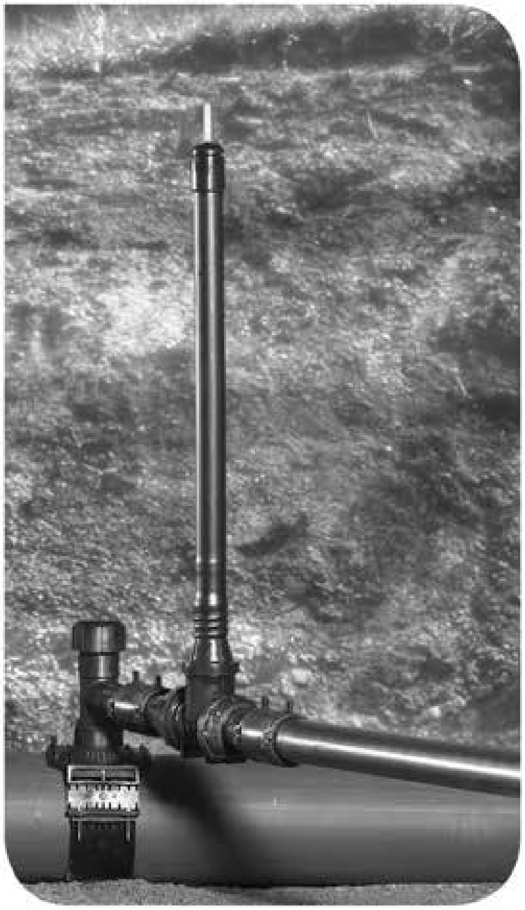
Technical Manual

For PE Piping Systems in Utilities



+GF+

GEORG FISCHER
PIPING SYSTEMS

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Introduction

Disclaimer

The technical data is not binding.They neither constitute expressly warranted characteristics nor guaranteed properties nor guarateed durability. They are subject to modification.
Our General Terms of Sale apply.

Adding Quality to People's Lives

People all over the world rely on the commitment of Georg Fischer to satisfy their needs today and tomorrow.

Comfort

A reliable supply of clean water is becoming a crucial challenge. **GF Piping Systems** makes the worldwide supply of drinking water easier and enables the transport of liquids for industrial purposes.

Mobility

People are increasingly mobile, and they have ever greater demands for comfort and safety in their vehicles. With its highly stress-resistant cast parts made of light metal and iron, **GF Automotive** products makes it possible to build passenger and commercial vehicles that are both lightweight and safe.

Precision

Series production of consumer goods and quality components requires extreme precision and demanding manufacturing technologies. The necessary moulds, tools and parts are produced with machines and system solutions from **GF Machine Tools** (Agie Charmilles GF).

GF Piping Systems

GF Piping Systems is one of the three businesses units of the Georg Fischer Corporation and a leading supplier of piping systems in plastic and metal with a global market presence.

We are dedicated to designing, manufacturing and marketing piping systems for the safe and secure conveyance of liquids and gases.

One-stop shopping at GF Piping Systems with over 50000 products for diverse applications and specialised markets: from pipes and fittings to valves and measurement instruments and their respective jointing technologies. Tailor-made solutions for any application in which fluids or gases are conveyed, whether for industrial systems, in building technology or for water and gas utilities.

Sales companies in 20 countries and representatives in another 80 countries ensure customer support round-the-clock.

Manufacturing sites in Europe, Asia and the US are near the customers and meet local requirements. All components and systems comply with the applicable standards in each market area and are tested in accredited test laboratories.

Our own distribution centre together with e-commerce and information technology ensure rapid delivery.

We are your partner for the safe and secure conveyance of liquids and gases

The requirements placed on piping systems are as diverse and demanding as the applications in which they are implemented. Here you can find a selection of market segments where we offer solutions. Our wide range of systems can also be used in many other applications. Please contact us for more information.

Quality, environmental and social policies

Introduction

Quality,environment and social policies are a major concern of the Georg Fischer Corporation. Approximately 90 % of the 12000 persons employed at the end of 2005 worked in corporate subsidiaries with quality management systems certified to internationally recognised standards such as ISO 9001. We create competitive advantages for ourselves and our customers with consistent quality tailored to their needs and continuous improvements to business processes.

Our products achieve increasingly higher ecological efficiency. This means that products are becoming more efficient while the impact on the environment in the production and utilisation phase remains the same or is reduced. Plastic piping systems from GF are lightweight to transport, corrosion-resistant and durable. They protect drinking water, a valuable resource, all the way from its source to individual homes.

Quality assurance at all levels

Improvement process
Your experiences with our products and services help us to continuously improve our scope of performance and to react quickly to your needs. Our employees are fully behind this concept with their know-how and expertise.

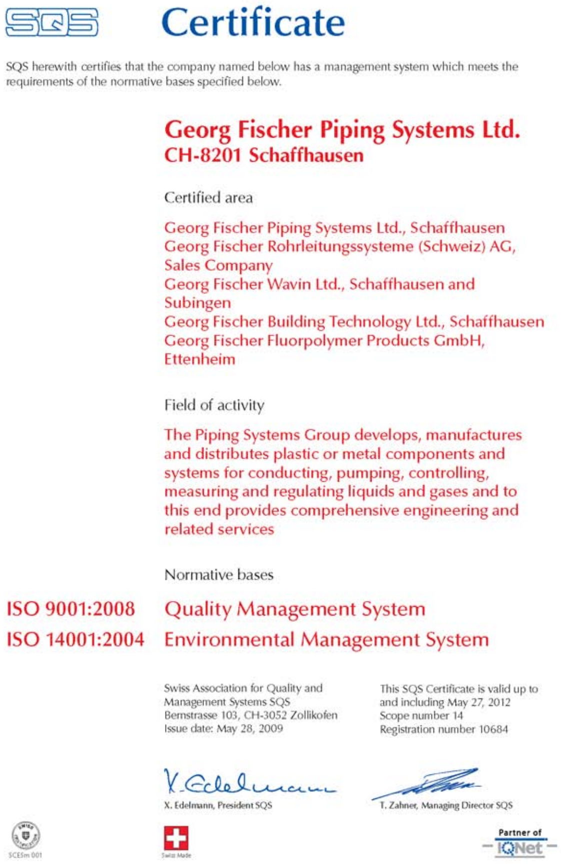
Customer satisfaction
This and more we offer for your benefit:

- Complete systems for a wide spectrum of applications
- Reliable, high-quality products
- Comprehensive service: customer support and training, fusion machine rentals, planning tools
- We fulfil the various technical requirements: international standards, approvals required for specific countries and applications
- Effective logistics

Quality planned, manufactured and tested
You can expect consistent quality from us at all levels.

- Dynamic research and development
- The most modern production technology with integrated quality control in our plants
- Accredited test laboratory according to ISO/IEC 17025

A certified management system according to ISO 9001 is essential in reaching our uppermost goal: customer satisfaction.


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

SCESm 001

Swiss Made

Partner of IQNet

Environment

Application know-how for a clean environment
Our wealth of expertise in plastic piping systems applications has always been exercised with regard to a clean environment.

- ABS for the conveyance of environmentally friendly cooling agents in refrigeration
- Secondary containment systems for increased safety of persons and the environment when conveying aggressive media
- Better energy efficiency with plastics as compared to other pipe materials

Value added for the customer
We aim to understand and meet customer requirements regarding environmentally friendly products and services, and in doing so are a competent partner for environmentally conscientious customers.

We achieve this by designing products and production processes which are compatible with environmental requirements and also by communicating intensively with our customers to understand what their needs are and adjusting our performance accordingly.

Environmental management
Our environmental management system enables us to:

- handle environment-related questions professionally
- control risks
- continuously evaluate and improve processes, products and services

ISO 14001 certification is only just the beginning. We are committed to evaluating and improving our environmental performance on a regular basis.


IQNet

THE INTERNATIONAL CERTIFICATION NETWORK

CERTIFICATE

IQNet and SQS

hereby certify that the organisation

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has implemented and maintains a

Management System

which fulfills the requirements of the following standard

ISO 9001:2008 / ISO 14001:2004

Scope No: 14
Issued on: 2009-05-28
Validity date: 2012-05-27
Registration Number: **CH-10684**

René Wasmer
President of IQNet

Theodor Zahner
Managing Director SQS

IQNet Partners:*

AENOR *Spain* AFNOR Certification *France* AIB-Vinçotte International *Belgium* ANCE *Mexico* APCER *Portugal* CISQ *Italy* CQC *China* CQM *China* CQS *Czech Republic* Cro Cert *Croatia* DQS Holding GmbH *Germany* DS *Denmark* ELOT *Greece* FCAV *Brazil* FONDONORMA *Venezuela* HKQAA *Hong Kong China* ICONTEC *Colombia* IMNC *Mexico* Inspecta Certification *Finland* IRAM *Argentina* JQA *Japan* KFQ *Korea* MSZT *Hungary* Nemko AS *Norway* NSAI *Ireland* PCBC *Poland* Quality Austria *Austria* RR *Russia* SII *Israel* SIQ *Slovenia* SIRIM QAS International *Malaysia* SQS *Switzerland* SRAC *Romania* TEST St Petersburg *Russia* TSE *Turkey* YUQS *Serbia*

IQNet is represented in the USA by: AFNOR Certification, CISQ, DQS Holding GmbH and NSAI Inc.

** The list of IQNet partners is valid at the time of issue of this certificate. Updated information is available under www.iqnet-certification.com*

Social policies

Responsibility in all areas

Reporting

At the end of 2005, the Corporation for the first time systematically collected and evaluated detailed information on the workforce, terms of employment, health and safety in the workplace, training and continuing development. This project is being managed by the Corporate Sustainability Officer, who reports directly to the Head of Corporate Planning and therefore to a member of the Executive Committee. The results will be used as the basis for setting targets and defining any necessary improvements.

Employees

Well-qualified, highly trained and dedicated employees are a key factor for Georg Fischer's success. Interesting tasks, in-depth training, attractive pay and social benefits are just as important as a responsible attitude to employees, even in an intensely competitive and difficult business environment.

Employee development

Georg Fischer's continuing personal and professional development programmes range from apprenticeships to further training courses for employees and managers and seminars for senior management. By providing focused development opportunities, we keep our employees fit for the job, which in turn improves both their career prospects and our competitiveness.

Employee satisfaction surveys

Georg Fischer carries out regular employee satisfaction surveys. In one year, some 4000 employees were asked to provide feedback. The responses of employees, employee representatives and management, were then used as the basis for plans of action with clearly defined responsibilities. These are now in implementation ideas management has also played an important role for the improvement of work processes for many years. Furthermore, working conditions at almost every location have been improved by installing lifting equipment, reducing noise and particle emissions, replacing and/or reducing hazardous substances and other measures.

Training

Invest in the training of your employees
Qualified personnel is one of the key factors for the success of a company.

Only skilled employees with the appropriate know-how and customer focus are reliable partners.

We offer you an interesting training experience
GF Piping Systems, as a professional system and solution provider, offers you training courses with a focus on products, applications, sales arguments and different customer requirements.

The jointing technologies, as well as measurement and control technology are increasingly innovative. To stay up-to-date, you need continuing education.

GF Piping Systems contributes essentially to your know-how. No matter what your expert field may be – utilities, building technology or industrial applications – you can benefit from the training courses, which are adapted to the different market segments and applications.

We offer a customised programme for salespersonnel and occupational groups like installers, planners and constructors. Besides the theory, we attach great importance to hands-on practice. Our rooms are especially equipped for practical training. They are suitable for simultaneous training of up to 100 persons under ideal conditions.

For the choice of trainers, we work closely with our sales staff. There are Basic, Advanced and Master Courses covering the full spectrum of issues. More information about our current training program:
http://www.piping.georgfischer.com

Accredited test centre for components used in plastic piping systems

General

A testing laboratory which is an officially accredited test centre for components used in piping systems accredited to ISO/IEC 17025.

The Georg Fischer testing laboratory is fully equipped to perform the most diverse tests on products used in piping systems such as pipes, fittings, manual and automatic valves, flow meters and other pipeline components in accordance with relevant standards as well as own and external test specifications.

Contracts for test laboratory programmes are executed on behalf of research and development departments, manufacturing plants, end-users of GF Piping Systems components as well as for authoritative organisations.

Development and product release tests are completed for R & D departments (TT type testing, ITT initial type testing), batch release tests (BRT) and process verification tests (PVT) for our own production units as well as other test programmes for outside companies.

The experience and competence of our personnel, the high standard of continuous education, the technical level of our test facilities and equipment as well as the well-documented recording of laboratory procedures answer all fundamental prerequisites for an ISO/IEC 17025 accreditation. The accreditation through the SAS (Schweizerische Akkreditierungsstelle) is verified by a certificate. A reassessment for the accreditation is made on an annual basis whilst a re-accreditation inspection is implemented every 5 years.

The SAS, which is responsible for and has issued our accreditation, is a member of the International Laboratory Accreditation Cooperation (ILAC). All laboratories accredited by the ILAC are obliged to formally recognise any test report issued by a fellow member. This permits us, and our customers, to use all accredited test reports originating from our laboratory to obtain product approvals and quality certificates etc.. Therefore, potential expenditure and time consumption is considerably reduced.

The accredited test programme also includes:

- Long-term internal pressure testing (EN ISO 10931, EN ISO 15493, EN ISO 15494, ISO 9393)
- Burst tests on fittings and pipes
- Flattening tests (ISO 9853)
- Impact resistance tests (ISO 8085, ISO 13957)
- Decohesion test
- Peeling test (ISO 13954)
- Tensile strength and failure mode on butt-fused test specimens (ISO 13953)
- Pressure drop test (EN 12117)
- Determination of density (EN ISO 1183)
- Melt flow rate (EN ISO 1133)
- Oxidation induction time OIT (EN 728)

A complete listing of accredited tests can be seen in a table. This table, which is constantly updated, can be referred to by consulting the following internet site: www.sas.ch =>Accredited bodies =>Search =>STS 094.

Test laboratory certificate

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Department of Economic Affairs DEA
Swiss Accreditation Service SAS

Based on the Accreditation and Designation Ordinance dated 17 June 1996 (as of 1 December 2007) and on the advice of the Federal Accreditation Commission, the Swiss Accreditation Service (SAS) grants to

Georg Fischer Piping Systems Ltd.
Testing Laboratory
Ebnatstrasse 101
CH-8201 Schaffhausen

the accreditation as

Testing laboratory for components of piping systems

in accordance with the Standard ISO/IEC 17025. The scope of accreditation is defined in the Official Directory of the Accredited Testing Laboratories.

Accreditation mark and number: STS 094
Date of accreditation: 11 January 1995
Date of the last renewal of accreditation: 11 December 2009
The accreditation is valid until: 10 December 2014

CH-3003 Berne-Wabern, 25.03.2010
Swiss Accreditation Service

The Head
Hanspeter Ischi

SAS is a signatory of the multilateral agreements of the European co-operation for Accreditation (EA) for calibration, testing, inspection and certification of products, personnel, quality and environmental management systems, of the International Accreditation Forum (IAF) for certification of products, quality and environmental management systems and of the International Laboratory Accreditation Cooperation (ILAC) for calibration and testing.

Introduction to plastics

History

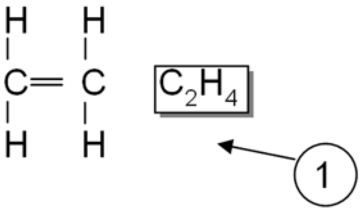
As early as 1838 Viktor Regnault succeeded in producing polyvinylchloride in a laboratory by exposing vinylchloride to the sun.

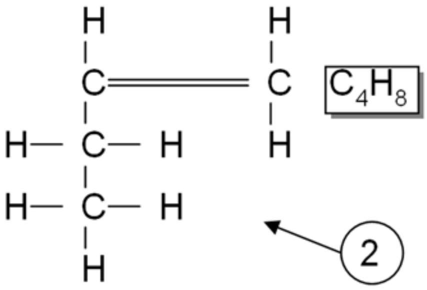
In 1912 Fritz Klatte discovered the fundamentals for the practical production of PVC.

During the World War I, plastics, which were still new, had to replace other materials falling into short supply. They were then sometimes overspecified with respect to their application. Therefore, plastics needed to be improved. It was necessary to scrutinise the internal structure of these new materials closely.

Only in 1938 did the production of plastics in any, significant volume begin, when the numerous application possibilities had been recognised.

Structure of plastics





1 Ethylene-Monomer

2 Butylene-Monomer

Plastics are materials which are created by chemical conversion of natural products or in a synthetic[1] manner from organic[2] compounds. The main components are the elements **carbon (C) and hydrogen (H).** The basis of most plastics are **carbon-hydrogen compounds,** from which the single components of plastics, the so-called monomers[3], are produced.

1) Synthesis: production of a chemical compound from different elements or simple molecules. Synthesis is the opposite of analysis.

2) Organic media are pure non-metals of natural occurrence, e. g. petroleum, coal, wood, natural gas. Inorganic media are compounds of metal and non-metals, e .g. minerals, ores etc.

3) Monomers are the basic molecules, i. e. the smallest components of which plastics are built.

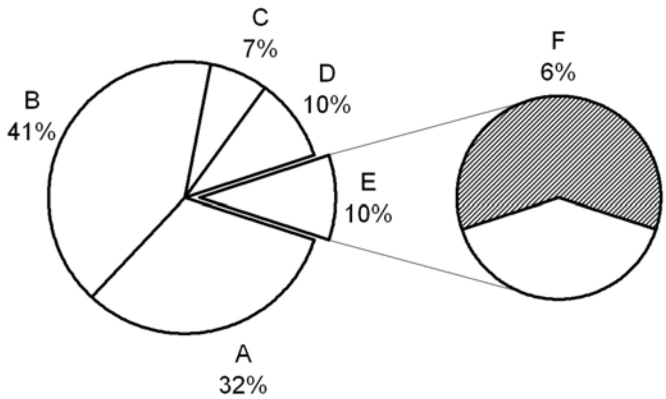
The raw material

Raw materials for the manufacture of plastics are natural compounds, such as cellulose, coal, petroleum and natural gas. In a refinery, petroleum is separated into several components by means of distillation. Grouped into evaporisation ranges, gas, benzene, petroleum, gaseous oil, and as a residue bitumen are obtained during distillation.

All components consist of hydrocarbons which only differ in size and form of the molecules. The most important component for plastics production is crude benzene.

In a heat cracking process this crude benzene is broken down into ethylene, propylene, butylene and other hydrocarbons and is then modified.

The production of plastics



A Heating 32 %

B Traffic 41%

C Other 7 %

D Industry 10 %

E Chemicals 10 %

F incl. 6 % Plastics

Plastics are manufactured by compounding together large number of similar basic components (monomers) through chemical bonding.

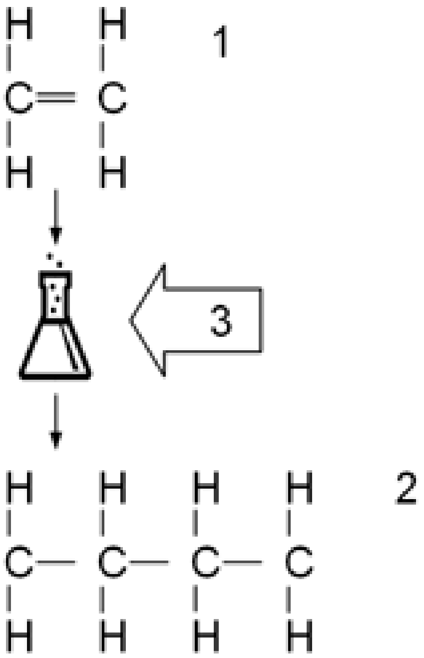
The plastic industry only consumes approximately 6 % of the petroleum products originating from refineries.

In Germany the chemical industry uses approximately 10 % of the entire crude oil consumption and this includes 6 % for plastics.

To produce plastics three different processes are used:

- Polymerisation
- Polycondensation
- Polyaddition

Polymerisation



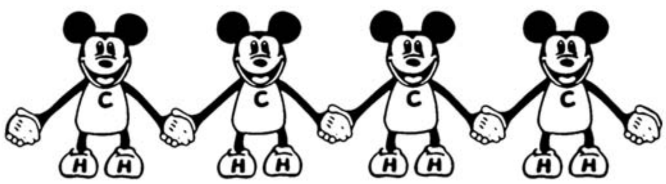
1 Monomer: Ethylene
2 Macromolecule chain: Polyethylene
3 Polymerisation process -->Energy, Catalist, Additives

Polymerisation is the most frequently used procedure for the synthesis of plastics. Polymerisation means the lining up of **macromolecule chains** without separation of foreign matter.

For example polyethylene, polybutene, polypropylene, polyvinylchloride and other plastics are all produced by means of polymerisation.

Examples:

Ethylene C_2H_4



Polyethylene

Polycondensation

Phenol + Formaldehyde
↓ ↓
Phenolic resin Water

During polycondensation similar and dissimilar monomers are lined up to become macromolecule chains, at the same time separating a by product, e. g. water, hydrochloric acid, etc.

Polycondensation is applied, for example, to produce phenolic resins and polyamids.

Polyaddition

During polyaddition macromolecules are created from chemically different molecules, however without separating a by-product.

The procedure is used for the production of polyurethanes and exposed resins (e. g. Araldit).

Classification of plastics

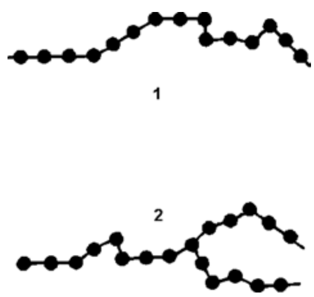
Plastics are subdivided into three main groups:	» Thermoplastics » Thermosets » Elastomers
Thermoplastics are again divided into:	» amorphous » semi-crystalline
Thermosets are divided into:	» Thermoelastics » Resins
Elastomers are divided into:	» Synthetic caoutchouc (rubber)

Distinction of plastics

In the production process, the procedure and the addition of additives (stabilisers, catalists, fibres, slip additives, etc.) create macromolecules with different basic structures.

Thermoplastics

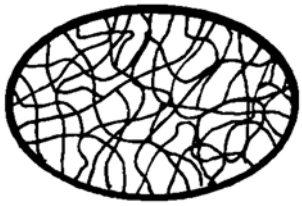
Thermoplastics consist of long filamentary molecules with or without branches.



1 Filamentary molecules without branches
2 Filamentary molecules with branches

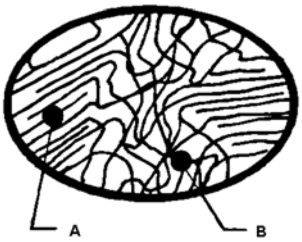
These filamentary molecules can be arranged as follows:

amorphous, i. e. in an inordinate structure



or **semi-crystalline**, i. e. in a partially ordinate structure

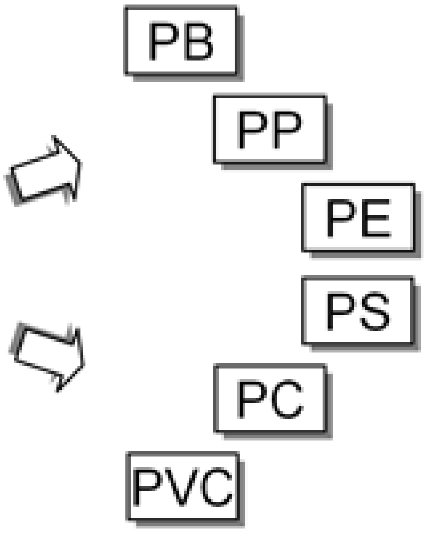
Crystallisation is increased by slow cooling.



A crystalline

B amorphous

Semi-crystalline thermoplastics are polyolefines, for example:



Amorphous thermoplastics are styrenes and vinyl chlorides, for example:

PE Polyethylene	**PVC** Polyvinylchloride
PB Polybutene	**PS** Polystyrene
PP Polypropylene	**PC** Polycarbonate

Thermoplastics are plastics with simple or branched filamentary molecules (macromolecules) which have an inordinate or partially ordinate structure. They distort during heating, melt and solidify again on cooling. This process can be repeated at all times. They can be plastically deformed, distended and recovered. Due to these properties, thermoplastics are suited for injection-moulding, extrusion and fusion.

”Plastic deformation” is the processing of a material by means of e. g. injection moulding, extrusion etc.

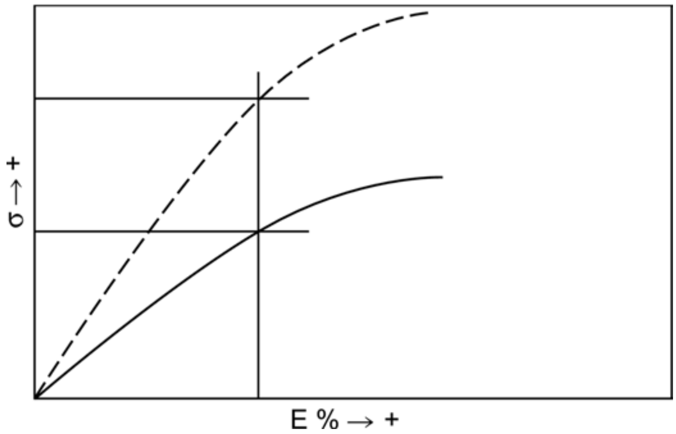
”Distension” is the longitudinal or longitudinal and transversal stretching of amorphous molecule chains to improve the material properties.

The ”recovery ability” is the memory behaviour of a material where the material is melted by heating and recover again in the original order during the cooling phrase.

Polyolefines belong to the semi-crystalline thermoplastics group. Compared with amorphous thermoplastics (e. g. PVC-U, PVC-C) they show less tensile strength, hardness, melting temperature and a lower E modulus. However they exhibit higher impact resistance, elongation at rupture and thermal expansion.

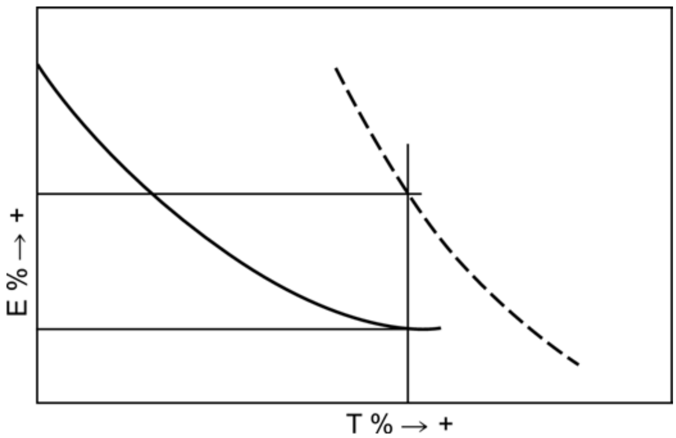
Semi-crystalline thermoplastics are more suited for fusion jointing than amorphous thermoplastics which are ideal for solvent cement jointing.

\- - - - amorphous -------- semi-crystalline



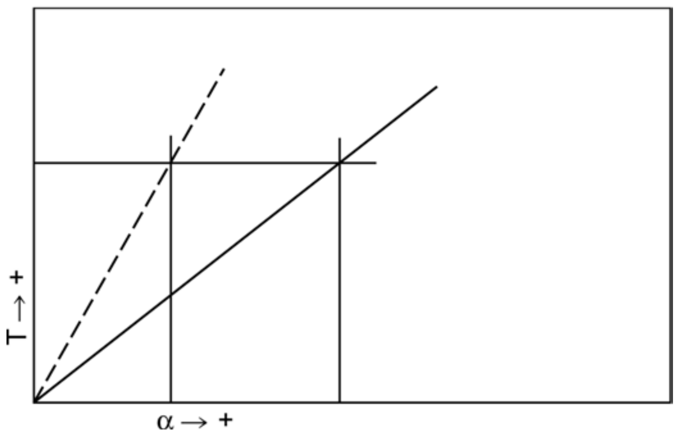
σ Tensile strength

E Strain %



ε Strain

T Temperature



α Thermal expansion

T Temperature

Thermosets

By means of a hardener the polymer chains of the fluid and solid thermoset resins are cross-linked. Thermosets which have been hardened in this way cannot be melted, fused or deformed.

Thermosets are normally reinforced with glass, textile or carbon fibres and other filling materials.

PF Phenolic resin

EP Epoxy resin

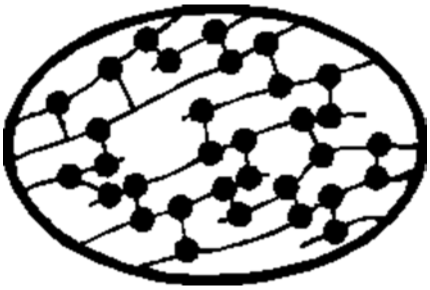
UP Polyester resin

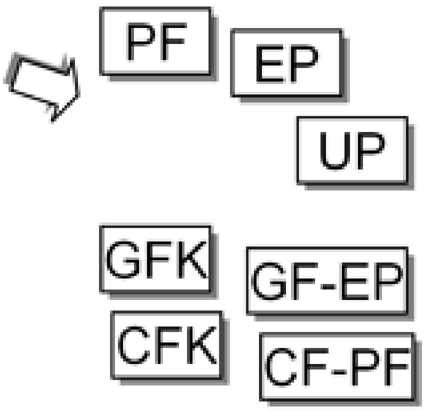
GFK Glass fibre plastic

CFK Carbon-fibre plastic

GF-EP Glass-fibre epoxy resin

CF-PF Carbon-fibre phenolic resin





Elastomers

Elastomers are rubber-elastic plastics, also called "synthetic caoutchouc". In contrast to thermosets, the network has a large mesh width. By means of vulcanisation aids the polymer chains are cross-linked. The amount of the cross-links, determines the hardness (the hardness is indicated in Shore degrees of hardness) of the rubber.

The elastomer is very elastic, can not be melted, is not fusible, can be deformed, but not reshaped.

Elastomers are for example

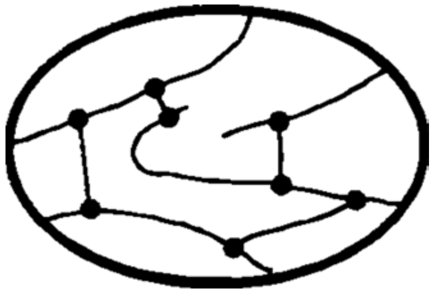
NR Natural rubber

EPDM Ethylene propylene rubber

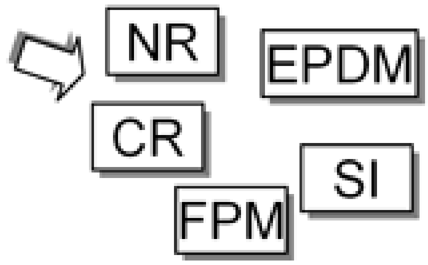
CR Chloroprene rubber

SI Silicone rubber

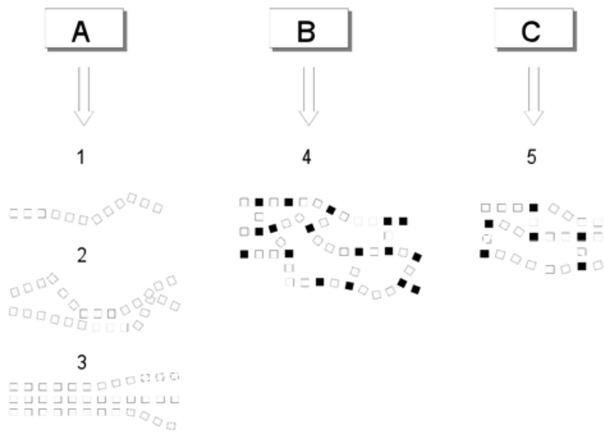
FPM Fluorocarbon rubber



Wide meshed, low cross-linked elastomer net



Comparison of thermoplastics, thermosets and elastomers



1 Filamentary molecules
2 Amorphous
3 Semi-crystalline
4 Space-net molecules, close-meshed
5 Space-net molecules, wide-meshed
A Thermoplastic
B Thermoset
C Elastomer

Thermoplastics

- repeated melting
- fusible
- the amount of crystallites determines the density and mechanical properties
- under strong mechanical stress they tend to creep and show lasting deformation
- the strength value decreases with increased heating
- can be transformed and deformed several times

Thermosets

- do not melt
- cannot be fused
- number of links is decisive for mechanical properties
- can be deformed under mechanical load, but regain their original form after load is removed
- only behave elastically in a relatively narrow upper temperature range, therefore more heat stable
- can only be deformed once

Elastomers

- do not melt
- cannot be fused
- number of links is decisive for the rubber hardness
- can be strongly deformed under mechanical stress
- remain elastic down to low temperatures

Relevant properties of thermoplastics

Compared to conventional materials, plastics offer the following general advantages:

- low weight
- high elasticity
- chemical resistance
- low heat conduction
- smooth surfaces

low density = low weight	Plastic 0.9 - 1.5 g/cm³
chemical resistance = no corrosion like known from metals	Metals link with oxygen and rust, except for stainless and acids-resistant steel.
low heat conductivity = small thermal loss	Plastics are poor heat conductors, but good insulators Thermal conductivity: PB 0.22 W/m K PE 0.38 W/m K PVC 0.15 W/m K
little condensation	Due to the poor thermal conductivity of plastic, less condensation occurs than with metal pipes.
high elasticity	Resistant against impact and bending stresses.
abrasion resistance	Approximately four times more abrasion resistant than steel pipelines.
leakproof connections	Plastics can be fused, solvent-cemented and compression jointed. Fusion connections and solvent-cemented joints can be made which are absolutely leakproof without any additional components.
smooth surface	Smooth surfaces ensure low pressure losses and no encrustation.
expansion	Plastics react more to temperature changes than metals. The longitudinal expansion of plastics is approx. 10 to 20 times greater than that of steel.
behaviour in fire	Most thermoplastics are combustible. Classification is made according to the standard material fire test.
electrically nonconducting	No electrolytic corrosion
sun rays	Some plastics are sensitive to UV rays and have to be protected - however, resistance to weathering is good.

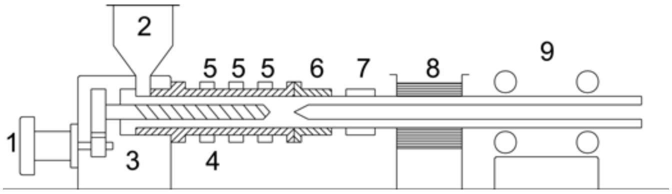
Processing of plastics

Plastics are processed differently depending on the material and application. Some common methods are:

- Extrusion
- Compression moulding
- Injection moulding
- Foaming

Extrusion

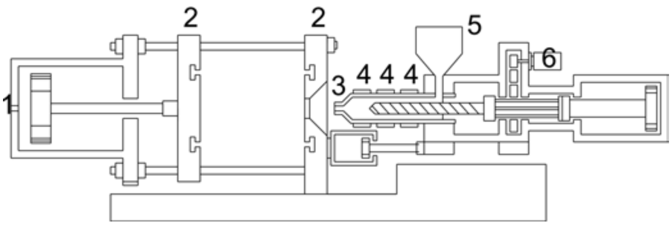
In this process thermoplastic material is melted and is continuously forced through a tool via a worm screw. The extruded bar is then calibrated, cools down and is withdrawn via a take-off unit.



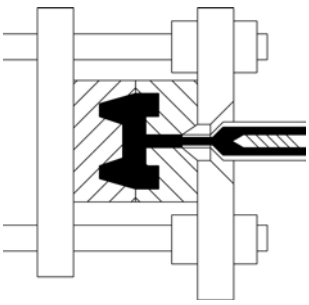
1 Driving motor
2 Material supply
3 Extruder
4 Plasticizing worm
5 Electric heat strips
6 Die
7 Calibration device
8 Cooling tank
9 Take-off unit

Injection moulding

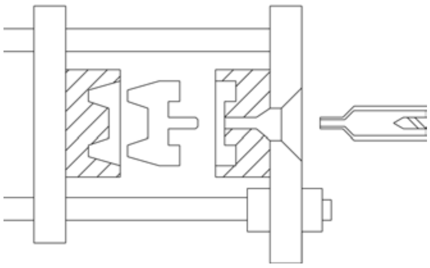
Thermoplastic material in granular or powder form is gradually melted in the cylinder and the mass is injected by means of the worm screw into a mould under high pressure. The plastic then solidifies and is ejected from the mould as a finished part.



1 Hydraulic mould closing cylinder
2 Mounting plates for both halves of the injection mould
3 Cylinder with injection nozzle
4 Electric cylinder heating
5 Material conveyor
6 Driving motor for worm screw



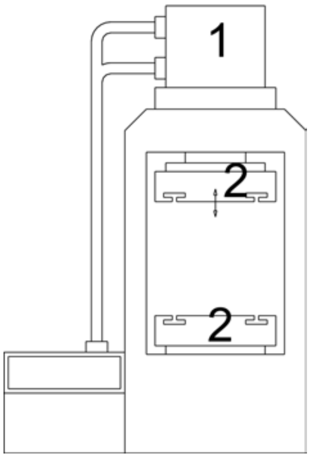
Injection



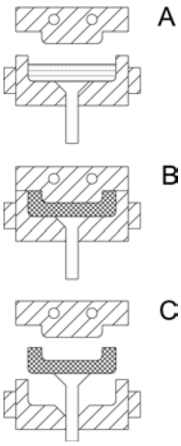
Ejection of the finished part

Compression moulding

Thermosetting material is poured into the open compression mould in powder form. Under the impact of the mould pressure and heat, it then chemically reacts and solidifies to the desired finished part.



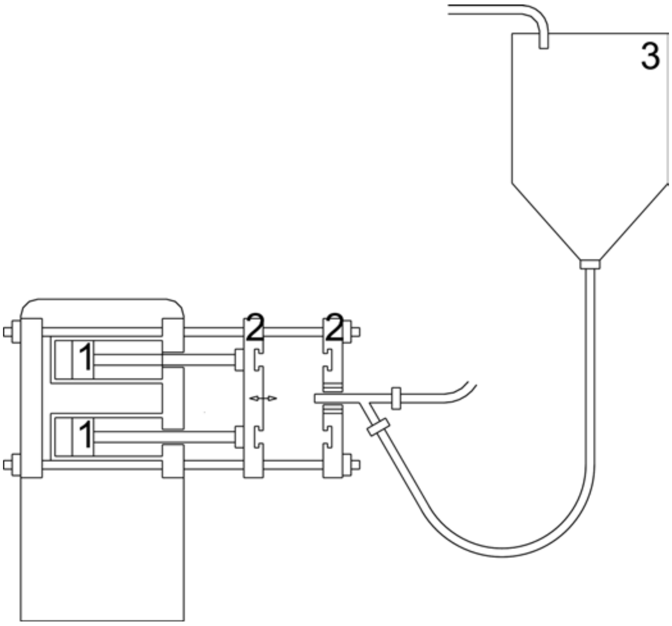
1 Pressure cylinder
2 Mounting plates for both halves of the pressure mould



A Fill in
B Press
C Ejection

Steam foaming

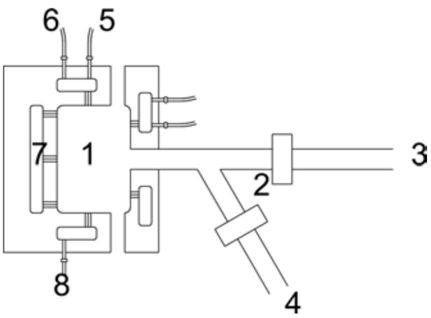
Foam machine



1 Mould closing cylinder
2 Mounting plates for both mould halves
3 Injector to blow in the pre-foamed material

Granular plastic containing a blowing agent is injected into the mould, expanded by means of hot steam, cooled with water and ejected from the foam mould as an extremely light weight part. Water absorption is impossible as all pores are closed.

Foaming mould



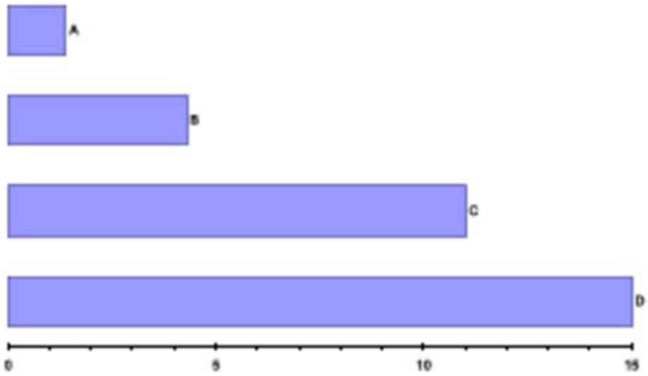
1 Mould cavity
2 Injector
3 Compressed air
4 Pre-foamed granulates
5 Steam
6 Cooling water
7 Steam nozzles
8 Cooling water outlet

Plastics and the environment

Using plastics means saving energy

Plastics constitute only a small percentage of the entire crude oil usage. But crude oil resources are limited. Already today we have to fall back upon raw materials which can be recycled and extend alternative energy sources. In this context we talk about re-usable raw materials.

All working processes need energy (heat, pressure, motor power). In comparison with metals, manufacturing plastics requires less energy. The production of 1 dm^3 material requires an amount of energy which is given in kilograms oil equivalent per litre material in the chart below.



A Plastics, e. g. PE/PP/PB/PVC
B Steel
C Copper
D Aluminium

Recycling

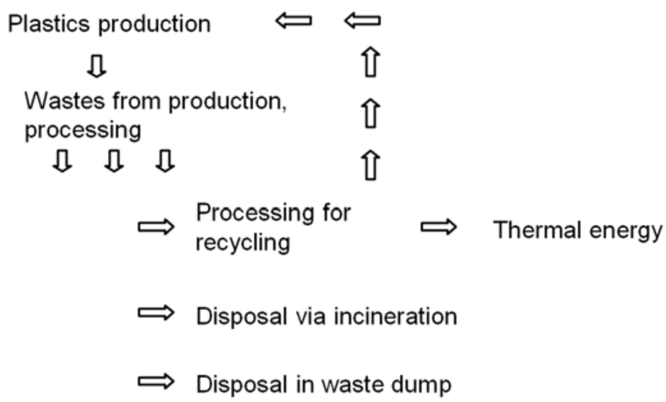
Although plastics make up only 6 % of oil consumption, the conclusion is that the energy value of plastic must be used. There are two possibilities of recycling:

- **reutilisation**, production of new products
- **combustion,** production of thermal energy.

In the case of **reutilisation** the plastic waste is brought back to its original form in different procedures (hydrolysis, pyrolysis, regranulation).

At GF, production waste is regranulated and integrated into the production process of products with lower quality and hygienic requirements than that of pipes and fittings.

All **thermoplastics** are **recyclable**, e. g. **PE, PP, PB, PVC-U, PVC-C, ABS** or **PVDF**. This is, however, not the case for thermosetting plastics and thermoelastomers such as PE-X.



Incineration together with domestic waste (no PVDF) does not pose any problems. In this case we talk about **energy recycling,** as almost all incineration plants recover waste heat. For example in Germany the annual plastic waste incinerated in this way supplies as much energy as 500 000 t of heating oil.

Thermal value of different materials

PE/PP/PB	44000 kJ/kg
Heating oil	44000 kJ/kg
Coal	29000 kJ/kg
PVC/PVC-C	19000 kJ/kg
Paper	16800 kJ/kg
Wood	16000 kJ/kg
Domestic waste	8000 kJ/kg

The production of corrosive combustion products is not possible in the case of polyolefines (PE, PP, PB) and ABS as halogens (e. g. chlorine) are missing in the molecular structure. In the case of PVC-U, PVC-C and PVDF special scrubbing towers are installed.

Plastics as well as other materials cannot be transformed into nothing, so **disposal in waste dumps** is not the solution. This is why the use of recyclable and energy recyclable plastics should be promoted.

Reflections on pipeline work

Planning and installation of piping systems is a true engineering task, necessitating the organisation of a multitude of requirements and goals. For piping installations, simple, critical and aggressive media in each case require suitable materials. The idea is to especially cover the requirements of functionality, operating safety, optimal service life, environmental conditions and adequate profitability. Included in this are overall ecological, technical and economic assessments. High-performance plastics for piping installations, such as those, which you can obtain from our company, are proven and implementable where special endurance problems in connection with the media need solving.

Environmental protection is an important responsibility affecting us all. Each one of us, businesses and industrial concerns alike have to meet this great challenge. We at Georg Fischer actively pursue these responsibilities in the development of our products as well as for investments in our production facilities. In 1992 our company was distinguished within the scope of a competition for ecologically sound technology by the Environmental Protection Minister.

Our manufacturing plant is systematically analysed in accordance with strict criteria for improving environmental protection and updated accordingly. In this sector we have had outstanding success, which our customers can themselves appraise on-site.

Political approaches or one-sided evaluations of individual aspects of materials, products and processes for piping installations do not lead to intelligent solutions. Only comprehensive and objective as well as comparative balancing of accounts can bring us forward at any one time. In this respect, ecological balance is especially useful.

In the following we present an ecological balance for plastic piping installations:

Ecological balance for plastic piping systems

Passive	**Active**
• Raw material requirements	• Applications
• Energy requirements	• Product use - long service life - proven in practice - good recycling characteristics - high chemical resistance properties - simple handling - negligible piping losses - cost-effective
• Impact on: - hygienically safe - air - water - disposal	
• Profit: - economic - technical - ecological	

If one analyses the individual positions of such an ecological balance, it can be demonstrably established that plastic piping systems are not only economical, but also technically and especially ecologically profitable when compared with other material systems.

Following many years of research, Prof. Georg Menges has concluded that: ”Consistent environmental protection would intrinsically require that crude oil be first processed to plastic for use as commodity goods wherever possible and only then be allowed to be burned.”

We have inhouse a PVC-U sample pipe that was installed in Hamburg in 1937.The PVC pipes were joined using bonding agents. The system was operated at 4 to 6 bar. The material was used to supply drinking water to the public and was, without exception, successful. Even after this long operational period, there was no evidence of incrustation or deposits.

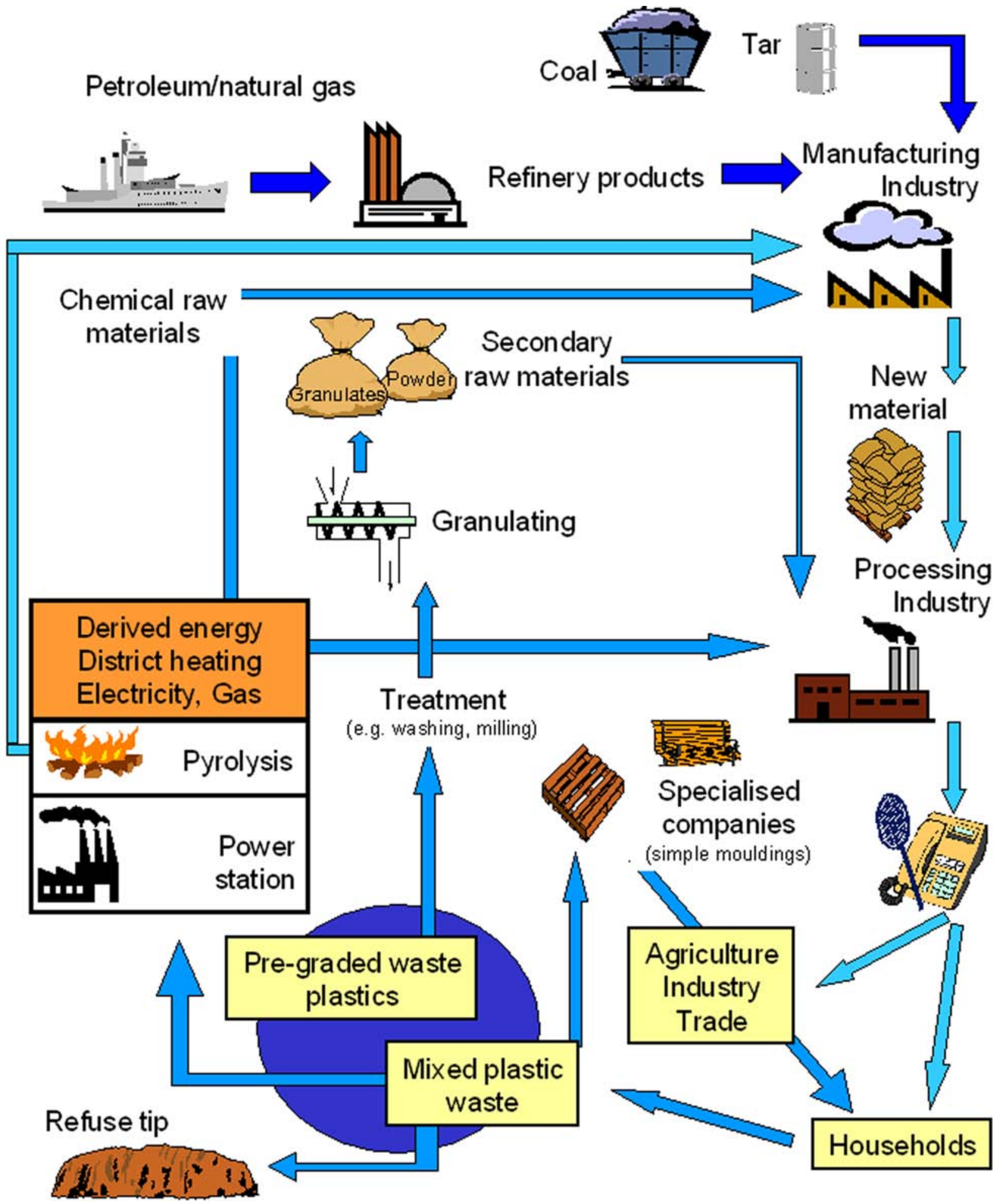
Currently PVC, besides polyethylene, is the most important material of consideration which, because of its versatility, is not achieved by any other raw material. Piping components of PVC have attained such great significance that not using them in many applications is no longer imaginable. Even in the case of public criticism from various sources, assertions and facts have been known to deviate greatly from one another.

During PVC manufacture, pool concentrations of all dangerous intermediate products are abided by or only handled in closed systems, allowing the exclusion of risks to employees. During PVC processing, all effective industrial safety regulations are clearly improved upon and, with lowered energy requirements, the impact on the environment is additionally reduced. Owing to their chemical stability, PVC products are completely non-toxic in normal use, are suitable for use with food, and are used in applications involving blood conservation and dialysis. Tin is used as a stabiliser for our PVC materials so that risks associated with heavy metals are not a consideration.

It is frequently claimed that during fires additional hazards from PVC exist for those in the immediate area. Intensive fire testing has been carried out with PVC. Building fires can also set fire to the difficult-to-ignite and self-extinguishing PVC. PVC, however, does not contribute to the spread of the fire. In cases of fire, the fumes are always toxic, regardless of the type of material burning. The greatest danger in a fire arises from the production of highly poisonous carbon monoxide gas. From an insurance viewpoint, PVC is handled in the same manner as other customary construction materials. Dioxins/furans have been shown to be produced in all combustion processes. PVC components have even been shown to play a subordinate role.

If all the positions of the above ecological balance are taken into account, then the conclusion is that currently there are no acceptable substitutions for PVC piping installations. PVC and the other high-performance plastics have many positive and few critical characteristics from an ecological viewpoint. If you would like more information about these considerations, our specialists would be happy to be of service to you.

Recycling possibilities



Materials used for industrial pipe work

The material polyethylene (PE)

PE properties (reference values)

	PE 80	PE 100		
Characteristics	**Value**	**Value**	**Units**	**Test Standard**
Density	0.93	0.95	g/cm³	EN ISO 1183-1
Yield stress at 23 °C	18	25	N/mm²	EN ISO 527-1
Tensile e-modulus at 23 °C	700	900	N/mm²	EN ISO 527-1
Charpy notched impact strength at 23 °C	110	83	kJ/ m²	EN ISO 179-1/1eA
Charpy notched impact strength at -40 °C	7	13	kJ/ m²	EN ISO 179-1/1eA
Ball indentation hardness (132N)	37		MPa	EN ISO 2039-1
Crystallite melting point	131	130	°C	DIN 51007
Thermal expansion coefficient	0.15 ... 0.20		mm/m K	DIN 53752
Heat conductivity at 23 °C	0.43	0.38	W/m K	EN 12664
Water absorption at 23 °C	0.01 - 0.04		%	EN ISO 62
Colour	9005		-	RAL
Limiting oxygen index (LOI)	17.4		%	ISO 4589-1

General

Polymers which consist only of carbon and hydrogen (hydrocarbons) are called polyolefins.
Polyethylene (PE) belongs to this group. It is a semi-crystalline thermoplastic. Polyethylene is the best known standard polymer.
The chemical formula is: $(CH_2\text{-}CH_2)_n$. It is an environmentally friendly hydrocarbon product.

PE and PP belong to the non-polar materials. Because of this, the material does not dissolve in common solvents and, in addition, hardly swells. As a result, PE pipes cannot be solvent cemented. The appropriate jointing method for this material is welding. For piping installations we offer three welding techniques in our product range: butt fusion, socket welding and electrofusion.

The latter jointing technique is preferred for piping systems transporting gas, water, compressed air or other less aggressive media. Butt and socket welding are preferably used on a diameter-specific basis.

High molecular PE grades of medium to high density have become state of the art for industrial piping installations. The grades are classified in accordance with their internal pressure resistance in PE80 (MRS 8 MPa) and PE100 (MRS 10 MPa).

In this context, we also talk about PE grades of the 3rd generation. PE80 grades belong, in most cases, to the 2nd generation. PE grades of the 1st generation – PE63 according to current classifications— have practically no application anymore.

In piping construction, PE is mostly used for buried gas and water lines. For this range of applications, polyethylene has become the dominant material in numerous countries. But also building technology and industrial piping installations make use of the advantages of this material.

The advantages include:

- low weight
- outstanding flexibility
- good abrasion resistance
- corrosion resistance
- high impact resistance even at very low temperatures
- good chemical resistance
- safe and easy jointing by welding
- excellent cost-performance ratio

Mechanical properties

Modern PE100 grades show a bimodal molecular weight distribution, i. e. they consist of two different kinds of molecular chains (short and long). These polyethylenes combine a high tensile strength with a high resistance against fast and slow crack propagation. In addition, the short molecular chains provide a good processability.

Similar to ABS, PE also shows a very high impact strength, even at low temperatures. For this test, a specimen is weakened with a sharp notch and then struck. In doing this the impact energy absorbed by the material is measured. This test proves that polyethylene is insensitive to surface damage with subsequent impact stress. A robust behaviour like this, combined with a high elongation to break, is of big advantage in a lot of applications, e.g. in regions that have a high risk of earthquakes.

The long-term behaviour for internal pressure resistance is provided by the hydrostatic strength curve based on the EN ISO 15494 standard (see the Calculation and Long-Term Behaviour section for PE). 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

Due to its non-polar nature as a hydrocarbon of high molecular weight, polyethylene shows a high resistance against chemical attack. PE is resistant to acids, alkaline solutions, solvents, alcohol and water. Fat and oil swell PE slightly. PE is not resistant against oxidising acids, ketones, aromatic hydrocarbons and chlorinated hydrocarbons.

For detailed information, please refer to the detailed list of chemical resistance from GF or contact your local GF subsidiary.

If polyethylene is exposed to direct sunlight over a long period of time, it will, like most natural and plastic materials, be damaged by the short wave UV portion of sunlight together with oxygen in the air, causing photo-oxidation. Because of this, our black polyethylene grades are effectively stabilised against UV light by adding carbon black.

As with ABS, PE also has excellent resistance against abrasion. As a result, PE piping systems are used in numerous applications for transporting solids and slurries.
Experience has shown that PE as well as ABS 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 PE, ABS and other materials for your media.

Thermal properties

Polyethylene pipes can be used at temperatures ranging from -50 °C to +60 °C.

At higher temperatures, the tensile strength and stiffness of the material are reduced. Therefore, please consult the pressure-temperature diagram. For temperatures below 0 °C it must be ensured, as for every other material, that the medium does not freeze, consequently damaging the piping system.

Like all thermoplastics, PE shows a higher thermal expansion than metal. Our PE has a coefficient of linear thermal expansion of 0.15 to 0.20 mm/m K, which is 1.5 times greater than that of e. g. PVC. As long as this is taken into account during the planning of the installation, there should be no problems in this regard.

The thermal conductivity is 0.38 W/m K. Because of the resulting insulation properties, a PE piping system is notably more economical in comparison to a system made of a metal like copper.

Combustion behaviour

Polyethylene belongs to the flammable plastics. The oxygen index amounts to 17 %. (Materials that burn with less than 21 % of oxygen in the air are considered to be flammable).

PE drips and continues to burn without soot after removing the flame. Basically, toxic substances are released by all burning processes. Carbon monoxide is generally the combustion product most dangerous to humans. When PE burns, primarily carbon dioxide, carbon monoxide and water are formed.

The following classifications in accordance with different combustion standards are used: According to UL94, PE is classified as HB (Horizontal Burning) and according to DIN 53438-1 as K2. According to DIN 4102-1 and EN 13501-1, PE is listed as B2 (normally flammable). In the French classification of building materials, polyethylene corresponds to M3 (of average flammability rating).

The self-ignition temperature is 350 °C.

Suitable fire-fighting agents are water, foam, carbon dioxide or powder.

Electrical properties

Because of the low water absorption of PE, its electrical properties are hardly affected by continuous water contact.

Since PE is a non-polar hydrocarbon polymer, it is an outstanding insulator. These properties, however, can be worsened considerably as a result of pollution, effects of oxidising media or weathering. The specific volume resistance is $>10^{17}$ Ωcm; the dielectric strength is 220 kV/mm.

Because of the possible development of electrostatic charges, caution is recommended when using PE in applications where the danger of fires or explosion is given.

Physiological properties

The black material types from GF are authorised for use in food applications. The fittings are odourless and tasteless as well as physiologically inert. Usage in all related areas is thus possible.

The material polypropylene (PP)

PP properties (reference values)

Characteristics	PP-R	β PP-H	Units	Test Standard
Density	0.90-0.91	0.90-0.91	g/cm³	EN ISO 1183-1
Yield stress at 23 °C	25	31	N/mm²	EN ISO 527-1
Tensile e-modulus at 23 °C	900	1300	N/mm²	EN ISO 527-1
Charpy notched impact strength at 23 °C	30.9	85	kJ/ m²	EN ISO 179-1/1eA
Charpy notched impact strength at 0 °C	3.4	4.8	kJ/ m²	EN ISO 179-1/1eA
Ball indentation hardness (132N)	49	58	MPa	EN ISO 2039-1
Heat distortion temperature HDT B 0.45 MPa	75	95	°C	EN ISO 75-2
Crystallite melting point	145-150	150-167	°C	DIN 51007
Thermal expansion coefficient	0.16 ... 0.18		mm/m K	DIN 53752
Heat conductivity at 23 °C	0.23		W/m K	EN 12664
Water absorption at 23 °C	0.1	0.1	%	EN ISO 62
Colour	neutral	7032	-	RAL
Limiting oxygen index (LOI)	19		%	ISO 4589-1

General

Polypropylene is a thermoplastic belonging to the polyolefin group. It is a semi-crystalline material. Its density is lower than that of other well-known thermoplastics. Its mechanical characteristics, its chemical resistance and especially its relatively high heat deflection temperature have made polypropylene one of the most important materials used in piping installations today.

PP is formed by the polymerisation of propylene (C_3H_6) using Ziegler-Natta catalysts.

There are three different types which are conventionally supplied for piping installations:

- Isotactic PP Homopolymeride (PP-H)
- PP block co-polymeride (PP-B)
- PP random co-polymeride (PP-R).

Because of its high internal pressure resistance, PP-H is preferred for industrial applications. On the other hand, PP-R is used predominantly in sanitary applications because of its low e-modulus (flexible piping) and its high internal pressure resistance at high temperatures. PP-B is mainly used for sewage piping systems because of its high impact strength especially at low temperatures and its low thermal endurance.

PROGEF = Polypropylene Georg Fischer

PROGEF is the subbrand for piping systems in polypropylene:

Subbrand: Pipes, fittings, valves	Material	Dimension	Nominal Pressure, SDR
PROGEF Standard	β-PP-H and PP-R	d16 - d500	SDR11 / PN10 and SDR17 resp. SDR17.6 / PN6
PROGEF Plus: Silcone- and oilfree	β-PP-H and PP-R	d20 - d315	SDR11 / PN10
PROGEF Natural	PP-R unpigmented	d20 - d63	SDR11 / PN10

Beta (β)-PP-H

Most of the grades are offered with nucleating agents (crystallisation seeds), because PP crystallises at least 10 times slower than PE. This way, we achieve lower internal stress and a finer structure. We differentiate between α and β nucleation.
Nucleation is realised by merely adding ppm (parts per million) of nucleating agents.

PP is one of the non-polar materials whose surface hardly swells or dissolves. Cementing is not possible without special surface treatment. On the other hand, PP welds very well. Pressure piping systems can use heating element socket welding, heating element butt welding or the no-contact infrared (IR-Plus) fusion technology developed by GF.

The internal pressure resistance is ensured through long-term testing in accordance with EN ISO 9080 and certified with the value of MRS 10 (minimum required strength).

The Beta (ß)-PP used by GF for industrial pipeline engineering is characterised by

- good chemical resistance
- high internal pressure resistance
- high impact strength
- high thermal ageing and thermal forming resistance
- high stress fracture resistance
- outstanding weldability
- homogeneous, fine structure

PROGEF Natural (PP-R, unpigmented)

Specially for applications related to the BCF Plus (bead and crevice-free) welding technology, such as the life science/pharmaceutical industry, GF offers the PROGEF Natural system in addition to our PROGEF Standard.

For such requirements, the welding technology plays a decisive role. In using the BCF Plus welding technology, beads and dead zones are avoided. This prevents micro-organisms from accumulating, thus improving the water quality.

For all other industrial applications, especially those involving aggressive media, high impact and temperature stress, GF recommends PROGEF Standard, which has an optimal characteristics profile.

The material used for PROGEF Natural system is an unpigmented random copolymer, particularly distinguished by the following characteristics:

- excellent resistance against certain disinfectants and chemicals (mainly alkaline solutions)
- translucence
- very high surface finish quality
- good weldability (BCF Plus and IR Plus weldable)
- high temperature resistance

Mechanical properties

PP-H has the highest crystallinity and therefore the highest hardness, tensile strength and stiffness, so the pipes hardly sag and a greater distance between supports is possible. PP-R has a very good long-term creep strength at higher temperatures, such as, for example, 80 °C at continuous stress.

Unlike PE, PP is not as impact resistant below 0 °C. Because of this, GF recommends ABS or PE for low temperature applications.

The long-term behaviour for internal pressure resistance is provided by the hydrostatic strength curve based on the EN ISO 15494 standard (see the Calculation and Long-Term Behaviour section for PE). The application limits for pipes and fittings, as shown in the pressure-temperature diagram, can be derived from these curves.

Chemical, weathering and UV resistance

Due to its non-polar nature, polypropylene shows a high resistance against chemical attack.

The resistance of PP is nevertheless lower than that of PE because of its tertiary C atoms.

PP is resistant against acids, alkaline solutions, solvents, alcohol and water. Fats and oils swell PP slightly. PP is not resistant to oxidising acids, ketones, petrol, benzene, halogens, aromatic hydrocarbons, chlorinated hydrocarbons and contact with copper.

For detailed information, please refer to the detailed list of chemical resistance from GF or contact your local GF subsidiary.

If polypropylene is exposed to direct sunlight over a long period of time, it will, like most natural and plastic materials, be damaged by the short-wave UV portion of sunlight together with oxygen in the air, causing photo-oxidation.
Fluorescent tubes create weakening the same effect.

PP fittings and valves are highly heat stabilised. As per approvals, polypropylene has no special additive against the effects of UV radiation. The same applies to PP piping. Piping which is exposed to UV light should therefore be protected. This is achieved by covering the pipes, e. g. with insulation or also by painting the piping system with a UV absorbing paint.

Thermal properties

In general polypropylene can be used at temperatures from 0 °C to +80 °C, β-PP-H in the range from -10 °C up to 95 °C. Below -10 °C, the outstanding impact strength of the material is reduced. On the other hand, the stiffness is even higher at low temperatures. Please consult the pressure-temperature diagram for your maximum working temperature. For temperatures below 0 °C it must be ensured, as for every other material, that the medium does not freeze, consequently damaging the piping system.

As with all thermoplastics, PP shows a higher thermal expansion (0.16 to 0.18 mm/m K) than metal. As long as this is taken into account during the planning of the installation, there should be no problems in this regard.

The thermal conductivity is 0.23 W/m K. Because of the resulting insulation properties, a PP piping system is notably more economical in comparison to a system made of a metal like copper.

Combustion behaviour

Polypropylene is a flammable plastic. The oxygen index amounts to 19%. (Materials that burn with less than 21% of oxygen in the air are considered to be flammable).

PP drips and continues to burn without soot after removing the flame. Basically, toxic substances are released by all burning processes. Carbon monoxide is generally the combustion product most dangerous to humans. When PP burns, primarily carbon dioxide, carbon monoxide and water are formed.

The following classifications in accordance with differing combustion standards are used:
According to UL94, PP is classified as HB (Horizontal Burning) and according to DIN 53438-1 as K2.
According to DIN 4102-1 and EN 13501-1, PP is listed as B2 (normally flammable). In the French classification of building materials, polypropylene corresponds to M3 (of average flammable rating).

The self-ignition temperature is 360 °C.
Suitable fire-fighting agents are water, foam or carbon dioxide.

Electrical properties

Since PP is a non-polar hydrocarbon polymer, it is an outstanding insulator. These properties, however, can be worsened considerably as a result of pollution, effects of oxidising media or weathering.

The dielectric characteristics are essentially independent of temperature and frequency.

The specific volume resistance is $>10^{16}$ Ωcm; the dielectric strength is 75 kV/mm.

Because of the possible development of electrostatic charges, caution is recommended when using PP in applications where the danger of fires or explosion is given.

Physiological properties

The materials used for GF's PROGEF Standard and PROGEF Plus are in compliance with the formulation requirements of the common drinking water directives (see separate list in clause Approvals).

The polypropylene grade PROEF Natural satisfies the requirements for articles or components of articles that come into contact with food. The parts are tasteless and odourless and are physiologically inert regarding acidic, neutral and alcoholic foods as well as dairy products according to Directive 2007/19/EC.

The material polyvinyl chloride unplasticized (PVC-U)

PVC-U properties (reference values)

Characteristics	Value	Units	Test Standard
Density	1.38	g/cm³	EN ISO 1183-1
Yield stress at 23 °C	≥ 52	N/mm²	EN ISO 527-1
Tensile e-modulus at 23 °C	≥ 2500	N/mm²	EN ISO 527-1
Charpy notched impact strength at 23 °C	≥ 6	kJ/m²	EN ISO 179-1/ 1eA
Charpy notched impact strength at 0 °C	≥ 3	kJ/m²	EN ISO 179-1/ 1eA
Ball indentation hardness (358N)	≥ 105	MP	EN ISO 2039-1
Heat distortion temperature HDT A 1.80 MPa	66	°C	EN ISO 75-2
Vicat heat distortion temperature B/50N	≥ 76	°C	ISO 306
Thermal expansion coefficient	0.07 ... 0.08	mm/m K	DIN 53752
Heat conductivity at 23 °C	0.15	W/m K	EN 12664
Water absorption at 23 °C	≤ 0.1	%	EN ISO 62
Colour	7011	-	RAL
Limiting oxygen index (LOI)	42	%	ISO 4589-1

General

Polyvinylchloride, widely known by its abbreviation PVC, is one of the most important and oldest mass-produced polymers. World-wide consumption of PVC is only exceeded by PE and PP, PVC was first produced in the middle of the nineteenth century. An industrial production process was, however, first patented in 1913. Nowadays, many industrial applications couldn’t be realised without PVC. But also in the use of daily products, PVC has become irreplaceable.

PVC is a polymer having approximately 56 % by weight of chlorine. Only by using additives does it become a processable and usable material. The additives allow a wide variation of its characteristics and allows it to be adjusted to the planned application. There are two classes of PVC materials. Soft PVC (PVC-P), produced by adding plasticizers (such as, e. g. phthalate), is not used by GF. Hard PVC, the so-called unplasticized PVC (PVC-U) is used for pipeline engineering.

PVC-U is an amorphous thermoplastic. The characteristics of PVC-U moulded parts are strongly dependent on the composition of the formula, but also on the processing. Because of our 40-year experience in PVC processing and the continuous advancement of our own formula, GF has become a benchmark in the field of PVC-U piping.

GF's PVC-U is characterised by the following characteristics:

- universal use
- very good chemical and corrosion resistance
- proven physiological harmlessness and therefore suitable for contact with food
- no influence on drinking water quality
- biologically inert; no support of microbial growth
- high mechanical tensile strength with good impact strength
- self-extinguishing
- secure solvent cementing using Tangit© and Dytex©
- adhesive development designed for GF PVC-U
- use of tin stabilisers for fittings and valves
- low friction loss owing to smooth surfaces
- recyclable

Mechanical properties

PVC-U from GF reflects a balanced picture regarding the mechanical short-term properties. Because of the strong interaction between the chlorine atoms in the polymer chain, PVC-U shows a high tensile strength and stiffness. At the same time, the elasticity of the GF structural parts is good, a characteristic guaranteed by regular quality control testing.

The long-term behaviour for internal pressure resistance is provided by the hydrostatic strength curve based on the EN ISO 15493 or DIN 8061 standards (also see the Calculation and Long-Term Behaviour of PVC-U section). The application limits for pipes and fittings, as shown in the PVC-U pressure-temperature diagram, can be derived from these curves.

Behaviour during dynamic loading corresponds to the highest quality requirements and is tested regularly.

Chemical and weathering resistance

The outstanding chemical resistance of PVC-U extends to high concentrations. Resistance against the influence of most mineral acids, bases and salt solutions and also sodium hypochlorite solutions is very good. Resistance to aliphatic hydrocarbons and elemental chlorine is also good. PVC-U, in general, shows weakness against aromatic or chlorinated solvents, esters and ketones. Use with gases is also not recommended. If the use of oils, varnish or fats is being considered, a prior investigation is advisable.

For detailed information, please refer to the detailed list of chemical resistance from GF or contact your GF subsidiary.

These specifications are also valid - with exceptions - for adhesive joints, which normally are implemented by applying strongly dissolving gap-filling solvent cement to the PVC-U.

PVC-U is very resistant to weathering. Long-term influence of direct sunlight as well as the effect of wind and rain damage the material only superficially. Despite its very good weathering resistance regarding ultraviolet radiation, PVC-U loses some of its impact strength. In extreme applications it can be advantageous to protect the material from direct sunlight exposure.

Thermal properties

PVC-U shows very good characteristics in the temperature range from 0 to 60 ºC. At lower temperatures, the impact strength drops considerably. Tensile strength and stiffness drop with increased temperatures. Please consult the pressure-temperature diagram especially for your maximum working temperature. Because the softening-point temperature of the fitting and valve materials lies above 76 ºC, applications must remain limited to temperatures below 60 ºC.

The thermal expansion coefficient of PVC-U at 0.07 to 0.08 mm/m K lies clearly above that of metals. Of all the materials for industrial piping installations, available from GF, PVC-U shows one of the lowest expansion coefficients. Nevertheless, the thermal expansion has to be taken into account during the planning of the installation.

Similar to all polymers, PVC-U is a good thermal insulator. At 0.15 W/m K, the heat conductivity of PVC-U is very low. The value for steel, on the other hand, is 250 W/m K.

Combustion behaviour

The high chlorine content of PVC-U causes an advantageous combustion behaviour. Self-ignition resulting from temperature influences occurs only at 450 °C. PVC-U burns when exposed to an open flame, but extinguishes immediately after removing the flame.

The oxygen index amounts to 42 %. (Materials that burn with less than 21 % of oxygen in the air are considered to be flammable).

PVC-U thus falls in the best flammability class V0 according to UL94, and in the B1 building material class (difficult to ignite) according to DIN 4102-1. According to the French test method NF P 92-501, GF PVC-U is tested as M2.

Because the combustion of PVC produces hydrogen chloride, which forms a corrosive acid in connection with water, immediate cleaning of areas susceptible to corrosion is necessary after a fire. Danger to personnel from HCl is minimal because its pungent odour allows early escape from toxic combustion gases, mainly from the odourless carbon monoxide.

There are no restrictions concerning the choice of fire-fighting agents.

Electrical properties

PVC-U is, as all unmodified thermoplastics, non-conductive. This means that no electrochemical corrosion takes place in PVC-U systems. On the other hand, these non-conductive characteristics have to be taken into account because an electrostatic charge can develop in the piping. It is especially important to take this condition into account in areas where explosive gases can appear. There are various methods available to avoid the occurrence of electrostatic charges on polymer piping systems. Please contact your GF representative for more information regarding these methods.

The specific volume resistance is $>10^{15}\ \Omega$cm.

Physiological properties

The PVC-U formulas were developed by GF for use with drinking water and food. PVC-U's physiological harmlessness regarding neutral, acidic and alcoholic foods and the non-influence on drinking water in respect to odour, taste or microbiological effects is regularly checked and monitored by neutral institutions in various countries.

GF offers PVC-U systems free from lead and cadmium for your applications in the fields of drinking water or food. The residual monomer content of vinyl chloride lies below the detection limit of modern analytical methods.

Approvals and standards for distribution systems

Approvals for materials

PE

The following information is provided by the raw materials manufacturers with regard to approvals/testimonials:

Austria	ÖVGW LHG 1975	Water supply Foodstuffs
Germany	DVGW	Water and gas supply
	GKR	Gas supply
Belgium	Eandis	Gas supply
	Université de Liege	Water supply
Czech Republic	ITC	Water and gas supply
France	LNE GdF ACS	Water and gas supply, industry Gas supply
Italy	IIP	Water and gas supply
Hungary	EMI	Gas supply
Netherlands	KIWA GIVEG	Water supply Gas supply
Poland	IGNIG INSTAL	Gas supply Water supply
Slovenia	Analog DVGW	Water and gas supply
Croatia	Analog DVGW	Water and gas supply
Sweden	KP	Water supply
Denmark	Miljostyrelsen	Water supply
Switzerland	SVGW	Water and gas supply
Spain	Aenor	Gas supply
UK	DOE British Gas	Water supply Gas supply

PVC-U

Existing drinking water and food approvals:

- Physiologically harmless in conjunction with neutral, acid and alcoholic foods as per consumer goods order and BgW recommendations for PVC-U.
- From a microbiological view, suitable for use with drinking water as per DVGW W 270 test.
- Conformance with KTW (plastic materials and drinking water) recommendations issued by the BGA (Federal Health Bulletin 1977)
- Conformité Sanitaire (circulaires DGS/VS4/N94/9, -155 and Arreté Interministériel of 1997)
- KIWA requirements for organoleptic and microbial growth
- NSF approval in preparation

The following information is provided by the raw materials manufacturers with regard to approvals/ testimonials:

USA FDA 21 CFR, paragraphs 177/178

EEC Directive 90/128 EEC (as at 1990), 78/142 (1978) 80/432 (1981), 80/766 (1980), 2002/72 EC (Contact with foodstuff)

Italy: Dichiarazione di conformità alla C.M. n. 102 del 02.12.1978: Disciplina igienica concernente le materie plastiche e gomme per tubazioni ed accessori destinati a venire in contatto con acqua potabile e da potabilizzare.

Standards

Relevant standards for PE gas and water

ASTM D 2657 (2007-00)	Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
CEN/TS 12201-7 (2003-08)	Plastics piping systems for water supply - Polyethylene (PE) - Part 7: Guidance for the assessment of conformity
CEN/TS 15223 (2008-04)	Plastics piping systems - Validated design parameters of buried thermoplastics piping systems
DIN 19537-3 (1990-11)	Prefabricated high density polyethylene (PE-HD) manholes for use in sewerage systems; dimensions and technical delivery conditions
DIN 3543-4 (1984-08)	High density polyethylene (HDPE) tapping valves for HDPE pipes; dimensions
DIN 3544-1 (1985-09)	High-density polyethylene (HDPE) valves; tapping valves; requirements and test
DIN 8074 (1999-08)	Polyethylene (PE) - Pipes PE 63, PE 80, PE 100, PE-HD - Dimensions
DIN 8075 (1999-08)	Polyethylene (PE) pipes - PE 63, PE 80, PE 100, PE-HD - General quality requirements, testing
DIN 8075 Beiblatt 1 (1984-02)	High density polyethylene (HDPE) pipes; chemical resistance of pipes and fittings
DIN 8076 (2008-11)	Pressure pipelines made from thermoplastics materials - Metal and plastics compression fittings for polyethylene (PE) pipes - General quality requirements and testing
DIN CEN/TS 1555-7 (2003-08)	Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 7: Guidance for the assessment of conformity; German version CEN/TS 1555-7:2003
DIN EN 12007-2 (2000-08)	Gas supply systems - Pipelines for maximum operating pressure up to and including 16 bar - Part 2: Specific functional recommendations for polyethylene (MOP up to and including 10 bar); German version EN 12007-2:2000
DIN EN 13244-5 (2003-04)	Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage - Polyethylene (PE) - Part 5: Fitness for purpose of the system; German version EN 13244-5:2002
DIN EN 14141 (2004-03)	Valves for natural gas transportation in pipelines - Performance requirements and tests; German version EN 14141:2003
DVGW VP 302 (2006-06)	Shut-off valves made of polyethylene (PE 80 und PE 100) - Requirements and tests
DVS 2207-1 (2005-09)	Welding of thermoplastics - Heated tool welding of pipes, pipeline components and sheets made of PE-HD
EN 12201-1 (2003-03)	Plastics piping systems for water supply - Polyethylene (PE) - Part 1: General
EN 12201-2 (2003-03)	Plastics piping systems for water supply - Polyethylene (PE) - Part 2: Pipes
EN 12201-3 (2003-03)	Plastics piping systems for water supply - Polyethylene (PE) - Part 3: Fittings
EN 12201-4 (2001-12)	Plastics piping systems for water supply - Polyethylene (PE) - Part 4: Valves
EN 12201-5 (2003-03)	Plastics piping systems for water supply - Polyethylene (PE) - Part 5: Fitness for purpose of the system
EN 1555-1 (2010-09)	Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 1: General
EN 1555-2 (2010-09)	Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 2: Pipes
EN 1555-3 (2010-09)	Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 3: Fittings / Note: To be amended by EN 1555-3/prA1 (2004-12).
EN 1555-4 (2010-12)	Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 4: Valves
EN 1555-5 (2010-09)	Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) - Part 5: Fitness for purpose of the system
ISO 12176-1 (2006-07)	Plastics pipes and fittings - Equipment for fusion jointing polyethylene systems - Part 1: Butt fusion
ISO 12176-2 (2008-06)	Plastics pipes and fittings - Equipment for fusion jointing polyethylene systems - Part 2: Electrofusion
ISO 12176-3 (2011-02)	Plastics pipes and fittings - Equipment for fusion jointing polyethylene systems - Part 3: Operator's badge
ISO 12176-4 (2003-11)	Plastics pipes and fittings - Equipment for fusion jointing polyethylene systems - Part 4: Traceability coding
ISO 14236 (2000-03)	Plastics pipes and fittings - Mechanical-joint compression fittings for use with polyethylene pressure pipes in water supply systems

ISO 3458 (1976-06)	Assembled joints between fittings and polyethylene (PE) pressure pipes ; Test of leakproofness under internal pressure
ISO 3459 (1976-10)	Polyethylene (PE) pressure pipes; Joints assembled with mechanical fittings; Internal under-pressure test method and requirement
ISO 3501 (1976-06)	Assembled joints between fittings and polyethylene (PE) pressure pipes; Test of resistance to pull out
ISO 3503 (1976-06)	Assembled joints between fittings and polyethylene (PE) pressure pipes; Test of leakproofness under internal pressure when subjected to bending
ISO 4427-1 (2007-08)	Plastics piping systems - Polyethylene (PE) pipes and fittings for water supply - Part 1: General
ISO 4427-2 (2007-08)	Plastics piping systems - Polyethylene (PE) pipes and fittings for water supply - Part 2: Pipes
ISO 4427-3 (2007-08)	Plastics piping systems - Polyethylene (PE) pipes and fittings for water supply - Part 3: Fittings
ISO 4427-5 (2007-08)	Plastics piping systems - Polyethylene (PE) pipes and fittings for water supply - Part 5: Fitness for purpose of the system
ISO 4437 (2007-06)	Buried polyethylene (PE) pipes for the supply of gaseous fuels - Metric series - Specifications / Note: To be replaced by ISO/DIS 4437 (2004-12).
ISO 8085-1 (2001-09)	Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels - Metric series; Specifications - Part 1: Fittings for socket fusion using heated tools
ISO 8085-2 (2001-09)	Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels - Metric series; Specifications - Part 2: Spigot fittings for butt fusion, for socket fusion using heated tools and for use with electrofusion fittings
ISO 8085-2 Technical Corrigendum 1 (2001-12)	Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels - Metric series; Specifications - Part 2: Spigot fittings for butt fusion, for socket fusion using heated tools and for use with electrofusion fittings; Technical Corr
ISO 8085-3 (2001-09)	Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels - Metric series; Specifications - Part 3: Electrofusion fittings / Note: Corrected and reprinted in 2004-09
ISO 9623 (1997-02)	PE/metal and PP/metal adaptor fittings for pipes for fluids under pressure - Design lengths and size of threads - Metric series
ISO/TS 10839 (2000-03)	Polyethylene pipes and fittings for the supply of gaseous fuels - Code of practice for design, handling and installation
JIS K 6774 (2005-03)	Polyethylene pipes for the supply of gaseous fuels

Relevant standards for flanges

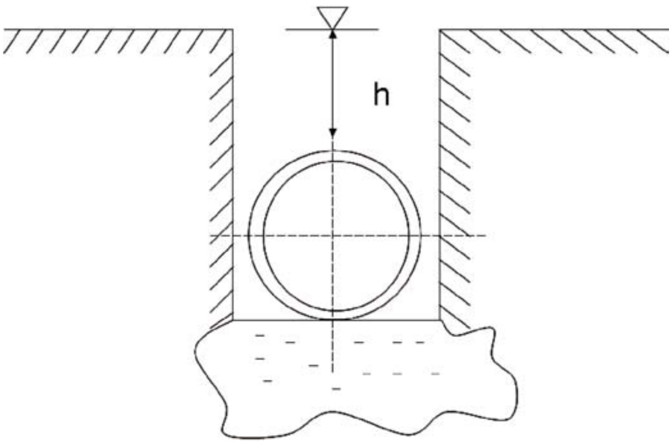
ANSI B16.1 (2005-00)	Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250
ANSI/ASME B 16.5 (2009-00)	Pipe Flanges and Flanged Fittings
ASTM D 4024 (2005-00)	Standard Specification for Machine Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
ASTM D 5421 (2005-00)	Standard Specification for Contact Molded "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
BS 10:2009 (2009-04)	Specification for flanges and bolting for pipes, valves, and fittings
BS 1560-3.1:1989 (1989-06)	Circular flanges for pipes, valves and fittings (class-designated). Steel, cast iron and copper alloy flanges. Specification for steel flanges
BS 1560-3.2:1989 (1990-03)	Circular flanges for pipes, valves and fittings (class-designated). Steel, cast iron and copper alloy flanges. Specification for cast iron flanges
BS EN 1515-1:2000 (2000-02)	Flanges and their joints. Bolting. Selection of bolting
BS EN 1759-1:2004 (2004-11)	Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, class-designated. Steel flanges, NPS 1/2 to 24
BS EN 1759-3:2003 (2004-03)	Flanges and their joint. Circular flanges for pipes, valves, fittings and accessories, class designated. Copper alloy flanges
DIN 2429-2 (1988-01)	Symbolic representation of pipework components on engineering drawings; functional representation
DIN 16831-7 (2004-02)	Pipe joints and components of polybutene (PB) for pipes under pressure; PB 125 - Part 7: Flange adapters, flanges, sealing rings for socket welding; dimensions
DIN 16872 (1993-10)	Pipe joints assemblies for pipelines of thermoplastics; glass fibre reinforced polyester resin (UP-GF) flanges; dimensions
DIN 16966-6 (1982-07)	Glass fibre reinforced polyester resin (UP-GF) pipe fittings and joint assemblies; collars, flanges, joint rings, dimensions
DIN 16966-7 (1995-04)	Pipe joints and their elements of glass fibre reinforced polyester resins - Part 7: Bushings, flanges, flanged and butt joints; general quality requirements and test methods
DIN 28403 (1986-09)	Vacuum technology; quick release couplings; clamped type couplings
DIN 28404 (1986-10)	Vacuum technology; flanges; dimensions
DIN 8063-12 (1987-01)	Pipe joint assemblies and fittings of unplasticized polyvinyl chloride (U-PVC) pressure pipelines; dimensions of flanged and socket fittings
DIN 8063-4 (1983-09)	Pipe joint assemblies and fittings for unplasticized polyvinyl chloride (PVC-U) pressure pipes; bushings, flanges, seals; dimensions
DIN EN 1092-1 (2008-09)	Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, PN designated - Part 1: Steel flanges
DIN EN 1092-2 (1997-06)	Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, PN designated - Part 2: Cast iron flanges
DIN EN 1514-8 (2005-02)	Flanges and their joints - Dimensions of gaskets for PN-designated flanges - Part 8: Polymeric O-Ring gaskets for grooved flanges
DVS 2205-4 (1988-11) suppl.	Calculation of thermoplastic tanks and apparatuses - Flanged joints
DVS 2205-4 Beiblatt (1996-11) suppl.	Calculation of thermoplastic tanks and apparatuses - Welded flanges, welded collars - Constructive details
DVS 2210-1 Beiblatt 3 (2006-5)	
EN 558 (2008-01)	Industrial valves - Face-to-face and centre-to-face dimensions of metal valves for use in flanged pipe systems - PN and Class designated valves
ISO 5752 (1982-06)	Metal valves for use in flanged pipe systems; Face-to-face and centre-to-face dimensions
ISO 7005-1 (1992-04)	Metallic flanges; part 1: steel flanges
ISO 7005-2 (1988-12)	Metallic flanges; part 2: cast iron flanges
ISO 7005-3 (1988-02)	Metallic flanges; part 3: copper alloy and composite flanges
ISO 7483 (1991-10)	Dimensions of gaskets for use with flanges to ISO 7005
ISO 8483 (2003-12)	Glass-reinforced thermosetting plastics (GRP) pipes and fittings - Test methods to prove the design of bolted flange joints
ISO 9624 (1997-02)	Thermoplastics pipes for fluids under pressure - Mating dimensions of flange adapters and loose backing flanges

JIS B 2220 (2004-01)	Steel pipe flanges
JIS B 2239 (2004-03)	Cast iron pipe flanges
EN ISO 15493 (2003-04)	Plastics piping systems for industrial applications - Acrylonitrile-butadiene-styrene (ABS), unplasticized polyvinyl chloride (PVC-U) and chlorinated polyvinyl chloride (PVC-C) - Specifications for components and the system; Metric series (ISO 15493:2003)
EN ISO 15494 (2003-04)	Plastics piping systems for industrial applications - Polybutene (PB), polyethylene (PE) and polypropylene (PP) - Specifications for components and the system; Metric series (ISO 15494:2003)
EN ISO 10931 (2005-12)	Plastics piping systems for industrial applications - Poly(vinylidene fluoride) (PVDF) - Specifications for components and the system (ISO 10931:2005)

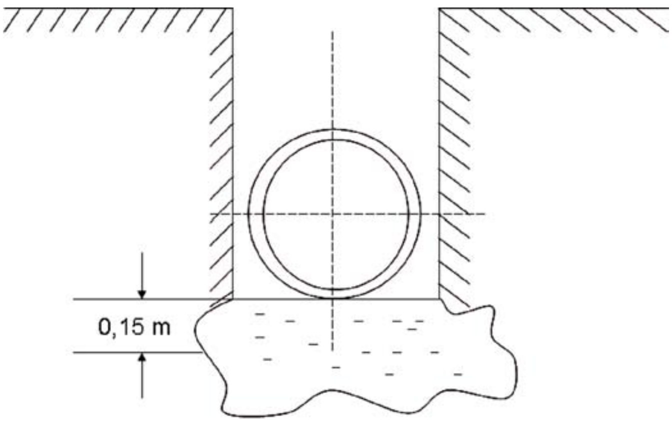
Installation

The trench

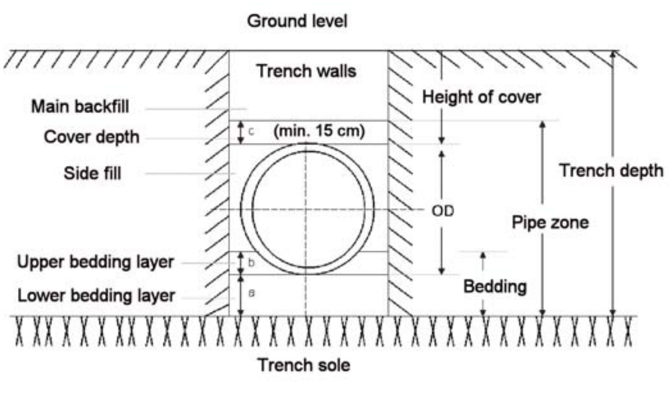
National and regional regulations and directives for soil covered pipelines are to be followed during the construction of the necessary trench. The trench has to allow all parts of the pipeline to be in a frost-safe depth.



The base of the trench has to enable the pipeline to bear on smoothly. In case of bedrock the trench has to be excavated deeper and filled to the desired depth with appropriate material which grain size does not damage the pipe.



The crucial factor to attain a good load capacity of pipes and fittings under ground is a correct construction of the area around the pipe. The correct design of the pipe zone is detemining the load capacity of PE pipes and fittings. The pipe zone consists from bedding side fill and cover depth.



The pipe zone has to be designed according to flanning fundamentals and static calculation. The area between trench sole and side fill is referred to as bedding. By exchanging ground a load carrying bedding has to be created. Usually, the minimum bedding is according to EN1610 a = 100mm, in case of bedrock or compacted underground a= 150mm. Further, there are demands concerning the filling material. Materials with elements bigger than:

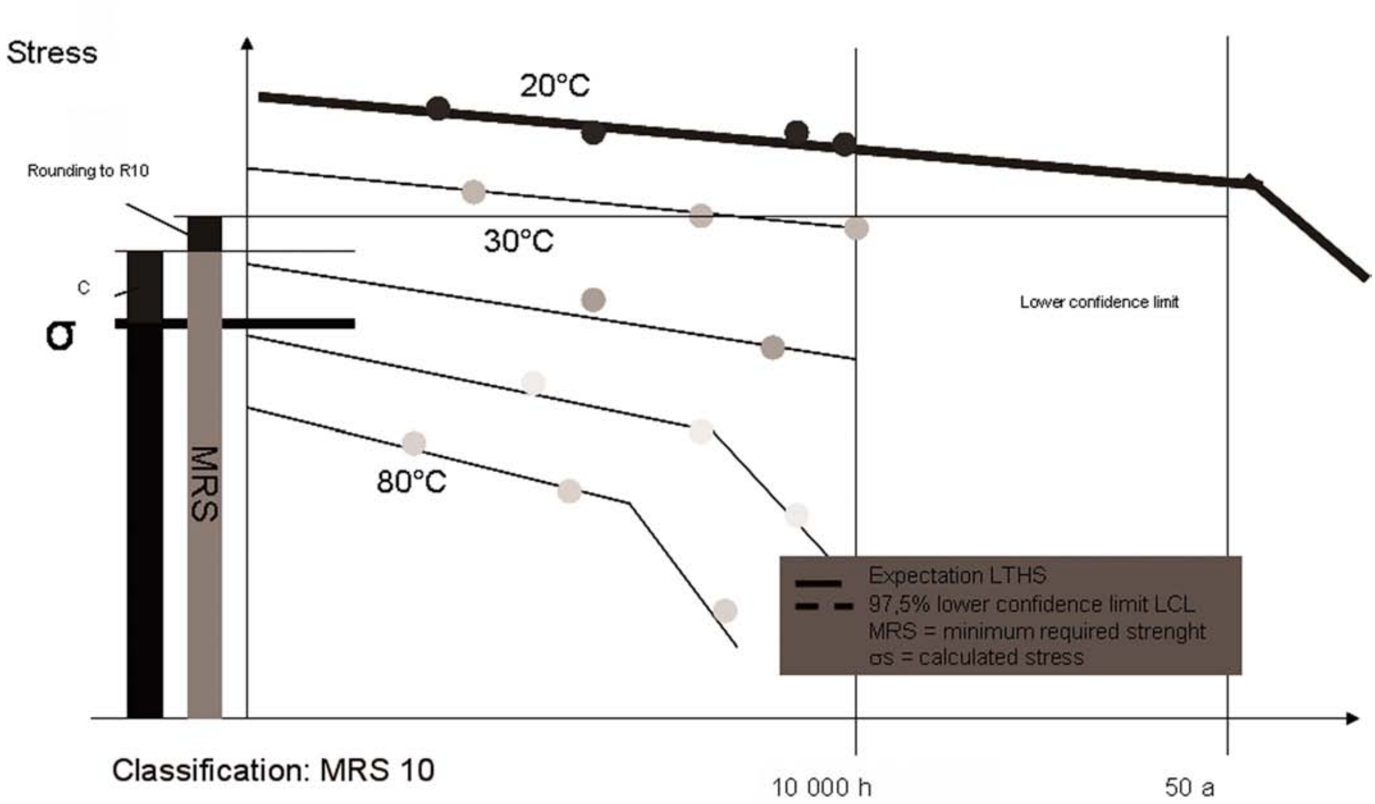
- 22 mm at DN $\leq$ 200
- 40 mm at DN >200 until DN $\leq$ 600

should not be used.

The upper bedding layer b is assessed from static calculations. It is important to assure no cavities below the pipe. The bedding dissipates all loads from the pipe evenly into the ground. For this reason the PE pipe has to lay evenly on the bedding over its complete length. The upper end of the pipe zone is defined according to EN 1610 as 150mm above the pipe apex respectively 100mm above the pipe connection. When filling and compacting the cover depth and the main backfill one has to make sure not to damage the pipe.

Design

Material classification according to MRS



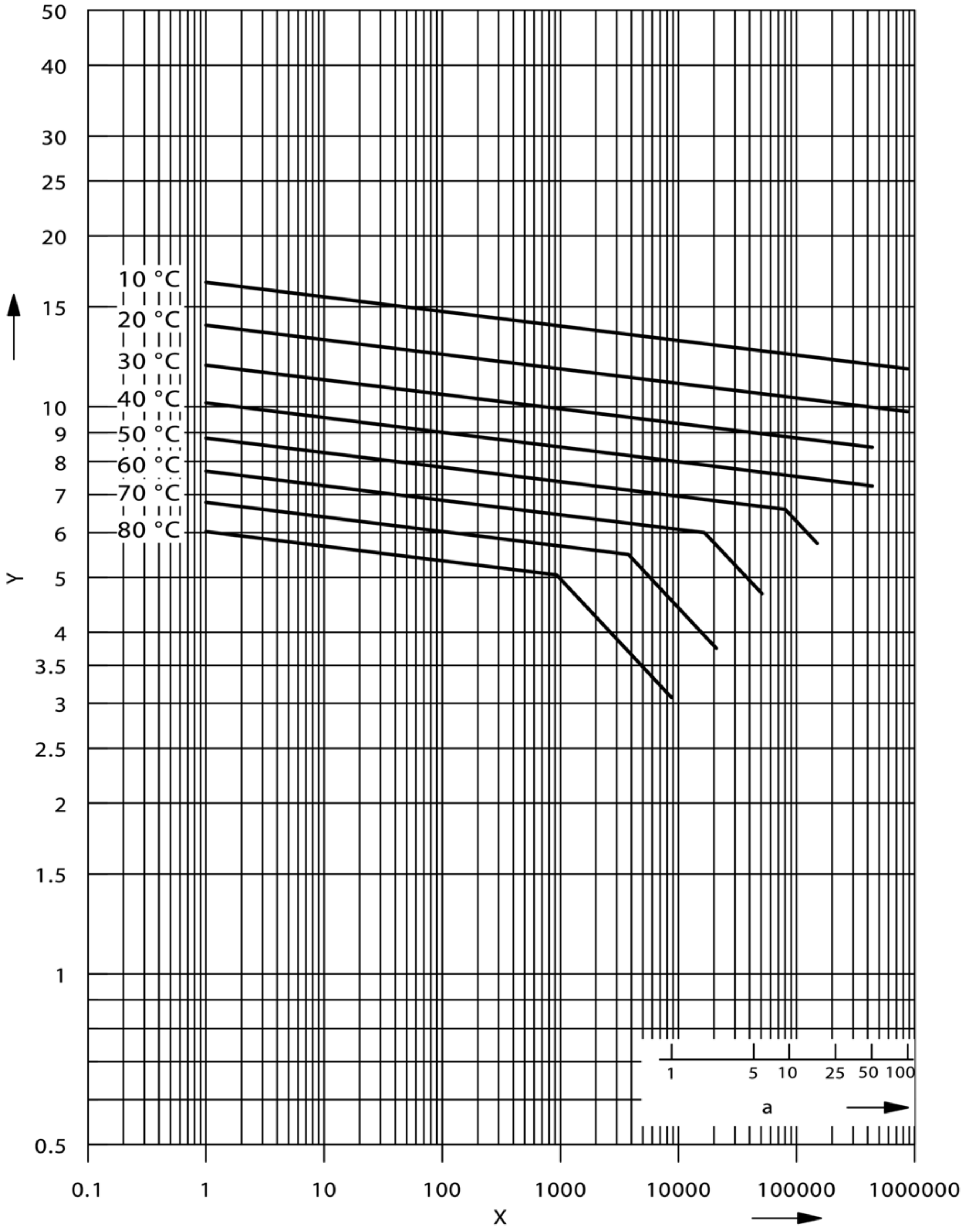
Long-term behaviour characteristics of pressurized plastic pipes are differentiated in a standard classification system. As a basis for this classification long-term pressure diagramms are created and extrapolated. The maximum stress depending on time at a constant temperature is determined. The expected value LTHS (Long Therm Hydrostatic Strength) describes the theoretical curve of the measured test data. Using the lower confidence limit (LCL) the statistical spread of measurments is buffered (LCL = 97,5% LTHS). The stress at 50 years, determined this way (rounded to the nearest lower standard value) results in the MRS-value (Minimum Required Strength), the material-specific minimum strength.

Classification of PE-materials

Type of Material	MRS [MPa]
PE 63	6.3-7.99
PE 80	8.0-9.99
PE100	10.0-11.19

Long-term behaviour of thermoplastic material

The most important characteristic of pressurized plasics is the pressure-time-behaviour. This means the empirical and calculated life-time of pipes and parts of piping systems under depending boundary conditions such as inner pressure, temperature and time. The allowable stresses are always to be regarded dependent in contrast to metallic parts. By increasing the temperature during testing it becomes possible to conclude on long-time-behaviour at 20°C based on short-term tests.
The following picture shows the long-term behaviour of PE 100 according to EN ISO 15494:2003.



Y Stress in Megapascal (MPa) / 1MPa = 1 N/mm2

X Time to failure (h)

a years

Calculation of allowed pressure/wall thickness

The technical design of pressurized thermoplastic pipes is carried out strictly according to strenght requirements by means of the kesselformula. All pipe dimensions in standards are based on this formula. Deviations are just possible in smaller diameters since certain wall thicknesses will not under-run be due to practical and production limitations.

$$e = \frac{p\ d}{20\ \sigma_{zul.} + p}$$

Using:

e	wall thickness in mm
d	outer pipe diameter in mm
p	allowable pressure in bar
σ_{zul}	allowable stress in N/mm²

Simply using the nominal pressure is not enough any more. The usual deployment of PN as a measure for the pipe size can harbour a danger of confusion regarding butt fusion. Plastic pipes and fittings equally pressure tolerable are meanwhile marked pressure-neutrally. The goal is to prevent a misuse of pipes in different application areas or different conditions. According to ISO 4065 pipes are classified into series. The series determines the load resistance without possibility of confusion as the nominal pressure did.

The pipe series is marked by the letter S. This series is based on the following formula:

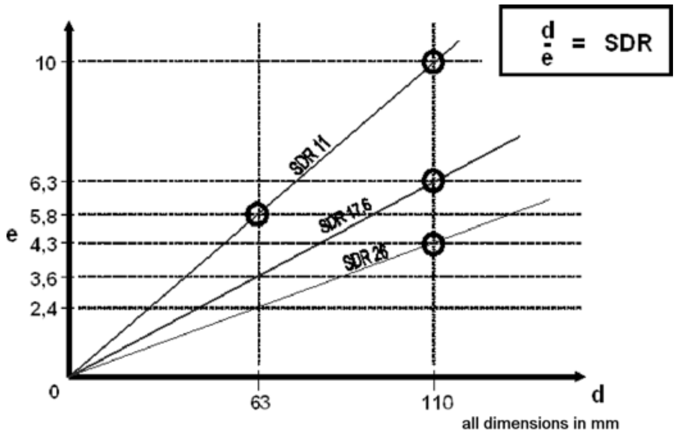
$$S = \frac{10\ \sigma_{zul}}{p\ C} = \frac{d - e}{2\ e}$$

Consequently, S is dimensionless. For an PE-pipe with the dimensions 110 x 10 mm the formula yields
S = 5 = (110 - 10) / (2 * 10).
Further the denotation SDR is known. SDR stands for Standard Dimension Ratio. SDR indicates the diameter/ wall-thickness-ratio.

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

Series- and SDR are connected through the following formula: SDR = 2 * S + 1 or S = (SDR-1) / 2.
Using the upper example:
SDR = 110/10 = 11 = 2 * 5 + 1
Currently all three indicators PN, S and SDR are used in the market. Georg Fischer recommends to always state dimension, wall-thickness and pipe series or SDR.

SDR	Pipe series S	Nominal Pressure PN
SDR = d / e = 2 S +1	$S = \frac{d - e}{2e}$	$PN = \frac{10\,\sigma_s}{S}$
e.g.: SDR of 110/10 = 11	$S = \frac{100 - 10}{2 \times 10} = 5$	$= \frac{20\,\sigma_s}{SDR - 1}$ σ_s = Designed stress



Calculation of design factor

To calculate design factor and allowable operating pressure it is necessary to know the creep strength of the material. Depending on expected useful life and the max. operating temperature this diagram contains the value of the creep strenght σ. Since the wall thicknesses of fittings and valves are higher compared to pipes due to the shape of the parts, it is necessary to base the calculation upon outer diameter and wall thickness of a pipe of the same pressure rating. The effective design factor can be calculated using the following formula:

$$C = \frac{\sigma_s \; 20 \; e}{p \; (d - e)}$$

with:

C	designfactor
σ	stress in N/mm²
e	wall thickness of the pipe in mm
d	outer diameter of the pipe in mm
p	pressure in bar

The following example is based on the previously used numbers. In this case the usual minimum value of design factor of PE100 is applied.

p_{max} = (20 * 10 *10/1.25) / (110 - 10) = 16 bar

Remark: The previously described calculation is only valid for freely moving pipelines. Axially fixed pipes have to be checked for buckling. In most of the cases, this examination leads to a reduction of the maximum inner pressure and shorter distances between the support brackets. Further, locally applied forces at fixed points have to be considered.
For assistance, please contact your nearest GF representative.

Max. allowable pressure for PE-pipes

C Design Factor	Material	SDR 17	SDR 11
Water	PE63	6	10
1.25	PE80	8	12.5
	PE100	10	16
Gas	PE63	4	6
2.0	PE80	5	8
	PE100	6	10

Calculation of elongation

The following formula describes the temperature-dependet elongation:
ΔL=L⁺ΔT⁺α
With:

- ΔL = temperature dependent elongation (mm)
- L = pipe length (m)
- ΔT = temperature difference (K)
- α = linear expansion coefficient (mm/(m K))

Some expansion coefficients of polymer materials:

Material	α = mm/(m K)
PE	0.15-0.20
PP	0.16-0.18
PVC-U	0.07-0.08

Important: A higher working temperature compared to the installation temperature results in an elongation of the pipe. A lower working temperature results in a shorter pipe.

Consequently: Installation temperature, minimum and maximum working temperature have to be considered.

1.Pipe at installation temperature

2.Working temperature above installation temperature

3.Working temperature below installation temperature

An elongation of the pipe is denoted by "+" a shortage by "-"

Note: Further details are mentioned in "Planning Fundamentals for Industrial Piping Systems"

Required pipe diameter

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:

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

or

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

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

Relation ship: Outside diameter to inside diameter

To find the outside diameter using the inside diameter and the applicable SDR, use the following formula:

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

Correlation outside diameter to inside diameter for SDR11 and SDR17

d_i (mm)	SDR11 (PE, PP)
16	d20
20	d25
26	d32
33	d40
41	d50
52	d63
61	d75
74	d90
90	d110
102	d125
115	d140
131	d160
147	d180
164	d200
184	d225
205	d250
229	d280
258	d315
290	d355
327	d400
368	d450
409	d500
458	d560
515	d630
581	d710
655	d800

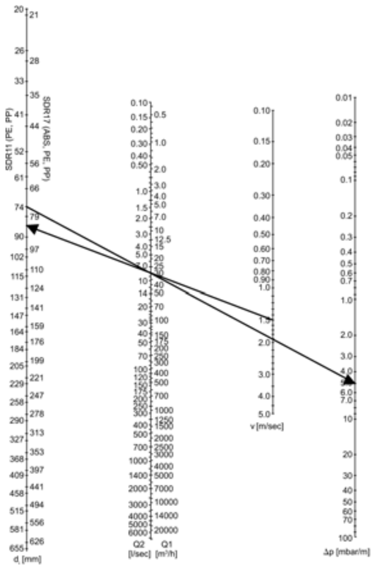
d_i (mm)	SDR17 SDR17.6 (ABS, PE, PP)
16	d20
21	d25
28	d32
35	d40
44	d50
56	d63
66	d75
79	d90
97	d110
110	d125
124	d140
141	d160
159	d180
176	d200
199	d225
221	d250
247	d280
278	d315
313	d355
353	d400
397	d450
441	d500
494	d560
556	d630
626	d710
705	d800

Nomogram for easy determination of diameter and pressure loss

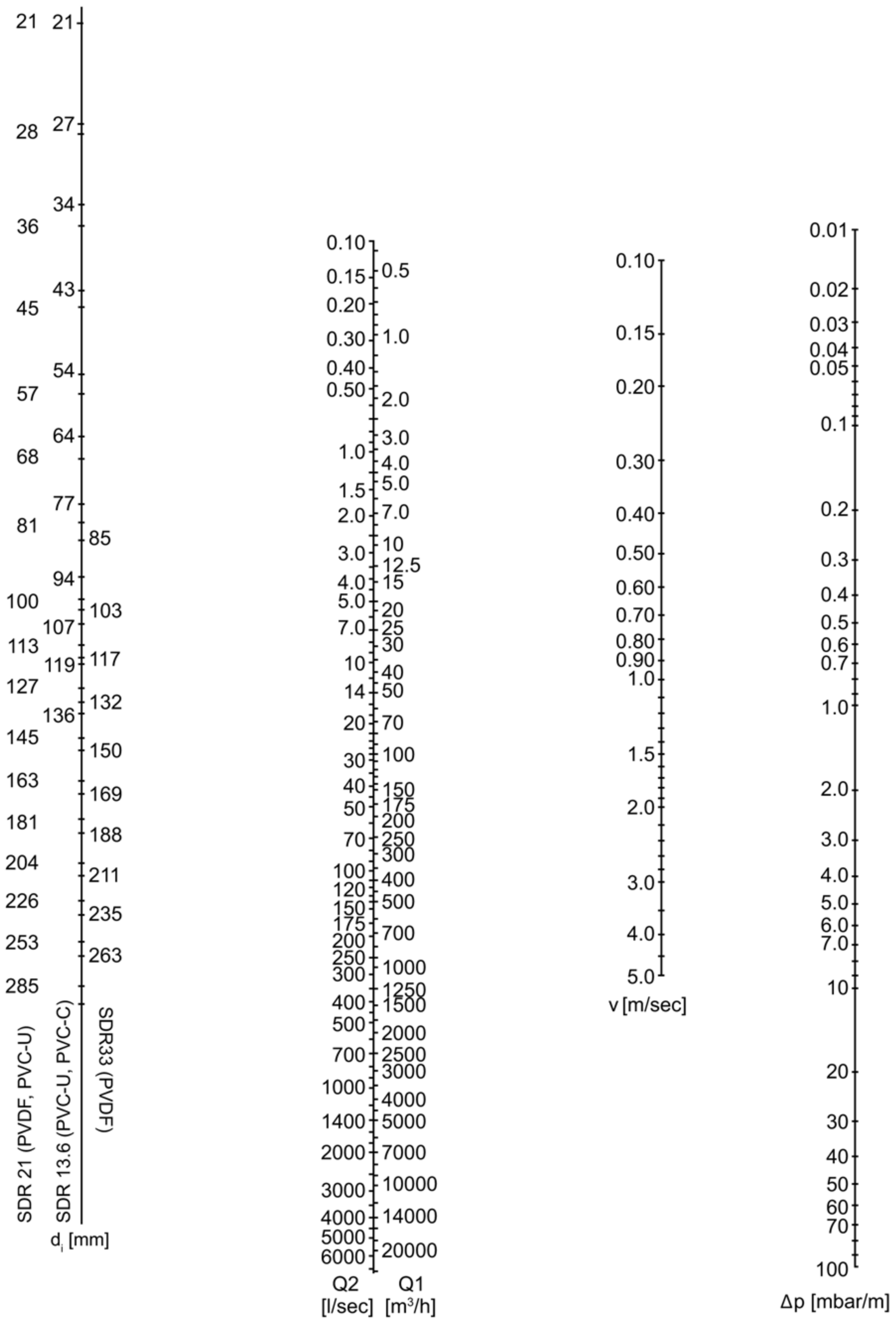
The following nomogram simplifies the determination of the required diameter. In addition the pressure loss of the pipes per meter pipe length can be read off.

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 (SDR13.6, SDR21, SDR33)



+GF+

Load due to buckling pressure

Regarding the pipe there is no difference between inner negative pressure and outer positive pressure. The important factor is the resistance against buckling of the pipe. Short-term (less than one hour)and long-term loads are differentiated.

Inner negative pressure can occur, when a suction is induced through dynamic drain or fast closing of a valve. These are mostly short-term loads.

Outer positive pressure occurs as a long-term load through ground water considering soil covered pipelines.

Buckling pressure-calculation

The critical buckling pressure can be calculated as follows:

$$P_k = \frac{E_c}{4 \cdot (1-\mu^2)} \cdot \left(\frac{e}{r}\right)^3$$

P_k	critical buckling pressure in N/mm² (10 N/mm² = 1 bar)
E_c	creep modulus in N/mm²
μ	Poisson`s ratio
e	wall thickness in mm
r	mean pipe radius in mm

A pipe under absolute vacuum is adequately dimensioned against buckling when the critical buckling pressure P_k=2 bar, i.e. when a minimum safety factor of 2 is calculated. Any influence caused by out-of-roundness and eccentricity must be specially taken into account.

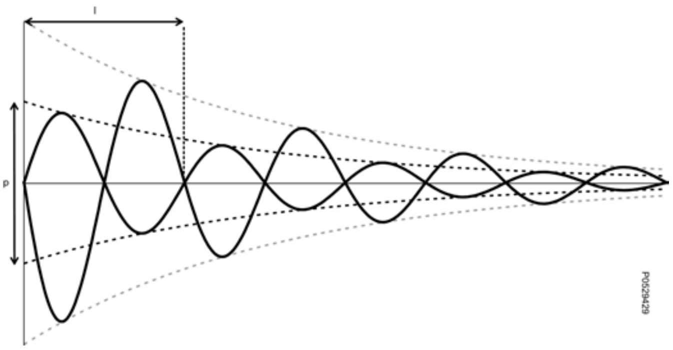
In case of questions, please contact your nearest GF representative.

Water hammer

Water hammer, or surge pressure, is a term used to describe dynamic surges caused by pressure changes in a piping system. They occur whenever there is a deviation from the steady state, i.e. when the velocity of the fluid is increased or decreased, and may be transient or oscillating. Waves of positive or negative pressure may be generated by any of the following:

- opening or closing of a valve
- pump startup or shutdown
- change in pump or turbine speed
- wave action in a feed tank
- entrapped air

The pressure waves travel along at speeds limited by the speed of sound in the medium, causing the pipe to expand and contract. The energy carried by the wave is dissipated and the waves are progressively damped (see Figure).
The pressure excess to water hammer must be considered in addition to the hydrostatic load, and this total pressure must be sustainable by the piping system. In case of oscillatory surge pressures extreme caution is needed as surging at the harmonic frequency of the system leads to catastrophic damages.



Damped pressure wave
l Wavelength
p Pressure change

PE-pipes are able to take water hammers relatively well as long as the mean stress is not bigger than the stress executed by the maximum allowable operating pressure.
For example a PE-pipe SDR 11 having a maximum operating pressure of 16 bar is able to take a pressure amplitude of 0 to 32 bar. The pressure amplitude for water at 20°C and PE-pipes is calculated using the following formuls (Differentiation of the Joukowsky-Formula):

$$P_s = \pm \frac{14.49}{\sqrt{1 + \frac{1.25 \times d_n \times e_n}{e_n}}} v_0$$

P_s pressure amplitude [bar]
v_0 flow velocity of the water [m/s]
d_n pipe outer diameter [mm]
e_n wall thickness of the pipe [mm]

Pressure Loss

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
$\Sigma\zeta$	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:

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

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

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

Application technology PE

General information

Electro fusion

Using electrofusion to connect PE pipes and valves permits a safe, systematic, economic and efficient installation for both buried and above-ground PE piping systems.

ELGEF Plus electrofusion products are supplied with a data carrier, which contains all relevant product information, traceability and fusion information required for jointing.

Compatibility

The ELGEF Plus range is suitable for jointing all PE 63, PE 80 and PE100 material types whose melt flow range (MFR) is within the limits of 0.2 to 1.4 g/10min and are listed below:

Trace. coding ISO 12176-4	**Manufacturer**	**Material Type**	**Material**	**Melt flow range MFR 190/5 [g/10 min.]**
F 01	**Total Petrochemicals**	MDPE 3802B	MDPE 80	0.92
F 02		MDPE 3802YCF	MDPE 80	0.92
F 05		HDPE XS10B	HDPE 100	0.30
F 06		HDPE XS10H	HDPE 100	0.30
F 07		HDPE XS10orangeYCF	HDPE 100	0.30
F 10		HDPE 4701B	HDPE 80	0.70
F 50		HDPE XS10OS	HDPE 100	0.30
F 51		HDPE XS10YS	HDPE 100	0.30
L 01		HDPE 2001TBK46	HDPE 80	0.45
L 02		MDPE 2002TBK40	HDPE 80	0.75
H10	**Basell**	Hostalen CRP 100 Black	HDPE 100	0.22
H11		Hostalen CRP 100 Blue	HDPE 100	0.22
H12		Hostalen CRP 100 Orange-yellow	HDPE 100	0.30
H13		Hostalen GM 5010 T3 Black	HDPE 80	0.43
H15		Hostalen CRP 101 Orange-yellow	HDPE 100	0.30

N04	**Borealis A.B.**	Borstar® ME3444	MDPE 80	0.80
N05		Borstar® ME3441	MDPE 80	0.90
N06		Borstar® ME3440	MDPE 80	0.90
N15		Borstar® HE3470-LS	HDPE 80	0.30
N16		Borstar® HE3490-LS	HDPE 100	0.30
N17		Borstar® HE3492-LS	HDPE 100	0.30
N18		Borstar® HE3494-LS	HDPE 100	0.30
V00	**Sabic Polyolefine**	SABIC Vestolen A 6060 R black 10000	HDPE 100	0.30
V01	**GmbH**	SABIC Vestolen A 6060 R blue 65307	HDPE 100	0.35
V10		SABIC Vestolen A 5061 R black 10000	HDPE 80	0.50
V20		SABIC Vestolen A 4062 R black 10000	MDPE 80	0.80
V22		SABIC Vestolen A 4062 R yellow 62429	MDPE 80	0.80
B03	**Ineos Polyolefins**	Eltex PC 2040 Yellow	MDPE 80	0.85
B04		Eltex PC 002-50 R 102 black	MDPE 80	0.85
B05		Rigidex PC 002-50R 968 blue	MDPE 80	0.85
(E03)/E04		ELTEX TUB 121	HDPE 100	0.45
E05		ELTEX TUB 121 N 2025	HDPE 100	0.30
E06		ELTEX TUB 124	HDPE 100	0.48
E07		ELTEX TUB 124 N 2025	HDPE 100	0.32
E08		ELTEX TUB 125 N 2025	HDPE 100	0.32
E10		ELTEX TUB 131 N 2010	HDPE 80	0.46
E11		ELTEX TUB 131 N 2012	HDPE 80	0.46
E12		ELTEX TUB 171	MDPE 80	0.85
E13		ELTEX TUB 172	MDPE 80	0.85
E14		ELTEX TUB 174	MDPE 80	0.85
E15		ELTEX TUB 121 N 3000	HDPE 100	0.30
E16		ELTEX TUB 121 N 2035	HDPE 100	0.20

There are no claims that this list is complete.Please contact the pipe or pipe material manufacturer should further information be required.

Information concerning the suitability of using other PE pipe material types, composite pipes as well as other pipes whose MFR values are outside those given in the above list can be obtained upon request from GF Piping Systems Ltd. Additionally, the compatibility of ELGEF Plus System products with certain PE-X_a pipes has already been proven. Please contact a GF Piping Systems sales company for detailed information.

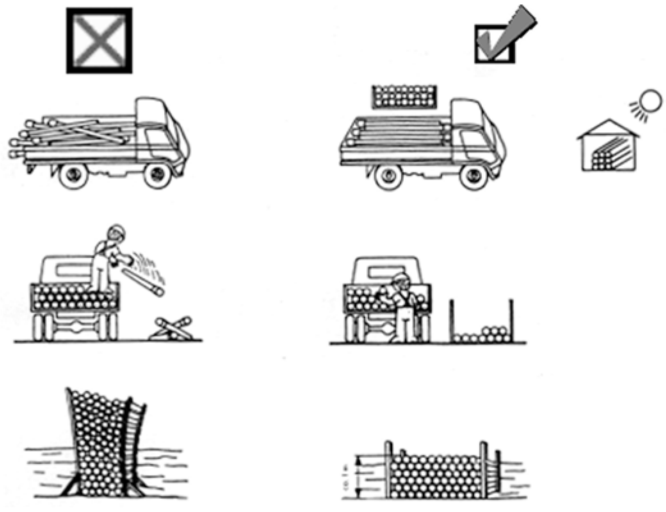
Tests have shown that our ELGEF Plus products are compatible with the above mentioned Polyethylene raw material grades of the pipes. The process and varying additives used in pipe manufacturing may have a negative impact on the compatibility. As we have no knowledge of the specific manufacturing processes and the additives used in the manufacture of the pipes, Georg Fischer cannot warrant the compatibility of its ELGEF Plus products with pipes produced in a specific process or containing specific additives.

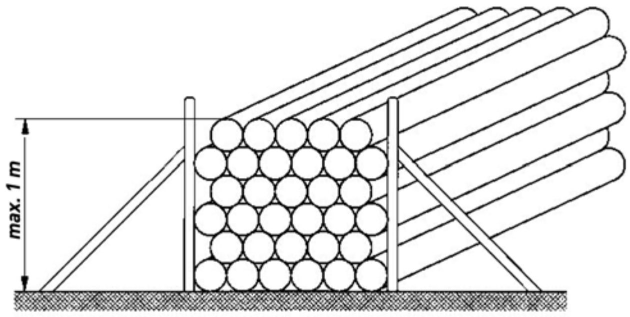
Handling of piping systems

Transport

Vehicles for transporting pipes should be selected in such a way so that the pipes can lay completely flat on the bed of the vehicle without any over-hang. All pipes are to be supported so that they cannot bend or become deformed. The area of the truck where the pipes are laid should be covered with either protective sheeting or cardboard (including all side supports) in order to prevent any possible damage from protruding rivets or nails etc. Pipes and fittings should be protected from possible damage during transport and not be dragged over the bed of the truck or across open ground prior to installation.

Pipes and fittings should always be loaded and unloaded with extreme care. Special support frames are to be employed when using cranes for loading or unloading from vehicles. Throwing pipes onto the ground from the bed of the transport truck must be prevented at all times.





The location where pipe and piping components is stored must provide as much protection as possible. Pipes should not be allowed to come into contact with fuels, solvents, oil, greases, paints (silicones) or heat sources during storage.

Dragging pipes and coils over the ground must be avoided at all times.

Sudden shock impacts are to be avoided under all circumstances. This is especially important at ambient temperatures around or below 0º C under which circumstances the impact resistance of almost all materials is considerably reduced.

Pipes and fittings are to be transported and stored in such a way so that they do not become contaminated by earth, mud, sand, stones, water, oils, chemicals, solvents, other liquids, animal excrement and the effects of weather etc. We strongly recommend that all open pipe ends are covered by protective caps to prevent the ingress of foreign substances and matter inside the pipes.

Coiled pipes are to be fastened in such a way so that they cannot become loose and damaged during their transport.

Following delivery, loose or individual pipes should be laid out flat so that they rest on their entire length as soon as possible and then secured so that they cannot roll against one another. All storage surfaces in contact with the pipes must be kept free from sharp-edged objects. Storing pipes on their pallets will offer basic protection from damage.

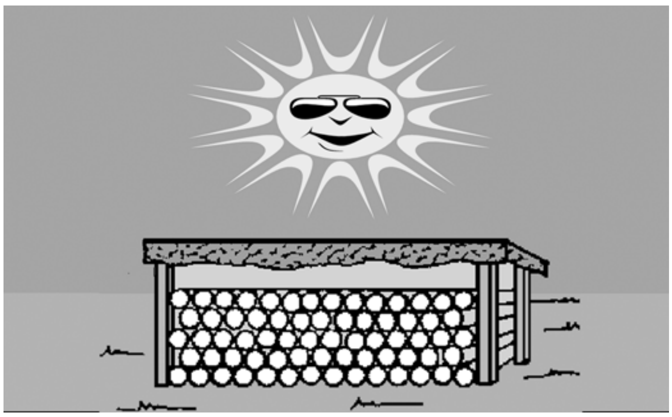
Storage
All storage areas should be flat and kept free from stones and sharp-edged objects.

Pipes are to be stored in such a way to prevent any contamination of the insides. End closure caps should be removed just before installation.

Storage zones and stack heights are to be chosen which avoid possible damage or permanent deformation. Large diameter pipes with low wall-thicknesses are to be provided with stiffener rings. Single point or longitudinal contact support for any pipe is to be avoided.Non-palletted pipes should be stacked in heights not exceeding 1 meter. This is not applicable for pipes which are stacked on pallets providing their full weight is supported by the frame of the pallet. In principle, coiled pipes are to be either laid flat or placed in a suitable protective framework for storage.

Fastening bands should not be removed until shortly before installation. If pipes are correctly stacked on pallets and secured against lateral movement, stacking heights may be increased by 50%.

Influence of weather
The influence of weather on all stored piping components, is to be kept to an absolute minimum, i.e. such items should be kept in a covered warehouse.
If pipes are stored in the open (for example, on construction sites) they must be covered with suitable coloured or plain black sheeting to protect them from the effects of weather (e.g. UV radiation). Furthermore, a one-sided exposure to direct sunshine can ultimately lead to deformation of the pipe.



Measures are to be undertaken to obtain either a declaration of suitability from the manufacturer or a special fitness-for-purpose statement (national regulations must be followed) before attempting to use pipe and fittings which have been stored in the open for more than a year.

All piping components should be used in the order of their manufacture or delivery to ensure a systemised stock rotation.

Pipes and piping components should be checked before use to ensure their perfect condition and complete compliance with national marking regulations. The depth of any groove, scratch or flat abraded surface is permitted up to a total depth not exceeding 10% of the respective wall thickness. Pipes or fittings with damage in excess of this value may not be used.

Fittings

Fittings and valves supplied by GF Piping Systems are individually packed in PE bags and additionally in cartons to protect them from UV radiation as well as general contamination. A product should not be removed from its packaging until immediately before use to prevent a possible soiling of the fusion zones. If the fittings are protected from direct sunlight and are kept in their original packaging[1] they can be stored for up to 10 years if the storage temperature remains below 50º C. The storage duration commences on the date of production.

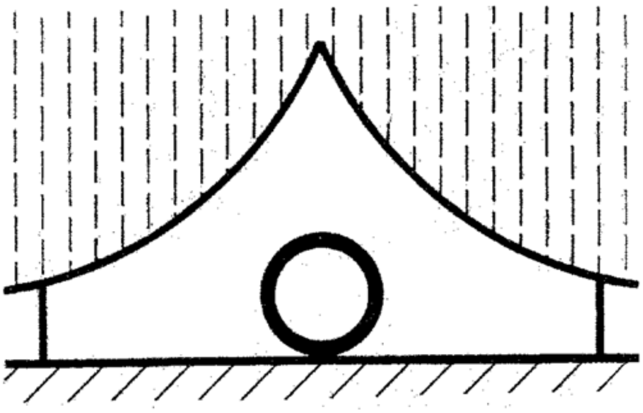
[1]i.e. in sealed PE bag and closed carton.

Drinking water disinfection

High concentrations of chlorinated disinfectants (Chlorine Dioxide, Chlorine, …) or inappropriate disinfection procedure may harm components or reduce the life time of PE piping systems. Please refer to your national regulations (i.e. DVGW W291; Water Supply Hygiene and Technical Guidance Note of Water UK) for state of the art disinfection for drinking water pipelines, to establish the expected 50 years life time of your PE piping system and to avoid also a negative effect on the potable water quality.

Handling instructions

The quality of the joint depends to a considerable extent on the care with which the preparatory work is performed. Electrofusion jointing may only be carried out by trained personnel.



Ensure the fusion zone is protected from weather influences such as rain, snow or wind. The admissible ambient temperature for electrofusion ranges from -10º C to + 45º C. All national guidelines are to be observed. An even temperature can be achieved around the entire pipe circumference by shielding the fusion zone against direct sunlight or inclement weather.

Special care should be taken to ensure that the electrofusion control unit and all components to be fused have been kept in and are jointed under identical environmental conditions (temperature).

Protection of the fusion area

The pipe and fitting surfaces to be fused should be fully protected from dust, grease, oil and lubricants. Only use cleaning agents which are suitable for PE (further information concerning suitable cleaning agents can be found in the respective Assembly and Operating Instructions: Cleaning).

The fusion zone must be kept free from all greases such as hand cream, silicones and oily rags etc.!

Working pressure and operating temperature

PE fittings and saddles are so dimensioned that they fulfil the long-term requirements of the respective ISO 4065 pipe series.

Working pressures for water at 20º C
(safety coefficient C min. = 1.25)

Pipe class	Operating Pressure PE100 [bar]	Operating Pressure PE80 [bar]
SDR7.4 ISO S3.2	-	16
SDR11 ISO S5	16	12.5
SDR17/17.6 ISO S8	10/9.6	8/7.6
SDR26 ISO S12.5	6.4	5

Working pressures for gas at 20º C
(safety coefficient C min. = 2.0)

Pipe Class	Operating Pressure PE100 [bar]	Operating Pressure PE80 [bar]
SDR11 ISO S5	10	4
SDR17/17.6 ISO S8	5	1

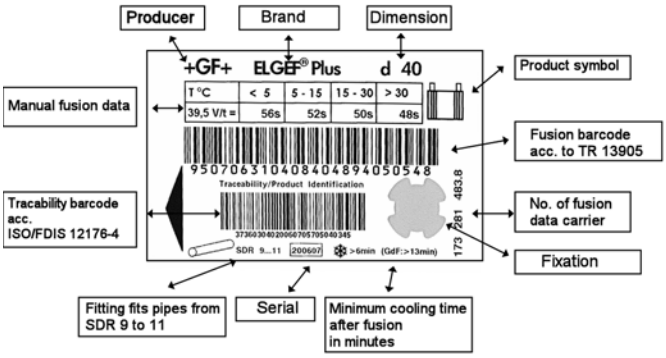
Detailed information concerning the relationship between working pressures and operating temperatures is available upon request from GF Piping Systems.

Products and fusion data

ELGEF Plus electrofusion products are supplied with a data carrier, which contains all relevant product information, traceability and fusion information required for jointing in the form of a barcode, fusion data table and a magnetic stripe.

Advantages of a fusion data carrier

- Offers 3 different ways to enter fusion data, either manually, from a barcode or a magnetic stripe.
- Fusion barcode and traceability barcode on single data carrier. Information covering compatibility with pipes of different wall thicknesses, e.g. SDR 9 to SDR 11.
- Simple functioning and reading of barcode from all body positions i.e. no contortions in the trench.
- ELGEF Plus products can be processed by all control units (40V) which conform to current international standards.



Preparation for jointing

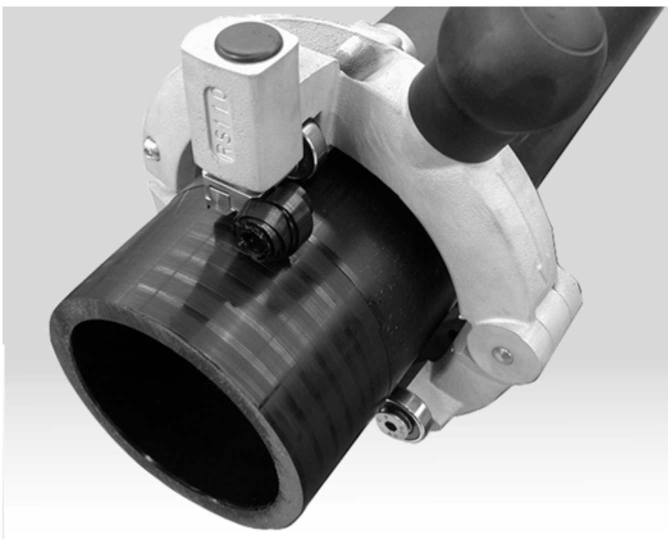
The pipe must be wiped free from any surface contamination, fully peeled ensuring continuous shaving and finally degreased with Tangit PE cleaner only in the area of the pipe which has been peeled. Rotary peeling tools for an even and time-saving preparation of the fusion zone should be used. The appropriate assembly and operation instructions are to be closely followed.

The following scraping depth limits are recommended:

d Pipe [mm]	Minimum wall reduction [mm]	Minimum allowable pipe diameter after peeling* [mm]
20-25	0.20	d nom. -0.4*
32-63	0.20	d nom. -0.5*
75-225	0.20	d nom. -0.6*
>225	0.20	d nom. -0.7*

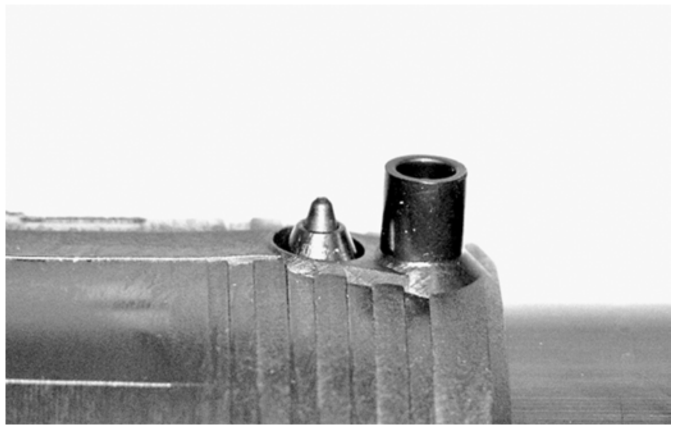
Note: Maximum pipe ovality = 1.5 % (according to DVS 2207 – 1)

*these values refer to the nominal outside diameter of the pipe, i.e. if the mean outside diameter of the pipe is on the upper tolerance limit, this diameter can be reduced through peeling to the minimum allowable pipe outside diameter. Additional information can be obtained from the “Assembly and Operating Instructions”.



Control of the fusion indicators

When the fusion cycle has finished a check is to be made to ensure the fusion indicators have functioned. The accompanying picture shows that the indicator pin is clearly protruding following a completed fusion process. This protrusion indicates that fusion pressure has developed but it does not necessarily guarantee any integrity for the joint. The height of the extended pin is dependant upon the fitting in use, component tolerances as well as pipe material.



Application of electrofusion fittings for different pipe classes*(fusion compatibility)

Next to the GF specifications for fusion compatibility the national regulations must be considered. The weakest component defines the max. allowable operating pressure.
All pipes must be in accordance with international regulations. The melt flow rate (MFR) must be between 0.2 and 1.4 g/10 min. National rules and regulations must be adhered to. All data given relates to PE 100 pipes.

ELGEF Plus electrofusion couplers

Couplers (with integrated clamps from d 20 – 63 mm) are used in conjunction with PE pipes and PE spigot fittings. Both socket outlets are fused simultaneously (mono-filament) on couplers ≤ d 500 mm. Each socket is fused separately (bi-filament) for all couplers of d 560 mm and above.

ELGEFPlus - electrofusion couplers SDR11

Pipe diameter d [mm]	SDR 9 ISO S 4	SDR 11 ISO S5	SDR 17/17.6 ISO S8	SDR 26 ISO S12.5	SDR 33 ISO S16
20		+			
25		+			
32		+			
40		+			
50		+	+**		
63		+	+**	+**	+**
75	+*	+	+	+**	+**
90	+*	+	+	+**	+**
110	+*	+	+	+**	+**
125	+*	+	+	+**	+**
140	+*	+	+	+**	+**
160	+*	+	+		
180	+*	+	+		
200	+*	+	+		
225	+*	+	+		
250	+*	+	+		
280	+*	+	+		
315	+*	+	+		
355	+*	+	+		
400	+*	+	+		

+ suitable

+* conditionally suitable depending on temperature, pressure and medium, but only for water applications. Please contact your local GF contact.

+** conditionally suitable depending on temperature, pressure and medium. Please contact your local GF contact.

ELGEFPlus - electrofusion couplers SDR17

Pipe diameter d [mm]	SDR 11 ISO S5	SDR 17/ 17.6 ISO S8	SDR 26 ISO S12.5	SDR 33 ISO S16
160	+	+	+	+**
180	+	+	+	+**
200	+	+	+	+**
225	+	+	+	+
250	+	+	+	+
280	+	+	+	+
315	+	+	+	+
355	+	+	+	+
400	+	+	+	+
450	+	+	+	+
500	+	+	+	+
560	+	+	+	+
630	+	+	+	+

+ suitable

+** conditionally suitable depending on temperature, pressure and medium. Please contact your local GF contact.

ELGEF Plus - electrofusion fittings SDR11

Pipe diameter d [mm]	SDR 11 ISO S5	SDR 17/ 17.6 ISO S8	SDR 26 ISO S12.5	SDR 33 ISO S16
20	+			
25	+			
32	+			
40	+			
50	+	+**		
63	+	+**		
75	+	+**		
90	+	+**	+**	
110	+	+	+**	
125	+	+	+**	
160	+	+	+**	
180	+	+	+**	
200	+	+	+	
225	+	+	+	
250	+	+	+	

+ suitable

+** conditionally suitable depending on temperature, pressure and medium. Please contact your local GF contact.

ELGEF Plus - branch fittings SDR11

Pipe diameter d [mm]	SDR 11 ISO S5	SDR 17/17.6 ISO S8	SDR 26 ISO S12.5
90	+	+	
110	+	+	
125	+	+	
160	+	+	
180	+	+	
200	+	+	
225	+	+	
250	+	+	
280	+	+	+
315	+	+	+
355	+	+	+
400	+	+	+
450	+	+	+
500	+	+	+
560	+	+	+
630	+	+	+

+ suitable

+** conditionally suitable depending on temperature, pressure and medium. Please contact your local GF contact.

ELGEF Plus electrofusion saddles

These saddles are used for service and branch connections from PE pressure mains pipelines in gas and water distribution systems as well as for industrial applications. Additionally, saddles can be used when creating by-pass systems, to install stop-off bags in gas lines, to connect control valves and to repair minor pipe defects

A special feature of GF Piping Systems tapping saddles and pressure tapping valves is the branch outlet which can be rotated through 360º. The saddles can also be installed on pressurised mains pipes. The integral cutter (cutting drill, punch drill) permits the tapping through into both pressurised as well as non-pressurised pipelines. The disc cut out of the pipe is permanently retained in the cutter.

Remark constraints in compatibility of tapping saddles and pressure tapping valves due to drilling (thickness of the pipe wall).

[1] Constraints for pressure tapping valves

[1,2] Constraints for pressure tapping valves and tapping saddles

ELGEF Plus - electrofusion saddles SDR11

Pipe diameter d [mm]	SDR 11 ISO S5	SDR 17/17.6 ISO S8	SDR 21 ISO S10.5	SDR 26 ISO S12.5	SDR 33 ISO S16
for ELGEF Plus - monoblock					
40	+				
50	+				
63	+				
90	+	+			
110	+	+			
125	+	+			
160	+	+			
for ELGEF Plus - modular system					
63	+				
75	+				
90	+	+**			
110	+	+	+		
125	+	+	+		
140	+	+	+	+	
160	+	+	+	+	
180	+	+	+	+	+
200	+	+	+	+	+
225	+	+	+	+	+
250	+[1]	+	+	+	+
280	+[1]	+	+	+	+
315	+[1]	+	+	+	+
355	+[1,2]	+[1]	+[1]	+	+
400	+[1,2]	+[1]	+[1]	+	+

+ suitable

+** conditionally suitable depending on temperature, pressure and medium. Please contact your local GF contact.

Detailed product information can be found in the Product Range booklet.

Working pressure and temperature

PE fittings and saddles are so dimensioned that they conform to the long-term requirements of the corresponding ISO pipe series (i.e. ISO S 3.2, ISO S 5 and ISO S 8 in accordance with ISO 4065).

In accordance with national and ISO standards for gas and water distribution systems this corresponds to the values given in the table below.

Detailed information concerning the relationship between working pressures and operating temperatures is available upon request from GF Piping Systems.

Pipe class	Operating Pressure PE100 [bar]		Operating Pressure PE 80 [bar]		Temperature [°C]
	Water ($c_{min.}$ = 1.25)	**Gas** ($c_{min.}$ = 2.0)	**Water** ($c_{min.}$ = 1.25)	**Gas** ($c_{min.}$ = 2.0)	
SDR7.4 ISO S3.2	-	-	16	-	20
SDR11 ISO S5	16	10	12.5	5	20
SDR17/17.6 ISO S8	10	5	8	1	20

Vacuum conditions:
up to 800 mbar below atmospheric pressure with a minimal pipe wall-thickness of SDR 17/17.6

Electrofusion unit

The MSA family

At a glance				
Features	**MSA 250**	**MSA 300**	**MSA 350**	**MSA 400**
Temperature-dependent energy control	+	+	+	+
Wide input voltage range (180 - 264 V)	+	+	+	+
Suitable for generator operation	+	+	+	+
Automatic fusion data input via barcode-pen/scanner	+	+	+	+
For series and long-term jointing	+	+	+	+
Dust and wash-down proof (IP 65)	+	+	+	+
Maximum protection from electrical hazards, Protection Class 1	+	+	+	+
Lightweiht, robust aluminium housing	+	+	+	+
Sturdy transport box	+	+	+	+
Housing with active cooling system	+	+	+	+
Manual input of fusion time	+	+	+	+
Fusion time and energy display	+	+	+	+
Menu guide in more than 24 languages	-	+	+	+
Programmable maintenance intervals	-	+	+	+
User guide	-	+	+	+
Individual configuration	-	+	+	+
Pipe logbook software MSA WIN-WELD	-	-	+	+
Internal safeguard of fusion data	-	-	+	+
Fusion data recording	-	-	+	+
Memorycard for 400 fusion cycles	-	-	-	+
Complete trancability possible for individual piping components	-	-	-	+

Technical data of the MSA family

Technical Data	MSA 250	MSA 300	MSA 350	MSA 400
Input voltage range	180 - 264 AC	180 - 264 AC	180 - 264 AC	180 - 264 AC
Frequency range	45 - 65 Hz	45 - 65 Hz	45 - 65 Hz	45 - 65 Hz
Current consumption	16 A	16 A	16 A	16 A
Power consumtion	3500 W	3500 W	3500 W	3500 W
Fusion voltage	8 - 42 V (48 V)	8 - 42 V (48 V)	8 - 42 V (48 V)	8 - 42 V (48 V)
Fusion current	0.5 - 90 A	0.5 - 90 A	05 - 90 A	05 - 90 A
Safety cut-out	16 A inert	16 A inert	16 A inert	16 A inert
Protection rating	IP 65	IP 65	IP 65	IP 65
Protection class	1	1	1	1
Housing	Aluminium	Aluminium	Aluminium	Aluminium
Intergrated cooling system	Yes	Yes	Yes	Yes
Connecting cables	3 m	3 m	3 m	3 m
Fusion cables	3 m	3 m	3 m	3 m
Weight (ready for use, including cable)	11.5 kg	11.5 kg	11.5 kg	11.5 kg
Dimensions (B/H/T)	284/364/195	284/364/195	284/364/195	284/364/195
Processable barcodes	Code I 2/5 Code 128 C	Code I 2/5 Code 128 C	Code I 2/5 Code 128 C	Code I 2/5 Code 128 C
Working temperature range	-10 ° to +45 °C	-10 ° to +45 °C	-10 ° to +45 °C	-10 ° to +45 °C
Automatic temperature compensation	Yes	Yes	Yes	Yes
Fusion current monitoring	Yes	Yes	Yes	Yes
Recognition of short circuit in coil	Yes	Yes	Yes	Yes
Display	LED 7-Seg x 4N	LCD grafical	LCD grafical	LCD grafical
Documentation of fusion data	-	-	Yes	Yes
Documentation of traceability data	-	-	-	Yes
Internal data storage	-	-	Yes, 750	Yes, 750
External data storage, memorycard	-	-	Yes, 400	Yes, 400
Series interface	-	-	Yes	Yes
Parallel interface	-	-	Optional	Optional
Protocol software MSA WINWELD	-	-	Yes	Yes
Data transfer cabel	-	-	Optional	Optional
Memorycard	-	-	Optional	Yes, 256 kB
Operator ID (Configurable as compulsory)	-	-	Yes	Yes
Manual fusion data input	Yes	Yes	Yes	Yes
Number of languages	-	24	24	24
Angle adapter 4.0 mm	Yes	Yes	Yes	Yes
Barcode scanner	Optional	Optional	Optional	Optional
Transportbox (aluminium/wood)	Yes	Yes	Yes	Yes
Recommended generator rating	3.5 kVA	3.5 kVA	3.5 kVA	3.5 kVA
Standards: CE, EN 55014, EN 50081-1, EN 50082-1, EN 61000-3-3, EN 60335-1, EN 60335-2-45	Yes	Yes	Yes	Yes

MSA 210 - Manual electrofusion unit

Simple, robust 40 V (39,5 V) electrofusion unit. Manual input of fusion time, easy to use, wide range of application.

Generally, the MSA 210 can be used for all sizes of fittings. However, the cooling times for the unit must be followed for prolonged fusion times as well as for large diameter fittings (d>355 mm).

Supplied with: 1 pair angle adapters, 4.0 mm,Operating Instructions

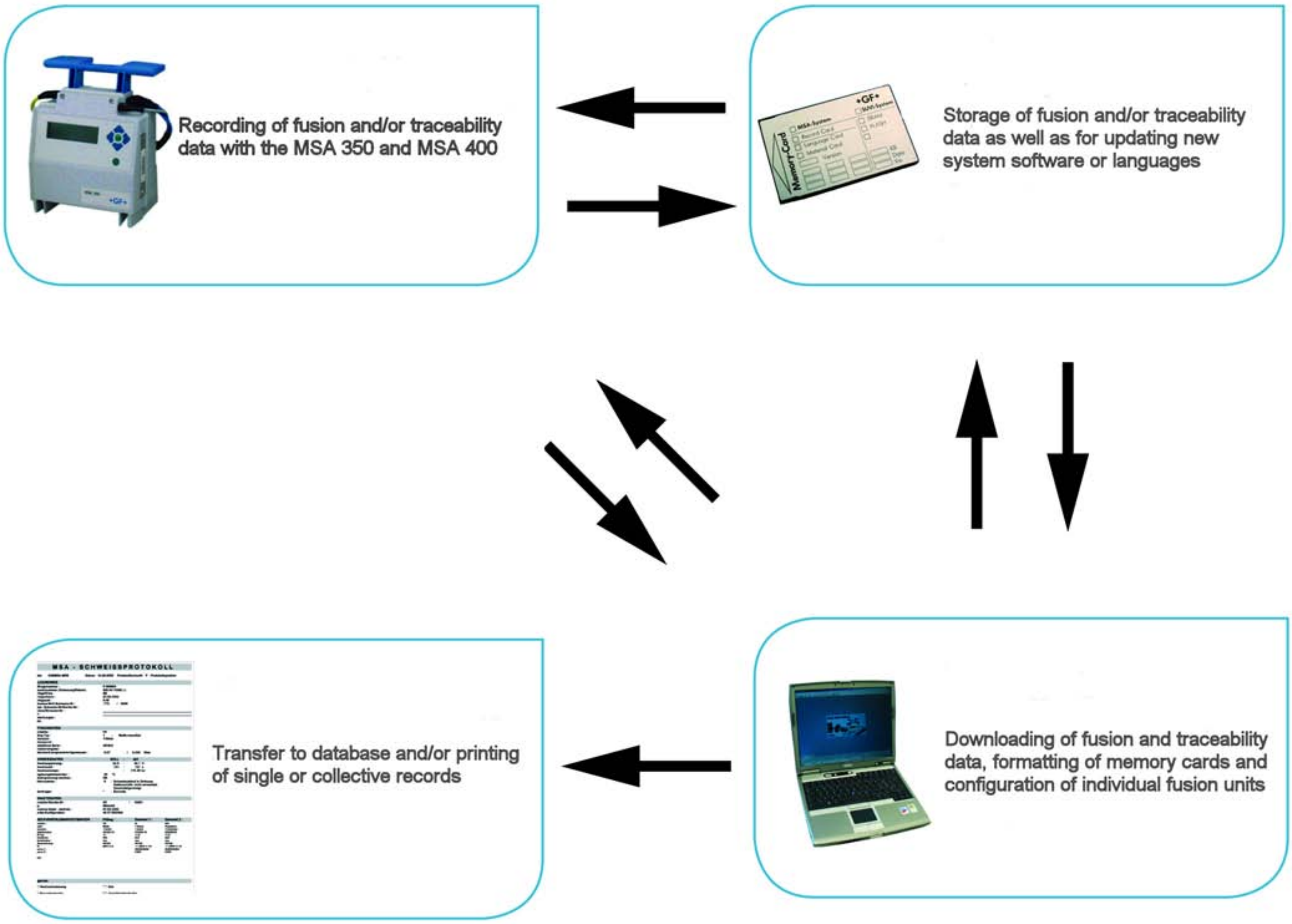
Technical Data	
Input voltage range	180 - 260 V AC
Frequency range	45 - 64 Hz
Power consumption	2750 W
Fusion voltage	39.5 V
Fusion current	max. 80 A
Safety cut out	16 inert
Connecting cables	4 m
Fusion cables	3 m
Display	LED 7-Segment x 4N
Size of display	50 x 18 mm
Operating temperature range	-10°C bis +45°C
Dimensions (B/H/T)	270/480/150
Recommended generator	3.5 kVA
Weight (ready for use, incl. cable)	21 kg
Protection rating	IP65
Protection class	1
Standards	CE label, UNI 10566, ISO 12176-2

WIN-WELD software

The WIN-WELD software package is a valuable tool for the documentation of a piping network or for individual sections of it. It offers a complete documentation, from the individual fusion connections and piping components used (fittings, pipes, mechanical parts) up to the entire piping system.

Furthermore, the WIN-WELD software package offers the following additional possibilities:

- Creation of individual and collective fusion records
- Individual configuration of fusion units
- Creation of welder IDs in accordance with ISO12176-3
- Fusion data processing and management
- Importing fusion data in CSV format
- Exporting data in EXCEL or ACCESS
- Formatting memory cards
- Creation of individual barcodes
- Reading-out of fusion data
- Creation of a piping system manual
- Use of piping manual to calculate the capacity of the network
- Piping system documentation in accordance with ISO12176-4


Recording of fusion and/or traceability data with the MSA 350 and MSA 400
Storage of fusion and/or traceability data as well as for updating new system software or languages
Downloading of fusion and traceability data, formatting of memory cards and configuration of individual fusion units
Transfer to database and/or printing of single or collective records

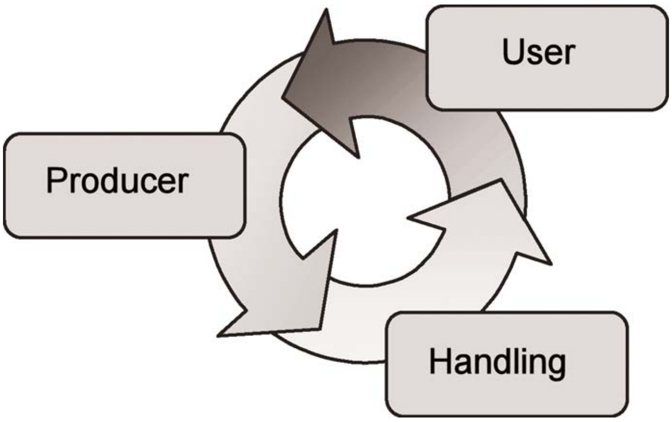
Traceability and quality assurance

Product tracability

Product-traceability in polyethylen piping systems
Today, everyone who is involved with the installation of pipeline systems especially for gas and water distribution systems is confronted with the most varying requirements. Keywords such as quality assurance, product liability, duty of the service provider, cost reductions, profitability of participating companies etc., have different perspectives.

If differing interests have to agree with varying demands, then it is necessary to create an electronic documentation of all relevant data for reasons of traceability. Based on the new traceability system, all the prerequisites for a uniform and safe system with respect to standards, pipe and fitting manufacturers and manufacturers of fusion units are available today. Now the service provider and network administrators only need to correctly install this economical and clearly structured resource in their companies to fulfil the requirements with regard to all-embracing quality assurance.

Although diverse interests such as quality assurance, product liability, duty of the service provider, cost reductions, profitability of the participating companies etc, are in conflict while creating pipeline systems especially for gas and water distribution, it should be certainly possible to integrate them as a whole in a quality cycle.



Therefore, it should be feasible to entirely complete this quality cycle, however, and for various reasons, this has been only partially or not possible at all, until today.

In particular, when using system components from different suppliers the necessary instruments to implement the quality cycle were only partly available or, sometimes even, not available whatsoever.

The key to a data recording system is reflected in a reliable documentation that cannot be manipulated. It should be possible to create such a system efficiently and without any significant additional costs. Considering the QA cycle, the fusion unit subsequently becomes the central documentation instrument.

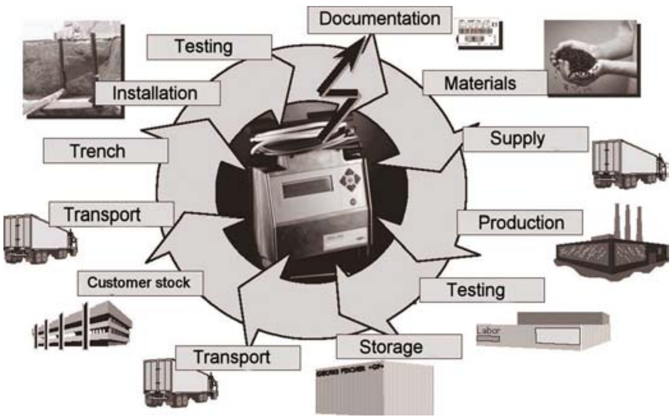
DVS Worksheet 2207 Part 1 stipulates at least one manually written fusion record. In the draft version of DVGW Worksheet G 472, a mechanically (electronic) created fusion record has been envisaged for operating pressures of 4 bar.

If all the varying interests are to be brought into line with the market requirements, any future system must be able to provide a reliable electronic documentation.

This record should contain the following information:

- Fusion jointing data
- Details of fitting used
- Details of pipe used
- Installation data

The result is a comprehensive pipe log book or network log book for the respective piping system operator. These days many operators maintain pipe or network log books to be able to locate the position of individual components at a later date. This is mostly done manually and of course results in additional costs and efforts for the administration. Electronic documentation offers an optimal, economical solution for data management.



Requirements
As part of the quality assurance for the complete system and the traceability of all products from raw material to installation, it is essential to be able to locate each individual component accurately and at any time. As a result the requirements for the operator extend beyond just the documentation of the fusion jointing process. Other system components such as pipes, valves, plain fittings without heating coils, wall-inlet fittings etc. should also be included. If this is possible, then an automated documentation system becomes really significant. This means recording measurements such as lengths and distances on site during the actual installation. Therefore, an electronic logbook with the following content is the consequence:

- Length/distance
- Product type
- Product manufacturer
- Product details
- Material
- Production date/series
- Installation parameters
- Name of installer
- Installation company

The procedure mentioned above, not only affects the manufacturer of the system components, but also the person laying the pipes in the trench. It becomes immediately clear, when considering the realities, that installation equipment such as electrofusion control units and butt-fusion machines are to be used.

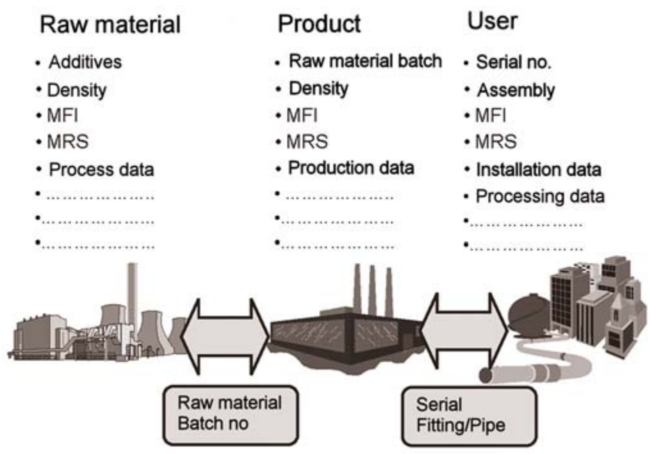
Many system providers and installers already possess sufficient practical experience in connection with the full documentation of fusion details, serving as a starting point for information concerning other products or data still to be added. Product and installation data must be harmonised as the requirements for such system components can stem from different sources. This is the only way that manufacturer-dependant compatibility can be established.

The viewpoint of the operator or installer
Such a system offers distinct advantages for the operator. They can enter a database at any time to obtain information on products with association to a particular installation quickly and efficiently. For them, the distribution system becomes more transparent. For example, it is possible to study an installed product from different points of view.

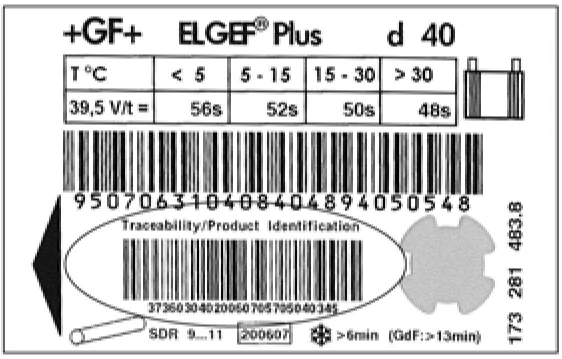
It must be possible to store information in a universal format and to process and link data with different kinds of systems. Any individual data format that cannot be linked to other systems appears to be inadequate. The installer will realise use can be made of a tool in the pipe trench to process product data as well as all pertinent geometric data (lengths and measurements). Nevertheless, this requires increased effort and more reliability from the installer whilst working. The advantage being that the quality being produced by the installer is being documented. Such an application comprises special significance with respect to product liability.

International standardisation
As there are differing views and standpoints at national and international levels, it becomes necessary to adopt such a development for economical reasons and to find a common denominator. Operators, installers and manufacturers have, in mutual agreement, defined their common interests. The new traceability system is described in ISO 12176 Part 4.

Implementation
With regard to the recording options that should preferably be integrated into existing electrofusion control units and butt-fusion machines, manufacturers are expected to ensure compatibility of the various systems on the basis of the above-mentioned standard. So-called batch or serial numbers are used to ensure the technical traceability from raw material through to the installed component. This establishes the link between the principle and decisive stages for each product.



Traceability Barcode
All relevant information concerning the traceability of the product and fusion process in accordance with ISO 12176-4 is incorporated in the traceability code on the data carrier card enclosed with the product.



Digit barcode structure

26-digit barcode structure (ISO 12176-4)

Figure	Description	Example
1	Name of manufacturer (additional dimensional information)	GF = Georg Fischer
2		
3	Use of a test digit: Yes/No	Test digit active = +3
4		
5	Component, e.g. Coupler, tapping saddle elbow 45º etc.	03 = Coupler
6		
7	Dimension	e.g. 032
8		
9		
10	Batch number of component	2006 01 = Year 2006 Series 01
11	6 digits can be defined by manufacturer	
12		
13		
14		
15		
16	Place of manufacture as supplement to batch	00 = Schaffhausen plant
17		
18	SDR of component, e.g. SDR 11	7 = SDR11/8 = SDR9
19	Raw material from which component was manufactured	F01 = Finathene 3802b
20		E04 = Eltex Tub 121
21		
22		
23	Material status (virgin, recycled, mixed)	0 = virgin
24	MRS of material (PE80/PE100)	2 = PE80 / 3 = PE100
25	MFR of material	1 = MFR $\leq$ 5
26	Test digit	If figure 3 = yes (+3): Code acc. TR 13950

Based on this method, all prerequisites for the standards, pipe and fitting manufacturers as well as for the manufacturers of fusion control units regarding a universal and reliable traceability have been established.

Now it is up to the operators and persons responsible for the network to integrate this low-cost method efficiently into their organisations in order to ensure the requirements of achieving a complete quality assurance are fulfilled.

Assembly and operating instructions

General information

ELGEF Plus Electrofusion fittings

Electrofusion for PE pipes and PE fittings enables a safe, efficient and economical installation for piping systems. Owing to the high quality of our products, tools and equipment, electrofusion jointing is practical and easy to do.

A careful preparation of the fusion area is an essential prerequisite and may not be neglected!

Preparation

The fusion zones should remain fully protected during poor weather (e.g. rain, snowfall etc.).

Ensure the fusion control unit and the components to be fused have identical ambient temperatures.

Georg Fischer Fittings and the appropriate magnetic card are put together and sealed in a PE bag at the conclusion of the production process. Fittings which reach the place of installation in their original packaging must neither be machined nor cleaned with Tangit PE cleaner. If spigot ends are peeled in a correct manner no reduction of joint quality will occur. Transition fittings should only be peeled if difficulties occur during assembly.

Before fusion please check if magnetic card and product fit together.

If the fusion zones are touched by hand during assembly, or come into contact with any contaminated object, the fittings are to be carefully cleaned with Tangit PE cleaner.

Peeling

Rotary peeling tools for an even and time-saving preparation of the fusion zone are to be used. The pipe must be wiped free from any surface contamination, fully peeled ensuring continuous shavings and finally degreased with Tangit PE cleaner.

Assure that no unpeeled area remains in the fusion zone on the pipe (especially when using coiled pipe).

The tensile strength and surface hardness of PE 100 is greater than that of PE 80. The increased rate of wear on peeling tools is especially noticeable. Therefore, regular checks and maintenance of parts subject to wear is necessary. We recommend that peeling tools are serviced at least once a year.

The following scraping depth limits are recommended:

d pipe [mm]	min. wall reduction [mm]	min. allowable pipe diameter after peeling* [mm]
20-25	0.20	d $_{nom.}$ -0.4*
32-63	0.20	d $_{nom.}$ -0.5*
75-225	0.20	d $_{nom.}$ -0.6*
>225	0.20	d $_{nom.}$ -0.7*

Note: Maximum pipe ovality = 1.5 %
(according to DVS 2207 – 1)

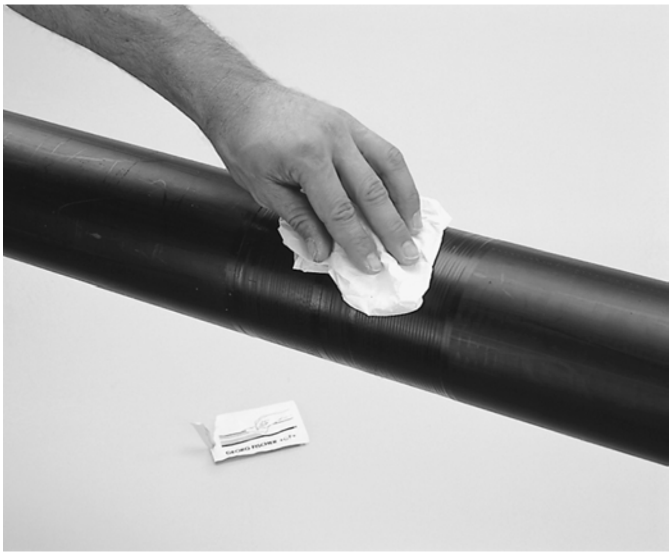
*these values refer to the nominal outside diameter of the pipe, i.e. if the mean outside diameter of the pipe is on the upper tolerance limit, this diameter can be reduced through peeling to the minimum allowable pipe outside diameter.

Minimum allowable pipe diameter after peeling at 23°C:

d pipe [mm]	Recommendation for peeling (min, shaving thickness) [mm]	Minimum allowable pipe diameter after peeling [mm]
20	0.20	19.6
25	0.20	24.6
32	0.20	31.5
40	0.20	39.5
50	0.20	49.5
63	0.20	62.5
75	0.20	74.4
90	0.20	89.4
110	0.20	109.4
125	0.20	124.4
140	0.20	139.4
160	0.20	159.4
180	0.20	179.4
200	0.20	199.4
225	0.20	224.4
250	0.20	249.3
280	0.20	279.3
315	0.20	314.3
355	0.20	354.3
400	0.20	399.3
450	0.20	449.3
500	0.20	499.3
560	0.20	559.3
630	0.20	629.3

Cleaning

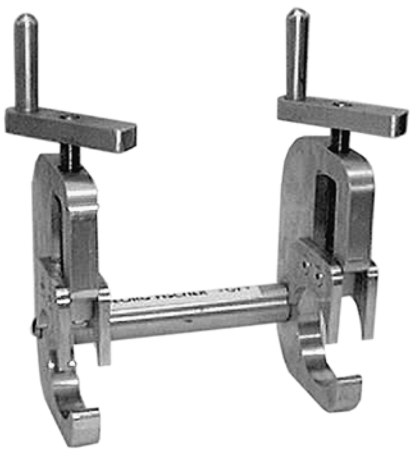
Tangit cleaning fluid, or the factory-prepared degreasing cloths soaked in Tangit PE cleaning fluid and packed in closable plastic boxes, must comprise a 100% rapid-evaporating solvent. Agents tested in accordance with DVGW VP 603 conform to this requirement. The use of other commercially available alcohol and water based mixtures can lead to reductions in joint quality due to their water content and are not to be used. Paper used for degreasing must be clean, unused, absorbent, non-fibrous, and colourless. Cleaning cloths soaked in Tangit PE cleaning fluid can be used. Allow time for full evaporation to take place.



Only degrease the peeled fusion zone.
Otherwise there is danger of contaminating the pre-cleaned surface.
Ensure that ink does not penetrate into the fusion zone when using marker pens. Should it be necessary to remove marker ink, take care that none is wiped into the fusion zone. Marker ink cannot be completely removed from an affected fusion zone despite repeated cleaning. The section of affected pipe must be either peeled once more or replaced.

Assembly

Pipes that are not round or are oval should be re-rounded in the fusion zone with re-rounding clamps.



The clamps integrated into the fitting are to be used to clamp pipes or fittings. Use mechanical double clamps or other pipe clamps should a high stress situation occur during assembly. In particular, and when working with pipe from coils, ensure that no stress exists between the pipe and fusion zone during the fusion and cooling phases.

Two pipe clamps arranged eccentrically will form a quadruple clamp, thus ensuring the jointing area remains mainly stress-free.

Only the actual magnetic card or the barcode printed on this card which is enclosed in the original bag with the fitting is to be used to transfer fusion data to the fusion control unit.

Wait until the minimum cooling time has elapsed before loosening clamps, tapping or conducting pressure tests.

The detailed assembly instructions should be observed at all times!

If a power breakdown occurs due to external influences (e.g. generator fault) and the fusion process is subsequently interrupted, the sequence can be repeated providing the joint is allowed to cool to its original ambient temperature. However, the following points must be observed:

- cause of fault must be located and eliminated. The appropriate error messages on the fusion unit display will indicate the probable cause
- pipe clamps may not be removed
- the fitting must fully cool to ambient temperature. No forced means may be used (cold water etc.)

Check the resistance of the fitting in display. This is to return to its original value.

- the jointing area must be protected from contamination and moisture during the cooling phase
- the fusion process is carried out again in accordance with the assembly instructions and the information on the enclosed data carrier
- the joint is checked for leak-tightness. Conduct a pressure test

Do not repeat yet another fusion process should the joint fail a pressure test!

ELGEF Plus fittings are designed to permit just one repetition of the fusion process

Overview ELGEF Plus couplers, fittings and transition adaptors

	Sequence of tasks	Couplers/ Fittings d20-d63	Couplers/ Fittings d75-d500	Couplers d560-630
				
1	Rough clean pipe(s), cut at right angles and deburr	+	+	+
2	Remove oxidised layer on pipe(s) with peeling tool	+	+	+
3	Clean pipe(s) in fusion zone with Tangit cleaning cloth or Tangit PE cleaner	+	+	+
4	Mark insertion depth[1]on the pipe	+	+	+
5	Remove fitting(s) from the bag without touching the fusion surface(s)	+	+	+
6	Push pipe into socket up to centre stop or marking.	+	+	+
7	Alternately, tighten integrated pipe fixation screws	+	-	-
8	Mount and tighten pipe clamp (if joint is under stress)	-	+	+
9	Push second pipe up to centre stop or marking	+	+	+
10	Tighten integrated pipe fixation screws alternately	+	-	-
11	Mount and fix pipe clamp (if joint is under stress)	-	+	+
12	Complete fusion procedure in accordance with instructions for unit	+	+	+
13	After fusion, check indicators on fitting and the display in fusion control unit, then remove cables.	+	+	+
14	Wait for cooling time[2] then remove pipe clamp if used	-	+	+
15	Wait at least the minimum cooling time[2] required before conducting any pressure test	+	+	+

+ = compulsory
O = optional
- = unnecessary

When using oval pipes, re-rounding clamps should be mounted on both sides of the fitting to be fused.

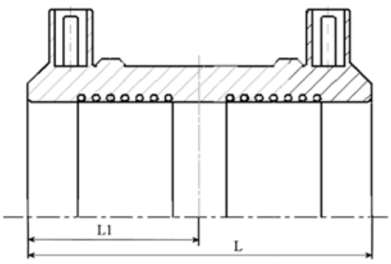
	Sequence of tasks	End Caps d20-d63	End Caps d75-d225	Transition Adaptor d20-d63	Transition Adaptor (loose nut) d20-d63
					
1	Rough clean pipe(s), cut at right angles and deburr.	+	+	+	+
2	Remove oxidised layer on pipe(s) with peeling tool	+	+	O difficult assembly conditions	O difficult assembly conditions
3	Clean pipe(s) in fusion zone with Tangit cleaning cloth or Tangit PE cleaner	+	+	+	+
4	Mark insertion depth[1] on the pipe	+	+	-	-
5	Remove fitting(s) from the bag without touching the fusion surface(s)	+	+	+	+
6	Screw or unscrew transition adaptor	-	-	+	O
7	Push pipe into socket up to centre stop or marking	+	+	-	-
8	Alternately, tighten integrated pipe fixation screws	+	-	-	-
9	Mount and tighten pipe clamp (if joint is under stress)	-	+	-	-
10	Push second pipe up to centre stop or marking	-	-	+	+
11	Alternately, tighten integrated pipe fixation screws	-	-	+	+
12	Mount and fix pipe clamp (if joint is under stress)	-	+	-	-
13	Complete fusion procedure in accordance with operating instructions for unit	+	+	+	+
14	After fusion, check indicators on fitting and the display in fusion control unit, then remove cables	+	+	+	+
15	Wait for cooling time[2], then remove pipe clamp if used	-	+	-	-
16	Screw or unscrew transition adaptor with loose nut (if used)	-	-	-	O
17	Wait for the minimum cooling time[2] and conduct pressure test	+	+	+	+

+ = compulsory
O = optional
- = unnecessary

When using oval pipes, re-rounding clamps should be mounted on both sides of the fitting to be fused.

[1] Insertion depth for couplers and fittings

	Insertion depth L1 [mm]	
d [mm]	**SDR11**	**SDR17**
20	34	
25	34	
32	36	
40	40	
50	44	
63	48	
75	55	
90	62	
110	72	
125	79	
140	84	
160	90	
180	95	
200	101	
225	110	
250	122	
280	126	
315	132	
355	122	
400	122	
450		145
500		145
560		196
630		221



[2] Minimum cooling time for couplers and fittings in minutes

d	SDR	Removal of clamp	Pressure test p ≤ 6 bar	p ≤ 18 bar
[mm]		[min.]	[min.]	[min.]
20-63	11	6	10	30
75-110	11	10	20	60
125-160*	11	20	30	75
180-225**	11	20	45	90
250-315	11	30	60	150
355-400	11	45	90	150
*fittings d 160	11	30	45	90
**fittings d 180	11	30	60	90

p = test pressure

d	SDR	Removal of clamp	Pressure test p ≤ 6 bar	p ≤ 18 bar
[mm]		[min.]	[min.]	[min.]
125-160	17	20	30	75
180-225	17	20	45	90
250-315	17	30	60	150
355-400	17	45	90	150
450-630	17	60	90	150

p = test pressure

Overview ELGEF Plus saddles and tapping valves

	Sequence of tasks	Tapping Saddle Monoblock d40 - d160	Tapping Saddle with rotatable outlet d63-d250	Pressure Tapping Valve d63-d250
				
1	Clean pipe in fusion area, remove oxidised layer with rotary scraper, ensuring continuous shavings	+	+	+
2	Clean pipe in fusion zone with Tangit cleaning cloth or Tangit PE cleaner	+	+	+
3	Remove saddle from packaging, and locate lower part in hinge (without touching fusion surfaces)	+	+	+
4	Remove modular system component from packaging and assemble (without touching fusion surfaces)	-	O	O
5	Place saddle on pipe and tighten fixation screws (spring clamp for reinforcing saddle)	+	+ ≤ d250	+ ≤ d250
6	Align rotatable outlet tee, then fully tighten integrated clamping screws of tee, alternately	-	+	+
7	Complete fusion procedure in accordance with operating instructions for unit	+	+	+
8	After fusion, check indicators on saddle and the display in fusion control unit, then remove cables	+	+	+
9	Wait for the minimum cooling time and conduct pressure test	+	+	+
10	Wait for the minimum cooling time, then remove screw cap or electrofusion cap	+	+	-
11	Wait for minimum cooling time[1], then tap clockwise. Withdraw cutter anticlockwise to upper stop (see detailed assembly instructions)	+	+	+
12	Handtighten screw or electrofusion cap	+	+	-
13	Complete fusion procedure in accordance with operating instructions for unit	O	O	-

+ = compulsory
O = optional
- = unnecessary

When using oval pipes, re-rounding clamps should be mounted on both sides of the fitting to be fused.

	Sequence of tasks	Spigot Saddle d63-d400	Stop-off Saddle d63-d400	Repair Saddle d63-d400
				
1	Clean pipe in fusion area, remove oxidised layer with rotary scraper, ensuring continuous shavings	+	+	+
2	Clean pipe in fusion zone with Tangit cleaning cloth or Tangit PE cleaner	+	+	+
3	Remove saddle from packaging, and locate lower part in hinge without touching fusion surfaces	+	+	+
4	Place saddle on pipe and tighten fixation screws (spring clamp for reinforcing saddle)	+ ≤ d250	+ ≤ d250	+ ≤ d250
5	Remove modular system component from packaging and assemble (without touching fusion surfaces)	O	O	-
6	Align rotatable outlet tee, then fully tighten integrated clamping screws of tee, alternately	O	-	-
7	Complete fusion procedure in accordance with operating instructions for unit	+	+	+
8	After fusion, check indicators on saddle and the display in fusion control unit, then remove cables	+	+	+
9	Wait for the minimum cooling time and conduct pressure test	+	+	+
10	Wait for the minimum cooling time, then remove screw cap or electrofusion cap	-	-	-
11	Wait for minimum cooling time[1], then tap clockwise. Withdraw cutter anticlockwise to upper stop. (see detailed assembly instructions).	+	-	-
12	Handtighten screw or electrofusion cap	-	-	-
13	Complete fusion procedure in accordance with operating instructions for unit	-	-	-

+ = compulsory
O = optional
- = unnecessary

When using oval pipes, re-rounding clamps should be mounted on both sides of the fitting to be fused.

[1]Minimum cooling time for saddles in minutes

d	Pressure test	
	p ≤ 6 bar	p ≤ 18 bar
[mm]	[min.]	[min.]
40, 50	10	30
63 - 400 (with separate lower part)	20	60
110 / 160 (with moulded-on lower part)	30	90
Branch fittings d110 - 630	30	90

p = Test pressure

ELGEF Plus couplers, fittings and transition adaptors

Sequence of tasks

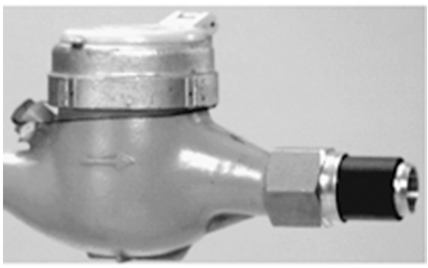
1 Clean pipe(s), cut at right angles and deburr edges.

2 Remove oxidised layer of pipe(s) with rotary scraper (note max. allowable wall thickness reduction).

3 Clean pipe(s) in peeled area with cleaning cloth and Tangit PE cleaner.

4 Mark the insertion depth on the pipe.

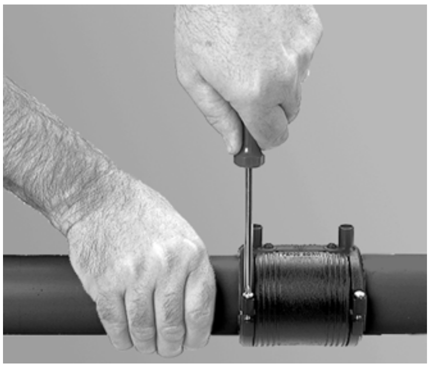
5 Remove fitting(s) from the packaging without touching the fusion surface(s).



6 Screw-up transition adaptor. Only peel transition adaptors should assembly prove to be difficult. Do not touch the fusion surface.

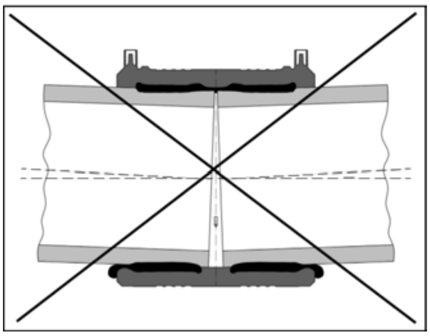
7 Push in the PE pipe up to centre stop or marking.

8 Firmly tighten the integrated clamping screws alternately, until it is no longer possible to rotate or move the fitting on the pipe.



9 Push in second PE pipe up to centre stop or marking.

10 Firmly tighten the integrated clamping screws alternately, until it is no longer possible to rotate or move the fitting on the pipe.

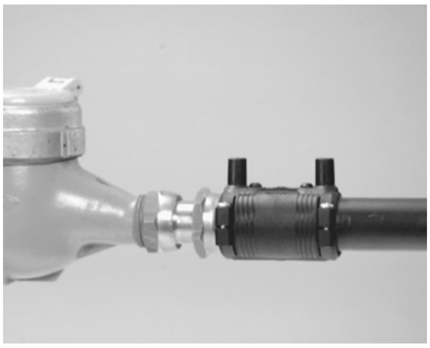


11 The components to be jointed must remain stress-free.

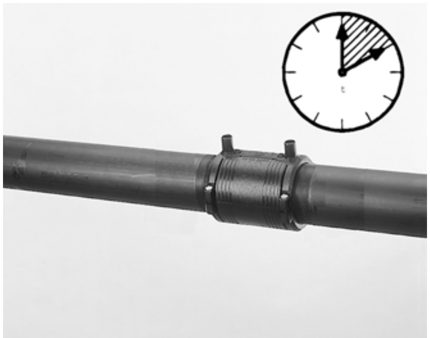
12 Complete fusion procedure in accordance with the operating instructions for the control unit.

13 After fusion, check indicators on fitting and the display in fusion control unit, then remove cables

14 Ensure jointing area remains stress-free until cooling period has elapsed.



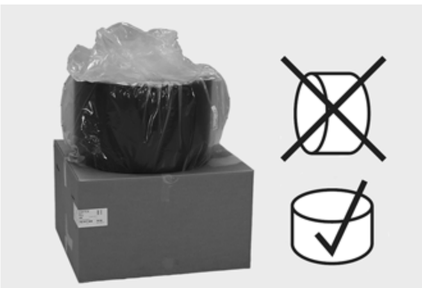
15 Screw-up transition adaptor with loose nut (if used).



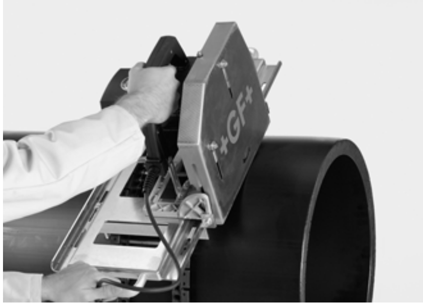
16 Wait for the minimum cooling time and conduct pressure test.

ELGEF Plus coupler d560 - d630mm

Sequence of tasks



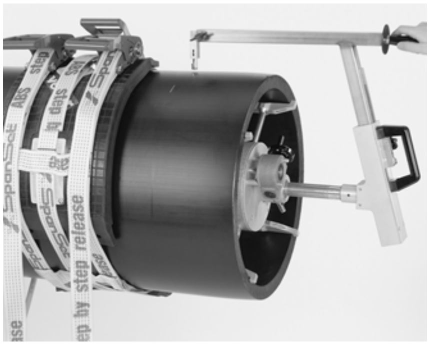
1 Ensure that the coupler is in its original packaging before use. Always store flat. ELGEF Plus Couplers d560 and d630 can only be correctly installed in conjunction with the +GF + pressure pad kit.



2 Rough clean pipes with a dry, clean cloth, cut ends at right angles and deburr accordingly. It is recommended to cut each pipe to length before starting the installation procedure for the coupler to prevent any negative effects caused by pipe end collapse (KS 1600 Plastic pipe cutter). Then deburr pipe.

3 Check pipe diameter with a circumferential measuring band before and after the peeling operation. The minimum allowable outside diameters are:

Unpeeled pipe	Peeled pipe
560.0 mm	>559.3 mm
630.0 mm	>629.3 mm



4 Attach peeling tool (e.g. RTC 710) and adjust to the required peeling length. Check roundness of pipe by rotating tool once around circumference (without use of cutter). If necessary, any re-rounding measures are to be carried-out in accordance with the “Instructions for large diameter couplers using the pressure pad set” (instructions are included with the pressure pad set).

5 Remove oxidised layer with a suitable peeling tool (do not exceed permissible reduction of wall thickness). Re-rounded pipes may be continuously peeled-down with a rotary peeler until the coupler slides easily on to the pipe. Do not exceed the minimum allowable diameter for peeled pipes (see Point 3)! It is not necessary to fully cover the area where pipe end collapse has occurred through multiple peeling!

6 Degrease the fusion zone of the pipe with a clean cloth soaked in Tangit PE cleaning agent (the entire slide-over length is to be treated for slide-over couplers).

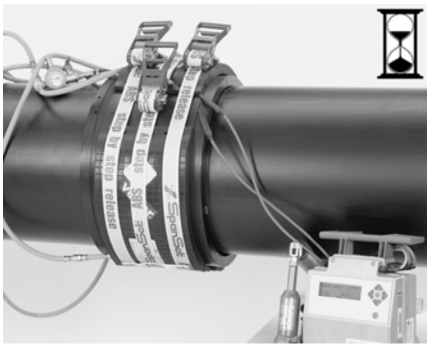
7 Mark the insertion depth of the coupler around the circumference of the pipe in three equidistant places (120º apart).

8 Remove fitting from its packaging without touching the fusion surfaces. Carry out an optical check to ensure product is undamaged. Degrease both fusion surfaces of the coupler with a clean cloth soaked in Tangit PE cleaning agent.

9 Push first pipe end up to the marking. If pipe is excessively oval, pipe re-rounding measures will be required in accordance with the detailed “Instructions for large diameter couplers with the pressure pad kit”.

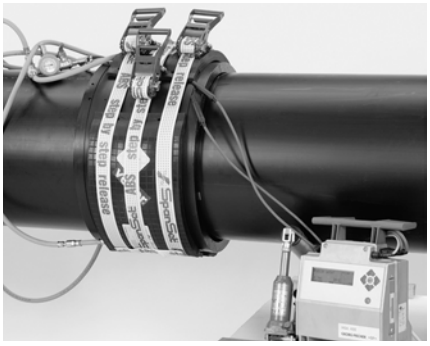
10 Push second pipe up to the marking. Once again, if excessive pipe ovality is evident, pipe re-rounding measures are to be carried out. Then wrap pressure pads around coupler and align edges of pressure pads along the fitting groove on the first side to be fused. Pre-set pressure pads in position using the fixation strap.

11 Wrap strap corset centrally around pressure pads. Fully tighten middle strap first, then tighten outer straps. Pressurise pads and maintain pressure in accordance with the values given. For details consult the “Assembly instructions for large diameter couplers using the pressure pad kit”. Check complete arrangement is correct, then connect fusion cables to the terminals on the first side of the coupler and carry out a fusion operation.



12 After fusion, check display on the control unit for errors and remove fusion cables. Wait until cooling time has elapsed, relieve pressure in pads and loosen straps. The required cooling time can be seen either on the magnetic card or in the display on the control unit.

13 Should it be necessary to continue working on the second side wait for at least 20 minutes of the cooling time of side 1 before mounting the pressure pads on the other side of the coupler and aligning edges with the groove on the side of the fitting. Centralise the strap corset around the pressure pads again and pressurise as before (complete entire operation within a maximum of 2 minutes). Connect the control unit cables to the terminals on the second side and carry-out the fusion process.



14 Upon completion of the second fusion operation, check display on the control unit for errors and remove cables. Following completion of the cooling time, depressurise the pads and remove the entire pressure pad set

15 Check appearance of both fusion indicators and observe minimum cooling time before applying a pressure test

Detailed instructions can be found in the separate Assembly Instruction GMST 5909, or, in the Assembly Video.

ELGEF Plus saddles and pressure tapping valves

Sequence of tasks

1 Clean pipe in fusion area, remove oxidised layer with rotary scraper (ensure continuous shavings, observe max. allowable wall thickness reduction).

2 Clean pipe in fusion area with cleaning cloth and Tangit PE cleaner.

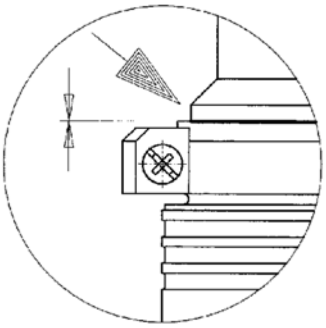
3 Remove saddle from packaging without touching fusion surfaces. Locate lower part in hinge, check if lugs fit correctly in the slots in upper part. In order to simplify the positioning of the screws in the lower half and aid assembly it is recommended, as a first step, to screw in the fastening bolts up to their heads (see Fig.).

4 Remove modular system component from packaging and assemble accordingly, without touching fusion surfaces (also on outlet spigot).

5 Place saddle on pipe and tighten pre-assembled fastening bolts.

6 Tighten fastening bolts alternately (spring clamp for reinforcing saddle).

7 Align rotatable outlet tee and tighten the integrated clamping screws alternately, until it is no longer possible to rotate or move the fitting.



7a During assembly, ensure the tee is fully inserted into saddle outlet and no gap is visible.

8 Complete fusion procedure in accordance with the operating instructions for the control unit.

9 After fusion, check indicators on fitting and the display in fusion control unit, then remove cables.

10 Wait for the minimum cooling time and conduct pressure test.

11 Remove screw cap or electrofusion cap.

12 After the minimum cooling time, tap clockwise. Then withdraw cutter anticlockwise to upper stop. See detailed assembly instructions.

13 Handtighten screw cap or electrofusion cap (do not use thread paste or lubricant).

14 Complete fusion procedure in accordance with operating instructions for unit.

ELGEF Plus saddles with rotatable outlet

Assembly is carried out in accordance with the “General Assembly Instructions for ELGEF Plus Saddles and Pressure Tapping Valves”.

1. Two screws are used to fasten the saddle bottom half for d63 to d160 mm. Tighten these screws alternately up to the stops on the bottom half until it is no longer possible to rotate or move the saddle on the pipe.
2. Four screws are used to fasten the saddle bottom half for d180 to d250 mm. Tighten these screws alternately up to the stops on the bottom half until it is no longer possible to rotate or move the saddle on the pipe. Assemble saddles above d250 mm using a top loader.
3. Ensure tapping tee is fully inserted into saddle outlet. Align rotatable outlet tee and tighten the integrated clamping screws alternately, until it is no longer possible to rotate the tee in the saddle.

Recommended tapping tool

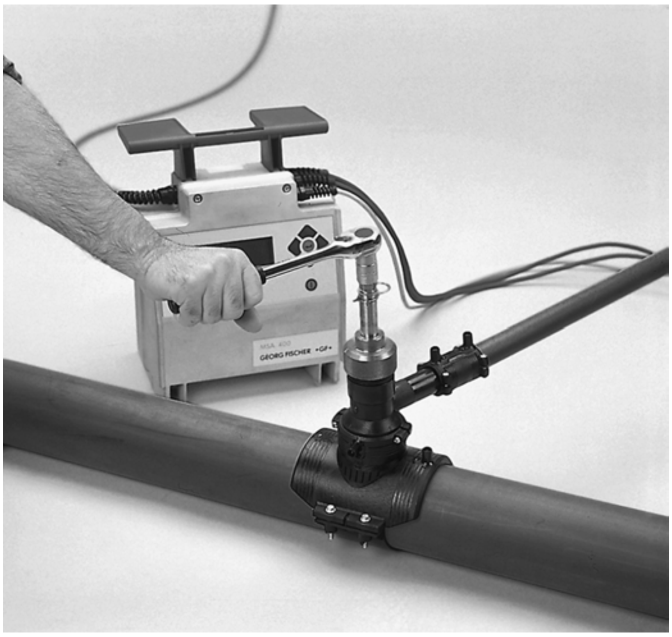
Combined assembly and tapping key
Code-Nr. 799 198 079

Tapping attachment for gas-free under pressure tapping
Type S 54 for d20, 25, 32 and 40 mm outlets,
Code-Nr. 799 100 061
Type S 67 for d50 and 63 mm outlets,
Code-Nr. 799 100 062

Assembly and tapping key
s= 17 mm, Code-Nr. 799 198 047

Do not use electrically powered tools for tapping operations

Tapping sequence, general

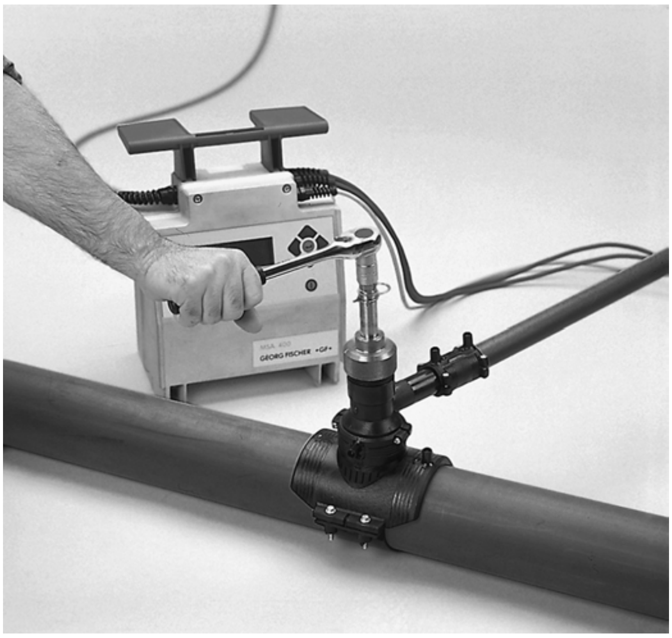


1. After fusion jointing is complete, wait the minimum cooling time before commencing a tapping.
2. Ensure that the GF tapping tool is fully located in the cutter.
3. Using a hexagon spanner, turn the cutter steadily clockwise until the pipe has been tapped through The position of the cutter can be determined from the marking on the GF tapping tool.
4. Withdraw the cutter by turning the tool steadily anticlockwise until it reaches the upper stop. The cutter will form a complete seal in this position.

Tapping procedure with tapping tool type S54/ S67 (gas-free under-pressure tapping)

Turn the connector whilst applying a light pressure with the cross-head screwdriver and it will slide through into the cutter. Then turn the screwdriver 90º clockwise and the locking pin on the connector will locate in a recess in the cutter.

The operating rod can no longer be extracted by hand.



- Wait for the minimum cooling time to elapse before tapping
- Remove cap and screw tapping attachment onto tapping saddle
- For tapping attachment S54, set the stop on the operating rod to the upper groove
- Insert the operating rod in the cutter, if necessary turn the rod until the hexagon locates correctly
- Use a cross-head screwdriver to lock the connector in the operating rod into the cutter
- Using a suitable tool, turn the cutter by means of the operating rod downwards until the end (plug spring) is reached. The pipe has now been tapped through.
- For reasons of safety, only now may the locking arrangement between the tapping attachment and cutter be released. Unscrew tapping attachment. Always keep the tapping attachment clean and the moving parts lightly lubricated.

STOP If these instructions are not followed closely during tapping operations on under-pressure pipelines, the operating rod can eject suddenly and cause injury.

ELGEF Plus tapping valves

Work sequence

Assembly is to be completed in accordance with our “General assembly instructions for “ELGEF Plus saddles and pressure tapping valves”.

1. Two screws are used to fasten the saddle bottom half for d63 to d160 mm. Tighten these screws alternately up to the stops on the bottom half.
2. Four screws are used to fasten the saddle bottom half for d180 to d250 mm. Tighten these screws alternately up to the stops on the bottom half. Assemble saddles above d250 mm using a top loader.
3. Ensure valve tee is fully inserted into saddle outlet. Align rotatable outlet tee, then tighten the integrated clamping screws alternately, until it is no longer possible to rotate the tee in the saddle.

During assembly, ensure the valve tee is fully inserted into saddle outlet and no gap is visible.

It is recommended to align and assemble the valve tee in the saddle outlet before tightening the saddle to the mains pipe.

Recommended tapping tool

Square-headed ratchet, 14mm across flats

Tapping operation

1. Wait for the minimum cooling time after fusion jointing to elapse before tapping.
2. Using a square-headed ratchet, turn the spindle clockwise and evenly until the lower stop has been reached. The pipe is now tapped through and the valve closed: max. torque = 130 Nm.
3. Open the valve by turning the spindle anti-clockwise until the upper stop is reached.

Do not use electrically powered tools for tapping operations!

ELGEF Plus spigot saddle with cutter

Work sequence

Only suitable for use for attachment to unpressurised pipelines!

1. Two screws are used to fasten the saddle bottom half for d63 to d160 mm.
2. Tighten these screws alternately up to the stops on the bottom half. Four screws are used to fasten the saddle bottom half for d180 to d250 mm and are tightened in a similar manner.
3. Assemble spigot saddle with cutter and tighten the integrated clamping screws alternately, until it is no longer possible to rotate or move the fitting on the pipe.

Recommended tapping tool

- **Hexagon tapping key,** 12.7 mm across flats, for 32 mm outlet diameter
- **Hexagon tapping key,** 17 mm across flats, for 63 mm outlet diameter

Tapping operation

1. Wait for the minimum cooling time after fusion jointing to elapse before tapping.
2. Tap by turning key clockwise.
3. **Turn cutter anti-clockwise and remove.**

ELGEF Plus stop-off saddle for stop-off setting kit

Preparatory work

Stop-off saddles with brass adaptors are designed for use with stop-off setting kits.

Assembly is to be completed in accordance with our “General assembly instructions for “ELGEF Plus saddles and pressure tapping valves”.

1. Remove protective cap and plug.
2. Bottom saddles for d63 to d160 mm are fastened, alternately, with two screws.
3. Four screws are used to fasten the saddle bottom half for d180 to d250 mm and are fastened in a similar manner.
4. Fit stop-off saddle adaptor, then fasten with the screws of the integrated clamp. Tighten these screws alternately, until it is no longer possible to rotate or move the adaptor in the saddle outlet.

Recommended tapping tool

1. Use standard tapping and stop-off bag setting equipment (e.g. Hütz and Baumgarten)
2. Follow manufacturer’s operating instructions. Use a suitable tool on the flats to steady the adaptor when inserting the stop-off bag.

Tapping operation

1. Wait for the minimum cooling time after fusion jointing to elapse before tapping.
2. Follow the manufacturer’s operating instructions when using all tapping and stop-off equipment.

ELGEF Plus repair saddles

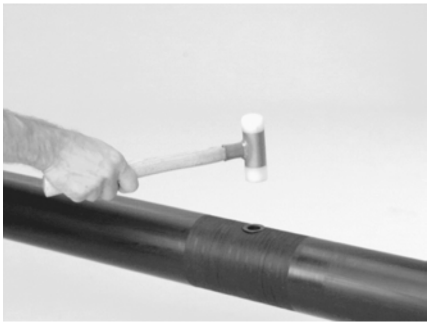
Repair sequence

1 Clean the pipe around the damaged area and the surrounding fusion zone.

2 Attach the tapping tool to the pipe.

3 Drill out damaged area of the pipe.
Pipes up to d63mm, use 30mm cutter
Pipes from d75mm, use 39mm cutter

4 Remove tapping tool.



5 Using a plastic-headed hammer, drive the PE repair plug into the hole until its upper rim touches the pipe.

6 Use a rasp to file the PE plug down until it is flush with the pipe contour.

Minor damage in PE pipes can be repaired using repair saddles. The fitting of the saddles is in accordance with our general assembly instructions.

Tools required

Basic tapping tool with securing strap
(Code 799 150 015)

Pipe adaptor
(Code 799 150 352)

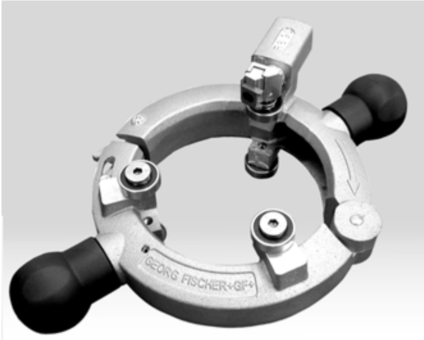
Ratchet
(Code 799 150 032)

Cutter
(Code 799 198 013 bzw. 012)

PE pipe repair plug for d30 to d39 mm
(Code 799 199 033 bzw. 089)

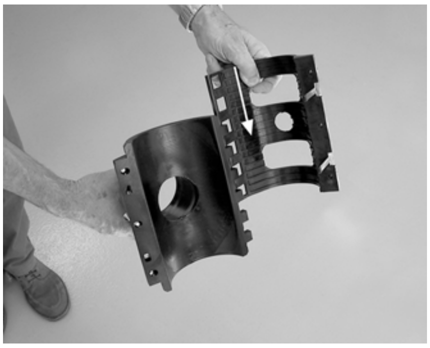
ELGEF Plus branch saddles

Working sequence on mains pipe

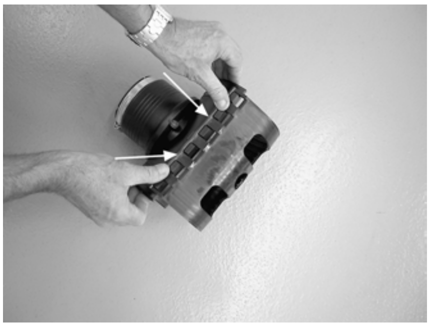


1 Clean pipe in fusion area. Remove oxidised layer with rotary scraper (ensure continuous shavings and observe maximum allowable pipe wall reduction). The peeled area should be rather wider than the width of the saddle.

2 Clean pipe in fusion zone with cleaning cloth and Tangit PE cleaner.

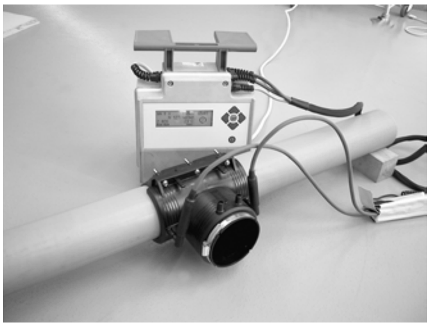


3a Remove saddle from packaging without touching fusion surfaces. Either slide lower part into hinge from the side,



3b or, clip lower part in from the front. Should the fusion zone of the saddle be touched with the hands or become contaminated in any other form, it must be subsequently cleaned in accordance with Point 2.

4 Place branch saddle on pipe and tighten the fixation screws. Tighten screws alternately and up to the stop so that the gap closes and the saddle can no longer be turned or moved on the pipe.

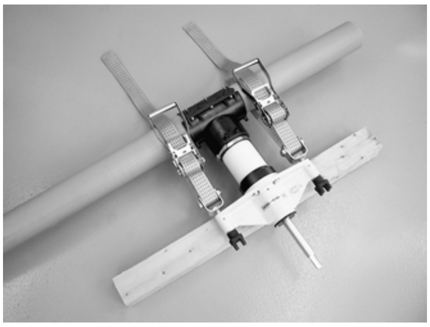


5 Complete fusion procedure in accordance with operating instructions for the MSA control unit.

6 After fusion, check indicators on branch saddle, then remove cables.

7 Observe minimum cooling time.

Fusion jointing a branch connection (for non-pressurised pipes)



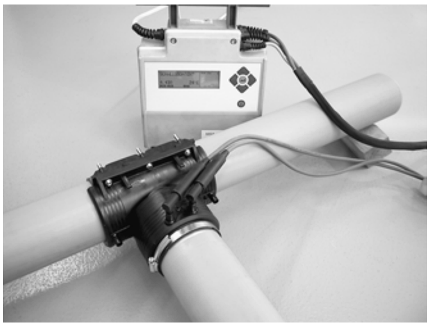
1 Tap the mains pipe using a standard and approved tapping attachment.

2 As an alternative, a standard drill can be used (with a suitable pipe cutter). Observe the maximum allowable cutter diameter (65 mm or 86 mm).

3 Clean branch pipe in fusion area. Remove oxidised layer on pipe with a rotary scraper (ensure continuous shavings and observe maximum allowable pipe wall reduction). The peeled area should be at least equivalent in length to the insertion depth of the branch saddle outlet.

4 Clean branch pipe in fusion zone with cleaning cloth and Tangit PE cleaner. Mark insertion depth.

5 Push branch pipe into socket and up to the stop. Alternately, tighten screws of integrated clamp.

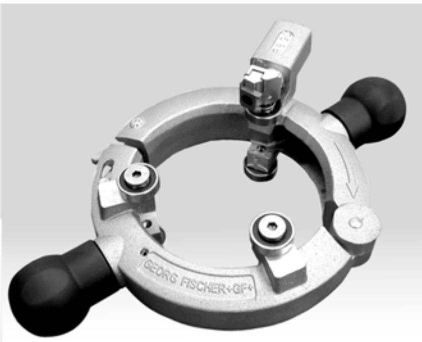


6 Complete fusion procedure in accordance with operating instructions for the control unit. Ensure the branch pipe remains at the correct insertion depth.

7 After fusion, check indicators on branch saddle, then remove cables.

8 Observe the minimum cooling time before a pressure test, and then complete the pressure test.

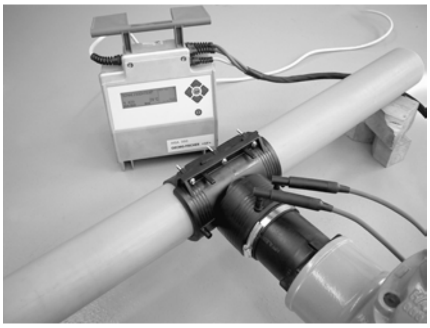
Fusion jointing a branch connection (for under-pressure pipes)



1 Clean branch pipe in fusion area. Remove oxidised layer on pipe with a rotary scraper (ensure continuous shavings and observe maximum allowable pipe wall reduction). The peeled area should be at least equivalent in length to the insertion depth of the branch saddle outlet.

2 Clean branch pipe in fusion zone with cleaning cloth and Tangit PE cleaner.

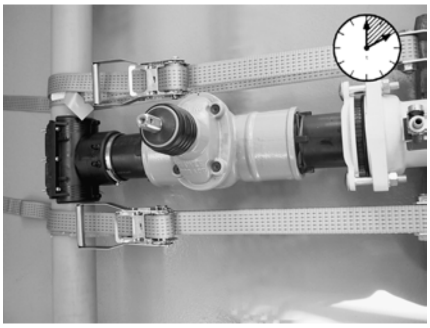
3 Mark insertion depth on branch pipe.



4 Complete fusion procedure in accordance with operating instructions for the control unit. Ensure the branch pipe remains at the correct insertion depth.

5 After fusion, check indicators on branch saddle, then remove cables.

6 Observe the minimum cooling time before a pressure test, and then complete the pressure test.



7 Observe minimum cooling time before tapping.

8 Tap the mains pipe using a standard and approved tapping attachment.

ELGEF Plus tapping saddles (Top-Load)

Preparation

1 Clean pipe in fusion area.
2 Remove oxidised layer with rotary scraper.

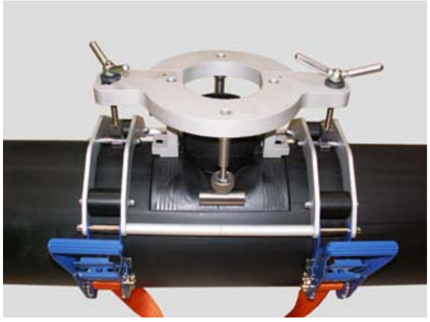
3 Clean pipe in fusion zone with cleaning cloth and Tangit PE cleaner.

Assembly sequence for branch saddles, d280-630mm

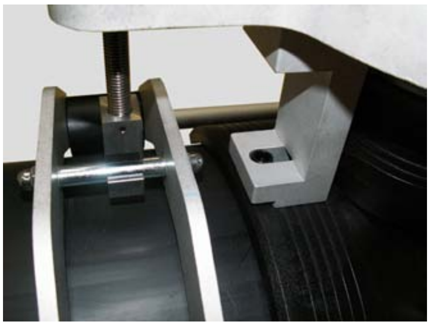
1 Mount top-load tool on pipe.

2 Attach and fully tighten securing straps.

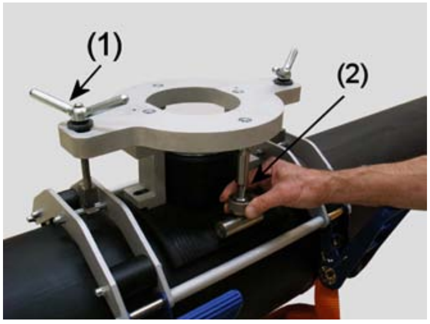
3a Position branch saddle...



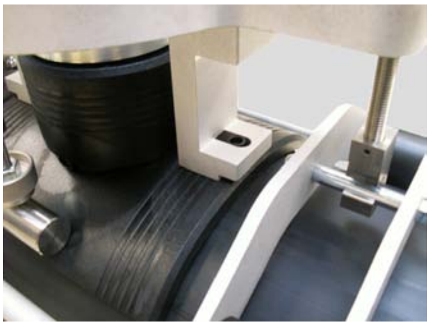
3b ... and set clamping device.



4 Ensure the terminals are correctly positioned.



5 Clamp branch saddle first of all with the clamping handles (1) and then with the stop screws (2) evenly and firmly to the pipe.



6 Following assembly, the gap between saddle and pipe around the periphery should never exceed a maximum of 0.5 mm. The size of this gap may be easily checked by sliding a clean magnetic card into the space between the two components.
7 The figure above shows correct assembly.

Additional information the regarding correct adjustment of clamping forces:

On the crown of the pipe, slide the magnetic card between pipe and saddle, moving the card to the left and right, up to the arrowhead (approx. 5 mm). Tighten clamp handles evenly until the card is pinched. Then loosen slowly until the card can be just eased out.

Further steps are to be completed in accordance with our “General assembly instructions for “ELGEF Plus saddles and tapping valves”.

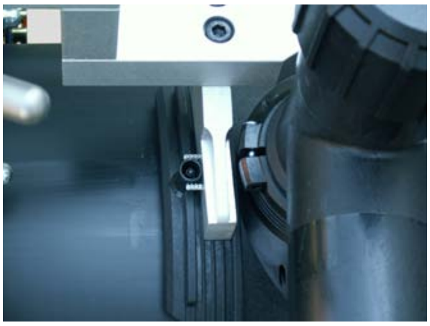
Assembly sequence for top-load saddles, d280-400mm

1 Mount top-load tool on pipe.

2 Attach and fully tighten securing straps.

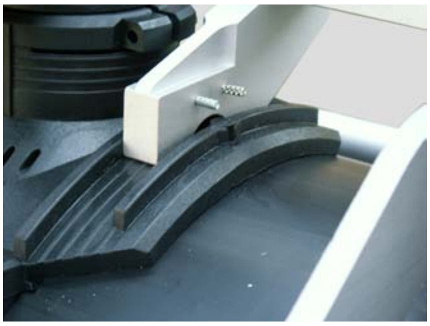
3a Position electrofusion saddle ...

3b ... and set clamping device.



4 Ensure that the terminals are correctly positioned.

5 Clamp electrofusion saddle evenly and firmly to the pipe using the clamping handles.



6 Following assembly, the gap between saddle and pipe around the periphery should never exceed a maximum of 0.5 mm. The size of this gap may be easily checked by sliding a clean magnetic card into the space between the two components.

7 On the crown of the pipe, slide the magnetic card between pipe and saddle, moving the card to the left and right, up to the arrowhead (approx. 5 mm). Tighten clamp handles evenly until the card is pinched. Then loosen slowly until the card can be just eased out.

Further steps are to be completed in accordance with our “General assembly instructions for “ELGEF Plus saddles and tapping valves”.

ELGEF Plus reinforcing saddle 24 volt

Repair sequence

See ELGEF Plus repair saddles - Repair sequence

PE pipes with minor damage or weakened areas can be strengthened using reinforcing saddles in conjunction with a basic tapping tool kit. Preparation for the assembly of the saddle (removal of oxidised layer, cleaning) is carried out in accordance with our general assembly instructions. The reinforcing saddle can only be correctly fusion jointed using control units producing a 24 volt fusion secondary current (MSA 250, MSA 300, MSA 350 and MSA 400).

Tools required

Spring clamp
(Code 799 150 090)

Basic tapping tool with securing belt
(Code 799 150 015)

Pipe adaptor
(Code 799 150 352)

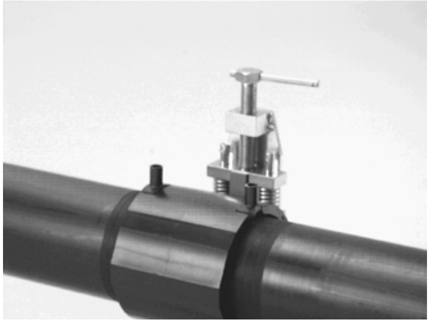
Ratchet
(Code 799 150 032)

Cutter
(Code 799 198 013 bzw. 012)

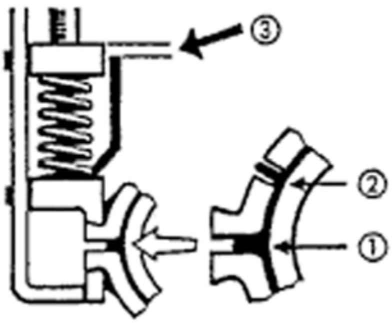
PE repair plug, d30 to d39mm
(Code 799 199 033 bzw. 089)

Saddle assembly

1. Attach saddle to pipe using a spring clamp, taking care to ensure the fusion mat is centralised.



2. Tighten down clamping bolt until the red indicator plate is flush with the upper edge of the compressor bar.
3. The fusion process is to be completed in accordance with our general assembly instructions.
4. Completion of a correct fusion cycle is shown by the appearance of fusion melt between the two saddle halves (1) and by the fusion indicator (2). The red indicator plate is also no longer flush with the upper edge of the compressor bar (3).



Tools and assembly accessories

General information

Special care should be taken when preparing the fusion zone. Surfaces which have been poorly peeled or are contaminated will have a negative effect on the quality of the joint. GF Piping Systems offer various tools for reliable joint preparation. When designing these tools, special attention was paid to achieving a robust and safe operation during service. Additionally, the skill and care taken by the user is of decisive importance. Therefore, we recommend attendance at one of the specialised schooling and training courses offered by GF Piping Systems.

The following scraping depth limits are recommended:

d Pipe [mm]	Min. wall reduction [mm]	Minimum allowable outer pipe diameter after peeling [mm]
20-25	0.20	d nom. -0.4*
32-63	0.20	d nom. -0.5*
75-225	0.20	d nom. -0.6*
>225	0.20	d nom. -0.7*

Note:
Maximum pipe ovality = 1.5 % (DVS 2207 – 1)
*these values refer to the nominal outside diameter of the pipe, i.e. if the mean outside diameter of the pipe is on the upper tolerance limit, this diameter can be reduced through peeling to the minimum allowable pipe outside diameter. In this case the peeled depth can be greater than 0.3mm.

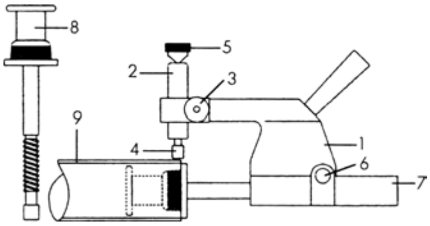
Storage and care

We recommend that tools are carefully handled and that they are kept in a suitable case after use. All guide-ways and spindles should be lightly oiled on a monthly basis. In this way, a contamination of the fusion zone can be avoided during the peeling process. The peeling depth (see table above) and the quality of peeling itself are to be checked on a regular basis. They are essential factors necessary to maintain a high standard of fusion jointing. The depth of the peeling cut should also be checked regularly during the service controls.
GF Piping Systems recommends an annual check-over on all tools which are subject to wear.

Operating instructions

Peeling tool PT 1E

Preparation of the PE-pipe
The appropriate pipe mandrel suited to each individual pipe diameter and wall thickness is to be fitted to the tool frame (1) before commencing work. Clean pipe beforehand, then cut-off at right angles to length.



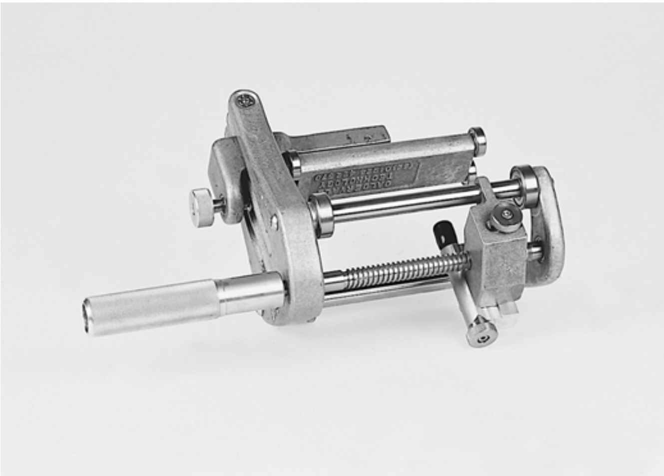
1 Tool frame
2 Cutter holder
3 Knurled nut
4 Cutter
5 Head nut
6 Quick-release head
7 Chamber
8 Pipe mandrel
9 Pipe (PE 80, PE 100, and PEX)

- After fitting the appropriate pipe mandrel, insert the complete tool into pipe end.
- Free the cutter holder (2) by loosening the knurled nut (3) so that the holder can move up and down. Slide the cutter holder upwards, and, using the knurled nut, lock in the uppermost position.
- Pull on the head nut (5) so that the cutter locator is freed from the v-groove then simultaneously turn the nut until it is at 90º to the v-groove, and release.
- Whilst holding the quick-release head (6) position the tool, as seen in the diagram, on the threaded shaft of the mandrel at the end of the pipe (9). The quick-release head can now be released.

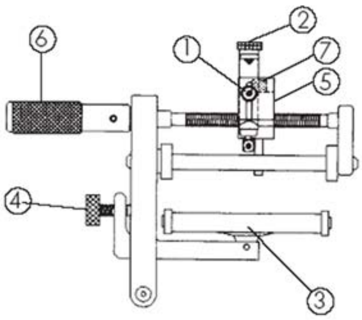
- Loosen the knurled nut (3) and slide the cutter holder downwards until the cutter (4) is positioned approximately 4 mm above the pipe. Then retighten the knurled nut.
- Turn the head nut back 90º until it relocates in the v-groove, thereby applying pressure to the cutter.
- Rotate the tool around the pipe until the required length of pipe has been peeled. The peeling operation is now complete.
- The tool is removed after, first of all, releasing the spring pressure and raising the cutter by turning the head nut through 90º. The quick-release head is then actuated and the tool slid off the mandrel. Take care not to touch the peeled surface when removing the mandrel from the pipe.

Exchanging the PT 1E cutter
Use a 3 mm Allen key and avoid contaminating parts.

Peeler PT 2



Preparation of the PE-pipes (PE80, PE100)
Clean pipe and cut to length at right angles.



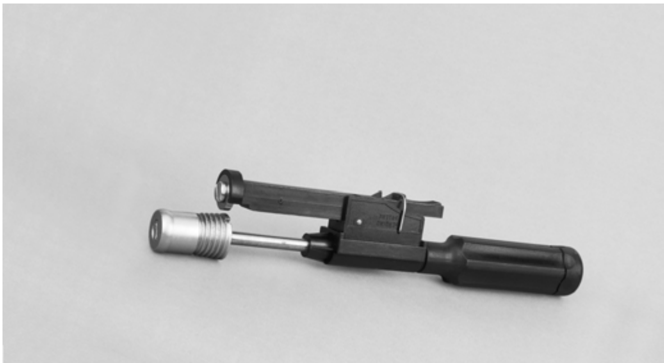
1 Clamp screw
2 Head nut
3 Support arm
4 Lock nut
5 Cutter holder
6 Handle
7 Clamping nut

- Raise cutter to upper position (loosen clamp screw (1) allowing the tool holder to be lifted). Retighten clamp screw. Remove protection cap from cutter.
- Turn the spring-loaded head nut (2) to produce a pre-tensioning effect (wedge rests on a flat surface).
- Release support arm (3) with lock nut (4), slide tool over pipe end and raise support arm as far as possible upwards and hold in position by retightening the lock nut. The tool can rotate around the pipe.
- Loosen clamping nut (7) so that the cutter holder (5) can be moved to the pre-marked peeling length.
- Loosen clamp screw (1) and slide cutter until it rests on the pipe.
- Retighten clamp screw.
- Turn spring-loaded head (2) nut so that the cutter is under pressure (the wedge sits in the v-groove).
- Hold the tool by the handle (6) and turn evenly clockwise until the surface has been uniformly peeled.

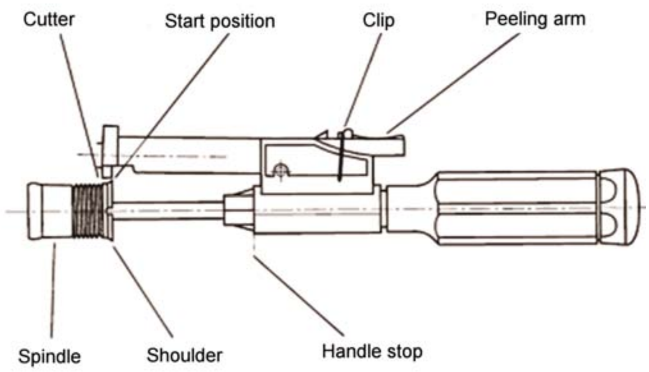
Dismantling the tool
- Turn the spring-loaded head nut (2) thus producing a pre-tensioning effect (wedge sits on flat surface).
- Loosen clamp screw (1) and withdraw cutter unit. Retighten the clamp screw.
- Place protection cover over cutter. Ensure tool remains clean.

Exchanging the PT 2 cutter
Use a 3 mm Allen key and avoid contaminating parts.

Peeling tool PT 4



Preparation of the PE-pipe
Clean pipe and cut to length at right angles.



- Turn spindle until the start position is reached, i.e. cutter and shoulder of spindle must be in line.
- Release clip. Depress spring-loaded peeling arm with the thumb and, at the same time, drive spindle into pipe end up to the shoulder. Now release the peeling arm.
- Turn the handle clockwise until the desired peeling length has been reached, i.e. to the handle stop.
- Depress spring-loaded peeling arm and pull spindle out of pipe end. Remove any shavings without touching peeled surface.

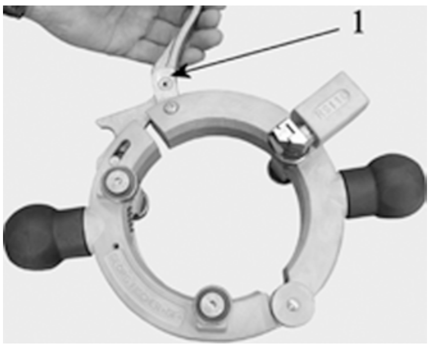
Exchanging the PT 4 cutter
The cutter disc comprises four separate cutting blades set at 90º to each other. Remove retaining screw. Pull cutter disc from square-headed boss. Turn cutter 90º. Reset on boss. Replace and retighten retaining screw.

Rotary peeler RS

Preparation
Follow our general instructions for the preparation and assembly of fittings.

Work sequence

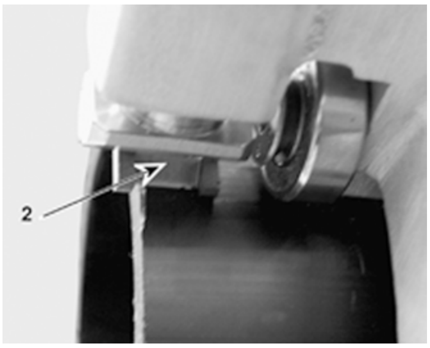
1 Mark peeling length (end point) on pipe. Mark start and finishing points if mounting saddles.



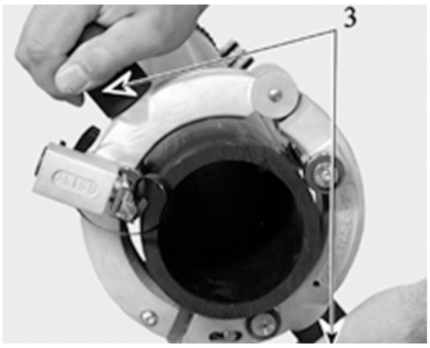
2 Open peeling tool by releasing clamp arm (1).

3 Release catch lever.

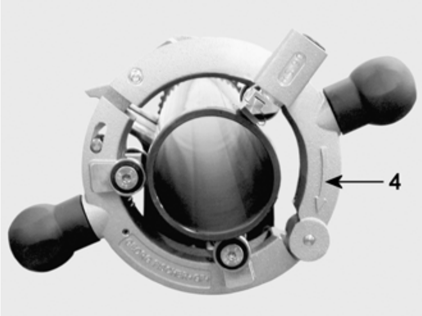
4 Wrap tool around pipe and close using the clamp arm (1).



5 To achieve an optimal cut, the cutter (2) must have at least a 2/3 contact with the pipe surface.



6 By holding the ball handles, rotate the tool around the pipe evenly, until the end marking has been reached. The marking for the finishing point, made in step 1, must also be peeled away.



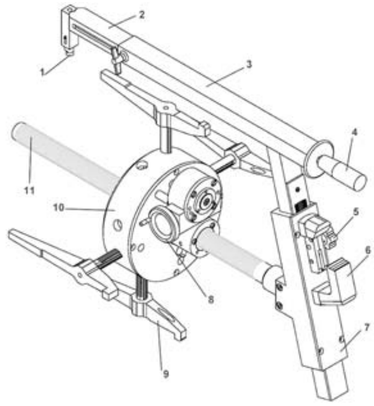
7 The peeling tool must be rotated in the direction shown by the arrow on the frame.

8 The shavings created during the peeling operation should free themselves automatically as the tool is released from the pipe. These should be removed by hand, however, if this is not the case.

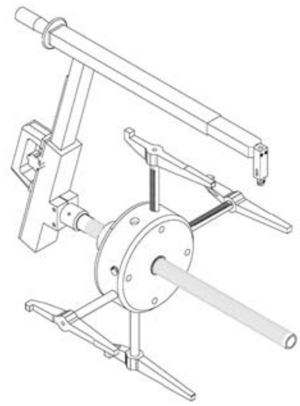
9 Loosen clamp arm (1) and remove peeling tool from pipe. The pipe is now ready for continued work.

Peeling tool RTC 710

Product design



1. Cutter
2. Extension arm
3. Peeling arm
4. Rotating handle
5. Adjustment wheel
6. Handle
7. Peeling arm guide
8. Hand-wheel
9. Support
10. Self-centring clamp
11. Trapezoidal-threaded bolt

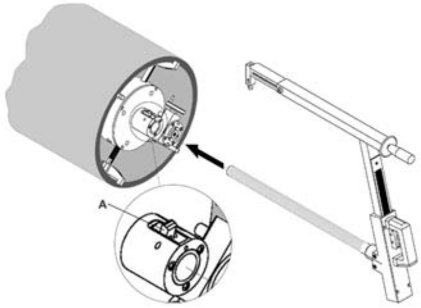


Preparation

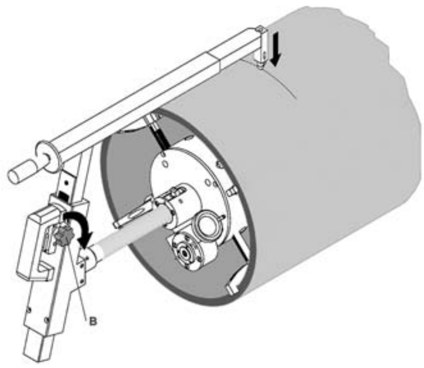
As a first step, and to ensure correct peeling, mark the distance representing half of the insertion depth for the fitting plus another 1 cm, on the pipe.

Working sequence

1. Insert self-centring clamping unit into the pipe and extend the support arms by turning the hand-wheel (X) clockwise. Ensure all four support arms sit correctly on the end face of the pipe.

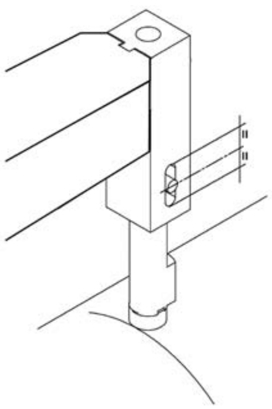


2. To enable a fast and simple insertion of the long trapezoid-threaded bolt on the peeling arm, depress catch A as long as is necessary, until the previously made marking on the pipe has been reached.

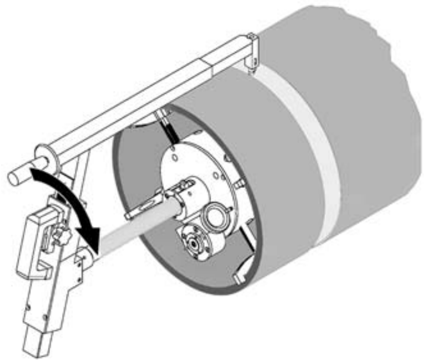


3. Turn hand-wheel B clockwise until the cutter is in contact with the pipe.

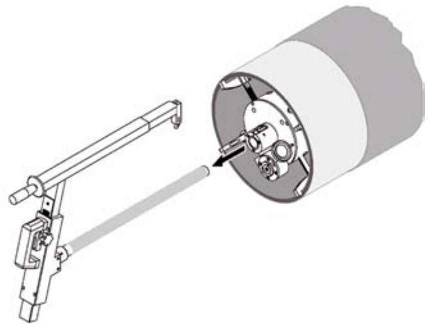
Do not over-tighten the hand wheel, the mechanism could be damaged!



4. By turning hand-wheel B, press the cutter into the pipe until the indicator pin which can be seen in the narrow slot above the cutter, reaches the centre of the slot.



5. Commence the peeling operation by turning the peeling arm evenly clockwise.



6. After peeling is complete, depress catch A and remove peeling arm. Then turn hand-wheel X anti-clockwise and withdraw the clamping unit.

Keep the tool clean at all times. Contamination can have a serious adverse effect on the life of the tool.

Mechanical joints

Flange joints

Creating flange joints

When making a flange connection, the following points have to be taken into consideration:

There is a general difference between the connection of plastic pipes and so-called adapter joints, which represent the transition from a plastic pipe to a metal pipe or a metal valve. Seals and flanges should be selected accordingly.

Flanges with sufficient thermal and mechanical stability should be used. GF flange types fulfil these requirements.

Orientation of bolts outside main axis.
Horizontal pipelines should have the shown orientation of the bolts in order to avoid in case of leakage medium drop on the bolts.

Information: Within the range of flexible sections and/or expansion loops no flange connections shall be used, because the bending load can lead to leakages.

Ensure centrically alignment of flange adaptor, flange and the seal with pipe axis.

When inserting a seal between the flange connections, the dimensions of the seal should be checked to make sure they correspond to the outer and inner diameter of the flange adapters. If the deviation between the inner diameter of the seal and the adapter is more than 10 mm, problems may arise with the flange connection.

Before pre-tightening the bolts, the jointing faces must be flush and must sit closely on the seal. Pulling the pipes together within the flange connection is to be strictly avoided because of the tensile stress which results thereof.

The length of the bolts should be selected so that the thread at the nut does not protrude more than 2 to 3 turns. A washer should be placed under the bolt head and also under the nut.

To make sure that the connecting bolts can be easily removed after a lengthy period of use, the thread should be coated with e. g. molybdenum sulphide.

Tighten the bolts diagonally and evenly first assemble the bolts and hand-tighten nut, so that the gasket is perfectly in place and the flange adapters have a minimum offset. Then tighten all the bolts diagonally up to 50 % of the recommended torque, and afterwards to 100 % of the torque.

We recommend checking at a later time and, if necessary, retightening 24 hours after assembling.

After the pressure test, check and cinch if necessary.

For more information on flange connections, see DVS 2210-1 Suppl. 3.

Bolt tightening torque
The torque of the bolts in flange connections is of particular importance. We observe several different methods in practice:

As tight as possible: In time this will definitely overstrain a flange connection in plastic piping systems.

By feel: This requires a good deal of experience and material know-how.

Use of a torque wrench: This is the best method. We have listed the recommended values below; however, deviations can occur in practice. These can be caused by the use of, for example, self-locking nuts or pipe axes which are not flush. The Shore hardness of the seal can also influence the necessary torque force (see also the following information concerning sealing materials).

Bolt tightening torque guidelines for metric (ISO) flange connections with PP-V, PP- steel and PVC flanges.

Nominal diameter DN	Pipe diameter d	Bolt tightening torque [Nm]		
		Flat gasket up to max. pressure of 10 bar / 40 °C	Profile gasket up to max. pressure of 16 bar	O-ring up to max. pressure of 16 bar
15	20	10	10	10
20	25	10	10	10
25	32	15	10	10
32	40	20	15	15
40	50	25	15	15
50	63	35	20	20
65	75	50	25	25
80	90	30	15	15
100	110	35	20	20
125	125, 140	45	25	25
150	160, 180	60	35	30
200	200, 225	70 [1]	45	35
250	250, 280	65 [1]	35	30
300	315	90 [1]	50	40
350	355	90 [1]	50	-
400	400	100 [1]	60	-
500	450, 500	190 [1]	70	-
600	560, 630	220 [1]	90	-

1) Up to a maximum working pressure of 6 bar

Information: Please observe the special bolt tightening torques given for DN250 and DN300 recommended for butterfly valves, see clause "Fundamentals for butterfly valves, hand operated".

The indicated torques are recommended by GF; with these torques a sufficient tightness of the flange connection is ensured. They deviate from the data in the

DVS 2210-1 Supplement 3, which are to be understood as upper limit values. Of course our components of the flange connection (adapters, flanges) are designed to withstand these upper limit values.

Dimensions of metric (ISO) flange connections.

Nominal diameter DN	Pipe diameter d	Min. bolt length (calculated)	Max. bolt length (calculated)	Number of screws x thread diameter
15	20	52	69	4 x M12
20	25	56	73	4 x M12
25	32	60	75	4 x M12
32	40	70	91	4 x M16
40	50	72	95	4 x M16
50	63	78	102	4 x M16
65	75	82	110	4 x M16
80	90	86	114	8 x M16
100	110	89	119	8 x M16
125	125, 140	101	137	8 x M16
150	160, 180	108	145	8 x M20
200	200, 225	130	167	8 x M20
250	250, 280	134	177	12 x M20
300	315	150	185	12 x M20
350	355	168	192	16 x M20
400	400	179	207	16 x M24
500	450, 500	249	253	20 x M24
600	560, 630	291	295	20 x M27

The minimum and maximum bolt lengths are given only for orientation. They are depending from the type of flanges and flange adaptors.
Exact values can be calculated from the information shown in the following clause "Length of bolts".

Bolt tightening torque guidelines for ANSI flange connections with PP-V, PP- steel and PVC flanges.

Nominal diameter Inch	Nominal diameter DN	Bolt tightening torque [lb-ft]	
		Flat gasket up to max. pressure of 10 bar / 40 °C	**Profile gasket up to max. pressure of 16 bar**
½	15	15	10
¾	20	15	10
1	25	15	10
1¼	32	15	10
1½	40	15	10
2	50	30	20
2½	65	30	20
3	80	40	30
4	100	30	20
6	150	50	33
8	200	50	33
10	250	60 [1]	40
12	300	75 [1]	53

1) Up to a maximum working pressure of 6 bar

PP-V flanges

The PP-V flange shows the following properties:

- Corrosion-free backing flange made of polypropylene PP (30 % glass-fibre reinforced)
- High chemical resistance (hydrolysis resistant)
- Maximum break resistance (deforms if it gets tightened too strongly)
- Suitable up to 80 °C ambient temperature. Remark: The temperature of the medium is restricted by the material of the plastic piping system, i. e. ABS, PVC-U, PVC-C, PP, PE.
- For PVDF up to 140 °C media temperature, the ambient temperature is limited to 40 °C
- UV-stabilised

- Integrated fixation aids for the bolts
- Self-centering of the flanges on the flange adapters
- Symmetric design allows double-sided installation: "wrong-side installation“ is not possible, all important information is visible

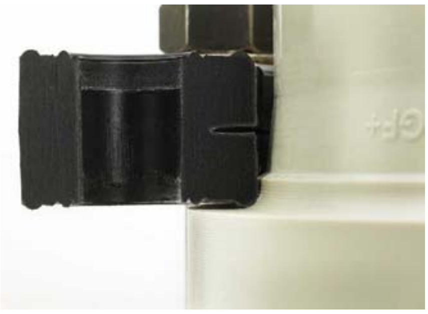
- Instructions for use with pictogram:

Socket systems

Butt fusion systems

V-groove (patented)

- To distribute the forces evenly over the flange adapter
- Reduces “creeping” effect on flange adapters
- No deformation of the flange during the tightening of the bolts up to the recommended torque value



PP-steel flanges

The PP-steel flange is a stiff and robust flange universally applicable. Its characteristics are as following:

- Corrosion-free plastic flange made out of polypropylene PP-GF30 (glass-fibre reinforced) with steel inlay
- High chemical resistance (esp. against hydrolysis)
- The ambient temperature is max 80°C
- UV-stabilized

Length of bolts

In practice it is often difficult to specify the correct bolt length for flange connections. It can be derived from the following parameter:

- Thickness of the washer (2x)
- Thickness of the nut (1x)
- Thickness of the seal (1x)
- Flange thickness (2x)
- Thickness of the flange adapter (2x)
- Thickness of the valve, if applicable (1x)

The following tables are useful in determining the necessary bolt length. Due to the various combinations of the individual components, only thicknesses of the single parts of flange connections can be given. However you simply add them together to determine the necessary bolt length.

Remark: According to DVS 2210-1 you should determine the necessary bolt length in order to ensure 2-3 screw turns.

1. Thickness of the washer

DN10 to DN25	3 mm
DN32 to DN600	4 mm

2. Thickness of the nut (= nut height)

DN10 to DN25	M 12	SW 18	1.7 mm pitch	10.4 mm nut height
DN25 to DN125	M 16	SW 24	2.0 mm pitch	14.1 mm nut height
DN150 to DN350	M 20	SW 30	2.5 mm pitch	16.9 mm nut height
DN400 to DN500	M 24	SW 36	3.0 mm pitch	20.2 mm nut height
DN600	M 27	SW 41	3.0 mm pitch	23.8 mm nut height

3a. Thickness of the flat gasket

DN10 to DN80	ca. 2 mm
DN100 to DN600	ca. 3 mm

3b. Thickness of the profile gasket

DN10 to DN40	ca. 3 mm
DN50 to DN80	ca. 4 mm
DN100 to DN125	ca. 5 mm
DN150 to DN300	ca. 6 mm
DN350 to DN600	ca. 7 mm

4. Flange thickness

	PP-V	**PP-Steel**	**PVC-U PVC-C**	**Blank Flange (PVC-U)**
DN10	--	--	10 mm	--
DN15	16 mm	12 mm	11 mm	12 mm
DN20	17 mm	12 mm	12 mm	13 mm
DN25	18 mm	16 mm	14 mm	15 mm
DN32	20 mm	20 mm	15 mm	16 mm
DN40	22 mm	20 mm	16 mm	17 mm
DN50	24 mm	20 mm	18 mm	20 mm
DN65	26 mm	20 mm	19 mm	21 mm
DN80	27 mm	20 mm	20 mm	22 mm
DN100	28 mm	20 mm	22 mm	24 mm
DN125	30 mm	24 mm	26 mm	28 mm
DN150	32 mm	24 mm	28 mm	30 mm
DN200	34 mm	27 mm	32 mm	36 mm
DN250	38 mm	30 mm	36 mm	36 mm
DN300	42 mm	34 mm	36 mm	36 mm
DN350	--	40 mm	38 mm	38 mm
DN400	--	40 mm	42 mm	42 mm
DN500	--	49 mm	--	--
DN600	--	68 mm	--	--

5a. Thickness of the metric flange adapter for socket systems, flat or profile gasket

	ABS PVC-C PVC-U	PP PE	PVDF
DN10	6 mm	--	--
DN15	6 mm	7 mm	6 mm
DN20	7 mm	9 mm	7 mm
DN25	7 mm	10 mm	7 mm
DN32	8 mm	11 mm	8 mm
DN40	8 mm	12 mm	8 mm
DN50	9 mm	14 mm	9 mm
DN65	10 mm	16 mm	--
DN80	11 mm	17 mm	--
DN100	12 mm	18 mm	--
DN125	14 mm	--	--
DN150	16 mm	--	--
DN200	24 mm	--	--
DN250	23 mm	--	--
DN300	27 mm	--	--
DN350	32 mm	--	--
DN400	34 mm	--	--

5b. Thickness of the metric flange adapter for socket systems, O-ring

	PVC-C PVC-U	PP PE	PVDF
DN10	9 mm	--	--
DN15	9 mm	9 mm	9 mm
DN20	10 mm	10 mm	10 mm
DN25	10 mm	10 mm	10 mm
DN32	13 mm	13 mm	13 mm
DN40	13 mm	13 mm	13 mm
DN50	14 mm	14 mm	14 mm
DN65	15 mm	15 mm	--
DN80	16 mm	16 mm	--
DN100	18 mm	18 mm	--
DN125	20 mm	--	--
DN150	22 mm	--	--
DN200	31 mm	--	--
DN250	30 mm	--	--
DN300	35 mm	--	--
DN350	--	--	--
DN400	--	--	--

5c. Thickness of the metric flange adapter for butt fusion systems, flat or profile gasket

	PP PE SDR11	PP PE SDR17	PVDF SDR33 SDR21
DN10	--	--	--
DN15	7 mm	--	6 mm
DN20	9 mm	--	7 mm
DN25	10 mm	--	7 mm
DN32	11 mm	--	7 mm
DN40	12 mm	12 mm	8 mm
DN50	14 mm	14 mm	9 mm
DN65	16 mm	16 mm	10 mm
DN80	17 mm	17 mm	12 mm
DN100	18 mm	18 mm	13 mm
DN125	25 mm	25 mm	16 mm
DN150	25 mm	25 mm	17 mm
DN200	32 mm	32 mm	22 mm
DN250	35 mm	35 mm	--
DN300	35 mm	35 mm	--
DN350	40 mm	40 mm	--
DN400	46 mm	46 mm	--
DN500	60 mm	60 mm	--
DN600	60 mm	60 mm	--

6. Thickness of valves installed between flange adapters

	Butterfly valve, type 567/568	Butterfly valve, type 367	Butterfly valve, type 037/038	Wafer check valve, type 369
DN32	--	--	--	15 mm
DN40	--	--	--	16 mm
DN50	45 mm	--	43 mm	18 mm
DN65	46 mm	46 mm	46 mm	20 mm
DN80	49 mm	49 mm	46 mm	20 mm
DN100	56 mm	56 mm	52 mm	23 mm
DN125	64 mm	64 mm	56 mm	23 mm
DN150	72 mm	70 mm	56 mm	26 mm
DN200	73 mm	71 mm	60 mm	35 mm
DN250	113 mm	76 mm	68 mm	40 mm
DN300	113 mm	83 mm	78 mm	45 mm
DN350	129 mm	--	--	--
DN400	169 mm	--	--	--
DN450	179 mm	--	--	--
DN500	190 mm	--	--	--
DN600	209 mm	--	--	--

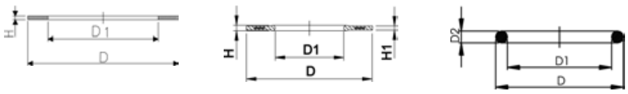
Selection of the seals for flange connections

With consideration to the operating conditions and the sealing forces, the selection of suitable flange seals in thermoplastic piping systems depends on the following factors:

- Form
- Dimension
- Material

Form of the seal

Flat gasket　　Gasket with profile　　O-ring



In applications with low working pressures the customary flat gasket, which is made of 2 to 5 mm thick sheet material (depending on the nominal diameter), is used. For flange connections with flat gaskets, flanges which are sturdy enough to withstand the higher torque required for fastening the bolts in such connections are necessary. All flanges from GF meet these requirements.

For increased working and testing pressures, the profile flange gaskets and O-rings have proved useful. Compared to the flat gasket, the profile flange gasket is made of two components. One is the crowned flat gasket part which is reinforced with steel, and the other is the profiled part (O-ring, lip seal) on the seal inner side.

The stabilised profile flange gasket as well as O-ring gaskets have the following advantages:

- Reliable seal with little screw torque
- Can be used with higher internal pressure and internal vacuum
- Easy to install
- Influenced less by the flange surface
- Safe when connecting pipes of different materials.

Selection of suitable seals, related to the form, can be done with the table below.

Seal form	Recommended limits	Flange version
Flat gasket	P = 1 to 10 bar, above DN200 only to 6 bar T to 40 °C	With sealing grooves
Profile flange gasket	P = 0 to 16 bar T= whole application range	With or without sealing grooves
O-ring	P = 0 to 16 bar T= whole application range	With groove

Seal material

The choice of a seal material is based on the flow media. Details on the suitability of the seal material, or specifically the chemical resistance, can be found in our resistance tables.

The use of seal materials with a high degree of hardness, e. g. as in steel pipes, is restricted in thermoplastic piping systems because the flange or the adapter could become deformed under the great sealing forces. Elastomer materials, such as EPDM, CSM or FPM, with a Shore-A-hardness up to 75 ° are preferable.

Dimensions of the seal

The dimensions of the seal are determined in the general standards for pipe jointing components. Too big divergences in the inner or outer diameter of the seal as compared to the flange adapter can lead to increased mechanical stress of the flange connection, to accelerated wear of the inner side of the seal as well as deposits inside the pipe.

One gasket for everything

GF Piping Systems makes it easy for you to find the right gasket. Our new standardized gasket is ideal for both butt fusion and socket fusion systems alike. It no longer makes any difference what SDR your piping system has. Save time in selecting the right gasket. Avoid mistakes and stock less variations. Everything has become much easier. The new standardized gasket, available as profile flange gasket or flat gasket, always puts you on the safe side.

All it takes are three simple steps

- Select the gasket type
- Select the dimension
- Select the material

+GF+

Application technology PVC-U

General information

Assembly and operation instructions

General information

PVC-parts are not allowed to come in contact with solvents, especially chlorinated hydrocarbons or cements (chemical resistance PVC according to DIN 16929). Exception: special Tangit PVC-cleaner and cement. The same holds for lubricants (grease) and oils that are not released by Georg Fischer.

Working pressure and temperature

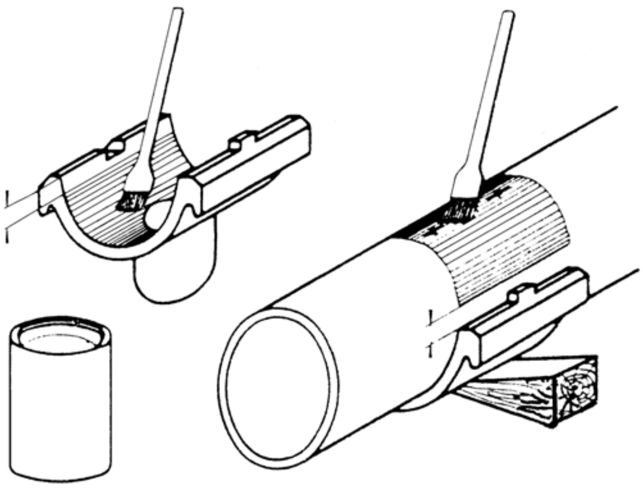
STEMU-fittings from PVC maximum working temperature 60 °C, depending on inner pressure. Plastic valves, branch- and tapping saddles from PVC, maximum working temperature 45 °C, depending on inner pressure.

Dimension	Pipe series	Working pressure [bar]	Tempera-ture [°C]
d63 - d160	SDR 17 ISO S8	10	20
d200, d225	SDR 21 ISO S10	10	20

PVC branch and tapping saddles

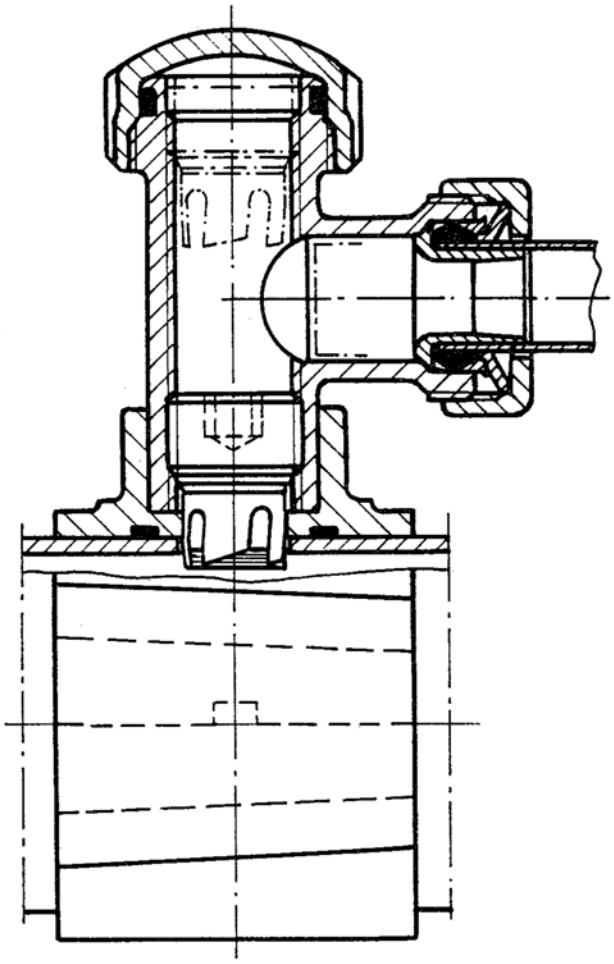
Assembly of the saddle onto the pipe

1. **Branch- and tapping saddles with rubber sealing**
   The contact surfaces of PVC pipe, upper part of the saddle, the cotters and the radial groove have to be clean and dry. Within the area of the sealing the PVC pipe must not show rills, scratches or burrs. The lip seal has to be precisely inserted into the upper part of the saddle. Upper and lower part of the saddle are positioned onto the pipe without shifting. Subsequently, the cotters have to be mounted and fixed alternatingly by means of a plastic hammer until the cotters are flush with the end of the saddle.



2. **Cementable branch saddles**
   The contact surfaces of PVC pipe, saddle parts and cotters have to be clean and dry. At first, the positioning of the upper part of the saddle has to be determined. Both surfaces to be cemented have to be cleaned with Tangit PVC cleaner. Subsequently, the Tangit PVC cement is applied axially onto PVC pipe and inner surface of the saddle using a 50 x 5 mm brush. The upper part of the saddle has to be positioned correctly without delay. Cams and gaps of the upper part of the saddle have to be cement-free. If any cement leaks, it has to be removed using al lint-free cloth. Finally, the lower part of the saddle is put into position and the cotters are mounted. By means of a plastic hammer the cotters are fixed alternatingly until they are flush with the end of the saddle. Any surplus cement is removed using a lint-free cloth.

Further information on PVC can be taken from "Planning Fundamentals for Industrial Piping Systems.



3. This PVC branch saddle is suitable to be connected to a metal male thread, e.g. metal angle valve/gate valve or thermometer /pressure gage connection. Assembly according to 1.

Assembly of house connection
General information

Metal pipes and metal valves must not be connected directly to PVC branch and tapping saddles. Exceptions: Kat.-Nr.: 21 111 550

PVC-tapping saddle with PVP-threaded outlet
Setting up of a pipe outlet (house connection) and further information are available in «PVP pipe connections».

Pressure test
Prior to tapping a pressure test has to be conducted. Advantageously, the pressurisation is conducted from the building side.

Installation of the distribution line, tapping saddle and house connections has to be carried out according to KRV-PVC installation manual.

Since cement and cleaner etch PVC-U, pipes and fittigs must not lie in slopped left-overs of cement nor even touch any cement oddments.

The trench must not be used as a rubbish pit!

Drying time and pressure test
The drying time of the solvent cemented connection until it is subjected to test- or working pressure depends on drying temperature and outer conditions.

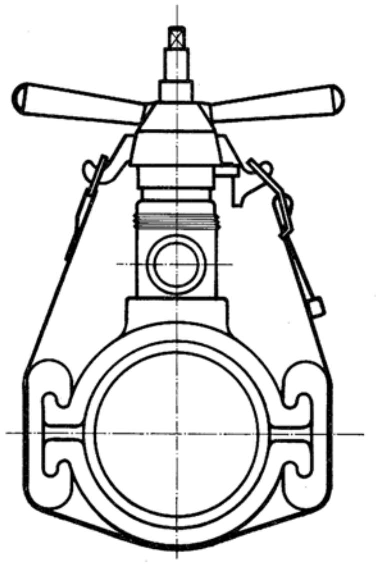
As a rule of thumb:
1 h waiting time per bar working pressure

Nominal pressure [PN]	Test pressure* [bar]	Waiting time [h]
10	15	15
16	21	24

* 1,5 x PN, max. (PN + 5) bar

Tapping

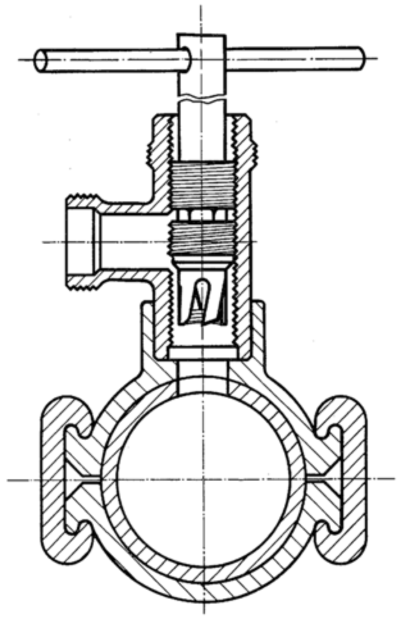
Branch saddle



Only use the basic tapping tool kit from GF Piping Systems.

This tool is only suitable for non-pressurised pipes!

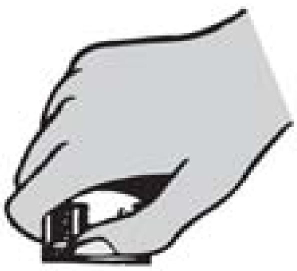
Tapping saddle with integrated cutter



- Only use the hexagon key for PVC-U saddles when tapping pressurised pipes.
- Insert hexagon key into integral cutter and screw both down together.
- Tap pipe.
- Unscrew cutter until it is flush with the top of the tapping saddle. The hexagon key is designed to prevent any leakage from the pipeline medium as the key passes the branch.
- If necessary, an emergency shut-off can be achieved by screwing the cutter down to its lowest point.
- The cutter is intended to be used once only. It must not be removed. The coupon cut out of the pipe and the shavings are retained securely in the cutter.

Sealing the tapping saddle

Coat the rubber seal on the tapping tee with water or a lubricant suitable for PVC-U pipes (do not use grease, oil thread sealing paste etc.).



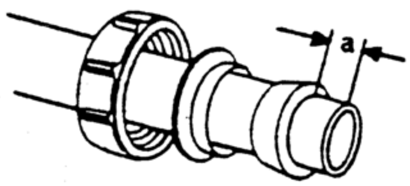
Tighten the screw cap by hand as far as the stop.

Do not use sharp-edged tools!

Materials: PVC-U branch and tapping saddles

Threaded insert	**Gun metal**
Cutter	**Brass**
Seal	**NBR (Nitrile rubber)**

PVP-pipe connections



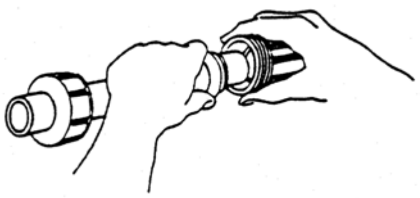
1. Cut pipe end at right-angles.

   Chamfer inside of pipe end for approximately half the wall thickness. Remove adhesive tape and slide components over end of pipe.
   Set sealing ring at distance "a" from pipe end:

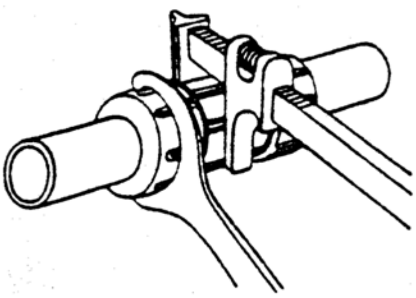
   ≤ d32 mm a = 10 mm
   ≥ d 32 mm a = 15 mm.

   Slide spring follower back against sealing ring. Apply a light coating of a lubricant suitable for PVC-U pipes to the outside diameter of sealing ring as well as the inside of the socket and the outside thread on the fitting body.

Do not use grease, oil, thread sealing paste or similar.

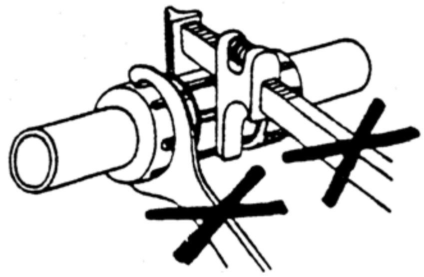


2. Hold the pipe firmly behind the spring follower and push into fitting socket. If the pipe and fitting are already in a fixed position, apply a light coating of lubricant suitable for PVC-U pipes to the pipe under the sealing ring. Then, using a wooden drift and with light blows from a hammer, drive the sealing ring into the fitting socket. Tighten locking nut by hand.



3. No more than two threads should be visible on the body of the fitting when joint is complete. If necessary, the nut can be tightened accordingly with a wrench. Special keys are available for sizes 1” to 2” (32 – 63 mm).

   Do not use sharp-edged tools!



Connections with o-ring seals:

1. Remove adhesive band and slide locking nut over pipe end.
2. Moisten o-ring, push body into fitting socket and tighten locking nut by hand.

Do not use a spanner or wrench to tighten locking nut!

Appendix

Metric and inch system

For those unfamiliar with the difference between metric and inch sizes the following note may be helpful. In imperial systems, the sizes of pipes, fittings and other components such as valves are identified by reference to the nominal size of the bore of the pipe expressed in inches and fractions of an inch.

In metric systems, however, sizes are identified by references to the outside diameter of the pipe expressed in millimetres.

The table below shows the metric sizes which are regarded for practical purposes as being generally equivalent to imperial sizes. It should, however, be understood that metric sizes are not simply inch sizes which have been converted into millimetres and called metric; their actual dimensions are slightly different and they are with the exception of 2½ " (75 mm) and 5" (140 mm) not interchangeable.

Imperial Sizes		Metric Sizes	
Nominal bore DN (inch)	**Pipe outside diameter d (mm)**	**Pipe outside diameter d (mm)**	**Nominal bore DN (mm)**
1/8	10.2	10	6
1/4	13.5	12	8
3/8	17.2	16	10
1/2	21.3	20	15
3/4	26.9	25	20
1	33.7	32	25
1 1/4	42.4	40	32
1 1/2	48.3	50	40
2	60.3	63	50
2 1/2	75.3	75	65
3	88.9	90	80
3 1/2	101.6	-	-
4	114.3	110	100
-	-	125 1)	100
-	-	125 2)	125
5	140.3	140	125
6	168.3	160	150
-	-	180 1)	150
7	193.7	180 2)	175
8	219.1	200	200
8	219.1	225	200
9	244.5	250	250
10	273.0	280	250
12	323.9	315	300
14	355.6	355	350
16	406.4	400	400
18	457.2	450	450
20	508.0	450	500
20	508.0	500	500
22	558.2	560	600
24	609.6	630	600
26	660.4	-	-
28	711.2	710	700
30	762.0	-	-
32	812.8	800	800
34	863.6	-	-
36	914.4	900	900
40	1016.0	1000	1000

1) only butt fusion systems

2) only cementing socket systems

Abbreviations

Materials

ABS	Acrylonitrile-butadiene-styrene
CR	Chloroprene rubber, e. g. Neoprene
EPDM	Ethylene propylene rubber
FPM	Fluorocaoutchouc, e. g. Viton
Ms	Brass
NBR	Nitrile rubber
NR	Natural rubber
PB	Polybutene
PE	Polyethylene
PE-X	Cross-linked polyethylene
PP	Polypropylene
PTFE	Polytetrafluorethylene, e. g. Teflon
PVC	Polyvinyl chloride
PVC-C	Polyvinyl chloride, postchlorinated (increased chlorine content)
PVC-U	Polyvinyl chloride, unplasticized
PVDF	Polyvinylidene fluoride
TG	Malleable iron
UP-GF	Unsaturated polyester resin, glassfibre reinforced

Dimensions and units

Dimensions are given in mm and/or inches and are to be taken as nominal or standard dimensions.

The right to make modifications in design is reserved.

d, d1, d2, d3, d4	Diameter
DN	Nominal diameter
SC	Size for hex screws
AL	Number of holes
s	Width across flats
g	Weight in gram
SP	Number per standard pack
GP	Number per large pack
e	Wall thickness of pipe
PN	Nominal pressure at 20 °C, water
Rp	Cylindrical pipe - internal thread to ISO 7/1
R	Conical pipe – external thread to ISO 7/1
ppm	Parts per million
1 bar	= 0.1 N/mm² = 0.1 Mpa (Megapascal) = 14.504 psi
C	Design factor
S	Pipe series
SDR	Standard Dimension Ratio
MFR	Melt Flow Rate

SI units

SI basic units

SI units are the seven basic units and the units derived thereof coherently, i. e. with numerical factor 1.

Basic quantity		**SI basic unit**	
Name	**Symbol**	**Name**	**Symbol**
Length	l	Metre	m
Mass	m	Kilogram	kg
Time	t	Second	s
Electric current	I	Ampere	A
Thermodynamic temperature	T	Kelvin	K
Amount of substance	n	Mole	mol
Luminous intensity	I_n	Candela	cd

Internationally defined prefixes

	Prefix		**Factor as**	
Meaning	**Name**	**Symbol**	**power of ten**	**decimal**
Trillion	exa	E	10^{18}	= 1 000 000 000 000 000 000
Thousand billion	peta	P	10^{15}	= 1 000 000 000 000 000
Billion	tera	T	10^{12}	= 1 000 000 000 000
Thousand million	giga	G	10^{9}	= 1 000 000 000
Million	mega	M	10^{6}	= 1 000 000
Thousand	kilo	k	10^{3}	= 1 000
Hundred	hecto	h	10^{2}	= 100
Ten	deca	da	10^{1}	= 10
Tenth	deci	d	10^{-1}	= 0.1
Hundredth	centi	c	10^{-2}	= 0.01
Thousandth	milli	m	10^{-3}	= 0.001
Millionth	micro	µ	10^{-6}	= 0.000 001
Thousand millionth	nano	n	10^{-9}	= 0.000 000 001
Billionth	pico	p	10^{-12}	= 0.000 000 000 001
Thousand billionth	femto	f	10^{-15}	= 0.000 000 000 000 001
Trillionth	atto	a	10^{-18}	= 0.000 000 000 000 000 001

Units

Size	Symbol	SI units	Permissible units other than SI	Conversion into associated SI unit and ratios	No longer permissible units and conversions
Length	l	m (metre)			1" (inch = 0.0254 m) 1 nm = (nautical mile) = 1852 m
Surface	A	m^2 (square metre)			1 b (barn) = 10^{-28} m^2 1 a (are) = 10^2 m^2 1 ha (hectare) = 10^4 m^2 sq.m., sq.dm., sq.cm., etc. (Names allowed, symbol not allowed)
Volume	V	m^3 (cubic metre)	l (litre)	1 l = 10^{-3} m^3	
Solid angle	Ω	sr (steradian)		1 sr = 1 m^2/m^2	1 ° (square degree) = 3.046 • 10^{-4} sr 1 g (square grade) = 2.467 • 10^{-4} sr
Time	t	s (second)	min (minute) h (hour) d (day)	1 min = 60 s 1 h = 3600 s 1 d = 86400 s	
Frequency	f	Hz (Hertz)		1 Hz = 1/s	
Rotation speed	n	s^{-1}	rpm rpm	1 rpm^{-1} ($1/_{60}$) s^{-1} 1 rpm = 1 (1/min)	
Velocity	v	m/s	km/h	1 km/h = (1/3.6) m/s	
Acceleration	g	m/s^2		normal fall acceleration g_n= 9.80665 m/s^2	1 gal (gal) = 10^{-2} m/s^2
Mass	m	kg (kilogram)	t (tonne)	1 t = 10^3 kg	1 q (metric hundred weight) = 100 kg
Density	ρ	kg/m	t/m^3 kg/l	$1t/m^3$ = 1000 kg/m^3 1kg/l = 1000 kg/m^3	
Moment of inertia	J	kg • m^2			1 kp • m s^2 = 9.81 kg • m^2
Force	F	N (Newton)		1 N = 1 kg • m/s^2	1 dyn (dyn) = 10^{-5} N 1 p (pond) = 9.80665 • 10^{-3} N 1 kp (kilopond) = 9.80665 N
Torque	M	N • m			1 kpm = 9.80665 Nm 1 Nm = 0.7375 lb-ft
Pressure	p	Pa (Pascal)	bar	1 Pa = 1 N/m^2 1 bar = 10^5 Pa	1 atm = 1.01325 bar 1 at = 0.980665 bar 1 Torr = 1.333224 • 10^{-3} bar 1 m CE = 98.0665 • 10^{-3} bar 1 mm Hg = 1.333224 • 10^{-3} bar
Mechanical stress	σ	N/m^2 Pa		1 N/m^2 = 1 Pa	1 kp/m^2 = 9.80665 N/m^2 1 kp/cm^2 = 98.0665 10^{-3} N/m^2 1 kp/mm^2 = 9.80665 • 10^{-6} N/m^2
Dynamic viscosity		Pa • s		1 Pa • s = 1 N • s/m^2	1 P (Poise) = 10^{-1} Pa • s
Kinematic viscosity		m^2/s		1 m^2/s = 1 Pa • s • m^3/kg	1 St (stokes) = 10^{-4} m^2/s
Work energy	W E	J (Joule)	eV (electronvolt) W • h	1 J = 1 Nm = 1 H_2O 1 W • h = 3.6 KJ	1 cal = 4.1868 J 1 kpm = 9.80665 J 1 erg = 10^{-7} J
Electric charge	Q	C (Coulomb)		1 C = 1 A • s	
Electric potential	U	V (Volt)		1 V = 1 W/A	
Electric current	I	A (Ampere)			

Electric resistance	R	Ω (Ohm)		1 Ω = 1 V/A	1 Ω abs = 1 Ω
Power	P	W (Watt)		1 W = 1 J/s = 1 Nm/s 1 W = 1 V • A	1 PS = 735.498 W 1 kcal/h = 1.163 W 1 kpm/s = 10 W
Electric capacitance	C	F (Farad)		1 F = 1 C/V	
Magnetic field strength	H	A/m			1 Oe (Oersted) = 79.5775 A/m
Magnetic flux	Φ	Wb (Weber)		1 Wb = 1 V • s	1 Mx (Maxwell) = 10^{-8} Wb
Magnetic flux density	B	T (Tesla)		1 T = 1 Wb/m²	1 G (Gauss) = 10^{-4} T
Inductance	L	H (Henry)		1 H = 1 Wb/A	
Electric conductance	G	S (Siemens)		1 S = 1/Ω	
Thermodynamic temperature	T	K (Kelvin)		Δ1 °C = Δ 1 K O °C = 273.15 K	
Temperature (C)	t, ϑ	°C (degree Celsius)		Δ 1 °C = Δ 1 K O K = -273.15 °C	
Thermal capacity	C	J/K			1 Kcl/degree = 4.1868 10^{-3} J/K 1 Cl (clausius) = 4.1868 J/K

+GF+

Conversion tables

Delivery volumes

m³/h	l/min	l/s	m³/s	Imp. gal/min	US gal/min	cu. ft./h	cu. ft./s
1.0	16.67	0.278	2.78×10^{-4}	3.667	4.404	35.311	9.81×10^{-3}
0.06	1.0	0.017	1.67×10^{-5}	0.220	0.264	2.119	5.89×10^{-4}
3.6	60	1.0	1.00×10^{-3}	13.20	15.853	127.12	3.53×10^{-2}
3600	60000	1000	1.0	13200	15838	127118	35.311
0.2727	4.55	0.076	7.58×10^{-5}	1.0	1.201	9.629	2.67×10^{-3}
0.2272	3.79	0.063	6.31×10^{-5}	0.833	1.0	8.0238	2.23×10^{-3}
0.0283	0.47	0.008	7.86×10^{-6}	0.104	0.125	1.0	2.78×10^{-4}
101.94	1699	28.32	2.83×10^{-2}	373.77	448.8	3600	1.0

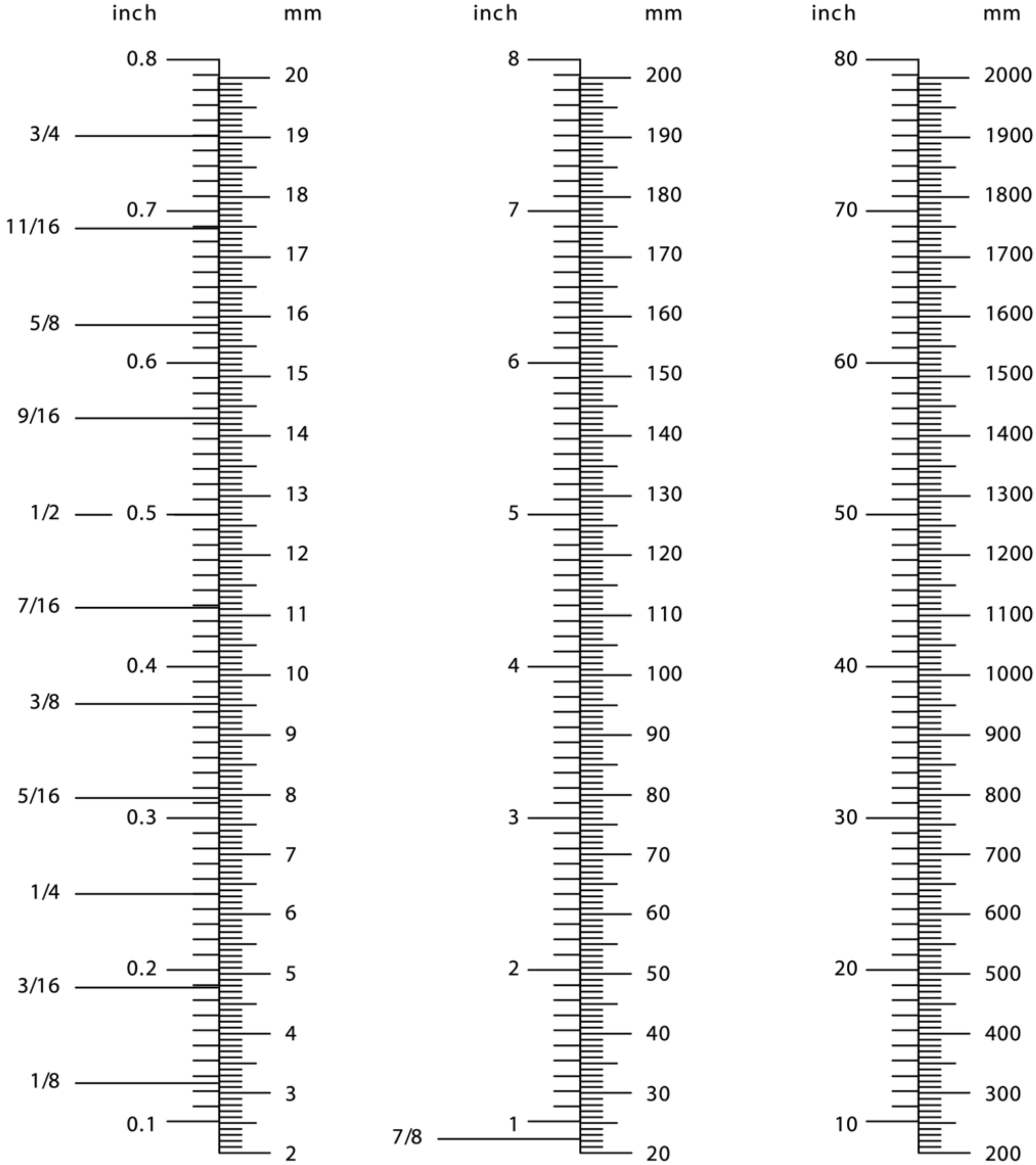
Pressure and pressure heads

bar	kg/cm²	lbf/sq. in.	atm	ft H_2O	m H_2O	mm Hg	in. Hg	kPa
1.0	1.0197	14.504	0.9869	33.455	10.197	750.06	29.530	100
0.9807	1.0	14.223	0.9878	32.808	10	735.56	28.959	98.07
0.0689	0.0703	1.0	0.0609	2.3067	0.7031	51.715	2.036	6.89
1.0133	1.0332	14.696	1.0	33.889	10.332	760.0	29.921	101.3
0.0299	0.0305	0.4335	0.0295	1.0	0.3048	22.420	0.8827	2.99
0.0981	0.10	1.422	0.0968	3.2808	1.0	73.356	2.896	9.81
13.3×10^{-4}	0.0014	0.0193	13.2 x 10-4	0.0446	0.0136	1.0	0.0394	0.133
0,0339	0.0345	0.4912	0.0334	1.1329	0.3453	25.40	1.0	3.39
1.0×10^{-5}	10.2×10^{-6}	14.5×10^{-5}	9.87×10^{-6}	3.34×10^{-4}	10.2×10^{-5}	75.0×10^{-4}	29.5×10^{-5}	1.0

atm = international standard atmosphere

kg/cm² = metric atmosphere

Conversion inch/mm



General Condition of Supply of Georg Fischer Piping Systems Limited, Schaffhausen

1 General

1.1 These General Conditions shall apply to all Products supplied by Georg Fischer to the Purchaser. They shall also apply to all future business even when no express reference is made to them.

1.2 Any deviating or supplementary conditions especially Purchaser's general conditions of purchase and verbal agreements shall only be applicable if accepted in writing by Georg Fischer.

1.3 The written form shall be deemed to be fulfilled by all forms of transmission, evidenced in the form of text, such as telefax, e-mail, etc.

2 Tenders

Tenders shall only be binding if they contain a specifically stated period for acceptance.

3 Scope of Delivery

3.1 Georg Fischer's product range is subject to change.

3.2 The confirmation of order shall govern the scope and execution of the contract.

4 Data and Documents

4.1 Technical documents such as drawings, descriptions, illustrations and data on dimensions, performance and weight as well as the reference to standards are for information purposes only. They are not warranted characteristics and are subject to change.

4.2 All technical documents shall remain the exclusive property of Georg Fischer and may only be used for the agreed purposes or as Georg Fischer may consent.

5 Confidentiality, Protection of Personal Data

5.1 Each party shall keep in strict confidence all commercial or technical information relating to the business of the other party, of which it has gained knowledge in the course of its dealing with the other party. Such information shall neither be disclosed to third parties nor used for other purposes than those for which the information has been supplied.

5.2 In the context of the contractual relation with the Purchaser personal data may be processed. The Purchaser agrees to the disclosure of said data to third parties such as foreign subcontractors and suppliers etc .

6 Local Laws and Regulations, Export Controls

6.1 The Purchaser shall bring to the attention of Georg Fischer all local laws and regulations at the place of destination which bear connection with the execution of the contract and the adherence to relevant safety regulations and approval procedures.

6.2 In case of re-exports, Purchaser shall be responsible for compliance with pertinent export control regulations.

7 Price

7.1 Unless agreed otherwise, the prices shall be deemed quoted net ex works (according to Incoterms 2010 of the ICC, or latest version) including standard packing. All supplementary costs such as the cost of carriage, insurance, export-, transit- and import- licences etc. shall be borne by the Purchaser. The Purchaser shall also bear the costs of all taxes, fees, duties etc. connected with the contract.

7.2 If the costs of packing, carriage, insurance, fees and other supplementary costs are included in the tender price or contract price or are referred to specifically in the tender or confirmation of order, Georg Fischer reserve the right to revise their prices accordingly should any change occur in the relevant tariffs.

8 Terms of Payment

8.1 The Purchaser shall make payment in the manner agreed by the parties without any deductions such as discounts, costs, taxes or dues.

8.2 The Purchaser may only withhold or off-set payments due against counter claims which are either expressly acknowledged by Georg Fischer or finally awarded to the Purchaser.
In particular, payment shall still be made when unessential items are still outstanding provided that the Products already delivered are not rendered unusable as a result.

9 Retention of Title

9.1 The Products shall remain the property of Georg Fischer until the Purchaser shall have settled all claims, present and future, which Georg Fischer may have against him.

9.2 Should the Purchaser resell Products to which title is reserved, in the ordinary course of business, he shall hereby be deemed to have tacitly assigned to Georg Fischer the proceeds deriving from their sale together with all collateral rights, securities and reservations of title until all claims held by Georg Fischer shall have been settled. Until revoked by Georg Fischer, this assignment shall not preclude Purchaser's right to collect the assigned receivables.

9.3 To the extent the value of the Products to which title is reserved together with collateral securities exceeds Georg Fischer's claims against the Purchaser by more than 20%, Georg Fischer shall re-assign the above proceeds to Purchaser at his request.

10 Delivery

10.1 The term of delivery shall commence as soon as the contract has been entered into, all official formalities such as import and payment permits have been obtained and all essential technical issues have been settled. The term of delivery shall be deemed duly observed when, upon its expiry, the Products are ready for despatch.

10.2 Delivery is subject to the following conditions, i.e. the term of delivery shall be reasonably extended:

a) if Georg Fischer are not supplied in time with the information necessary for the execution of the contract or if subsequent changes causing delays are made by the Purchaser.

b) if Georg Fischer are prevented from performing the contract by force majeure. Force majeure shall equally be deemed to be any unforeseeable event beyond Georg Fischer's control which renders Georg Fischer's performance commercially unpractical or impossible, such as delayed or defective supplies from sub contractors labour disputes, governmental orders or regulations, shortages in materials or energy, serious disturbances in Georg Fischer's works, such as the total or partial destruction of plant and equipment or the breakdown of essential facilities, serious disruptions in transport facilities, e.g. impassable roads.
Should the effect of force majeure exceed a period of six months, either party may cancel the contract forthwith.
Georg Fischer shall not be liable for any damage or loss of any kind whatsoever resulting therefrom, any suspension or cancellation being without prejudice to Georg Fischer's right to recover all sums due in respect of consignments delivered and costs incurred to date.

c) if the Purchaser is in delay with the fulfilment of his obligations under the contract, in particular, if he does not adhere to the agreed conditions of payment or if he has failed to timely provide the agreed securities.

10.3 If for reasons attributable to Georg Fischer the agreed term of delivery or a reasonable extension thereof is exceeded, Georg Fischer shall not be deemed in default until the Purchaser has granted to Georg Fischer in writing a reasonable extension thereof of not less than one month which equally is not met.
The Purchaser shall then be entitled to the remedies provided at law, it being however understood that, subject to limitations of Art. 16, damage claims shall be limited to max. 10% of the price of the delayed delivery.

10.4 Part shipments shall be allowed and Georg Fischer shall be entitled to invoice for such partial deliveries.

10.5 If the Purchaser fails to take delivery within a reasonable time of Products notified as ready for despatch, Georg Fischer shall be entitled to store the Products at the Purchaser's expense and risk and to invoice them as delivered. If Purchaser fails to effect payment, Georg Fischer shall be entitled to dispose of the Products.

10.6 Should Purchaser cancel an order without justification and should Georg Fischer not insist on the performance of the contract, Georg Fischer shall be entitled to a penalty amounting to 10% of the contract price, Georg Fischer's right to prove and claim higher damages remaining reserved. Purchaser shall be entitled to prove, that Georg Fischer has suffered no or a considerably lower damage than the penalty forfeited.

11 Packing

If the Products are provided with additional packing over and above the standard packing, such packing shall be charged additionally.

12 Passing of Risk

12.1 The risk in the Products shall pass to the Purchaser as soon as they have left Georg Fischer's works (EX WORKS, Incoterms 2010 ICC, or latest version), even if delivery is made carriage-paid, under similar clauses or including installation or when carriage is organized and managed by Georg Fischer.

12.2 If delivery is delayed for reasons beyond Georg Fischer's control, the risk shall pass to the Purchaser when he is notified that the Products are ready for despatch.

13 Carriage and Insurance

13.1 Unless agreed otherwise, the Purchaser shall bear the cost of carriage.

13.2 The Purchaser shall be responsible for transport insurance against damage of whatever kind. Even when such insurance is arranged by Georg Fischer it shall be deemed taken out by the order of and for the account of the Purchaser and at his risk.

13.3 Special requests regarding carriage and insurance shall be communicated to Georg Fischer in due time. Otherwise carriage shall be arranged by Georg Fischer at their discretion, but without responsibility, by the quickest and cheapest method possible.
In case of carriage-paid delivery transport arrangements shall be made by Georg Fischer. If the Purchaser specifies particular requirements, any extra costs involved shall be borne by him.

13.4 In the event of damage or loss of the Products during carriage the Purchaser shall mark the delivery documents accordingly and immediately have the damage ascertained by the carrier.
Not readily ascertainable damages sustained during carriage shall be notified to the carrier within six days after receipt of the Products.

14 Inspection, Notification of Defects and Damages

14.1 The Products will be subject to normal inspection by Georg Fischer during manufacture.
Additional tests required by the Purchaser shall be agreed upon in writing and shall be charged to the Purchaser.

14.2 It shall be a condition of Georg Fischer's obligation under the warranties stated hereinafter that Georg Fischer be notified in writing by the Purchaser of any purported defect immediately upon discovery. Notice concerning weight, numbers or apparent defects is to be given latest within 30 days from receipt of the Products, notice of other defects immediately latest within 7 working days after discovery, in any event within the agreed warranty period.

14.3 Purchaser shall not dispose of allegedly defective Products until all warranty and/or damage claims are finally settled. At its request, defective Products are to be placed at Georg Fischer's disposal.

14.4 At its request, Georg Fischer shall be given the opportunity to inspect the defect and/or damage, prior to commencement of remedial work, either itself or by third party experts.

15 Warranty

15.1 At the written request of the Purchaser, Georg Fischer undertakes to repair or replace at its discretion, as quickly as possible and free of charge, all Products supplied which demonstrably suffer from faulty design, materials or workmanship, from faulty operating or installation instructions or which become defective or unusable due to faulty advice.
In order to protect employees from toxic or radioactive substances which may have been transported through defective parts returned to Georg Fischer's sales organisation, said parts must be accompanied by a Material Safety Disclosure Form. The form may be obtained from Georg Fischer's local sales company or via www.piping.georgfischer.com.
Replaced parts shall become property of Georg Fischer, unless Georg Fischer waives such claim.

15.2 For Products which are manufactured to specifications, drawings or patterns supplied by the Purchaser, Georg Fischer's warranty shall be restricted to proper materials and workmanship.

15.3 The Purchaser shall be entitled to rescind the contract or to demand a reduction of the contract price if

- the repair or replacement of the defective Product is impossible
- the defective Product is not repaired or replaced within a reasonable period
- Georg Fischer refuses the repair or replacement or if for reasons attributable to Georg Fischer the repair or replacement is delayed.

15.4 For Products or essential components manufactured by a third party and supplied by Georg Fischer under this contract, Georg Fischer's warranty is limited to the warranty provided by said third party.

15.5 This warranty shall not apply to damage resulting from normal wear and tear, improper storage and maintenance, failure to observe the operating instructions, overstressing or overloading, unsuitable operating media, unsuitable construction work or unsuitable building ground, improper repairs or alterations by the Purchaser or third parties, the use of other than original spare parts and other reasons beyond Georg Fischer's control.

15.6 No action or claim may be brought by the Purchaser on account of any alleged breach of warranty or any other obligation of Georg Fischer after the expiration of twelve (12) months from receipt of the Products by the end user or at the latest within eighteen (18) months of the Products being despatched by Georg Fischer.

15.7 In case of Products for use in domestic installations or in utilities

- Georg Fischer will assume the costs of dismantling the defective Product and restoring the damaged object up to CHF 1'000'000 per occurrence.
- warranty or damage claims - contrary to Section 15.6 – are time-barred 5 years from the date of installation or 10 years from the production date, whichever is earlier.

16 Limitation of Liability

The rights and remedies of the customer shall be exclusively governed by these General Conditions of Supply and shall be in lieu of any remedies at law. All further claims for damages, reduction of the purchase price, termination of or rescission of the contract are excluded.
In no case whatsoever shall the customer be entitled to claim damages other than compensation for costs of remedying defects in the supplies. This in particular refers, but shall not be limited, to loss of production, loss of use, loss of orders, loss of profit, third party recovery claims and other direct or indirect or consequential damages.
This limitation of liability equally applies to the extent Georg Fischer is liable for acts or omissions of its employees or third parties engaged for the performance of its obligations. It does not apply in case unlawful intent or gross negligence on the part of Georg Fischer's management and in case of Georg Fischer's statutory liability, in particular under applicable product liability laws.

17 Severability

Should any term or clause of these General Conditions in whole or in part be found to be unenforceable or void, all other provisions shall remain in full force and effect and the unenforceable or void provision shall be replaced by a valid provision, which comes closest to the original intention of the unenforceable or invalid provision.

18 Place of Performance and Jurisdiction

18.1 Place of performance for the Products shall be the Georg Fischer works from which the Products are despatched.

18.2 The contract shall be governed by Swiss law without regard to conflict of law provisions that would require the application of another law.

18.3 Any civil action based upon any alleged breach of this contract shall be filed and prosecuted exclusively in the courts of Schaffhausen, Switzerland.
Georg Fischer however reserves the right to file actions in any court having jurisdiction over controversies arising out of or in connection with the present contract.

01/2011

GF Piping Systems – worldwide at home

Our sales companies and representatives
ensure local customer support in over 100 countries.

www.piping.georgfischer.com

The technical data is not binding. They neither constitute expressly warranted characteristics nor guaranteed properties nor a guaranteed durability. They are subject to modification. Our General Terms of Sale apply.

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