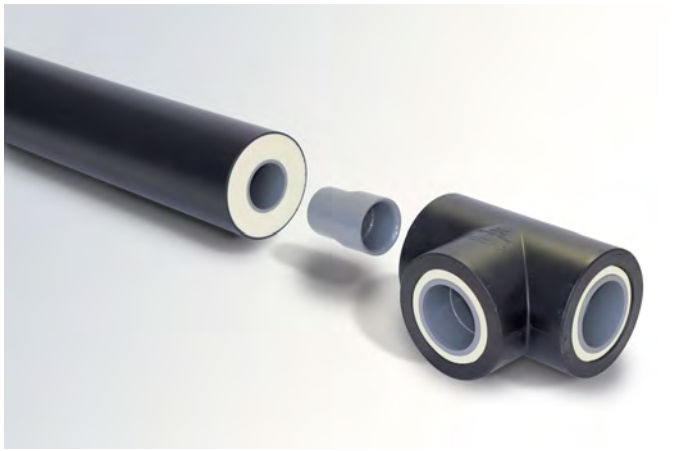
COOL-FIT® Engineering Information

General information

COOL-FIT is a complete system solution for secondary cooling and refrigeration piping systems. The system is based on the tried and tested COOL-FIT ABS plastic system from GF Piping Systems which contains pipe, fittings, valves, and transition fittings, now with the option for pre-insulated pipe and fittings with black outer jackets.



Refrigeration and cooling plants in general using plastic pipe as the carrier system offer complete corrosion resistance and a cost effective solution compared to traditional metal materials.

Pipe
COOL-FIT pipe and fittings are available in three versions:

- COOL-FIT ABS: standard un-insulated, to be insulated on-site with traditional insulation
- COOL-FIT ABS Lite: pre-insulated with Armaflex®
- COOL-FIT ABS Plus: pre-insulated with black jacket

Armaflex® is a registered trademark of Armacell Enterprise GmbH

Fittings
A complete range of fittings compatible to the pipe is also available either as standard or as insulated with black outer jackets.
The COOL-FIT ABS range contains shut-off valves, control valves, pneumatic and electric actuated valves, as well as a complete range of transition fittings for metal to plastic connections.

GF Piping Systems COOL-FIT ABS raw material
ABS is a material used in a wide range of general engineering applications from general housings for vacuum cleaners to car bumpers. GF Piping Systems COOL-FIT ABS raw material has been specifically developed for long-life pressure bearing piping systems. For physical properties see EN ISO 15493 and/or ASTM F2806 and chapter "The material ABS." Acrylonitrile Butadiene Styrene (ABS) is a styrene acrylonitrile copolymer grafted to polybutadiene to produce a homogeneous material with excellent impact and low temperature characteristics. ABS is halogen free with a low thermal conductivity and non-toxic. COOL-FIT ABS has a range of internationally recognized approvals. Please ask if you require any details regarding approvals or raw material properties.

PUR insulation
COOL-FIT ABS Plus pre-insulated pipe and fittings are delivered ready to install using high density PUR $\geq$ 45 kg/m³ as the insulation material. PUR is CFC free and recyclable.

Jacket pipes in black
The outer jacket in black is manufactured from high density polyethylene (PE). PE offers extremely good impact resistance and a good resistance to oil splashes and grease or other external contamination. The PE is smooth, non-corroding, and easy to clean with a long life-span. Black PE is UV resistant and ideally suited to outdoor applications and for general use.

Typical working conditions
Working temperatures range from:

- -58°F to +104°F (-50°C to +40°C) for pre-insulated COOL-FIT ABS Plus
- -58°F to +140°F (-50°C to +60°C) for the standard COOL-FIT ABS system and COOL-FIT ABS Lite

and with a maximum working pressure of 150 psi/10 bar (water at +68°F/+20°C) pre-insulated ABS.

Typical mediums
COOL-FIT can be used, for example, with the following mediums:

- chilled water and general water
- salt solutions
- glycol solutions
- alcohol solutions

For compatibility of ABS to non-water mediums, please consult GF Piping Systems.

Note: ABS is not for use with primary gases such as Ammonia, Propane, R407, R22, and also not for use for compressed air systems.

Application areas:
Dairies, slaughter houses, meat processing, industrial cooling water, breweries, food production, fish industry and air conditioning.

ABS technical information and installation details are available separately on request.

GF offers technical support during the planning phase and on-site training and certification for joining and handling; please contact GF for details.

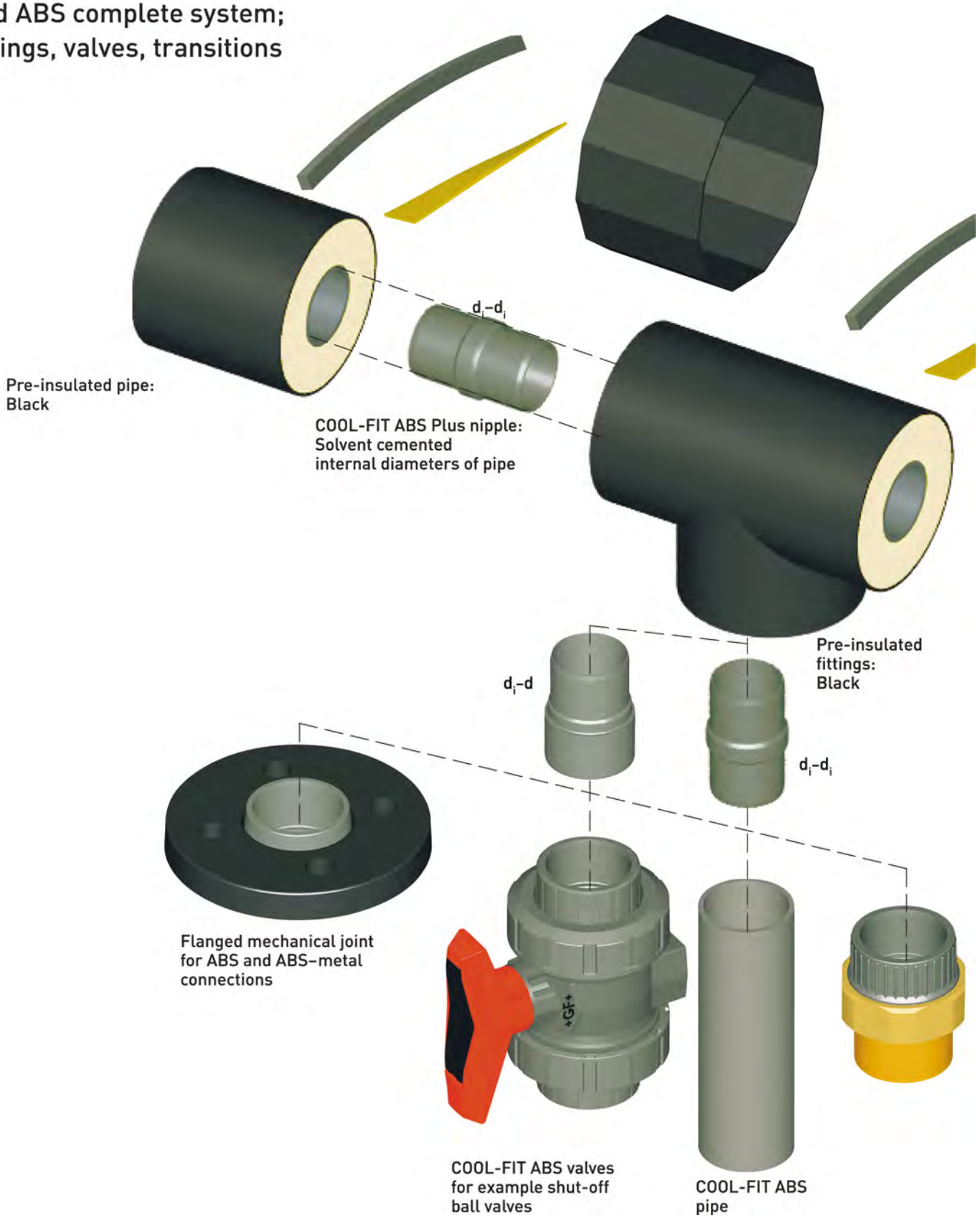
COOL-FIT Top quality

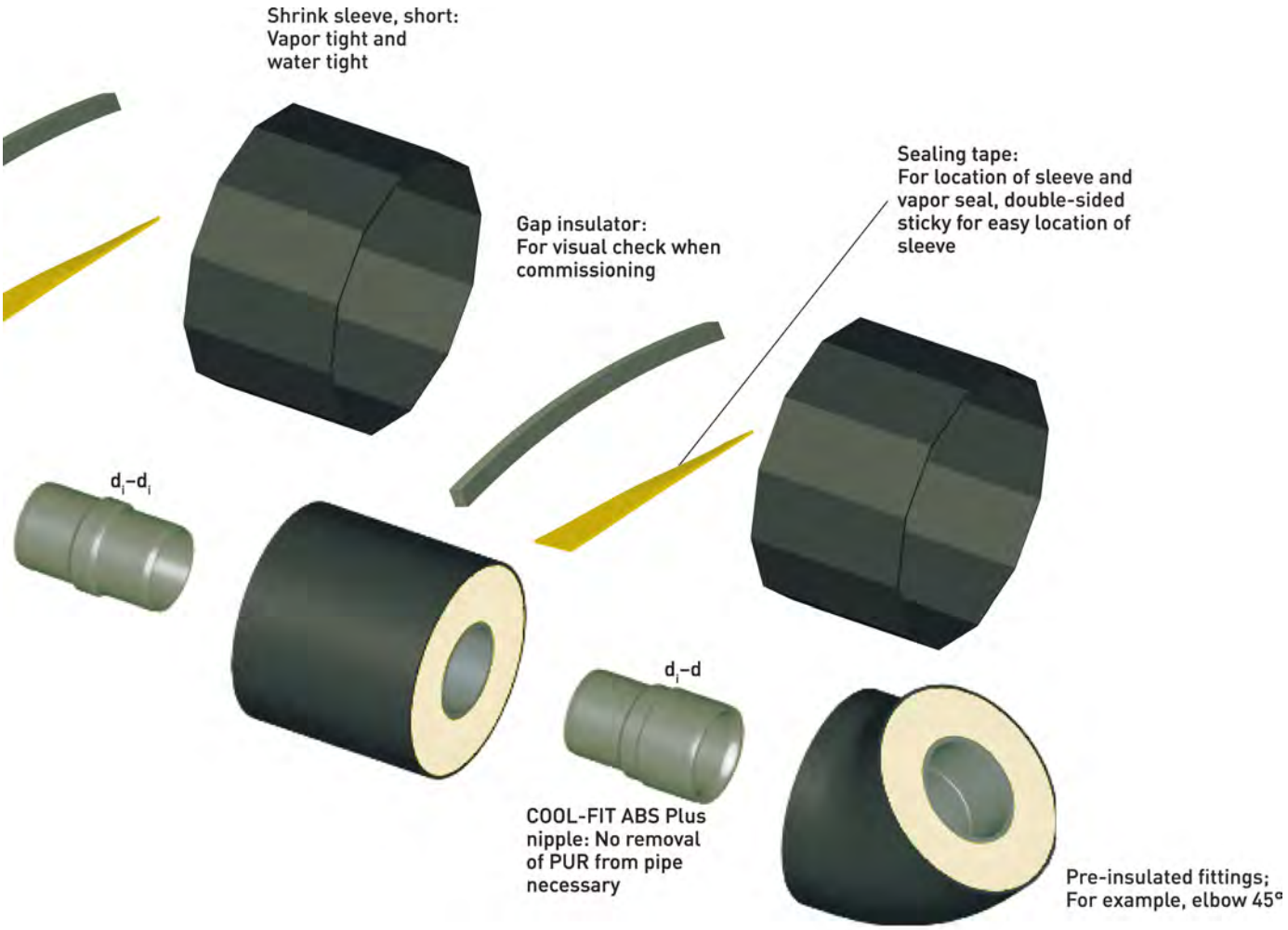
Minimum on site time

P1101887

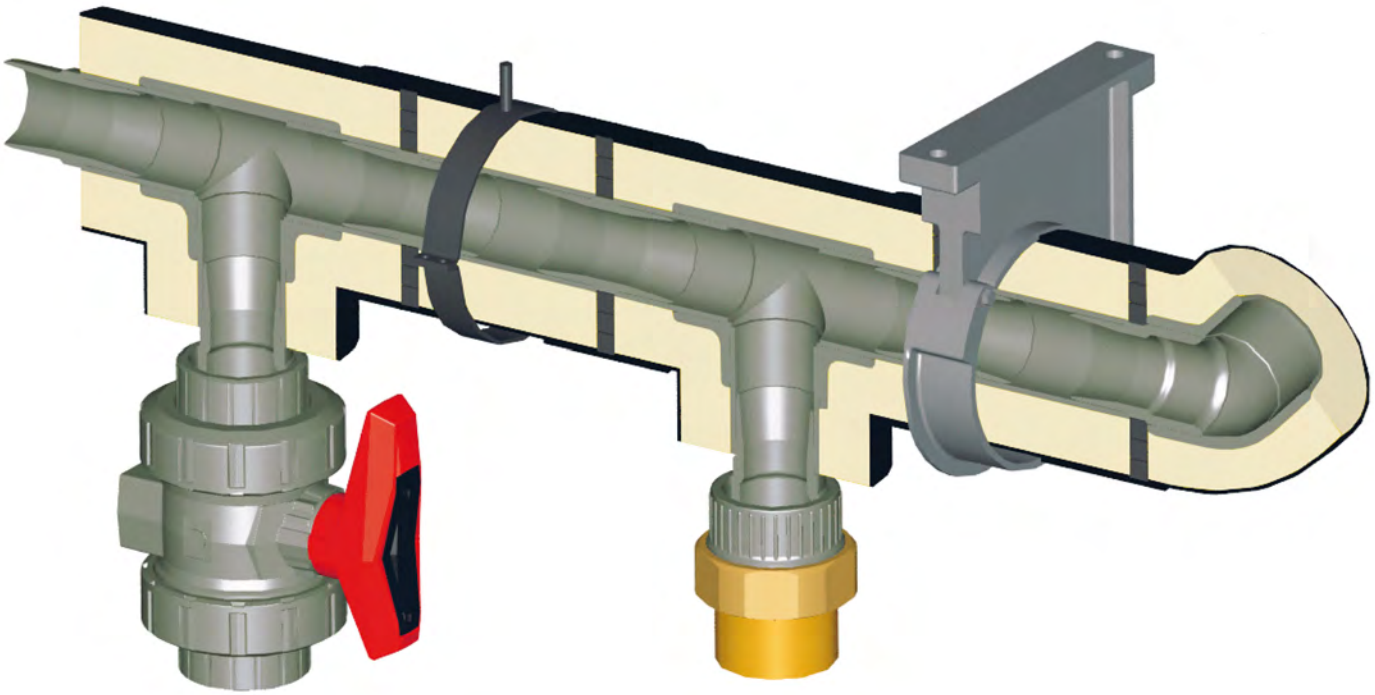
COOL-FIT® for Secondary Cooling Systems and Refrigeration

Pre-insulated pipe and fittings
Standard ABS complete system;
Pipe, fittings, valves, transitions




Shrink sleeve, short:
Vapor tight and
water tight
Sealing tape:
For location of sleeve and
vapor seal, double-sided
sticky for easy location of
sleeve
Gap insulator:
For visual check when
commissioning
d_i–d_i
d_i–d
COOL-FIT ABS Plus
nipple: No removal
of PUR from pipe
necessary
Pre-insulated fittings;
For example, elbow 45°
Transition unions:
Copper–ABS with O-ring
for reliable sealing,
stainless steel and threaded
connections also available

System advantages: Your benefit



Speed
Fittings and pipes are delivered direct to the site ready to install. Simple installation technique uses speedy solvent cementing with no need to remove the PUR using internal diameter joining fittings. Time and cost saving handling due to the low weight of plastics.

Zero corrosion
No maintenance, reduced downtime, constant long-term efficiency.

Reduce costs for your hanging system
Simplified pipe supports on outer jacket, no need for special refrigeration pipe hangers. Preinsulated pipe requires about 30% fewer hangers than standard plastic pipe. Lower weight compared to metals means lower structural costs. 0.02 to 0.08 mm/m K expansion coefficient helps simplify pipeline design.

Top efficiency
Save energy, thermal conductivity 0.026 W/m K. PUR density ≥ 45 kg/m³ with standard thickness of 35 mm for excellent insulating properties. Smooth pipes: no encrustation, low pressure drops, no energy bridges due to support on outer jacket.

Reliability
Quality: GF Piping Systems products is the number 1 Plastics Industrial Piping system manufacturer in the world. Tried and Tested jointing technique with gap filling solvent cement COOL-FIT Cement.

Innovative and clever
Developed for your needs. Internal pipe connections means no need to remove the PUR insulation from the pipe or fitting.

Outdoor and indoor systems:
Vapor-sealed black shrink sleeve for 100% vapor sealing, 100% water-tight system.

Hygienic and aesthetic
Top quality in performance and looks. Smooth outer surfaces for hygienic environments. No detrimental effects under high pressure cleaning.

Full technical design supports
See www.cool-fit.georgfischer.com for online calculations of energy losses, temperature differences and more. CAD libraries for accurate and quicker drawing. Specialist guidelines for design and installation and design of venting equipment, measuring equipment, transitions.

Full technical support during installation
On-site advice and joining technique training. Training video for ABS joining technique.

Sustainability
Reduce the carbon footprint of your plant and factory with recyclable plastics. Lower ODP and GWP values compared to traditional metal systems.

System Specification

COOL-FIT ABS Metric Piping System

1 Scope
This specification covers requirements for the GF Piping Systems ABS intended for a wide range of applications including water and wastewater treatment as well as process cooling water and secondary refrigeration. The components of the ABS pipe system are in accordance with the following standards.

2 Acrylonitrile Butadiene Styrene Material
GF Piping Systems ABS pipes and fittings shall be manufactured from acrylonitrile butadiene styrene, ABS. The raw material used shall be material designed for use with pressure bearing piping systems with long term hydrostatic properties in accordance with EN ISO 15493 and/or ASTM F2806, as supplied by GF Piping Systems.

3 ABS Pipe
All ABS pipe shall be metric sizes manufactured in accordance with the requirements of EN ISO 15493, supplied by GF Piping Systems.

4 ABS Fittings
All ABS fittings shall be metric sizes manufactured by GF Piping Systems or equal, with dimensions and tolerances in accordance with ISO 727 and EN ISO 15493 and/or ASTM F2806. All threaded connections shall have pipe threads in accordance with the requirements of ISO 7.

5 ABS Valves
All ABS valves shall be metric sizes manufactured by GF Piping Systems or equal in accordance with EN ISO 16135 to 16138.

6 Solvent Cement Jointing and Installation
Should be in accordance with GF Piping Systems Guide to the Installation and Use of Plastic Pipelines.

Pre-insulated COOL-FIT ABS Plus Pipes and Fittings

1 Scope
This specification covers requirements for GF Piping Systems pre-insulated ABS pipes and fittings, intended primarily for use in refrigeration and cooling plants for the secondary piping systems. The system consists of preinsulated pipes and fittings using ABS carrier pipes and fittings, with insulation from PUR and outer jacket in PE. The components of the pre-insulated pipes and fittings are in accordance with the following standards.

2 ABS Carrier Pipe and Fittings
2.1 Raw Material
GF Piping Systems ABS pipes and fittings shall be manufactured from acrylonitrile butadiene styrene, ABS. The raw material used shall be a material for use with pressure bearing plastic pipe systems in accordance to EN ISO 15493 and/or ASTM F2806.
2.2 Physical Properties
The ABS carrier pipe and fittings shall be manufactured to metric sizes in accordance with the requirements of EN ISO 15493 and/or ASTM F2806, supplied by GF Piping Systems.

3 PUR Insulation
The insulating material shall be hard polyurethane foam, PUR, with a thermal conductivity, landa value, of $\leq$ 0.026 W/mK and a density of $\geq$ 45 kg/m³.

4 PE Outer Jacket
The outer jacket shall be manufactured from PE, high density polyethylene, black. Colours of the jacket shall be black to RAL 9004. The black jacket shall be UV resistant according to EN ISO 16871.

5 Solvent Cement Jointing and Installation
Should be in accordance with GF Piping Systems Guide to the Installation and Use of Plastic Pipelines.

COOL-FIT technical details

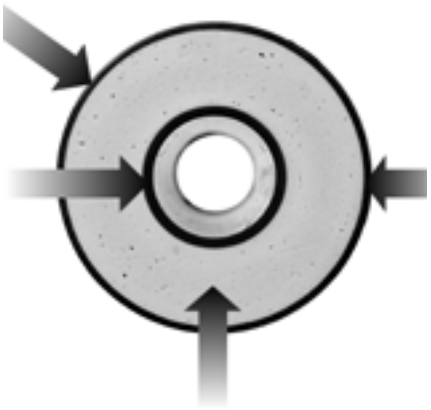
COOL-FIT ABS Plus pipe

COOL-FIT ABS Plus is produced using high grade ABS pressure piping raw material, in use for over 20 years together with high grade low temperature PUR produced in high density to offer optimal insulating qualities.

All three materials are bonded together deliberately to ensure expansion and contraction as one. COOL-FIT ABS Plus contraction coefficient: 0.02 to 0.08 mm/m K (the change in length must be calculated per installation).

Pipe specification
Product identification; PN 10, production date marking,
COOL-FIT ABS, product code

Carrier pipe ABS
150 psi rated, cement joined ABS plastic pipe. 5 meter (16.4 ft) lengths (d25 - d225).
ABS pipe to EN ISO 15493 and/or ASTM F2806.



Hard Polyurethane Foam (PUR)

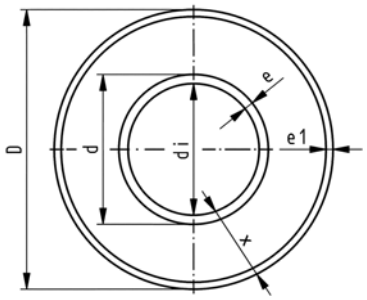
Jacket Pipe
Black RAL 9004, PE to DIN 8075.
Functional requirements on the basis of EN 253. Black is UV resistant.

Thermal Conductivity at 20°C	≤ 0.026 W/m K	Foamed using CO_2	-
Axial Shear Strength	≥ 0.12 N/mm²	Core density	≥ 45 kg/m³
Tensile Strength	≥ 0.2 N/mm²	Average Cell Sizes	max. 0.5 mm
Compressive Strength	≥ 0.3 N/mm²		

Carrier pipe ABS d x e	Carrier pipe ABS d_i	Jacket pipe PE D x e1	Weight (PE + ABS + PUR) lb/ft	Volume l/m	Pipe support distance ft	Heat transfer coefficient W/m K	Xmax - Xmin ≤ in mm
25 x 2.3	20.4	90 x 2.2	0.83	0.36	5.09	0.13	6
32 x 1.9	28.2	90 x 2.2	0.87	0.61	5.09	0.16	6
40 x 2.4	35.2	110 x 2.7	1.18	0.95	5.41	0.17	6
50 x 3.0	44.0	110 x 2.7	1.27	1.49	5.41	0.21	6
63 x 3.8	55.4	125 x 3.0	1.67	2.34	5.74	0.25	6
75 x 4.5	66.0	140 x 3.0	2.13	3.36	6.23	0.27	6
90 x 5.4	79.2	160 x 3.0	2.76	4.80	6.73	0.29	6
110 x 6.6	96.8	180 x 3.0	3.51	7.21	7.22	0.34	10
140 x 8.6	122.8	225 x 3.2	5.48	11.69	8.37	0.35	10
160 x 9.9	140.2	250 x 3.9	6.34	15.22	9.02	0.37	10
200 x 12.3	175.4	280 x 4.4	9.02	24.50	10.01	0.50	10
225 x 13.9	197.2	315 x 4.9	9.16	30.05	10.83	0.50	10
250 x 9.6	230.8	355 x 5.6	9.99	41.84	10.83	0.49	10
280 x 10.7	258.6	400 x 6.3	12.54	52.50	11.80	0.48	10
315 x 12.1	290.8	450 x 7.0	15.90	66.42	12.46	0.48	10

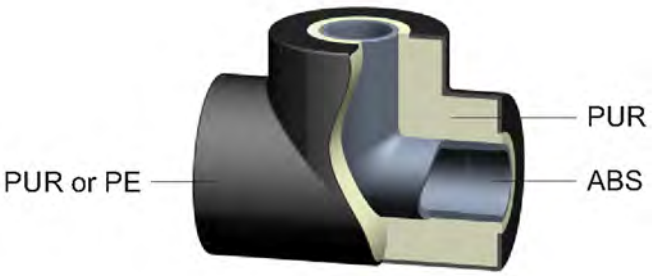
- COOL-FIT ABS Plus support distances are the same from -50°C to +40°C (-58°F to +104°F)
- d: nominal outside diameter of ABS pipe
- d_i: nominal internal diameter of ABS pipe
- D: nominal outside diameter of PE pipe
- e and e1: nominal wall thicknesses

- x: radial distance between outside diameter of PE pipe and inside diameter of ABS pipe

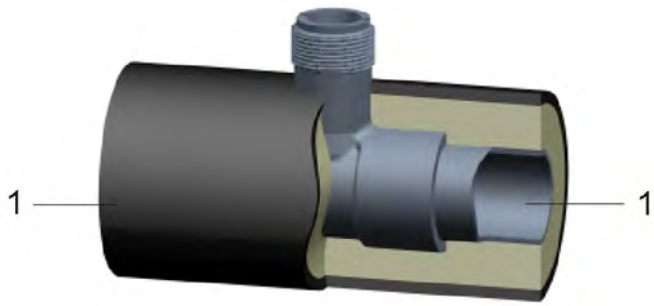


Pre-insulated ABS fittings

COOL-FIT ABS Plus Fittings are manufactured using the same raw materials as the pipe and are thus completely compatible with COOL-FIT ABS Plus pipe in terms of insulating properties and also joining technique.

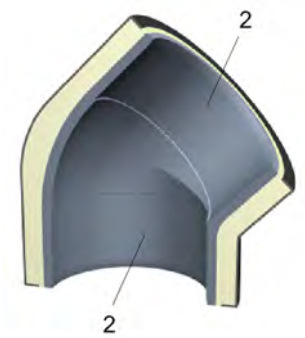


There are 2 types of pre-insulated ABS fittings, the d_i type and the d type. To cement d_i fittings to pre-insulated ABS pipe requires a d_i–d_i nipple.



1 ABS pipe end for d_i connection

d_i is the designation for a joint which takes place in the internal diameter of the pipe. d_i25 for instance refers to the internal diameter of d25 pipe.

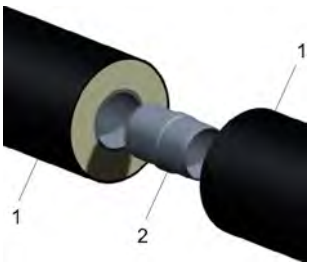


2 ABS socket fitting for d connection

d is the designation for a normal socket solvent cemented joint as per the standard GF Piping Systems ABS range.

The joining material and technique for d_i and d are the same, with the same cement and the same tooling.

Pre-insulated ABS pipe to pipe connections are achieved using the d_i–d_i pre-insulated ABS nipple, see diagram.



1 Pre-insulated ABS pipe
2 COOL-FIT ABS nipple d_i - d_i

Note: Dimensions from d_i140 (incl.) must be calibrated using the COOL-FIT calibration tool.

Accessory Equipment

COOL-FIT ABS Nipple
The nipple exists in three versions:

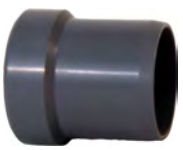
d_i - d_i

for pipe to pipe and pipe to d_i–d_i type fitting connections using the internal diameter of the pipes

d_i - d

for pipe to d_i–d type fitting connections

d red - d_i



to reduce diameter of the carrier pipe (Note: for dimensions d140 and above the COOLFIT ABS Calibration Tool is required before joining the internal diameters of the pipe).

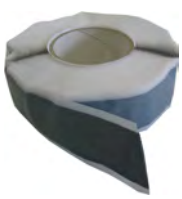
COOL-FIT ABS Calibration Tool

It is necessary to calibrate pipe in dimension d140 and above to allow joining using the ABS nipple. This tool calibrates the inside diameter of the pipe to an exact dimension to allow internal joining.

COOL-FIT Gap Insulator

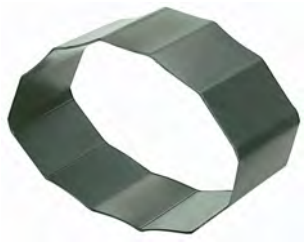
Width 13 mm and a lamda / heat conductivity of 0.04 W/m K, use of this insulation ensures nearly the same insulating properties in the gap as the pipe.

COOL-FIT Sealing Tape



A roll of 40mm wide, butylene rubber-based band. For a water- and steam-tight sealing of inspection gaps in combination with shrink sleeves or shrink sockets.

COOL-FIT Shrink Sleeve, short

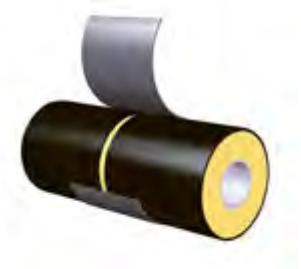


Used to vapor seal the control gap on the outer jacket between pipe and pipe or pipe and fitting. The sleeve is 100mm wide and can only seal equal dimensioned jackets. To ensure the proper functionality of the system, the shrink sleeve must be used in conjunction with the gap insulator and the butylene-rubber sealing tape. It can be shrunk with an open burner (soft, yellow flame) or alternatively with a powerful hot-air gun. For a long-lasting quality seal, GF recommends the use of the shrink sleeve.

COOL-FIT Shrink socket

Used to vapor seal the control gap on the outer jacket between pipe and pipe or pipe and fitting. The socket is 100mm wide and can therefore only seal equal dimensioned jackets. To ensure the proper functionality of the system, the shrink socket must be used in conjunction with the gap insulator and the butylene-rubber sealing tape. This heavy-duty version provides additional mechanical strength with regards to bending forces. It shrinks uniformly, resulting in a good visual appearance. It can be shrunk with an open burner (soft, yellow flame). For a long-lasting quality seal combined with high mechanical strength and good appearance, GF recommends the use of the shrink socket.

COOL-FIT Cold shrink tape



Used to vapor seal the control gap on the outer PE jacket between pipe and pipe or pipe and fitting. For indoor use only! It shrinks without the application of heat. The tape is 100mm wide and can therefore only seal equal dimensioned PE jackets. It is applied pulling firmly with an overlap of ca. 10 cm. To ensure the proper functionality of the system, the shrink tape must be used in conjunction with the gap insulator.

Use of other insulating and sealing methods such as tape is possible. Please consult the manufacturers of these materials for application instructions, insulating properties and lifespan.

Accessory Equipment for Solvent Cement Joining, Reducing Diameters and End Caps

COOL-FIT Cement and Cementing Equipment

The solvent cementing equipment is exactly the same for internal d_i joining as for standard d joining using COOL-FIT Cement.

COOL-FIT Shrink Sleeve, Long

This sleeve is 285 mm long, only to be used when sealing PE to PE outer jackets, not for use on ABS. For exact reducing possibilities, see below.

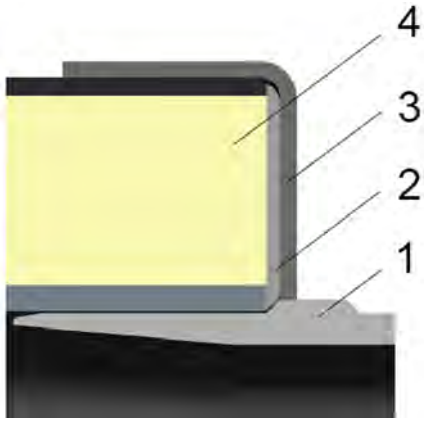
Shrink Sleeve, Long Reducing Diameters

The COOLFIT short shrink sleeve can only seal equal dimensions of PE outer jacket. The table below shows which dimensions can be sealed using which long shrink sleeve. NOTE: the sealing tape should be applied to both outer diameters of the PE pipes.

90	110	125	140	160	180	225	250	280	315
738.011.167									
					738.011.170				
							738.011.173		

End-Caps

Endcaps are to be used for sealing the PUR against any water ingress at the transition to ABS standard.



1 Connecting nipple (di-di)
2 Sealing mass
3 PE end cap
4 Pre-insulated pipe

Sealing the PUR should be achieved using a chemically compatible sealing mass to ABS.
GF Piping Systems offers a sealing mass. If silicon products are prohibited then nonsolvent based glues can be used. Chemical compatability can also be checked by GF Piping Systems.

Shrink cap

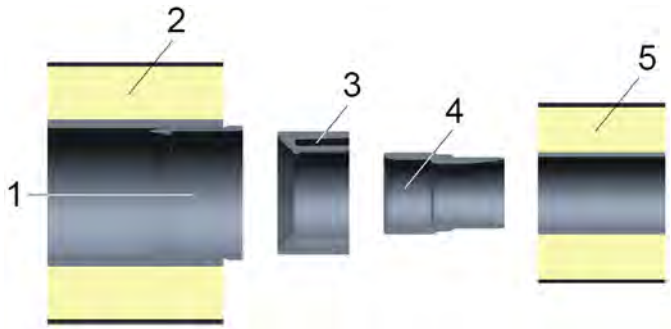
The shrink cap is only to be used to seal PE to PE, not to be used on ABS pipe. The flame used to shrink the sleeve may damage the ABS pipe.
Ideal for use with T90° reducers. For dimensions please refer to the product range. No separate sealing tape is required; the sealant is integrated into the cap.
If the length of the cap is longer than the surface to be sealed, then the cap can be cut back but without removing any sealant.

Reducing diameters

Reducing Pipe Dimensions for COOL-FIT ABS

To reduce the ABS carrier pipe diameter see diagrams below. The example below shows how the carrier pipe dimension is reduced from COOLFIT ABS Plus d90/ D160 (3"/6") to d50/D110 (1½"/4").

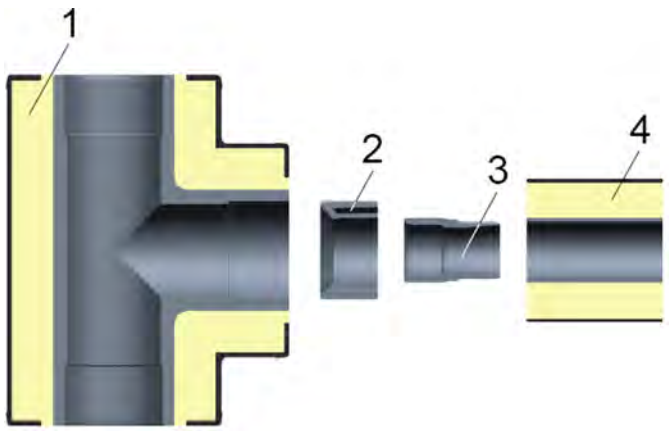
Note: The configuration below results in a gap twice as wide as usual (ca. 20 mm) and therefore twice the amount of gap filler is required.



1 COOL-FIT ABS Plus nipple di-d red., di90-d75
2 COOL-FIT ABS Plus pipe d90 / D160
3 ABS short reducer d75-d50
4 COOL-FIT ABS Plus nipple d-di, d50-di50
5 COOL-FIT ABS Plus pipe d50 / D110

Reducing from a d type COOL-FIT ABS Fitting to COOLFIT ABS Pipe

The d type fittings have a standard ABS d joint as the fitting connection and therefore the standard ABS short reducers can be used to reduce the diameter and then the d–di COOLFIT ABS nipple for the connection to the COOLFIT ABS pipe.



1 COOL-FIT ABS tee 90° equal, d75
2 ABS short reducer d75-d50
3 COOL-FIT ABS nipple d-di, d50-di50
4 COOL-FIT ABS pipe d50 / D110

Technical Data

General comments to plastics oriented pipeline design and installation

The design and installation of thermoplastic pipe systems requires designers and installers alike to take into account the fact that plastics have different physical characteristics to metal. Although GF Piping Systems COOL-FIT ABS and pre-insulated COOL-FIT ABS Plus are both very robust systems, nevertheless, care should be taken during handling and transport to avoid damage. Also thermoplastics have certain physical characteristics, such as a high expansion coefficient, which need to be taken into account in the design phase.

GF Piping Systems has been successfully developing and selling plastic pipe systems into a spectrum of high performance installations, such as highly concentrated chemicals, for over 50 years, and experience has shown that when engineers and installers take into account the advice given in our technical literature, plastics are an economical and reliable alternative to metals.

As a general rule for designing and installing plastics, one of the major differences is that plastics can and should be allowed to move after commissioning, i.e. move under the influence of temperature fluctuation and pressure changes. For instance, using pipe brackets that allow horizontal movement and not clamping the system in place is a must for plastic piping installations.

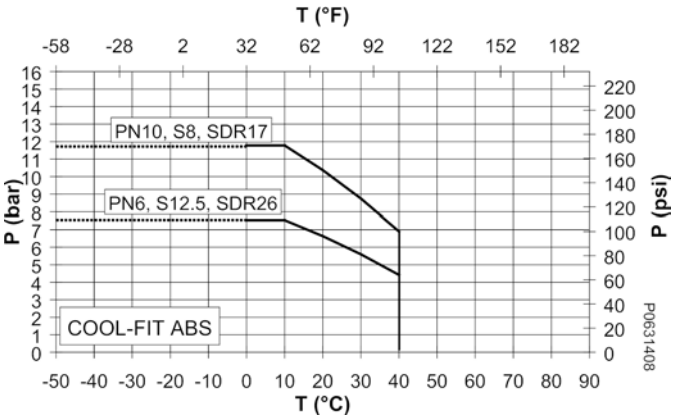
The following technical information covers the fundamental information required to ensure an economical and trouble free installation: Not all details, however, are published in this document; for more detailed information or if you have a specific question please ask your local GF Piping Systems company, consult www.coolfit.georgfischer.com or email us at info@coolfit.georgfischer.com for advice if you have any questions.

COOL-FIT ABS pressure-temperature diagram

Pressure ratings for thermoplastic pipe are always quoted for water at 68ºF/20ºC. It can be used at higher temperatures, but it is a fundamental principle in thermoplastic pipework that if the working temperature is increased, then the working pressure must be reduced.

The table below shows, for pre-insulated COOL-FIT ABS Plus pipes and fittings, the maximum permissible pressures at various temperatures up to the maximum allowable working temperature of 104ºF/+40ºC. The table is based on an ambient temperature of 68ºF/20ºC with water as the medium. A safety factor of 1.8 is incorporated into all calculations with a minimum life time of 25 years.

Pressure-temperature diagram for COOL-FIT ABS Plus pipes and fittings 25-years-values incorporating the safety factor (with water as medium).



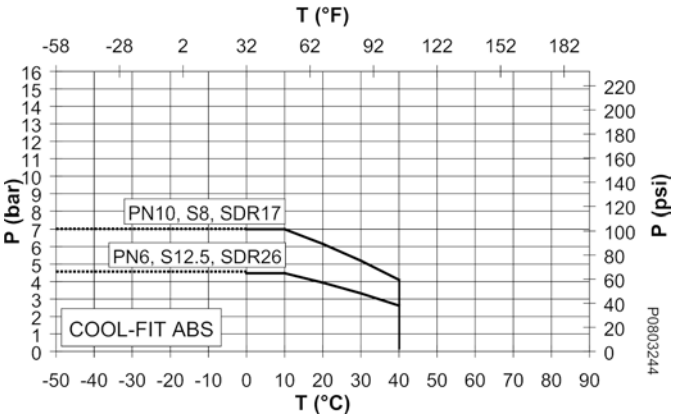
P Permissible pressure in bar, psi

T Temperature in °C, °F

For working temperatures below 32ºF/0ºC, an antifreeze has to be used in the water to prevent freezing. The above pressure temperature curve applies only when the medium is water, therefore for non pure water mediums a derating factor has to be applied to the above curve. This is standard procedure for all plastic piping systems.

Example: Water-diluted glycol
For example, if the medium is a water-diluted glycol solutions ≤ 50% (max. concentration allowable for ABS), then a derating factor of 0.6 applies to the standard pressure temperature curve. So at 14ºF/–10ºC for a minimum lifespan of 25 years, the maximum allowable working pressure is 0.6 x 174 psi = 104 psi.

Pressure-temperature diagram for COOL-FIT ABS Plus pipes and fittings 25-years-values incorporating the safety factor (with water-diluted glycol as medium).



P Permissible pressure in bar, psi

T Temperature in °C, °F

For more details regarding these derating values for chemical solutions or trade named products please consult GF Piping Systems.

Chemical resistance
ABS is generally resistant to most diluted inorganic acids, bases and salts and to most animal oils and fats. It is not resistant to organic solvents, pure alcohols, petrol, acetic acid and vegetable oils.

Please consult GF Piping Systems for detailed information regarding chemical resistance. GF Piping Systems offers written confirmation on material compatibility for all chemical applications.

Ice Slurry

Ice slurry is a mixture of ice particles (0.01– 0.03 mm width), water and an antifreeze agent, usually an alcohol, salt or glycol. GF Piping Systems has undertaken extensive testing of ice slurry with ABS and can give recommendations regarding for example pipeline layout, flow rates and pressure drops. Please ask your local GF Piping Systems representative for details.

Glycol Solutions
ABS can be used with glycol solutions (e. g. Antifrogen L, Dowfrost); however a derating factor applies to the standard water based pressure-temperature curve, see example.

Organic Salt Solutions
These mediums are usually potassium formate or acetate water based solutions, with low viscosities at low temperatures. Tradename examples: HYCOOL, TEMPER, TYFOXIT, ANTIFROGEN KF. ABS can be used with these types of mediums; however, a derating factor applies to the standard water-based pressure/temperature curve. Please consult GF Piping Systems for details. It is important that the complete pipe, irrespective of pipe system material is properly devented both during filling and commissioning. It is very important to follow the manufacturer's instructions for pipeline design and handling of these mediums.

COOL-FIT Online calculation tool

For further more detailed technical information as well as references and product range documentation please consult the COOL-FIT homepage or the GF Piping Systems homepage:
www.cool-fit.georgfischer.com
www.georgfischer.com

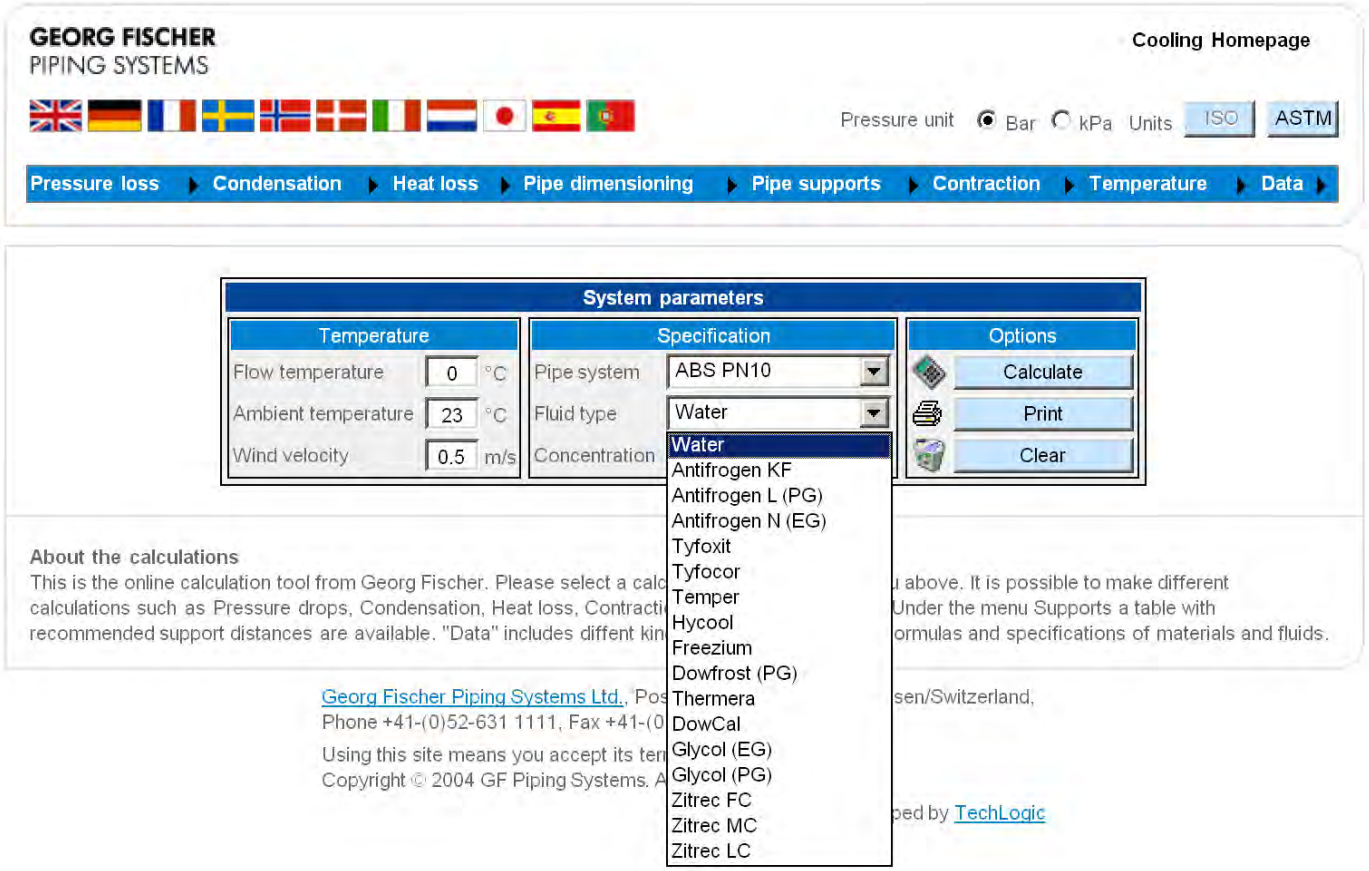
The COOL-FIT homepage offers a free of charge, real-time on-line calculation tool to calculate all the important characteristics of a piping system. Available in 9 different languages all the standard fluids and concentrations thereof on the market are available as options.

The planning engineer or consultant can thus calculate his core system parameters using this tool for COOL-FIT ensuring optimal dimensioning and design of the system.

Core functions which can be calculated are shown at the top of the menu, once chosen then the various sub-functions appear below in a drop-down menu. The core functions are: pressure drop, condensation, heat loss, pipe dimensioning, pipe support distances, contraction and temperature.

For example under the Pressure Drop function the user has 5 options. He can calculate individual products in all dimensions, for example pipe, fittings or valves. The network option allows the user to calculate the pressure drop in complete pipeline consisting of different dimensions and products. The last option, comparison, allows the pressure drop along COOL-FIT pipe to be compared to metal pipe (copper, stainless steel or steel). The surface roughness of the metal system can be entered individually, for example if the user would like to compensate for future encrustation and corrosion of the metal pipe.

Many other calculation options exist, including for example energy gain comparison calculation along a piping system, pipe dimensioning, temperature loss along a given piece of pipe etc. All available via the internet page.


GEORG FISCHER
PIPING SYSTEMS
Cooling Homepage
Pressure unit
Bar
kPa
Units
ISO
ASTM
Pressure loss
Condensation
Heat loss
Pipe dimensioning
Pipe supports
Contraction
Temperature
Data
System parameters
Temperature
Flow temperature
0
°C
Ambient temperature
23
°C
Wind velocity
0.5
m/s
Specification
Pipe system
ABS PN10
Fluid type
Water
Concentration
Water
Antifrogen KF
Antifrogen L (PG)
Antifrogen N (EG)
Tyfoxit
Tyfocor
Temper
Hycool
Freezium
Dowfrost (PG)
Thermera
DowCal
Glycol (EG)
Glycol (PG)
Zitrec FC
Zitrec MC
Zitrec LC
Options
Calculate
Print
Clear
About the calculations
This is the online calculation tool from Georg Fischer. Please select a calc
u above. It is possible to make different
calculations such as Pressure drops, Condensation, Heat loss, Contracti
Under the menu Supports a table with
recommended support distances are available. "Data" includes diffent kin
ormulas and specifications of materials and fluids.
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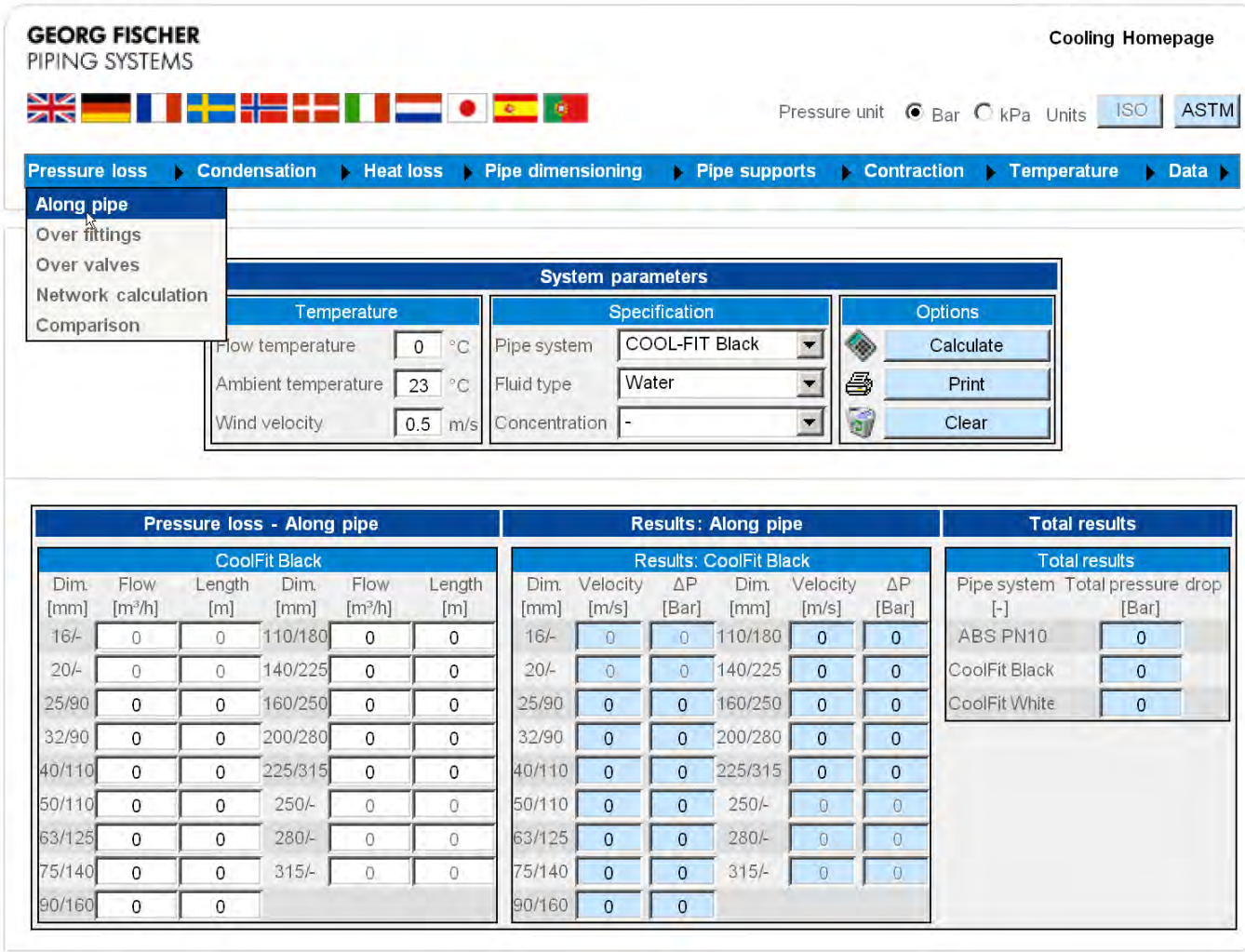
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PIPING SYSTEMS
Cooling Homepage
Pressure unit Bar kPa Units ISO ASTM
Pressure loss Condensation Heat loss Pipe dimensioning Pipe supports Contraction Temperature Data
Along pipe
Over fittings
Over valves
Network calculation
Comparison
System parameters
Temperature
Flow temperature 0 °C
Ambient temperature 23 °C
Wind velocity 0.5 m/s
Specification
Pipe system COOL-FIT Black
Fluid type Water
Concentration -
Options
Calculate
Print
Clear
Pressure loss - Along pipe
CoolFit Black
Dim. [mm] Flow [m³/h] Length [m] Dim. [mm] Flow [m³/h] Length [m]
16/- 0 0 110/180 0 0
20/- 0 0 140/225 0 0
25/90 0 0 160/250 0 0
32/90 0 0 200/280 0 0
40/110 0 0 225/315 0 0
50/110 0 0 250/- 0 0
63/125 0 0 280/- 0 0
75/140 0 0 315/- 0 0
90/160 0 0
Results: Along pipe
Results: CoolFit Black
Dim. [mm] Velocity [m/s] ΔP [Bar] Dim. [mm] Velocity [m/s] ΔP [Bar]
16/- 0 0 110/180 0 0
20/- 0 0 140/225 0 0
25/90 0 0 160/250 0 0
32/90 0 0 200/280 0 0
40/110 0 0 225/315 0 0
50/110 0 0 250/- 0 0
63/125 0 0 280/- 0 0
75/140 0 0 315/- 0 0
90/160 0 0
Total results
Total results
Pipe system [-] Total pressure drop [Bar]
ABS PN10 0
CoolFit Black 0
CoolFit White 0

The material acrylonitrile-butadiene-styrene (ABS)

ABS properties (reference values)

Characteristics	Value *)	Units	Test Standard
Density	≥ 1.035	g/cm³	ISO 1183-1
Yield stress at 23 °C	≥ 40	N/mm²	EN ISO 527-1
Tensile e-modulus at 23 °C	≥ 1600	N/mm²	EN ISO 527-1
Charpy notched impact strength at 23 °C	42	kJ/m²	EN ISO 179-1/1eA
Charpy notched impact strength at -40 °C	≥10	kJ/m²	EN ISO 179-1/1eA
Ball indentation hardness (358N/30s)	87	MPa	EN ISO 2039-1
Heat distortion temperature HDT A 1.82 MPa	≥ 74	°C	EN ISO 75-2
Vicat-heat distortion temperature B/50N	≥ 94	°C	ISO 306
Heat conductivity at 23 °C	0.17	W/m K	EN 12664
Water absorption at 23 °C	≤ 0.45	%	EN ISO 62
Colour	similar 7001	-	RAL
Limiting oxygen index (LOI)	19	%	ISO 4589-1

*) Typical values measured on the material. These values should not be used for design purposes.

General

Acrylonitrile-Butadiene-Styrene (ABS) is a versatile standard polymer. In addition to its application in piping systems, ABS is mainly common in automotive applications and in high-quality household devices.

The wide area of application relates to the versatile characteristic profile of ABS. It can be adapted to the application by varying the composition of its three components: acrylonitrile, styrene and polybutadiene.

While acrylonitrile provides strength to the material and gives ABS an improved chemical resistance relative to polystyrene, the styrenic component provides both strength and a quality surface finish. The chemically bound polybutadiene-rubber particles, on the other hand, give the material its toughness and impact strength, even at very low temperatures.

The ABS used by GF shows a good balance between toughness and strength, making it especially suitable for low temperature applications. Accordingly the areas of application are mainly refrigeration and air-conditioning systems as well as water treatment.

The advantages of ABS include:

- high impact strength even at low temperatures
- corrosion resistance
- simple installation via solvent cement joints
- low heat conductivity
- halogen free
- non-toxic
- biologically inert; no support of microbial growth
- low weight
- low pressure losses due to smooth surfaces
- good abrasion resistance
- problem-free recycling

Mechanical properties

In addition to the good strength and stiffness, ABS is especially characterised by a very high impact strength. Impact strength is a measure of impact energy that the material absorbs until it breaks. For this test, a specimen is weakened with a sharp notch and then struck. Without a notch, there is no breakage of the test specimen. The exceptionally high notched impact strength values, even at low temperatures, indicate the material's high robustness and tolerance against surface damage.

GF ABS pipes are routinely tested for their toughness according to EN ISO 15493 and/or ASTM F2806. In this test, a weight falling from a height of 2 meters (6.5 feet) hits the pipe that has been cooled to 32ºF (0ºC). The mass of the falling weight varies, depending on the pipe dimensions, from 1 (d_n = 20 mm) to 20 lb (d_n = 225 mm). The high load in the falling-weight test ensures that the excellent toughness of the material is not reduced as a result of processing into pipe.

The internal pressure resistance is provided by the hydrostatic strength curve based on the EN ISO 15493 and/or ASTM F2806 standard (also see the ABS Calculation and Long-Term Behavior section). The application limits for pipes and fittings, as shown in the pressure-temperature diagram, can be derived from these curves.

Chemical, weathering and abrasion resistance

ABS is characterised by its good resistance to various chemicals. In general, ABS is resistant to water, salt solutions and most dilute acids and bases. Its resistance to alcohols, aliphatic hydrocarbons, oils and greases is, however, to be regarded as limited. ABS is not resistant to concentrated mineral acids, organic acids and solvents such as esters, ketones and chlorinated and aromatic hydrocarbons. For detailed information, please refer to the detailed list of chemical resistance from GF or contact your local GF subsidiary.

If the ABS piping system is exposed to direct sunlight over a long period, its surface loses its shine and the colour shifts to light grey. Due to the very high impact strength of ABS, the resulting loss of toughness generally causes no problems in moderate climate zones. For extreme weather conditions or very high loads on the piping system, we nevertheless recommend protecting the surface from direct sunlight.

In addition to the excellent impact strength, the polybutadiene rubber particles in ABS cause an outstanding resistance against abrasion. Because of this, ABS piping systems have been used for a long time to transport solids and slurries, for example, in mining applications.

Experience has shown that ABS, as well as PE, offers considerable advantages over metal and other plastics for many such applications. Please contact GF if you are planning such an application. We would be glad to advise you about the suitability of our ABS, PE and other materials for your media.

Thermal properties

The outstanding characteristics of ABS allow its application in a wide temperature range between -58°F to +140°F (-50°C to +60°C). At higher temperatures, the tensile strength and stiffness of the material drop and at lower temperatures, they rise. Therefore, please consult the pressure-temperature diagram for your maximum working temperature.

As all thermoplastics, ABS shows a higher thermal expansion than metals. This is not a problem if the thermal expansion is taken into account during the planning stage of the piping system. The expansion coefficient amounts to 0.1 mm/m K in the application temperature range.

At 0.17 W/m K, the heat conductivity of ABS is very low. Because of the insulation properties of the material and the resulting savings in energy or insulation, an ABS piping system is notably more economical in comparison to a system made of copper (370 W/m K) or other metals.

Should there be a need for additional insulation, e. g. in cooling applications, GF offers COOL-FIT ABS Plus, a system specially dedicated to this market. COOL-FIT ABS Plus is a pre-insulated ABS system that has the advantage of quick and easy installation.

Combustion behavior

ABS self-ignites at temperatures exceeding 842ºF (450ºC). ABS burns when exposed to an open flame. After removing the flame, the material continues burning. The oxygen index amounts to 19%. (Materials that burn with less than 21% of oxygen in the air are considered to be flammable).

According to UL-94, ABS has a HB (Horizontal Burning) flammability coefficient and falls into building material class B2 (conventional inflammable, non-dripping) according to DIN 4102-1. Basically, toxic substances are released by all burning processes. Carbon monoxide is generally the combustion product most dangerous to humans. When ABS burns, primarily carbon dioxide, carbon monoxide and water are formed. Tests have shown that the relative toxicity of the products of combustion are similar or even lower than those of natural products such as wood, wool and cotton. ABS combustion gases are not corrosive. Nevertheless, the burning forms soot. Because of this, smoke develops during combustion. Water, foam and carbon dioxide are suitable fire-fighting agents.

Electrical properties

ABS has good electrical insulation capacity. The specific volume resistance is 3.5×10^{16} Ωcm and the specific surface resistance is 10^{13} Ω. These figures have to be taken into account wherever there is a danger of fires or explosion.

Physiological properties

The GF ABS is toxicologically harmless and biologically inert. Drinking water approvals in the UK (DWI) and in Germany (KTW) have been applied for.

Hydraulic calculation

What size should the pipe be?

Formulas

The following formula can be used for a first approximation of the pipe size required for a given flow rate:

$$d_i = 18.8 \sqrt{\frac{Q_1}{v}} \quad \text{or} \quad d_i = 35.7 \sqrt{\frac{Q_2}{v}}$$

where:

v	flow velocity in m/s
d_i	inside pipe diameter in mm
Q_1	flow rate in m³/h
Q_2	flow rate in l/s
18.8	conversion factor for units
35.7	conversion factor for units

The flow velocity must first be approximated according to the intended use of the pipeline. Standard values for the flow velocity are:

Liquids
v = 0.5-1.0 m/s for suction
v = 1.0-3.0 m/s for delivery

Gases
v = 10-30 m/s

The calculations of pipe diameter have not taken into account hydraulic losses. These require special calculations for which we offer the following information and recommendations.

Conversion table

m³/h	l/min	l/s	m³/s
1.0	16.67	0.278	2.78×10^{-4}
0.06	1.0	0.017	1.67×10^{-5}
3.6	60	1.0	1.00×10^{-3}
3600	60000	1000	1.0

The following example shows how to utilise the formulas:
PP pipe SDR 11
Flow rate Q_2 = 8 l/sec
Flow velocity v = 1.5 m/sec
Inside pipe diameter ? mm

$$d_i = 35.7 \bullet \sqrt{\frac{8}{1.5}} = 82.4\text{mm}$$

In this case a DN 80 or 3" pipe can be used.

After defining the outside diameter, the real flow velocity can be calculated with the following formula:

$$v = 354 \bullet \frac{Q_1}{d_i^2} = 1.9 \frac{m}{sec}$$

or

$$v = 1275 \bullet \frac{Q_2}{d_i^2} = 1.9 \frac{m}{sec}$$

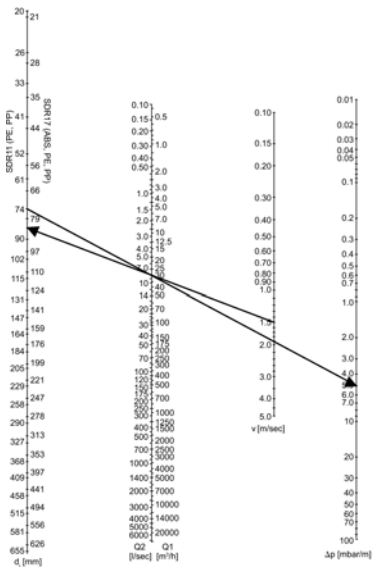
v	flow velocity in m/s
d_i	inside pipe diameter in mm
Q_1	flow rate in m³/h
Q_2	flow rate in l/s
354	conversion factor for units
1275	conversion factor for units

Nomogram for easy determination of diameter and pressure loss

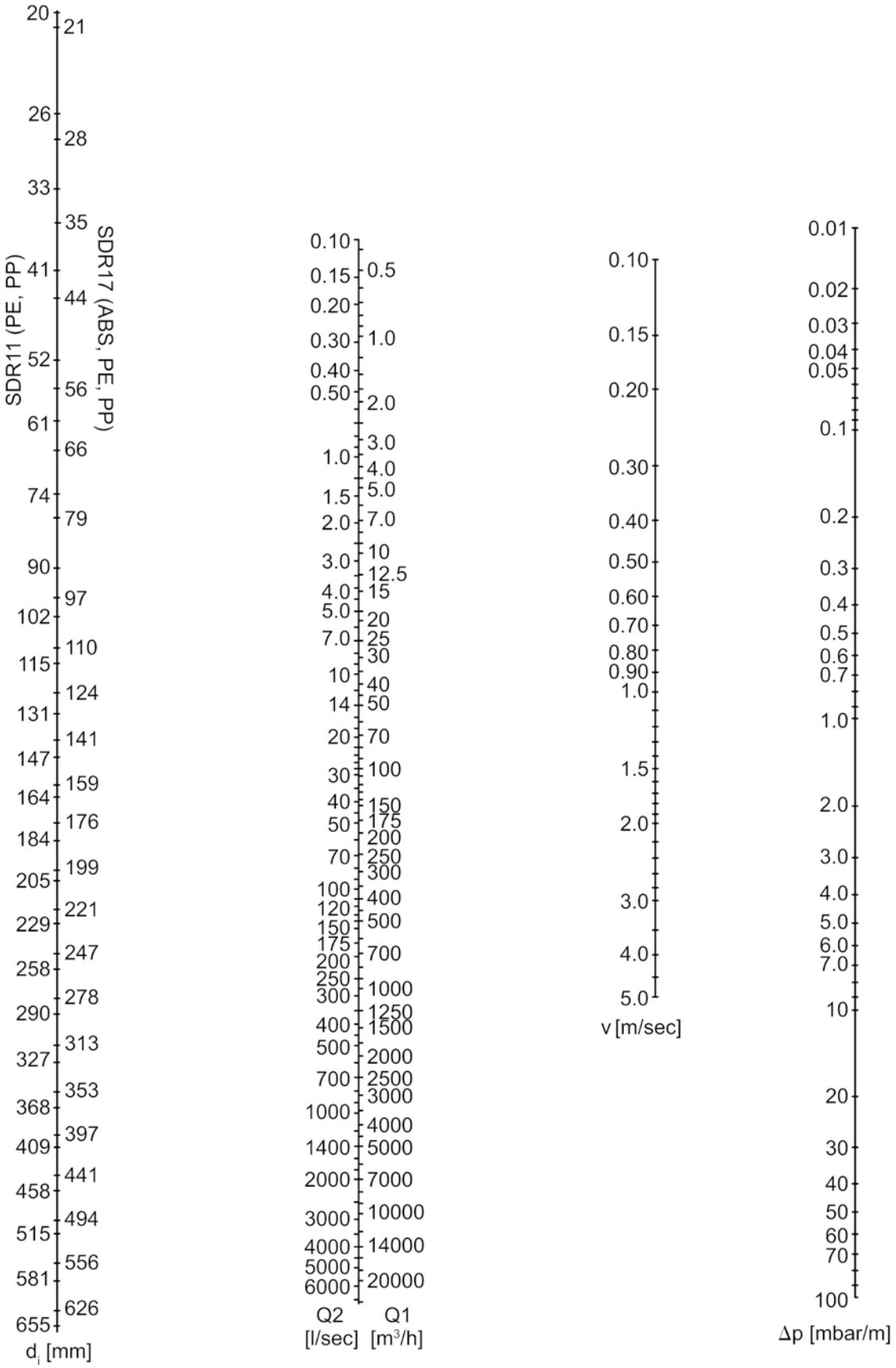
The following nomogram simplifies the determination of the required diameter. In addition the pressure loss of the pipes per meter pipe length can be read off.

Remark: The determined pressure loss from the nomogram applies only to a density of the flow medium of 1000 kg/m³, e. g. for water. Further pressure losses of fittings, valves, etc. have to be considered as shown in the following.

Example how to use the nomogram:
Starting with a flow velocity of 1.5 m/sec draw a line through the required quantity of flow (e. g. 30 m³/h) until you cut the axis of the inside diameter d_i (≈ 84 mm). Then select a diameter nearby (74 mm at SDR11) and draw a second line back through the same quantity of flow to the axis of the pressure losses Δp (5 mbar per meter pipe).



Nomogram for metric pipes (SDR11, SDR17)



Pressure losses

Pressure loss in straight pipes

When calculating the pressure loss in straight pipe lengths there is a distinction between laminar and turbulent flow. The important unit of measurement is the Reynold's number (Re). The changeover from laminar to turbulent flow occurs at the critical value, Reynold's number (Re) = 2320.

Laminar flow occurs, in practice, particularly in the transport of viscous media, i. e. lubricating oil. In the majority of applications, including media similar to water, a turbulent flow, having an essentially steady velocity in a cross-section of pipe, occurs.

The pressure loss in a straight length of pipe is inversely proportional to the pipe diameter and is calculated by the following formula:

$$\Delta p_R = \lambda \ \frac{L}{d_i} \ \frac{\rho}{2 \ 10^2} \ v^2$$

Note: In practice, when making a rough calculation (i. e. smooth plastic pipe and turbulent flow) it is enough to use the value λ = 0.02 to represent the hydraulic pressure loss.

where:

Δp_R	pressure loss in a straight length of pipe in bar
λ	pipe friction factor
L	length of the straight length of pipe in m
d_i	inside diameter of pipe in mm
ρ	density of transported media in kg/m³ (1 g/cm³ = 1000 kg/m³)
v	flow velocity in m/s

Pressure loss in fittings

Coefficient of resistance
The pressure losses depend upon the type of fitting as well as on the flow in the fitting. The so-called ζ-value is used for calculations.

Fitting type	Coefficient of resistance ζ	
90 ° bend	bending radius R	ζ-value
	1.0 * d	0.51
	1.5 * d	0.41
	2.0 * d	0.34
	4.0 * d	0.23
45 ° bend	bending radius R	ζ-value
	1.0 * d	0.34
	1.5 * d	0.27
	2.0 * d	0.20
	4.0 * d	0.15
90 ° elbow	1.2	
45 ° elbow	0.3	
Tee 90 ° *)	1.3	
Reduction (Contraction)	0.5	
Reduction (Extension)	1.0	
Connection (Flange, union, welding between two pipes)	d >90 mm: 0.1 20 ≤ d ≤ 90 mm: 1.0 to 0.1: d20: 1.0 d50: 0.6 d25: 0.9 d63: 0.4 d32: 0.8 d75: 0.3 d40: 0.7 d90: 0.1	

*) For a more detailed view differentiate between coalescence and separation. Values for ζ up to a maximum of 1.3 can be found in the respective literature. Usually the part of a tee in the overall pressure loss is very small, therefore in most cases ζ = 1.3 can be used.

Calculation of the pressure loss
To calculate the total pressure loss in all fittings in a pipeline take the sum of the individual losses, i. e. the sum of all the ζ-values. The pressure loss can then be calculated according to the following formula:

$$\Delta p_{Fi} = \Sigma\zeta \ \frac{v^2}{2 \ 10^5} \ \rho$$

where

Δp_{Fi}	pressure loss in all fittings in bar
Σζ	sum of the individual losses
v	flow velocity in m/s
ρ	density of the transported medium in kg/m³ (1 g/cm³ = 1000 kg/m³)

Pressure loss in valves

The k_v factor is a convenient means of calculating the hydraulic flow rates for valves. It allows for all internal resistances and for practical purposes is regarded as reliable.

The k_v factor is defined as the flow rate of water in litres per minute with a pressure drop of 1 bar across the valve.

The technical datasheets for valves supplied by GF contain the so-called k_v values as well as pressure loss diagram. The latter make it possible to read off the pressure loss directly. But the pressure loss can also be calculated from the k_v value according to the following formula:

$$\Delta p_{Ar} = \left(\frac{Q}{k_v} \right)^2 \bullet \frac{\rho}{1000}$$

where:

Δp_{Ar}	pressure loss of the valve in bar
Q	flow rate in m³/h
ρ	density of the medium transported in kg/m³ (1 g/cm³ = 1000 kg/m³)
k_v	valve flow characteristic in m³/h.

Pressure difference caused by static pressure

Compensation for a geodetic pressure difference may be necessary when a pipeline is vertically installed. The pressure difference can be calculated with the following formula:

$\Delta p_{geod} = \Delta H_{geod} \cdot \rho \cdot 10^{-4}$

where:

Δp_{geod}	geodetic pressure difference in bar
ΔH_{geod}	difference in elevation of the pipeline in m
ρ	density of media kg/m³ (1 g/cm³ = 1000 kg/m³)

Sum of pressure losses

The sum of all the pressure losses in the pipeline is then given by

$$\Sigma \Delta p = \Delta p_R + \Delta p_{Fi} + \Delta p_{Ar} + \Delta p_{geo}$$

Example for pressure loss calculation

The following example shows the calculation to determine the pressure loss of a pipeline:
PVDF-pipeline d40, SDR 21 with a quantity of flow of 1.5 l/sec, medium stannous chloride, density 1.9 g/cm³
Length of strait pipes: 15 m
Amount of fittings:
12 elbows 90°
4 elbows 45°
3 tees
3 unions
2 flange adapters
1 diaphragm valve, 30 % opened
Height difference 2.0 m

The **wall thickness** of this pipeline can be calculated with the SDR:

$$e = \frac{d}{SDR} = \frac{40mm}{21} = 1.9mm$$

The **inside diameter** of the pipeline is as follows:

$$d_i = d - 2 \bullet e = d - \frac{2 \bullet d}{SDR} = 36.2mm$$

With the required quantity of flow of 1.5 l/sec the **flow velocity** is as follows:

$$v = 1275 \bullet \frac{Q_2}{d_i^2} = 1275 \bullet \frac{1.5}{36.2^2} \frac{m}{sec} = 1.46 \frac{m}{sec}$$

Calculation of pressure losses
Pressure loss of strait **pipes**:

$$\Delta p_R = 0.02 \ \frac{15}{36.2} \ \frac{1900}{2 \ 10^2} \ 1.46^2 [bar] = 0.17bar$$

Pressure loss of **fittings** and **connections**:

$$\Sigma \zeta = (12 \ 1.2) + (4 \ 0.3) + (3 \ 1.3) + (5 \ 0.7) = 23$$

$$\Delta p_{Fi} = 23 \ \frac{1.46^2}{2 \ 10^5} \ 1900 [bar] = 0.47bar$$

Pressure loss of the **valve**, 30 % opened. With the flow characteristics diagram, type 314, and 30% lift a percentile kv-value of 50 % can be read out, that means 50 % of kv100 values: 0.5 * 21.2 m³/h (quantity of flow 1.5 l/sec = 5.4 m³/h):

$$\Delta p_{Ar} = (\frac{5.4}{0.5 \ 21.2})^2 \ \frac{1900}{1000} [bar] = 0.49bar$$

Pressure loss of **height difference**:

$$\Delta p_{geod} = 2.0 \ 1900 \ 10^{-4} [bar] = 0.38bar$$

Total pressure loss of the pipeline:
ΣΔp = 0.17 bar +0.47 bar + 0.49 bar + 0.38 bar
ΣΔp = 1.51 bar

Change in length and flexible sections

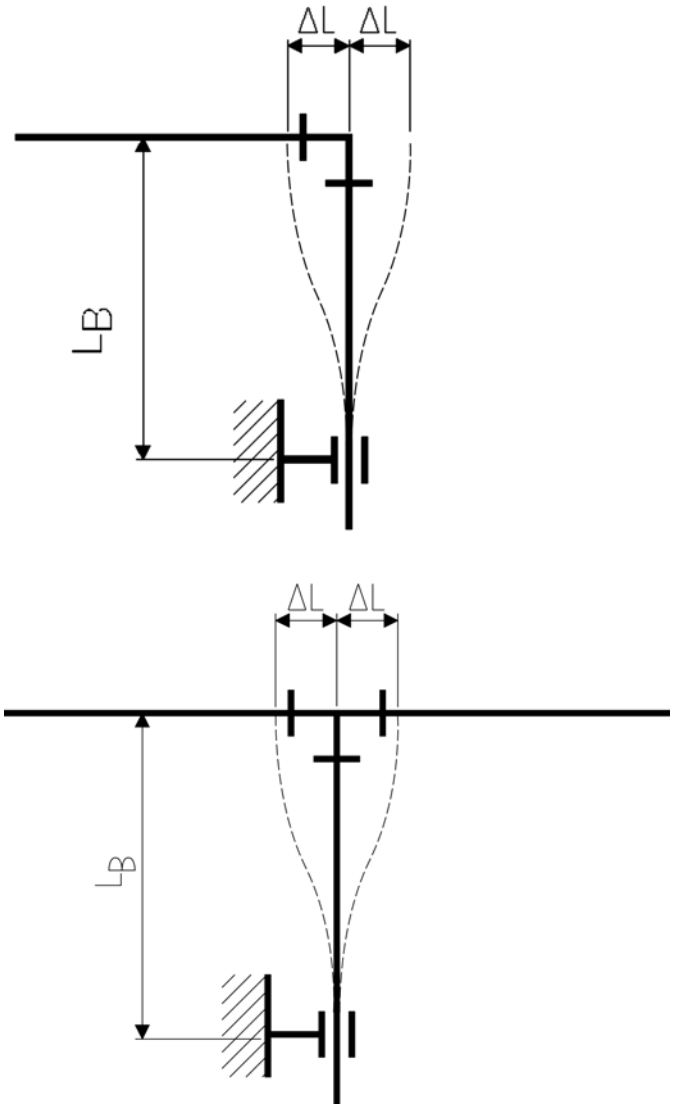
Introduction

General

Thermoplastics are subject to greater thermal expansion and contraction than metals. Pipes installed above ground, against walls or in ducts, especially those exposed to temperature variations, require changes in length to be taken up in order to prevent extra strain on the pipes. Length changes can be taken up by:

a) flexible sections
b) compensators

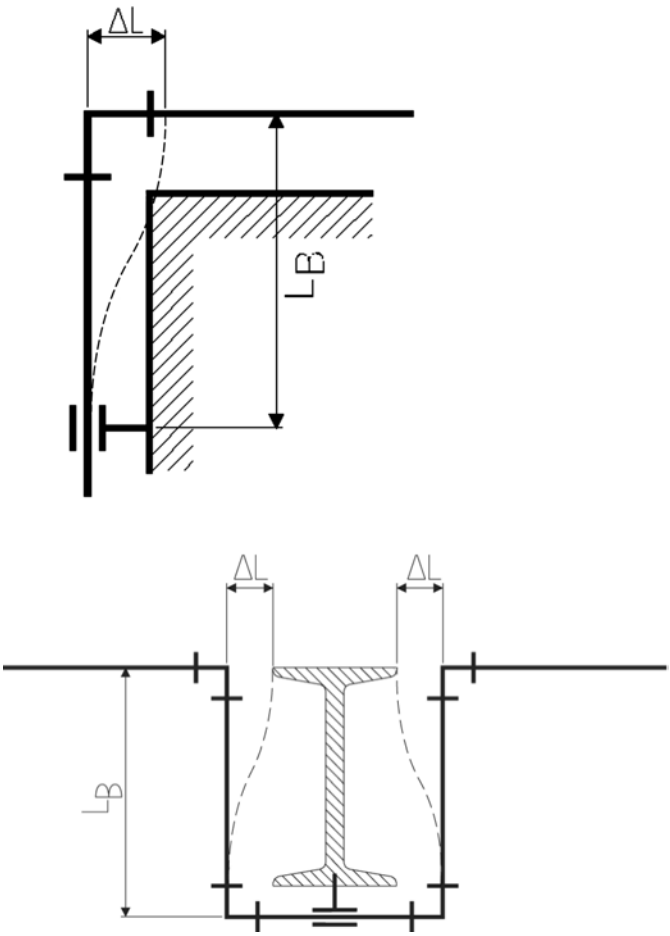
Flexible sections are the most common solution, being the simplest and the most economical. The calculations for and the positioning of flexible sections are therefore described in detail.



Fundamentals

The low modulus of elasticity of thermoplastics allows changes in length to be taken up by special pipe sections, where pipe supports are positioned so that they can take advantage of the natural flexibility of the material. The length of such sections is determined by the diameter of the pipeline and the extent of the thermal expansion to be compensated.

Flexible sections arise naturally at any branching or change in direction of the pipeline. The movement L_B of the flexible section as a result of a change ΔL in the length must not be restrained by fixed pipe brackets, protrusions wall, girders or the like.



Calculation of change in length

The **change in length caused by temperature** can be calculated using the following formula:

$$\Delta L = L \ \Delta T \ \alpha$$

with:

- ΔL = temperature-related change in length (mm)
- L = length of the pipe section (m)
- ΔT = difference of temperature (K)
- α = coefficient of linear expansion (mm / m K)

Coefficients of linear expansion of polymers:

Material	α in mm/m K
ABS	0.10
pre-insulated ABS	0.02 - 0.08*
PA	0.10
PB	0.13
PE	0.15 - 0.20
PP	0.16 - 0.18
PPS	0.15
PVC-U	0.07 - 0.08
PVC-C	0.06 - 0.07
PVDF	0.12 - 0.18

* Exact values can be calculated using GF's online tool (www.cool-fit.georgfischer.com) or ask your local GF representative.

Tip: If the operating temperature is higher than the installation temperature, then the pipe expands. If, on the other hand, the operating temperature is lower than the installation temperature, then the pipe contracts in length.

The installation temperature must therefore be incorporated into the calculations as well as the **maximum** and **minimum** operating temperatures.

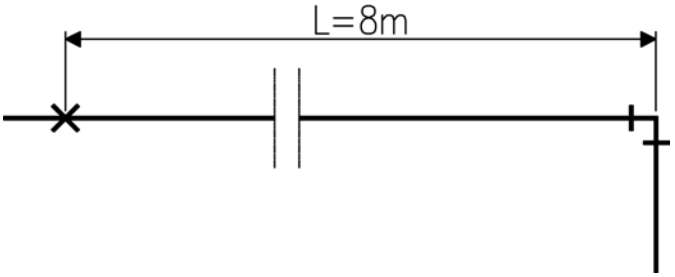
It is preferable to use "+" to indicate expansion of the pipe and "-" to indicate contraction.

The larger change in length is the one to be used for determining the required length of the flexible section.

Example: Determining the required flexible section

Calculating the relevant change in length
The example of an ABS process pipe serves to illustrate the procedure:
Length of piping from the fixed point to the branch point where the change in length is to be taken up:

- L = 8 m.
- Installation temperature: T_M = 20 °C
- Max. working temperature: T_1 = 35 °C
- Min. working temperature: T_2 = -20 °C



Expansion of the section during heating
$+\Delta L_1 = L \cdot \Delta T_1 \cdot \alpha = 8 \cdot 15 \cdot 0.10 = 12$ mm

Contraction during cooling
$-\Delta L_2 = L \cdot \Delta T_2 \cdot \alpha = 8 \cdot 40 \cdot 0.10 = 32$ mm

Temperature differences
$\Delta T_1 = T_1 - T_M = 15$ °C
$\Delta T_2 = T_2 - T_M = -40$ °C

Maximum change in temperature chosen
$\Delta T = 40$ °C

Determining the length of the flexible section for ABS
The values needed to determine the necessary length are:

- The maximum change in temperature from the 0-position (i. e. from the position in which the pipe was installed). But remember that the pipe could just as well contract as expand.
- The pipe diameter d.
- The length of the pipe section L.

With these values the required length of the flexible section can be read off from the diagram for ABS.

Continuing with the example introduced before and supposing that an ABS pipe with d = 50 mm is installed, the maximum change in temperature being ΔT= 40 °C, the required length of the flexible section is seen directly from the diagram to be L_B = 1300 mm.

Flexible sections of COOL-FIT ABS pipelines

Flexible length (swing arm) in inches

Length change in inches (Expansion or contraction ΔL)	Pipe size																
	16	20	25	32	40	50	63	75	90	110	140	160	200	225	250	280	315
0.10	8	9	10	12	13	15	16	18	19	22	24	26	29	31	32	34	36
0.20	12	13	15	16	18	21	23	25	28	30	34	37	41	44	46	49	51
0.30	14	16	18	20	22	25	28	31	34	37	42	45	50	53	56	59	63
0.40	16	18	21	23	26	29	33	36	39	43	49	52	58	62	65	69	73
0.50	18	21	23	26	29	32	36	40	44	48	54	58	65	69	73	77	81
0.60	20	22	25	28	32	36	40	44	48	53	59	64	71	75	79	84	89
0.70	22	24	27	31	34	38	43	47	51	57	64	69	77	81	86	91	96
0.80	23	26	29	33	37	41	46	50	55	61	69	73	82	87	92	97	103
0.90	25	28	31	35	39	44	49	53	58	65	73	78	87	92	97	103	109
1.10	27	30	34	38	43	48	54	59	65	71	81	86	96	102	108	114	121
1.20	28	32	36	40	45	50	56	62	67	75	84	90	101	107	112	119	126
1.30	30	33	37	42	47	52	59	64	70	78	88	94	105	111	117	124	131
1.40	31	34	38	43	49	54	61	66	73	81	91	97	109	115	121	128	136
1.50	32	36	40	45	50	56	63	69	75	83	94	101	112	119	126	133	141
1.60	33	37	41	46	52	58	65	71	78	86	97	104	116	123	130	137	146
1.70	34	38	42	48	54	60	67	73	80	89	100	107	120	127	134	142	150
1.80	35	39	44	49	55	62	69	75	83	91	103	110	123	131	138	146	154
1.90	36	40	45	51	57	63	71	77	85	94	106	113	126	134	141	150	159
2.00	37	41	46	52	58	65	73	79	87	96	109	116	130	138	145	154	163
2.10	38	42	47	53	59	66	75	81	89	99	111	119	133	141	149	157	167
2.20	38	43	48	54	61	68	76	83	91	101	114	122	136	144	152	161	171
2.30	39	44	49	56	62	70	78	85	93	103	116	124	139	148	156	165	175
2.40	40	45	50	57	64	71	80	87	95	105	119	127	142	151	159	168	178
2.50	41	46	51	58	65	73	81	89	97	108	121	130	145	154	162	172	182
2.60	42	47	52	59	66	74	83	91	99	110	124	132	148	157	165	175	186
2.70	43	48	53	60	67	75	85	92	101	112	126	135	151	160	169	178	189
2.80	43	49	54	61	69	77	86	94	103	114	128	137	154	163	172	182	193
2.90	44	49	55	63	70	78	88	96	105	116	131	140	156	166	175	185	196
3.00	45	50	56	64	71	79	89	97	107	118	133	142	159	169	178	188	199
3.10	46	51	57	65	72	81	91	99	108	120	135	145	162	171	181	191	203
3.20	46	52	58	66	73	82	92	101	110	122	137	147	164	174	184	194	206
3.30	47	53	59	67	75	83	94	102	112	124	139	149	167	177	186	197	209
3.40	48	54	60	68	76	85	95	104	113	125	142	151	169	179	189	200	212
3.50	49	54	61	69	77	86	96	105	115	127	144	154	172	182	192	203	215
3.60	49	55	62	70	78	87	98	107	117	129	146	156	174	185	195	206	218
3.70	50	56	62	71	79	88	99	108	118	131	148	158	177	187	197	209	222
3.80	51	57	63	72	80	89	100	110	120	133	150	160	179	190	200	212	224
3.90	51	57	64	72	81	91	102	111	122	134	152	162	181	192	203	214	227
4.00	52	58	65	73	82	92	103	112	123	136	154	164	184	195	205	217	230
4.25	54	60	67	76	85	95	106	116	127	140	158	169	189	201	211	224	237
4.50	55	62	69	78	87	97	109	119	131	144	163	174	195	206	218	230	244
4.75	57	63	71	80	89	100	112	122	134	148	167	179	200	212	224	237	251
5.00	58	65	73	82	92	103	115	126	138	152	172	184	205	218	229	243	257
5.25	59	66	74	84	94	105	118	129	141	156	176	188	210	223	235	249	264
5.50	61	68	76	86	96	108	121	132	144	160	180	192	215	228	241	255	270
5.75	62	70	78	88	98	110	123	135	148	163	184	197	220	233	246	260	276
6.00	64	71	79	90	101	112	126	138	151	167	188	201	225	238	251	266	282
6.25	65	73	81	92	103	115	129	140	154	170	192	205	229	243	256	271	288
6.50	66	74	83	94	105	117	131	143	157	173	196	209	234	248	262	277	294
6.75	67	75	84	95	107	119	134	146	160	177	199	213	238	253	267	282	299

L Length of the pipe section in mm

L_B Required length of flexible section in mm

Remark: Please observe the explanations to the hatched area in the clause boundary conditions

Flexible length for pre-insulated ABS

For calculation the change in length ΔL of pre-insulated ABS pipes the following temperatures are needed:

- Installation temperature
- Minimum media temperature
- Maximum media temperature
- Minimum ambient temperature
- Maximum ambient temperature

Please use our online-tool to calculate the applicable change in length out of these temperatures:
www.cool-fit.georgfischer.com

The L_B value for a given ΔL and dimension can be read from the table below, ΔL and L_B values are in mm.

Flexible length (swing arm) in inches for COOL-FIT ABS Plus

Length change (Expansion or contraction ΔL)			Pipe size														
	mm	inches	25/90	32/90	40/110	50/110	63/125	75/140	90/160	110/180	140/250	160/250	200/280	225/315	250/355	280/400	315/450
	10	**0.39**	31	31	33	33	35	37	41	43	49	51	57	61	65	69	73
	20	**0.79**	43	43	47	47	51	55	57	61	69	73	81	87	91	96	102
	30	**1.18**	53	53	59	59	63	67	71	75	85	89	100	106	112	118	126
	40	**1.57**	61	61	67	67	73	77	83	87	96	102	114	122	128	136	144
	50	**1.97**	69	69	77	77	81	87	93	96	108	114	128	136	144	152	161
	60	**2.36**	75	75	83	83	89	94	100	106	118	126	142	150	157	167	177
	70	**2.76**	81	81	91	91	96	98	108	114	128	136	152	161	169	181	191
	80	**3.15**	87	87	96	96	102	108	116	122	138	146	163	173	181	193	205
	90	**3.54**	92	92	102	102	108	114	122	130	146	154	173	183	193	205	217
	100	**3.94**	96	96	108	108	114	122	130	138	154	163	181	193	203	215	228
	150	**5.91**	118	118	132	132	140	148	159	167	189	199	222	236	250	264	280
	200	**7.87**	138	138	152	152	161	171	183	195	217	230	258	274	287	305	323
	300	**11.81**	167	167	185	185	199	211	224	238	266	281	315	335	352	374	396

Pipe bracket spacing and support of pipelines

General

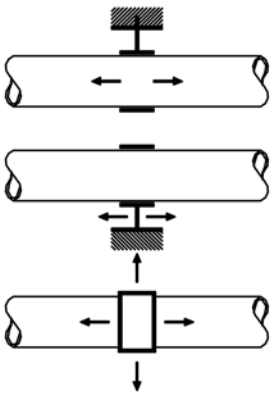
Pipe support for plastics pipes

Plastic pipe systems should be installed using supports designed for use with plastics and should then be installed taking care not to damage or over stress the pipe.

Arranging Loose Brackets

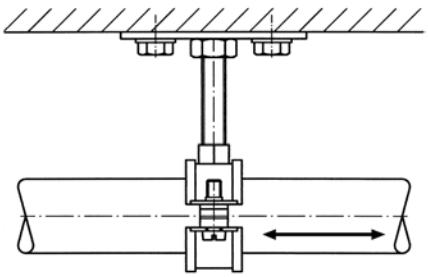
What is a loose pipe bracket?

A loose pipe bracket is a bracket which allows axial movement of the pipe, to allow stress free compensation of temperature changes and compensation of any other operating condition changes.



The inner diameter of the bracket should be larger than the outside diameter of the pipe to allow free movement of the pipe. The inner edges of the brackets should be free from any sharp contours which could damage the plastic. If the brackets' inside diameter is not larger than the pipe then the bracket should not be fully tightened, thus allowing the pipe to move.

Another method is to use brackets with spacers which also avoids clamping the bracket on the pipe.



Spacer to avoid clamping

Axial movement of the pipeline must not be prevented by fittings placed next to pipe brackets or by any other component affecting the diameter of the pipe.

Sliding brackets and hanging brackets permit the pipe to move in different directions. Attaching a sliding block to the base of the pipe bracket permits free movement of the pipe along a flat supporting surface. Sliding and hanging brackets are needed in situations where the pipeline changes direction and free movement of the pipe must be allowed.

Arranging fixed points

What is a fixed point?

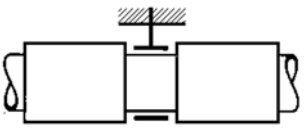
A fixed pipe bracket is a bracket which prevents the pipe from moving in any direction. The aim of which is to control system stresses caused by temperature changes.

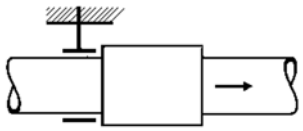
NOTICE

Construction of fixpoint

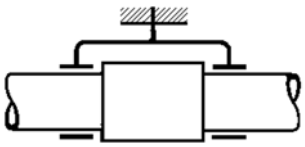
This should not be done by simply clamping the bracket onto the outside of the pipe! This can cause deformation and physical damage to the pipe, damage that sometimes only later becomes visible.

- It should be done either by using pipe brackets located between two fittings or a double bracket must be used.(double-sided fixed point).
- Placing a pipe bracket immediately adjacent to a fitting restricts movement due to changes in length to one direction (one-sided fixed point).





one-sided fixed point



double-sided fixed point

Information:

Pipe brackets must be robust and mounted firmly to be able to take up the forces arising from changes in length in the pipeline. Hanging brackets or KLIP-IT pipe brackets are unsuitable for use as fixed points.

KLIP-IT pipe brackets

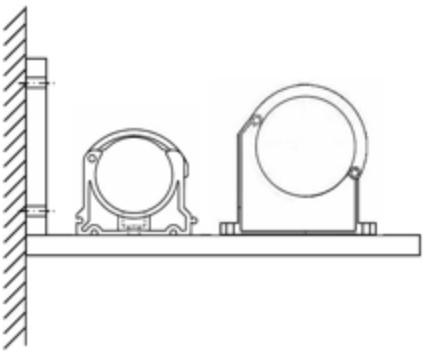
These robust plastic pipe brackets can be used not only under rigorous operating conditions, but also where the pipework is subject to aggressive media or atmospheric conditions. They may be used for all materials of pipes. Don't use KLIP-IT pipe brackets as fixed points!

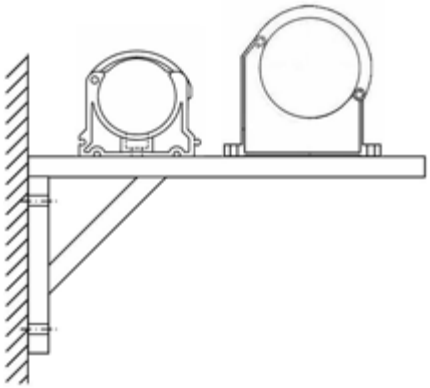
d 16 to d32

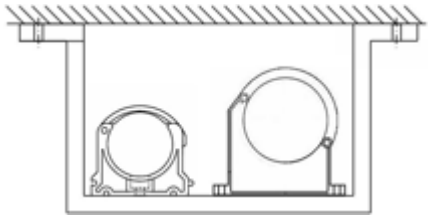
d 40 to d 160

d 90 to d 400

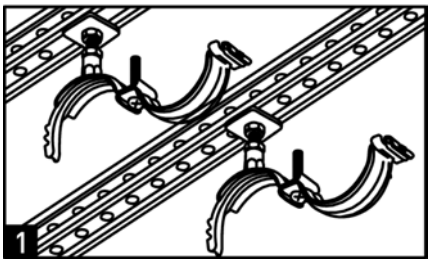
Starting from the dimension d90 the KLIP-IT brackets must be installed standing, like shown in the assembly examples. The support distances given in the following, specified for the KLIP-IT tubing clamps, apply only to this mounting method.



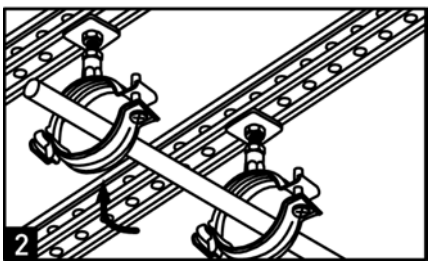




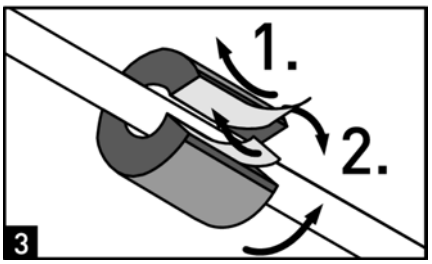
Pipe brackets for cold insulation (MIP)



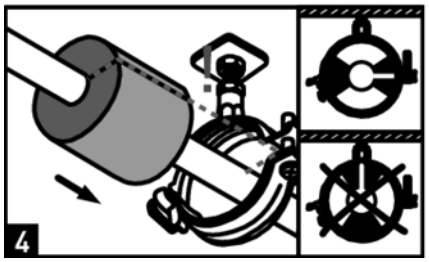
Open handle



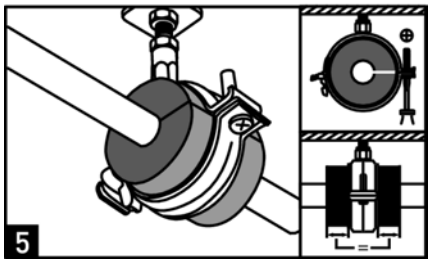
Insert pipe
Close handle with quick-action clamp



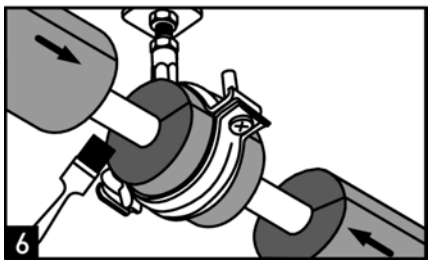
Assemble insulation
1. Take off foil
2. Press area of contact



Move insulation into the bracket. Attention! Make sure the insulator is positioned correctly.



Tighten the screw



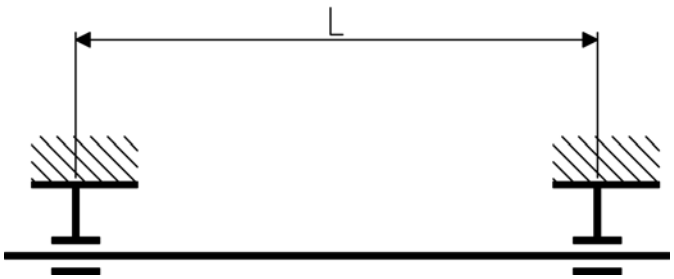
Coat areas of contact with adhesive and bond them

Using the tables for pipe bracket spacing

Plastic pipelines need to be supported at certain intervals depending on several factors: the material, the average pipe wall temperature, the density of the medium transported and the size and wall thickness of the pipe. Determining the spacing between pipe brackets is based on the permissible deflection of the pipe between consecutive brackets.

Information:
The values given in the tables apply only to pipelines which are freely movable in the axial direction.

Pipelines which are fastened tightly in the axial direction (fixed installations) must be checked for buckling. In most cases, this leads to a reduction of the maximum inner pressure and shorter distances between the support brackets. Furthermore, the forces that act on the fixed points must also be taken into consideration. For assistance, please contact your nearest GF representative.



Pipe bracket spacing for COOL-FIT ABS pipes

Liquids with a density of 16.8 g/inch³

d mm	DN inch	Pipe bracket intervals L for pipes PN10 / SDR17 / S8 or class C in feet at pipe wall temperature:				
		68°F	86°F	104°F	122°F	140°F
16	3/8	2.29	2.13	1.97	1.80	1.48
20	1/2	2.62	2.30	2.13	1.97	1.64
25	3/4	2.79	2.62	2.46	2.13	1.97
32 *	1	3.54	3.22	3.06	2.74	2.42
40 *	1¼	3.90	3.58	3.42	3.10	2.78
50	1½	3.77	3.61	3.28	2.95	2.62
63	2	4.27	3.94	3.61	3.28	2.79
75	2½	4.92	4.43	3.94	3.61	3.12
90	3	5.25	4.76	4.43	3.94	3.45
110	4	5.91	5.41	5.09	4.43	3.94
140	5	6.73	5.91	5.58	4.59	4.10
160	6	7.22	6.07	5.74	4.76	4.27
200	8	7.55	6.73	6.07	5.09	4.43
225	8	7.87	7.22	6.23	5.25	4.76
250	10	8.20	7.54	6.56	5.41	4.92
280	10	8.69	7.87	6.88	5.57	5.25
315	12	9.18	8.20	7.21	5.90	5.41

* PN16 Pipe
For other SDR/PN values or classes, multiply the values given in the table with the following factor.

SDR11 / PN16 1.08
Class B 0.90
Class D 1.05
Class E 1.09

The pipe bracket spacing given in the table may be increased by 30% in the case of vertical pipe runs, i.e. multiply the values given by 1.3.

Fluids of a density other than 16.8 g/inch³

If the liquid to be transported has a density not equal 16.8 g/inch³, then the bracket spacings in the table above should be multiplied by the factor given in the following table.

Density of the fluid in 16.8 g/inch³	Type of fluid	Factor for pipe bracket spacing
1.00	Water	1.00
1.25 1.50 1.75 2.00	Other	0.96 0.92 0.88 0.84
≤ 0.01	Gaseous	1.30

Pre-insulated COOL-FIT ABS Plus

Pipe diameter **mm** (carrier pipe)	**Pipe bracket intervals L for pre-insulated ABS COOL-FIT** **ft**
25	5.09
32	5.09
40	5.41
50	5.41
63	5.74
75	6.23
90	6.73
110	7.22
140	8.37
160	9.02
200	10.01
225	10.83
250	10.83
280	11.80
315	12.46

Installation

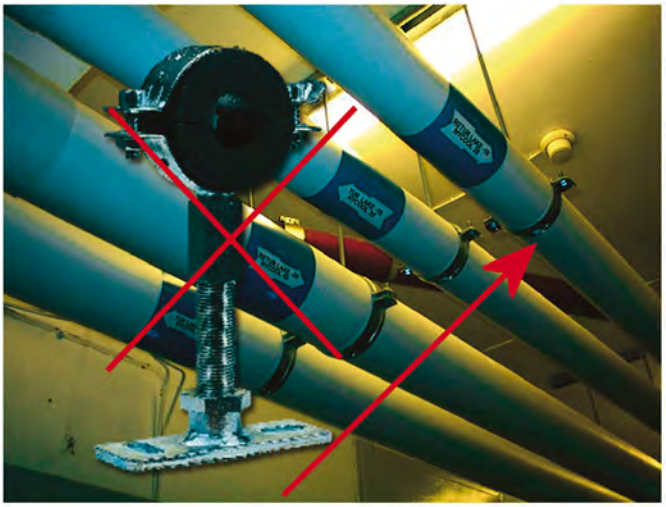
COOL-FIT fixed point

Fixed points are created using the special COOL-FIT fix point. The product consists of two components namely a welding band and a pipe bracket. Electro-fusion welded band as permanent connection to transmit the forces that occur in the pipe to the fixed point. The delivered pipe brackets are needed to deliver welding pressure during installation and give stability during operation. For welding, use an MSA 250, 300, 350, 400 or commercially availabe 220 V fusion machines. If you use an MSA fusion machine from GF Piping Systems, use the 799 350 339 adapter. Please take note of the maximum allowed forces for this version in the table below.

Outside diameter D (mm)	Maximum force Pounds force
90	337
110	450
125	787
140	1236
160	2023
180	2023
225	2023
250	2023
280	2023
315	2023

Remark: Fixed point brackets and cross braces have to be calculated and obtained by the installer. They are not included in the fixed point set from GF.

No need for pipe brackets for cold insulation
Due to the excellent characteristics of the pre-insulated ABS pipes no special pipe brackets for cold insulation are needed.

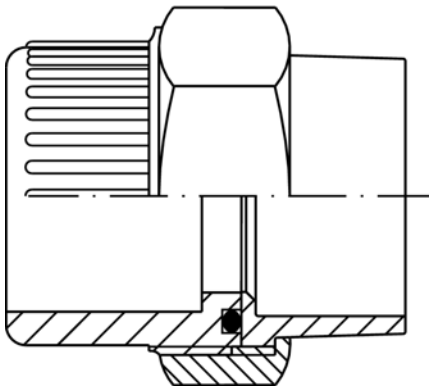


Use only simple pipe brackets

Plastic to Metal Connections

Fundamentally, three options are available for plastic to metal connections: threads, flanged connection and unions.
GF Piping Systems recommends that wherever possible, mechanical connections are used (unions and flanges) along with a located gasket such as O-Ring.

Union Connections
This is the most reliable and cost-effective method to connect metal to plastic.
GF Piping Systems has a whole range of transition unions with O-Rings specially designed to compensate for the changes in length which can occur in COOL-FIT ABS and COOLFIT ABS Plus due to temperature fluctuations. See ABS product range for details of the copper, brass, stainless steel and malleable iron transition unions available.



ABS | Located O-ring | Copper

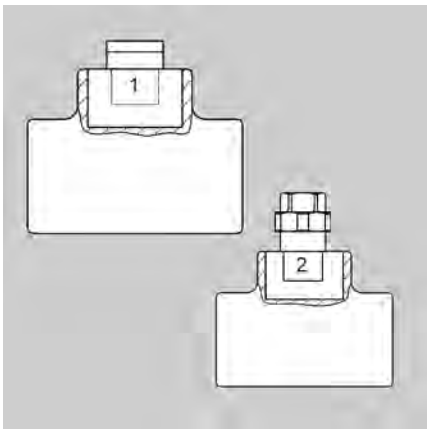
Flange Connections
Metal to ABS and also ABS to ABS connections using flange adaptors are possible up to DN300. For bolt torques, tightening sequences, etc., please refer to standard the GF Piping Systems Plastics Technical Handbook.

GF Piping Systems's new revolutionary PN16 PP- V flange is lightweight, with location stubs to aid installation and is designed to avoid high stresses during tightening. GF Piping Systems recommends this type of flange for use with plastic flange connections.
All mechanical connections including flanges should be retightened after commissioning if the working temperature is lower than the temperature during installation.

Threaded Connections
GF Piping Systems recommends avoiding threaded connections for plastic wherever possible; solvent cementing is a very reliable and speedy method of joining and is preferred to threaded connections. Mechanical wrenches should not be used to tighten the joint. Strap type wrenches prevent damage to the plastic components.
For sealing threaded joints, the mating parts should always be parallel to tapered. In the ABS range, only the plastic female thread with reinforced ring should be used for connection to metal threads. For sealing we recommend PTFE tape. Apply 2 layers of tape in a clockwise direction, then join components carefully to avoid damage to the plastic thread.
Alternatively, thread sealing cord Henkel Tangit Uni-Lock or Loctite 55 and/or thread sealing paste Loctite 5331 can be used. Please consider the appropriate installation guidelines of the manufacturer. If other sealing materials are used, compatibility with the plastics to be used must be checked first.

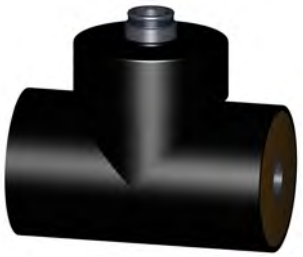
Measuring Equipment in an ABS System

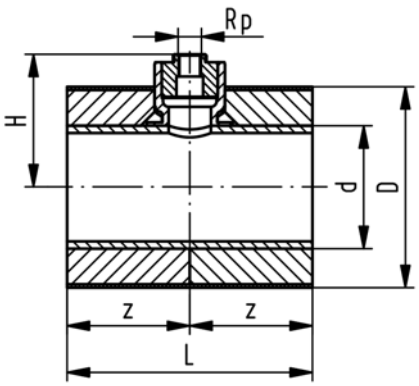
Tee 90° reduced in COOL-FIT ABS
Standard ABS tees can be fitted with a short reducer and then a threaded nipple or a piece of pipe with a transition union to install equipment; this should be planned in in the design stage of the plant. We recommend use of a transition union rather than a threaded connection.



1 ABS nipple in an ABS reducing tee 90°
2 Transition union with ABS pipe

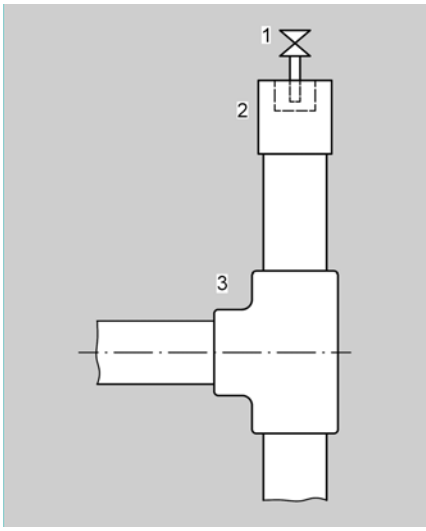
Measuring Equipment in COOL-FIT ABS Plus
As in the COOL-FIT ABS system, Tee 90° reducers are available in COOLFIT ABS Plus. These then need to be planned into the system during the design phase of the plant. At present it is not possible to install equipment into an already existing COOLFIT ABS Plus pipe, other than cutting the pipe and placing a Tee in the pipe.





De-venting or De-aeration
It is always important to remove air from any piping system; for salt solutions, this is particularly important due to their corrosive nature. Summary of Deaeration process:

- always fill the system slowly from the bottom up
- induce a vacuum in the system before filling
- install manual and/or automatic deaerators at the highest points in the system
- long horizontal runs should be installed at a slight gradient
- avoid low points, e.g. U-configurations, where air can be trapped
- install deaerators with a buffer zone of fluid below them, see diagram below
- always observe the medium manufacturer's specific recommendation for filling, mixing, etc., as secondary fluids differ in their composition

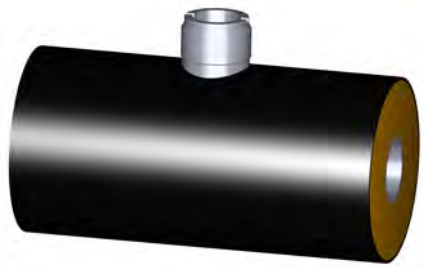


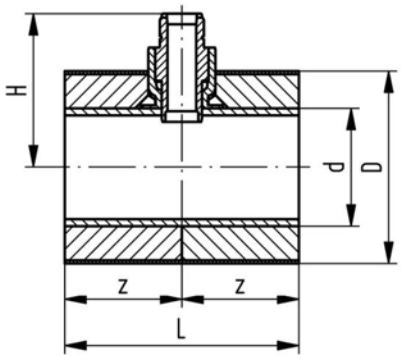
1 Vent valve Type 591
2 ABS reducer fitting
3 ABS tee 90°

SIGNET Flow Measuring Equipment

GF Piping Systems Signet offer paddle wheel flow measuring equipment which can be used to very cost effectively measure the flow of your medium, with digital and analogue display devices including cabinet housings for installation in display units.

These SIGNET flow sensors can be installed using specially designed installation fittings, ask GF Piping Systems for installation fittings details.





Other installation topics

Foaming ABS with PUR On-Site

There are various types of PUR on the market using different types of activators to initiate the foaming process. All are, however, an exothermic reaction, i.e. generate heat, usually reaching temperatures of about 248ºF (120ºC), which can be dangerous for thermoplastics. ABS has a vicat point (softening point) of 208ºF (98ºC); this means that any temperatures reached above this have a detrimental effect on the ABS. Usually the foaming onsite takes place in an enclosed volume which then causes external pressures on the component.

For these reasons we recommend that ABS fittings and pipe are not insulated using PUR foaming onsite.

COOLFIT ABS Plus is foamed under controlled conditions ensuring that the quality of the ABS is not affected by the PUR foaming process.

Insulating ABS

ABS is not chemically resistant to solvents. Solvents are used in the joining process to soften and swell the ABS to create a weld. This use of solvent takes place under controlled conditions and uses double wall thickness by inserting pipe in fitting.
Any other contact of solvents with ABS should be avoided. Some insulation materials on the market use solvent based glues to position the insulation, as per manufacturers' instructions only the insulation itself should be glued together.

Any excess glue which may come into contact directly with the ABS should be removed with a cloth.
If insulation has been glued directly to the pipe this does not mean that the system is now dangerous. It can however only be determined on a case to case basis if the situation will have a detrimental effect on the performance of the pipe. Contact GF Piping Systems if you require more information on this subject.

Insulation to Avoid Dew on ABS

To calculate the necessary thickness of insulation required on ABS to avoid dew or condensation can be done via GF Piping Systems's online cooling calculation program, see www.coolfit.georgfischer.com

Under the button "condensation" you can input the system parameters and type of insulation. The results are guideline values based on tradename published data and general physical data regarding types of insulation. We recommend the user consult the insulation manufacturer for detailed specific advice regarding the insulation when not using COO-LFIT ABS.

COOL-FIT ABS Plus: Condensation, Yes or No?
COOL-FIT ABS has set thicknesses of insulation, once again via www.coolfit.georgfischer.com the user can input his system parameters and the program will identify whether when using COOL-FIT ABS Plus, dew will appear on the outside of the pipe or not.

PUR has a thermal conductivity of 0.026 W/m.K and the thickness is +/–35mm (1.38") for all dimensions so the system parameters need to be extreme for dew to appear on the outside of COOL-FIT ABS Plus.

For example:	
Medium temperature:	–58ºF (–50°C)
Temperature of the surrounding	68ºF (+20°C)
Relative atmospheric humidity	75%
Wind velocity:	1 m/s

Under the above circumstance there will be no condensation on the pipes.

Defrosting
Many secondary refrigeration loops are not only used for normal and low temperature cooling but are also used for defrosting. GF Piping Systems has many years of good experience with the use of ABS in such dual defrost/cooling systems without any detrimental effects to the system.

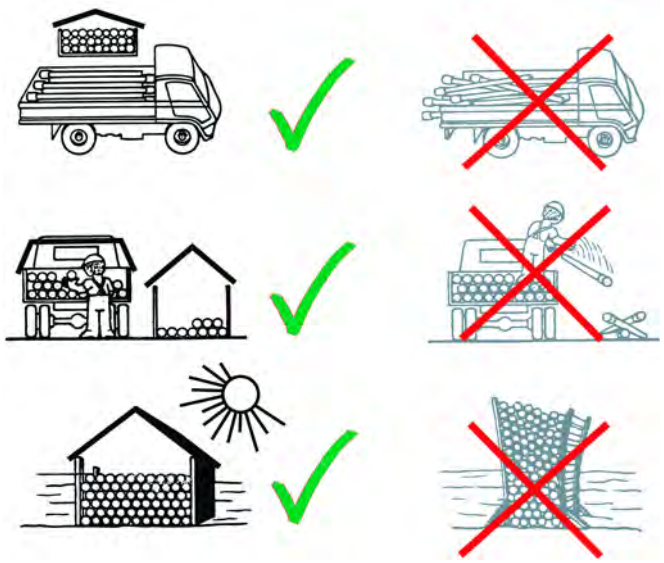
Heat transfer coefficient of pipes: Pre-insulated ABS

Pipe diameter mm	U-Value pre-insulated ABS W/m K	R-Value pre-insulated ABS m K/W
25	0.13	7.7
32	0.16	6.3
40	0.17	5.9
50	0.21	4.8
63	0.25	4.0
75	0.27	3.7
90	0.29	3.4
110	0.34	2.9
140	0.35	2.9
160	0.37	2.7
200	0.50	2.0
225	0.50	2.0
250	0.49	2.1
280	0.48	2.1
315	0.48	2.1

Handling

How to carry COOL-FIT pipes after connection with ABS nipples:

Pipes must be kept straight!



Storage
All plastic pipes, including pre-insulated plastic pipes, i.e. COOL-FIT ABS Plus, should be stacked on a flat surface free from sharp edges, such as stones or building debris for instance. During handling, care should be taken to avoid damage to the outside surface of the pipe, for instance don't drag along the ground. Avoid pipe overhangs when stored as this will cause the pipe to bend.

UV Resistance
Most plastics suffer some loss of physical properties when exposed to UV light; only PE Black, used for the outer jacket of the COOL-FIT ABS Plus, is UV resistant. The impact strength of ABS reduces under UV light over a time period of approximately one year, after which the oxidized layer on the outside surface of the ABS acts as a barrier and the impact strength does not deteriorate further.
Although the ABS impact strength is reduced under UV light, it still remains at a very high level.

Underground Installation
Pre-insulated ABS can be used underground. Standard guidelines for installation of plastic pipe systems should be followed. Please pay attention to local regulations. In general, trenches should not be less than 1 meter deep. To avoid frost damage, trenches can be deeper.

The pipe should be laid in a sand bed, and all large pieces of rock and sharp objects must be removed. Compressed sand should be used to pack the pipe.
We recommend use of the long shrink sleeves from the COOL-FIT ABS Plus product range (265 mm) for the pipe-to-pipe connections.
Pre-insulated ABS pipes have a higher stiffness and weight than standard ABS. It is therefore recommended to perform joining in the trench itself wherever possible to avoid unnecessary stressing of the joints.
It should not be necessary to use any mechanical expansion elbows in the system design underground. Please consult GF for technical advice.

The Environment
ABS and COOL-FIT ABS are halogen free. The materials used in COOL-FIT ABS (ABS, PE, and PUR) are all recyclable materials. GF Piping Systems as a company aims to understand and meet customer requirements regarding the environment. We design products and develop our processes taking into account the environment and its needs. TEWI, ODP and GWP values and reports exist for COOL-FIT pre-insulated pipe, please see www.coolfit.georgfischer.com

SQS Certificate

SQS herewith certifies that the company named below has a management system which meets the requirements of the normative bases specified below.

Georg Fischer Piping Systems Ltd.
CH-8201 Schaffhausen

Certified area

Georg Fischer Piping Systems Ltd., Schaffhausen
Georg Fischer Rohrleitungssysteme (Schweiz) AG, Sales Company
Georg Fischer Wavin Ltd., Schaffhausen and Subingen
Georg Fischer Building Technology Ltd., Schaffhausen
Georg Fischer Fluorpolymer Products GmbH, Ettenheim

Field of activity

The Piping Systems Group develops, manufactures and distributes plastic or metal components and systems for conducting, pumping, controlling, measuring and regulating liquids and gases and to this end provides comprehensive engineering and related services

Normative bases

ISO 9001:2008 Quality Management System
ISO 14001:2004 Environmental Management System

Swiss Association for Quality and Management Systems SQS
Bernstrasse 103, CH-3052 Zollikofen
Issue date: May 28, 2009

This SQS Certificate is valid up to and including May 27, 2012
Scope number 14
Registration number 10684

X. Edelmann, President SQS

T. Zahner, Managing Director SQS

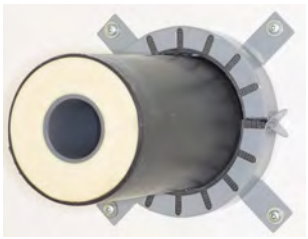
Partner of IQNet

Flammability
According to UL94, ABS has an HB (Horizontal Burning) flammability coefficient and falls into building material class B2 (conventional inflammable, nondripping) according to DIN 41021. Fundamently, toxic substance are released by all burning process. Carbon monoxide is generally the most important. When ABS burns, primarily carbon dioxide, carbon monoxide and water are formed. Tests have shown that the relative toxicity of the products of combustion are similar or even lower than those of natural products such as wood, wool and cotton. ABS combustion gases are not corrosive. That the burning nevertheless forms soot, smoke develops during combustion. Suitable firefighting agents are water, foam and carbon dioxide.

PE Flammability
The following classifications in accordance with differing combustion standards: According to UL94, PE is classified as HB (Horizontal Burning) and according to DIN 534381 as K2. According to DIN 4102 part 1 and ÖNORM B3800 part 1, PE is listed as B2 (normally flammable). In the French classification of building materials, polyethylene corresponds to M3 (of average flammable rating). The self ignition temperature is 662°F (350°C). Suitable firefighting agents are water, foam, carbon dioxide or powder.

PUR Flammability
Rigid polyurethanebased foams are effective insulation materials commonly used in the construction industry. Polyurethane foam will burn if exposed to flames. The combustibility characteristics vary with chemical composition. Unlike expanded polystyrene (eps), polyurethane does not melt. It flashes into flames between 800°F and 850°F (427°C and 454°C), and only chars rather than melts at temperatures below that range. The charring may in fact help protect the adjacent foam. Some studies have indicated that Douglas fir was more toxic than polyurethane foam, in a paper presented at the 1985 Society of the Plastics Industry, annual meeting on polyurethane foam. Please consult GF Piping Systems for further details.

Fire Wall Penetrations



To seal a combustible pipe penetrating a fire wall, it is necessary to use locally approved sealing systems to preserve the integrity of the fire wall. There are various international and local companies offering solutions for plain combustible pipe (e.g. plastic pipe). COOL-FIT ABS – for sealing plain ABS please consult locally approved fire wall penetration products for standard combustible pipe. ABS + Insulation – as per plain ABS, solutions exist tested and approved on combustible pipe with various different types of insulation. COOL-FIT ABS Plus – is a pre-insulated combustible pipe. The company Kuhn has tested their product series ROKU® R AWM II to the EN1366-3 (European Standard for “Fire resistance tests for service installations – Part 3 Penetration seals) on COOL-FIT pipe at the IBMB Institute in Braunschweig, Germany. The COOL-FIT tested passed the requirements as outlined in this standard to EI 90 / EI 120. The system has a national technical approval in Germany and is listed under Z-19.17-1194. In Austria it is listed under test report No. 06112903-2a, and in Switzerland under the number of Z 10933 respectively 10339. Test data is available from the company Kuhn which can be extrapolated by local test authorities to show the integrity of the solution.
For product information see
www.kuhn-brandschutz.com
KUHN Brandschutz Systems
Solutions for building services

Comparision pipe diameter

DN, plastics/metal, mm/inch

Plastic piping				Metal piping				
Size Outside diameter mm	COOL-FIT ABS inside diameter mm	COOL-FIT ABS Lite inside diameter mm	COOL-FIT ABS Plus inside diameter mm	Size Nominal diameter inches	Refrigeration Size outside diameter inches	M Copper inside diameter mm	Carbon steel Schedule 40 inside diameter mm	SS Schedule 10 inside diameter mm
16	12.4			3/8	1/2			
20	15.4			1/2	5/8			
25	20.4	20.4	20.4	3/4	7/8	20.6	20.9	22.5
32	26.2	26.2	28.2	1	1 1/8	26.8	26.6	27.9
40	32.6	32.6	35.2	1 1/4	1 3/8	32.8	35.1	36.6
50	44.0	44.0	44.0	1 1/2	1 5/8	38.8	40.9	42.7
63	55.4	55.4	55.4	2	2 1/8	51.0	52.5	54.8
75	65.8	65.8	65.8	2 1/2	2 5/8	63.4	62.7	66.9
90	79.2	79.2	79.2	3	3 1/8	75.7	77.9	82.8
110	96.8	96.8	96.8	4	4 1/8	99.9	102.3	104.8
140	121.6		121.6	5		124.6	128.2	134.5
160	139.0	139.0	139.0	6	6	149.4	154.1	157.1
200	173.8		173.8	8				
225	195.4		195.4	8			202.7	211.6
250	230.8		230.8	10			254.5	266.2
280	258.6		258.6	10				
315	290.8		290.8	12			303.3	315.9

Solvent cement joining

Instructions for solvent cement joining of COOL-FIT ABS dimension d20 to d315

General

Solvent cement joining calls for adequate technical expertise, which can be acquired in the appropriate training courses. Your GF representative will gladly provide you with information about training possibilities.

The dimensions of GF pipes, fittings and valves conform generally to the various national standards as well as to ISO 727-1 concerning dimensions of sockets. Our fittings and valves can be used with any ABS pipes whose outside diameter tolerance conforms to ISO 11922-1.

According to ISO 727-1 the following minimal cement lengths are as shown in the table:

Pipe outside diameter / socket inside diameter d (mm)	Minimal cement length L (mm)
20	15.0
25	17.5
32	21.0
40	25.0
50	30.0
63	36.5
75	42.5
90	50.0
110	60.0
125	67.5
140	75.0
160	85.0
200	105.0
225	117.5
250	130.0
280	145.0
315	162.5

Recommendation for solvent cement jointing of ABS fittings of dimensions 250 - 315 mm

ABS solvent cement fittings d250 to d315 from GF are designed and tested for a nominal pressure of PN6 (6 bar).

Our experience and tests reveal that pipes above d250 can be slightly oval, which can produce a heightened cementing gap. GF therefore recommends that pipes from dimensions d250 should be operated at max. 6 bar working pressure.

Please note the special remarks for dimensions 250 - 315 in the following jointing instructions.

Tools and equipment

Pipe cutter Type KRA	d10 - 63 d50 - 110 d110 - 160	790 109 001 790 109 002 790 109 003
Pipe cutter type KS 355	230 V / 50 - 60 Hz	790 202 001
Chamfering tool	d16-200 d63-400	790 309 003 790 309 004
COOL-FIT Cleaner	1 qt. can	799 298 102
COOL-FIT ABS solvent cement	1 qt. can	799 298 101
Brush sizes		
Pipe outside diameter in mm	Brush	
20-32	Round brush ø8 mm	799 299 002
40-63	Flat brush 1" 25 x 3 mm	799 299 003
75-225	Flat brush 2" 50 x 5 mm	799 299 004
250-315	Flat brush 3" 75 x 6 mm	799 298 005
Cap for cement		799 298 028
White absorbent paper	commercially available	
Solvent resistant protecting gloves	commercially available	

Solvent cementing equipment

COOL-FIT cement and cleaner: Amounts required

Pipe diameter d (mm)	COOL-FIT cement amount per 100 joints (lb)	COOL-FIT cement number of joints per quart can
20	0.77	238
25	0.88	208
32	0.99	184
40	1.32	138
50	1.98	92
63	2.42	75
75	2.75	66
90	3.74	48
110	5.51	33
140	11.02	16
160	14.33	12
200	22.04	7
225	27.55	6
250	35.20	5
280	41.80	4
315	58.30	3

Pipe diameter d (mm)	COOL-FIT cleaner amount per 100 joints (fl. oz.)	COOL-FIT cleaner number of joints per quart can
20	10.14	350
25	13.52	260
32	16.90	211
40	23.67	150
50	30.43	117
63	37.19	96
75	43.96	81
90	47.34	74
110	57.48	62
140	71.00	50
160	84.53	42
200	118.35	30
225	152.16	23
250	185.98	19
280	219.79	15
315	344.90	10

Note: The quantities specified above are to be understood as practice-orientated maximum values. In principle the quantities depend on gap dimensions, temperatures, working technique.

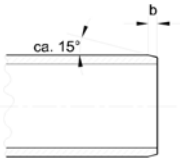
Preparations

Cutting the pipe to length

Chamfering the pipe

The pipe must be cut off at right angles. Remove the inside edges and chamfer the outside ones as illustrated in the sketch. Only then is an optimal solvent cemented joint possible.

Important: Well-chamfered pipe ends prevent the layer of cement from being removed as the pipe is inserted into the fitting.



Pipe outside diameter	b
20 - 50 mm	2 - 3 mm
63 - 225 mm	3 - 6 mm
250 - 315 mm	6 - 8 mm

Marking the joining length

Wipe the outside of the pipe and the inside of the socket with a clean cloth to remove obvious dirt. Marking the joining length on the pipe end makes it possible to check afterwards whether the pipe has been inserted to the full extent of the socket.

Note: If the outside diameter of the pipe and the inside diameter of the socket are at opposite extremes of their tolerances, then the pipe cannot be inserted dry into the fitting socket. This will only become possible once the cement has been applied.

Checking the cement

The COOL-FIT cement is supplied ready for use. Stir thoroughly before using! Cement of the correct consistency will run evenly from a wooden spatula held at a slant. Cement which no longer runs smoothly is unusable. The cement must not be thinned.

For more information please consult the safety-datasheets under the following link:
www.sdb.henkel.de/index.cfm

Cement and cleaner should be stored in a cool, dry place (41–95°F)! Under these conditions the cement and cleaner are durable for 36 months starting from the date of filling (imprinted on the can).

Cementing

Clean the outside of the pipe end and the inside of the socket **thoroughly** with COOL-FIT cleaner and absorbent paper.

Use a fresh piece of paper for each component. If the surfaces are free from grease, cleaning with absorbent paper and COOL-FIT cleaner is not absolutely necessary for ABS.
But remove any condensation which may have formed on the parts.

Important: Pipe end and fitting socket must be dry and free from grease and dirt and must not be touched after cleaning.

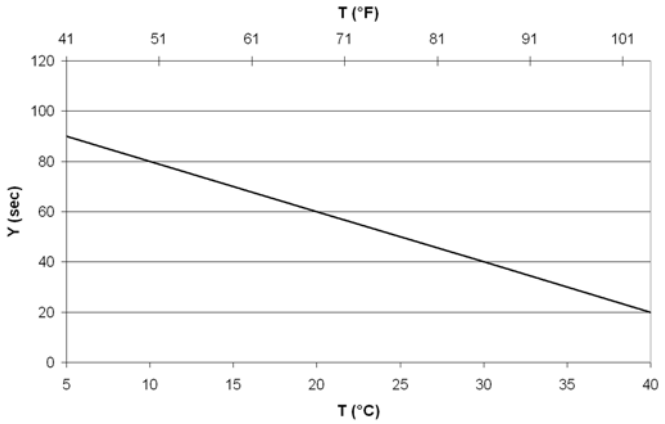
Cleaning the pipe and socket

ABS pipes should be cemented at temperatures between +41°F and +104°F. Take the following protective measures if the temperatures deviate from the above:

Installation at low temperatures requires utmost care. Since COOL-FIT cement cures physically by evaporation, hardening may be slowed down considerably. Special installation techniques are therefore required at temperatures below +41ºF.
Cement and cleaner should be stored at room temperature. To remove condensation or ice water which may have formed, pipe ends and sockets to be bonded are warmed to +77 to +86ºF by means of a suitable hot-air blower (explosion proof) and then bonding is done as described. The finished joint must be kept at +77 to +86ºF according to the waiting times mentioned in the following before the next cementing.

Avoid uneven overheating (→ shorten the opening time) when cementing at higher temperatures by protecting the joining area from direct sunlight.

The quick curing time of the cement necessitates that the joint is made within the opening time after application of the cement has started. The opening time of the COOL-FIT cement varies with the ambient temperature and the thickness of the cement applied:



T Temperature in °C / °F

Y Opening time [sec]

Begin by applying a normal layer of cement to the fitting and then a thicker one to the pipe end with firm brush pressure. **Work in well.** The brush strokes should always be in an axial direction.

To ensure that both joining surfaces are completely covered with a smooth, even layer of cement, the brush should be generously loaded with cement.

Applying the cement

Range of dimension up to d63

Apply cement
The cement joints can be produced by one person.

Joining
After the cement has been applied, insert the pipe to the full depth of the socket immediately without twisting and bring them into the correct alignment. Ensure that the outlet of the fitting is in the correct position. Hold them briefly in this position to allow the cement to set.

Waiting time between cementing
Wait at least 10 minutes before the next joint, extend the waiting time at temperatures under 50°F or above 86°F to 15 minutes.

Range of dimension d75 to d140

Apply cement
The fitting socket and end of pipe should be coated-with cement simultaneously by two persons, otherwise the opening time of the cement cannot be observed.

Joining
After the cement has been applied, insert the pipe tothe full depth of the socket immediately without twist-ingand bring them into the correct alignment. Ensure thatthe outlet of the fitting is in the correct position. Holdthem briefly in this position to allow the cement to set.

Waiting time between cementing
Wait at least 10 minutes before the next joint, extend the waiting time at temperatures under 50°F or above 86°F to 15 minutes.

Range of dimension d160 to d225

Apply cement
The fitting socket and end of pipe should be coated with cement simultaneously by two persons, otherwise the opening time of the cement cannot be observed.

Joining
After the cement has been applied, insert the pipe to the full depth of the socket immediately without twisting and bring them into the correct alignment. Ensure that the outlet of the fitting is in the correct position. Hold them briefly in this position to allow the cement to set.

Waiting time between cementing
Wait at least 30 minutes before the next joint, extend the waiting time at temperatures under 50°F or above 86°F to 60 minutes.

Range of dimension d250 to d315

Apply cement
Deviating from the usual method of application, pour the cement directly from the tin onto the middle of the cementing surface and distribute first radially and then axially all over with a flat brush. Make sure that the cement layer is consistent and covers the entire surface as appropriate for the larger tolerances. Apply a thinner layer of cement in the fitting than on the pipe ends. The cementing of pipe work in this range of dimensions should be carried out by at least 2 persons. The minimum thickness of the cement layer for fittings is 1 mm, apply more generously on the pipe ends.

Joining
After applying the cement, the pipe and fitting should be slowly pushed together to the stop or the mark without twisting by 3-4 persons and aligned. Ensure that the outlet end of the fitting is in the correct position. Hold the joint in this position for 1 minute.

Waiting time between cementing
A waiting time of 1 hours should be observed before further joining; this time should be increased to 2 hours at temperatures under 50°F or above 86°F.

Replace the lid of the cement can during work breaks

Remove any surplus cement immediately, using absorbent paper.

After use, clean the brush of excess cement with dry absorbent paper and then clean thoroughly using COOL-FIT cleaner. Brushes must be dry before being re-used (shake out).

A bead of excess solvent cement around the complete external circumference of the joint and a slightly smaller bead again around the complete internal circumference show that the joint has been performed correctly.

Replace the lid of the cement can after use to prevent the solvent from evaporating. Using the conical lid allows leaving the brush in the cement can during breaks.

Solvent cement dissolves ABS. Pipes and fittings must therefore not be laid on or allowed to come into contact with spilled cement or paper containing cement residues.

Do not close off cement pipelines during the drying process. This is particularly important at temperatures below +41°F, when there is otherwise a danger of damaging the material.

After the drying process (see waiting times in the following table) the pipelines can be filled. To remove extant solvent vapor, it is recommended to flush the pipeline before use.
For pipes that are not put into immediate use, it is recommended, after careful cleaning, to fill them with water and flush regularly. Do not use compressed air for flushing.

Drying period and pressure testing

The length of the drying period before the joint may be subjected to testing or operating pressure depends on the ambient temperature, the dimension and the tolerances. The following tables shows the different waiting times.

Remark: For temperatures above 68°F (20°C), the test pressure must be reduced according to the requirements given in the chapter "Final testing and commissioning."

Attention: Care should be taken, if the medium has a large temperature difference to the installation temperature. Please consult your local GF Representative.

Internal pressure test with water

This pressure test shall be carried out according to the information given in the chapter "Internal pressure test with water or a similar incompressible fluid." The waiting time after the last joint until the pressure test is shown in the following table:

Range of dimension d20 to and including d225

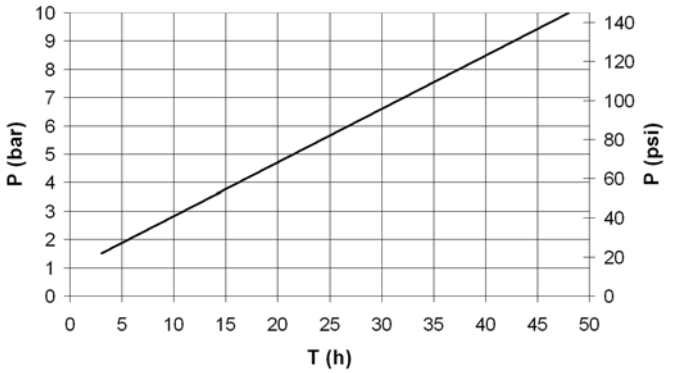
Ambient Temperature	Waiting time
50° to 86°F (10° to 30°C)	min. 24 hours
- below 50°F (10°C) - above 86°F (30°C)	min. 48 hours

Range of dimension d250 to and including d315

Ambient Temperature	Waiting time
50° to 86°F (10° to 30°C)	min. 48 hours
- below 50°F (10°C) - above 86°F (30°C)	min. 72 hours

Internal pressure test or leak tightness test with gas/air

Due to the risk of a pressure test with a compressible test medium this pressure test shall be carried out only in exceptional cases! Please consult also the safety precautions given in the chapter "Internal pressure test of ABS pipelines." The following diagram shows the waiting time depending on the test pressure for a ambient temperature between 50° to 86°F (10° to 30°C):



Ambient temperature between 50° to 86°F (10° to 30°C)

P Test pressure in bar, psi

T Waiting time after last joint in hour

Repair works

If the pipeline is only subjected to the operating pressure with fluids, e. g. after adaptation or repair works, the following rule of thumb for the waiting time applies, which depends on the diameter:

Dimension d20 up to d140 (1/2" - 5")

Ambient Temperature	Waiting time for testing with fluids (non compressible)
50° to 86°F (10° to 30°C)	1-hour waiting time per 15 psi operating pressure
- below 50°F (10°C) - above 86°F (30°C)	2-hour waiting time per 15 psi operating pressure

Dimension d160 up to d225 (6" - 8")

Ambient Temperature	Waiting time for testing with fluids (non compressible)
50° to 86°F (10° to 30°C)	2-hour waiting time per 15 psi operating pressure
- below 50°F (10°C) - above 86°F (30°C)	4-hour waiting time per 15 psi operating pressure

Dimension d250 up to d315 (9" - 12")

Ambient Temperature	Waiting time for testing with fluids (non compressible)
50° to 86°F (10° to 30°C)	4-hour waiting time per 15 psi operating pressure.
- below 50°F (10°C) - above 86°F (30°C)	8-hour waiting time per 15 psi operating pressure.

Safety precautions

COOL-FIT cement and cleaner contain highly volatile solvents. This makes good ventilation or adequate fume extraction essential in closed spaces. Since the solvent fumes are heavier than air, extraction must occur at floor level, or at least below the working level. Place pa-

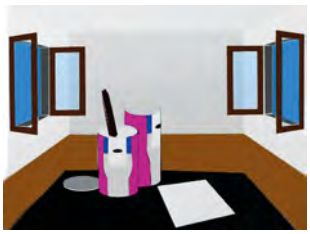
per which has been used for cleaning or for the removal of surplus cement into closed containers to minimise the amount of solvent fumes in the air.

Cement and cleaner are flammable. Extinguish open fires before commencing work. Switch off unprotected electrical apparatus, electric heaters, etc. Do not smoke! Discontinue any welding operations. Furthermore, observe all instructions issued by the solvent cement manufacturer (e.g. can label and any supplementary documentation).

Protect pipe and fittings from spilled solvent cement, cleaner, and absorbent paper which has been used to wipe off cement. Do not dispose of surplus solvent cement or cleaner in drainage systems.

The use of protective gloves is recommended to avoid contact with skin. If the cement or the cleaner get in contact with eyes, rinse immediately with water. Consult a doctor! Immediately change clothes that have solvent cement on them.

Always obey the safety regulations issued by the authorities responsible.



Adequate ventilation of the workplace

No open flames when cementing. No smoking.

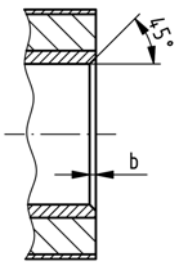
Instructions for solvent cement joining of COOL-FIT ABS Plus dimension d25 to d225

Solvent cementing instructions

The joining technique for COOL-FIT ABS Plus internal joining follows the same tried and tested technique as for standard ABS using exactly the same tooling and COOL-FIT cement.

Following is a summary of ABS solvent cement joining for COOL-FIT ABS Plus. Please refer to the standard ABS solvent cement joining instructions for exact curing times, handling instructions, health and safety advice and commissioning procedure.

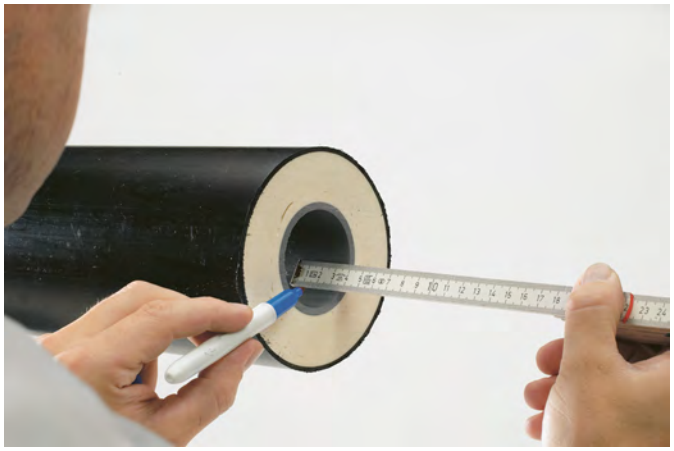
Chamfer to ≈ 45° with a width according to the following table the internal diameter of the ABS pipe.



Pipe diameter d	Chamfered width b
25 - 50 mm	1 mm
63 - 90 mm	2 mm
≥ 110 mm	3 mm

Check the consistency of the COOL-FIT cement. The cement should run smoothly. Before joining, check that all tools required are on hand.

The outside surface of the COOL-FIT ABS nipple and the inner surfaces of the COOL-FIT ABS pipe must always be cleaned using COOL-FIT cleaner with clean absorbent paper.



Mark the inside diameter of the pipe to the minimum socket depth required. Socket depth is always d/2 + 5 (mm), for example socket length for d90 = 50 mm (90/2 +5).

Apply a normal layer of ABS Solvent cement to the inside surface of the COOL-FIT ABS Plus pipe. Apply the cement to the depth marked, axially, smoothly in one action, in an even layer. Use a firm pressure on the brush when applying the cement to work the cement into the pipe.

Apply a thicker layer, approximately 1 mm, of ABS cement to the outside of the COOL-FIT ABS Plus nipple, using the same technique as with the pipes.

Insert the COOL-FIT ABS Plus nipple axially into the pipe, being careful not to rotate the parts. Remove all excess cement using absorbent paper.
The installer should take note of the COOL-FIT cement opening time and safety precautions written on the can and in standard ABS joining instructions.

Instruction for pipe preparation - Calibration only required for d140 (8") and above

Please read the operating instructions prior to using the Calibration Tool

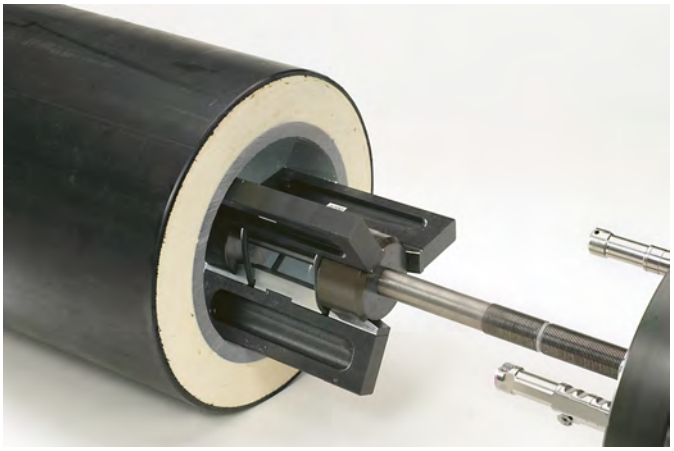
1 Cut pipe at right angles, 90°.

For ABS dimensions below d140 calibration of the pipe is not required, please follow cementing instructions.

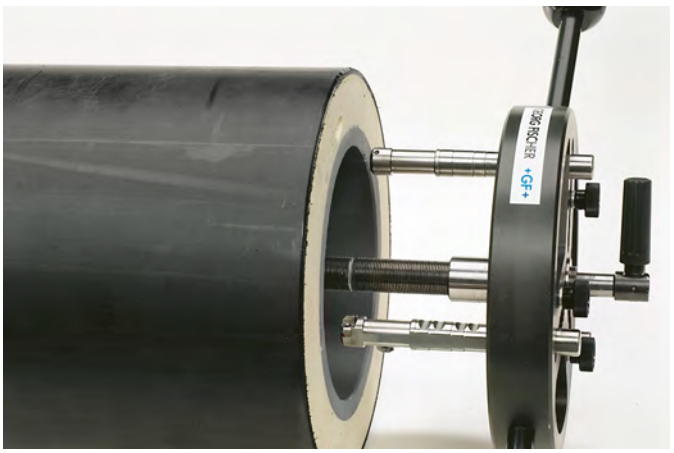
2 For dimensions d140 and above the internal diameter of the pipe needs to be calibrated using the COOL-FIT ABS Plus calibration tool.

3 Assemble the COOL-FIT ABS Plus calibration tool using the relevant parts for the required dimension.
Detailed instructions are delivered with the tool.

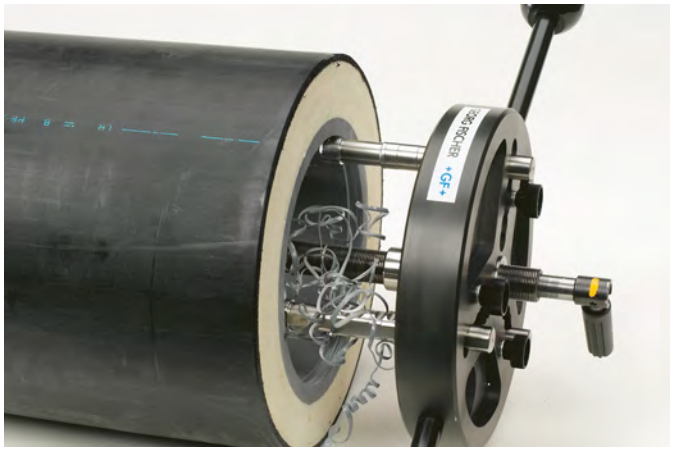
4 Always ensure that the pipe has been chamfered before inserting the calibration tool.



5 Insert the tool into the pipe to the depth indicated on the spindle. For short lengths of pipe see instructions packed with the tool.



6 Wind out the jaws of the tool until the tool is firmly located.

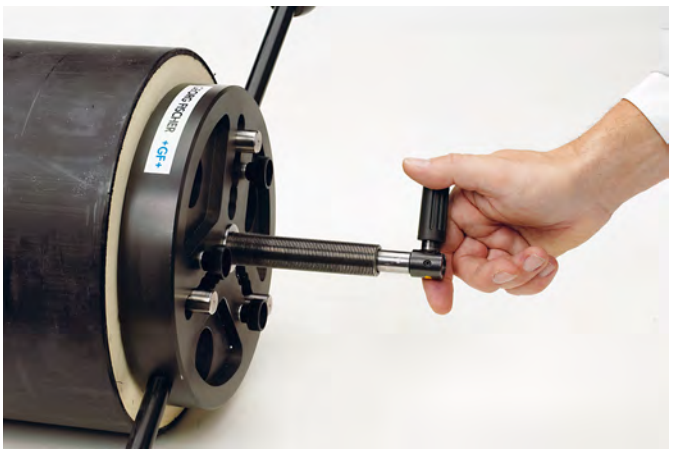


7 Wind in cutting head, checking that the cutting knife and the other 2 locating heads are assembled in the correct location.

8 Please note that the tool calibrates the pipe and therefore may not always remove material and may remove different amounts of material as it cuts.

9 The cutting knife can be rotated to cut with a fresh edge if the knife becomes blunt or if it is damaged.

10 Wind in the cutting head until it butts up to the end of the pipe.



11 Wind in the locating jaws until the tool is loose, then carefully retract the tool, taking care not to damage the pipe.

12 It is recommended that the installer checks the diameter of the calibrated pipe using the enclosed gauge. The internal diameters required are also listed in the COOL-FIT ABS catalog and in the tooling instructions.

13 After the calibration process the pipe must be chamfered again!

Instruction for insulating the gap

Please take care that the short shrink sleeve has been placed over the pipe before joining.

If it is not possible to use the shrink sleeve or the sleeve is damaged, GF Piping Systems has a sealing wrap, effectively a heavy-duty tape available on demand. It is also possible to use other heavy-duty insulating tapes instead of the shrink sleeve. For the lifespan and sealing properties of these tapes, please consult the individual manufacturers.

Wrap the gap insulator into the gap between the COOLFIT ABS Plus components, taking care to ensure that the gap is completely filled.

Apply the double sided sealing tape around the complete circumference of the outer pipe.

Place the shrink sleeve over the middle of the gap. Fittings of the latest generation do have indicators that help to position the shrink sleeve correctly. Locate the sleeve by pressing it onto the double sided sticky tape.

Using an open flame apply heat to the sleeve, taking care to keep the flame moving to avoid the sleeve melting. To avoid the sleeve distorting apply the heat to the middle of the sleeve, not from the side. The sleeve will now shrink to the outside diameter of the jacket pipe.
Note: hot air can be used to shrink the sleeve but is not recommended due to the high amount of energy required to activate shrinking.

Retrofit of adapter fittings into an existing ABS, PVC, or CPVC pipeline

Existing situation:
Occasionally there is the need to install measuring devices, venting devices, or similar into an existing piping system without using additional installation fittings.

Solution:
At the section of the piping system with greatest wall thickness (in the middle of the joint) a hole is drilled for the spigot of the adapter fitting. Then a suitable adapter fitting is solvent cemented into the hole which acts as socket.

Installation steps in detail:

1. The hole is drilled into a drained pipe section.
2. The hole is drilled at a right angle to the pipe axis.
3. The hole diameters and tolerances given in the attached table correspond to socket dimensions according to ISO 727-1 and are to be observed.
4. The dimension X in the attached table indicates the distance from the entrance of the socket to the middle of the hole to be drilled in order to place it in the middle of the joint.
5. Use a suitable deburring tool to deburr the edges of hole.
6. Shavings should be removed from the pipe.
7. Allowed combinations of pipe and adapter fitting are indicated in the attached table with *yes*.
   The selection is such that the spigot of the adapter fitting does not reach into the medium-filled pipe for more than 1 mm as well as fully covering the hole drilled into the joint.
8. The spigot is solvent cemented into the drilled hole according to the instructions for solvent cement jointing given in our Planning Fundamentals.
9. Attend to waiting times before refilling and applying pressure to the system.

When correctly installed, the above joint is good for PN10 at 68°F with water as the medium.

Allowed combinations of pipe and adapter dimensions

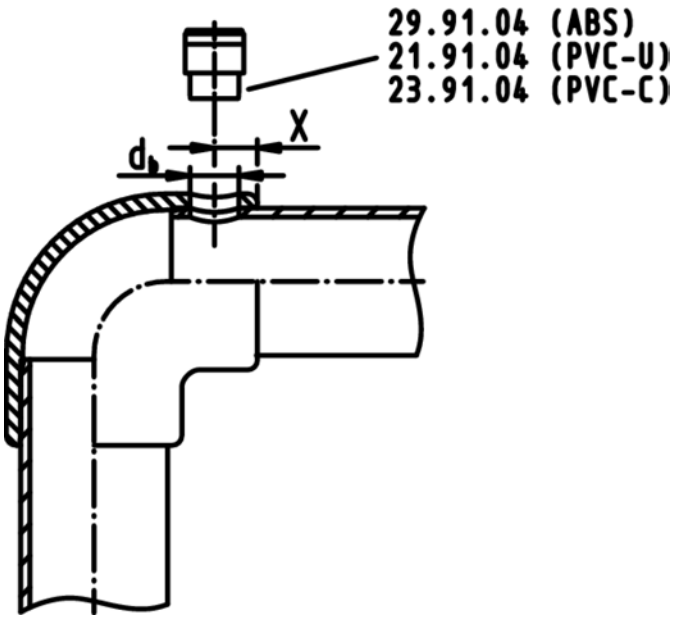
ABS PN10		**Wall thickness, e**	**Adapter dimensions**			
pipe diameter		S8, SDR17	20	25	32	40
75	x	4.5	Yes	Yes	No	No
90	x	5.4	Yes	Yes	No	No
110	x	6.6	Yes	Yes	No	No
125	x	7.4	Yes	Yes	No	No
140	x	8.3	Yes	Yes	No	No
160	x	9.5	Yes	Yes	No	No
180	x	10.7	Yes	Yes	Yes	No
200	x	11.9	Yes	Yes	Yes	No
225	x	13.4	Yes	Yes	Yes	Yes

ABS PN6		**Wall thickness, e**	**Adapter dimensions**			
pipe diameter		S12.5, SDR26	20	25	32	40
250	x	9.6	No	Yes	Yes	No
280	x	10.7	No	Yes	Yes	Yes
315	x	12.1	No	No	Yes	Yes

PVC PN10		**Wall thickness, e**	**Adapter dimensions**			
pipe diameter		S10, SDR21	20	25	32	40
125	x	6.0	No	No	No	No
140	x	6.7	Yes	No	No	No
160	x	7.7	Yes	Yes	No	No
180	x	8.6	Yes	Yes	No	No
200	x	9.6	Yes	Yes	Yes	No
225	x	10.8	Yes	Yes	Yes	Yes
250	x	11.9	No	Yes	Yes	Yes
280	x	13.4	No	Yes	Yes	Yes
315	x	15.0	No	No	Yes	Yes
400	x	19.1	No	No	Yes	Yes

PVC PN16		**Wall thickness, e**	**Adapter dimensions**			
pipe diameter		S6.3, SDR13.6	20	25	32	40
125	x	9.2	Yes	No	No	No
140	x	10.3	Yes	Yes	No	No
160	x	11.8	Yes	Yes	Yes	No

Dimensions of hole to be drilled



Adapter dimension	Hole diameter, d_b in mm
20	20.2
25	25.2
32	32.2
40	40.2
Tolerance	± 0.1 mm

Pipe dimension	Drill position X in mm
75	22
90	26
110	31
125	34
140	38
160	43
180	48
200	53
225	59
250	66
280	73
315	82
400	103
Tolerance	± 1 mm

Internal pressure test and leak test

Introduction to pressure testing

Overview of the different testing methods

Testing method	Internal pressure test			Leak test	
Medium	Water	Gas *	Compressed air *	Gas/air (oil free)	Gas/air (oil free)
Art	incompressible	compressible	compressible	compressible	compressible
Test pressure (overpressure)	$p_{p(perm)}$ resp. 0.85 x $p_{p(perm)}$	Operating pressure + 29 psi	Operating pressure + 29 psi	7 psi	7 psi
Endangerment during pressure test	small	high	high	small	middle
Material	all plastics	ABS	PB, PE	all plastics	ABS
Informative value	High: Proof of resistance to pressure including tightness against test medium	High: Proof of resistance to pressure including tightness against test medium	High: Proof of resistance to pressure including tightness against test medium	small	middle

* Please consider the applicable safety precautions More information is available in DVS 2210-1 Suppl. 2.

A lot of international and national standards and guidelines are available for leak and pressure tests. Therefore often it is not easy to find the applicable test procedure or for example the test pressure.

The purpose of a pressure test is

- first to ensure the resistance to pressure of the pipeline and
- in addition to show the leak tightness against the test media.

Usually the pressure test is done as a **water pressure test** and only in exceptional cases (with consideration to special safety precautions) as a gas pressure test with air or nitrogen.

The following comparison should point out the difference between water and air as a test medium:

- Water is an incompressible medium, which means, setting for example a 1m PVDF pipe d160 under a pressure of 44 psi results in an energy of ca. 1 Joule.
- In contrast, air is a compressible medium; the same pipe has with 44 psi pressure an energy of already 5000 Joule.
- If there were a failure during the pressure test, the water-filled pipe would fly ¾ inch high; the airfilled pipe, 361 feet! And this with a test pressure of only 44 psi.

Fracture behavior of thermoplastics
In case of failures, thermoplastic materials show different behaviors. PE and PB (to a lesser degree ABS) have a ductile behavior, which means brittle fracture cannot occur.

Nevertheless, the following safety precautions must be taken into consideration during the internal pressure test. As mentioned before, the pressure test is the first loading placed on the pipeline and uncovers any existing processing faults (e.g. insufficient welding).

Remark: Gas leak tightness cannot be demonstrated by a water pressure test, also not with increased test pressure!

Internal pressure test with water or a similar incompressible test fluid

General

The internal pressure test is done when installation work has been completed and necessitates an operational pipeline or operational test sections. The test pressure load should furnish experimental proof of operational safety. The test pressure is not based on the working pressure, but rather on the internal pressure load capacity, derived from the pipe wall thickness.

Supplement 2 of DVS 2210-1 forms the basis for the following information. This replaces the data in DVS 2210-1 entirely. The modifications became necessary because

- the reference value ”nominal pressure (PN)” is being used less and less to determine the test pressure (1.5 x PN, or 1.3 x PN) and is being replaced by SDR,
- a short-term overload or even a reduction in the service life can occur if in the course of the internal pressure test based on the nominal pressure the pipe wall temperature T_R = 68°F is exceeded by more than 41°F.

Test pressures are therefore determined in relation to SDR and the pipe wall temperature. The 100-h value from the long-term behavior diagram is used for the test clamping.

Test Parameters

The following table indicates recommended methods of testing the internal pressure.

Object	Pre-test	Main test
Test pressure p_p (depends on the pipe wall temperature or the permissible test pressure of the built-in components, see clause "Determining the test pressure")	$\leq p_{p(perm)}$	$\leq 0.85\ p_{p(perm)}$
Test duration (depends on the length of the pipeline, respectively the sections)	L ≤ 100 m: 3 h 100 m <L ≤ 500 m: 6 h	L ≤ 100 m: 3 h 100 m <L ≤ 500 m: 6 h
Checks during the testing (test pressure and temperature progression should be recorded)	At least 3 checks, distributed over the test duration **with** restoring the test pressure	At least 2 checks, distributed over the test duration **without** restoring the test pressure

Pre-test

The pre-test serves to prepare the piping system for the actual test (main test). In the course of pre-testing, a tension-expansion equilibrium in relation to an increase in volume will develop in the piping system. A material-related drop in pressure will occur which will require repeated pumping to restore the test pressure and also frequently a re-tightening of the flange connection screws.

The guidelines for an expansion-related pressure decrease in pipes are:

Material	Pressure drop
PVC	7 psi/h
CPVC	9 psi/h
ABS	9 psi/h
PP	12 psi/h
PE	17 psi/h
PB	20 psi/h
PVDF	12 psi/h

Main test

In the context of the main test, a much smaller drop in pressure can be expected at constant pipe wall temperatures so that it is not necessary to pump again. The checks can focus primarily on leak detection at the flange joints and any position changes of the pipe.

Observe if using compensators

If the pipeline to be tested contains compensators, this has an influence on the expected axial forces of the pipeline. Because the test pressure is higher than the working pressure, the axial forces on the fixed points become higher. This has to be taken into account when designing the fixed points.

Observe if using valves

When using a valve at the end of a pipeline (end or final valve), the valve and the pipe end should be closed by a dummy flange or cap. This prevents inadvertent opening of the valve or any pollution of the inside of the valve.

Filling the pipeline

Before starting with the internal pressure test, the following points must be checked:

- Was installation done according to the available plans?
- All pressure relief devices and flap traps mounted in the flow direction?
- All end valves shut?
- Valves in front of other devices are shut to protect against pressure.
- Visual inspection of all joints, pumps, measurement devices and tanks.
- Has the waiting period after the last fusion / cementing been observed?

Now the pipeline can be filled from the geodetic lowest point. Special attention should be given to the air vent. If possible, vents should be provided at all the high points of the pipeline and these should be open when filling the system. Flushing velocity should be at least 1 m/sec.

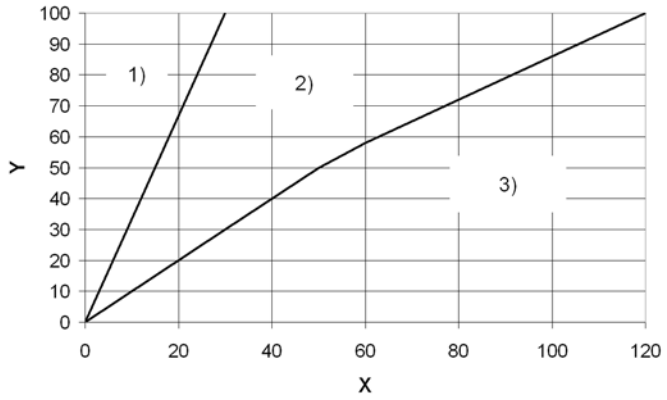
Reference values for the filling volume are given in the table below.

d	V (l/sec)	d	V (l/sec)
90	0.15	280	2.0
110	0.3	315	3.0
160	0.7	400	6.0
225	1.5	500	>9.0

Adequate time should be allowed between filling and testing the pipeline, so that the air contained in the piping system can escape via the vents: ca. 6 - 12 h, depending on the nominal diameter.

Applying the test pressure

The test pressure is applied according to the diagram. Here it is important that the pressure increase rate does not cause any water hammer !



Y test pressure in %

X time for pressure increase in min

1) pressure increase rate up to DN100

2) range of pressure increase rates between DN100 - 400

3) values for pressure increase rate DN500 and greater is: 500 / DN [bar/10 min]

Determining the test pressure

The allowable test pressure is calculated according to the following formula:

$$P_{p(perm)} = \frac{1}{SDR} \cdot \frac{20 \cdot \sigma_{v(T,100h)}}{S_P \cdot A_G}$$

with

$\sigma_{v(T, 100h)}$ Long-term creep strength for the pipe wall temperature T_R (at t = 100 h)

S_p Minimum safety factor for long-term creep strength

A_G Processing or geometrical specific factor that reduces the allowable test pressure

T_R Pipe wall temperature: average value of test medium temperature and pipe surface temperature

NOTICE

Diaphragm valves, types 314-319, 514-519

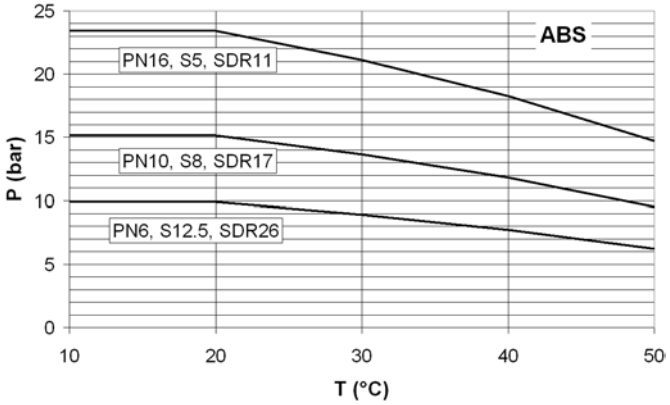
Don't overload diaphragm valves!

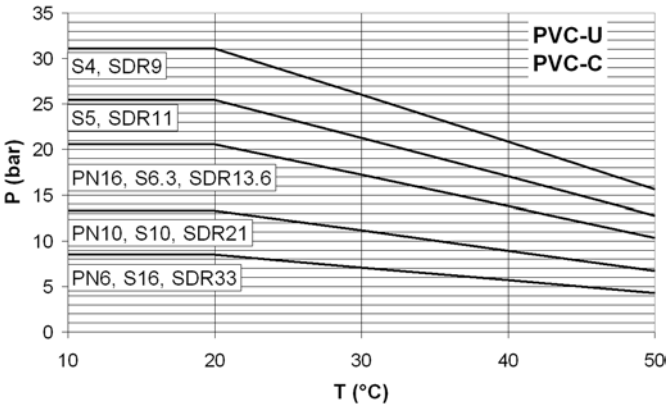
- If the piping system contains diaphragm valves, the maximum allowable test pressure is limited to the nominal pressure.

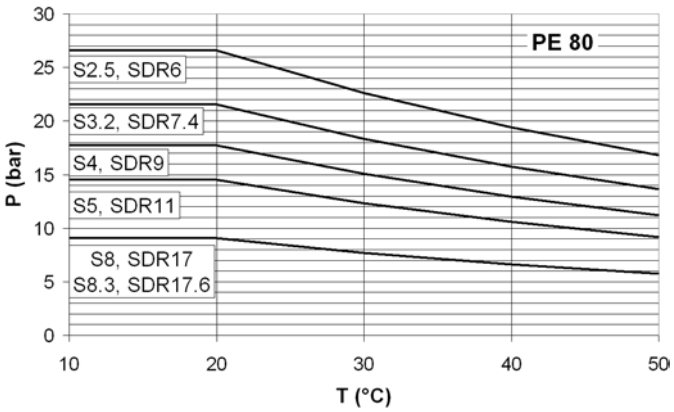
Material	S_p Minimum safety factor
ABS	1.6
PE80, PE100	1.25
PP-H	1.8
PP-R	1.4
PVC, CPVC	2.5
PVDF	1.4

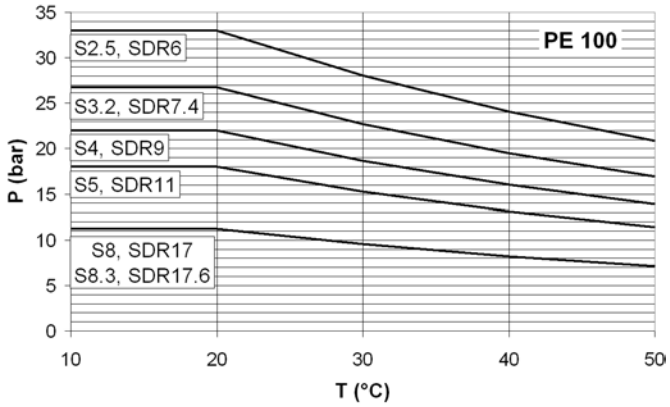
To make things easier, the permissible test pressures can be taken directly from the following diagrams.

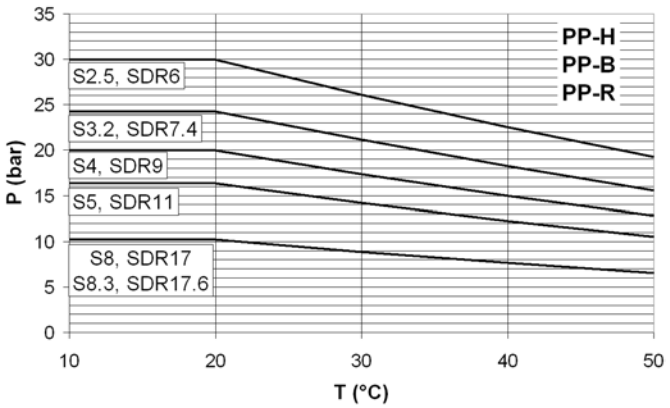
Definitions:
P = permissible test pressure in bar
T = pipe wall temperature in °C

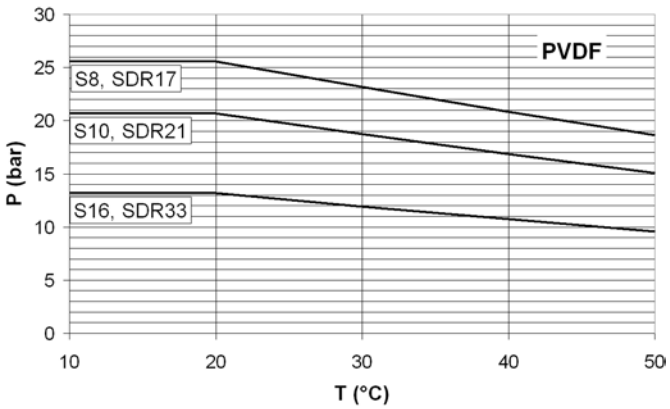












Checks during testing

The following measurement values must be recorded consistently during testing:

- Internal pressure at the absolute low point of the pipeline
- Medium and ambient temperature
- Water volume input
- Water volume output
- Pressure drop rates

Internal pressure test and leak tightness test of ABS pipelines with gas/air as test fluid (compressible medium)

Introduction

Usually the pressure test is done as a **water pressure test** and only in exceptional cases (with consideration of special safety precautions) as a gas pressure test with air or nitrogen (please consider also the general chapter "Introduction into pressure testing").

Safety precautions

WARNING

Compressible media like gas, air or nitrogen under internal pressure.

In case of failure danger to life during the internal pressure testing by explosively exhaust of medium.

- The area around the pipeline under test pressure is to be clearly restricted for access only by persons assigned with the testing.
- Necessary control equipement is to be placed at a safe distance.
- The testing should be timed so that there are as few persons as possible in the immediate area.
- In particular at the entrances to the endangered area additional signs are to be set up (Entry prohibited, Attention! Gas pressure tests!). If necessary, persons in neighboring buildings are to be informed.

Observe if using compensators

If the pipeline to be tested contains compensators, this has an influence on the expected axial forces of the pipeline. Because the test pressure is higher than the working pressure, the axial forces on the fixed points become higher. This has to be taken into account when designing the fixed points.

Observe if using valves

When using a valve at the end of a pipeline (end or final valve), the valve and the pipe end should be closed by a dummy flange or cap. This prevents inadvertent opening of the valve or any pollution of the inside of the valve.

Minimum waiting times for the internal pressure test

Before carrying out the pressure test, observe the minimum waiting times after the last cementing given in the following table:

Ambient Temperature	Waiting time
50-86°F	min. 48 hours

Testing procedure of the internal pressure test
The test pressure shall be least 29 psi higher than the operating pressure but with a maximum pressure of nominal pressure PN of the installed piping system. Any components with a lower PN than the rest of the piping systems shall be considered. The test temperature shall be between 50-86°F.

The pipelines must be free from any grease or paint.

Only oil free air or inert gases such as nitrogen should be used as the test medium. No refrigerant gases, such as R22, may be used.

Once the pressure in the system has stabilized, hold the pipeline under the test pressure for at least 15 minutes. If a drop in pressure is observed and inspection of the joints is necessary, this can be done using a foam-building agent. Using a soap solution which can be removed simply with water after the test is recommended.

NOTICE

Leak detection sprays

Commercial leak detection sprays can cause stress cracks in plastics.

- When using these sprays, remove any residues after testing.

Information:
For valves leak tightness using a gas is not representative of the valves leak tightness with a fluid. Therefore if a GF valve shows a leakage under internal pressure test with a gas it is recommended to reduce the pressure to 22 psi and re-inspect the valves.

Leak tightness test with gas/air
For checking the leak tightness shortly after installation a test pressure of up to 22 psi bar with a minimum waiting time of 3 hours applies.