	AG	Z	L	R
50	19 05 xx 517	1	222,79	EL	3030	5000	1775
63	19 06 xx 517	1	233,66	EL	3030	5000	1781
75	19 07 xx 517	1	246,70	EL	3030	5000	1787
90	19 09 xx 517	1	272,78	EL	3030	5000	1795
110	19 11 xx 517	1	312,98	EL	3030	5000	1805
125	19 12 xx 517	1	454,26	EL	3030	5000	1812
140	19 14 xx 517	1	492,30	EL	3030	5000	1820
160	19 16 xx 517	1	586,85	EL	3030	5000	1830
180	19 18 xx 517	1	643,36	EL	3030	5000	1840
200	19 20 xx 517	1	752,03	EL	3030	5000	1850
225	19 22 xx 517	1	859,62	EL	3030	5000	1862
250	19 25 xx 517	1	944,39	EL	3030	5000	1875
280	19 28 xx 517	1	1124,79	EL	3030	5000	1890
315	19 31 xx 517	1	1358,44	EL	3030	5000	1907
355	19 35 xx 517	1	1608,39	EL	3030	5000	1927
400	19 40 xx 517	1	1956,15	EL	3030	5000	1950
450	19 45 xx 517	1	2320,22	EL	3030	5000	1975
500	19 50 xx 517	1	2814,68	EL	3030	5000	2000
560	19 56 xx 517	1	3314,59	EL	3030	5000	2030
630	19 63 xx 517	1	4020,98	EL	3030	5000	2065

Composition Art. Nr.:
xx = 97 for 90°
xx = 67 for 60°

Dimensions apply for bend 90°.

Bends 90°/60° with R > 2,5 x d_e are provided with a steel fixation.

Variances of +5°/-3° are possible.
Fabrication on order, returning not possible.

akatherm

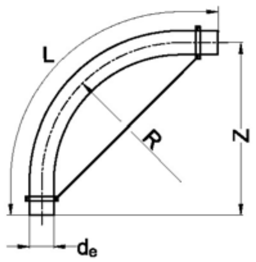
PE100 pressure fittings

Bend seamless formed Ri = 1750 mm SDR 11 90°/60°

PE100
SDR 11

for butt-welding and electrofusion

water 16 bar/gas 10 bar



d_e	Art. Nr.	q	€	AG	Z	L	R
50	**19 05 xx 511**	**1**	**232,56**	**EL**	3030	5000	1775
63	**19 06 xx 511**	**1**	**251,04**	**EL**	3030	5000	1781
75	**19 07 xx 511**	**1**	**268,43**	**EL**	3030	5000	1787
90	**19 09 xx 511**	**1**	**303,21**	**EL**	3030	5000	1795
110	**19 11 xx 511**	**1**	**355,37**	**EL**	3030	5000	1805
125	**19 12 xx 511**	**1**	**504,25**	**EL**	3030	5000	1812
140	**19 14 xx 511**	**1**	**556,42**	**EL**	3030	5000	1820
160	**19 16 xx 511**	**1**	**669,44**	**EL**	3030	5000	1830
180	**19 18 xx 511**	**1**	**748,78**	**EL**	3030	5000	1840
200	**19 20 xx 511**	**1**	**881,36**	**EL**	3030	5000	1850
225	**19 22 xx 511**	**1**	**1019,37**	**EL**	3030	5000	1862
250	**19 25 xx 511**	**1**	**1141,09**	**EL**	3030	5000	1875
280	**19 28 xx 511**	**1**	**1374,74**	**EL**	3030	5000	1890
315	**19 31 xx 511**	**1**	**1679,03**	**EL**	3030	5000	1907
355	**19 35 xx 511**	**1**	**2015,93**	**EL**	3030	5000	1927
400	**19 40 xx 511**	**1**	**2472,36**	**EL**	3030	5000	1950
450	**19 45 xx 511**	**1**	**2977,70**	**EL**	3030	5000	1975
500	**19 50 xx 511**	**1**	**3483,04**	**EL**	3030	5000	2000
560	**19 56 xx 511**	**1**	**4216,59**	**EL**	3030	5000	2030
630	**19 63 xx 511**	**1**	**5428,32**	**EL**	3030	5000	2065

Composition Art. Nr.:
xx = 97 for 90°
xx = 67 for 60°

Dimensions apply for bend 90°.

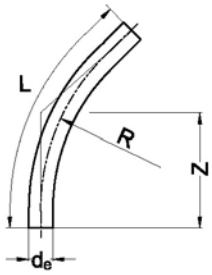
Bends 90°/60° with R > 2,5 x d_e are provided with a steel fixation.

Variances of +5°/-3° are possible.
Fabrication on order, returning not possible.

Bend seamless formed Ri = 1750 mm SDR 17 45°/30°/22°/11°

PE100
SDR 17
water 10 bar/gas 5 bar

for butt-welding and electrofusion



d_e	Art. Nr.	q	€	AG	Z	L	R
50	**19 05 xx 517**	**1**	**136,93**	**EL**	2550	5000	1775
63	**19 06 xx 517**	**1**	**155,41**	**EL**	2550	5000	1781
75	**19 07 xx 517**	**1**	**157,58**	**EL**	2550	5000	1787
90	**19 09 xx 517**	**1**	**185,84**	**EL**	2550	5000	1795
110	**19 11 xx 517**	**1**	**214,10**	**EL**	2550	5000	1805
125	**19 12 xx 517**	**1**	**340,16**	**EL**	2550	5000	1812
140	**19 14 xx 517**	**1**	**373,84**	**EL**	2550	5000	1820
160	**19 16 xx 517**	**1**	**407,54**	**EL**	2550	5000	1830
180	**19 18 xx 517**	**1**	**458,61**	**EL**	2550	5000	1840
200	**19 20 xx 517**	**1**	**514,04**	**EL**	2550	5000	1850
225	**19 22 xx 517**	**1**	**600,98**	**EL**	2550	5000	1862
250	**19 25 xx 517**	**1**	**675,96**	**EL**	2550	5000	1875
280	**19 28 xx 517**	**1**	**783,55**	**EL**	2550	5000	1890
315	**19 31 xx 517**	**1**	**1004,16**	**EL**	2550	5000	1907
355	**19 35 xx 517**	**1**	**1255,20**	**EL**	2550	5000	1927
400	**19 40 xx 517**	**1**	**1499,72**	**EL**	2550	5000	1950
450	**19 45 xx 517**	**1**	**1863,78**	**EL**	2550	5000	1975
500	**19 50 xx 517**	**1**	**2276,75**	**EL**	2550	5000	2000
560	**19 56 xx 517**	**1**	**2733,18**	**EL**	2550	5000	2030
630	**19 63 xx 517**	**1**	**3363,50**	**EL**	2550	5000	2065

Composition Art. Nr.:
xx = 52 for 45°
xx = 37 for 30°
xx = 29 for 22°
xx = 18 for 11°

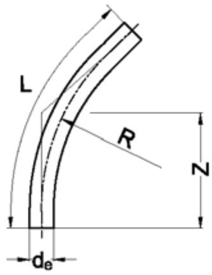
Variances of +5°/-3° are possible.
Fabrication on order, returning not possible.

PE100 pressure fittings

Bend seamless formed Ri = 1750 mm SDR 11 45°/30°/22°/11°

PE100
SDR 11
water 16 bar/gas 10 bar

for butt-welding and electrofusion



d_e	Art. Nr.	q	€	AG	Z	L	R
50	**19 05 xx 511**	**1**	**146,72**	**EL**	2550	5000	1775
63	**19 06 xx 511**	**1**	**167,36**	**EL**	2550	5000	1781
75	**19 07 xx 511**	**1**	**176,05**	**EL**	2550	5000	1787
90	**19 09 xx 511**	**1**	**202,14**	**EL**	2550	5000	1795
110	**19 11 xx 511**	**1**	**229,31**	**EL**	2550	5000	1805
125	**19 12 xx 511**	**1**	**398,84**	**EL**	2550	5000	1812
140	**19 14 xx 511**	**1**	**451,01**	**EL**	2550	5000	1820
160	**19 16 xx 511**	**1**	**511,86**	**EL**	2550	5000	1830
180	**19 18 xx 511**	**1**	**591,19**	**EL**	2550	5000	1840
200	**19 20 xx 511**	**1**	**672,70**	**EL**	2550	5000	1850
225	**19 22 xx 511**	**1**	**779,21**	**EL**	2550	5000	1862
250	**19 25 xx 511**	**1**	**890,05**	**EL**	2550	5000	1875
280	**19 28 xx 511**	**1**	**1051,97**	**EL**	2550	5000	1890
315	**19 31 xx 511**	**1**	**1363,88**	**EL**	2550	5000	1907
355	**19 35 xx 511**	**1**	**1689,90**	**EL**	2550	5000	1927
400	**19 40 xx 511**	**1**	**2081,13**	**EL**	2550	5000	1950
450	**19 45 xx 511**	**1**	**2515,83**	**EL**	2550	5000	1975
500	**19 50 xx 511**	**1**	**2999,43**	**EL**	2550	5000	2000
560	**19 56 xx 511**	**1**	**3591,71**	**EL**	2550	5000	2030
630	**19 63 xx 511**	**1**	**4651,29**	**EL**	2550	5000	2065

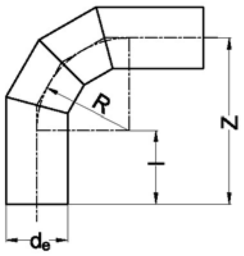
Composition Art. Nr.:
xx = 52 for 45°
xx = 37 for 30°
xx = 29 for 22°
xx = 18 for 11°

Variances of +5°/-3° are possible.
Fabrication on order, returning not possible.

Bend 90° welded R = 1,5 x d_e SDR 33

for butt-welding and electrofusion

PE100
SDR 33
water 2,5 bar



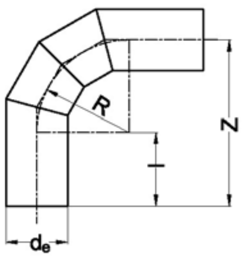
d_e	Art. Nr.	q	€	AG	Z	l	R
110	18 11 93 533	1	69,86	EL	315	150	165
125	18 12 93 533	1	81,03	EL	338	150	188
140	18 14 93 533	1	93,60	EL	360	150	210
160	18 16 93 533	1	97,80	EL	390	150	240
180	18 18 93 533	1	112,52	EL	420	150	270
200	18 20 93 533	1	122,94	EL	450	150	300
225	18 22 93 533	1	153,67	EL	488	150	338
250	18 25 93 533	1	182,12	EL	625	250	375
280	18 28 93 533	1	216,54	EL	670	250	420
315	18 31 93 533	1	285,00	EL	778	300	478
355	18 35 93 533	1	364,63	EL	833	300	533
400	18 40 93 533	1	476,39	EL	900	300	600
450	18 45 93 533	1	755,80	EL	975	300	675
500	18 50 93 533	1	952,78	EL	1100	350	750
560	18 56 93 533	1	1188,87	EL	1190	350	840
630	18 63 93 533	1	1508,79	EL	1295	350	945
710	18 71 93 533	1	1818,94	EL	1415	350	1065
800	18 80 93 533	1	2433,64	EL	1550	350	1200
900	18 90 93 533	1	3155,91	EL	1750	400	1350
1000	18 91 93 533	1	4407,64	EL	1900	400	1500

Reduced pressure class, see appendix B2 "Maximum operating pressure for pipes and fittings".
30°, 45° and 60° on request.
Fabrication on order, returning not possible.

Bend 90° welded R = 1,5 x d_e SDR 17

for butt-welding and electrofusion

PE100
SDR 17
water 6 bar



d_e	Art. Nr.	q	€	AG	Z	l	R
450	18 45 93 517	1	1025,42	EL	975	300	675
500	18 50 93 517	1	1330,74	EL	1100	350	750
560	18 56 93 517	1	1722,29	EL	1190	350	840
630	18 63 93 517	1	2280,09	EL	1295	350	945
710	18 71 93 517	1	3225,37	EL	1415	350	1065
800	18 80 93 517	1	4175,86	EL	1550	350	1200
900	18 90 93 517	1	5868,94	EL	1750	400	1350
1000	18 91 93 517	1	7279,94	EL	1900	400	1500

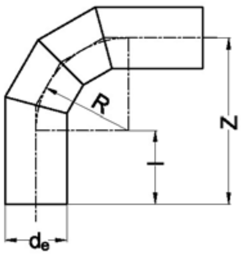
Reduced pressure class, see appendix B2 "Maximum operating pressure for pipes and fittings".
30°, 45° and 60° on request.
Fabrication on order, returning not possible.

PE100 pressure fittings

Bend 90° welded R = 1,5 x d_e SDR 11

for butt-welding and electrofusion

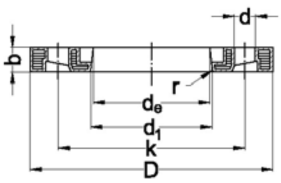
PE100
SDR 11
water 10 bar



d_e	Art. Nr.	q	€	AG	Z	l	R
450	**18 45 93 511**	**1**	**1323,88**	**EL**	975	300	675
500	**18 50 93 511**	**1**	**1696,88**	**EL**	1100	350	750
560	**18 56 93 511**	**1**	**2658,31**	**EL**	1190	350	840
630	**18 63 93 511**	**1**	**3370,41**	**EL**	1295	350	945

Reduced pressure class, see appendix B2 "Maximum operating pressure for pipes and fittings".
30°, 45° and 60° on request.
Fabrication on order, returning not possible.

Profile backing ring PP with ductile iron core
DIN 2501-PN10 (EN 1092)
for stub flange (butt-welding connection)



d_e/DN	Art. Nr.	q	€	AG		bar	d_1	D	k	b	d	n	M	r	kg
20/15	**47 01 09 010**	**20**	**6,80**	**TP**	*	16	28	106	65	18	14	4	M12	3	0,4
25/20	**47 02 09 010**	**20**	**7,50**	**TP**	*	16	34	118	75	18	14	4	M12	3	0,4
32/25	**47 03 09 010**	**20**	**9,64**	**TP**	*	16	42	122	85	17	14	4	M12	3	0,4
40/32	**47 04 09 010**	**20**	**11,70**	**TP**	*	16	51	142	100	17	18	4	M16	3	0,5
50/40	**47 05 09 010**	**16**	**13,66**	**TP**	*	16	62	156	110	19	18	4	M16	3	0,7
63/50	**47 06 09 010**	**16**	**16,98**	**TP**	*	16	78	171	125	20	18	4	M16	3	0,9
75/65	**47 07 09 010**	**12**	**18,81**	**TP**	*	16	92	191	145	21	18	4	M16	3	1,0
90/80	**47 09 09 010**	**10**	**22,38**	**TP**	*	16	108	206	160	21	18	8	M16	3	1,1
110/100	**47 11 09 010**	**10**	**27,02**	**TP**	*	16	128	226	180	22	18	8	M16	3	1,5
125/100	**47 12 09 010**	**10**	**27,02**	**TP**	*	16	135	226	180	23	18	8	M16	3	1,4
140/125	**47 14 09 010**	**8**	**41,59**	**TP**	*	16	158	261	210	25	18	8	M16	3	1,7
160/150	**47 16 09 010**	**6**	**47,70**	**TP**	*	16	178	296	240	28	22	8	M20	3	1,8
180/150	**47 18 09 010**	**6**	**47,70**	**TP**	*	16	188	296	240	27	22	8	M20	4	1,9
200/200	**47 20 09 010**	**1**	**67,99**	**TP**		16	235	350	295	32	22	8	M20	4	3,1
225/200	**47 22 09 010**	**1**	**67,99**	**TP**		16	238	350	295	31	22	8	M20	4	3,1
250/250	**47 25 09 010**	**1**	**99,03**	**TP**		16	288	412	350	36	22	12	M20	4	4,9
280/250	**47 28 09 010**	**1**	**99,03**	**TP**		16	294	412	350	35	22	12	M20	4	4,4
315/300	**47 31 09 010**	**1**	**136,35**	**TP**		16	338	462	400	42	22	12	M20	4	6,4
355/350	**47 35 09 010**	**1**	**287,32**	**TP**		16	376	525	460	52	22	16	M20	6	11,1
400/400	**47 40 09 010**	**1**	**325,06**	**TP**		16	430	586	515	56	26	16	M24	6	14,7
450/500	**47 45 09 010**	**1**	**385,21**	**TP**		10	514	690	620	55	27	20	M24	6	20,3
500/500	**47 50 09 010**	**1**	**385,21**	**TP**		10	530	690	620	55	27	20	M24	6	19,2
560/600	**47 56 09 010**	**1**	**522,40**	**TP**		10	615	804	725	62	30	20	M27	6	30,0
630/600	**47 63 09 010**	**1**	**522,40**	**TP**		10	642	804	725	62	30	20	M27	6	27,7
710/700	**47 71 09 010**	**1**	**999,89**	**TP**		6	740	912	840	49	30	24	M27	5	28,6
800/800	**47 80 09 010**	**1**	**1304,02**	**TP**	**	6	843	1026	950	58	33	24	M30	5	39,3
900/900	**47 90 09 010**	**1**	**1654,21**	**TP**	**	6	947	1129	1050	62	33	28	M30	5	48,5
1000/1000	**47 90 09 010**	**1**	**1654,21**	**TP**	**	6	1050	1245	1160	66	36	28	M33	5	60,0

* *identical to DIN 2501-PN16*

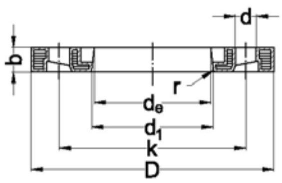
** *fabrication on order*

n = number of bolts.
bar = maximum operating pressure.
"DIN 2501-PN10" does not refer to the pressure class of the backing ring.

Convincing weight saving.
Corrosion resistant.
Calculated guaranteed high safety factor.
Substantially simplified handling.

PE100 pressure fittings

Profile backing ring PP with ductile iron core
DIN 2501-PN10 (EN 1092)
for flange adaptor (socket connection)

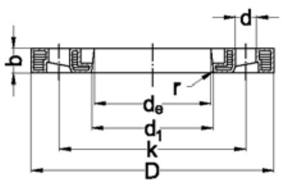


d_e/DN	Art. Nr.	q	€	AG	bar	d_1	D	k	b	d	n	M	r	kg
20/15	**47 01 09 010**	**20**	**6,80**	**TP** *	16	28	106	65	18	14	4	M12	3	0,4
25/20	**47 02 09 010**	**20**	**7,50**	**TP** *	16	34	118	75	18	14	4	M12	3	0,4
32/25	**47 03 09 010**	**20**	**9,64**	**TP** *	16	42	122	85	17	14	4	M12	3	0,4
40/32	**47 04 09 010**	**20**	**11,70**	**TP** *	16	51	142	100	17	18	4	M16	3	0,5
50/40	**47 05 09 010**	**16**	**13,66**	**TP** *	16	62	156	110	19	18	4	M16	3	0,7
63/50	**47 06 09 010**	**16**	**16,98**	**TP** *	16	78	171	125	20	18	4	M16	3	0,9
75/65	**47 07 09 010**	**12**	**18,81**	**TP** *	16	92	191	145	21	18	4	M16	3	1,0
90/80	**47 09 19 010**	**10**	**22,38**	**TP**	16	110	206	160	21	18	8	M16	3	1,2
110/100	**47 11 19 010**	**10**	**27,02**	**TP**	16	133	226	180	22	18	8	M16	3	1,5
140/125	**47 14 19 010**	**8**	**41,59**	**TP**	16	167	261	210	26	18	8	M16	3	1,9
160/150	**47 16 19 010**	**6**	**47,70**	**TP**	16	190	296	240	28	22	8	M16	3	2,6
225/200	**47 22 19 010**	**1**	**67,99**	**TP**	16	250	350	295	23	22	8	M20	3	2,7
250/250	**47 25 19 010**	**1**	**99,03**	**TP**	16	277	403	350	35	22	12	M20	4	5,3
280/250	**47 28 19 010**	**1**	**99,03**	**TP**	16	310	403	350	31	22	12	M20	4	3,8
315/300	**47 31 19 010**	**1**	**136,35**	**TP**	16	348	458	400	37	22	12	M20	4	5,7

* *identical to profile backing ring PP with ductile iron core DIN 2501-PN10 for stub flange*

n = number of bolts.
bar = maximum operating pressure.
"DIN 2501-PN10" does not refer to the pressure class of the backing ring.

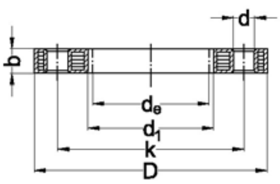
Profile backing ring PP with ductile iron core
ANSI 150 lb
for stub flange



DN/d_e	Art. Nr.	q	€	AG	bar	d_1	D	k	b	d	n	kg
63/2"	**47 83 09 010**	**10**	**23,44**	**TA**	16	78	164	121	18	19	4	0,8
90/3"	**47 85 09 010**	**10**	**29,58**	**TA**	16	108	196	153	19	19	4	1,0
110/4"	**47 86 09 010**	**8**	**35,43**	**TA**	16	128	237	191	25	19	8	1,8
160/6"	**47 87 09 010**	**5**	**60,66**	**TA**	16	178	297	242	30	22	8	3,2
225/8"	**47 88 09 010**	**1**	**86,51**	**TA**	16	238	354	299	34	22	8	5,1
250/10"	**47 89 09 010**	**1**	**103,50**	**TA**	16	288	425	362	39	26	12	6,9
315/12"	**47 90 29 010**	**1**	**146,73**	**TA**	16	338	497	432	51	26	12	12,8

n = number of bolts.
bar = maximum operating pressure.
ANSI B16.5 class 150

Backing ring PP with ductile iron core
DIN 2501-PN10 (EN 1092)
for stub flange



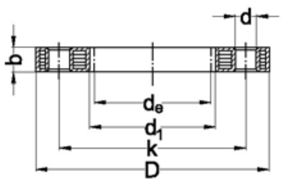
d_e/DN	Art. Nr.	q	€	AG		bar	d_1	D	k	b	d	n	M	kg
20/15	**47 01 08 010**	**1**	**7,15**	**TV**	*	16	28	95	65	12	14	4	M12	0,3
25/20	**47 02 08 010**	**1**	**7,90**	**TV**	*	16	34	105	75	14	14	4	M12	0,3
32/25	**47 03 08 010**	**1**	**10,15**	**TV**	*	16	42	115	85	14	14	4	M12	0,4
40/32	**47 04 08 010**	**1**	**12,32**	**TV**	*	16	51	140	100	16	18	4	M16	0,7
50/40	**47 05 08 010**	**1**	**14,37**	**TV**	*	16	62	150	110	16	18	4	M16	0,7
63/50	**47 06 08 010**	**1**	**17,88**	**TV**	*	16	78	165	125	19	18	4	M16	0,8
75/65	**47 07 08 010**	**1**	**19,80**	**TV**	*	16	92	185	145	19	18	4	M16	1,1
90/80	**47 09 08 010**	**1**	**23,57**	**TV**	*	16	108	200	160	21	18	8	M16	1,4
110/100	**47 11 08 010**	**1**	**28,46**	**TV**	*	16	128	220	180	22	18	8	M16	1,6
125/100	**47 12 08 010**	**1**	**28,46**	**TV**	*	16	135	220	180	22	18	8	M16	1,4
140/125	**47 14 08 010**	**1**	**43,80**	**TV**	*	16	158	250	210	26	18	8	M16	2,0
160/150	**47 16 08 010**	**1**	**50,24**	**TV**	*	16	178	285	240	27	22	8	M20	2,5
180/150	**47 18 08 010**	**1**	**50,24**	**TV**	*	16	188	285	240	27	22	8	M20	2,3
200/200	**47 20 08 010**	**1**	**71,61**	**TV**		16	235	340	295	28	22	8	M20	3,2
225/200	**47 22 08 010**	**1**	**71,61**	**TV**		16	238	340	295	28	22	8	M20	3,2
250/250	**47 25 08 010**	**1**	**104,28**	**TV**		16	288	406	350	31	22	12	M20	6,4
280/250	**47 28 08 010**	**1**	**104,28**	**TV**		16	294	406	350	31	22	12	M20	6,3
315/300	**47 31 08 010**	**1**	**143,60**	**TV**		16	338	460	400	34	22	12	M20	9,8
355/350	**47 35 08 010**	**1**	**302,59**	**TV**		16	377	520	460	39	23	16	M20	15,0
400/400	**47 40 08 010**	**1**	**342,33**	**TV**		16	430	580	515	43	27	16	M24	18,1
450/500	**47 45 08 010**	**1**	**405,68**	**TV**		10	517	678	620	45	26	20	M24	25,0
500/500	**47 50 08 010**	**1**	**405,68**	**TV**		10	533	678	620	45	26	20	M24	23,4
560/600	**47 56 08 010**	**1**	**550,15**	**TV**		10	618	790	725	50	30	20	M27	33,7
630/600	**47 63 08 010**	**1**	**550,15**	**TV**		10	645	790	725	50	30	20	M27	32,6

* *identical to DIN 2501-PN16*

n = number of bolts.
bar = maximum operating pressure.
"DIN 2501-PN10" does not refer to the pressure class of the backing ring.

PE100 pressure fittings

Backing ring PP with ductile iron core
ANSI 150 lb
for stub flange

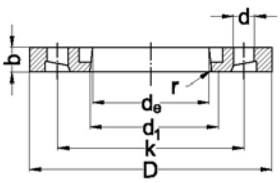


DN/d_e	Art. Nr.	q	€	AG	bar	d_1	D	k	b	d	n	kg
20/½"	**47 78 08 010**	**1**	**9,09**	**TA**	16	28	95	60,5	12	16	4	0,3
25/¾"	**47 79 08 010**	**1**	**11,34**	**TA**	16	34	102	69,9	12	16	4	0,3
32/1"	**47 80 08 010**	**1**	**13,38**	**TA**	16	42	114	79,3	16	16	4	0,4
40/1¼"	**47 81 08 010**	**1**	**15,40**	**TA**	16	51	130	88,9	16	16	4	0,5
50/1½"	**47 82 08 010**	**1**	**19,20**	**TA**	16	62	133	98,6	18	16	4	0,6
63/2"	**47 83 08 010**	**1**	**23,87**	**TA**	16	78	162	120,6	18	20	4	0,9
75/2½"	**47 84 08 010**	**1**	**29,49**	**TA**	16	92	184	139,7	18	20	4	1,1
90/3"	**47 85 08 010**	**1**	**34,58**	**TA**	16	111	194	152,4	18	20	4	1,0
110/4"	**47 86 08 010**	**1**	**45,12**	**TA**	16	133	229	190,5	18	20	8	1,6
160/6"	**47 87 08 010**	**1**	**85,21**	**TA**	16	178	283	241,3	24	22	8	2,5
200/8"	**47 88 08 010**	**1**	**123,28**	**TA**	16	236	345	298,5	24	22	8	3,4
250/10"	**47 89 08 010**	**1**	**158,75**	**TA**	16	288	412	361,9	27	25	12	5,9
315/12"	**47 90 08 010**	**1**	**244,88**	**TA**	16	338	487	431,8	32	25	12	12,8
355/14"	**47 91 08 010**	**1**	**418,25**	**TA**	16	376	533	476,2	42	28,5	12	15,7
400/16"	**47 92 08 010**	**1**	**478,52**	**TA**	16	430	596	539,7	44	28,5	16	17,6

n = number of bolts.
bar = maximum operating pressure.
ANSI B16.5 class 150

Profile backing ring ductile iron
DIN 2501-PN10 (EN 1092)
for stub flange

GGG40 epoxy coated



d_e/DN	Art. Nr.	q	€	AG		bar	d_1	D	k	b	d	n	M	r	kg
50/40	**47 05 13 010**	**16**	**14,14**	**TS**	*	16	62	150	110	16	18	4	M16	3	1,0
63/50	**47 06 13 010**	**16**	**16,19**	**TS**	*	16	78	165	125	16	18	4	M16	3	1,1
75/65	**47 07 13 010**	**10**	**18,23**	**TS**	*	16	92	185	145	16	18	4	M16	3	1,4
90/80	**47 09 13 010**	**10**	**21,36**	**TS**	*	16	108	200	160	19	18	8	M16	3	1,6
110/100	**47 11 13 010**	**10**	**23,59**	**TS**	*	16	128	220	180	19	18	8	M16	3	1,8
125/100	**47 12 13 010**	**9**	**23,59**	**TS**	*	16	135	220	180	19	18	8	M16	3	1,7
140/125	**47 14 13 010**	**8**	**29,67**	**TS**	*	16	158	250	210	19	18	8	M16	3	2,1
160/150	**47 16 13 010**	**6**	**37,57**	**TS**	*	16	178	285	240	19	22	8	M20	3	2,6
180/150	**47 18 13 010**	**6**	**37,57**	**TS**	*	10	188	285	240	19	22	8	M20	3	2,5
200/200	**47 20 13 010**	**1**	**54,35**	**TS**		10	235	340	295	18	22	8	M20	3	3,5
225/200	**47 22 13 010**	**1**	**54,35**	**TS**		10	238	340	295	18	22	8	M20	3	3,5
250/250	**47 25 13 010**	**1**	**79,55**	**TS**		10	288	395	350	22	22	12	M20	3	5,3
280/250	**47 28 13 010**	**1**	**79,55**	**TS**		10	294	395	350	22	22	12	M20	3	5,1
315/300	**47 31 13 010**	**1**	**98,69**	**TS**		10	338	445	400	26	22	12	M20	3	6,6
355/350	**47 35 13 010**	**1**	**163,92**	**TS**		10	376	505	460	30	22	16	M20	4	11,3
400/400	**47 40 13 010**	**1**	**208,86**	**TS**		10	430	565	515	34	26	16	M24	4	14,2
450/500	**47 45 13 010**	**1**	**319,50**	**TS**		10	517	670	620	42	26	20	M24	6	21,5
500/500	**47 50 13 010**	**1**	**319,50**	**TS**		10	533	670	620	38	26	20	M24	4	18,7
560/600	**47 56 13 010**	**1**	**489,51**	**TS**		10	618	785	725	50	30	20	M27	7	34,8
630/600	**47 63 13 010**	**1**	**489,51**	**TS**		10	645	785	725	40	30	20	M27	4	26,4
710/700	**47 71 13 010**	**1**	**736,63**	**TS**		6	740	900	840	45	30	24	M27	5	36,4
800/800	**47 80 13 010**	**1**	**972,58**	**TS**	**	6	843	1015	950	53	33	24	M30	5	50,5
900/900	**47 90 13 010**	**1**	**1090,07**	**TS**	**	6	947	1115	1050	56	33	28	M30	5	55,8
1000/1000	**47 91 13 010**	**1**	**1364,30**	**TS**	**	6	1050	1230	1160	62	36	28	M33	5	71,1
1200/1200	**47 92 13 010**	**1**	**1912,75**	**TS**	**	4	1260	1455	1380	68	39	32	M36	6	101
1400/1400	**47 93 13 010**	**1**	**1760,07**	**TS**	**	4	1441	1675	1590	72	42	36	M39	6	143
1600/1600	**47 94 13 010**	**1**	**o.r.**	**TP**	**	4	1644	1915	1820	84	48	40	M45	6	203

* *identical to DIN 2501-PN16*

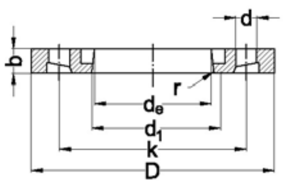
** *fabrication on order*

n = number of bolts.
bar = maximum operating pressure.
"DIN 2501-PN10" does not refer to the pressure class of the backing ring.

PE100 pressure fittings

Profile backing ring ductile iron
DIN 2501-PN16 (EN 1092)
for stub flange

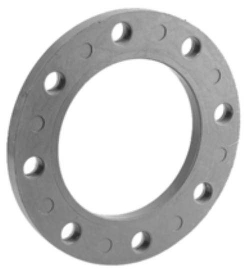
GGG40 epoxy coated

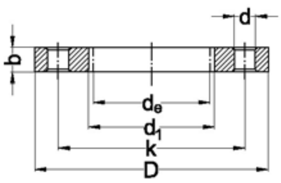


d_e/DN	Art. Nr.	q	€	AG	bar	d_1	D	k	b	d	n	M	r	kg
50/40	**47 05 13 010**	**16**	**14,14**	**TS**	16	62	150	110	16	18	4	M16	3	1,0
63/50	**47 06 13 010**	**16**	**16,19**	**TS**	16	78	165	125	16	18	4	M16	3	1,1
75/65	**47 07 13 010**	**10**	**18,23**	**TS**	16	92	185	145	16	18	4	M16	3	1,4
90/80	**47 09 13 010**	**10**	**21,36**	**TS**	16	108	200	160	19	18	8	M16	3	1,6
110/100	**47 11 13 010**	**10**	**23,59**	**TS**	16	128	220	180	19	18	8	M16	3	1,8
125/100	**47 12 13 010**	**9**	**23,59**	**TS**	16	135	220	180	19	18	8	M16	3	1,7
140/125	**47 14 13 010**	**8**	**29,67**	**TS**	16	158	250	210	19	18	8	M16	3	2,1
160/150	**47 16 13 010**	**6**	**37,57**	**TS**	16	178	285	240	19	22	8	M20	3	2,6
180/150	**47 18 13 010**	**6**	**37,57**	**TS**	16	188	285	240	19	22	8	M20	3	2,5
200/200	**47 20 13 016**	**1**	**58,07**	**TS**	16	235	340	295	23	22	12	M20	3	4,0
225/200	**47 22 13 016**	**1**	**58,07**	**TS**	16	238	340	295	23	22	12	M20	3	3,9
250/250	**47 25 13 016**	**1**	**94,46**	**TS**	16	288	405	355	29	26	12	M24	3	6,6
280/250	**47 28 13 016**	**1**	**94,46**	**TS**	16	294	405	355	29	26	12	M24	3	6,5
315/300	**47 31 13 016**	**1**	**120,68**	**TS**	16	338	460	410	34	26	12	M24	3	8,6
355/350	**47 35 13 016**	**1**	**208,06**	**TS**	16	376	520	470	39	26	16	M24	4	14,4
400/400	**47 40 13 016**	**1**	**246,24**	**TS**	16	430	580	525	43	30	16	M27	4	17,0
450/500	**47 40 13 016**	**1**	**246,24**	**TS**	16	517	715	650	46	33	20	M30	6,5	29,8
500/500	**47 40 13 016**	**1**	**246,24**	**TS**	16	533	650	650	46	33	20	M30	7	27,3
560/600	**47 40 13 016**	**1**	**246,24**	**TS**	16	618	840	770	55	36	20	M33	6	46,5
630/600	**47 40 13 016**	**1**	**246,24**	**TS**	16	645	840	770	55	36	20	M33	6	37,2

n = number of bolts.
bar = maximum operating pressure.
"DIN 2501-PN16" does not refer to the pressure class of the backing ring.

Backing ring GRP standard type
DIN 2501-PN10 (EN 1092)
for stub flange





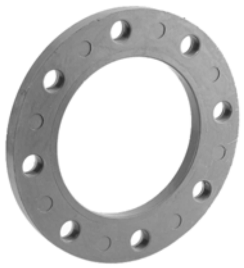
d_e/DN	Art. Nr.	q	€	AG		bar	d_1	D	k	b	d	n	M	kg
20/15	**47 01 07 010**	**1**	**7,46**	**TG**	*	6	28	95	65	14	14	4	M12	0,2
25/20	**47 02 07 010**	**1**	**8,11**	**TG**	*	6	34	105	75	14	14	4	M12	0,2
32/25	**47 03 07 010**	**1**	**9,21**	**TG**	*	6	42	115	85	16	14	4	M12	0,3
40/32	**47 04 07 010**	**1**	**11,29**	**TG**	*	6	51	140	100	16	18	4	M16	0,4
50/40	**47 05 07 010**	**1**	**12,25**	**TG**	*	6	62	150	110	16	18	4	M16	0,4
63/50	**47 06 07 010**	**1**	**14,21**	**TG**	*	6	78	165	125	16	18	4	M16	0,5
75/65	**47 07 07 010**	**1**	**17,72**	**TG**	*	6	92	185	145	16	18	4	M16	0,6
90/80	**47 09 07 010**	**1**	**20,40**	**TG**		6	108	200	160	18	18	8	M16	0,7
110/100	**47 11 07 010**	**1**	**24,39**	**TG**		6	128	220	180	18	18	8	M16	0,8
125/100	**47 12 07 010**	**1**	**24,39**	**TG**		6	135	220	180	18	18	8	M16	0,7
140/125	**47 14 07 010**	**1**	**29,70**	**TG**		6	158	250	210	18	18	8	M16	1,0
160/150	**47 16 07 010**	**1**	**35,31**	**TG**		6	178	285	240	18	23	8	M20	1,2
180/150	**47 18 07 010**	**1**	**35,31**	**TG**		6	188	285	240	18	23	8	M20	1,1
200/200	**47 20 07 010**	**1**	**51,37**	**TG**		6	235	340	295	25	23	8	M20	2,1
225/200	**47 22 07 010**	**1**	**51,37**	**TG**		6	238	340	295	25	23	8	M20	2,1
250/250	**47 25 07 010**	**1**	**65,44**	**TG**		6	288	395	350	28	23	12	M20	2,7
280/250	**47 28 07 010**	**1**	**65,44**	**TG**		6	294	395	350	28	23	12	M20	2,5
315/300	**47 31 07 010**	**1**	**78,58**	**TG**		6	338	445	400	30	23	12	M20	3,3
355/350	**47 35 07 010**	**1**	**113,03**	**TG**		6	376	505	460	28	23	16	M20	4,2
400/400	**47 40 07 010**	**1**	**125,34**	**TG**		6	430	565	515	32	27	16	M24	6,0
450/500	**47 45 07 010**	**1**	**165,85**	**TG**		6	533	670	620	38	27	20	M24	8,6
500/500	**47 50 07 010**	**1**	**165,85**	**TG**		6	533	670	620	38	27	20	M24	8,6

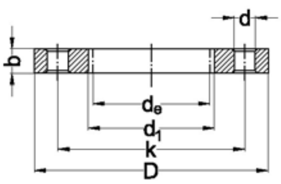
* *also suitable for flange adaptor (socket connection)*

n = number of bolts.
bar = maximum operating pressure.
"DIN 2501-PN10" does not refer to the pressure class of the backing ring.

PE100 pressure fittings

Backing ring GRP heavy type DIN 2501-PN10
DIN 2501-PN10 (EN 1092)
for stub flange





d_e/DN	Art. Nr.	q	€	AG		bar	d_1	D	k	b	d	n	M	kg
63/50	**47 06 06 010**	**1**	**19,54**	**TG**	*	10	78	165	125	18	18	4	M16	0,5
75/65	**47 07 06 010**	**1**	**22,96**	**TG**	*	10	92	185	145	20	18	4	M16	0,7
90/80	**47 09 06 010**	**1**	**24,71**	**TG**		10	108	200	160	22	18	8	M16	0,8
110/100	**47 11 06 010**	**1**	**30,09**	**TG**		10	128	220	180	28	18	8	M16	1,2
125/100	**47 12 06 010**	**1**	**30,09**	**TG**		10	135	220	180	28	18	8	M16	1,1
140/125	**47 14 06 010**	**1**	**36,18**	**TG**		10	158	250	210	30	18	8	M16	1,6
160/150	**47 16 06 010**	**1**	**44,90**	**TG**		10	178	285	240	30	23	8	M20	1,9
180/150	**47 18 06 010**	**1**	**44,90**	**TG**		10	188	285	240	30	23	8	M20	1,8
200/200	**47 20 06 010**	**1**	**62,78**	**TG**		10	235	340	295	32	23	8	M20	2,5
225/200	**47 22 06 010**	**1**	**62,78**	**TG**		10	238	340	295	32	23	8	M20	2,4
250/250	**47 25 06 010**	**1**	**77,62**	**TG**		10	288	395	350	34	23	12	M20	3,2
280/250	**47 28 06 010**	**1**	**79,61**	**TG**		10	294	395	350	34	23	12	M20	3,0
315/300	**47 31 06 010**	**1**	**90,18**	**TG**		10	338	445	400	36	23	12	M20	4,0
355/350	**47 35 06 010**	**1**	**144,91**	**TG**		10	376	505	460	38	23	16	M20	5,6
400/400	**47 40 06 010**	**1**	**162,36**	**TG**		10	430	565	515	42	27	16	M24	7,2
450/500	**47 45 06 010**	**1**	**199,29**	**TG**		10	533	670	620	48	27	20	M24	10,4
500/500	**47 50 06 010**	**1**	**199,29**	**TG**		10	533	670	620	48	27	20	M24	10,4
560/600	**47 56 06 010**	**1**	**379,84**	**TG**		10	645	780	725	56	30	20	M27	13,2
630/600	**47 63 06 010**	**1**	**379,84**	**TG**		10	645	780	725	56	30	20	M27	13,2

* *also suitable for flange adaptor (socket connection)*

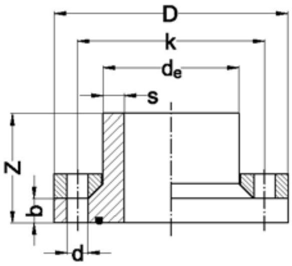
n = number of bolts.
bar = maximum operating pressure.
"DIN 2501-PN10" does not refer to the pressure class of the backing ring.

Flange connection short SDR 17

DIN 2501-PN10 (EN 1092)
for butt-welding

PE100
SDR 17
water 10 bar

d_e/DN	Art. Nr.	q	€	AG		bar	Z	D	k	b	d	n	M	kg
90/65	**47 06 09 017**	**1**	**231,39**	**TR**		10	90	185	145	30	18	4	M16	2,9
110/80	**47 08 11 017**	**1**	**253,12**	**TR**		10	90	200	160	30	18	8	M16	3,6
140/100	**47 10 14 017**	**1**	**263,03**	**TR**		10	90	220	180	30	18	8	M16	3,6
160/125	**47 12 16 017**	**1**	**300,22**	**TR**		10	100	250	210	35	18	8	M16	4,7
180/125	**47 12 18 017**	**1**	**327,50**	**TR**		10	125	250	210	35	18	8	M16	4,5
200/150	**47 15 20 017**	**1**	**376,94**	**TR**		10	100	285	240	35	23	8	M20	5,7
250/200	**47 20 25 017**	**1**	**435,87**	**TR**		10	100	340	295	40	23	8	M20	8,2
315/250	**47 25 31 017**	**1**	**660,51**	**TR**	*	10	130	395	350	40	23	12	M20	11,5
355/300	**47 30 35 017**	**1**	**671,60**	**TR**		10	110	445	400	40	23	12	M20	15,1
400/350	**47 35 40 017**	**1**	**798,96**	**TR**		10	130	505	460	60	23	16	M20	21,7
450/400	**47 40 45 017**	**1**	**1027,18**	**TR**		10	130	565	515	60	27	16	M24	29,0
560/500	**47 50 56 017**	**1**	**1237,20**	**TR**		10	140	670	620	60	27	20	M24	42,3



**	different construction*

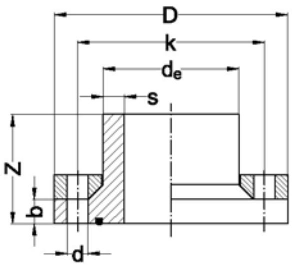
EPDM O-ring and hot dip galvanised steel backing ring.
n = number of bolts.
bar = maximum operating pressure.
For direct connection of valves without loss of cross section and without changing the nominal size.
"DIN 2501-PN10" does not refer to the pressure class of the backing ring.

Flange connection short SDR 11

DIN 2501-PN10 (EN 1092)
for butt-welding

PE100
SDR 11
water 16 bar

d_e/DN	Art. Nr.	q	€	AG		bar	Z	D	k	b	d	n	M	kg
90/65	**47 06 09 011**	**1**	**243,64**	**TR**		10	90	185	145	30	18	4	M16	2,9
110/80	**47 08 11 011**	**1**	**266,60**	**TR**		10	90	200	160	30	18	8	M16	3,6
140/100	**47 10 14 011**	**1**	**276,87**	**TR**		10	90	220	180	30	18	8	M16	3,6
160/125	**47 12 16 011**	**1**	**316,03**	**TR**		10	100	250	210	35	18	8	M16	4,7
180/125	**47 12 18 011**	**1**	**344,89**	**TR**		10	125	250	210	35	18	8	M16	4,5
200/150	**47 15 20 011**	**1**	**397,10**	**TR**		10	100	285	240	35	23	8	M20	5,7
250/200	**47 20 25 011**	**1**	**458,82**	**TR**		10	100	340	295	40	23	8	M20	8,2
315/250	**47 25 31 011**	**1**	**695,33**	**TR**	*	10	130	395	350	40	23	12	M20	11,5
355/300	**47 30 35 011**	**1**	**706,80**	**TR**		10	110	445	400	40	23	12	M20	15,1
400/350	**47 35 40 011**	**1**	**840,88**	**TR**		10	130	505	460	60	23	16	M20	21,7
450/400	**47 40 45 011**	**1**	**1081,36**	**TR**		10	130	565	515	60	27	16	M24	29,0
560/500	**47 50 56 011**	**1**	**1302,47**	**TR**		10	140	670	620	60	27	20	M24	42,3



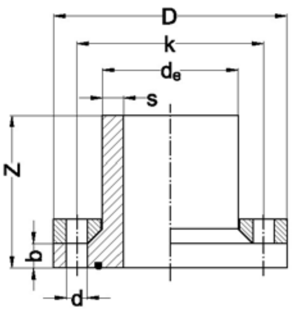
**	different construction*

EPDM O-ring and hot dip galvanised steel backing ring.
n = number of bolts.
bar = maximum operating pressure.
For direct connection of valves without loss of cross section and without changing the nominal size.
"DIN 2501-PN10" does not refer to the pressure class of the backing ring.

PE100 pressure fittings

Flange connection long SDR 17
DIN 2501-PN10 (EN 1092)
for butt-welding and electrofusion

PE100
SDR 17
water 10 bar



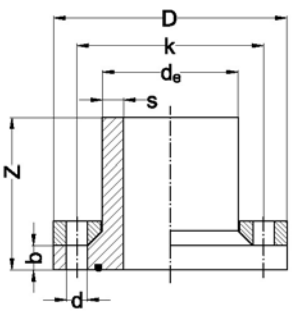
d_e/DN	Art. Nr.	q	€	AG		bar	Z	D	k	b	d	n	M	kg
90/65	**47 06 09 117**	**1**	**266,60**	**TR**		10	300	185	145	30	18	4	M16	3,3
110/80	**47 08 11 117**	**1**	**291,11**	**TR**		10	300	200	160	30	18	8	M16	4,3
140/100	**47 10 14 117**	**1**	**305,76**	**TR**		10	300	220	180	30	18	8	M16	4,6
160/125	**47 12 16 117**	**1**	**347,68**	**TR**		10	300	250	210	35	18	8	M16	6,1
180/125	**47 12 18 117**	**1**	**380,49**	**TR**		10	300	250	210	35	18	8	M16	6,2
200/150	**47 15 20 117**	**1**	**435,08**	**TR**		10	300	285	240	35	23	8	M20	7,8
250/200	**47 20 25 117**	**1**	**526,44**	**TR**		10	300	340	295	40	23	8	M20	11,5
315/250	**47 25 31 117**	**1**	**790,65**	**TR**	*	10	300	395	350	40	23	12	M20	16,8
355/300	**47 30 35 117**	**1**	**821,10**	**TR**		10	300	445	400	40	23	12	M20	21,8
400/350	**47 35 40 117**	**1**	**964,30**	**TR**		10	400	505	460	60	23	16	M20	30,2
450/400	**47 40 45 117**	**1**	**1237,20**	**TR**		10	400	565	515	60	27	16	M24	39,4
560/500	**47 50 56 117**	**1**	**1644,99**	**TR**		10	400	670	620	60	27	20	M24	58,9

* *different construction*

EPDM O-ring and hot dip galvanised steel backing ring.
n = number of bolts.
bar = maximum operating pressure.
For direct connection of valves without loss of cross section and without changing the nominal size.
"DIN 2501-PN10" does not refer to the pressure class of the backing ring.

Flange connection long SDR 11
DIN 2501-PN10 (EN 1092)
for butt-welding and electrofusion

PE100
SDR 11
water 16 bar



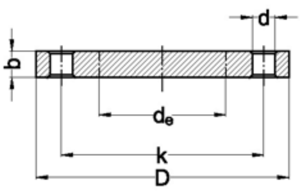
d_e/DN	Art. Nr.	q	€	AG		bar	Z	D	k	b	d	n	M	kg
90/65	**47 06 09 111**	**1**	**283,59**	**TR**		10	300	185	145	30	18	4	M16	3,5
110/80	**47 08 11 111**	**1**	**309,30**	**TR**		10	300	200	160	30	18	8	M16	4,6
140/100	**47 10 14 111**	**1**	**329,86**	**TR**		10	300	220	180	30	18	8	M16	5,1
160/125	**47 12 16 111**	**1**	**373,78**	**TR**		10	300	250	210	35	18	8	M16	6,7
180/125	**47 12 18 111**	**1**	**410,55**	**TR**		10	300	250	210	35	18	8	M16	7,0
200/150	**47 15 20 111**	**1**	**472,26**	**TR**		10	300	285	240	35	23	8	M20	8,9
250/200	**47 20 25 111**	**1**	**571,55**	**TR**		10	300	340	295	40	23	8	M20	13,1
315/250	**47 25 31 111**	**1**	**850,77**	**TR**	*	10	300	395	350	40	23	12	M20	19,3
355/300	**47 30 35 111**	**1**	**884,79**	**TR**		10	300	445	400	40	23	12	M20	25,0
400/350	**47 35 40 111**	**1**	**1051,70**	**TR**		10	400	505	460	60	23	16	M20	34,2
450/400	**47 40 45 111**	**1**	**1343,20**	**TR**		10	400	565	515	60	27	16	M24	44,8
560/500	**47 50 56 111**	**1**	**1783,02**	**TR**		10	400	670	620	60	27	20	M24	66,8

* *different construction*

EPDM O-ring and hot dip galvanised steel backing ring.
n = number of bolts.
bar = maximum operating pressure.
For direct connection of valves without loss of cross section and without changing the nominal size.
"DIN 2501-PN10" does not refer to the pressure class of the backing ring.

Blind flange PP with ductile iron core
DIN 2501-PN10 (EN 1092)

d_e/DN	Art. Nr.	q	€	AG		bar	D	k	b	d	n	M	kg
20/15	**47 01 85 010**	**1**	**42,55**	**TV**	*	16	95	65	12	14	4	M12	0,3
25/20	**47 02 85 010**	**1**	**43,20**	**TV**	*	16	105	75	12	14	4	M12	0,4
32/25	**47 03 85 010**	**1**	**44,31**	**TV**	*	16	115	85	16	14	4	M12	0,6
40/32	**47 04 85 010**	**1**	**47,44**	**TV**	*	16	140	100	16	18	4	M16	0,8
50/40	**47 05 85 010**	**1**	**53,74**	**TV**	*	16	150	110	18	18	4	M16	0,9
63/50	**47 06 85 010**	**1**	**58,50**	**TV**	*	16	165	125	18	18	4	M16	1,2
75/65	**47 07 85 010**	**1**	**68,53**	**TV**	*	16	185	145	18	18	4	M16	1,7
90/80	**47 09 85 010**	**1**	**75,44**	**TV**	*	16	200	160	18	18	8	M16	2,2
110/100	**47 11 85 010**	**1**	**103,05**	**TV**	*	16	220	180	18	18	8	M16	2,8
125/100	**47 11 85 010**	**1**	**103,05**	**TV**	*	16	220	180	18	18	8	M16	2,8
140/125	**47 14 85 010**	**1**	**126,55**	**TV**	*	16	250	210	24	18	8	M16	4,0
160/150	**47 16 85 010**	**1**	**159,66**	**TV**	*	16	285	240	24	22	8	M20	5,1
180/150	**47 16 85 010**	**1**	**159,66**	**TV**	*	16	285	240	24	22	8	M20	5,2
200/200	**47 20 85 010**	**1**	**177,31**	**TV**		16	340	295	24	22	8	M20	7,7
225/200	**47 20 85 010**	**1**	**177,31**	**TV**		16	340	295	24	22	8	M20	7,7
250/250	**47 25 85 010**	**1**	**231,72**	**TV**		16	400	350	30	22	12	M20	14,4
280/250	**47 25 85 010**	**1**	**231,72**	**TV**		16	400	350	30	22	12	M20	15,7
315/300	**47 31 85 010**	**1**	**338,32**	**TV**		16	463	400	34	22	12	M20	26,5
355/350	**47 35 85 010**	**1**	**661,77**	**TV**		10	515	460	42	22	16	M20	39,2
400/400	**47 40 85 010**	**1**	**756,00**	**TV**		10	574	515	46	27	16	M24	50,1



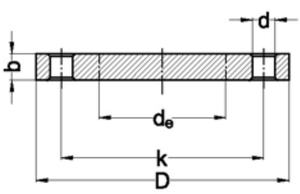
* *identical to DIN 2501-PN16*

n = number of bolts.
bar = maximum operating pressure.
"DIN 2501-PN10" does not refer to he pressure class of the backing ring.

Blind flange steel Rilsan coated DIN 2501-PN10
DIN 2501-PN10 (EN 1092)

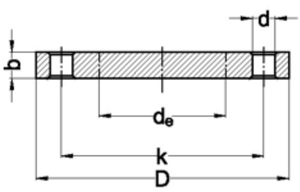
d_e/DN	Art. Nr.	q	€	AG	bar	D	k	b	d	n	M	kg
450/500	**47 50 55 010**	**1**	**1108,35**	**TR**	10	670	620	26	32	20	M24	87,0
500/500	**47 50 55 010**	**1**	**1108,35**	**TR**	10	670	620	26	32	20	M24	87,0
560/600	**47 63 55 010**	**1**	**1494,87**	**TR**	10	780	725	30	35	20	M27	106,0
630/600	**47 63 55 010**	**1**	**1494,87**	**TR**	10	780	725	30	35	20	M27	106,0
710/700	**47 71 55 010**	**1**	**2158,23**	**TR**	10	895	840	30	40	24	M27	150,0
800/800	**47 80 55 010**	**1**	**2949,12**	**TR**	10	1015	950	33	44	24	M30	190,0

n = number of bolts.
bar = maximum operating pressure.
"DIN 2501-PN10" does not refer to the pressure class of the backing ring.
Fabrication on order, returning not possible.



PE100 pressure fittings

Blind flange PP with ductile iron core
ANSI 150 lb

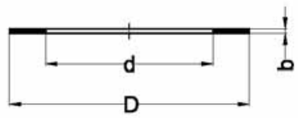


d_e/DN	Art. Nr.	q	€	AG	bar	D	k	b	d	n	kg
20/½"	**47 78 05 010**	**1**	**46,46**	**TA**	16	95	60,5	12	16	4	0,3
25/¾"	**47 79 05 010**	**1**	**47,16**	**TA**	16	102	69,9	12	16	4	0,3
32/1"	**47 80 05 010**	**1**	**48,31**	**TA**	16	114	79,3	16	16	4	0,5
40/1¼"	**47 81 05 010**	**1**	**51,78**	**TA**	16	130	88,9	16	16	4	0,8
50/1½"	**47 82 05 010**	**1**	**58,72**	**TA**	16	133	98,6	18	16	4	0,8
63/2"	**47 83 05 010**	**1**	**63,89**	**TA**	16	162	120,6	18	20	4	1,3
75/2½"	**47 84 05 010**	**1**	**73,04**	**TA**	16	184	139,7	18	20	4	1,5
90/3"	**47 85 05 010**	**1**	**82,35**	**TA**	16	194	152,4	18	20	4	1,9
110/4"	**47 86 05 010**	**1**	**112,50**	**TA**	16	229	190,5	18	20	8	3,0
160/6"	**47 87 05 010**	**1**	**174,41**	**TA**	16	283	241,3	24	22	8	4,9
200/8"	**47 88 05 010**	**1**	**193,76**	**TA**	16	345	298,5	24	22	8	7,7
250/10"	**47 89 05 010**	**1**	**252,92**	**TA**	10	412	361,9	27	25	12	15,0
315/12"	**47 90 05 010**	**1**	**369,64**	**TA**	10	487	431,8	32	25	12	29,0

n = number of bolts.
bar = maximum operating pressure.
ANSI B16.5 class 150.

Gasket flat EPDM

for stub flanges SDR 17



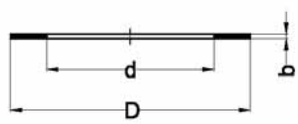
d_e/DN	Art. Nr.	q	€	AG	d	D	b
63/50	47 06 13 810	1	0,97	TG	58	107	3
75/65	47 07 13 810	1	1,35	TG	69	127	3
90/80	47 09 13 810	1	1,54	TG	84	142	3
110/100	47 11 13 810	1	1,93	TG	100	162	3
125/100	47 12 13 810	1	1,93	TG	114	162	3
140/125	47 14 13 810	1	2,48	TG	127	192	3
160/150	47 16 13 810	1	3,30	TG	146	218	3
180/150	47 18 13 810	1	3,30	TG	164	218	3
200/200	47 20 13 810	1	4,84	TG	181	273	3
225/200	47 22 13 810	1	4,84	TG	203	273	3
250/250	47 25 13 810	1	7,07	TG	226	328	3
280/250	47 28 13 810	1	7,07	TG	252	328	3
315/300	47 31 13 810	1	8,96	TG	283	378	3
355/350	47 35 13 810	1	11,47	TG	319	435	3
400/400	47 40 13 810	1	14,18	TG	359	489	3
450/500	47 45 13 810	1	18,77	TG	403	594	3
500/500	47 50 13 810	1	18,77	TG	447	594	3
560/600	47 56 13 810	1	25,27	TG	494	695	3
630/600	47 63 13 810	1	25,27	TG	555	695	3
710/700	47 71 13 810	1	32,59	TG	630	810	3
800/800	47 80 13 810	1	38,96	TG	710	915	3
900/900	47 90 13 810	1	42,18	TG	800	1020	3
1000/1000	47 91 13 810	1	45,24	TG	885	1120	3

Suitable for flange connections with maximum operating pressure water 10 bar.
For pressure class >10 bar we recommend our profile gaskets.

PE100 pressure fittings

Gasket flat EPDM

for stub flanges SDR 11

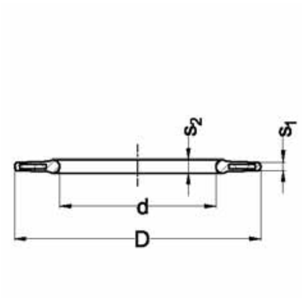


d_e/DN	Art. Nr.	q	€	AG	d	D	b
20/15	**47 01 13 910**	**1**	**0,29**	**TG**	16	51	3
25/20	**47 02 13 910**	**1**	**0,39**	**TG**	22	61	3
32/25	**47 03 13 910**	**1**	**0,47**	**TG**	28	71	3
40/32	**47 04 13 910**	**1**	**0,64**	**TG**	34	82	3
50/40	**47 05 13 910**	**1**	**0,74**	**TG**	42	92	3
63/50	**47 06 13 910**	**1**	**0,97**	**TG**	53	107	3
75/65	**47 07 13 910**	**1**	**1,35**	**TG**	63	127	3
90/80	**47 09 13 910**	**1**	**1,54**	**TG**	76	142	3
110/100	**47 11 13 910**	**1**	**1,93**	**TG**	93	162	3
125/100	**47 12 13 910**	**1**	**1,93**	**TG**	105	162	3
140/125	**47 14 13 910**	**1**	**2,48**	**TG**	117	192	3
160/150	**47 16 13 910**	**1**	**3,30**	**TG**	135	218	3
180/150	**47 18 13 910**	**1**	**3,30**	**TG**	151	218	3
200/200	**47 20 13 910**	**1**	**4,84**	**TG**	168	273	3
225/200	**47 22 13 910**	**1**	**4,84**	**TG**	188	273	3
250/250	**47 25 13 910**	**1**	**7,07**	**TG**	203	328	3
280/250	**47 28 13 910**	**1**	**7,07**	**TG**	233	328	3
315/300	**47 31 13 910**	**1**	**8,96**	**TG**	262	378	3
355/350	**47 35 13 910**	**1**	**11,47**	**TG**	294	435	3
400/400	**47 40 13 910**	**1**	**14,18**	**TG**	331	489	3
450/500	**47 45 13 910**	**1**	**18,77**	**TG**	372	594	3
500/500	**47 50 13 910**	**1**	**18,77**	**TG**	413	594	3
560/600	**47 56 13 910**	**1**	**25,27**	**TG**	451	695	3
630/600	**47 63 13 910**	**1**	**25,27**	**TG**	507	695	3

Suitable for flange connections with maximum operating pressure water 10 bar.
For pressure class >10 bar we recommend our profile gaskets.

Profile gasket EPDM with steel core

for stub flanges SDR 17



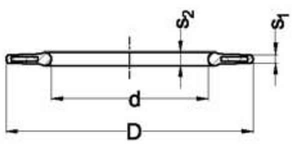
d_e/DN	Art. Nr.	q	€	AG	d	D	s_1	s_2
63/50	**47 06 13 610**	**1**	**9,82**	**TG**	58	107	4	5
75/65	**47 07 13 610**	**1**	**9,94**	**TG**	69	127	4	5
90/80	**47 09 13 610**	**1**	**10,52**	**TG**	84	142	4	5
110/100	**47 11 13 610**	**1**	**12,01**	**TG**	100	162	5	6
125/100	**47 12 13 610**	**1**	**13,45**	**TG**	114	162	5	6
140/125	**47 14 13 610**	**1**	**13,17**	**TG**	127	192	5	6
160/150	**47 16 13 610**	**1**	**16,19**	**TG**	146	218	6	8
180/150	**47 18 13 610**	**1**	**15,77**	**TG**	164	218	6	8
200/200	**47 20 13 610**	**1**	**21,45**	**TG**	181	273	6	8
225/200	**47 22 13 610**	**1**	**22,08**	**TG**	203	273	6	8
250/250	**47 25 13 610**	**1**	**26,79**	**TG**	226	328	6	8
280/250	**47 28 13 610**	**1**	**28,49**	**TG**	252	328	6	8
315/300	**47 31 13 610**	**1**	**34,19**	**TG**	283	378	6	8
355/350	**47 35 13 610**	**1**	**52,00**	**TG**	319	435	6	8
400/400	**47 40 13 610**	**1**	**62,62**	**TG**	359	489	6	8
450/500	**47 45 13 610**	**1**	**74,50**	**TG**	403	594	7	10
500/500	**47 50 13 610**	**1**	**89,42**	**TG**	447	594	7	10
560/600	**47 56 13 610**	**1**	**107,29**	**TG**	494	695	7	10
630/600	**47 63 13 610**	**1**	**128,72**	**TG**	555	695	7	10

Suitable for flange connections with maximum operating pressure water 16 bar.
Not allowed for potable water application.
NBR on request.

PE100 pressure fittings

Profile gasket EPDM with steel core

for stub flanges SDR 11

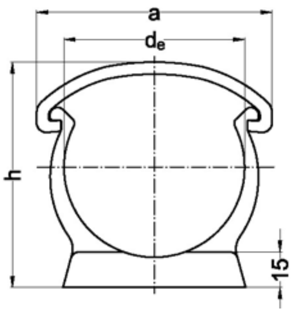


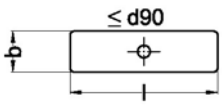
d_e/DN	Art. Nr.	q	€	AG	d	D	s_1	s_2
25/20	**47 02 13 710**	**1**	**9,21**	**TG**	22	61	3	4
32/25	**47 03 13 710**	**1**	**9,02**	**TG**	28	71	3	4
40/32	**47 04 13 710**	**1**	**9,24**	**TG**	34	82	3	4
50/40	**47 05 13 710**	**1**	**9,63**	**TG**	42	92	3	4
63/50	**47 06 13 710**	**1**	**9,94**	**TG**	53	107	4	5
75/65	**47 07 13 710**	**1**	**10,15**	**TG**	63	127	4	5
90/80	**47 09 13 710**	**1**	**10,73**	**TG**	76	142	4	5
110/100	**47 11 13 710**	**1**	**12,23**	**TG**	93	162	5	6
125/100	**47 12 13 710**	**1**	**13,81**	**TG**	105	162	5	6
140/125	**47 14 13 710**	**1**	**13,45**	**TG**	117	192	5	6
160/150	**47 16 13 710**	**1**	**16,55**	**TG**	135	218	6	8
180/150	**47 18 13 710**	**1**	**15,96**	**TG**	151	218	6	8
200/200	**47 20 13 710**	**1**	**21,24**	**TG**	168	273	6	8
225/200	**47 22 13 710**	**1**	**21,74**	**TG**	188	273	6	8
250/250	**47 25 13 710**	**1**	**28,01**	**TG**	208	328	6	8
280/250	**47 28 13 710**	**1**	**29,73**	**TG**	233	328	6	8
315/300	**47 31 13 710**	**1**	**35,54**	**TG**	262	378	6	8
355/350	**47 35 13 710**	**1**	**52,86**	**TG**	294	438	6	8
400/400	**47 40 13 710**	**1**	**64,55**	**TG**	331	489	6	8
450/500	**47 45 13 710**	**1**	**76,78**	**TG**	372	594	7	10
500/500	**47 50 13 710**	**1**	**92,12**	**TG**	413	594	7	10
560/600	**47 56 13 710**	**1**	**110,40**	**TG**	451	695	7	10
630/600	**47 63 13 710**	**1**	**132,46**	**TG**	507	695	7	10

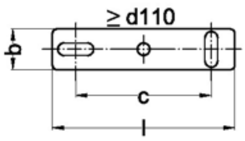
Suitable for flange connections with maximum operating pressure water 16 bar.
Not allowed for potable water application.
NBR on request.

Pipe clip - metric with retaining clip

PP







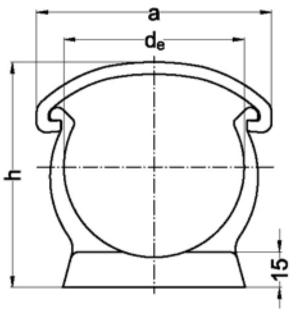
d_e	Art. Nr.	q	€	AG	a	b	h	l	c
16	**70 00 01 200**	**100**	**0,75**	**PR**	26	18	33	16	
20	**70 01 01 200**	**100**	**0,83**	**PR**	33	14	38	20	
25	**70 02 01 200**	**100**	**0,88**	**PR**	41	14	44	25	
32	**70 03 01 200**	**100**	**1,10**	**PR**	49	15	51	32	
40	**70 04 01 200**	**100**	**1,38**	**PR**	58	16	60	40	
50	**70 05 01 200**	**100**	**1,58**	**PR**	68	17	71	60	
63	**70 06 01 200**	**100**	**1,98**	**PR**	83	18	34	63	
75	**70 07 01 200**	**100**	**2,96**	**PR**	96	19	97	75	
90	**70 09 01 200**	**100**	**3,62**	**PR**	113	20	113	90	
110	**70 11 01 200**	**50**	**5,07**	**PR**	139	23	134	125	40
125	**70 12 01 200**	**10**	**6,66**	**PR**	158	25	151	140	60
140	**70 14 01 200**	**10**	**6,99**	**PR**	177	27	167	155	70
160	**70 16 01 200**	**10**	**8,09**	**PR**	210	30	190	180	90
180	**70 18 01 200**	**10**	**9,91**	**PR**	237	33	211	200	100

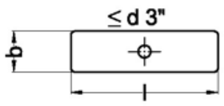
Easy mounting of (plastic) pipe systems indoor to floor, wall or ceiling.
Outdoor mounting with UV degradation restriction.
1 to 3 screws for solid connection to mounting surface.
Unrestricted axial pipe movement (expansion and contraction).
Prevents sideward movement.
Adapts radial expansion at elevated temperature.
No notch effect on pipe.
Colour grey RAL 7037.

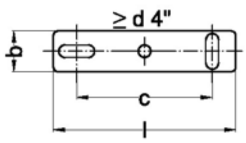
akatherm

PE100 pressure fittings

Pipe clip - inches with retaining clip PP







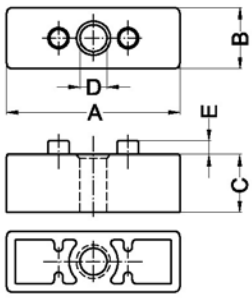
d_e	Art. Nr.	q	€	AG	a	b	h	l	c
3/8"	**70 77 01 200**	**100**	**0,75**	**PR**	26	13	34	16	
½"	**70 78 01 200**	**100**	**0,83**	**PR**	33	14	39	20	
¾"	**70 79 01 200**	**100**	**1,00**	**PR**	41	14	45	25	
1"	**70 80 01 200**	**100**	**1,05**	**PR**	49	15	52	32	
1¼"	**70 81 01 200**	**100**	**1,41**	**PR**	58	16	61	40	
1½	**70 82 01 200**	**100**	**1,58**	**PR**	68	17	67	50	
2"	**70 83 01 200**	**100**	**1,98**	**PR**	83	18	80	63	
2½"	**70 84 01 200**	**100**	**2,96**	**PR**	96	19	96	75	
3"	**70 85 01 200**	**100**	**3,62**	**PR**	118	20	110	90	
4"	**70 86 01 200**	**50**	**6,46**	**PR**	140	25	135	140	60
6"	**70 88 01 200**	**10**	**9,20**	**PR**	197	30	196	180	90

Easy mounting of (plastic) pipe systems indoor to floor, wall or ceiling.
Outdoor mounting with UV degradation restriction.
1 to 3 screws for solid connection to mounting surface.
Unrestricted axial pipe movement (expansion and contraction).
Prevents sideward movement.
Adapts radial expansion at elevated temperature.
No notch effect on pipe.
Colour grey RAL 7037.

Distance plate for pipe clip

PP

d_e	Art. Nr.	q	€	AG	A	B	C	D	E
32	**70 03 07 200**	**120**	**0,54**	**PR**	33	16	14	8	4
40	**70 04 07 200**	**80**	**0,72**	**PR**	41	17	17	8	4
50	**70 05 07 200**	**50**	**0,81**	**PR**	51	18	17	8	4
63	**70 06 07 200**	**40**	**0,92**	**PR**	64	19	22,5	8	4
75	**70 07 07 200**	**40**	**1,79**	**PR**	76	20	34,5	8	4



For alignment of pipe system with FIP valves.
Colour grey RAL 7037.

Jointing techniques

9 Welding polyolefins

9.1 General

Plastic can be welded with various welding techniques, although not every welding method is suitable for the welding of polyolefins. In designing a plastic pipe system, it is therefore important to obtain information about possible welding techniques and their applicability as early as the planning phase. The choice of the most appropriate welding procedure is usually influenced by following factors: economics, the construction of the component, external and internal influences on the system, as well as local conditions.

Figure 9.1 shows the welding practices most frequently used with plastics. The grey highlighted frames indicate the welding techniques usually employed for the welding of PE in plastic pipe construction. In practice, the welding methods most frequently used to connect PE pipe components are butt-welding and electrofusion.

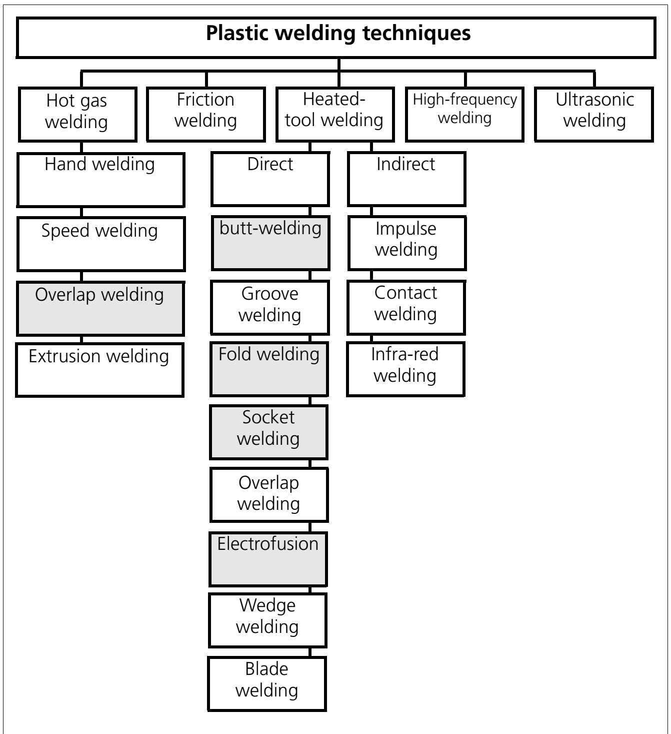


Figure 9.1 Welding techniques

9.2 Welding procedures

9.2.1 Socket welding

Description

Socket welding (also known a polyfusion) resembles butt-welding in its technique. The process is described in detail in the guidelines of DVS 2207 Sections 1, 5 and 11 with respect to the relevant plastic being used. In socket welding, both the spigot and socket are simultaneously heated. After ending the heating process, the socket is shoved over the spigot and pressure applied. The difference from butt-welding consists in the fact that the joining surfaces are connected in an overlapping manner. Therefore, one side of the heating element possesses a form on which to mount the socket (heating spigot) and the other side a form into which to plug the spigot (heating socket), see figure 9.2.

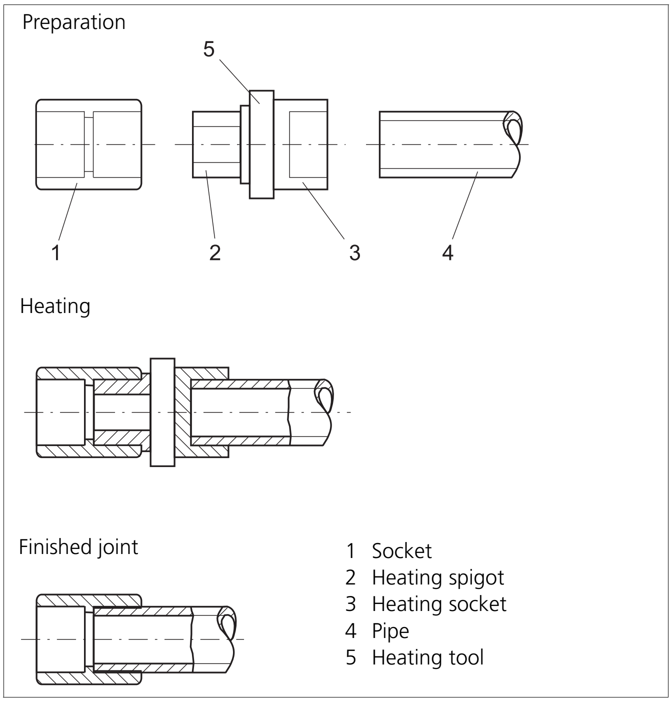


Figure 9.2 Socket welding

The sizes of the heating element and the elements to be welded conform to each other to the extent that the joining of the elements creates a welding pressure. Welded pipes up to a diameter of 50 mm can be welded by hand, larger diameters up to and including 110 mm must be welded with the aid of an apparatus.

Socket welding process - preparation

In principle, the areas corresponding to the welding seam must be carefully prepared, as faultless quality and leak-tightness can only be guaranteed when the joining surfaces are appropriately pre-treated. For this reason, the following rules for preparing the welding surfaces in pipe construction have a great deal of importance and should always be complied with:

- The welding surfaces are to be mechanically prepared immediately before the welding process using a scraper, grater or peeler in order to remove the oxidation layer.
- The spigot is to be bevelled as indicated in table 9.1. Figure 9.3 shows a properly bevelled spigot.
- The connecting surfaces of the pipes or fittings are prepared according to manufacture information.
- Bumping the end of the pipe against the floor of the heating tool to be avoided.
- In welds performed without machinery, the insertion depth equal to distance (E) in table 9.1 must be marked on the pipe.
- The joining surfaces must be free of grease and dust. The socket must be thoroughly cleaned on the inside and the spigot on the outside using a degreasing agent (e.g. industrial alcohol) and absorbent, non-fraying and uncoloured paper. The same applies to the heating element.
- The work site should be arranged so that there are areas in which welding can occur independent of atmospheric conditions.
- No welding work can be performed when ambient temperatures are under +5°C without taking special measures (e.g. protection by a heated tent). The temperature in the immediate proximity of the welding location should not vary more than 10°C during the welding procedure.
- The functional capacity of the machines and equipment has to be tested prior to welding. In particular, the welding parameters need to be checked. For PE the temperature of the heating element is 250-270°C.

akatherm

Welding polyolefins

Pipe diameter d_e (mm)	Pipe phase b (mm)	Insertion depth E (mm)
16	2	13
20	2	14
25	2	15
32	2	17
40	2	18
50	2	20
63	3	26
75	3	29
90	3	32
110	3	35
125	3	38

Table 9.1 Weld preparation phase for pipe ends

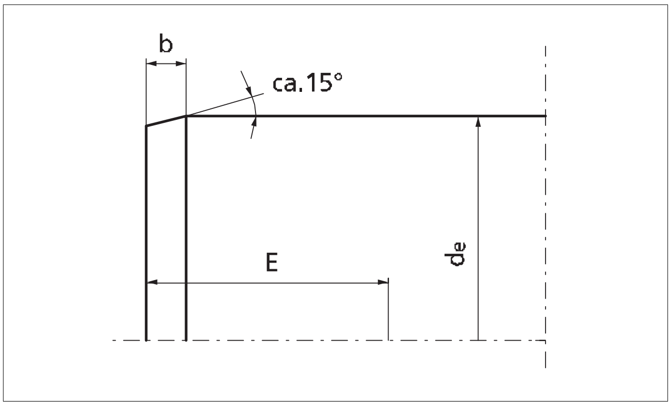


Figure 9.3 Pipe phase in socket welding

1	2		3	4	5
Outside pipe diameter (mm)	Heating SDR 11	SDR 17	Conversation (maximum time) (s)	Cooling fixed (s)	Cooling total (min)
16	5		4	6	2
20	5		4	6	2
25	7	(1)	4	10	2
32	8	(1)	6	10	4
40	12	(1)	6	20	4
50	12	(1)	6	20	4
63	24	(1)	8	30	6
75	30	15	8	30	6
90	40	22	8	40	6
110	50	30	10	50	8
125	60	35	10	60	8

(1) If wall strength is too small, welding is not advisable

Table 9.2 Standard values for socket welding of PE pipes and fittings under atmospheric temperature of 20°C and moderate measurable air current (DVS 2207 Section 1)

Execution

For heating, the pipes to be welded are to be shoved on the heating element of the device up to the mark designating the welding zone and fixed in place. The heating period specified in the data of table 9.2 then begins. During heating, the cross section of the pipe is to be absolutely prevented from resting on the end of the heating socket.
After completion of the heating period, the parts to be welded are to be quickly removed from the heating device and immediately pushed together without contortion up to the stopping point at the mark. In manual welding, the joining parts must be held in place for a period specified in table 9.2. The joint may only be exposed to mechanical loads after the cooling period has ended. The heating spigot and heating socket are to be cleaned after every welding procedure using non-fraying paper and an appropriate cleaning agent (e.g. industrial alcohol).

9.2.2 Butt-welding

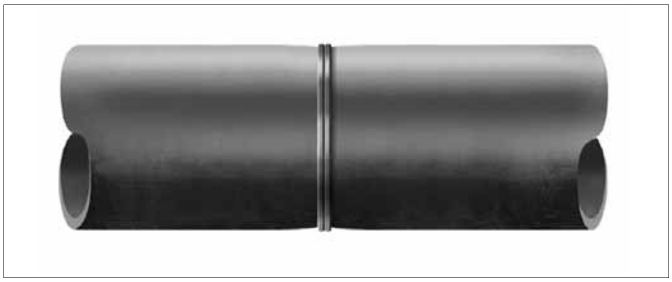


Figure 9.4

Description

Butt-welding is a very economical and reliable jointing technique in which an additional tool is required to create the non-detachable joint. Butt-welding is very well-suited to the pre-fabrication of pipe elements and the construction of special fittings.

It is a technique that is of great significance in the manufacture of welded fittings. In butt-welding, the welding surfaces (ends) of the components to be welded are first machined (planed). This produces coplanar ends that can later be simultaneously pressed against the heating element. The welding surfaces are then heated by the heating element (hot plate) and lined up under slight pressure (alignment pressure). Subsequently, heating proceeds under reduced pressure (heating time) and, after removing the heating element (conversion), the joint is formed under welding pressure. Diagram 9.1 provides a schematic representation of the butt-welding process. Adjustable heating temperatures can be varied to match wall thickness (figure 9.5).

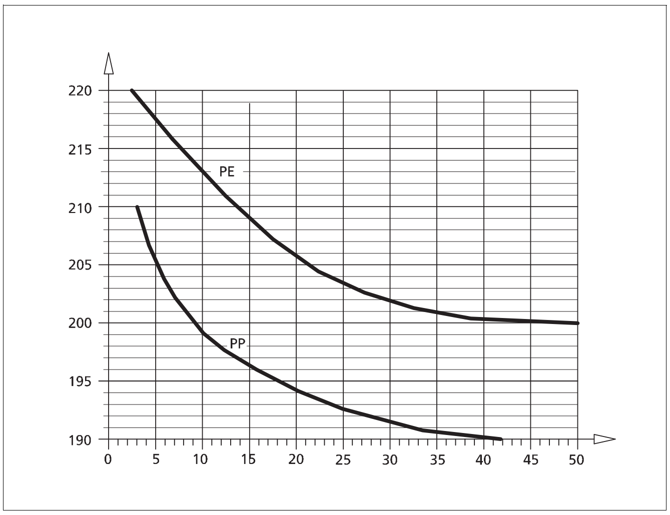


Figure 9.5 Heating temperature as s function of PE pipe wall thickness

Butt-welding process

The execution of the butt-welding process is described in 'NEN 7200 *Plastic piping for transporting gas, drinking water and waste water - Butt-welding pipes and fittings*'. ISO/TC138 has also composed working document 'ISO/WD21307' to standardise the butt-welding process.

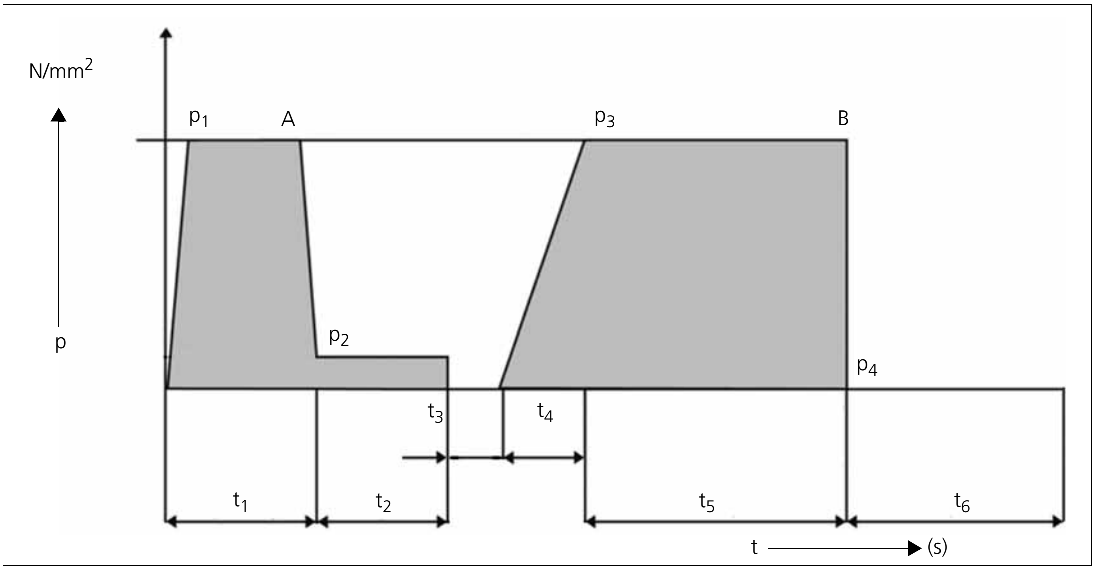


Diagram 9.1 The development of the proces of butt-welding

Sign	Name	Entity	
d_e	nominal outside diameter of pipe	mm	
e	minimum pipe wall thickness	mm	
A	bead size (end of alignment time)	mm	about (0.5 + 0.1 e) around even
B	bead size (end of cooling time under pressure)	mm	minimum 3 + 0.5 e maximum 5 + 0.75 e
p_1	pre-heating pressure	N/mm^2	0.18 +/- 0.01
p_2	heating pressure	N/mm^2	almost pressureless up to about 0.01
p_3	welding pressure	N/mm^2	0.18 +/- 0.01
p_4	cooling pressure	N/mm^2	0 (pressureless, without flexural and/or tensile stress)
t_1	pre-heating time	s	until bead size A is reached
t_2	heating time	s	(12 +/- 1) e
t_3	maximum conversion time	s	3 + 0.01 d_e
t_4	maximum built-up time	s	3 + 0.03 d_e
t_5	maximum welding time, under welding pressure	min	3 + e
t_6	maximum cooling time, under cooling pressure	min	1.5 e

Clarification of process parameters

	pipe SDR 11											pipe SDR 17										
d_e mm	$e_{(SDR11)}$ mm	F_1/F_3 * kN	A mm	F_d ** kN	t_2 s	t_3 s	t_4 s	t_5 min	B_{min} mm	B_{max} mm	t_6 min	$e_{(SDR17)}$ mm	F_1/F_3 * kN	A mm	F_d ** kN	t_2 s	t_3 s	t_4 s	t_5 min	B_{min} mm	B_{max} mm	t_6 min
32	2.9	0.05	0.8	0.003	35	3	4	6	4	7	4	1.9	0.03	0.7	0.00	23	3	4	5	4	6	3
40	3.7	0.08	0,9	0.004	44	3	4	7	5	8	6	2.4	0.05	0.7	0,00	29	3	4	5	4	7	4
50	4.6	0.12	1.0	0.01	55	4	5	8	5	8	7	3.0	0.08	0.8	0.00	36	4	5	6	5	7	5
63	5.8	0.19	1.1	0.01	70	4	5	9	6	9	9	3.8	0.13	0.9	0.01	46	4	5	7	5	8	6
75	6.8	0.26	1.2	0.01	82	4	5	10	6	10	10	4.5	0.18	1.0	0.01	54	4	5	8	5	8	7
90	8.2	0.38	1.3	0.02	98	4	6	11	7	11	12	5.4	0.26	1.0	0.01	65	4	6	8	6	9	8
110	10.0	0.57	1.5	0.03	120	4	6	13	8	13	15	6.6	0.39	1.2	0.02	79	4	6	10	6	10	10
125	11.4	0.73	1.6	0.04	137	4	7	14	9	14	17	7.4	0.49	1.2	0.03	89	4	7	10	7	11	11
140	12.7	0.91	1.8	0.05	152	4	7	16	9	15	19	8.3	0.62	1.3	0.03	100	4	7	11	7	11	12
160	14.6	1.20	2.0	0.07	175	5	8	18	10	16	22	9.5	0.81	1.5	0.04	114	5	8	13	8	12	14
180	16.4	1.52	2.1	0.08	197	5	8	19	11	17	25	10.7	1.02	1.6	0.06	128	5	8	14	8	13	16
200	18.2	1.87	2.3	0.10	218	5	9	21	12	19	27	11.9	1.27	1.7	0.07	143	5	9	15	9	14	18
225	20.5	2.37	2.6	0.13	246	5	10	24	13	20	31	13.4	1.60	1.8	0.09	161	5	10	16	10	15	20
250	22.7	2.92	2.8	0.16	272	6	11	26	14	22	34	14.8	1.97	2.0	0.11	178	6	11	18	10	16	22
280	25.4	3.66	3.0	0.20	305	6	11	28	16	24	38	16.6	2.47	2.2	0.14	199	6	11	20	11	17	25
315	28.6	4.63	3.4	0.26	343	6	12	32	17	26	43	18.7	3.13	2.4	0.17	224	6	12	22	12	19	28
355	32.2	5.88	3.7	0.33	386	7	14	35	19	29	48	21.1	3.98	2.6	0.22	253	7	14	24	14	21	32
400	36.3	7.47	4.1	0.41	436	7	15	39	21	32	54	23.7	5.04	2.9	0.28	284	7	15	27	15	23	36
450	40.9	9.46	4.6	0.53	491	8	17	44	23	36	61	26.7	6.39	3.2	0.36	320	8	17	30	16	25	40
500	45.4	11.67	5.0	0.65	545	8	18	48	26	39	68	29.7	7.90	3.5	0.44	356	8	18	33	18	27	45
560	50.6	14.58	5.6	0.81	607	9	20	54	28	43	76	33.2	9.89	3.8	0.55	398	9	20	36	20	30	50
630	57.2	18.53	6.2	1.03	686	9	22	60	32	48	86	37.4	12.53	4.2	0.70	449	9	22	40	22	33	56

* *at specific welding pressure of 0.18 N/mm^2*

** *at specific welding pressure of 0.1 N/mm^2*

Table 9.3 Process parameters for butt-welding

Welding polyolefins

Butt-welding of PE pressure pipes involves the following steps:

Preparation

The following rules are important for the execution of a good butt-weld:
- The worksite must be a sheltered location arranged so that it is independent of weather conditions.
- The functionality of the butt-welding equipment must be regularly checked. This especially applies to any machine used on a construction site.
- The pipes and/or fittings to be welded must be pressed against the machine in a line so that no discernible misalignment of the walls exists. Wall misalignment may be no more than 10% of wall thickness.
- The pipe and/or fitting surfaces to be welded must be planed to make them coplanar and parallel to the hot plate. The surfaces can consequently be evenly heated, and planing also removes the oxidation layer on PE. Failure to remove this layer will prevent a good butt-weld from forming.
- The prepared surfaces must be kept clean: welding surfaces must be free of oil, grease and dust.
- The hot plate must be regularly cleaned with a non-fraying paper and an appropriate cleaning agent (see manufacturer information).
- The temperature of the hot plate must be between 200°C and 220°C. The higher temperature is to be used with smaller wall thicknesses. The maximum temperature deviations are shown in table 9.4.

Hot plate with electrical temperature control

Usable surface	$\Delta\vartheta_1$	$\Delta\vartheta_2$	$\Delta\vartheta_{tot}$
up to 250 cm^2	5°C	3°C	8°C
> 250 cm^2	7°C	3°C	10°C

Table 9.4 Max. temperature deviations

$\Delta\vartheta_1$ = max. temperature difference within usable surface
$\Delta\vartheta_2$ = temperature difference over control interval
$\Delta\vartheta_{tot}$ = $\Delta\vartheta_1 + \Delta\vartheta_2$ = max. acceptable temperature deviation from setting

Preparing the welding surfaces

Surfaces are planed until they are coplanar and parallel to the hot plate (see figure 9.6).

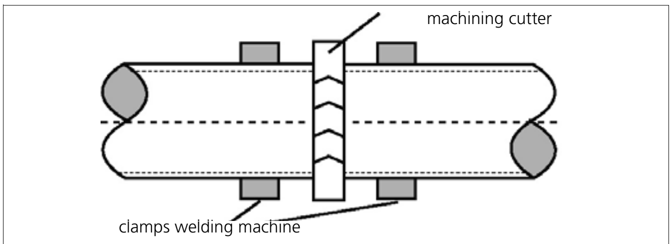


Figure 9.6 Planing welding surfaces

Heating

Both welding surfaces are pressed against the hot plate under the force of a heating pressure. Better preparation causes a more even weld bead to form. The pipe and/or fitting are held against the hot plate until the welding bead has reached a certain height. The heat saturation phase then follows.

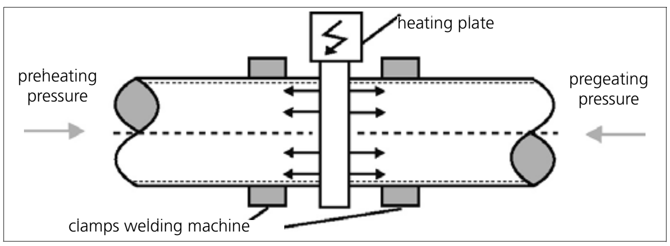


Figure 9.7 Heating a pipe or fitting

Heat saturation

During heat saturation, the welding surfaces must be held against the hot plate under slight pressure (just 0.01 N/mm^2). Heat will then be spread evenly through the pipe, and the weld bead will increase in height.

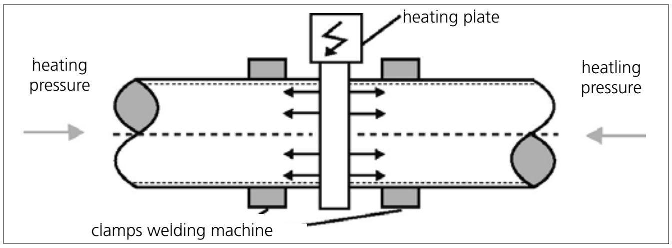


Figure 9.8 Heat saturating a pipe or fitting

Conversion

Between heating/heat saturation and welding, the hot plate must be removed and the welding surfaces pushed against each other. To avoid cooling, the removal of the hot plate must occur quickly.

Welding and cooling

The surfaces to be welded must be abutted very shortly after the heating time. The welding pressure is then to be applied during the pressure build-up time. According to NEN 7200, the specific welding pressure for PE100 is P = 0.18 N/mm^2.
The build-up of welding pressure must occur evenly with a deviation of no more than 0.01 N/mm^2.
A too rapid build-up of pressure will cause the plastic material to be pushed aside, pushing the surfaces too slowly together will cause the material too cool down too fast. Weld quality is insufficient in both cases.

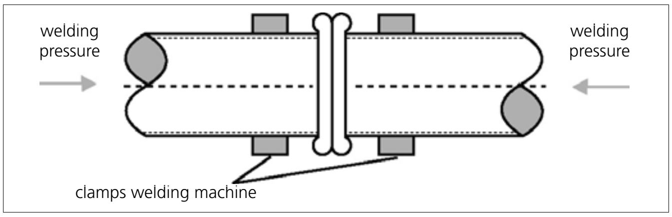


Figure 9.9 Welding / cooling a pipe or fitting

Cooling

The welding pressure is maintained throughout the entire cooling time. It must also be ensured that no mechanical load is placed on the welding seam. The welding zone is to be prevented from cooling to quickly or abruptly. After welding, an even double bead must have been formed. The form of the bead will give an initial indication about the evenness of the welding seam. Varied bead composition or irregular bead formation may not be an indication of poor workmanship. Often, it is the different flow behaviours (viscosities) of the molten plastics from the two components being welded that are responsible. The bead size "K" must always be > 0.

Diagram 9.1 and table 9.3 show the standard values for the weldcycle. The settings for the welding machine depend on machine resistance. The welding tables for the machine must be used to set welding pressure.

9.2.3 Electrofusion

Description

The electrofusion coupling underlying the process is employed to connect pipe components in pressure pipe installations for gas and water supply networks, industrial facilities and pressurised drainage systems. The process is suitable for connecting pipe components of the series:

ISO-S pipe series number / SDR

- S 5 / SDR 11 (PE100)
- S 8 / SDR 17 (PE100)

Figure 9.10 Electrofusion coupling

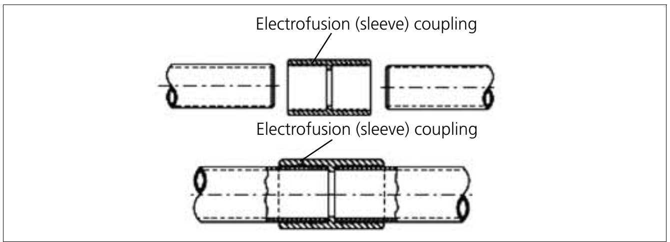


Figure 9.11 Electrofusion

Like butt-welding, electrofusion is a widespread welding technique in PE pipe construction.
Applications have the following advantages:

- simple procedure throughout the entire welding process
- uncomplicated operation of the welding apparatus
- regular quality of the welded joint due to reproducible equipment settings
- longitudinally rigid joint
- mo excess or weld bead inside pipe
- welding made possible for hard to access locations

Welding occurs in an overlapping form which means that the pipes and/or fittings are joined to each other through an electrofusion coupling. The resistance coil (heating coil) integrated into the electrofusion coupling are heated by an electrical welding unit, causing the surfaces of the pipes and the coupling (in immediate contact with the heating coil) to be plasticised. The thermal expansion of the plastic creates welding pressure so that the effects of these two parameters result in a homogeneous connection between coupling and pipe or fitting at the end of the welding time. The VM 102 guideline for welding practice applies to electrofusion on pressure pipe installations. The guideline also makes recommendations about quality assurance and describes possible testing methods.

Electrofusion process

The execution of the electrofusion process is described in the welding recommendation 'Electrofusion sleeve welding of thermoplastics'.

Preparation

- Inspect pipe and fitting for damage and proper sizing
- Check state and function of welding unit
- Take protective measures if weather conditions make it necessary
- Pipes, fittings and welding equipment are to be kept at a constant ambient temperature between -10°C and + 45°C
- Do not weld when medium is being discharged

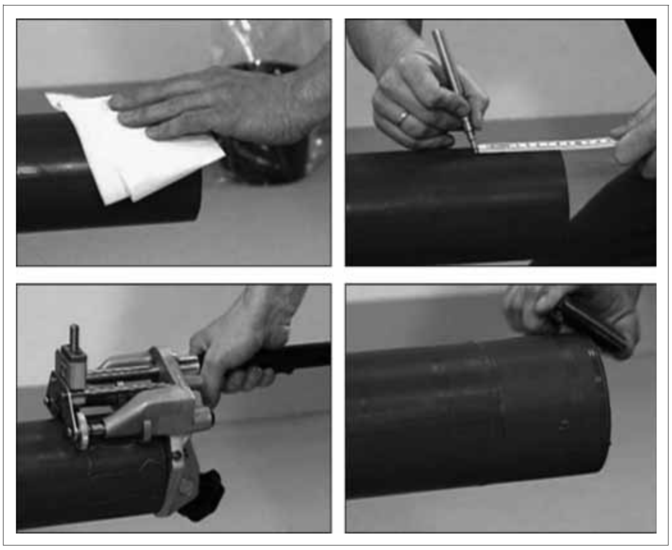


Figure 9.12 to 9.15

Pretreatment

1. Cut the pipe square
   - slanting cuts can result in inadequate melting, overheating or burning
2. Clean the pipe
3. Mark the welding zone
4. Remove oxidation layer
   - scrape off a long even continuous chip (min 0.15 mm thick)
   - an excessively thick chip will prevent the gap between coupling and pipe from being filled
   - scraping 5 mm extra in width is a sign of good workmanship
   - filing or sanding is not permitted
5. Debur the pipe
6. Make oval pipe round, be careful with pipes on cylinders and drums
   - use rounding clamps if ovality >1.5% diam. or >1.5 mm

Figure 9.16 to 9.18

Cleaning

1. Mark the welding zone again
2. Clean the welding surface of the pipe
   - welding surfaces must be absolutely clean
   - use PE cleaning agent and absorbent, non-fraying uncoloured paper
3. Clean inside of coupling
   - take fitting out of packaging just before use
   - prevent rubbing contaminants from untreated surfaces from entering the welding zone

Welding polyolefins

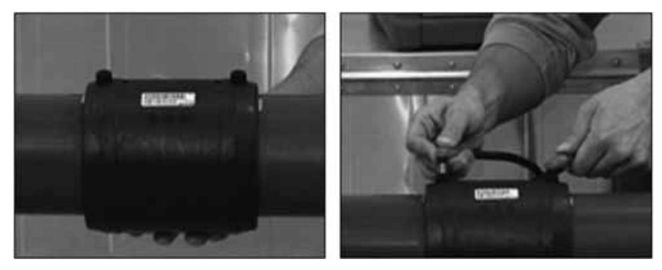


Figure 9.19 and 9.20

Positioning
1. Push the pipe into the fitting up to the mark
2. Connect contact plugs to fitting: pay attention to tension free assembly
   - shove pipe straight into coupling
   - do not rotate
   - coupling should be movable by hand
3. Guideline VM 102 prescribes: use clamps for tension-free assembly

Figure 9.21

Welding
1. Scan barcode with hand reader
2. Start welding process: electrofusion unit automatically regulates the amount of energy and welding time
   - safe distance to welding location is 1 m
3. Compare actual with required welding time
4. Note actual welding time on the pipe
   - welding indicator provides an impression of the completed weld, correctness is also indicated by the welding unit

Figure 9.22 to 9.25

Cooling
1. Adhere to the cooling time (CT) on the barcode before moving the connection
2. Cooling time prior to testing or operation pressure is indicated in the tables of the FRIALEN assembly manual

Figure 9.26

9.2.4 Hot gas welding

Description
- Type of welding
Hot gas welding is divided into:
- hand welding
- speed welding
- extrusion welding

The fundamentals for individual extrusion welding techniques are provided in the guidelines of DVS 2207 Sections 2, 4 and 5. The application of hot gas welding requires special knowledge and skills from the welder. The requirements are contained in DVS 2212 Section 1.

- Functional principles
In hot gas welding, the welding surface and filler are turned into a plastic state by hot air and welded to each other under pressure.
The heating of the air occurs in the welding tool. It must be absolutely certain that the hot air is free of moisture, dust and oil. Hot gas welding techniques will be described in more detail below.

1. Hand welding
In hot gas hand welding, the hot air is usually supplied to the elements to be welded through a round nozzle. The filler material must be appropriate for the welding substrate. Mostly, the filler material used is in the form of a rod with a diameter of 3-4 mm. For welding, the rod is placed in the seam at an angle slightly off perpendicular. With a light fanning motion, the round nozzle is pointed at the seam so that the hot air stream simultaneously heats both the rod and the substrate. By pressing down perpendicularly on the rod, the filler is pushed along the welding seam and, in this way, heated in the lower, curved area. A wave forms ahead of the welding thread and weld beads on both sides of the seam (figure 9.27).

1 Welding rod
2 Force
3 Hot air
4 Round nozzle
5 Welding tool
6 Fanning motion
7 Welding direction
8 Wave
9 Weld bead
10 Welding seam

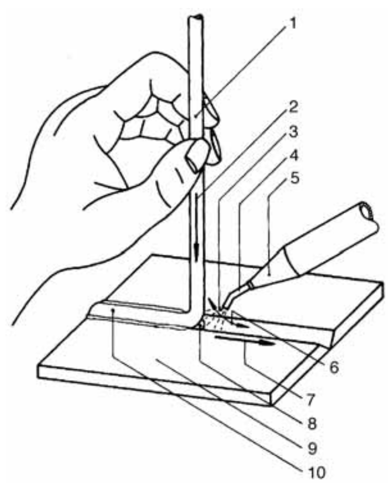


Figure 9.27 Hot gas hand welding

2. Speed welding
In hot gas speed welding, the welding rod is fed through a speed-welding nozzle, heated by the hot air and pressed into the weld joint by a beaked-form tip at the bottom of the nozzle (figure 9.28).
The forward movement of the nozzle is, as a rule, strong enough to draw the welding rod through the nozzle. The welding speed of speed welding is 3-4 times faster than that of hand welding. In contrast to hand welding, this welding procedure can evenly apply the required welding pressure. Speed welding cannot, however, be used in positions that are difficult to access.

1 Welding rod
2 Hot air
3 Welding tool
4 Welding direction
5 Weld bead
6 Welding seam
7 Force
8 Speed welding nozzle

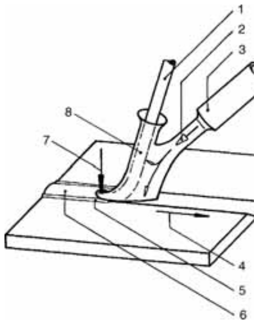


Figure 9.28 Speed welding

3. Extrusion welding

Extrusion welding is a partially mechanised hot-gas welding technique, primarily used to join thick-walled components. There are four variants of extrusion welding that are used. The data about hot-gas extrusion welding can be found in the guidelines contained in DVS 2207 Sections 4 and 5, as well as in DVS 2209 Sections 1 and 2.

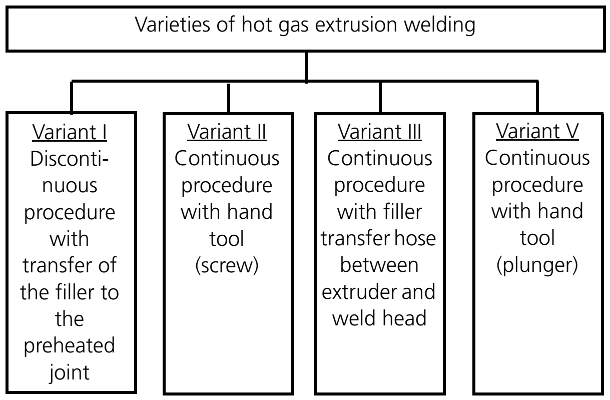
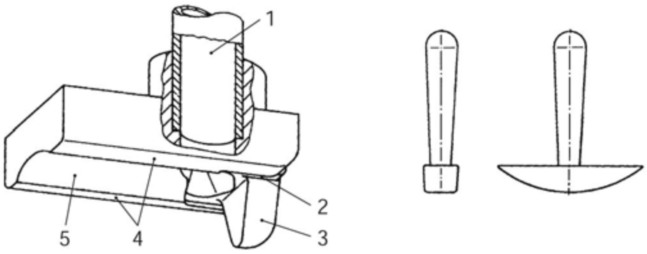


Figure 9.29 Varieties of hot gas extrusion welding

The principle machinery used in all the different variants of extrusion welding is the same.

The welding equipment consists of:
- Plasticising unit (extruder) for preparing the weld filler
- Heating using (hot gas tool) to heat the welding surfaces
- Tool to apply the required welding pressure in the form of a welding shoe or pressure tool (figure 9.30)

Welding show **Pressure mechanism**



1 Extrudate feed
2 Recess
3 Nose
4 Contact surfaces
5 Pressure mechanism / sliding surface

Figure 9.30 Welding shoe and pressure mechanism

The form of the welding tool or pressure tool depends on the procedure and weld shape. Welding shoes are most made of PTFE (Polytetrafluorethylene).
Hot air nozzles must be constructed in such a manner that the air is evenly distributed to the nozzle outlet and the temperature largely remains constant.
The commonest type is the hand extruder, which is constructed by design to have little weight and can therefore be operated by hand with relative ease. The extruder is made in both semi-automatic and fully automatic models. Extrusion welding enable various weld shapes to be made (e.g. V seam, double V seam, fillet weld). In a continuous process, the extruder deposits molten material (extrudate) in the weld joint, which is heated by the hot gas. The extrudate is placed in the joint by means of the weld shoe and pressed with the required welding force, causing a homogeneous weld to be made with the substrate surface, which has been plasticised by the hot gas.
Very large joints require extrudate to be applied in several runs. Welding with the extruder requires trained and experienced professionals, as the proper advancing speed together with the necessary pressure have a large influence on the quality of the weld. Table 9.6 shows the welding parameters (standard values) for the individual hot-gas extrusion variants.

Material Short symbol	Type of welding	Welding force (N) Round Ø 3 mm	Welding rod Round Ø 4 mm	Hot air temperature (°C)	Air quantity (l/min)
PE	Hand welding	6-10	15-20	300-350	40-60
PE	Speed welding	10-16	25-35	300-350	40-60

Table 9.5 Welding parameters: standard values for hand and speed welding

Method	Variant	Material thickness (for single-run welding) (mm)	Temperature of molten mass (°C)	Temperature of hot air (°C)	Air flow rate (l/min)	Weld filler flow rate (kg/h)
continuous	Variant II	0...15	200...230	250...300	≥ 300	0...2
procedure	Variant III	0...15	200...230	250...250	≥ 300	0...4
		15...30	200...230	250...300	≥ 400	0...6
	Variant V	0...15				
discontinuous procedure	Variant I	0... 5	200...230	250...300	≥ 300	0...4

Table 9.6 Welding parameters for hot-gas extrusion welding

Welding polyolefins

Notes to table 9.6:
1 If thicker components have to be welded, several welding runs are made.
2 The temperature of the molten mass is measured with a probe thermometer in the extrudate feed.
3 The hot-air temperature is measure between the nozzle outlet and 5 mm in the nozzle.
4 Air flow means here cold air at 20°C and one atmosphere in operation-ready state. In the case of air supply from compressed air networks, air pressure can be measured behind the air flow rate metre and by considering pressure and air flow conversion. No oil or grease may be included in the air.

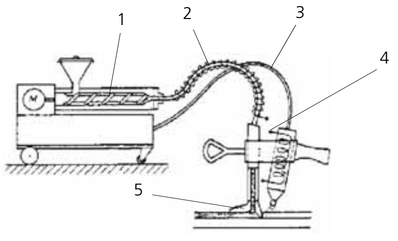
- Areas of application
The described extrusion welding techniques are predominantly used in:
- Machine construction (shaft and tank manufacture).
- Pipe construction (welding of casing pipes). The use to weld casing pipes is, however, rather infrequent.

Extrusion weld process - Preparation
To ensure weld quality, the preparation, as in all of the above welding procedures, must be carefully done.
In preparing the weld, the following list of points should therefore be attended to:
- The welding surfaces and the adjacent border zones must be mechanically prepared before welding. There are mechanical pre-process tools that are suitable for this purpose, such as scrapers and graters. Parts affected by atmospheric and chemical influences must be treated prior to welding right back to the unaffected zone.
- Care therefore needs to be taken that, during a welding process performed in the open, no weather conditions (e.g. wind, rain) may affect effectiveness. When ambient temperatures are under +5°C, the welding site must be protected (e.g. by a heated tent). The temperature variation in the immediate vicinity should be no more than 10°C throughout the duration of the welding process.
- The welding zone must be dust, oil and grease free.
- The functionality of machines and equipment are to be tested prior to welding. At such time, the appropriate welding parameters are to be set and the standard values to be verified against the actual values. The results are to be documented in a test record.

- Weld shapes
The shapes of the weld correspond to the conventional and well-known forms used in metalwork (e.g. filet weld, V seam, double V seam). Welding forms are described in the technical bulletins DVS 2205 Sections 3 and 5. Standard values for the welding parameters are listed in the technical bulletin DVS 2205 Section 3. Except from DVS 2207 Section 3 on the welding seam structure in hot gas welding.

	Material thickness (mm)	Welding rod x diameter
V seam	2	1x4
	3	3x3
	4	1x3+2x4
	5	6x3
Double V seam	4	2 (1x4)
	5	2 (3x3)
	6	2 (3x3)
	8	2 (1x3+2x4)
	10	2 (6x3)

Table 9.7 Weld shape as a function of material thickness with a cone angle of 60°C



1 Extruder
2 Heated hose
3 Air hose
4 Hot gas unit
5 Welding shoe

Figure 9.31 Extrusion welding (Variant III)

9.3 Test procedures for evaluating welds

Completed components are, as a rule, only tested by non-destructive test procedures. Destructive test methods are employed in cases involving damage claims or in the development of new materials and manufacturing procedures.

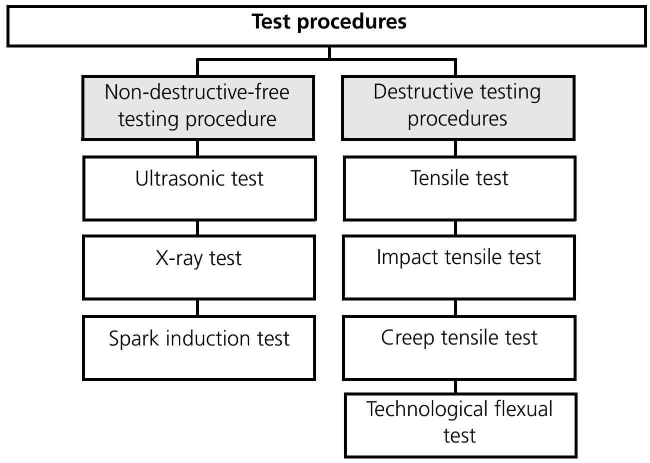


Figure 9.32 Test procedures used for plastic

The most frequently used test in plastic pipe construction is the visual inspection. This involves a purely external visual evaluation of semi-manufactured products, components and welds.
The visual inspection of butt-welds can be performed without special tools if the tester has the appropriate knowledge and experience.
The possibility of visual evaluation of electrofusions is limited. The checks therefore concentrate more on weld preparation and the implemented welding parameters.
The evaluation of welded joints for in pressure systems most used weld techniques is described in NEN 7200 and VM 102.

9.3.1 Visual inspection of butt-welds
Butt-welds are primarily visually inspected. The evaluation of butt-welds is described in NEN 7200.
The bead must be of uniform shape. The welding area must be free of tears, contamination or other damages. The dimensions of the bead must mach table 9.3.
The bead form is an indication of careful performance of the welding process. Both beads must be of the same form and size.
Differences between the beads can be caused by differences in the flow behaviour of the welding surfaces joined together. The weld can still be functionally sound. Figure 9.33 shows a good weld with identical beads.

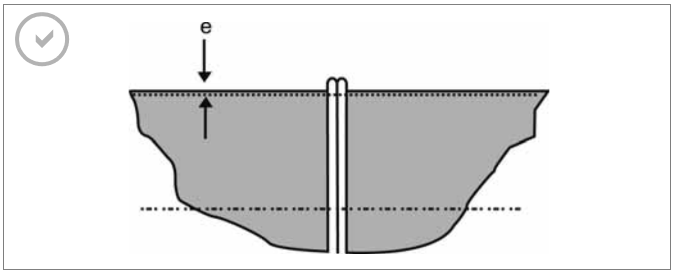


Figure 9.33 Butt-weld with identical welding beads (good)

Misalignment of the two ends can have various causes. Uneven narrowing of one of the ends or ovality are two of the possibilities. As long as the difference is smaller that 10% of the pipe / fitting wall thickness, the weld can be regarded as "acceptable" (see figure 9.34).

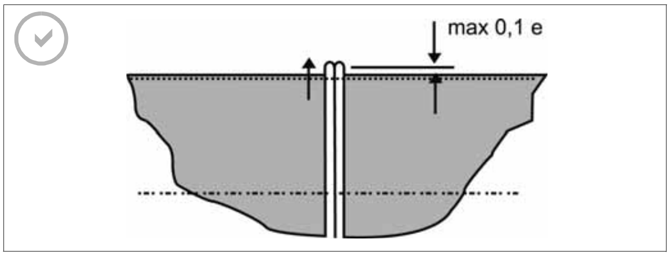


Figure 9.34 Butt-welding with acceptable wall misalignment

Too high heat or too strong pressure causes the beads to be too large. Figure 9.35 shows that the uniformity of the two beads makes this weld still "acceptable".

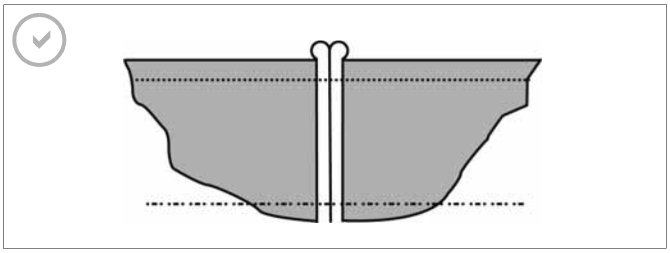


Figure 9.35 Butt-weld with welding beads that are too large but still acceptable.

Figure 9.36 represents a weld with beads that are too small, suggesting that the heating was too low and/or pressure too weak. In thick walled pipes, undersized beads are often associated with the formation of shrinkage cavities. These sorts of welds must be deemed "unacceptable".

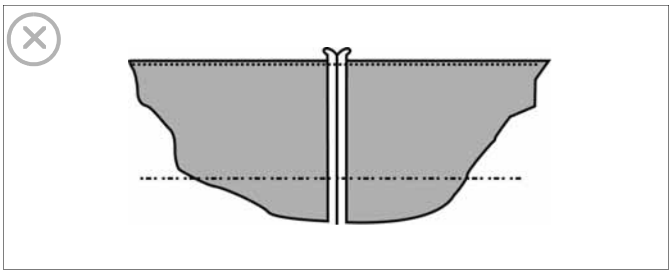


Figure 9.36 Unacceptable butt-weld

Figure 9.37 provides a cross-sectional view of a good weld. The bead is round, notch-free and with a misalignment of max. 0.1 e. Bead size "K" must be at least equal to wall thickness e.

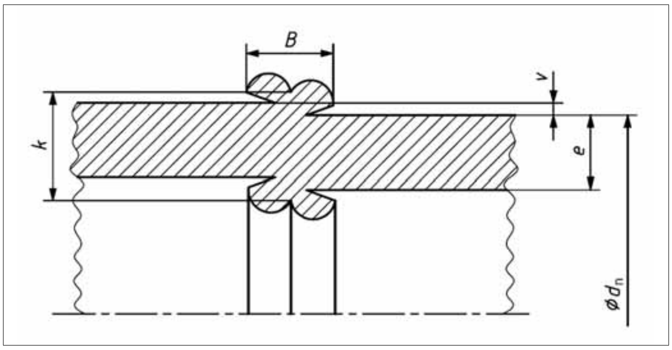


Figure 9.37 Cross-section of a good weld

9.3.2 Visual inspection of electrofusion joints

An indication of weld quality based on the bead form in butt-welding cannot be similarly obtained in electrofusion. Any opportunity to test the plasticisation and associated weld between electrofusion sleeve and the corresponding components to be welded can only occur on the basis of the changed indicators found on the coupling. If they do not provide any clear view of the quality of the weld and if the joint is not to be destroyed, one of the non-destructive testing procedures must be employed (e.g. ultrasound, X-rays). These are generally expensive and to inaccurate for evaluating the weld quality. In visually inspecting the weld, it must be absolutely certain that there are no discernible visible traces (e.g. scratches, tarnished surfaces, scoring in the immediate area of the coupling) relating to the mechanical procedures required for faultless weld quality.

The following description about evaluating electrofusions is a copy from NIL weld practice guideline VM102:

An electrofusion weld is of good quality when the weld has sufficient mechanical strength over the long term, and the welding zone is homogeneous and free of cracks, contaminants and holes. In addition, verification must be made of the correct welding and cooling times used in the process. For proper quality control, it is also necessary to make a few trial welds prior to the production welding. These are performed under controlled worksite conditions using the applicable type of material and accurately observing the welding conditions (welding and cooling times). A few of these welds are to be subjected to destructive analysis:

- on the basis of a tensile test
- on the basis of a detachment test

The test welds can be further used as reference material for visual inspections of the actual welds.

All joints welded with deviant parameters or in which the welding does not meet stated requirements concerning their execution are to be removed.

Welding polyolefins

Visual inspection
Apart from the sample destructive testing, an accurate visual inspection is of crucial importance, together with the establishment of welding parameters. The appearance of the actual welds must be scrupulously examined and compared to the reference welds. No large deviations from the reference welds may occur.

No scratches, impurities or other damage may appear in the welding zone.

Attention also has to be paid to:
- proper insertion depth of the pipe in the fitting.
- alignment of the various components in the pipe system.
- deviation from the straight position of the pipe in the coupling. No more that 1 mm deviation may be measured over a distance of 300 mm from the socket (angle of deviation < 0.2°).
- resistance coil is imperceptible.
- regular filling of the original gap between coupling and pipe.
- heat damage.
- bonding flaws due to bent pipes or insufficient shape-retention of saddles.
- the ovality of the pipe in the coupling. After welding, this may not be more that 1.5% of the average outside diameter of the pipe, with a maximum of 1.5 mm.
- the presence of welding indicators, if any.

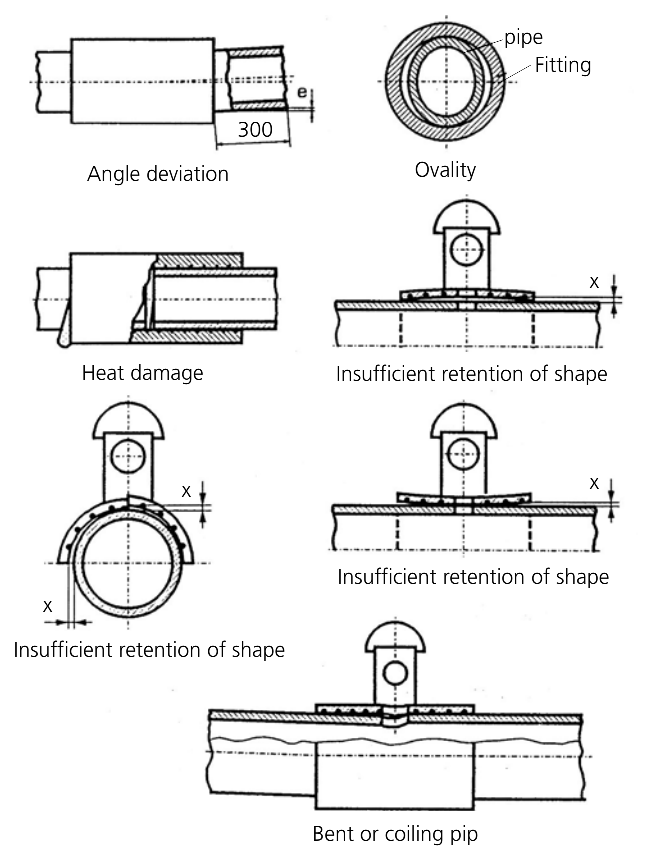


Figure 9.38

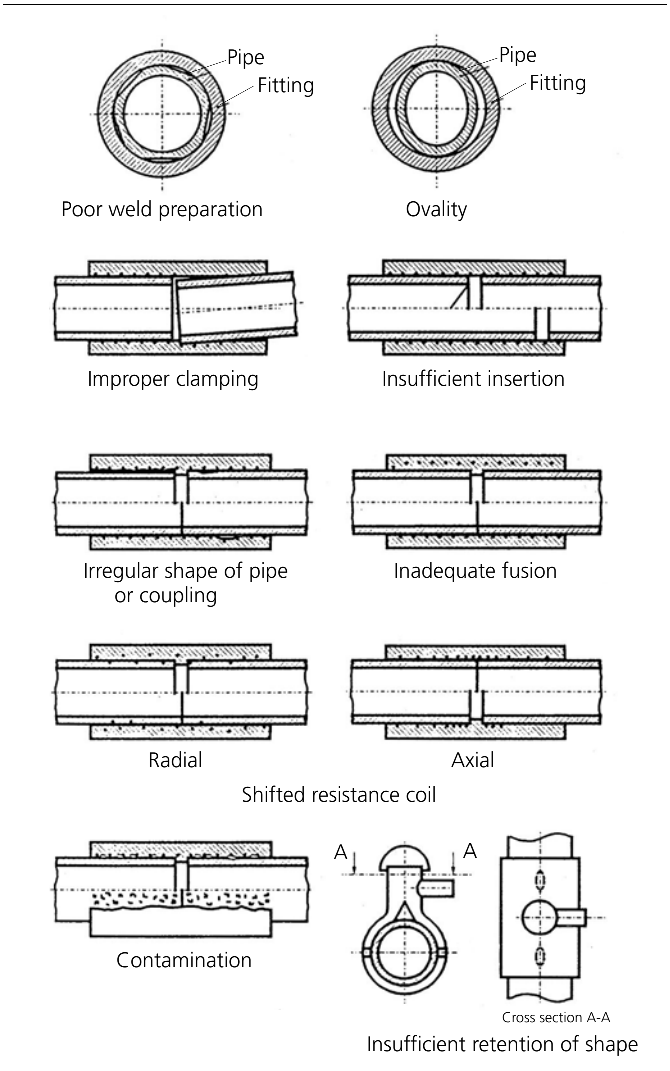


Figure 9.39

9.3.3 Testing joints produced by hot gas welding
Ultrasonic and spark induction tests are two non-destructive testing procedures that have proven use for machine construction in which hot gas extrusion welding is predominantly used. However, a simple visual inspection of the weld is often helpful in many cases. Relatively accurate recognition and location of flaws inside of a welded joint requires testing by means of ultrasound. These days, there are appropriately constructed senders and receivers for individual weld forms with which an experienced ultrasonic tester can recognise and properly interpret the smallest defect in the weld. Well-trained personnel having appropriate experience with this test method are, however, an absolute necessity, which makes the costs of such a test significantly high. In contrast, the spark induction test is substantially less expensive and simple to perform.

9.4 Chapter summary

PE welding	Welding is for plastic pipe systems and equipment construction a common jointing technique. PE pipe systems are prominently jointed by butt-welding and electrofusion methode.
Butt-welding equipment	The principle pieces of butt-welding equipment are: plane (in pipe construction machines), hot plate, clamping tool and hydraulic unit. Construction site (portable, e.g. trench welding machines) and workshop machinery (stationary welding machines) may be used. Construction-site machines are increasingly being converted to CNC controlled machines (fully automatic), which enable the construction-site operation to ensure reproducibility of welding joints and the automatic production of reports.
Bead formation in butt-welding	Visual inspection of the form in which the bead is created can provide an indication of weld quality. However, such evaluation requires sound, appropriate, practical and theoretical expertise about the welding process.
Electrofusion	Electrofusion is a practice also known as electric "sleeve" or "saddle" welding. The joining of the welding mates is effected by an electrofusion coupling on the inside of which an integrated heating coil (electrical resistance coil) is charged with current during the welding process and is heated as a result of its electrical resistance. As a consequence, the surfaces of both the coupling and the pipe or fitting (i.e. the contact areas) are plastcised. The process creates a homogeneous joint between electrofusion coupling and pipe/fitting.
Hot gas welding techniques	Hot gas welding is distinguished into hand welding, speed welding and extrusion welding. The plasticisation of the welding zones occurs by heating the welding surfaces (and filler material) with hot air. For this purpose, hot air is forced through a nozzle shaped specifically to sufficiently heat and plasticise the joint surfaces.
Hand welding	The welding tool in which the appropriate nozzle is mounted (in most cases a round nozzle) is moved in a fanning motion over the surfaces to be welded. In this way, the substrate and welding filler are heated until the material in the welding zone is placticised. The filler (mostly in the form of a rod) is perpendicularly pressed by hand into the welding zone. The necessary welding or joining pressure is applied by pushing down the welding rod by hand during the welding process. Appropriate welder skills and abilities are therefore required.
Speed welding	The heating of the substrate and filler occurs by means of the beak-shaped tip at the lower end of the speed-welding nozzle. The necessary welding pressure is applied by this nozzle.
Extrusion welding	Four different variants of extrusion welding are used. The individual variants are different in terms of material supply, type of welding equipment (e.g. hand extruder) and pressure tool (e.g. plunger, welding shoe). An extrusion welding extruder generally has the following elements: plasticising unit, hot gas tool and device for applying the required welding pressure.
Welding shoe / pressure tool	A welding shoe or pressure tool has an effect on the appearance, formal possibilities and quality of the weld. This equipment is manufactured and adjusted in accordance with the desired seam width and form. The welding shoe has the function of evenly distributing the molten material produced in extrusion into the joint and applying the appropriate welding pressure.
Tools used in extrusion welding	Work performed in extrusion welding makes use of a hand or stationary extruder with swivel head and transfer hose.
Weld preparation	Weld preparation is extremely important in all welding procedures. It has a significant effect on the quality of the weld and should therefore be undertaken with utmost care.
Testing welds	A distinction is made between destructive and non-destructive tests. Destructive test methods are chiefly used to evaluate cases involving damage claims.
Evaluating welded joints	Visual inspection is a non-destructive method of evaluating welds frequently employed in practice. This evaluation is primarily concerned with appearance (e.g. welding bead of butt-welding). It is however a type of assessment requiring theoretical and practical knowledge, as well as appropriate tester experience. If more accurate indications of weld quality are needed, then a more expensive non-destructive (e.g. ultrasonic or X-ray test) or destructive testing method has to be adopted.

10 Quality

10.1 Production quality

The Management System of Akatherm BV has been approved:
- ISO 9001 for the Quality Management System
- ISO 14001 for the Environmental Management System

This concerns the development, manufacturing, marketing and supply of plastic pipe systems.

PE100 pressure fittings are manufactured generally in accordance with the following standards:

Standard	Title
EN 12201:2003	Plastics piping systems for water supply - Polyethylene (PE)Part 3: Fittings
EN 1555:2002	Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE)Part 3: Fittings
EN 13244:2003	Plastics piping systems for buried and aboveground pressure systems for water for general purposes, drainage and sewerage - Polyethylene (PE)Part 3: Fittings
DIN 16963	Pipe joints and components of Polyethylene (PE) for pipes under pressure
ISO 15494:2003	Plastics piping systems for Industrial applications- Polybutene (PB) Polyethylene (PE) Polypropylene (PP)

Table 10.1

PE100 pressure fittings are subjected to the following mechanical product tests:
- Hydraulic test 20°C/100h EN921
- Hydraulic test 80°C/165h EN921
- Hydraulic test 80°C/1000h EN921
- Decohesive resistance test A ISO13954/ISO13955, for electrofusion fittings
- Decohesive resistance test B ISO13956, for electrofusion saddles
- Tensile strength ISO13953, for butt-fusion
- Impact resistance test EN1716, for electrofusion saddles
- Pressure drop test EN12117, for electrofusion saddles

10.2 Quality inspection during work-site assembly

Quality inspections during assembly are key to the manufacture of a reliable pipe system. Assembly has to be performed according the appicable standards and guidelines and the user needs to exercise constant care regarding quality assurance issues.
Instructions for quality-assurance measures during assembly work:
- Prior to assembly, check pipes and pipe components for flawless appearance and workmanship.
- Make sure that fittings and especially flange connections are incorporated in a stress-free manner.
- Check the brackets to ensure that linear or point loads cannot occur.
- Examine the construction of the brackets and fixed points. Are they stable or somewhat undersized?
- Have inappropriate compulsory guides for the pipe replaced.
- Can the pipe system expand without hindrance? If so, are the fixed points, sliding brackets and guide brackets (sliding and guide saddles) placed in the right locations?
- Is the movement of the pipe so large that it can easily begin to swing? In such case, additional guide brackets (guide saddles) are to be incorporated.
- Has care been taken to ensure that connections to pumps and tanks are elastic enough to enable longitudinal and transverse movement without large reaction forces?
- Place high value on strict adherence to welding regulations and have a record made of each seam.

The preceding abstract should encourage critical monitoring and correction of assembly work.

10.3 Leak test prior to initial use

Prior to initial use, pipe systems must be tested for strength and leak-tightness in order to demonstrate that they are leak-proof and sufficiently robust to withstand the mechanical load.

The goal of the pressure test is to subject the completely installed pipe system to loading above the operation load and therefore to perform an empirical demonstration of its reliability. Any existing leakage in flange connections can be promptly remedied and the effects of expansion processes under internal pressure and temperature changes observed. However, small defects in the pipe system may remain undetected. Only in the rarest cases do these result in failure of the pipe system in the operating state. As a result, the pressure test is a means of verifying the overall quality-control concept.

Leak test according to DIN 4279-1
DIN 4279-1 part 1 "Leak test of pressure pipe systems for water" contains guidelines for accomplishing the leak test. In DVS 2210-1 complementary guidelines for aboveground pressure systems are described.
After running the pressure test, the characteristics of plastic pipes result in an increase in the pipe's internal volume. At the same time, filling the pipe system with cold water causes, in most cases, a temperature change in the pipe wall. For instance, a temperature change in the pipe wall of 10°C during the pressure test will lead to a pressure decrease of 0.5 to 1 bar, even though the pipe network is absolutely sealed. This behaviour is taken into account by dividing the pressure test into two parts.

1. Pre-test stage
The pre-test is intended to eliminate volume change in order to enable a clear conclusion about the leak-tightness of the system to be drawn in the main test.

2. Main test stage
Even during the main test, consideration needs to be given to the fact that expansion processes are continuing, if only to a limited degree. To be certain, it is recommended not to begin the main test for 2 hours after terminating the pre-test.

Short term test
Pipes up to DN 50 and a total length of 100 m can be subjected to a short-term test. The short-term test represents a special case, as it is not very efficient in exposing deficiencies in the pipe system.

Quality

PE pipe systems	Pre test	Main test	Short term test
Test pressure (*)	1,5 * PN max (PN + 5) bar	1,3 * PN max (PN + 3) bar	1,5 * PN
Length of the test	min. 3 hours for pipe systems without branches with a total length ≤ 100 m min. 6 hours for pipe systems with branches with a total length > 100 m	min. 3 hours for pipe systems without branches with a total length ≤ 100 m min. 6 hours for pipe systems with branches with a total length > 100 m	min. 1 hours for pipe systems without branches with a total length ≤ 100 m min. 3 hours for pipe systems with branches with a total length > 100 m
Check during test	Every hour with recovery of test pressure	Every 1.5 hour with recovery of test pressure	Every hour with recovery of test pressure
Material specific pressure drop (direction)	≤ 0,8 bar / h	≤ 0,3 bar / h	≤ 0,8 bar / h
Direction for test	Normal	Normal	Exceptional case (approval of client required)

Table 10.2 Recommended test for installed pressure pipe systems

(*) The test pressure depends on the maximum operating pressure for the pipe series (SDR). The test pressure has to be selected in a way no damage will be caused to the pipe system. Also the reduced pressure load of fittings has to be taken into account. During the test connections have to be accessible. Complementary details can be found in DIN 4279 Part 1.

10.4 Chapter summary

General quality controls	In connection with general quality controls, relevant tests should be run to ensure the quality and functionality of the employed fittings as well as the factory-made or on-site manufactured pipe systems. Such tests are best served by non-destructive test procedures.
Pressure test	The pressure test is only used for pressure pipe systems. It verifies both internal pressure stability and the leak-tightness of the system. Pressure tests consist of two test stages: the pre-test and the main test. In exceptional cases, a short-term test can be urn on pipe systems in which $d_e \leq 50$ mm and pipe length is a max. 100 m.

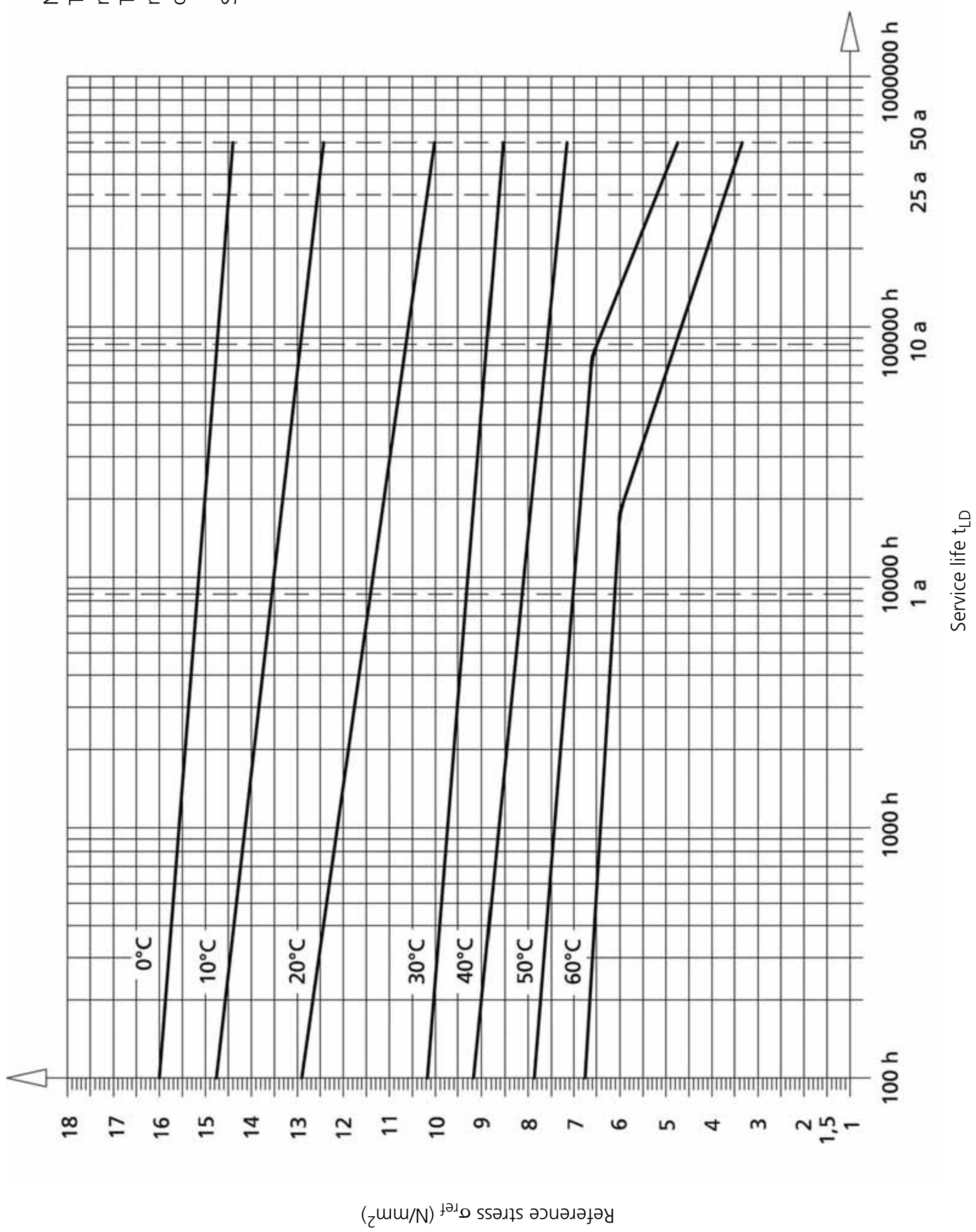
Appendices

Appendix A - General Diagrams

A-1 Reference stress for PE100

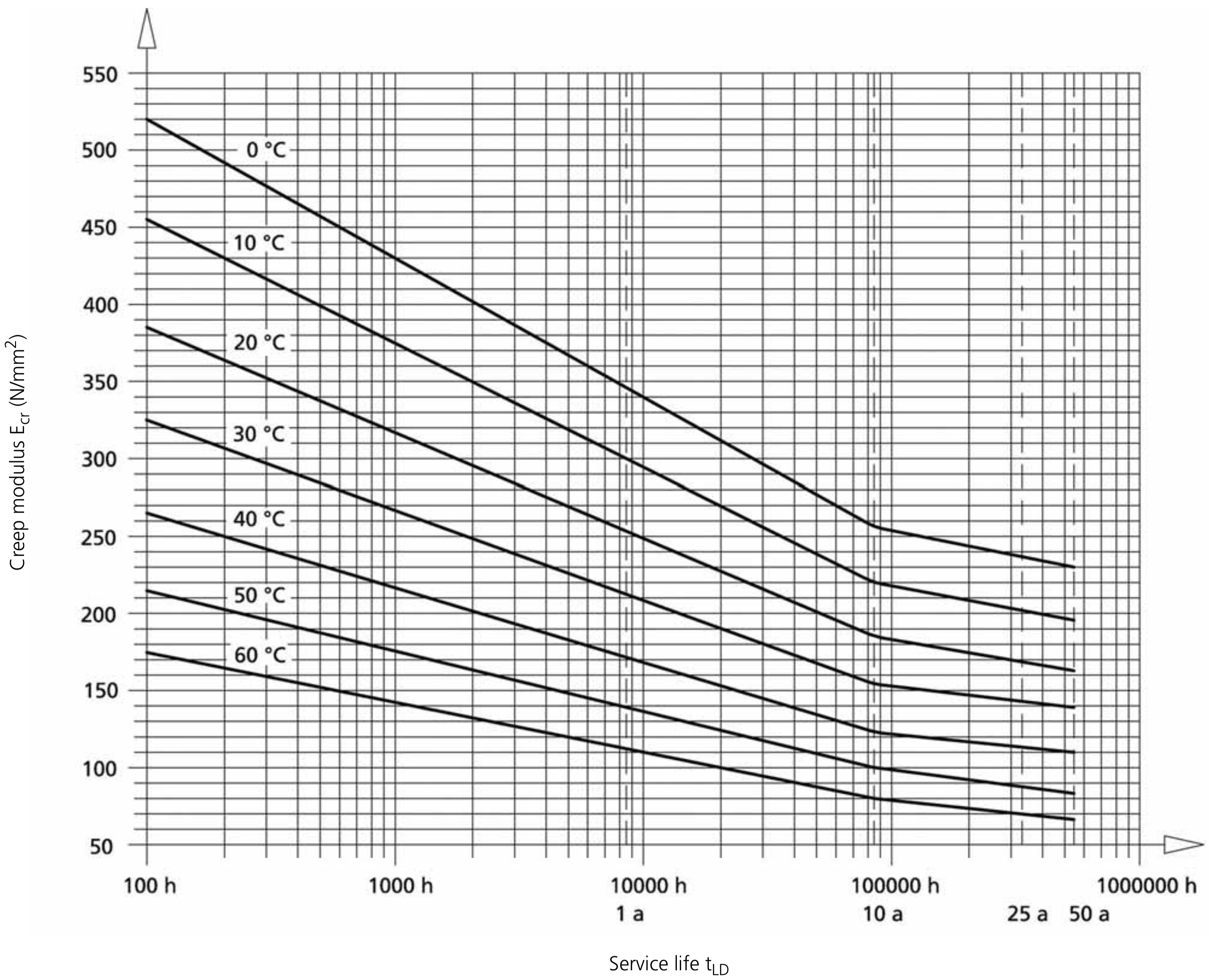
Note:
The reference stress represents the mechanical strength of plastic pipes. The reference stress is used to calculate mechanical strength using the equations shown in sections 7.2.4 to 7.2.9.

Source: DVS 2205-1



Appendix A - General Diagrams

A-2 Creep modulus for PE100



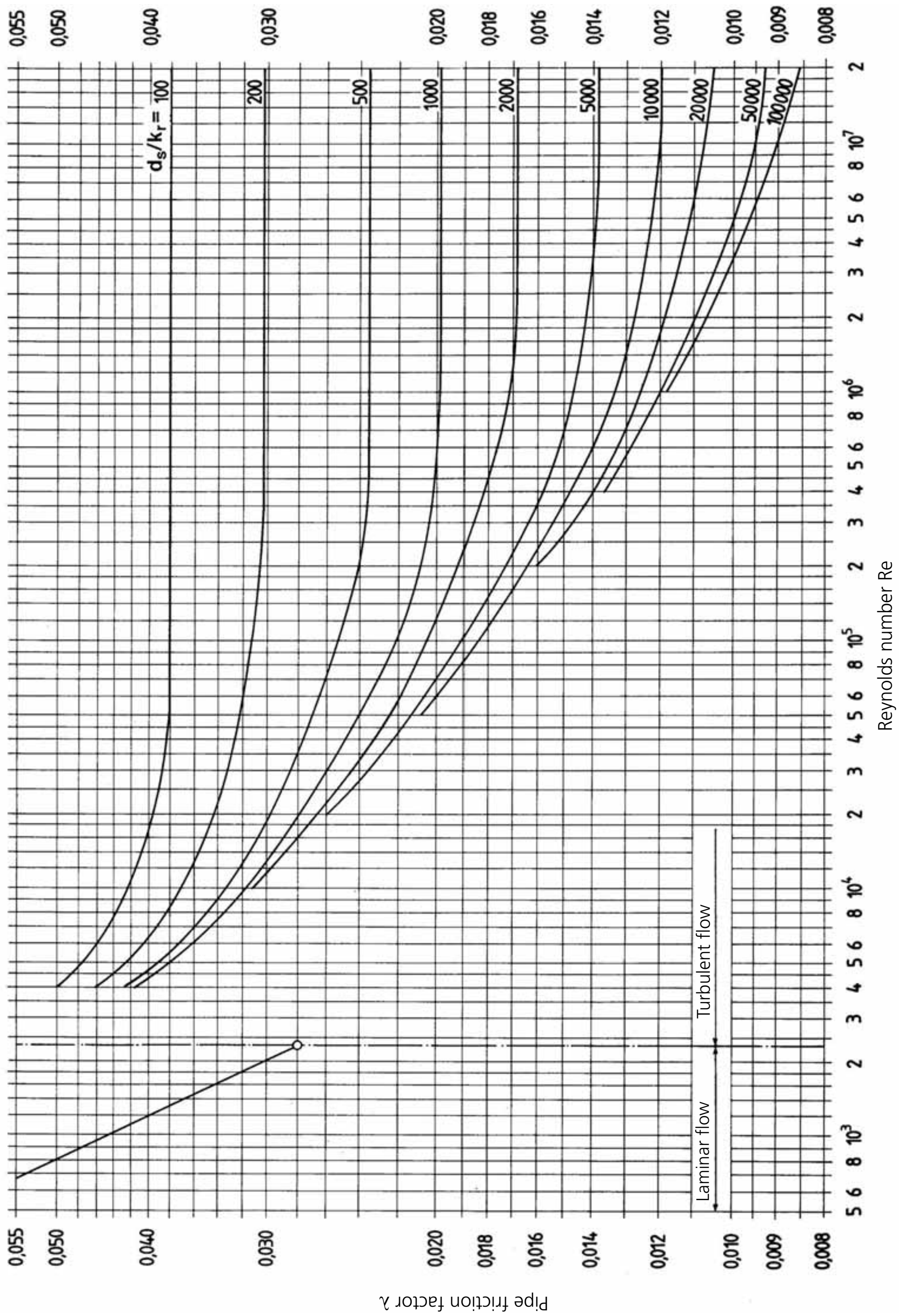
Note:
The creep modulus provides information about the elasticity of plastic pipes. The Creep modulus is used to perform the stability tests and calculations shown in sections 7.2.11 to 7.2.13.

Source: Pipe material manufacturer

Creep modulus E_{cr} (*) °C	(N/mm^2)
≤ 10	1100
20	800
30	550
40	390
50	270
60	190

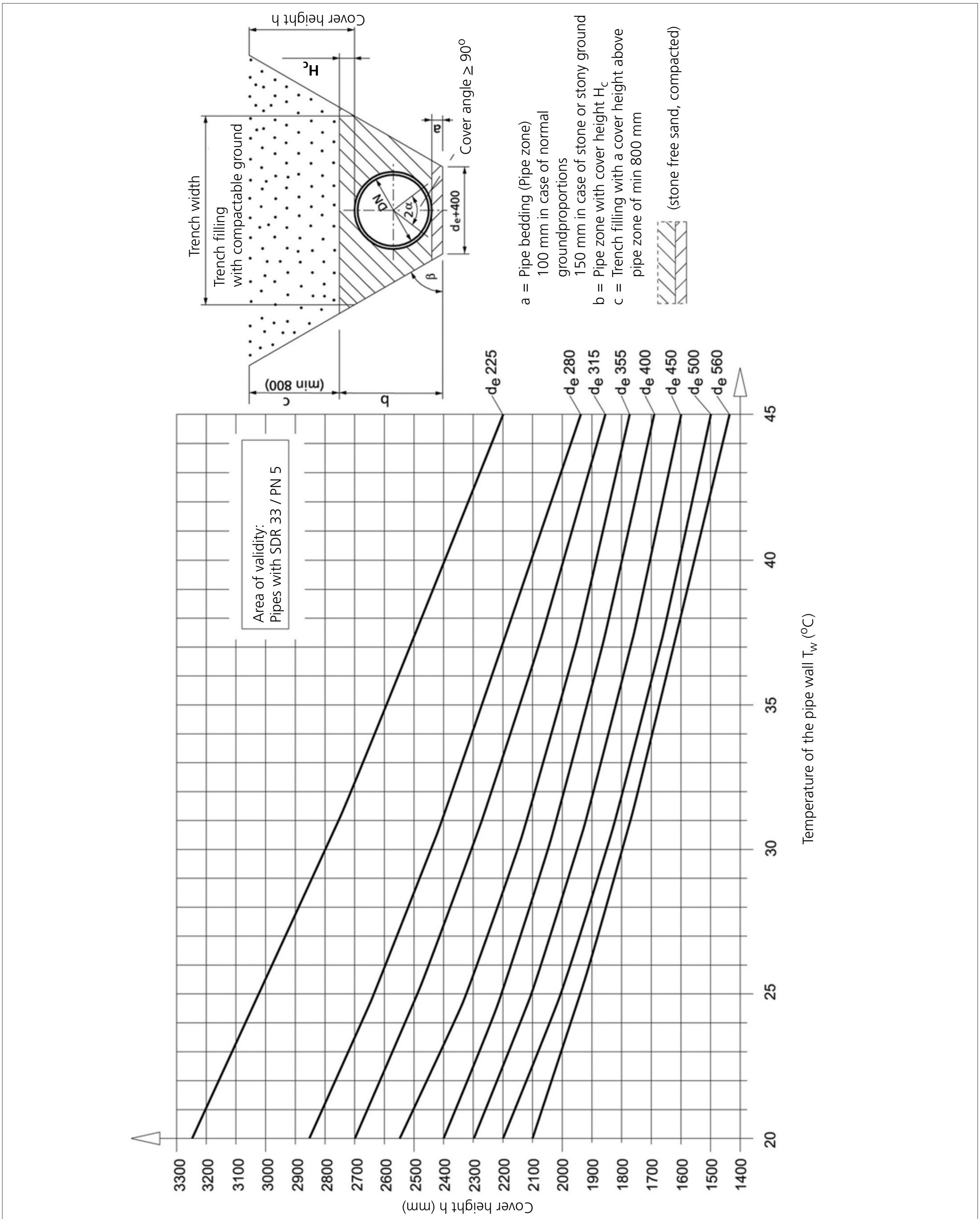
(*) Creep modulus E_{cr} =
short-term modulus for t = 100 min

A-3 Friction values for plastic pipes (according to Moody)

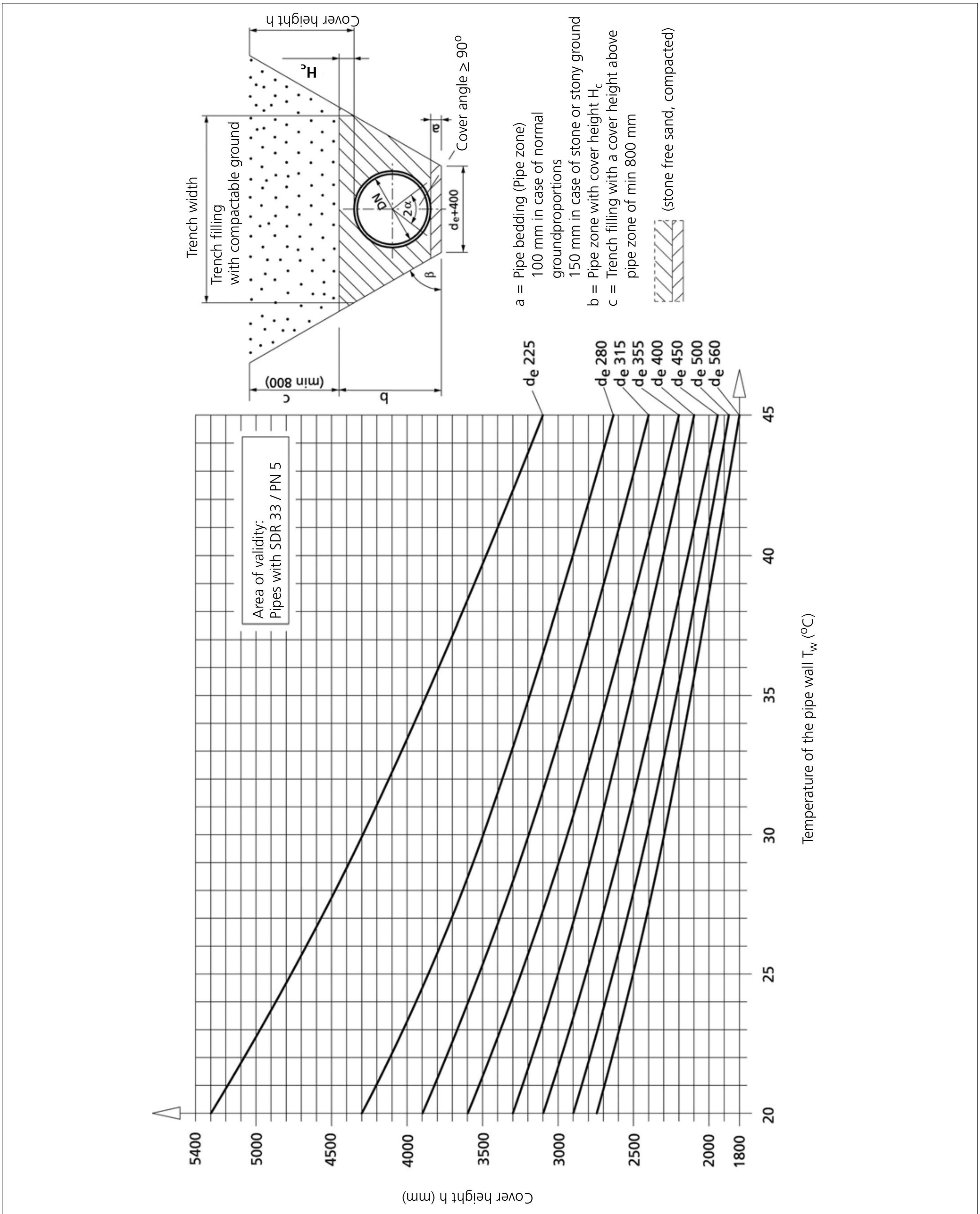


Appendix A - General Diagrams

A-4 Acceptable load of underground pipes of PE100 (SDR 33): Proctor density Dpr = 90%, gradient angle ß = 60º

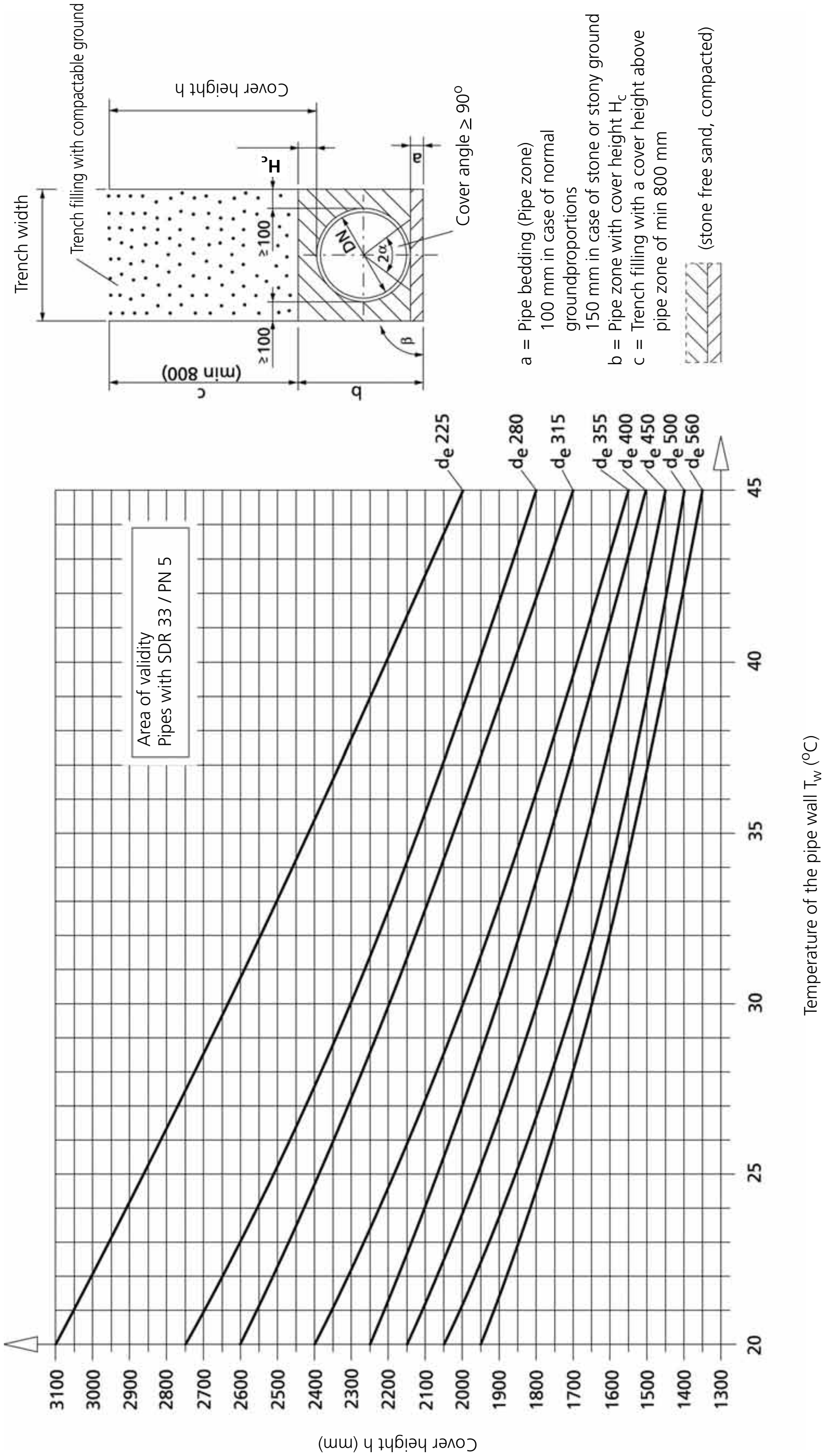


A-5 Acceptable load of underground pipes of PE100 (SDR 33): Proctor density Dpr = 95%, gradient angle ß = 60°

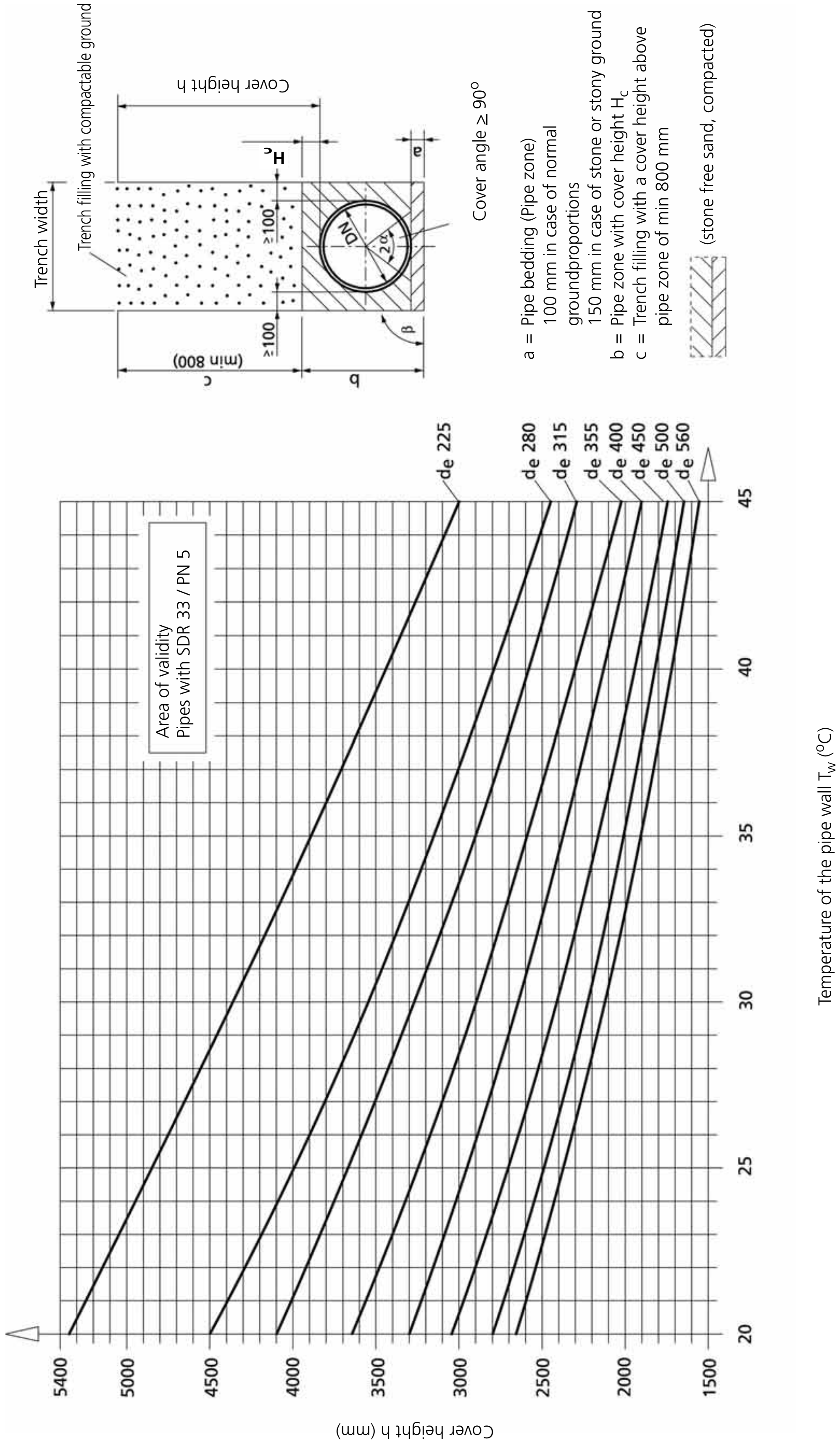


Appendix A - General Diagrams

A-6 Acceptable load of underground pipes of PE100 (SDR 33): Proctor density Dpr = 90%, gradient angle ß = 90°

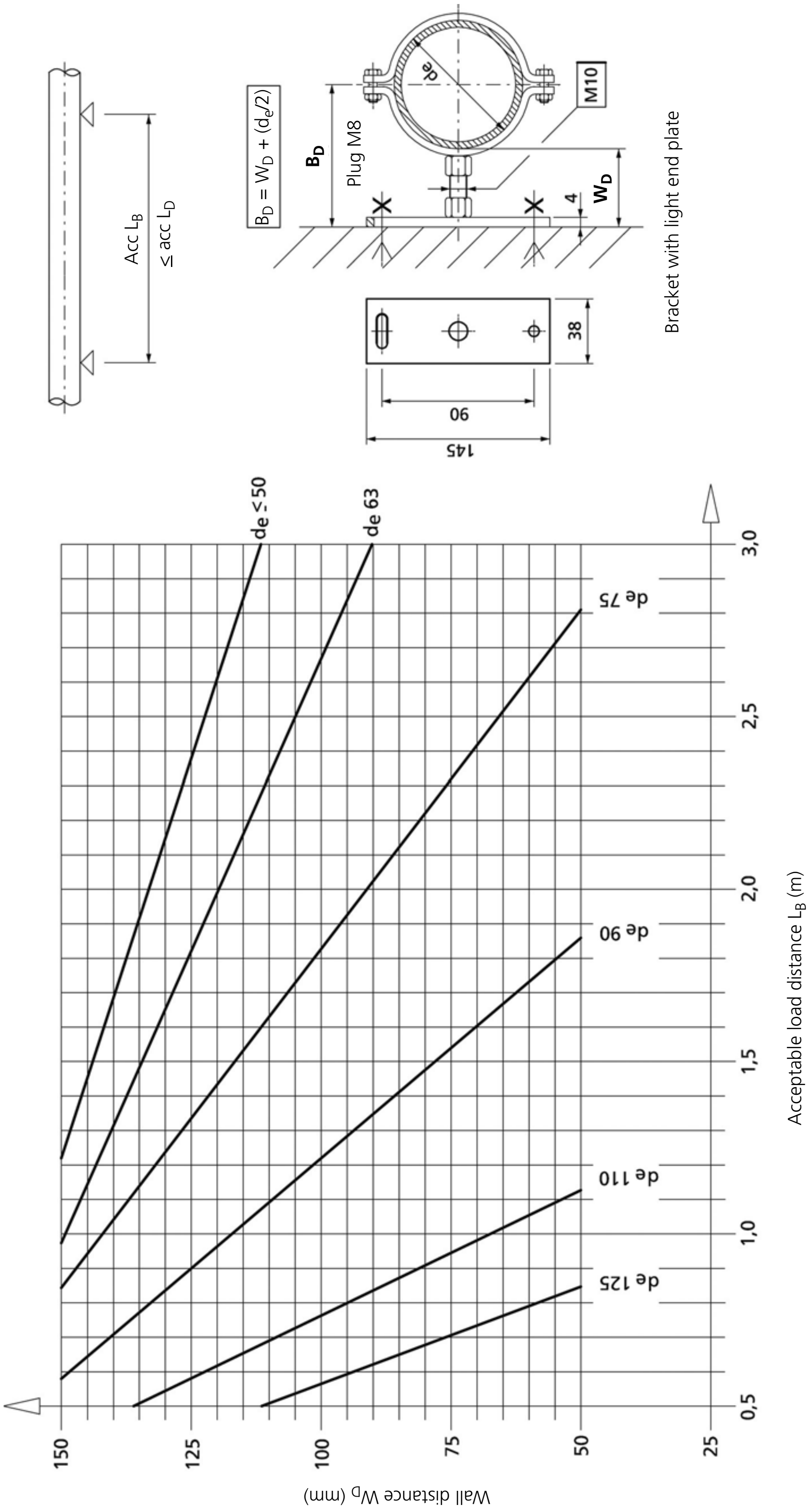


A-7 Acceptable load of underground pipes of PE100 (SDR 33): Proctor density Dpr = 95%, gradient angle ß = 90°

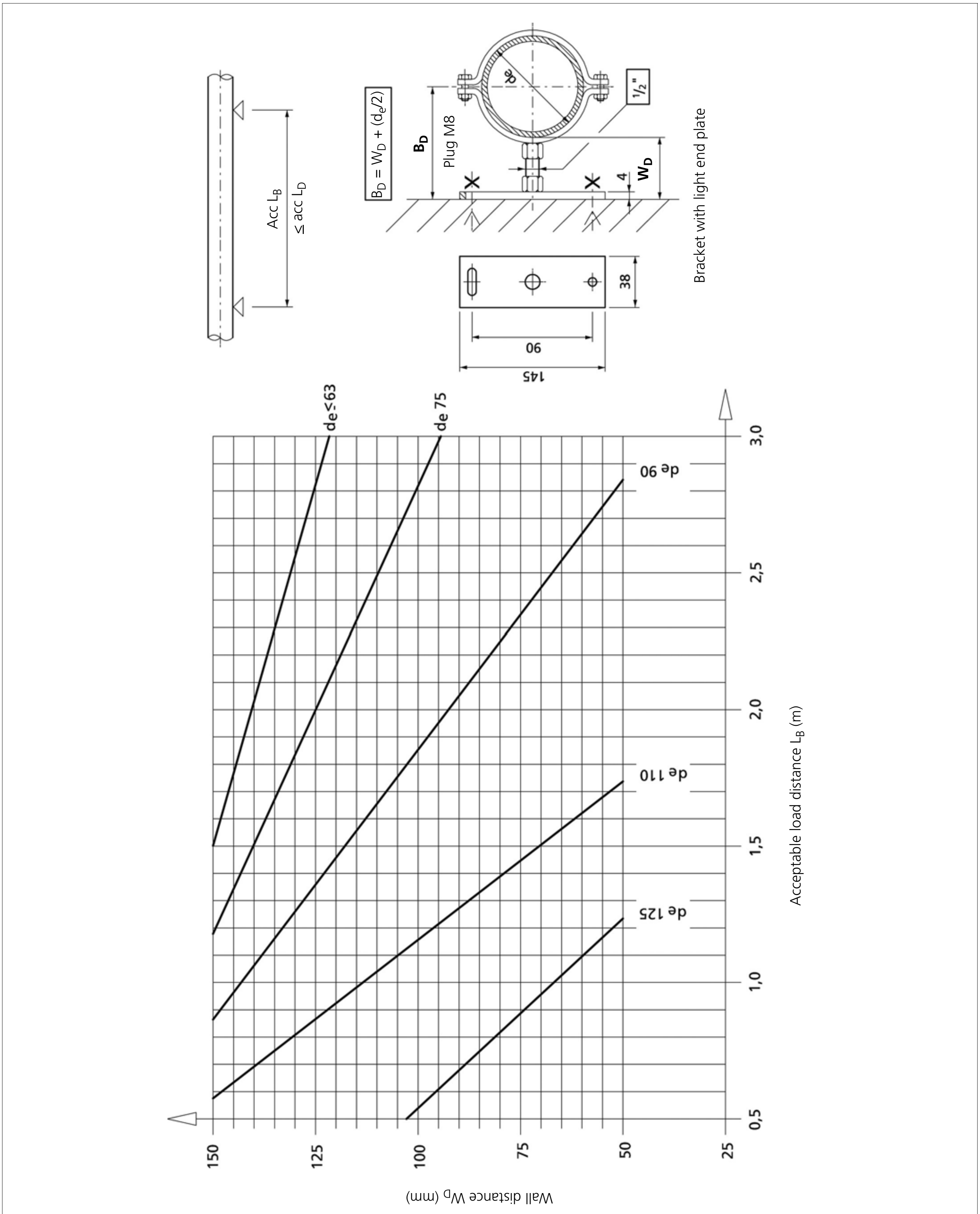


Appendix A - General Diagrams

A-8 Acceptable load distances for sliding brackets

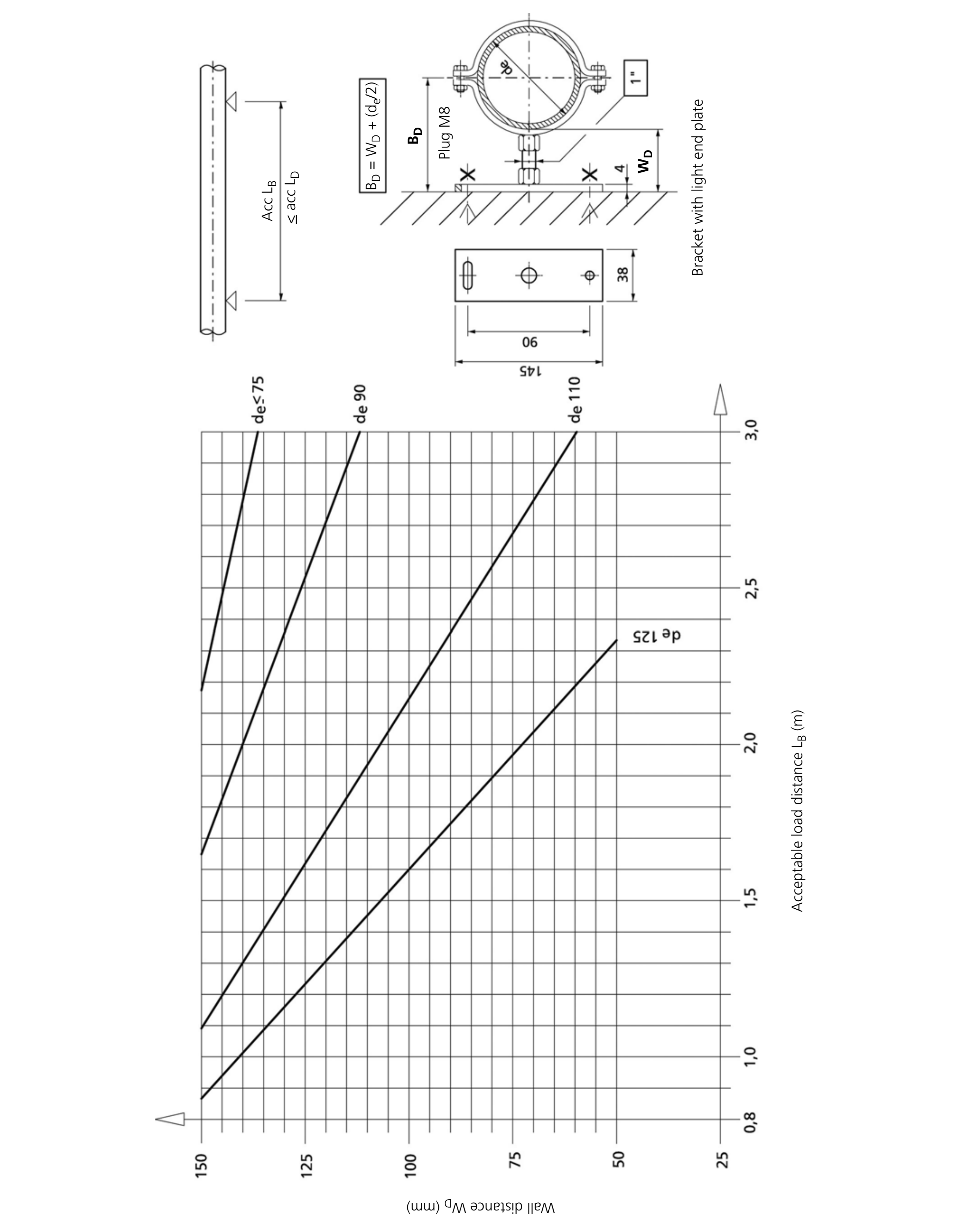


A-9 Acceptable load distances for sliding brackets

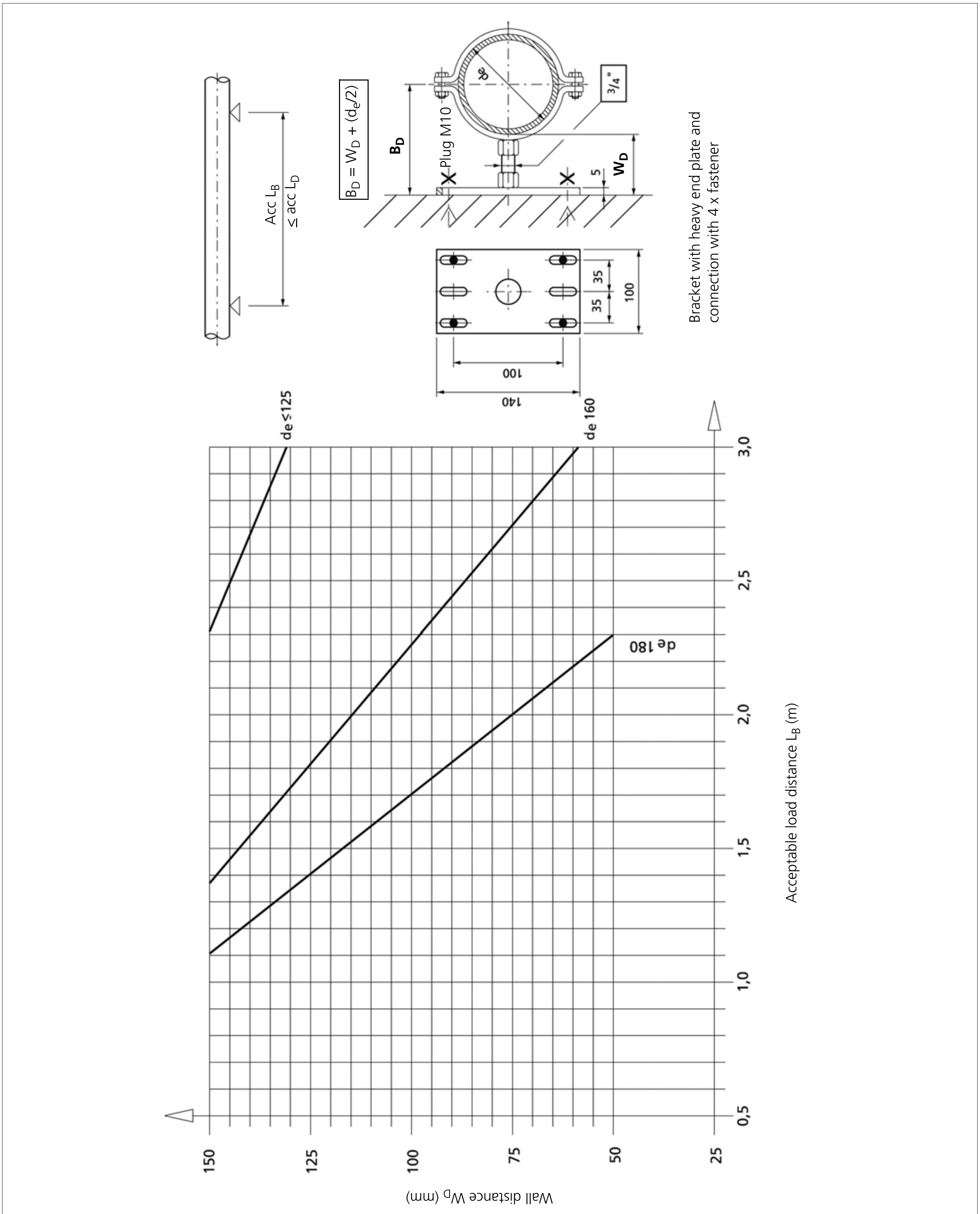


Appendix A - General Diagrams

A-10 Acceptable load distances for sliding brackets

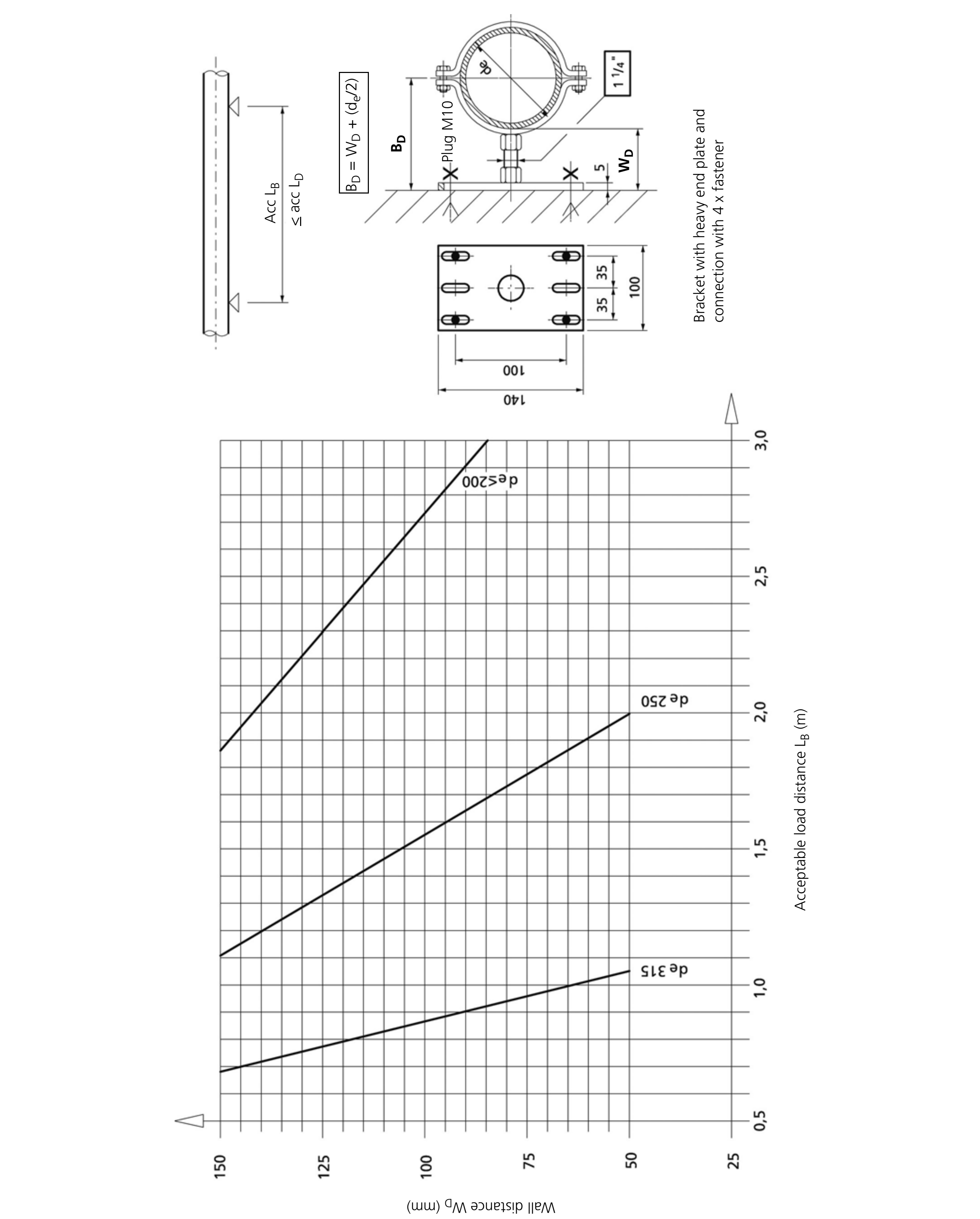


A-11 Acceptable load distances for sliding brackets

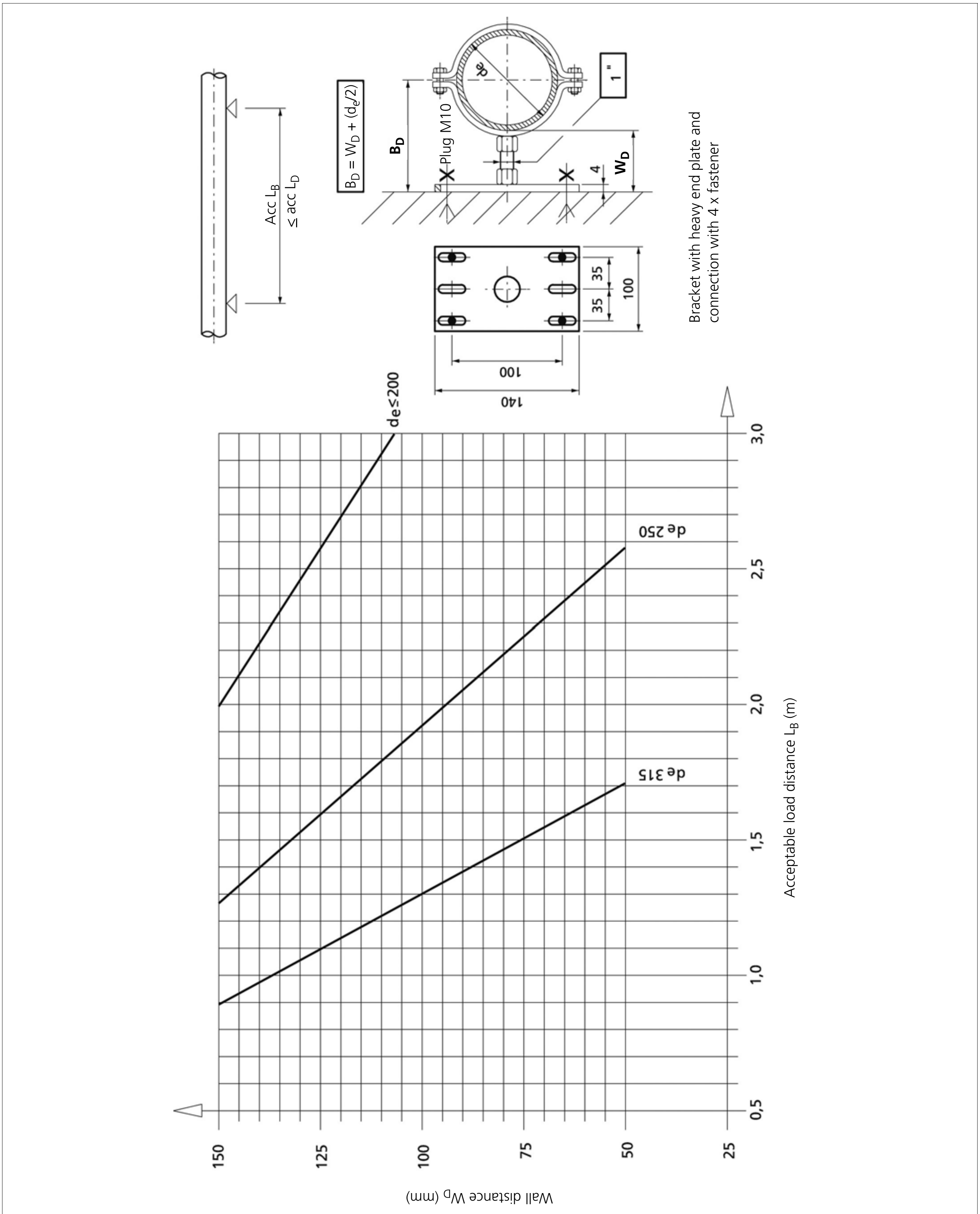


Appendix A - General Diagrams

A-12 Acceptable load distances for sliding brackets

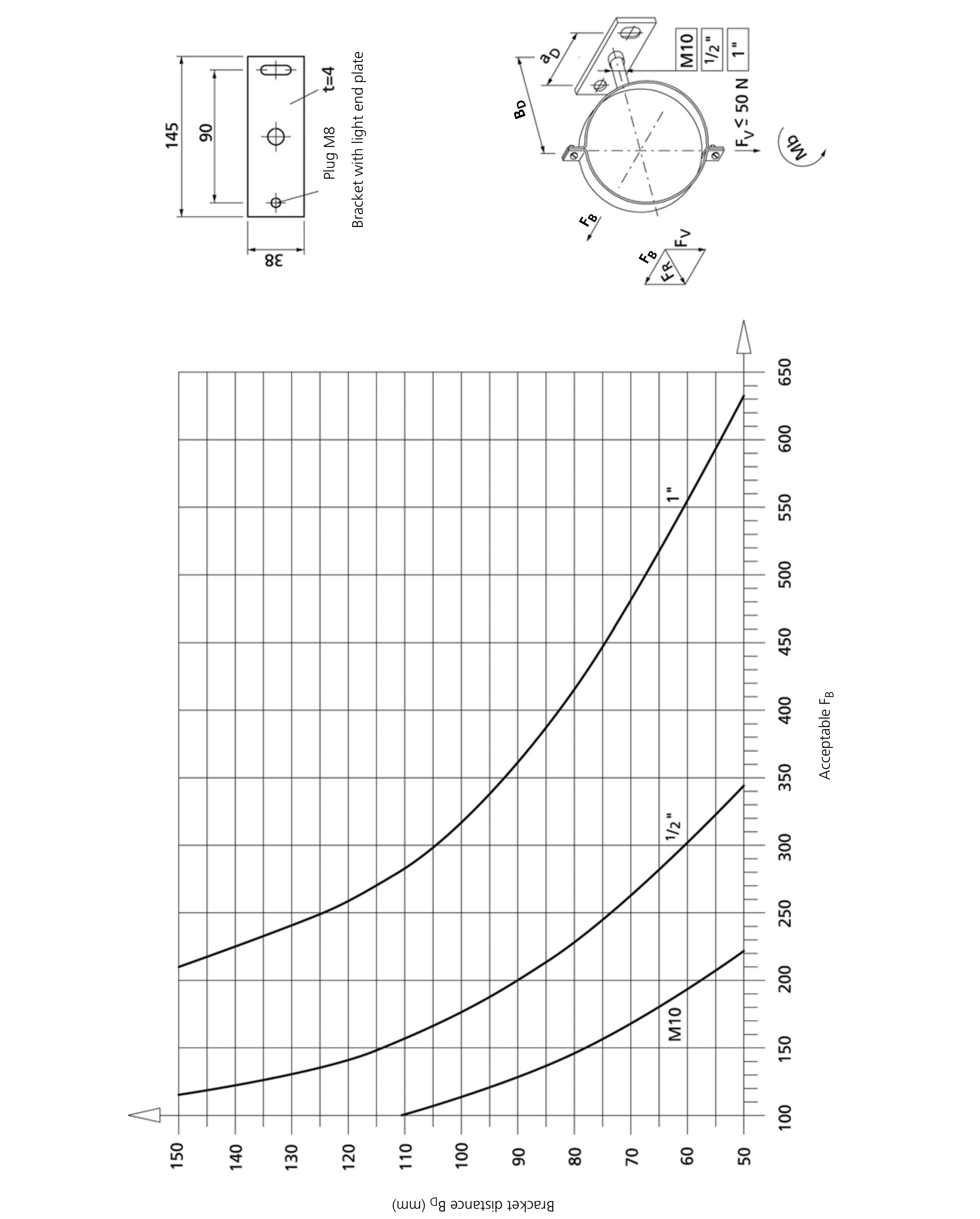


A-13 Acceptable load distances for sliding brackets

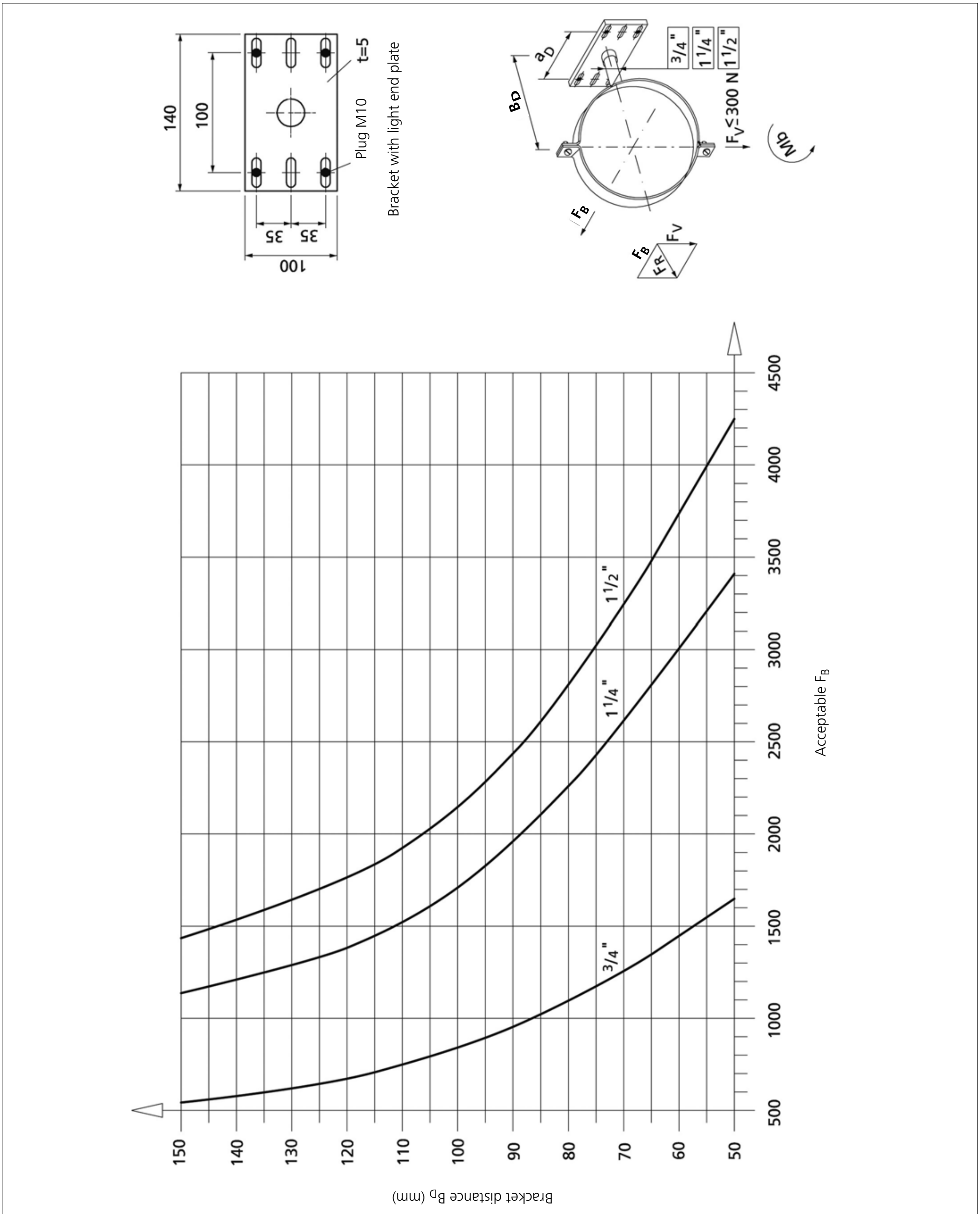


Appendix A - General Diagrams

A-14 Acceptable load distances for fixed-point brackets



A-15 Acceptable load distances for fixed-point brackets



Appendix A - General Diagrams

A-16 Flow nomogram for pressure PE100 pipe system in the SDR series 17 and 11

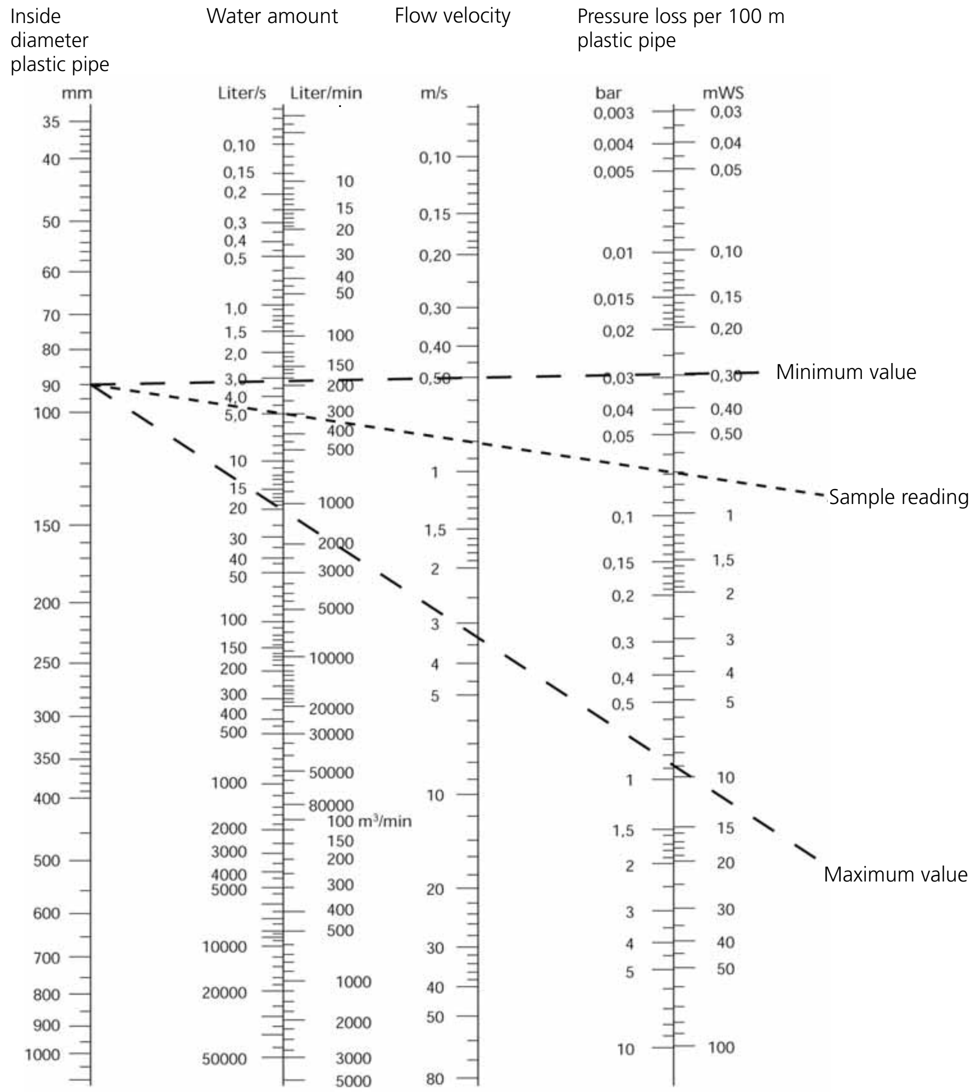
Table A16b and A16c indicate the range of applications (flow rate limits: minimum and maximum flow rate for individual pipe diameters) within which certain pipes of the PE100: SDR series 17 and 11 can be used (according to the pressure loss tables for PVC-U, PE-HD and PE-LD pressure pipes from the German Plastic Pipe Association).
The areas of validity for the listed flow-rate values correspond to tap water pipes as specified in DVGW W 302 with a flow-medium temperature (water) of 10°C. These values are used in the calculation because they usually form the basis of a tap water system. For deviating operating temperatures, the read values for pressure loss at a corresponding flow-rate amount are to be multiplied by the correction factor from table A16a. Intermediary values are to be interpolated or read directly from the pressure loss tables from KRV. The use of the flow nomogram (diagram A16) is illustrated by a small application example in the diagram. The broken lines indicate the upper and lower limits of the respective pipe dimensions. Given the pipe dimensions 110 x 10 mm (SDR 11), the corresponding values are read from the flow nomogram. To clarify the application limits of our example, the upper and lower boundaries of the flow capacity are shown as broken lines.

For instance, the selected pipe dimension d_e = 110x10 mm, inside diameter d_s = 90 mm and flow-rate volume ($\dot{V}$) = 5 l/s produces a flow velocity (w) ≈ 0,8 m/s and a pressure loss (Δp) of ≈ 0,7 bar/100 m.

Table A16a Correction factors for the determination of pressure loss with corresponding pipe dimensions

Operating temperature (T_O) (°C)	Correction factor (-)
0	1.07
10	1.00
20	0.96
30	0.92
40	0.89
50	0.87
60	0.85

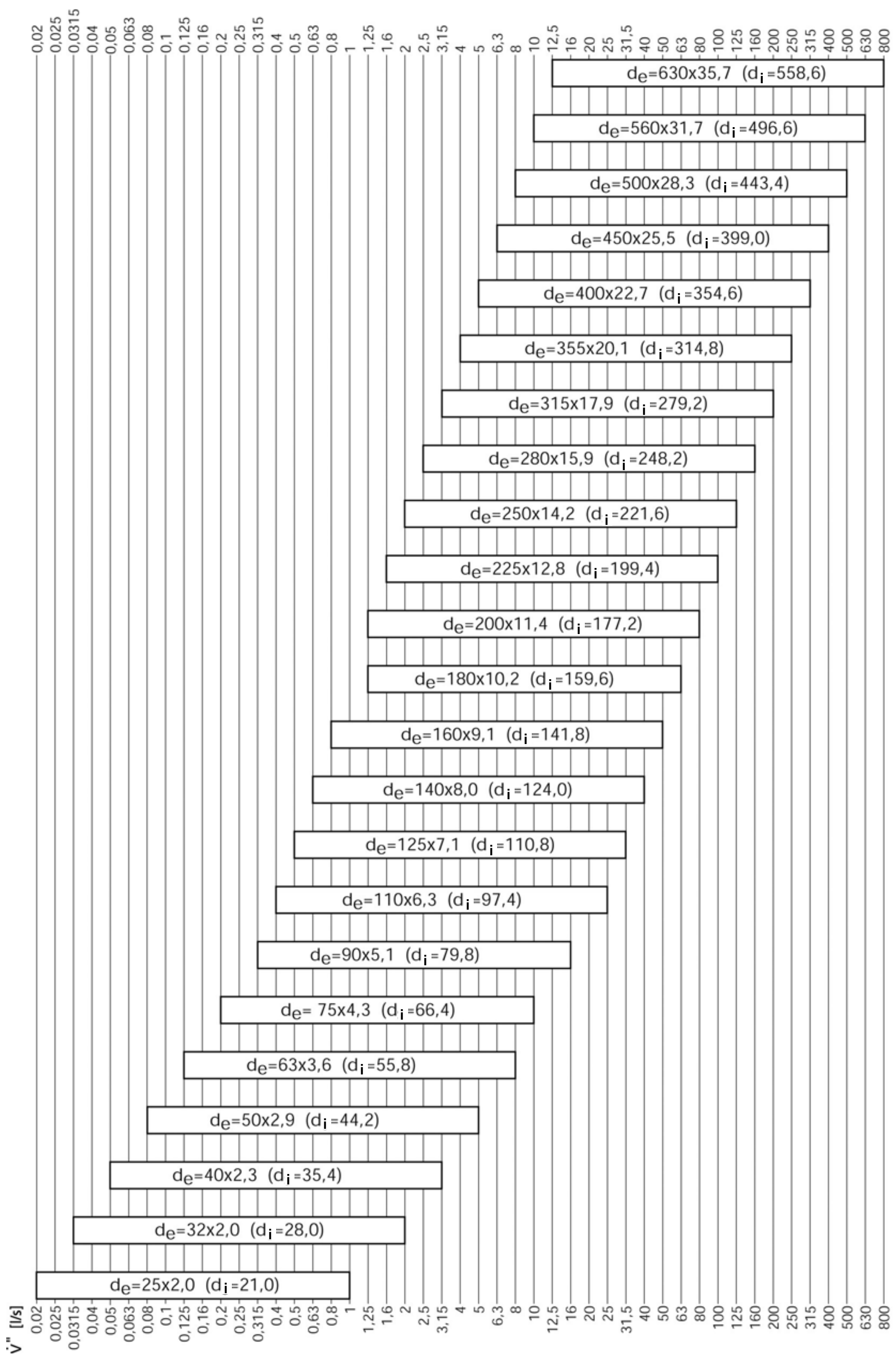
Diagram A16



Exact values see: DVGW Process Sheet W 302 Pressure tables from the RKV

Subject to changes

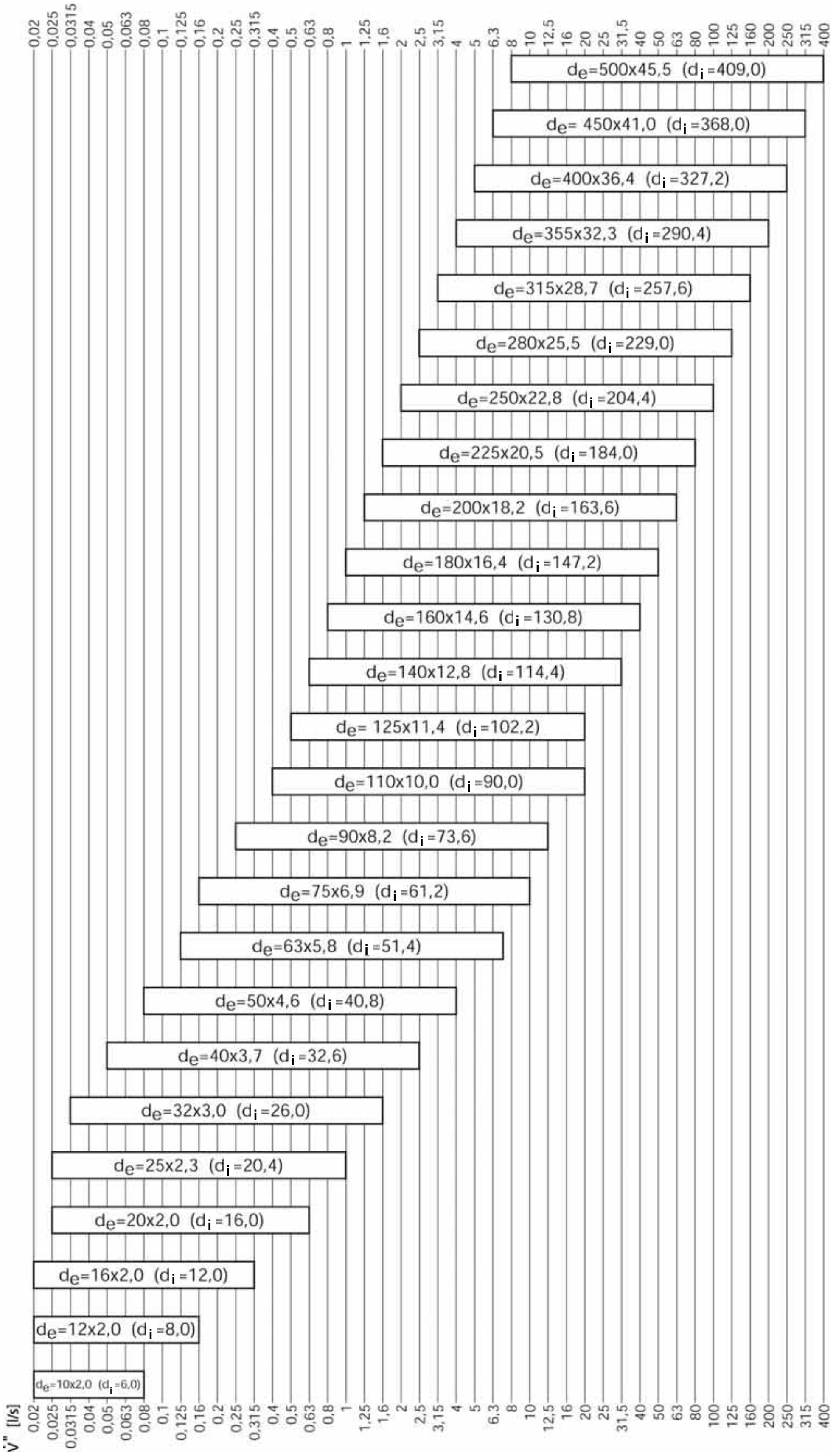
Table A16b Replacement ranges of SDR 17 pipes in terms of flow-rate capacity (min. and max. flow rate)



akatherm

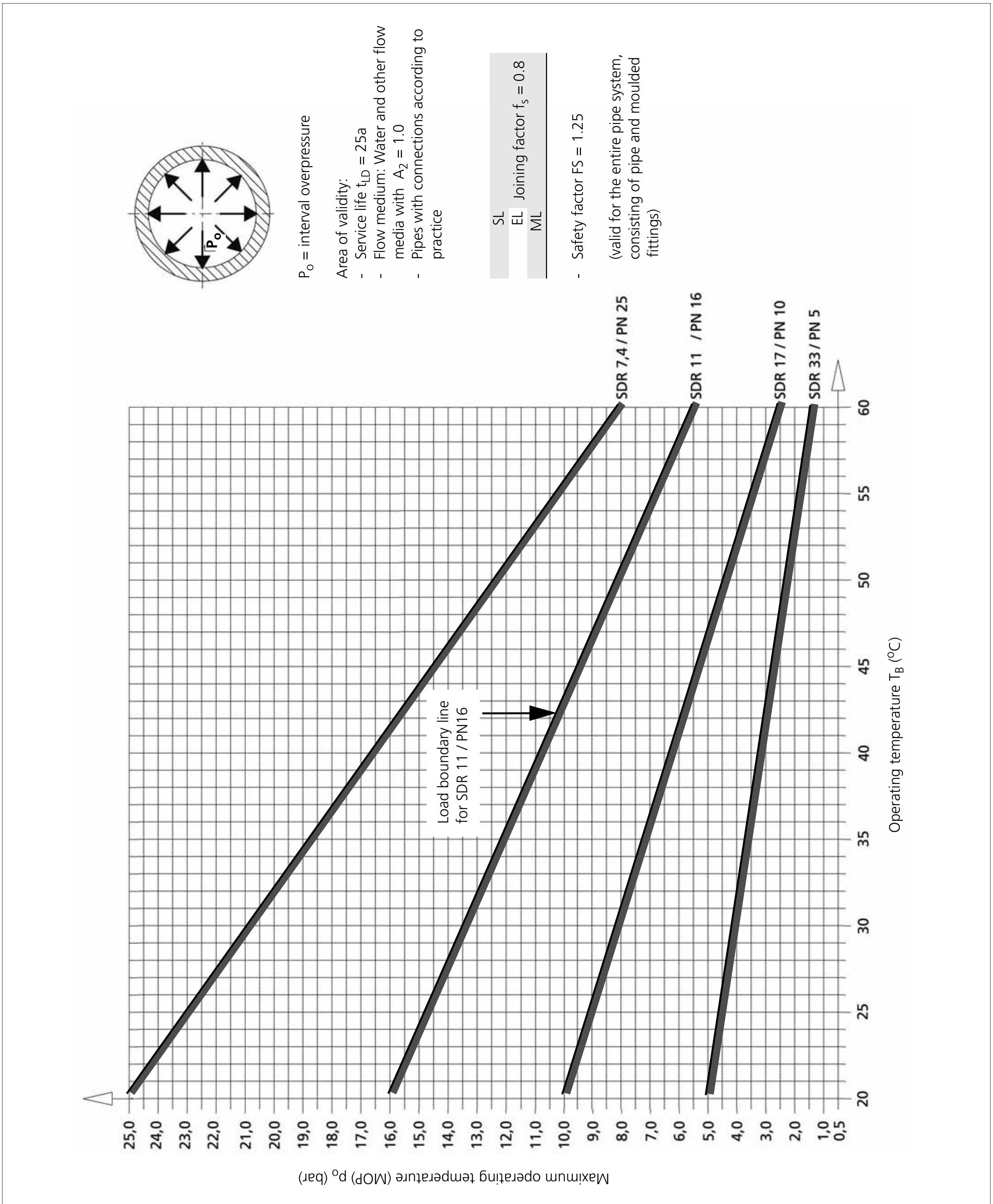
Appendix A - General Diagrams

Table A16c Replacement ranges of SDR 11 pipes in terms of flow-rate capacity (min. and max. flow rate)



Appendix B - Diagrams: Pressure pipe systems

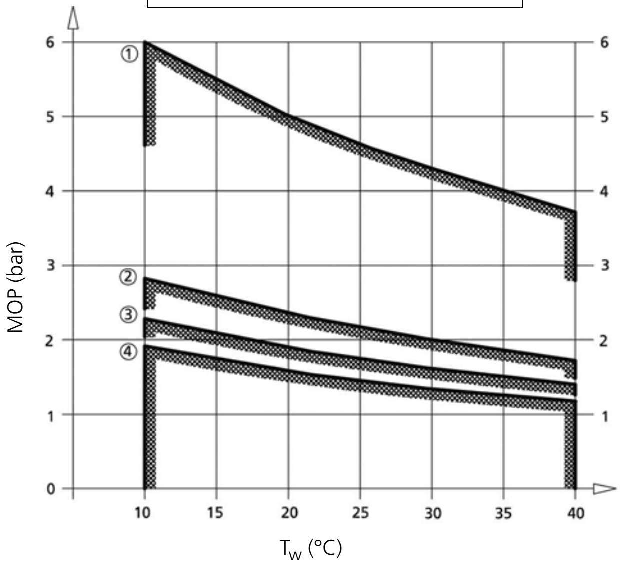
B-1 Maximum operating pressure for PE100 pressure pipe systems



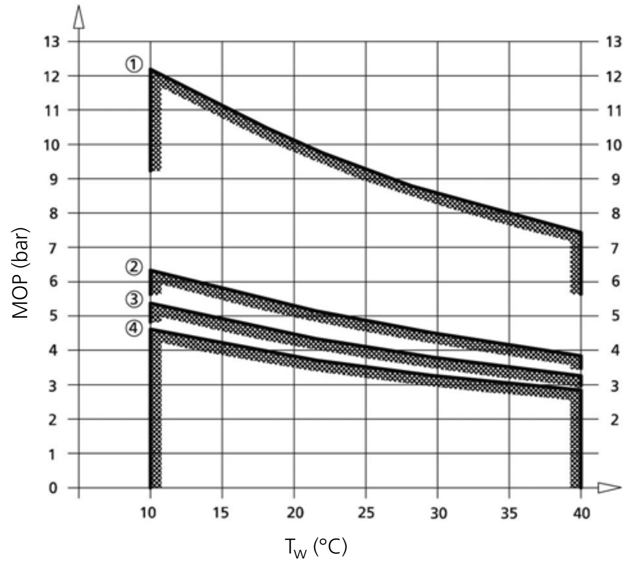
Appendix B - Diagrams: Pressure pipe systems

B-2 Maximum operating pressure for pipes and fittings of PE100 / SF = 1.25

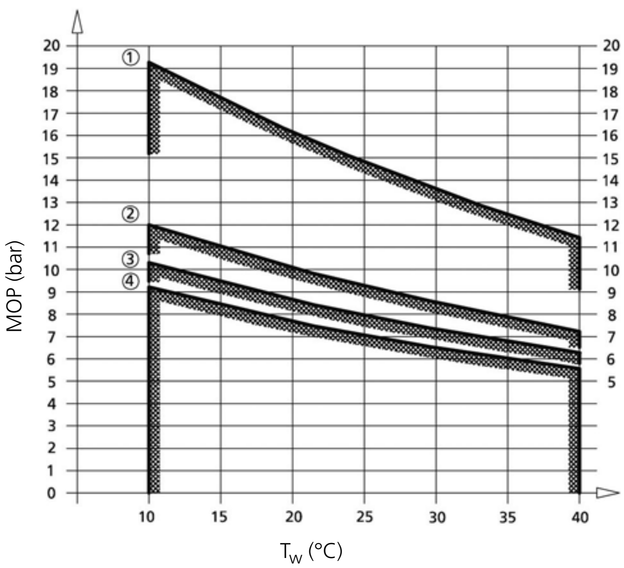
PE100/SDR11



PE100/SDR17



PE100/SDR33



The indicated values do not apply to pipes exposed to UV radiation. Maximum operating pressures of <1 are not included in the tables. For Siphonic Roof Drainage and Soil & Waste Systems, see the Technical Manual and pricelist for Akatherm Specialist Drainage Systems.

① = pipe, injection fittings, seamless bends and welded bends = 30°

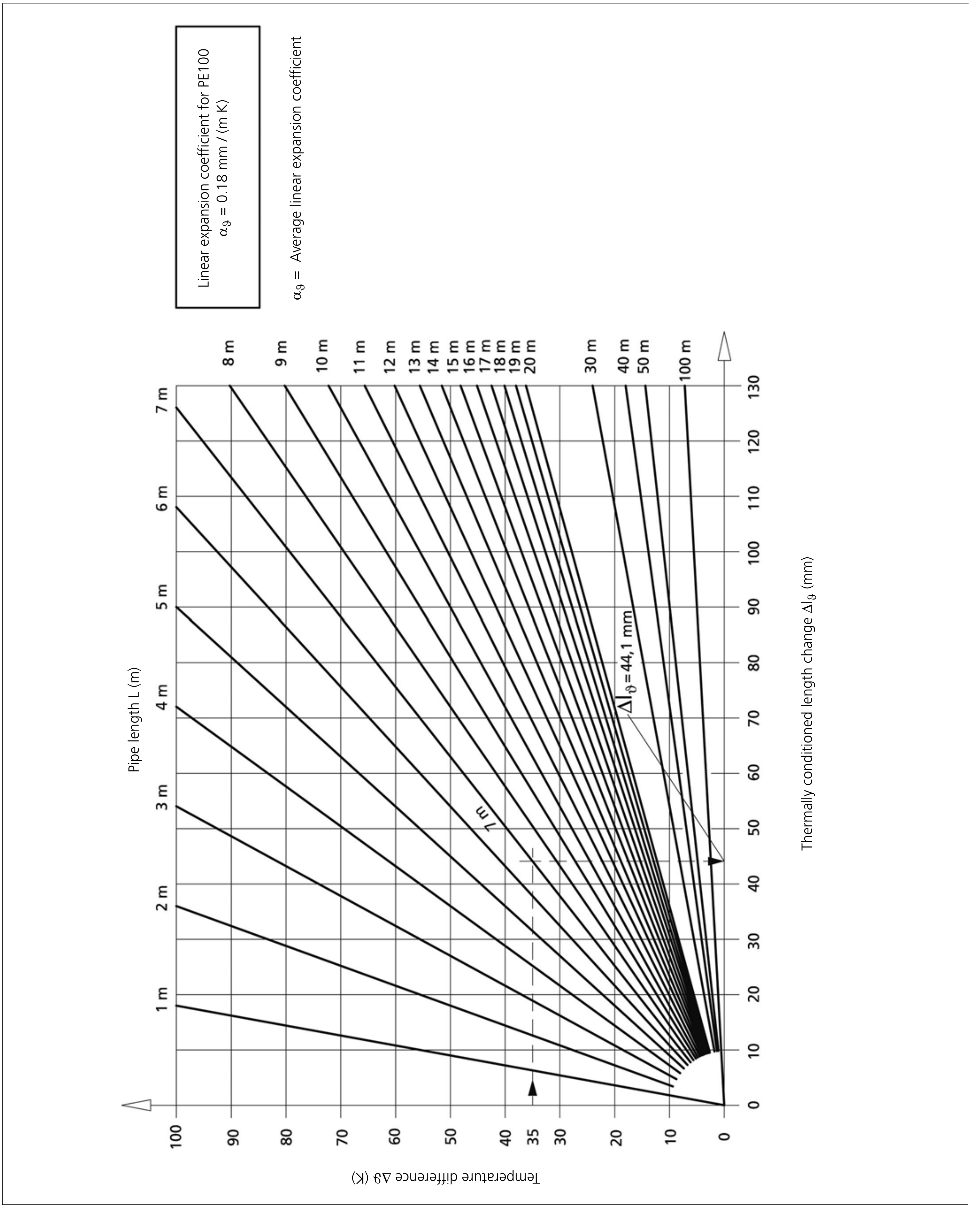
② = welded bends >30°- 90°, tees 90° welded

③ = welded 60° tees

④ = welded 45° tees

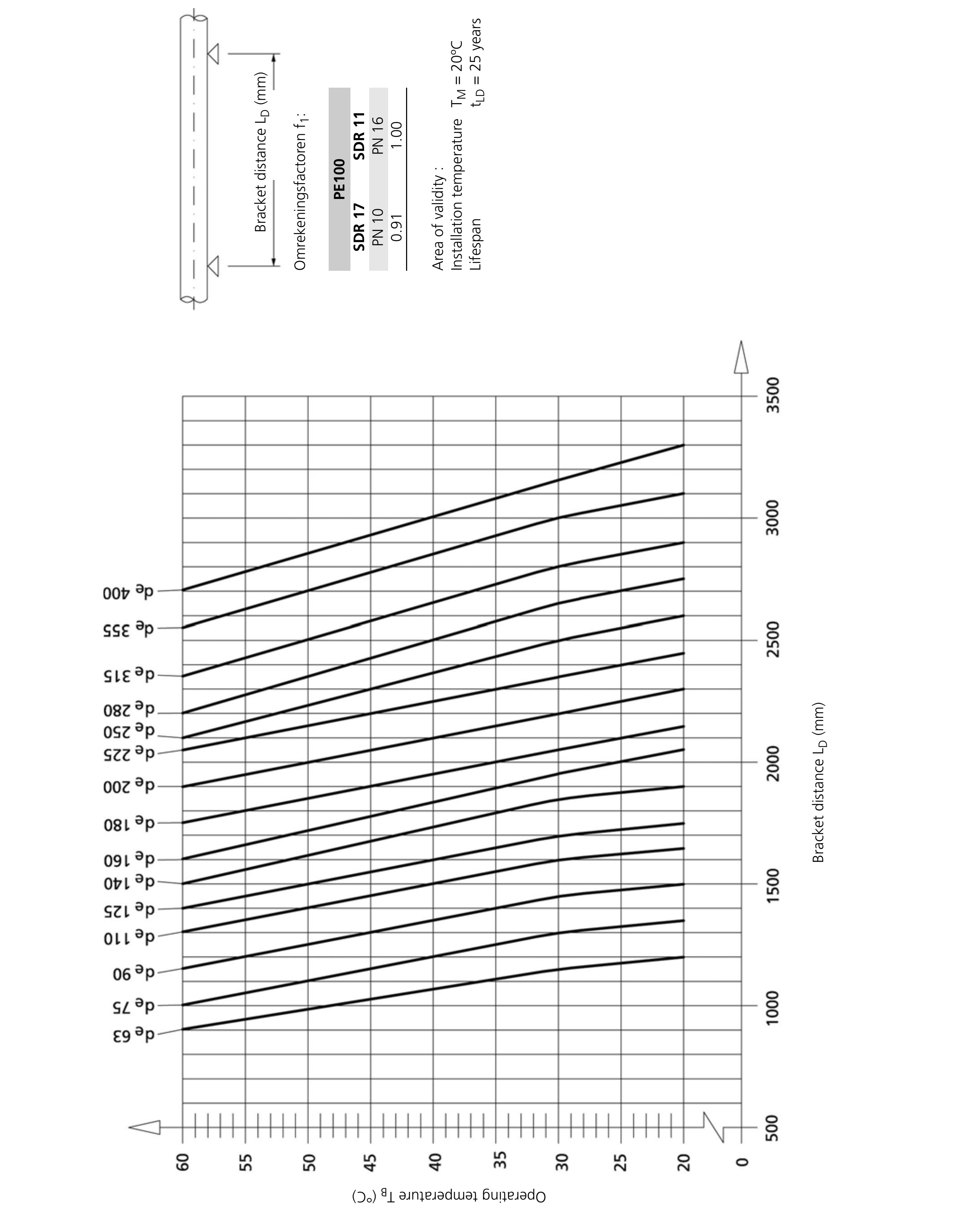
SF = safety factor 1.25
t_{ld} = lifespan 25a
MOP = internal pressure
T_w (°C) = pipe wall temperature

B-3 Thermal length change in PE100 pipe systems

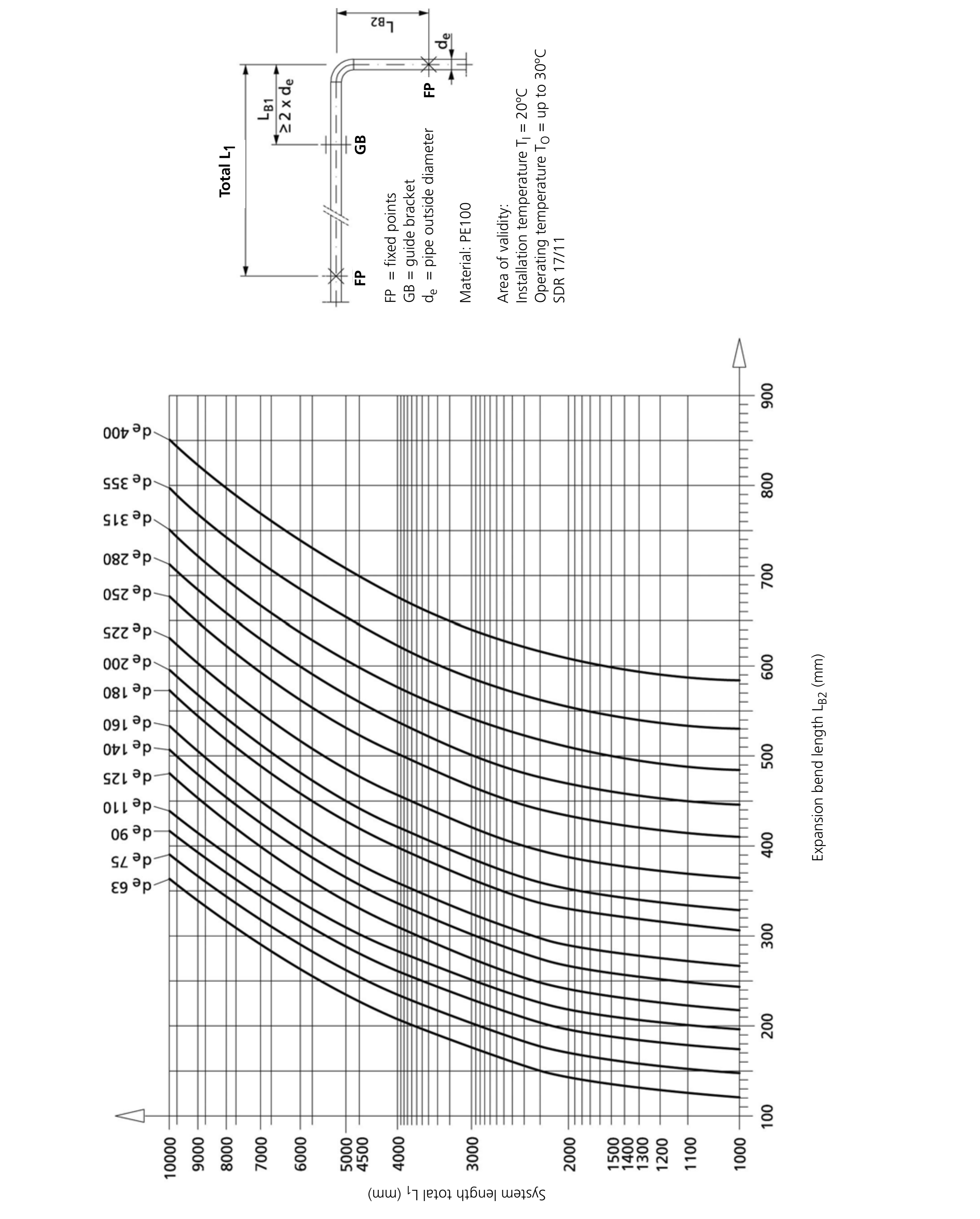


Appendix B - Diagrams: Pressure pipe systems

B-4 Acceptable support distance for water-filled PE100 pipes according to DVS guideline 2210 P1

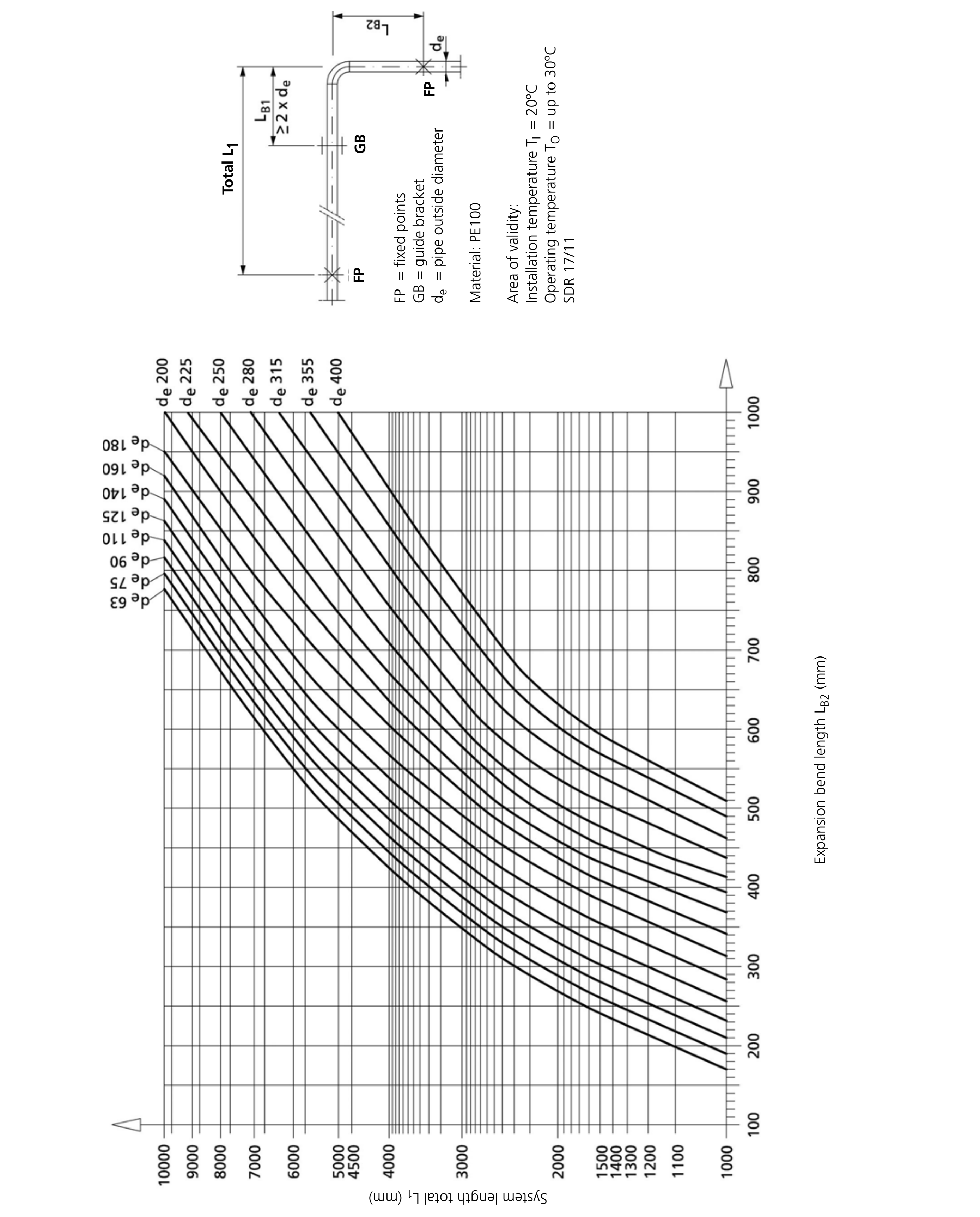


B-5 L-expansion bends

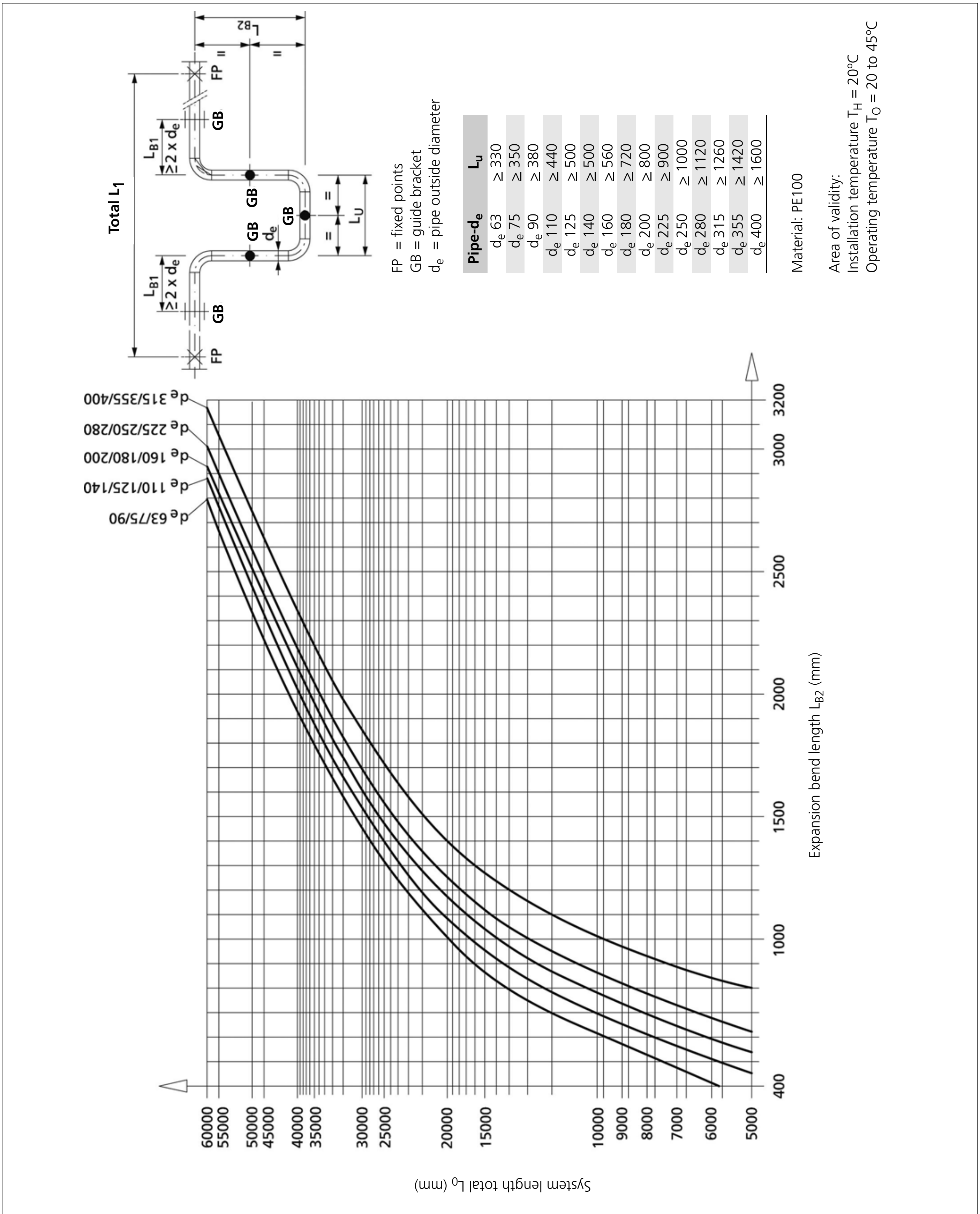


Appendix B - Diagrams: Pressure pipe systems

B-6 L-expansion bends



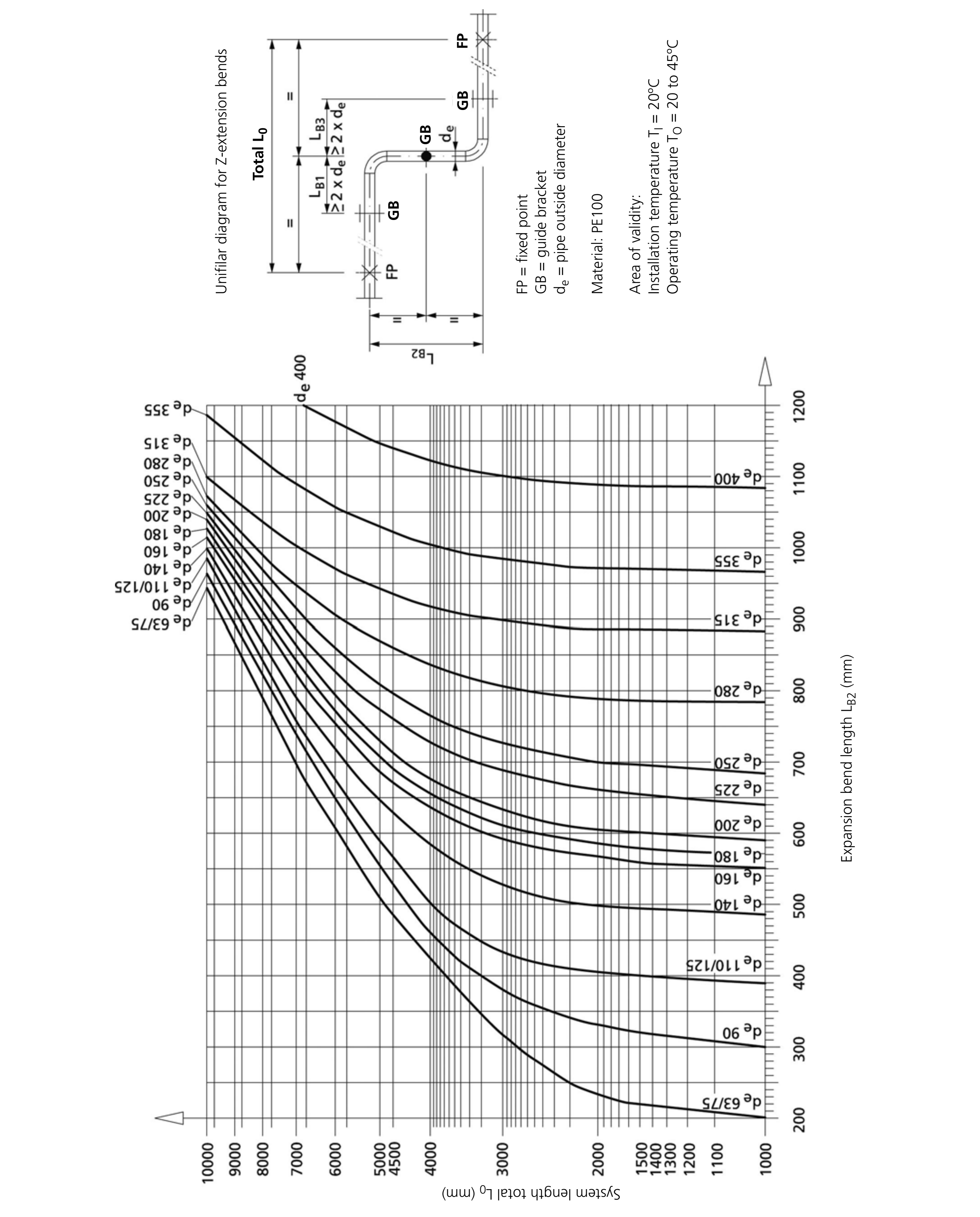
B-7 U-expansion bends



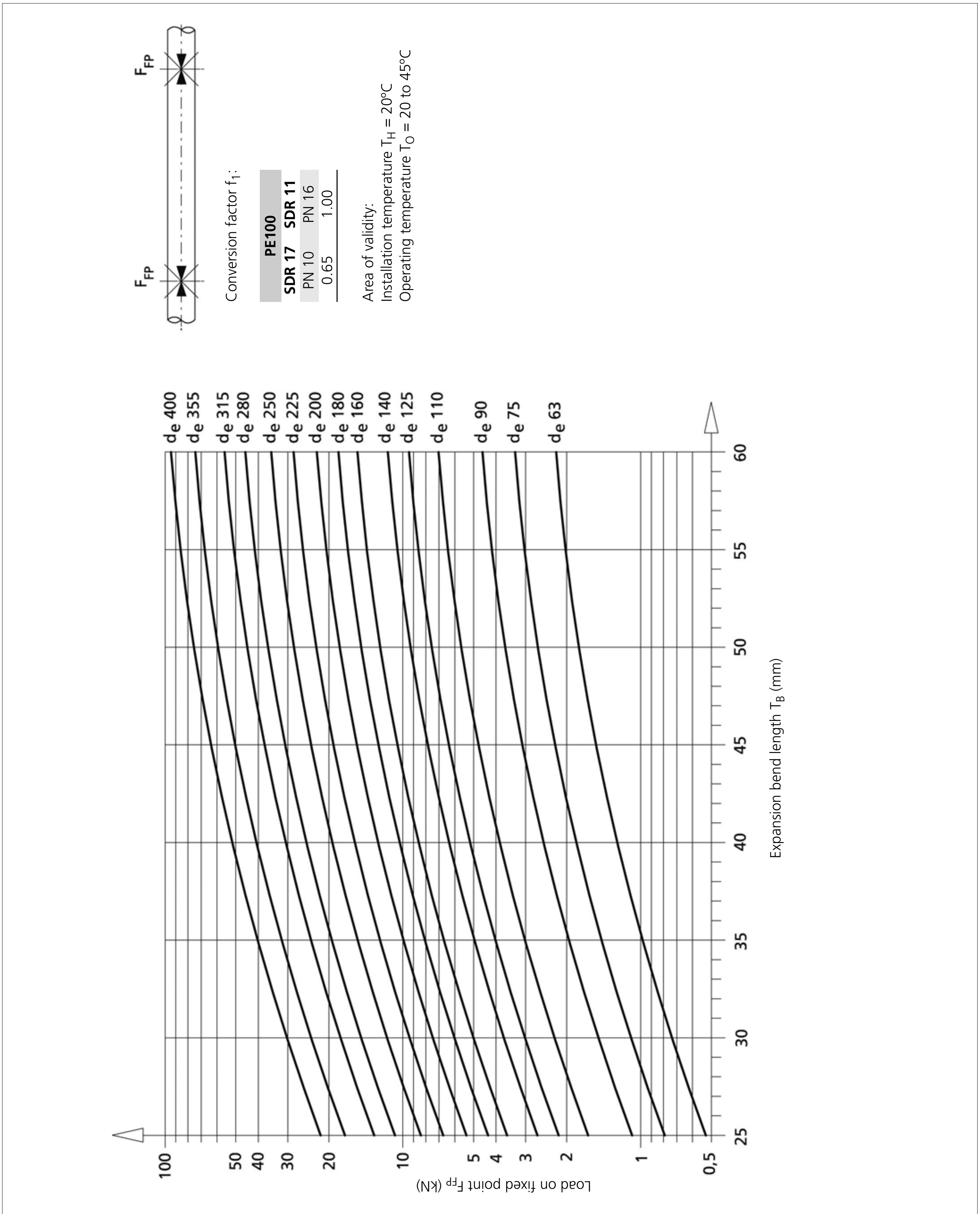
Pipe-d_e	L_U
d_e 63	≥ 330
d_e 75	≥ 350
d_e 90	≥ 380
d_e 110	≥ 440
d_e 125	≥ 500
d_e 140	≥ 500
d_e 160	≥ 560
d_e 180	≥ 720
d_e 200	≥ 800
d_e 225	≥ 900
d_e 250	≥ 1000
d_e 280	≥ 1120
d_e 315	≥ 1260
d_e 355	≥ 1420
d_e 400	≥ 1600

Appendix B - Diagrams: Pressure pipe systems

B-8 Z-extension bends



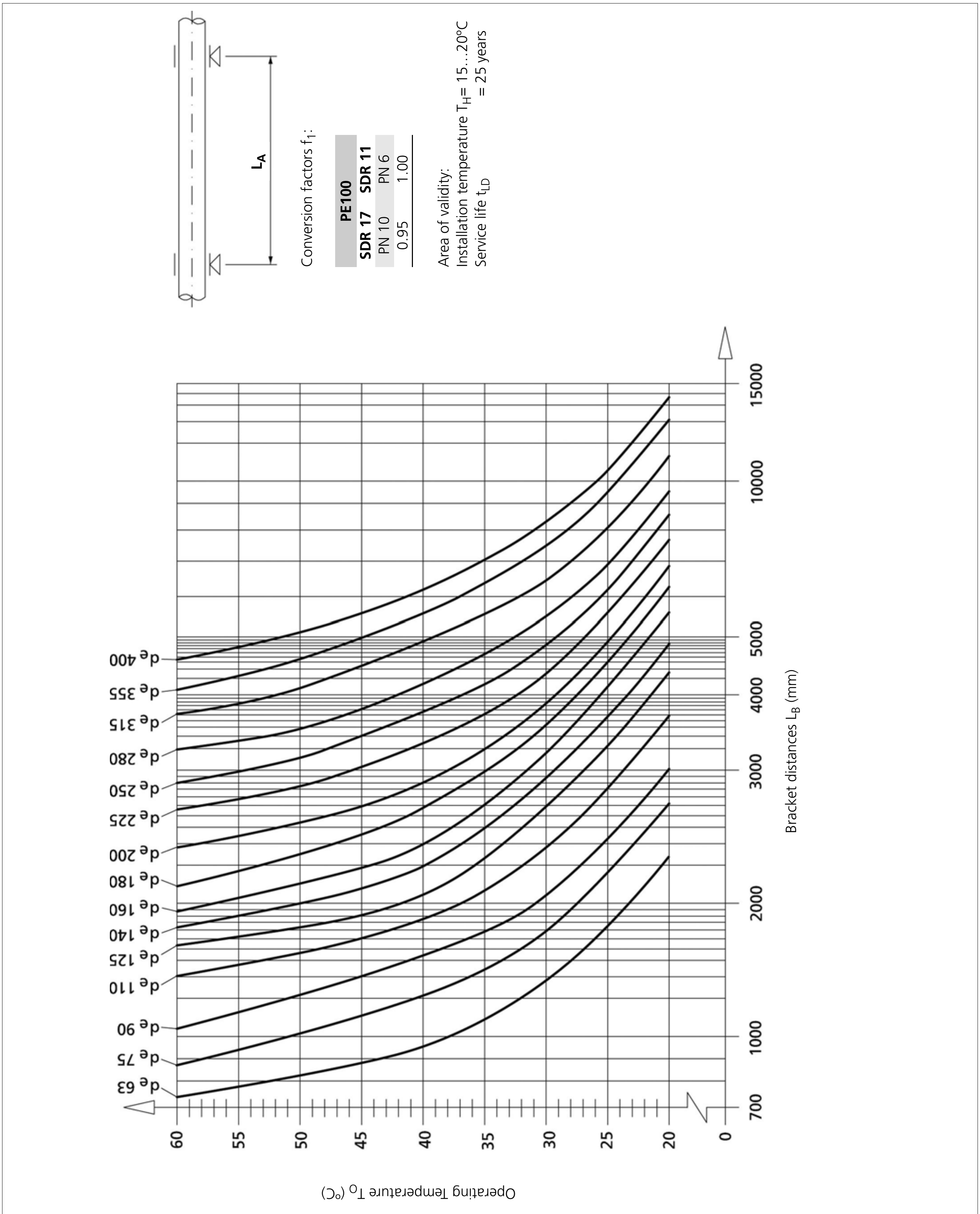
B-9 Forces at fixed points in axial constricted PE100 pipe systems



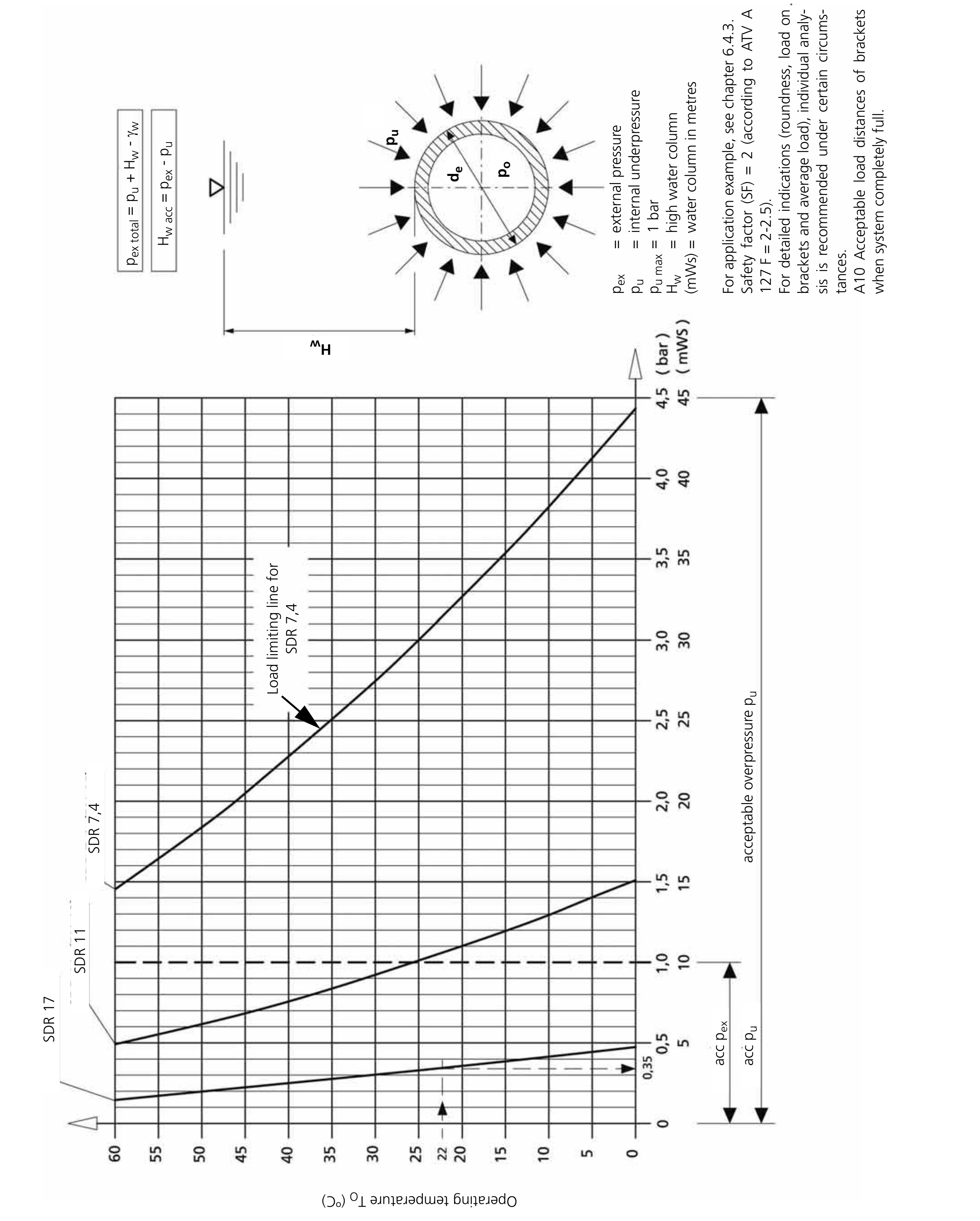
PE100	
SDR 17	**SDR 11**
PN 10	PN 16
0.65	1.00

Appendix B - Diagrams: Pressure pipe systems

B-10 Bracket distances in axial constricted PE100 pipe systems

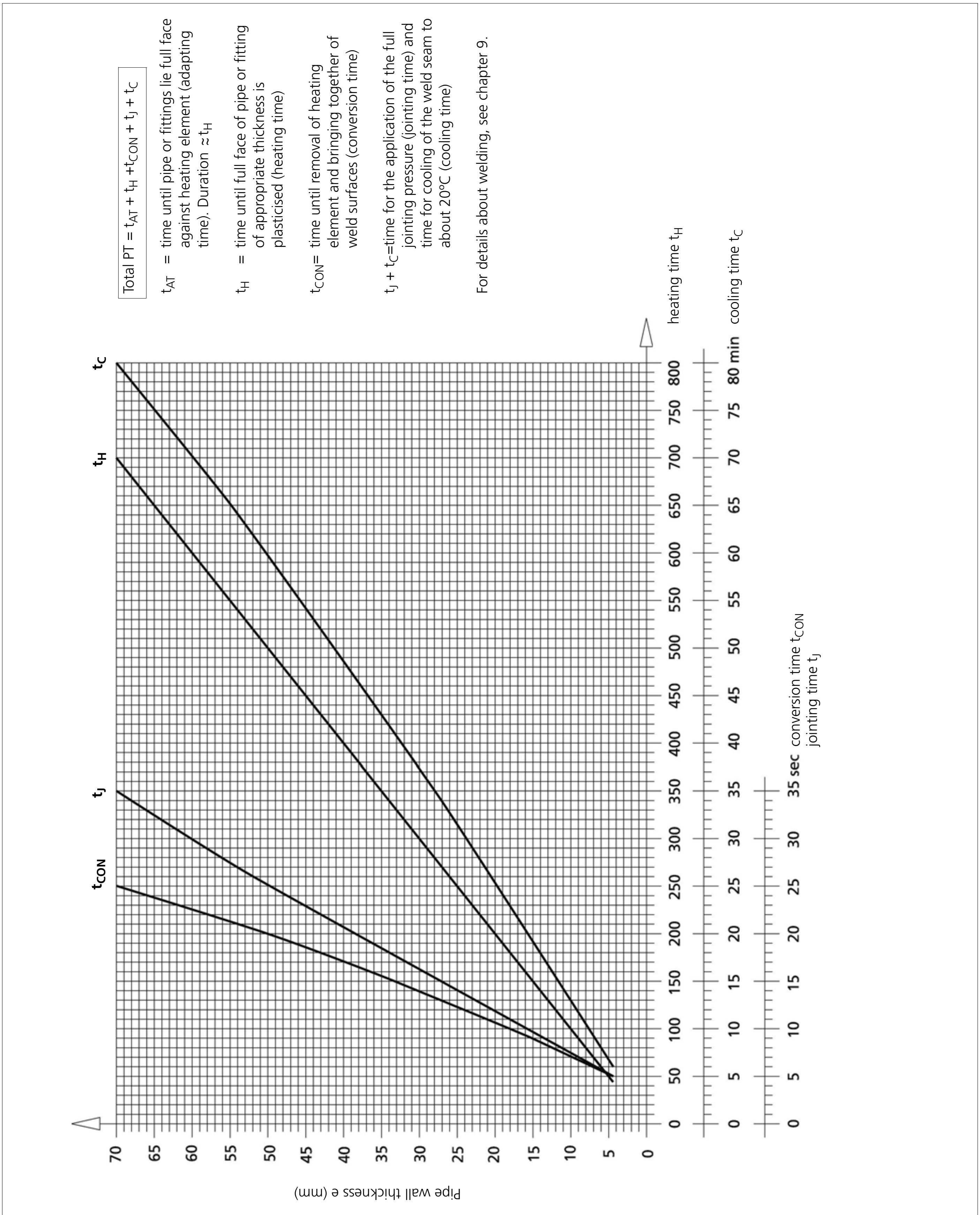


B-11 External pressure load or underpressure load of PE100 pipe systems (SDR 17, SDR 11)



Appendix B - Diagrams: Pressure pipe systems

B-12 Primary times for butt-welding of PE100 pipes and fittings



Appendix C - Explanation of the applied formulas and abbreviations

C-1 Applied symbols and signs in formulas

Formula sign	Entity	Explanation
$\dot{V}$	(m^3/h ; l/s)	Flow volume
$\dot{V}'$	(m^3/h)	Flow volume (flow rate)
$\dot{V}''$	(l/s)	Flow volume (flow rate)
$\dot{V}_a$	(m^3/h ; l/s)	Outgoing volume (at dividing or uniting flows)
$\dot{V}_d$	(m^3/h ; l/s)	Total continuous volume (at dividing or uniting flows)
$\dot{V}_s$	(m^3/h ; l/s)	Total flow volume (at dividing or uniting flows)
$\dot{V}_z$	(m^3/h ; l/s)	Incoming volume (at dividing or uniting flows)
A	(mm^2)	Cross-sectional area of flow channel
a	(m/s)	Travelling speed of the pressure surges
A_0	(mm^2)	Initial cross-section
a_0	(m/s)	Speed of sound
A_1	(-)	Reduction factor for the influence of the load period
A_2	(-)	Reduction factor for the influence of the flow medium
A_3	(-)	Reduction factor for the influence of the operating temperature
A_4	(-)	Reduction factor for the influence of the specific resilience of the material
a_F	(-)	Correction factor for road-traffic loads
A_k	(mm^2)	Surface subject to pressure
A_R	(mm^2)	Area of pipe annular surface
C	(-)	Aggregate work factor
d_e	(mm)	Outside diameter of the pipe
DN	(mm)	Nominal diameter of the pipe
d_i	(mm)	Inside diameter of the pipe
d_W	(m)	Thickness of the partition wall
E	(N/mm^2)	E-modulus
e	(mm)	Pipe wall thickness
e_0	(mm)	Minimum wall thickness
e_u	(mm)	Wall thickness on the outside of the bend
E_{B3}	(N/mm^2)	E-modulus from 3-point flexural test
E_{B4}	(N/mm^2)	E-modulus from 4-point flexural test
E_{cR}	(N/mm^2)	Elastcity modulus (E-modulus; creep modulus between 1 and 0.10 min); bending creep modulus
E_c	(N/mm^2)	E modulus from the compressive test
E_F	(N/mm^2)	E-modulus of the flow medium
e_i	(mm)	Wall thickness on the inside of the bend
E_t	(N/mm^2)	E modulus from the tensile test
F	(N)	Force
f_B	(mm)	Deflection
f_{Bo}	(-)	Factor for the outside of the bend
f_{Bi}	(-)	Factor for the inside of the bend
F_{FP}	(N)	Force at fixed points in a firmly fastened pipe string
F_W	(N)	Weight force
$F_{W\ (fill\ med)}$	(N)	Weight force (fill medium weight)
$F_{W\ (pipe)}$	(N)	Weight force (pipe weight)
$F_{W\ (Add\ load)}$	(N)	Weight force (additional load weight)

Formula sign	Entity	Explanation
F_h	(N)	Axial force component (axial fixed-point force (F_{FP}) or friction force (F_μ) as a result of a length change in the pipe string)
f_l	(-)	Long-term welding factor
F_{LB}	(N)	Fixed-point load at (L, Z, U) bends -> F_y c.q. F_x
F_{QV}	(N)	Transverse force
F_R	(N)	Resulting force; resulting load
f_s	(-)	Short-term welding factor (max. 1h)
f_{st}	(-)	Support factors for buried pipe systems
F_V	(N)	Vertical force
f_{acc}	(mm)	Acceptable pipe deflection
F_μ	(N)	Friction force
h	(m)	Height of the soil layer above the top of the pipe
B_d	(mm)	Bracket distance
H_{min}	(m)	Minimun soil layer above the pipe
H_P	(m)	Delivery height (e.g. pump)
H_{tr}	(mm)	Depth of the trench
H_{sl}	(mm)	Height of soil layer
h_W	(m)	Height of the water column above the top of the pipe
$h_{W\ acc}$	(m)	Acceptable height of the water column above the top of the pipe
J_R	(mm^4 ; cm^4)	Moment of inertial for the pipe
k	(-)	Heat transition coefficient
K_S	(-)	Pressure surge size
l_0	(mm)	Initial length
$L_{1,2}$	(mm)	System lengths
L_A	(m)	Bracket distance
$L_{A\ acc}$	(m)	Acceptable bracket distance
L_{valves}	(m)	Length of valves
L_B	(mm)	Length of the expansion bend
L_E	(m)	Bracket distance for end pieces
L_F	(mm)	Bracket distance
$L_{fittings}$	(m)	Length of fittings
$L_{FR\ acc}$	(m)	Acceptable load distance
L_{tot}	(m)	Total pipe length
L_K	(mm)	Critical buckling length
$L_{k\ acc}$	(mm)	Acceptable pipe length between two brackets
L_M	(mm)	Support distance for the middle of a continuous pipe
L_{pipe}	(m)	Length of straight pipe components; pipe length between valve mechanism or pump and reflection position (m)
M	(Nm)	Moment of torque
M_b	(Nm)	Bending moment
M_{RS}	(-)	Minimum strength
p_a	(bar)	External pressure, external overpressure
$p_{a\ tot}$	(bar)	Pressure difference between external overpressure and internal underpressure
$p_{a\ max}$	(bar)	Maximum external overpressure
p_{abs}	(bar)	Absolute pressure
p_{atm}	(bar)	Atmospheric pressure
p_{op}	(bar)	Soil stress (acc. to ATV A 127)
p_{Soil}	(kN/m^2)	Pump pressure, operating pressure
p_E	(kN/m^2)	External soil pressure
p_F	(kN/m^2)	Soil stress due to traffic load (acc. to ATV A 127)
p_{tot}	(bar)	Sum of individual pressure losses

Appendix C -Explanation of the applied formulas and abbreviations

Formula sign	Entity	Explanation
p_i	(bar)	Internal pressure
$p_{i\ max}$	(bar)	Maximum internal pressure
$p_{i\ min}$	(bar)	Minimum internal pressure
p_k	(bar)	Critical dent pressure
p_{kr}	(bar)	Critical underpressure
P_N	(bar)	Pressure rating, maximum operating pressure
p_R	(bar)	Pressure loss in straight pipe sections
p_{RV}	(bar)	Pressure loss in valves
p_{RF}	(bar)	Pressure loss in pipe fittings
p_{RJ}	(bar)	Pressure loss in pipe jointings
p_{spec}	(bar)	Specific welding pressure
p_{surge}	(bar)	Pressure surge
p_u	(bar)	Internal underpressure
$p_{u\ max}$	(bar)	Maximum internal underpressure
p_v	(kN/m^2)	Soil stress due to traffic load (acc. to ATV A 127)
p_W	(bar)	External water pressure
$p_{W\ acc}$	(bar)	Acceptable external water pressure
q	(N/mm^2)	Weight of the filled pipe along with any insulation
R	(mm)	Bending radius
Re	(-)	Reynolds number
R_m	(mm)	Average pipe radius
S	(-)	Load-dependent safety factor
SDR	(-)	Standard dimension ratio
SF	(-)	Safety factor = Aggregate pipe coefficient “C”
T_a	(°C)	Ambient temperature
$T_{a\ max}$	(°C)	Highest ambient temperature
$T_{a\ min}$	(°C)	Lowest ambient temperature
T_{op}	(°C)	Operating temperature
T_{eR}	(°C)	Outer pipe wall temperature
T_i	(°C)	Flow medium temperature
$T_{i\ max}$	(°C)	Highest flow-medium temperature
$T_{i\ min}$	(°C)	Lowest flow-medium temperature
T_{crit}	(°C)	Critical operating temperature
t_{LD}	(°C)	Calculated service life
T_m	(°C)	Average installation temperature
t_R	(s)	Reflection time
t_s	(s)	Closing time of the butterfly valve or delay fo the pump stop command after failure
T_{sR}	(°C)	Inner pipe wall temperature
T_W	(°C)	Pipe wall temperature
$T_{W\ max}$	(°C)	Maximum pipe wall temperature
$T_{W\ min}$	(°C)	Minimum pipe wall temperature
v_{RF}	(-)	Weakening factor of the fitting
w, w_o	(m/s)	Flow velocity
w_1	(m/s)	Leak test at the reflection position
W_D	(mm)	Distance to wall
W_B	(cm^3)	Resistance moment of the pipe
Z	(m)	Lever
Z_s	(-)	Surge degradation factor
Δl	(mm)	Length change
Δl_p	(mm)	Length change due to internal pressure
Δl_ϑ	(mm)	Thermal length change
Δw	(m/s)	Velocity difference
$\Delta\vartheta$	(K)	Temperature difference
$\Delta\vartheta_{max}$	(K)	Max. temperature difference
α_E	(°)	Angle of enlargement
α_W	(W/m^2K)	Heat transfer coefficient
α_ϑ	(K^{-1} ; 1/K ; mm/mK)	Thermal linear expansion coefficient

Formula sign	Entity	Explanation
$\alpha_{\vartheta m}$	(K^{-1} ; 1/K ; mm/mK)	Average thermal linear expansion coefficient
β_ϑ	(K^{-1} ; 1/K ; mm/mK)	Cubic (spatial) expansion coefficient Expansion)
ε	(-)	Expansion
ε_1	(-)	Expansion of 0.05%
ε_2	(-)	Expansion of 0.25%
ε_F	(-)	Expansion threshold value
$\varepsilon_{\sigma x}$, $\varepsilon_{\sigma y}$	(-)	Expansion along the x and y axes of stress in a multiaxial load
γ_W	(kN/m^3)	Specific weight of the fluid
γ_B	(kN/m^3)	Specific weight of the soil
η	(-)	Correction factor
φ	(-)	Shock factor for road-traffic loads
λ	(W/Km)	Heat conductivity
λ_B	(-)	Bend factor
λ_R	(-)	Pipe friction number
μ	(-)	Transverse contraction number
μ_R	(-)	Fiction coefficient
ν	(m^2/s)	Kinematic viscosity
ρ_F	(kg/m^3)	Density of the flow medium
ρ_R	(g/cm^3)	Density of the pipe material
σ	(N/mm^2)	Stress
σ_0	(N/mm^2)	Stress in straight pipe
σ_1	(N/mm^2)	Normal stress at 0.05% expansion
σ_2	(N/mm^2)	Normal stress at 0.25% expansion
σ_a, σ_l	(N/mm^2)	Axial stress
σ_b	(N/mm^2)	Flexural stress
σ_B	(N/mm^2)	Tensile strength
$\sigma_{b\ acc}$	(N/mm^2)	Acceptable flexural stress
σ_D	(N/mm^2)	Compressive stress
σ_r	(N/mm^2)	Radial stress
σ_R	(N/mm^2)	Breaking strength
σ_{res}	(N/mm^2)	Resulting stress
σ_S	(N/mm^2)	Yield stress
σ_t	(N/mm^2)	Tangential stress
σ_u	(N/mm^2)	Circumferential stress
σ_v	(N/mm^2)	Reference stress
σ_x, σ_y, σ_z	(N/mm^2)	Direction-dependent stress along the x, y and z axes
σ_Z	(N/mm^2)	Tensile stresses
σ_{acc}	(N/mm^2)	Acceptable stress
σ_ϑ	(N/mm^2)	Axial stress due to constricted thermal expansion
$\sigma_{\vartheta\ max}$	(N/mm^2)	Maximum axial stress due to constricted thermal expansion
ζ_A	(-)	Sum of the individual resistances of valves, metering equipment, etc.
ζ_F	(-)	Sum of the individual resistances of fittings and other components
ζ_{RA}	(-)	Resistance factors for pipe valves
ζ_{RF}	(-)	Resistance factors for pipe fittings
ζ_{RV}	(-)	Resistance factors for connections

C-2 Applied abbreviations

Abbreviation	Explanation
ES	Expansion socket
BZ	Load zone
DZ	Expansion cushion, expansion zone
E	Insertion depth
EFC	Electrofusion coupler
GB	Guide bracket
FP	Fixed point
FS	Stack trand
SB	Sliding bracket
GSV	Seat valve
SF	Socket welding
HFP	Fixed-point brackets
EF	Electrofusion
BW	Butt-welding
K	Size of the bead
FV	Butterfly valve
BV	Ball valve
MFI	Melt Flow Index
MFR	Melt Mass Flow Rate
MRS	Minimum Required Strength
DF	Diaphragm valve
MVI	Melt Volume Index
MVR	Melt volume flow rate
PE	Polyethylene
PE-HD	High density polyethylene
PP	Polypropylene
RFP	Pipe system fixed points
CV	Clapet valve
CF	Free flow clapet valve
GV	Gate valve
ISO-S	Pipe series
SB	Strap
SDR	Standard Dimension Ratio
ASV	Angle Seat Valve
TS	Support
VS	Residual deformation
WE	Warmgas Extrusion welding
WWWN	Warmgas wire welding - normal nozzle
WWWS	Warmgas wire welding - speed nozzle

Appendix C -Explanation of the applied formulas and abbreviations

Appendix D - Conversion tables

D-1 Prefixes and their symbols

da	deca	10^{1}	d	deci	10^{-1}
h	hecto	10^{2}	c	centi	10^{-2}
k	kilo	10^{3}	m	milli	10^{-3}
M	mega	10^{6}	μ	micro	10^{-6}
G	giga	10^{9}	n	nano	10^{-9}
T	tera	10^{12}	p	pico	10^{-12}
P	peta	10^{15}	f	femto	10^{-15}
E	exa	10^{18}	a	atto	10^{-18}

D-2 Basic variables and units in the international unit system (SI-units)

Basic variables	Basic variables	Basic unit	Basic unit
Name	Formal symbool	Name	Unit
Length	l	Metre	m
Mass	m	Kilogram	kg
Time	t	Second	s
Electrical current	I	Ampère	A
Thermodynamic temperature	T	Kelvin	K
Amount of substance	n	Mole	mol

D-3 Units of length

	m	μm	mm	cm	dm	km
1 m	1	10^{6}	10^{3}	10^{2}	10	10^{-3}
1 μm	10^{-6}	1	10^{-3}	10^{-4}	10^{-5}	10^{-9}
1 mm	10^{-3}	10^{3}	1	10^{-1}	10^{-2}	10^{-6}
1 cm	10^{-2}	10^{4}	10	1	10^{-1}	10^{-5}
1 dm	10^{-1}	10^{5}	10^{2}	10	1	10^{-4}
1 km	10^{3}	10^{9}	10^{6}	10^{5}	10^{4}	1

D-4 Units of area

	m^2	$μm^2$	mm^2	cm^2	dm^2	km^2
1 m^2	1	10^{12}	10^{6}	10^{4}	10^{2}	10^{-6}
1 $μm^2$	10^{-12}	1	10^{-6}	10^{-8}	10^{-10}	10^{-18}
1 mm^2	10^{-6}	10^{6}	1	10^{-2}	10^{-4}	10^{-12}
1 cm^2	10^{-4}	10^{8}	10^{2}	1	10^{-2}	10^{-10}
1 dm^2	10^{-2}	10^{10}	10^{4}	10^{2}	1	10^{-8}
1 km^2	10^{6}	10^{18}	10^{12}	10^{10}	10^{8}	1

D-5 Units of volume

	m^3	mm^3	cm^3	dm^3 = 1 l = 1 Litre	km^3
1 m^3	1	10^{9}	10^{6}	10^{3}	10^{-9}
1 mm^3	10^{-9}	1	10^{-3}	10^{-6}	10^{-18}
1 cm^3	10^{-6}	10^{3}	1	10^{-3}	10^{-15}
1 dm^3	10^{-3}	10^{6}	10^{3}	1	10^{-12}
1 km^3	10^{9}	10^{18}	10^{15}	10^{12}	1

Appendix D - Conversion tables

D-6 Units of mass

	kg	mg	g	dt	t = Mg
1 kg	1	10^{6}	10^{3}	10^{-2}	10^{-3}
1 mg	10^{-6}	1	10^{-3}	10^{-8}	10^{-9}
1 g	10^{-3}	10^{3}	1	10^{-5}	10^{-6}
1 dt	10^{2}	10^{8}	10^{5}	1	10^{-1}
1 t = 1 Mg	10^{3}	10^{9}	10^{6}	10	1

D-7 Units of time

	s	ns	µs	ms	min
1 s	1	10^{9}	10^{6}	10^{3}	$16{,}66 \cdot 10^{-3}$
1 ns	10^{-9}	1	10^{-3}	10^{-6}	$16{,}66 \cdot 10^{-12}$
1 µs	10^{-6}	10^{3}	1	10^{-3}	$16{,}66 \cdot 10^{-9}$
1 ms	10^{-3}	10^{6}	10^{3}	1	$16{,}66 \cdot 10^{-6}$
1 min	60	$60 \cdot 10^{9}$	$60 \cdot 10^{6}$	$60 \cdot 10^{3}$	1
1 h	3600	$3{,}6 \cdot 10^{12}$	$3{,}6 \cdot 10^{9}$	$3{,}6 \cdot 10^{6}$	60
1 d	$86{,}4 \cdot 10^{3}$	$86{,}4 \cdot 10^{12}$	$86{,}4 \cdot 10^{9}$	$86{,}4 \cdot 10^{6}$	1440

D-8 Units of force (weight)

	N[(1)]	kN	MN	(kp)
1 N	1	10^{-3}	10^{-6}	0,102
1 kN	10^{3}	1	10^{-3}	$0{,}102 \cdot 10^{3}$
1 MN	10^{6}	10^{3}	1	$0{,}102 \cdot 10^{6}$

(1) 1 N = 1 kg · m/s^2 = 1 Newton

D-9 Units of pressure

	Pa	N/mm^2	bar	(1 kp/cm^2)	(Torr)
1 Pa = 1 N/m^2	1	10-6	10^{-5}	1,02 10^{-5}	0,0075
1 N/mm^2	106	1	10	10,2	7,5 · 10 3
1 bar	105	0,1	1	1,02	750
(1 kp/cm^2 = 1 at)	98100	$9{,}81 \cdot 10^{-2}$	0,981	1	736
(Torr) (2)	133	$0{,}133 \cdot 10^{-3}$	$1{,}33 \cdot 10^{-3}$	$1{,}36 \cdot 10^{-3}$	1

(2) 1 Torr = 1 / 760 atm = 1,33322 mbar

Appendix E - Standards and guidelines

NEN-EN-ISO:

NEN-EN-ISO 62
Plastics - Determination of water absorption
NEN-EN-ISO 75-1
Plastics - Determination of temperature of deflection under load - Part 1: General test method
NEN-EN-ISO 75-2
Plastics - Determination of temperature of deflection under load - Part 2: Plastics
NEN-EN-ISO 179
Plastics - Determination of Charpy impact properties
NEN-EN-ISO 180
Plastics - Determination of Izod impact strength
NEN-EN-ISO 291
Plastics - Standard atmospheres for conditioning and testing
NEN-EN-ISO 527-1
Plastics - Determination of tensile properties - Part 1: General principles
NEN-EN-ISO 527-2
Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics
NEN-EN-ISO 868
Plastics and ebonite - Determination of indentation hardness by means of a durometer (Shore hardness)
NEN-EN-ISO 899-1
Plastics - Determination of creep behaviour - Part 1: Tensile creep
NEN-EN-ISO 1133
Plastics - Determination of melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics
NEN-EN-ISO 2039-1
Plastics - Determination of hardness - Part 1: Ball indentation method
NEN-EN-ISO 2039-2
Plastics - Determination of hardness - Part 2: Rockwell hardness
NEN-EN-ISO 6259
Thermoplastics pipes - Determination of tensile properties - Part 1: General test method
NEN-EN-ISO 6708
Pipe components - Definition and selection of DN (nominal size)
NEN-EN-ISO 12162
Thermoplastics materials for pipes and fittings for pressure applications - Classification and designation - Overall service (design) coefficient
NEN-EN-ISO 15494
Plastics piping systems for industrial applications - Polybutene (PB), polyethylene (PE) and polypropylene (PP) - Specifications for components and the system - Metric series

NEN-EN:

NEN-EN 762
Plastics pipes and ducting systems - Joints with elastomeric seals - Test method for retention of, and damage to, sealing rings
NEN-EN 1042
Plastics piping systems - Fusion joints between polyolefin pipes and/or fittings - Determination of resistance to internal pressure at constant temperature
NEN-EN 1091
Vacuum sewerage systems outside buildings
NEN-EN 1092-2
Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, PN designated - Part 2: Cast iron flanges
NEN-EN 1514-1
Flanges and their joints - Dimensions of gaskets for PN-designated flanges - Part 1: Non-metallic flat gaskets with or without inserts
NEN-EN 1555-1
Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 1: General
NEN-EN 1555-2
Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 2: Pipes
NEN-EN 1555-3
Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 3: Fittings
NEN-EN 1555-4
Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 4: Valves
NEN-EN 1555-5
Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 5: Fitness for purpose of the system
NEN-EN 1555-6
Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 6: Recommended practice for installation
NEN-EN 1555-7
Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 7: Guide for the assessment of conformity
NEN-EN 1610
Construction and testing of drains and sewers
NEN-EN 1716
Plastics piping systems - Polyethylene (PE) tapping tees - Test method for impact resistance of an assembled tapping tee
NEN-EN 1775
Gas supply - Gas pipework for buildings - Maximum operating pressure less than or equal to 5 bar - Functional recommendations
NEN-EN 12117
Plastics piping systems - Fittings, valves and ancillaries - Determination of gaseous flow rate/pressure drop relationships
NEN-EN 921
Plastics piping systems - Thermoplastics pipes - Determination of resistance to internal pressure at constant temperature
NEN-EN 12201-1
Plastics piping systems for water supply - Polyethylene (PE) - Part 1: General
NEN-EN 12201-2
Plastics piping systems for water supply - Polyethylene (PE) - Part 2: Pipes
NEN-EN 12201-3
Plastics piping systems for water supply - Polyethylene (PE) - Part 3: Fittings
NEN-EN 12201-4
Plastics piping systems for water supply - Polyethylene (PE) - Part 4: Valves
NEN-EN 12201-5
Plastics piping systems for water supply - Polyethylene (PE) - Part 5: Fitness for purpose of the system
NEN-EN 12201-6
Plastics piping systems for water supply - Polyethylene (PE) - Part 6: Recommended practice for installation
NEN-EN 12201-7
Plastics piping systems for water supply - Polyethylene (PE) - Part 7: Guide for the assessment of conformity
NEN-EN 12327
Gas supply systems - Pressure testing, commissioning and decommissioning procedures - Functional requirements
NEN-EN 13501-1
Fire classification of construction products and building elements - Part 1: Classification using test data from reaction to fire tests
NEN-EN 13244-1
Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage - Polyethylene (PE) - Part 1: General
NEN-EN 13244-2
Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage - Polyethylene (PE) - Part 2: Pipes

Appendix E - Standards and guidelines

NEN-EN 13244-3
Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage - Polyethylene (PE) - Part 3: Fittings
NEN-EN 13244-4
Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage - Polyethylene (PE) - Part 4: Valves
NEN-EN 13244-5
Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage - Polyethylene (PE) - Part 5: Fitness for purpose of the system
NEN-EN 13244-6
Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage - Polyethylene (PE) - Part 6: Recommended practice for installation
NEN-EN 13244-7
Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage - Polyethylene (PE) - Part 7: Guide for the assessment of conformity
prEN 15014
Pressure Drainage & Sewerage - Performance characteristics

NEN Standards:

NEN 1006
General requirements for drinkingwater installations (AVWI-2002)
NEN 3650
Requirements for pipe systems
NEN 3651
Aditional requirements for pipe systems crossing important waterworks
NEN 7200
Plastic pipe systems for transport of gas, drinkingwater en seweragewater - butt-welding of pipes and fittings of PE
NEN 7244
Netherlands edition bases on NEN-EN 12327 Gas supply systems - pipesystems for maximum operating perssure until 16 bar

Guidelines of the Netherlands:

A-blad "Kabel- en buizenlegger"
CROW, RAW 2005
Trench and trenchless techniques, pipework and cable work
ENV 1046
Plastics pipes and ducting systems - Outdoor systems for transport of water of sewerage water - Recommended practice for underground and above ground installation
NPR 3659
Underground pipe systems - Fundamentals for strenth calculations
VM102
Electro(coupler)fusion of thermoplastic Plastics

ISO standards:

ISO 13953
Polyethylene (PE) pipes and fittings - Determination of the tensile strength and failure mode of test pieces from a butt fused joint
ISO 13954
Plastics pipes and fittings - Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm
ISO 13955
Plastics pipes and fittings - Crushing decohesion test for polyethylene (PE) electrofusion assemblies

DIN Standards:

DIN 1910-1 1983.07 (en)
Schweißen - Begriffe, Einteilung der Schweißverfahren
DIN 2501-1 1972.02 (en)
Flansche - Anschlußmaße
DIN 2673 1962.08 (en)
Lose Flansche mit Vorschweißbund, Nenndruck 10 bar
DIN 3543-4 1984.08
Anbohrarmaturen aus Polyethylen hoher Dichte (HDPE) für Rohre aus HDPE - Maße
DIN 3544-1 1985.09 (en)
Armaturen aus Polyethylen hoher Dichte (HDPE) - Anforderungen und Prüfung von Anbohrarmaturen
DIN 4263 1991.04
Formen, Maße und geometrische Werte von Kanälen und Leitungen im Wasserwesen
DIN 8074 1987.09 (en)
Rohre aus Polyethylen hoher Dichte (PE-HD) - Maße
DIN 8075 1987.05 (en)
Rohre aus Polyethylen hoher Dichte (PE-HD) - Allgemeine Anforderungen
DIN 8076-1 1984.03 (en)
Druckrohrleitungen aus thermoplastischen Kunst-stoffen-, Klemmverbinder aus Metall für Rohre aus Polyethylen (PE) - Allgemeine Güteanforderungen, Prüfung
DIN 8076-3 1994.08
Druckrohrleitungen aus thermoplastischen Plastics - Teil 3: Klemmverbinder aus Plastics für Rohre aus Polyethylen (PE) - Allgemeine Güteanforderungen, Prüfung
DIN 16776-1 1984.12
Kunststoff-Formmassen - Polyethylen (PE)-Formmassen-, Einteilung und Bezeichnung
DIN 16888-1 1989.06
Bewertung der chemischen Widerstandsfähigkeit von Rohren aus Thermoplasten - Rohre aus Polyolefinen
DIN 16889-1 1989.06 (en)
Bestimmung der chemischen Resistenzfaktoren an Rohren aus Thermoplasten - Rohre aus Polyolefinen
DIN 16928 1979.04
Rohrleitungen aus thermoplastischen Plastics - Rohrverbindungen, Rohrleitungsteile, Verlegung, Allgemeine Richtlinien
DIN 16928 1979.04 (en)
Rohrleitungen aus thermoplastischen Plastics - Rohrverbindungen, Rohrleitungsteile, Verlegung, Allgemeine Richtlinien
DIN 16963-1 1980.08 (en)
Rohrverbindungen und Rohrleitungsteile für Druckrohrleitungen aus Polyethylen hoher Dichte (HDPE), Typ 1 und 2 - In Segmentbauweise hergestellte Rohrbogen für Stumpfschweißung, Maße
DIN 16963-2 1983.02 (en)
Rohrverbindungen und Rohrleitungsteile für Druckrohrleitungen aus Polyethylen hoher Dichte (HDPE) - Typ 1 und 2 - In Segmentbauweise und durch Aushalsen hergestellte T-Stücke und Abzweige für Stumpfschweißung-, Maße
DIN 16963-3 1980.08 (en)
Rohrverbindungen und Rohrleitungsteile für Druckrohrleitungen aus Polyethylen hoher Dichte (HDPE), Typ 1 und 2 - Aus Rohr geformte Rohrbogen für Stumpfschweißung, Maße
DIN 16963-4 1988.11 (en)
Rohrverbindungen und Rohrleitungsteile für Druckrohrleitungen aus Polyethylen hoher Dichte (PE-HD) - Bunde für Heizelement-Stumpfschweißung, Flansche, Dichtungen - Maße
DIN 16963-5 1989.10 (en)
Rohrverbindungen und Rohrleitungsteile für Druckrohrleitungen aus Polyethylen hoher Dichte (PE-HD) - Allgemeine Qualitätsanforderungen, Prüfung

E DIN 16963-5 1994.05
Rohrverbindungen und Rohrleitungsteile für Druckrohrleitungen aus Polyethylen hoher Dichte (PE-HD) - Allgemeine Qualitätsanforderungen, Prüfung
DIN 16963-6 1989.10 (en)
Rohrverbindungen und Rohrleitungsteile für Druckrohrleitungen aus Polyethylen hoher Dichte (PE-HD) - Fittings aus Spritzguß für Stumpfschweißung - Maße
DIN 16963-7 1989.10 (en)
Rohrverbindungen und Rohrleitungsteile für Druckrohrleitungen aus Polyethylen hoher Dichte (PE-HD) - Heizwendel-Schweißfittings - Maße
DIN 16963-8 1980.08 (en)
Rohrverbindungen und Rohrleitungsteile für Druckrohrleitungen aus Polyethylen hoher Dichte (HDPE), Typ 1 und 2 - Winkel aus Spritzguß für Muffenschweißung, Maße
DIN 16963-10 1980.08 (en)
Rohrverbindungen und Rohrleitungsteile für Druckrohrleitungen aus Polyethylen hoher Dichte (HDPE), Typ 1 und 2 - Muffen und Kappen aus Spritzguß für Muffenschweißung, Maße
DIN 16963-11 1980.08 (en)
Rohrverbindungen und Rohrleitungsteiie für Druckrohrleitungen aus Polyethylen hoher Dichte (HDPE), Typ 1 und 2 - Bunde, Flansche, Dichtungen für Muffenschweißung, Maße
E DIN 16963-11 1996.03
Rohrverbindungen und Rohrleitungsteile für Druckrohrleitungen aus Polyethylen hoher Dichte (PE-HD) Teil 11 - Bunde, Flansche, Dichtungen für Muffenschweißung - Maße
DIN 16963-14 1983.06 (en)
Rohrverbindungen und Rohrleitungsteile für Druckrohrleitungen aus Polyethylen hoher Dichte (HDPE) - Typ 1 und 2 - Reduzierstücke und Nippel aus Spritzguß für Muffenschweißung - Maße
DIN 16963-15 1987.06 (en)
Rohrverbindungen und Rohrleitungsteile für Druckrohrleitungen aus Polyethylen hoher Dichte (PE-HD) - Rohrverschraubungen - Maße
DIN 19537-1 1983.10 (en)
Rohre und Formstücke aus Polyethylen hoher Dichte (PE-HD) für Abwasserkanäle und -leitungen - Maße
DIN 19537-2 1988.01 (en)
Rohre und Formstücke aus Polyethylen hoher Dichte (PE-HD) für Abwasserkanäle und -leitungen - Technische Lieferbedingungen
DIN 19630 1982.08
Richtlinien für den Bau von Wasserrohrleitungen - Technische Regel des DVGW

German DVS Guidelines:

DVS 2201-1 1989.02
Prüfen von Halbzeug aus Thermoplasten - Grundlagen, Hinweise
DVS 2201-2 1985.07
Prüfen von Halbzeug aus Thermoplasten - Schweißeignung - Prüfverfahren - Anforderungen
DVS 2202-1 1989.12
Fehler an Schweißverbindungen aus thermoplastischen Plastics - Merkmale, Beschreibung, Bewertung
DVS 2203-1 1986.03 (en)
Prüfen von Schweißverbindungen aus thermoplastischen Plastics-, Prüfverfahren, Anforderungen
DVS 2205-1 1987.06
Berechnung von Behältern und Apparaten aus Thermoplasten - Kennwerte
DVS 2205-1 Beiblatt 8 1997.07
Berechnung von Behältern und Apparaten aus Thermoplasten - Zeitstandkurven für Rohre aus PE100
DVS 2205-3 1975.04 (en)
Berechnung von Behältern und Apparaten aus Thermoplasten - Schweißverbindungen
DVS 2205-4 1988.11
Berechnung von Behältern und Apparaten aus Thermoplasten - Flanschverbindungen
E DVS 2205-4 Beiblatt 1993.06
Berechnung von Behältern und Apparaten aus Thermoplasten - Schweißflansche, Schweißbunde, konstruktive Details
DVS 2206 1975.11 (en)
Prüfung von Bauteilen und Konstruktionen aus thermoplastischen Plastics
DVS 2207-1 1995.08
Schweißen von thermoplastischen Plastics - Heizelementschweißen von Rohren, Rohrleitungsteilen und Tafeln aus PE-HD
DVS 2207-5 1993.02
Schweißen von thermoplastischen Plastics - Schweißen von PE-Mantelrohren - Rohre und Rohrleitungsteile
DVS 2207-5 Beiblatt 1 1997.07
Schweißen von thermoplastischen Plastics - Schweißen von PE-Mantelrohren - Formstücke und Absperrarmaturen
DVS 2208-1 1997.12
Schweißen von thermoplastischen Plastics - Maschinen und Geräte für das Heizelementstumpfschweißen von Rohren, Rohrleitungsteilen und Tafeln
DVS 2210-1 1997.04
Industrierohrleitungen aus thermoplastischen Kunststoffen - Projektierung und Ausführung - Oberirdische Rohrsysteme
DVS 2211 1979.11 (en)
Schweißzusätze für thermoplastische Kunststoffe - Geltungsbereich, Kennzeichnung, Anforderung, Prüfung
E DVS 2208-1 1995.08
Schweißen von thermoplastischen Plastics - Maschinen und Geräte für das Heizelementstumpfschweißen von Rohren, Rohrleitungsteilen und Tafeln

Appendix E - Standards and guidelines

Alphabetical index

Alphabetical index

T

U

V

W

Z

akatherm

Index of article numbers

Index of article numbers

Index of article numbers

Index of article numbers

Index of article numbers

akatherm

Index of article numbers

Index of article numbers

akatherm

Index of article numbers

Index of article numbers

Index of article numbers

akatherm

Index of article numbers

Index of article numbers

akatherm

Index of article numbers

Index of article numbers

akatherm

Index of article numbers

Index of article numbers

General conditions Akatherm BV

1. Applicability

These General Terms and Conditions apply to all offers made by and/or agreements with Akatherm, at Panningen, Helden Municipality, The Netherlands, hereinafter referred to as Akatherm. Applicability of the purchaser's Terms and Conditions, including their Purchase Terms and Conditions are explicitly excluded, unless Akatherm has accepted in part or in whole in writing the applicability of the purchaser's Terms and Conditions.

2. Acceptance

All offers from Akatherm shall be without obligation, unless expressly stated otherwise in the offer. Agreements shall only be deemed to be effective from the moment that they are accepted or confirmed in writing by Akatherm.

3. Delivery

3.1 Unless explicitly otherwise agreed deliveries will take place ex works (EXW), at Panningen, the Netherlands, from which moment onwards the goods will be at the purchaser's risk. All delivery conditions shall apply in accordance with the Incoterms 2000.

3.2 Delivery periods shall be laid down per transaction. The delivery period shall commence from the moment the acceptance or confirmation of the order is sent by Akatherm, in accordance with Article 2. If the Purchaser has to put documents at the disposal of Akatherm in order to execute the Agreement, the delivery period shall commence from the moment Akatherm has received the documents from the Purchaser.

3.3 The agreed delivery period can never be regarded as a deadline unless explicitly otherwise agreed in writing. On overdue deliveries, Akatherm should be given a notice of default giving them a reasonable further period to fulfil their obligations. Should they again fail to deliver the goods, the purchaser may cancel the agreement, provided Akatherm is in default. However, Akatherm will never be liable to pay damages with respect to direct or consequential losses save for gross negligence or intentional acts or omissions.

4. Packaging

The Products shall be delivered in packaging material suitable for road transport, at no extra cost. The Purchaser shall not be required to return the packaging material, unless agreed otherwise in writing.

5. Prices

5.1 Prices are ex works (EXW, Incoterms 2000) at Panningen, the Netherlands, including packaging in accordance with clause 4 and excluding VAT and other levies by the authorities, unless otherwise agreed in writing. The prices are expressed in Euro (e).

5.2 Prices shall be based on exchange rates between domestic and foreign currencies, wage costs, raw materials prices, import duties, taxes and other levies, current at the time of the Agreement coming into effect.

5.3 If changes occur in one or several of the factors stated in Article 5.2 as a result of extraordinary circumstances before the delivery of has been made, Akatherm shall be entitled to make reasonable price alterations.

5.4 If the agreed final delivery date is exceeded, price increases made after said delivery date shall not be for the Purchaser's account, unless the delayed delivery is due to circumstances out of the control of Akatherm.

6. Payment

6.1 Unless agreed otherwise, payment shall be due within 30 days of the invoice date. Payment shall be made in full, in Euro and without claiming any compensation, to a Dutch bank in the Netherlands.

6.2 If it is agreed to use a letter of credit (L/C) as a means of payment, the letter of credit shall be a confirmed, irrevocable letter of credit in favour of Akatherm. The letter of credit shall cover the total contract price and shall be obtained by the Purchaser from a major bank within 15 days of the Agreement coming into effect, in accordance with Article 2. Confirmation shall be given by a Dutch bank. The letter of credit shall be subject to the 'Uniform Customs and Practice for Documentary Credits, 1993 Revision', ICC publication no.500.

6.3 Without prejudice to further rights of Akatherm, arising from legislation or the Agreement, the Purchaser shall, in the event of failure to make timely payment, be deemed, without any notice of default or judicial intervention, to be in default, and interest over the amount due shall be charged, equal to the legal interest rate laid down by De Nederlandsche Bank, plus 3%.

6.4 All judicial costs and extra-judicial costs in connection with debt-collection incurred by Akatherm due to untimely payment by the purchaser, including the fees of third parties engaged by Akatherm for the collection of the claim, shall be for the purchaser's account.

7. Security

7.1 Akatherm shall be entitled, before delivery or continuing delivery, to stipulate that sufficient security for the fulfilment of the payment obligations is provided, or payment is made in advance by the Purchaser.

7.2 If the Purchaser refuses to provide the required security, Akatherm shall be entitled, without intervention by a judge, to consider the Agreement as cancelled, and compensation shall be received for any loss and/or damages suffered by Akatherm.

8. Reservation of ownership

8.1 All sold and delivered products shall remain the property of Akatherm until all claims, including collecting charges and interests, Akatherm have on the Purchaser, for whatever reason, have been paid by the Purchaser to Akatherm.

8.2 Until the property is transferred to the Purchaser, he shall not be entitled to transfer ownership of said products, either in their original form, treated or processed, to third parties. Nevertheless, the Purchaser shall be authorised to sell the products on to third parties in the normal execution of his business activities. The Purchaser shall always cooperate to ensure that Akatherm is able to exercise it's right of ownership.

9. Quality

Deliveries shall be made in accordance with the agreed specifications. Akatherm shall ensure that the products it supplies comply with the legal safety regulations and approval specification of the country of destination, at the time of delivery.

10. Complaints

10.1 Within 14 days of the Purchaser receiving the products, the Purchaser should check the products and inform Akatherm immediately in writing, stating the order date, invoice number and article number, of any complaints with respect to the quality or quantity of the products. Faults, which can only be detected at a later date, should be brought to the attention of Akatherm within 14 days of the faults being detected. If the Purchaser fails to take the aforementioned into consideration, he shall lose any claim he has on Akatherm with respect of said faults.

10.2 Complaints shall not defer the Purchaser's payments obligations, unless Akatherm expressly gives the Purchaser its consent in writing.

10.3 The products can only be returned for the account and risk of Akatherm after it has expressly given its consent in writing.

11. Guarantee

11.1 Akatherm shall give a 6 month guarantee on the products from the moment of commissioning. If and in so far as the products do not meet the agreed quality standards, Akatherm shall, at its own discretion, either replace the products in question, or take back the products, depending on the extent to which the delivery does not comply with the agreed standards, and credit the purchase price to the Purchaser, provided that the Purchaser has complained within the guarantee period, in accordance with Article 10.

11.2 Akatherm's liability to the purchaser and/or its customers with respect to the products supplied to the purchaser is limited to fulfilling the obligation set out in clause 11.1. Akatherm is not liable for consequential damage or subsequent damage for whatever reasons or whatever nature.

11.3 The purchaser will indemnify Akatherm against claims of third parties with respect to damages in relation to or resulting from the goods supplied by Akatherm.

11.4 All claims on the guarantee shall become null and void if the products are not kept/or handled in accordance with the regulations belonging to the products.

12 Issued information, advice and standards

Information on the processing and use of the products, technical advice and any other data, issued by Akatherm, is correct to the best of its knowledge. Akatherm shall not accept any liability for data it issues. A reference to standards shall only serve as a description of the products, and therefore is not a guarantee obligation towards the Purchaser.

13. Industrial property

13.1 Akatherm shall expressly reserve all rights it has with respect to industrial and intellectual property regarding the products and/or documentation it supplies.

13.2 The Purchaser shall not be permitted to partially or completely alter delivered products, or affix a different brand name to said products, unless consent is expressly given in writing.

14. Force majeure

14.1 Should Akatherm not or partly not be able to fulfil its obligations under the respective agreement as a result of facts and circumstances that are reasonably beyond its control, Akatherm will be entitled to temporarily suspend its obligations towards the purchaser under the respective agreement until these circumstances or facts have ceased to exist. Should these facts or circumstances last for longer than six months, or are reasonably expected to continue, Akatherm will be entitled to cancel in part or in whole

the respective agreement without any judicial intervention, without being obliged to pay any compensation to the other party. Immediately after a force majeure situation has occurred, Akatherm should inform the purchaser of this.

14.2 Included in the facts and circumstances as meant in clause 14.1 are for instance war or similar situations, a state of siege, riots, sabotage, boycott, epidemics, natural disasters or lightning strikes, ¢re, explosion and leaching of dangerous substances or gases. This also includes work strikes, occupation, blockade, machine breakdown and other business interruptions at Akatherm and/or its suppliers, transport interruption, failure by suppliers and/or haulage companies and measures by the authorities (including a foreign authority) such as a prohibition on transport, import, export or manufacturing and moreover all other matters caused outside the fault or sphere of risk of Akatherm.

15. Applicable law

All offers by and/or agreements with Akatherm and the obligations arising from said offers and/or agreements, to which these Terms and Conditions partially or completely apply, shall only be subject to Dutch law.

16. Settlement of disputes

All disputes between parties, which cannot be resolved in mutual consultation, shall, at the discretion of Akatherm be adjudicated by the competent Dutch judge in the district where Akatherm has its
registered office.

17. Headings

Headings placed at the top of each clause serve exclusively to make reading easier. No meaning as to their contents should be given to these headings and in particular they have no effect on the nature and extent of the mutual rights and obligations.

18. Conversion

Should a provision of an agreement or these conditions be regarded as null and void, or be annulled, the parties will be bound to a provision which is, as far as is possible, of like tenor and which is not subject to annulment.