Building Technology

Plan, Build, Operate

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If you have any questions or suggestions regarding this manual, please write to:

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+GF+
Schaffhausen, 2021

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Preamble

Content

Preamble

GF Piping Systems is the worldwide expert in plastic piping systems for the safe transport of water, chemicals and gases. They have been proven in buildings in more than 100 countries because they are corrosion-resistant, very light, easy and quick to install. They are also the path to drinking water that is hygienically safe: An installation that is consistently designed to reduce bacterial growth, monitor water quality and temperature, provide thermal or chemical disinfection, assess risks, and optimises efficiencies.

This planning manual provides an overview of the solutions of GF Piping Systems: A comprehensive portfolio of more than 60,000 products – integrated systems of pipes, fittings, valves, measurement and control engineering, and connecting technologies and services. The book will assist in the planning and selection of materials, products and connectivity solutions in the field of building technology and provide information for the installation. Most importantly, the book will help to deliver the best service to the customers.

GF Piping Systems has been the preferred partner to the building industry, operators, planners and installers for more than 60 years. You benefit from this experience and our competence also in newer areas, for example in automation and digitisation. A particular focus for us is to advise our clients during the transition from traditional metal to modern plastic systems with all their benefits. At GF Piping Systems you will find partners with expertise in all phases of your project. Contact us at your convenience. The service life of our plastic piping systems is at least as long as the service life of the building (minimum of 50 years). Professional planning, the right selection and proper installation ensure that the piping systems are reliable, highly efficient and made-to-last.

When working with GF Piping Systems solutions you may rest assured that newly constructed or refurbished buildings are supplied with clean drinking water, cold and hot, and gas. Many other applications of our products can be found in the overview of the market segments.

We hope that this planning manual is the comprehensive support you need for your daily work. Do not hesitate to contact us if you need special advice, calculations or other help to assist you during your project. Thank you for being a partner of GF Piping Systems.

Schaffhausen, March 2019

About this manual

1 How to use this manual

The current demands on the building technology, which are increasing as a result of the fundamental change in the cooperation of all those involved and the influence of new methods and technologies, affect everyone – builders, planners, contractors and also the manufacturers and suppliers of construction products. Speed is the engine that drives change.

In this manual, GF Piping Systems provides an essential, in-depth and a diversified look at the required work equipment, as well as the range of piping system services and solutions that will help to safely and reliably convey fluids and gases.

1.1 Contents of the manual

The manual describes and explains the essential basics for planning and product selection, processing and operation of piping systems in building technology. It is suitable as a reference work as well as a document for training and further education or to support during a consultation meeting.
When selecting and assessing a specific subject-matter, we focus on explaining the planning and installation relevant areas.
All information is based on the applicable international ISO and EN standards, on various national standards, directives and additional data from raw material manufacturers. In addition, results from extensive, internal studies have been incorporated. This should help the sales consultant, the system designer, the engineer and the installer to better understand the complex systems incorporated in building technology and to plan and design the system correctly.
Detailed instructions for the systems and products can be found in the applicable installation and operating instructions, which are referred to individually.

Additional information
Additional information can be found at www.gfps.com
Or contact your national representative.

1.2 How this manual is structured

The manual is structured comprising several **parts**. The colour of the register makes it easy to quickly recognise each **part** and access this segment directly.

- The division into the three parts Plan, Build and Operate follows the insight that a project in the field of building technology begins with the first step – the brainstorming and concept formation – even before the actual building trades are being considered. Subsequently, the planning and realisation based on the aforementioned is continued and, after the handover and putting into operation, this also includes the activities during ongoing operation.
- The **parts** Basics, Plan and Build comprise several **sections**. These contain information on the basic subject matters concerning application design, products and systems.

Parts I to III cover basic and central topics at a glance.

- The Introduction gives an overview of Georg Fischer AG, its divisions and market segments.
- In **part** Plan – Build – Operate, the planning phases of a project (also in the context of BIM) and the services of GF are presented as well as basic detailed information on the hygiene concept.
- In **part** Basics, a representative cross-section of the media and materials are illustrated.

The following **parts IV to VI** are focusing on the essential project phases.

- The part Plan describes the basic procedures for planning the applications.
- In part Build, a detailed description follows. Here, all necessary technical information about the products is identified. The **part** Build also contains **sections** providing information on safety at the construction site, installing pipes in the floor (with pipe transfer bends and shuttering boxes), installation of junction box and sockets, and putting into operation (with pressure tests and flushing).
- The part Operate provides an overview of basic maintenance and upkeep activities.

The last part, the Annex contains general **directories**, an **index**, a scientific **formula collection** and the current **approvals** at the time of this manual's publication.

Register	Parts	Sections
I	Introduction	
II	Plan Build Operate	
III	The basics	Topics
		…
		…
IV	Plan	Applications
		…
		…
V	Build	Products and systems
		…
		Safety at work
		Installation
		Putting into operation
VI	Operate	
A	Annex	Annex A
		Annex B
		…

1.3 Signs and symbols

In this book, distinctive fonts, headlines and titles are used to highlight certain information.

TI.1
Typographical design elements

Element	Designation	Explanation
☑	Prerequisite, check point	Condition that must be met before an action, e.g. a planning action, assembly or installation, can be performed.
→ 1. 2.	Action, single Action, multiple	Work step, e.g. during the assembly of a component. Several work steps in a row result in an action sequence that is completed with a result. Several work steps can also be numbered in ascending order.
↳	Resultat	Result of a work step or action sequence
➨	Reference	Reference to another book chapter, table or graphic in this manual
❶, ❷ ... ①, ② ... Ⓐ, Ⓑ ... Ⓘ, Ⓘⅰ ...	Numbering	Numbering of work steps, position numbers in graphics and legends
TI.1	Title of a table	Tables are numbered this way throughout the manual.
GI.1	Title of a figure	Pictures, graphics and photos are numbered in this way throughout the manual. The Roman numeral refers to the book part, the Arabic numerals form the consecutive numbering in the book part

This manual uses symbols and characters to highlight specific information. The symbols and texts are in shown in boxes highlighted in certain colours.

TI.2
Symbols

Symbol	Designation	Explanation
i	Information	This symbol highlights information of particular importance.
➨	This symbol refers to chapters in the manual or to external sources	This symbol marks references to other book chapters or sources that contain more information
§	Reference to a standard, law or regulation	This symbol is used to identify a text excerpt from a standard, a statute or similar regulations. It refers to detailed information about a statement in standards and sections of laws, or legal notices.
✚	GF recommendation	This symbol is used when GF provides a general recommendation. The implementation of such general GF recommendations requires the involvement of a person skilled in the individual case.
√	Calculation	Calculations (and examples) are marked with this symbol.
⚠	Warning sign (Personal injury)	This warning symbol is used to warn of a hazard that may result in personal injury, e.g. caused by improper use of a tool or incorrect working method during assembly.
!	Warning sign (Damage to property)	This warning symbol is used to warn of a hazard that can damage tools, products or objects, e.g. caused by improper use of a tool or incorrect working method during assembly.

Introduction

I

Introduction

1 Georg Fischer Corporation

Georg Fischer AG comprises three divisions GF Piping Systems, GF Casting Solutions and GF Machining Solutions. Founded in 1802, the Corporation is headquartered in Schaffhausen (Switzerland) and is present in 34 countries, with 136 companies, 57 of which are production facilities.

Its approximately 15,835 employees generated sales of CHF 4,150 million in 2017. GF is the preferred partner for the safe transport of water, chemicals and gases, for lightweight casting components in vehicles and high-precision manufacturing technology.

GF Piping Systems

GF Piping Systems is the world's leading supplier of plastic piping systems. The division specialises in system solutions for the safe transport of water, chemicals and gas. The product portfolio includes high-quality pipes, fittings, valves, devices for the measurement and control technology, jointing technologies and services for all phases of a project.

GF Casting Solutions

GF Casting Solutions is a technologically pioneering development partner and manufacturer of casting solutions and systems made of aluminium, magnesium, and iron for the automotive industry as well as for the global industrial and consumer goods market. The highly complex light-weight casting components contribute significantly to making modern automobiles lighter and reducing CO_2emissions.

GF Machining Solutions

GF Machining Solutions is a manufacturer of precision components and the world's leading tool and mold maker with electric discharge machines, high speed milling machines and laser texturing machines. Key customer segments include information and communications technology, aerospace and the automotive industry.

2 GF Piping Systems

We support you in all phases of your project

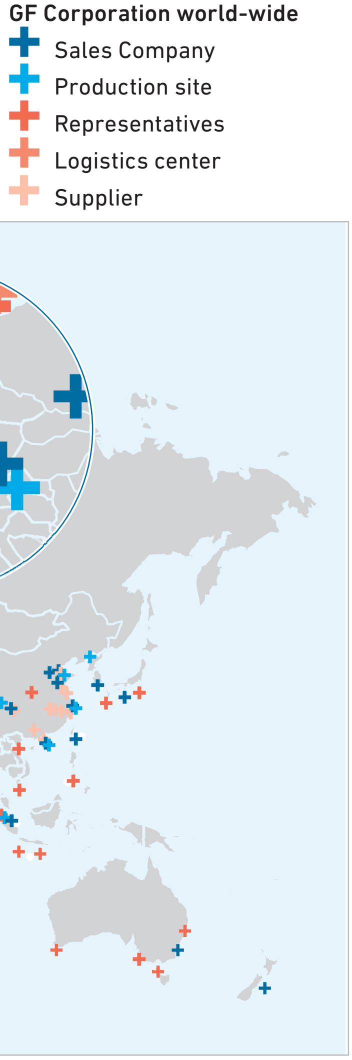
At the heart of all GF Piping Systems solutions is a comprehensive local presence that allows us to assist you directly in all phases of the project – from planning and costing to installation and quality control on site. GF Piping Systems has its own sales and representative offices in 34 countries and produces it products in 32 locations in Europe, Asia and America. Thus, your requirements can be implemented reliably and quickly wherever you are. A state-of-the-art logistics concept with on-site distribution centers ensures that you get the products you need quickly at all times so you can work with them immediately when needed.

Total solutions for increased safety and efficiency

Piping systems are more than the sum of the high-quality components that already make them. Pipes, fittings, valves, devices for the measurement and control technology, jointing technologies and services work hand-in-hand to accomplish even the most demanding applications. A typical example from the building systems engineering discipline is “GF Hycleen Solution”, the holistic approach to systematically eliminate all risks of bacterial contamination from the drinking water system.

GF Piping Systems' services and more than 60,000 products help you improve the quality and efficiency of each building, minimise health and legal risks, increase profitability and create long-term value.

GI.1
GF Corporation world-wide



2.1 Services

2.1.1 Consultancy, Planning, Construction and Operation – Worldwide expertise on site

As a leading supplier of piping systems, we offer our customers not only reliable products but also a comprehensive service package.

When it comes to the design and planning, implementation and operation, GFPS supports builders, architects, planners and installers with the necessary specialist knowledge in all phases. Detailed information on planning processes and operating phases, products, systems and materials is available as hard copy and in digital form as well as online in form of calculation tools and apps. Product knowledge is provided by GFPS in the form of digital data (libraries) and applications (apps and tools) supporting existing processes and applications. Thus, the knowledge of the implementing company and the manufacturing industry can be applied early in the planning and construction process.

Our support ranges from providing technical manuals and a comprehensive CAD library to an international team of experts, who are working closely with local sales companies. During implementation, our customers benefit from comprehensive training courses directly on-site or in one of our modern training centers worldwide.

2.1.2 Technical Support

Providing technical advice and selection of the right material is a key factor for our success. A team of experts is based in Switzerland and supports the local sales companies of GF Piping Systems worldwide. The specialists in the respective sales companies are personally available to our customers and assist with technical support or general information.

2.1.3 Questions about chemical resistance

Our expert teams have decades of experience in the field of chemical resistance. They offer individual support and advice on the selection of a specific system solution made of synthetic materials. Upon request, a team will advise you and select the right material for specific applications.

2.1.4 Technical manuals

We have documented the extensive know-how of GF Piping Systems in the planning and installation of plastic piping systems for our customers in technical manuals. These detailed documentations are available both as hard copy and in digital form. This reference book supports users in the planning of large and small projects.

Planning manuals, product and application notes and catalogs by GFPS provide detailed information on materials, dimensions, application techniques, approvals and standards, and convey further, valuable know-how.

Among other things, GFPS provides the following information as planning fundamentals for your project:

- Product catalogs and delivery programs
- Operating and assembly instructions
- Information on dimensioning and ejection times
- Pressure test and flushing protocols
- Bulletins on disinfection

2.1.5 Library and records

Data records according to VDI 3805

To support the project planning up to the implementation, data sets according to VDI 3805/ISO 16757 are available for the creation of the drinking water installation.

- In addition, all CAD data are available as an outline (2D and 3D) with different direct insertion drivers for downloading from www.gfps.com.
- BIM solutions are possible with Autodesk Revit.

Import from VDI 3805 standard data
The data import depends on the respective software. Data import information is available from the software manufacturer.

CAD library

As a result of digitisation, the construction products are also becoming increasingly digitalized: In this case, they are available as standardised product data. In geometric and technical planning, from calculation and design, tendering to logistics, on the construction site, in documentation and optimization in operation, these data influence our decisions.

The comprehensive CAD library is the most widely used planning tool provided by GF Piping Systems. The database contains more than 30,000 drawings and engineering details on pipes, fittings, measuring and control technology as well as details on manually operated and driven valves. The big advantage of the CAD library is that the data can be integrated directly into CAD models.

The CAD library offers:

- Data packets with all engineering drawings of a system
- Presentation in 3D and in 2D
- Direct insertion driver for the most popular CAD systems
- Optimised operator environment and fast access

The presentation of the buffer zones, which are used to control collisions, simplifies planning and prevents errors. The indication of the flow direction on the valves prevents the products from being planned incorrectly. With the Autodesk CAD plug-in, this data can be easily and quickly loaded directly into the local CAD program.

2.1.6 Onlinecalculation tools and mobile applications

This is where our diverse, multilingual online tools come in. They facilitate configuration and calculation. When using pressure-temperature diagrams, the pressure of liquid media recommended for pipes and fittings can be easily calculated for different temperatures.

Our mobile application **FlowCalc App** is an instrument for the on-site measurement of pipe diameters and flow velocities in order to determine the correct diameter of the piping system.

2.1.7 Customizing

The customizing teams at GF Piping Systems work closely together around the globe. The focus of our teams is the production of customised special parts for the completion of systems. In addition, various special solutions can be produced in small batches. Standardised processes guarantee the highest quality for our customers, even for individual solutions.

2.1.8 Training, seminars, instructions on-site

Courses providing instructions and education have a long tradition at GF Piping Systems. As a pioneer in the field of metal and plastic piping systems, GFPS offers its knowledge in these training courses.

The experts in building service technology, mechanics, processors, planners, system engineers, end users, technical instructors and sales agents need the latest knowledge, which is conveyed in the training courses and seminars of GF. Quality and reliability are top priority.

As a leading manufacturer of components and systems for building service technology, we offer appropriate training in application and processing technology.

With a diverse range of training options, GF Piping Systems offers its customers the opportunity to gain confidence in their products and proven jointing technologies. The hands-on training is clearly defined, structured and tailored to the different work experiences of the participants.

Our experts are also available to our customers locally and carry out on-site training in the various welding and jointing techniques. The duration and structure of the training courses depends on the project and the system to be installed.

Training and seminars

Our training courses and seminars in the Swiss training centers in **Sissach** and **Schaffhausen** are clearly structured and application-oriented in scope, methodology and content. Focused on the individual priorities of our customers, the different levels of knowledge and practical experience, these training courses offer the highest level of quality.

The seminars on building service technology can be adapted to the country-specific requirements and needs. The orientation sessions, training courses and educational classes are offered **internationally** and are carried out by local expert teams and coordinated by the respective sales companies.

Training and seminars

Detailed information on training and seminars can be found on the GF website; go to “Support & Services/Training & Seminars”.

There, a current **training program** is always available for download.

Topics

In addition to the presentation of the installation systems and the scope of the product, various topics are covered: Application and processing technology, material science, pipe network dimensioning and digitally supported planning.

In addition to the piping systems and fittings, the topics of drinking water hygiene and malleable iron fittings are also the focus point.

Practice rooms

There is no substitute for experience in application and it is the most decisive for the success of an installation. What is worth knowing in terms of the handling of the GF products and how the installation systems are used correctly and safely is also taught in the practice rooms. GF offers a modern and application-oriented training environment that considers all specific training requirements regarding the content and the structure of the training. Accompanied and supported by experts, the necessary experience and safety in dealing with our products is provided and the specific application are being taught.

Training Centre Sissach (Switzerland)

The training courses are held at the Centre of Excellence for Building Technology in Sissach, Switzerland.

Training Centre

Detailed information about the training courses and seminars can be found on the website of the Training Centre: ➨ http://www.gfps.com/jrg

Training Centre Schaffhausen (Switzerland)

Training Centre

Detailed information about the training courses and seminars can be found on the website of the Training Centre: ➨ http://www.gfps.com/

Learning on location (On-Site Training)

GF's experts are available to customers and conduct product training and instructions in the various fusion and jointing technologies on-site. The training duration and program depends on the actual project and the system to be installed.

Training Centre

Information about other Training Centres can be found on the GFPS website, go to: “Support & Services”/”Training & Seminars”.

2.1.9 Videos and Animations

In addition to conventional print media, GF also provides videos in which in-depth information on products and installation methods, and much more is illustrated.

Videos and Animations

GF presents on its YouTube channel a series of videos and animations on products and techniques in the field of building service technology.

➨ http://www.youtube.com/user/GFPScom

2.2 Quality

Quality assurance at all levels

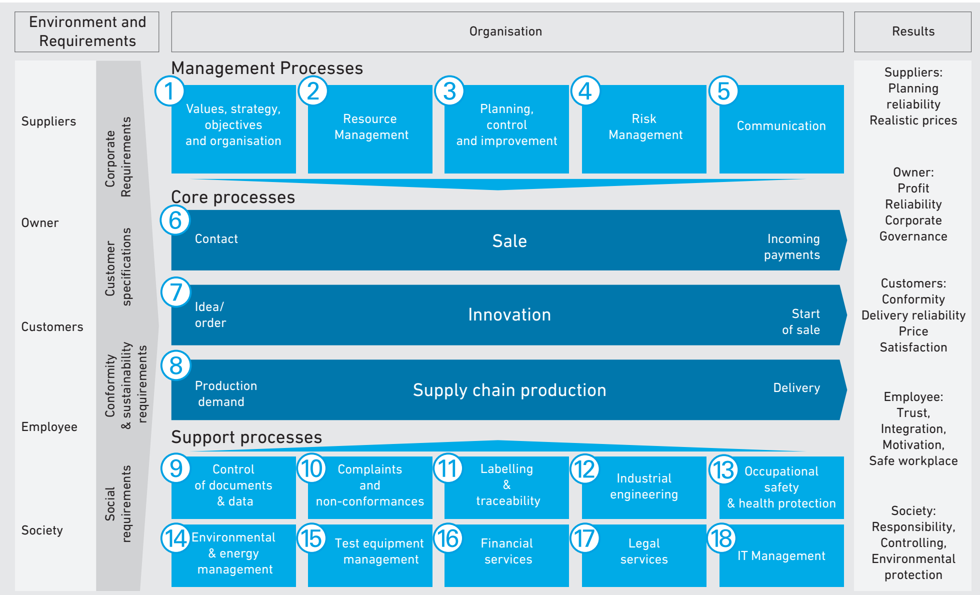
Quality creates safety and is the basis for trust. In customer relationships as well as in project work, development, production and in the specific application of products, quality awareness and standards decide on sustained success. The fundamental importance of quality determines our actions, shapes our understanding of quality, and is reflected in our own claim to quality.

The systematic integration of partners and suppliers is part of our comprehensive understanding of quality and guarantees the binding assurance of the quality standard along the entire value added chain.

GF Piping Systems is committed to the high quality standards of its customers and is actively responsible for meeting the customer requirements as well as ensuring legal standards. The rigorous implementation of our quality policy represents an obligation for every single employee. For example, a strong focus on quality when providing services is a matter of course for each and every employee working in our company.

Management Systems

Quality, environment, occupational safety and health protection have always played a very important role in the Georg Fischer Corporation. Accordingly, all production companies and many sales companies of GF Piping Systems are certified in accordance with the Quality Management System ISO 9001. Furthermore, all our production sites are certified accordance with ISO 14001, the worldwide standard for environmental management.



GI.2
Process landscape GPMS 2

Certificate

As part of our sustainability activities, all production sites have also been certified in accordance with OHSAS 18001 (or in future ISO 45001), the international standard in the area of occupational safety and health. Newly acquired or newly founded production companies are bound to establish a quality, environmental and occupational safety management regime within a period of three years.

Accredited test center

GF Piping Systems operates various test centers around the world. For example, the test laboratory of GF Piping Systems in Schaffhausen (Switzerland) is a test centre for components of piping systems and is accredited according to ISO/IEC 17025. Here, a wide variety of pipes, pipe connections, connecting elements, fittings, manual and actuated valves as well as flow meters is tested in accordance with relevant standards and the company's own external and in-house specifications. Customers for the test laboratory are the R&D departments, production plants, as well as customers who use piping parts from GF Piping Systems, and other external customers.

The following tests are conducted in the center:

- Development and product release tests are completed for R&D departments, (ITT = Initial Type Test)
- Inspection of the fabrication
- For our own plants we conduct batch release tests (BRT)
- Process verification tests (PVT)
- As well as other tests for external customers

The continuous training and specific expertise of our employees, the technical state of our test facilities and properly documented test procedures are the basic prerequisites for accrediting a test laboratory according to ISO/IEC 17025.

If the accreditation is approved, this will be confirmed by the SAS (Swiss Accreditation Service) with a certificate. Every year a review is conducted and every 5 years a renewal of the accreditation takes place.

Our accredited SAS is a member of the ILAC (International Laboratory Accreditation Cooperation). All laboratories accredited by the ILAC are obliged to formally recognize any test report issued by a fellow member. This, in turn, allows us and our customers to use the test reports originating from accredited analyzes from our test laboratory for product approvals, quality assessments, etc., for which specific test reports still need to be submitted. This reduces the time and expenditures considerably.

The accredited tests include:

- Resistance to internal pressure test (ISO 1167, ISO 9393)
- Burst test, mouldings and pipes
- Crushing test (ISO 9853)
- Ball drop test (ISO 13957, EN 1716)
- Decohesion test (ISO 13956)
- Determination of the tensile strength and failure mode of test pieces from butt fusion joints (ISO 13953)
- Pressure loss test (EN 12117)
- Determination of density (EN ISO 1183)
- Melt Flow Rate MFR (EN ISO 1133)
- Determination of oxidation induction time OIT (EN 728)

The full scope of the accredited tests is listed in the area of application. This area of application is always updated and can be retrieved from the SAS website. To do this, go to “Accredited Bodies” and enter the keyword **STS 094** in the search area.

Approvals

Information on the approvals of systems and products: ➨ Annex A “Approvals”

2.3 Sustainability and social responsibility

As an internationally active industrial concern, GF finds itself as the focal point of public attention. GF is a group of companies that not only pursues economic goals, but also progresses in the area of sustainability. Sustainability is one of the pillars of GF's business model. In order to do this, it is important to reconcile economical, ecological and social issues. Pursuant to this responsibility, our industrial and social activities are long-term and sustainable.

The company's products help to secure water supplies, reduce emissions and improve energy efficiency. The ultimate responsibility for sustainable action lies with the Executive Committee – ensuring a strong and clear commitment of the company.

It is our endeavour to make sustainability the keystone in all our production and sales companies. We act on the basis of our sustainability goals and the achievement which we communicate regularly and in a transparent way.

Sustainability objectives

The basis for achieving these objectives is the consistent compliance with our high company standards. This is also reflected in the cross-national establishment of certified management systems, which ensures a continuous review of processes, services and results.

Sustainability at GF Piping Systems

Water means life and is at the heart of any sustainable development. The distribution of clean drinking water places high demands on mankind. In 2015, 663 million people – that is to say, one in nine people – had no access to reliable drinking water sources. GF Piping Systems works on resource-efficient solutions for water supply, treatment and distribution, and helps ensure that water, the most valuable resource, is used efficiently. At the same time, the use of the corresponding products saves energy. Appropriate design, suitable material composition, correct dimensioning and needs-based control of the individual system components reduce the energy consumption. This, in turn, means lower costs for the customer.

However, not only the perfect water supply and the cleanliness of the drinking water is a huge challenge worldwide. The demands on hygiene are becoming increasingly higher. By applying state-of-the-art, environmentally friendly disinfection technologies, GF Piping Systems provides a supply of perfect water to large public buildings such as hospitals, schools or sports facilities. Gentle water treatment and safe distribution without leaks and contamination will continue to be the focus in the future. Extensive LCAs (Life Cycle Assessments) have shown that, for example, plastic pipe systems for water treatment and distribution represent a significantly lower environmental impact than conventional materials. The fact that users have access to important information and tools for using these systems strengthens the meaningful use of resource-saving technologies.

Environment

GF Piping Systems considers its own environmental responsibility as an integral aspect of all business activities. Because we understand environmental awareness as one of the most important values of our company, all internal structures and processes are oriented towards sustainability. We strive to conserve natural resources and are constantly working to optimise the environmental friendliness of our products and their application. Superior material properties and innovative technologies form the basis for our environmentally friendly and energy-saving solutions. By providing our customers with complete piping systems, we support and promote ecological and cost-efficient operations in many industries and in everyday life. In order to obtain detailed information about the environmental impact of our products, we closely monitor all phases of the product life cycle – ultimately improving the eco-balance of our products.

Social responsibility

Last but not least, attractive jobs, interesting tasks, targeted education and training, a fair salary and good social benefits contribute to securing the future. GF Piping Systems operates based on this responsibility. With facilities in over 30 countries, GF Piping Systems views the diversity of cultures, religions, nationalities, genders and ages as a valuable source of talent, creativity and experience. This makes the extraordinary performance of around 6,500 employees (end of 2016) possible, which GF Piping Systems employs worldwide.

Continuing education

As an expert system and solution provider, GF Piping Systems offers courses and training with a focus on conveying product knowledge and application know-how, correct sales arguments and different customer needs.

The jointing technology as well as the science of measuring and control engineering is becoming ever more innovative. To stay up to date, there is only one thing one can do: Continuing education. Here, GF Piping Systems makes a significant contribution. Whether professionals in distribution, building technology or industry – all benefit from the courses and training, which are geared to the individual market segments and applications.

Whether you are a sales person, an installers, a planners or an equipment manufacturers, we have a tailor-made program for you. In addition to theory, we attach great importance to the hands-on experience. Our practice rooms are furnished with state-of-the-art equipment. Here, we can teach up to 100 participants at the same time and under optimal conditions, providing hands-on training. When selecting the trainers, we work closely with our sales representatives. We offer basic, advanced and master courses, all content matched.

2.4 Product life cycle and eco-balance

Our vision is to be a leading supplier of environmentally friendly piping systems for industry, distribution and building technology with a focus on the application of the circulation of water. In light of this vision and with the claim to learn more about the potential environmental impacts of our products and systems compared to competing materials, the eco-balance project was launched.

Eco-balance or Life Cycle Assessment is a technique to assess environmental impacts associated with all the stages of a product, material, process or even system.
This technique is the most widely recognised method for quantifying environmental impacts. At GF Piping Systems, this means examining the process and design of piping systems, starting with the analysis of logistics and installation, to putting equipment into operation, and finally to maintenance and repair services.

Principles of our environmentally oriented product development

Function and benefits	
	Functionality Implementation of efficient functions, causing the lowest possible environmental impact.
	More efficiency Minimising the consumption of energy and materials.
	Optimisation of the service life Development of durable and reliable products.
	Interaction with conveying media Consideration of product purity, hygiene, vibration and noise.
	Safety Consideration of safety aspects during the entire service life cycle.
Material type, quantity and structure	
	Selection of the proper material Customer consultation, especially when choosing materials with low energy content and good climate balance.
	Avoiding dangerous substances Developing solutions without the use of hazardous substances.
	Promoting recycling Use of recyclable materials without additives affecting the recycling process.
	Reduction of weight and size Optimisation of the amount of material used and minimisation of the product size.
Production, packaging and delivery	
	Promoting (energy-) efficient production Design optimisation, reduction of emissions and decreasing the consumption of energy and resources.
	Packaging and delivery Reduction of energy and the decreasing the consumption of resources during transport.
Information	
	Customer information Providing all information necessary for the environmentally friendly and safe operation and data relevant for the recycling process.

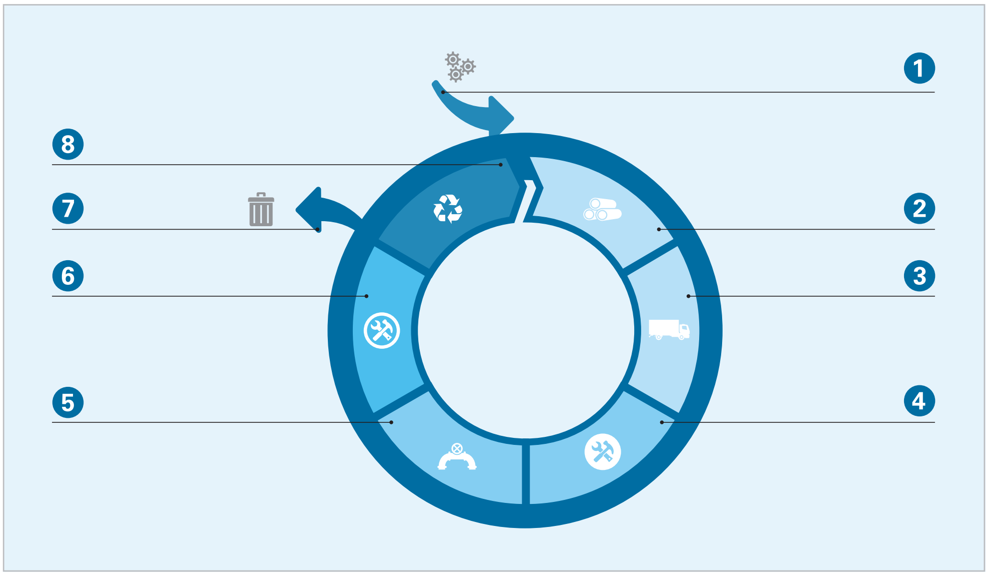
The text that follows describes in more detail the minimisation of the environmental influences during the individual phases of the service life cycle.

2.4.1 Product life cycle

Production of the raw material

GF Piping Systems obtains its raw materials from reputable suppliers. The GF Supplier Code establishes the requirements for sustainable business practice for all suppliers of goods and services. The Code covers key issues such as corporate ethics, respect for human rights, socially acceptable working conditions, compliance with environmental standards and the application of management systems.

An intensive and regular exchange ensures that the defined specifications and thus the required quality demands are met. In addition to technical aspects, the specifications also define the environmental requirements for the material, for example, compliance with the REACH Regulation.



GI.3
Product life cycle

1. Production of the raw material
2. Manufacturing
3. Transport
4. Assembly/Installation
5. Operation/maintenance
6. Disassembly
7. End of the service life cycle
8. Recycling

Manufacturing

During the production phase, energy consumption at GF Piping Systems is considered the highest environmental priority. Optimising the energy-intensive production phase will improve energy efficiency and reduce carbon dioxide emissions. This is achieved through the use of energy efficient machinery and the continuous modernisation of the production infrastructure.

Transport

Georg Fischer optimises logistics structures and thus reduces the number of transports. For this purpose, regional delivery structures were set up and local inventory adjusted to meet customer requirements in the respective territory. The optimal utilisation of loading capacities reduces empty runs or trips without the utilisation of a full capacity to a minimum.

Installation – operation and maintenance

During the installation phase, the concepts of GF Piping Systems are convincing, even with a minimum number of parts. This leads to savings in material usage and costs. The length of service of all components of a system results in the low consumption of resources and is of great benefits for the customer.

The **ecodesign** approach turns the products into real energy and material savers during the usage phase. For example, thanks to the optimised geometry of the flow body compared to the market standard, the new generation of diaphragm valves offers twice the flow rate with the same energy consumption. The linear flow characteristics of the new diaphragm valve also enable consistently stable processes with maximum energy efficiency.

In the drinking water installation system Sanipex MT, all materials are hygienically safe and offer maximum safety. Corrosion resistance and dead space clearance prevent health and environmental risks. Full flow capacity without cross-sectional constriction is another feature of Ecodesign.

End of the service life cycle

Not letting waste arise in the first or to return the waste to the material cycle effectively conserves valuable resources and is therefore a central component of GF's environmental management. At the same time, the costs of disposal are reduced and fewer raw materials need to be purchased. We also focus on reducing the amount of waste in production. The economical use of raw materials plays just as big a role as the consistent recycling of industrial waste.

In order to minimise the environmental impact of the disposal phase, GF Piping Systems takes into account the end of service life cycle when developing a new product or complete system, and determines, among other things, possibilities for recycling and appropriate disposal.

As a long-standing member of TEPPFA, The European Plastic Pipes and Fittings Association for manufacturers and other national plastics associations, GF Piping Systems is active in industry initiatives to promote recycling, such as VinylPlus, the voluntary commitment to sustainable development along the PVC value chain.

2.4.2 Eco-balance of raw materials by GF Piping Systems

Environmental Product Declaration

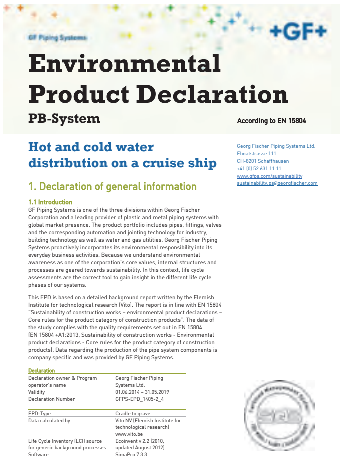
Climate change and the distribution of clean drinking water place the highest demands on society. We ensure that the materials used in our products, systems, and applications are ecologically sound; thereby making a sustainable contribution to the environment.

An "Environmental Product Declaration" (EPD) in accordance with EN 15804 exists for each of our systems. This declaration is based on the "Life Cycle Assessment" (LCA) according to ISO 14040 and ISO 14044. All documents are available for download from our Website.

On this Website, results of the entire life cycle of a system are summarised and also subjected to an external appraisal.

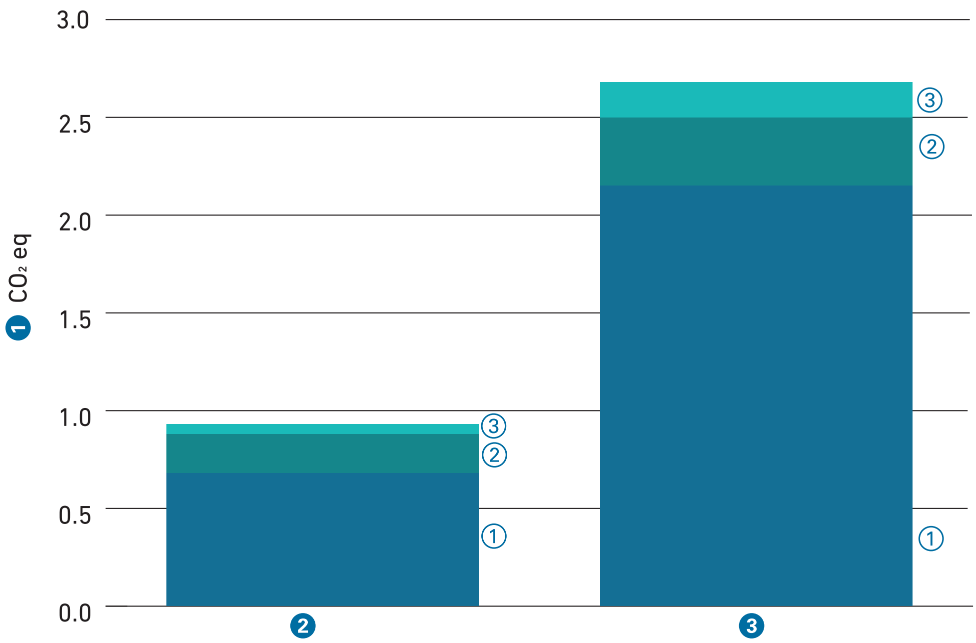
An Environmental Product Declarations (EPD) is a standardized form for communicating Life Cycle Assessment results. Anyone who is interested can assess the environmental impact of products.

The ISO Type III Declaration addresses many people with these quantitative statements about the environmental performance of construction products: Planners, architects, construction companies, real estate companies, facility managers and, of course, companies involved in manufacturing and services along the value chain from raw materials to the building.


+GF+
Environmental Product Declaration
PB-System
According to EN 15804
Hot and cold water distribution on a cruise ship
1. Declaration of general information

More information on sustainability and life cycle assessment

➨ www.gfps.com/com/en/about-GF-PipingSystems/sustainability/material.html



GI.4
Eco-balance of pipes

1 Contribution
2 PEX-pipe
3 Copper pipes

① Manufacturing
② Consumption
③ End of service life

3 steps to download

→ Go to the product catalogue on our Website:

- www.gfps.com

→ Choose your building technology system.

→ Open the “Documents” tab and download the applicable EPD or LCA.

More information

- www.gfps.com/nachhaltigkeit

Effective systems

Environmentally friendly systems that conserve resources at low cost, benefit the customer, the supplier, and the environment. All the more so if the systems are designed to perform for as long a period as possible.

Green Building Labels

JRG Sanipex MT

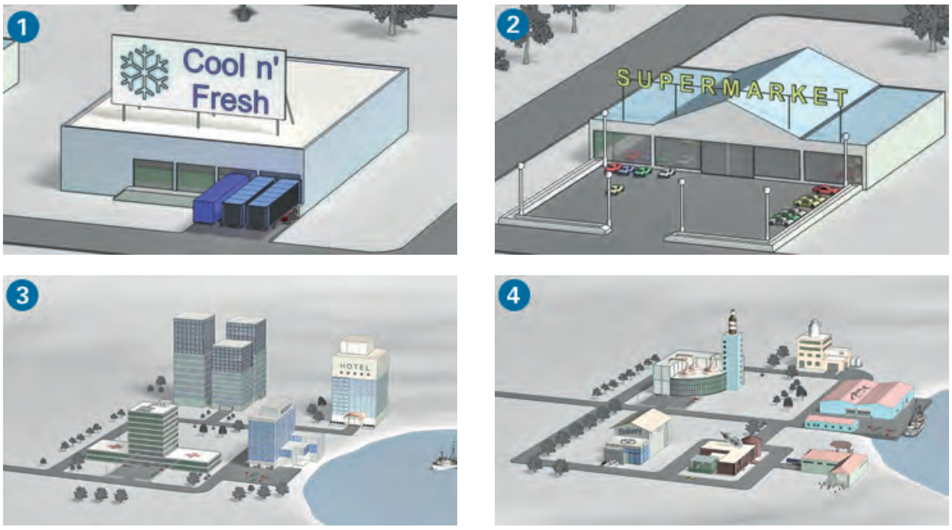
- www.tool.greenbuildingproducts.eu

2.5 Market segments

2.5.1 Cooling

GF Piping Systems provides application- and customer-oriented plastic piping systems for the transport of refrigerants in cooling systems (below 0°C/32°F) and cold water in air conditioning systems, air conditioning equipment and cooling water systems for general industrial use.

GF Piping Systems develops corrosion-resistant plastic piping systems to meet the requirements and expectations of the fast-growing refrigeration industry. These systems provide an easy and cost-effective installation; they are maintenance-free for at least 25 years, are made of CFC-free materials, and have low carbon emissions over their entire service life.



GI.5
Cooling
1. Commercial refrigeration
2. Air conditioning in commercial and residential buildings
3. Food production
4. Refrigerated warehouse

Cooling media 0°C / 32°F

Commercial refrigeration

In supermarkets and grocery stores, medium temperatures are required for fresh foods such as meat, fish and dairy products, as well as low temperatures for frozen foods. Secondary refrigeration systems using glycol and salt solutions require smooth, corrosion-resistant and drip-proof piping systems to ensure efficient transport of the cooling media and low carbon emissions.

Refrigerated warehouse

For the storage of fruit or vegetables after harvest or of dairy products, meat and fish, these large-scale refrigerated warehouses require efficient, durable and maintenance-free cooling systems. Hydraulic control circuits made of pre-insulated plastic piping systems provide precise temperature and humidity control with full corrosion resistance over a 25-year service life.

Industry refrigeration

Temperature controlled environments are essential for breweries, wineries, bakeries and where pre-cooked foods are prepared. The safety of the personnel, the strict hygiene requirements and the energy efficiency are the main factors when choosing a refrigeration system. Low-pressure circulation systems with glycol or saline solution and pre-insulated plastic pipes are straightforward and cost-effective.

Cooling media above 0°C / 32°F

Air conditioning

As soon as the cooling capacity of the system exceeds about 1,000 kW, centralized cold water circulation systems are the right choice, as they are efficient and flexible. For cold water between 5°C and 12°C and at low pressures between 3 bar and 4 bar, plastic systems are the ideal solution for vertical lines as well as for all distribution lines in a building.

Data centers

All industries – from banks to universities and insurance companies to communications providers – must provide storage for critical customer information. One effective way to dissipate heat is provided by a water circuit consisting of a corrosion-resistant, calcification-free, pressure-bearing plastic piping system.

Life Science

In the production and storage of pharmaceuticals as well as in medical research, the temperature in the workrooms must be controlled and precisely maintained. In terms of efficiency, hygiene and corrosion resistance, plastic piping systems achieve the best results over the entire service life.

Industry process refrigeration

Many industrial processes, such as casting or machining, produce excess temperatures that have to be dissipated with the help of circulating water. Corrosion-resistant, lightweight and cost-effective plastic piping systems meet these production line requirements.

2.5.2 Chemical process industry

The chemical process industry covers all industrial activities from the extraction of raw materials to the conversion of raw materials into the corresponding basic and special chemicals. Each chemical has its own value chain, with meticulous material and component selection being a prerequisite for materials requirements planner, designers and installers. The demanding environmental conditions in most industrial plants, the pursuit of efficiency and the guidelines for the responsible use of chemicals, place high demands on piping systems in terms of occupational safety, compliance with environmental standards, reliability and maintenance.

GI.6
Chemical process industry

1. Chemical extraction from natural resources
2. Chemical production/ commerce
3. Chemicals in commerce

Chemical extraction from natural resources

Mining and mineral processing

The mining and mineral processing industry is one of the largest consumers of water and chemicals in harsh environments with challenging installation, reliability and corrosion resistance requirements. The products of GF Piping Systems are used in the distribution units of the mines as well as in various process steps from iron ore smelting to hydrometallurgy.

Oil and gas industry

The design of the water circuits in the oil and gas industry is complex and demanding. In order to increase process performance and increase the efficiency of water treatment, many chemical additives are used. New developments in offshore systems and hydraulic fracturing technologies are increasingly relying on the plastic piping systems of GF Piping Systems due to the low weight of the pipelines, the modular installation and long service life in harsh environments.

Chemical production and commerce

Petrochemicals

Petrochemicals are the building blocks of many everyday objects. Their value chain is growing as new equipment becomes necessary due to rising standards of living in emerging economies and increasing urbanization. The industrial processing facilities for oleofins, aromatics and synthesis gas utilize highly complex piping systems for water and chemicals which are used as process additives or catalysts and in various chemical injection devices.

Fertilizers

Fertilizer plants play an important role in the global chemical industry as the demand for food production in industrial agriculture increases constantly. Fertilizer plants provide an excellent platform for monetisation ammonia gas in the form of nitrogen-based fertilizers. They are nodal point in the value chain of most industrial mineral acids worldwide, such as sulfuric acid and phosphoric acid.

Chlor-alkali

Chlor-alkali systems are the backbone of general, industrial, inorganic chemistry.
The piping solutions and thermoplastic installations of GF Piping Systems are used in the field of two-layer systems for salt water electrolysis, in the downstream processes of chlorine chemistry, in the industrial use of caustic soda, as well as in electrochemical chlorination and water disinfection.

GF Piping Systems offers key components as well as lightweight and high-quality solutions for chemical injection devices.

Inorganic basic chemicals, specialty chemicals, biochemicals

Products provided by GF Piping Systems are used in almost every step of the process, whether it be basic substances such as titanium dioxide and bromine or ingredients for pharmaceuticals, pigments, adhesives, water treatment chemicals or the electronics industry.

Chemicals in the manufacturing and processing trades

Steelworks and metal industry

Metallic materials form the basis for infrastructure development and for a large part of technical industrial and everyday products. Steel mills and base metal processing plants in the smelting, refining and recycling sectors consume a large amount of aggressive acids and bases, especially in the pickling process. Thermoplastic piping systems play an important role, for example, for cleaning exhaust gases.

Surface treatment, electroplating, batteries, painting and printing, glass industry

In addition to primary use in the transportation industry and household appliances, surface treatments are common industrial practice. This includes demanding, sophisticated electromechanical processes such as the galvanization of fashion accessories, the treatment of steel cord tires and the etching of electronic components. The preparation of metal surfaces for painting involves highly complex electro-deionization processes, with excellent material purity and leaching behavior of the GF Piping Systems components providing a proven benefit.

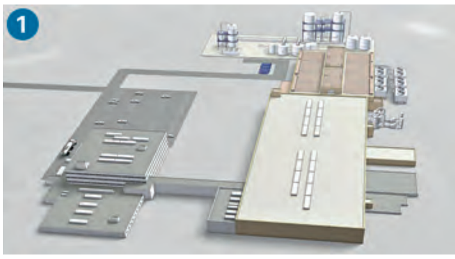
Pulp and paper, starch, yeast and sugar, cosmetics and detergents, textile industry

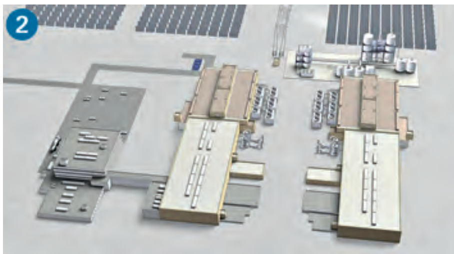
Driven by globalization and urbanization, rising living standards make great demands on the products of the manufacturing industries, for example, challenging quality and performance requirements and strict environmental and health and safety guidelines.
GF Piping Systems guaranties high quality products, durable materials and precise process controls for a wide variety of chemical applications.

2.5.3 Microelectronics

High-tech factories for the manufacture of chips produce around the clock. Consequently, reliable and safe piping systems that continuously provide critical process fluids are a must.

Preventing unnecessary downtime is a priority at GF Piping Systems. Supplying high-quality plastic piping and welding technology products, combined with dedicated and knowledgeable staff, GF Piping Systems has been able to ensure factory continuity for more than two decades. During this time, fabricators and users were able to experience the added benefits of plastic piping systems and replace other materials to ensure safety, quality and productivity.





GI.7
Microelectronics
1. Semiconductors, TFT/ HB-LED, Storage media
2. Photovoltaics

Semiconductors

The complexity and sensitivity of processes and products in the semiconductor industry can be met by highly specialized equipment that produces under strictly controlled cleanroom conditions. GF Piping Systems offers a portfolio of high-purity plastic systems for the safe and reliable transportation of critical process fluids in semiconductor manufacturing.

Photovoltaics

High demands in terms of purity, safety and quality characterize the processes in photovoltaic production. The reliable transport of the required media under clean room conditions must be ensured and monitored. Whether in process engineering or in production: the product portfolio of GF Piping Systems serves all high-end water applications in the photovoltaic industry.

TFT/HB-LED

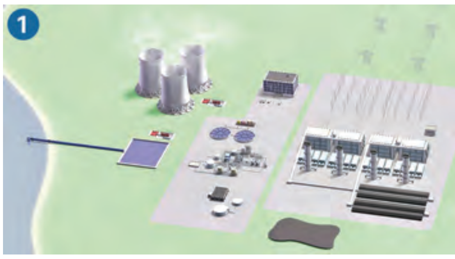
The manufacture of TFT / HB-LED technologies (HB = High Brightness) is subdivided into the processes of wafer cleaning and metallization, surface treatment and etching, which are mapped in typical applications such as process cooling water, neutralization and chemicals trading. GF Piping Systems offers the right solution based on process requirements, temperature conditions and chemical concentrations.

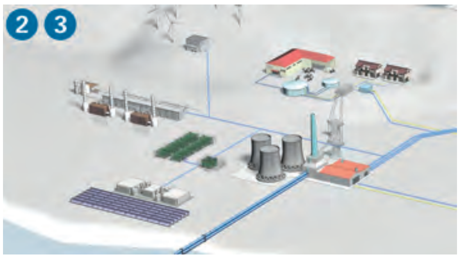
Storage media

Since storage capacities have been growing steadily, manufacturers of mechanical storage media are increasingly interested in pure and ultrapure materials for building their facilities in a variety of applications.

2.5.4 Energy

As awareness of sustainability grows, the way energy is gained, distributed and used will begin to change profoundly. GF Piping Systems offers intelligent plastic solutions for the successful operation of highly specialized water and chemical applications in power generation today and tomorrow. Corrosion is the biggest cause of pipeline failure in a power plant. Therefore, the aim is to replace metal pipes with thermoplastic solutions. Depending on the application, this allows corrosion resistance over a period of up to 50 years.





GI.8
Energy

1. Conventional power plants
2. Renewable energies
3. Forward-looking, environmentally friendly solutions

Conventional power plants

Conventional energy production from fossil fuels or nuclear energy sources still has a large market share worldwide today and is being further expanded by new developments. Solutions for cooling, wastewater and chemicals maximize safety and are corrosion resistant.

Renewable energies

Generating energy using renewable natural resources is a dynamic sector with high global growth rates, as a sustainable form of energy generation will shape the future and has already led to a significant change in the energy generation landscape. GF Piping Systems' intelligent cooling and double containment piping systems for water and chemical treatment processes reduce energy costs and potential environmental impact due to leaks, while maximizing operational safety.

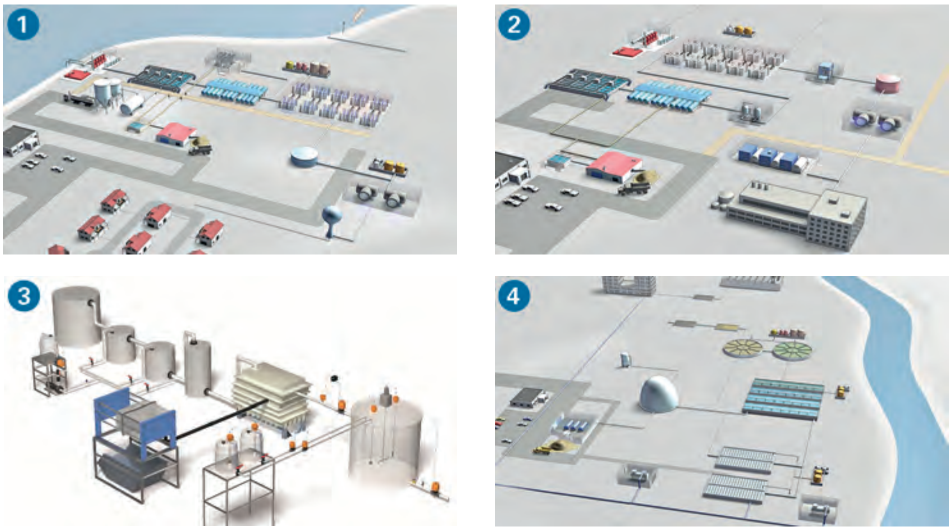
Forward-looking, environmentally friendly solutions

The development of innovative, green technologies for the intelligent use of alternative energy sources is a promising future market. GF Piping Systems offers state-of-the-art products and technologies for the transportation of water and chemical media, providing cost-effective solutions that meet the highest standards of health, safety and the environment.

2.5.5 Water treatment

Since the late 1990s, the water treatment business has been growing steadily. In countries where water is scarce, it is even considered to be the most investment-intensive and important industry in the next decades. Depending on the field of application, customers of GF Piping Systems are faced with a wide variety of challenges when it comes to the treatment of water. These challenges range from ensuring high water quality and reliable measurements to adhering to the strictest regulations.

GF Piping Systems fulfils these challenges with a comprehensive range of pipes, fittings, valves, the ideal connection technology and an optimally adapted selection of components for automation technologies.



GI.9
Water treatment

1. Drinking water
2. Industrial processing water
3. Industrial wastewater
4. municipal wastewater

Drinking water

The production of drinking water is a major challenge and requires the right systems in the background. Depending on the field of application, plastic as a material for pipes, valves and fittings can be an integral part of a long-lasting system. The high-quality plastic solutions from GF Piping Systems guarantee optimum compatibility with all components.

Industrial processing water

A high degree of purity of water is a central requirement of today's industry for steam boilers, cooling systems and production processes. Technologies, such as ion exchange, ultrafiltration, reverse osmosis and electro-deionization can avoid all forms of contamination, calcification and corrosion.

Industrial wastewater

Wastewater treatment plants for inorganic alkalis and acids are in themselves small chemical factories. Corrosion resistance and occupational safety are top priorities for pipelines containing hazardous waste. The philosophy of GF Piping Systems to ensure the safe transport of liquids and gases meets these process needs.

Municipal wastewater

Strict guidelines and binding legislation demand state-of-the-art technology in today's wastewater treatment plants. Membrane technologies, chemical dosing systems, and polymer treatment plants are just a few examples of the solutions required for efficient and safe piping systems.

2.5.6 Marine

Ships and offshore platforms are exposed to the forces of nature. Wind, rain and salt water aggressively attack the structure, the hull, the outer shell and the supply lines. Therefore, corrosion protection has the highest priority. However, corrosion is no longer a problem with GF Piping Systems' products. The plastic piping systems reduce maintenance times and increase productivity.

Plastic piping systems are about five times lighter than metal systems. When using plastic components, the carbon emissions of the entire system can be reduced.

GF Piping Systems offers IMO-compliant and fully approved marine piping systems suitable for both new construction and retrofitting existing equipment.

GI.10
Marine

1. Cruise ships and ferries
2. Cargo vessels
3. Offshore system

Cruise ships and ferries

Cruise ships and ferries are floating cities that require safe transport of potable water and gray and black water in conjunction with high quality water treatment. Galleys and laundries need to be operated around the clock and demand corrosion-resistant materials. Piping for air conditioning has become indispensable to ensure the comfort on board. Pre-insulated piping also offers higher thermal efficiency.

Offshore systems

Floating hotels, accommodations and houseboats require a higher standard of living aboard. In addition to the supply of hot and cold water, rainwater harvesting systems and managing chemicals inside and outside, are particularly affected by corrosion and encrustation.

Cargo vessels

International maritime transport today is dominated by fleets of large cargo vessels. This trend is linked to higher environmental protection requirements to counteract the environmental impact of increased trade and tourism. Commercial fleets can benefit from lighter and corrosion-resistant piping solutions for ballast water, water treatment, ventilation pipes and waste water from scrubbers. GF Piping Systems supports the industry to meet these technical, operational and environmental challenges. The corrosion-, abrasion- and chemical-resistant systems are optimally adapted to the extreme conditions on the high seas, are cost-effective and offer a long service life.

2.5.7 Gas supply

For decades, gas has become an important energy source worldwide. Gas is distributed to households and industry via a network of underground transportation and supply lines.

In recent years, the gas supply industry has made large investments to increase the uniform quality of operation and maintenance of gas supply networks. GF Piping Systems provides high-quality systems and services for the construction and maintenance of these networks.

GI.11
Gas

1. Gas transport lines
2. Gas supply lines
3. Gas house connections and house connection lines

Gas transport lines

When transporting gas to residential areas, safe and reliable connections are an important success factor. At the same time, however, this can be very challenging. GF Piping Systems knows the requirements placed on appropriate tools, high-performance connection technologies and connectors as well as expert on-site support.

Gas supply lines

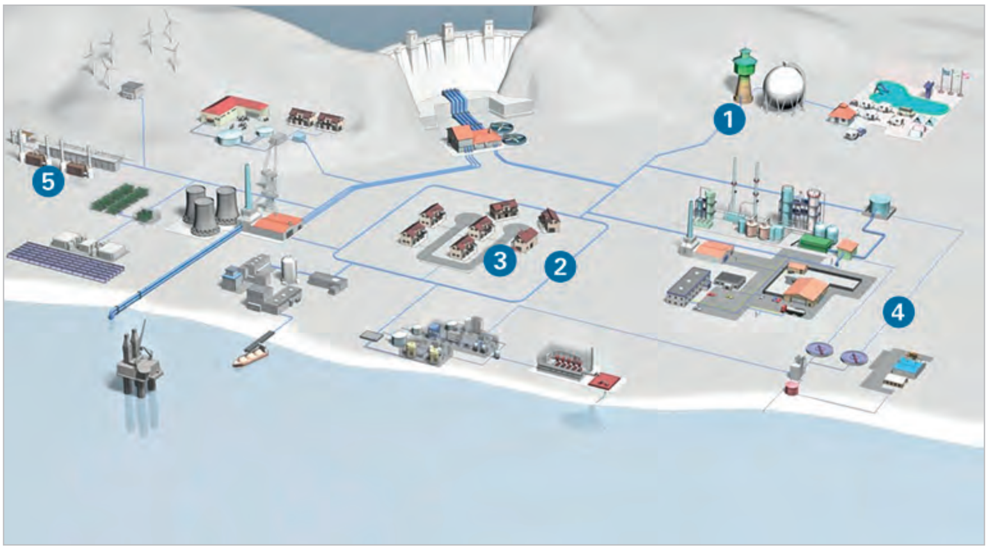
In order to ensure a reliable, economical and sustainable gas supply, it is essential that the connections of all piping components such as pipes, fittings and valves are secure and reliable. GF Piping Systems offers a comprehensive assortment of connection technologies. The electrofusion system ELGEF Plus creates a homogeneous material connection between pipe and fitting to ensure the reliability of the gas network. When using the MULTI/JOINT system, many different materials can be connected quickly, safely and easily.

Gas house connections and house connection lines

In the last phase of the gas supply network, house connections bring the gas to the meter. Due to its flexibility, homogeneous material jointing technologies and many other positive features, PE is the preferred material for today's new installations. Thanks to the modular electric welding system ELGEF Plus, a suitable solution is found for every application. Each ELGEF fitting and saddle are matched to form a reliable and leak-proof connection when assembled. With only a few products many different combinations can be realized. Here, too, PE valves make an important contribution to the creation of a reliable and secure network as part of the ELGEF Plus system.

2.5.8 Water supply

Hygienically perfect drinking water is one of the most important prerequisites for health. The demand for a safe distribution of clean drinking water is increasing worldwide.
For the broad range of water supply, GF Piping Systems offers a full range of innovative technologies and specialized products tailored to the water supply industry. Leading know-how and expertise in all water applications help GF Piping Systems find the right solution.



Gl.12
Water supply

1. Water transport lines
2. Water supply lines
3. Water house connections and house connection lines
4. Pressure drainage pipes
5. Irrigation

Water transport lines

When transporting water to residential areas, safe and reliable connections are an important success factor. At the same time, however, this can be very challenging. GF Piping Systems knows the requirements placed on appropriate tools, high-performance connection technologies and connectors as well as expert on-site support.

Water supply lines

In order to ensure a reliable, economical and sustainable water supply, it is essential that all piping components such as pipes, fittings and valves are securely and reliably connected. GF Piping Systems offers a comprehensive assortment of connection technologies.
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Water house connections and house connection lines

In the last phase of the water supply network, water house connections bring the water to the meter. Due to its flexibility, homogeneous material jointing technologies and many other positive features, PE is nowadays the preferred material for new installations. Thanks to the modular electric welding system ELGEF Plus, a suitable solution is found for every application. Every single ELGEF fitting and saddle are matched to form a reliable, leak-proof connection when assembled. With only a few products many different combinations can be realized. Here, too, PE valves make an important contribution to the creation of a reliable and secure network as part of the ELGEF Plus system.

Pressure drainage pipes

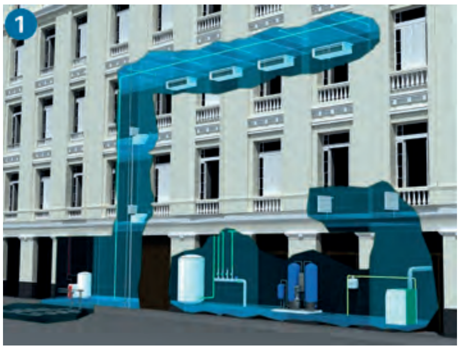
Instead of gravity, pumps are used in pressure drainage systems to deliver the wastewater to the treatment plants. Pressure drainage systems generally use pipes with smaller diameter. This is more cost-effective and easier to install. It choosing a PE system from GF Piping Systems, a reliable network with a service life of 100 years can be realized.

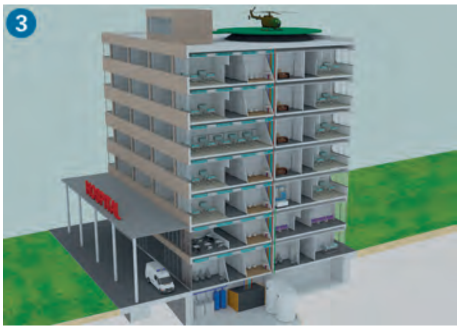
Irrigation

A growing world population and climate change are increasing food and water shortages. The food production is becoming increasingly independent of local weather conditions: Large greenhouses and comprehensive irrigation systems will be built to increase food production per square meter. Easy-to-install systems and ensuring water supply throughout the product lifecycle are becoming increasingly important. GF Piping Systems offers a comprehensive product range for irrigation systems as well as on-site training for personnel and fast deliveries.

2.5.9 Building Technology

Drinking water hygiene, comfort and sustainability are the buzzwords – both in new buildings as well as renovations. Environmentally friendly and cost-effective piping systems make the difference in terms of dead space, noise reduction, corrosion resistance and pre-assembly.





GI.13
Building Technology
1. Hotels
2. Residential buildings
3. Hospitals
4. Industrial buildings

Hotels

Hotels are an oasis for travelers to relax and unwind. Guests expect first-class comfort. This includes perfectly functioning and environmentally friendly air conditioning and water supply at all times.

Hospitals

Hospitals and health facilities are places of healing and recovery. Hygienic water supply is a central concern and a great challenge at the same time: washing hands before surgery, cleaning surgical instruments and medical equipment, in the catering area, in hospital cleaning and in the laundry.

Industrial buildings

Office buildings, factories and research facilities have one thing in common: You need an environmentally friendly heating and a cooling system as well as reliable drinking water, gas and compressed air distribution lines.

Residential buildings

Comfort, hygiene and sustainability are currently the most important trends in modern home decor. For new construction, refurbishment or extension projects, environmentally friendly heating and cooling systems are used, as well as a long-lasting drinking water installation that is hygienically safe.

Plan – Build – Operate

Plan – Build – Operate

1 Introduction

The tasks in the building technology are structured and presented in this manual on the basis of the usual course of the project phases.

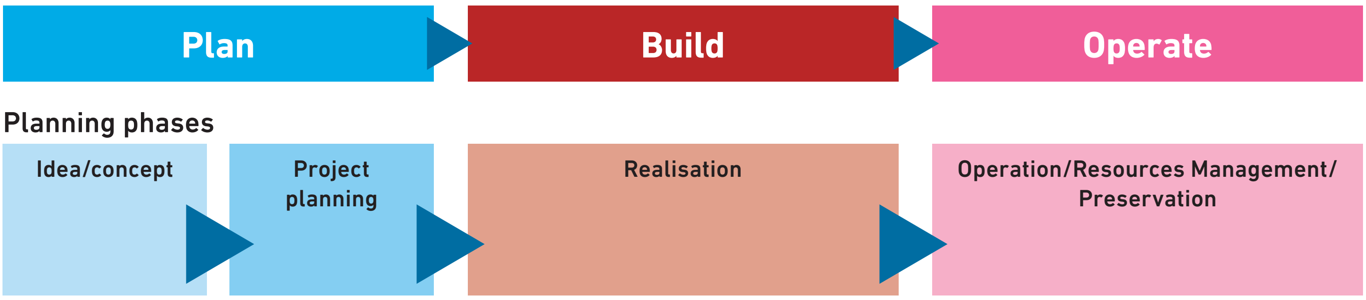
Project phases

GII.1
Structure of the book and project phases

The structure of this handbook into the chapters Plan - Build - Operate, follows the insight that building technology begins with brainstorming and concept formation, even before the actual building trades are being considered.

2 Planning phases

The complexity of the tasks in the building technology will continue to rise steadily, especially as the architectural, technical, economic, but also the ecological and social dimensions of a **building project** and a **building** have to be incorporated at an increasing amount and taken into account in their mutual relationships.
The considerations that all those stakeholders in the construction work have to make, must cover the entire service lifecycle of a building and must be presented in a well-formulated construction planning model.
Basically, a construction project includes one or more structures, which usually consist of the load-bearing structure and non-loadbearing components.
The work on the construction project begins in the conception phase, before the actual project planning and includes a variety of analyses on the requirements and feasibility. Subsequently, the actual construction planning follows with the early involvement of, for example, the requirements for maintenance and service. The demolition is not covered in this presentation, since it usually represents a separate project.



GII.2
Overview of the phases

The further structure of this model depends mainly on the scope of services, the size, the complexity and the duration of the project.

§ **Application of national laws, regulations, directives**
The planning phases may be defined by local laws and regulations and may differ from those described in this manual.

2.1 Roles, Activities and Functions

§ **Application of national laws, regulations, directives**
The roles as well as responsibilities and tasks may be defined by local laws and regulations and may differ from those described in this manual.

In order to successfully carry out a project in **Building Technology**, the responsibilities of all stakeholders must be defined and their respective tasks and roles, their work steps and results must be separated. These **roles**, in which different people and institutions in a construction project carry out key functions, can be described as follows – limited to the most important ones. In general, these roles can be identified according to their functions and their legal status.

Builder (Purchaser, Client)
The builder, e.g. landowner or investor, is the final decision maker in a construction project. In most cases, he is the purchaser and client of a building, i.e. the contract partner of the designer. He specifies his requirements.

Designer (BIM Detailer, Lead Designer)
The designer is an architect or engineer who carries out the design as well as the functional and constructive planning of a building. **Application Specialists** and **Subject Matter Experts** can take over sub-tasks.
The designer, for example, the Sanitary Engineer is the representative appointed by the builder. He requires the installation company to follow a predefined procedure in order to ensure a standard-compliant installation that ascertains the best possible quality.
For example, the installation company must abide by an established QM system and specified quality standards.
A **BIM Detailer** undertakes to assume those services that correspond to his profession and where those tasks were requested by the client.
On the other hand, a **Lead Designer** undertakes to assume all services and has third parties render these services.
Thus, the **Design Team** includes the BIM Managing Director, the Application Specialist and the Subject Matter Expert.

Management
Manufacturers and suppliers as well as all stakeholders in the construction answer to the **Construction Management** who acts as the representation of the builder. This management function can be divided into **Construction Management** and **Technical Construction Management**.
The **BIM Upper Management** comprises the coordination of the Planning Team. It organises the entire communication between client, stakeholders in the construction and third parties. The BIM Managing Director carries out these tasks.

Building Inspection
The regular supervision of the construction site and the execution of the construction project is carried out at the building inspection level, which complements the construction management in this way.

Manufacturer
The manufacturer is responsible to provide high quality products as well as the supply of piping systems and fittings used in building technology.

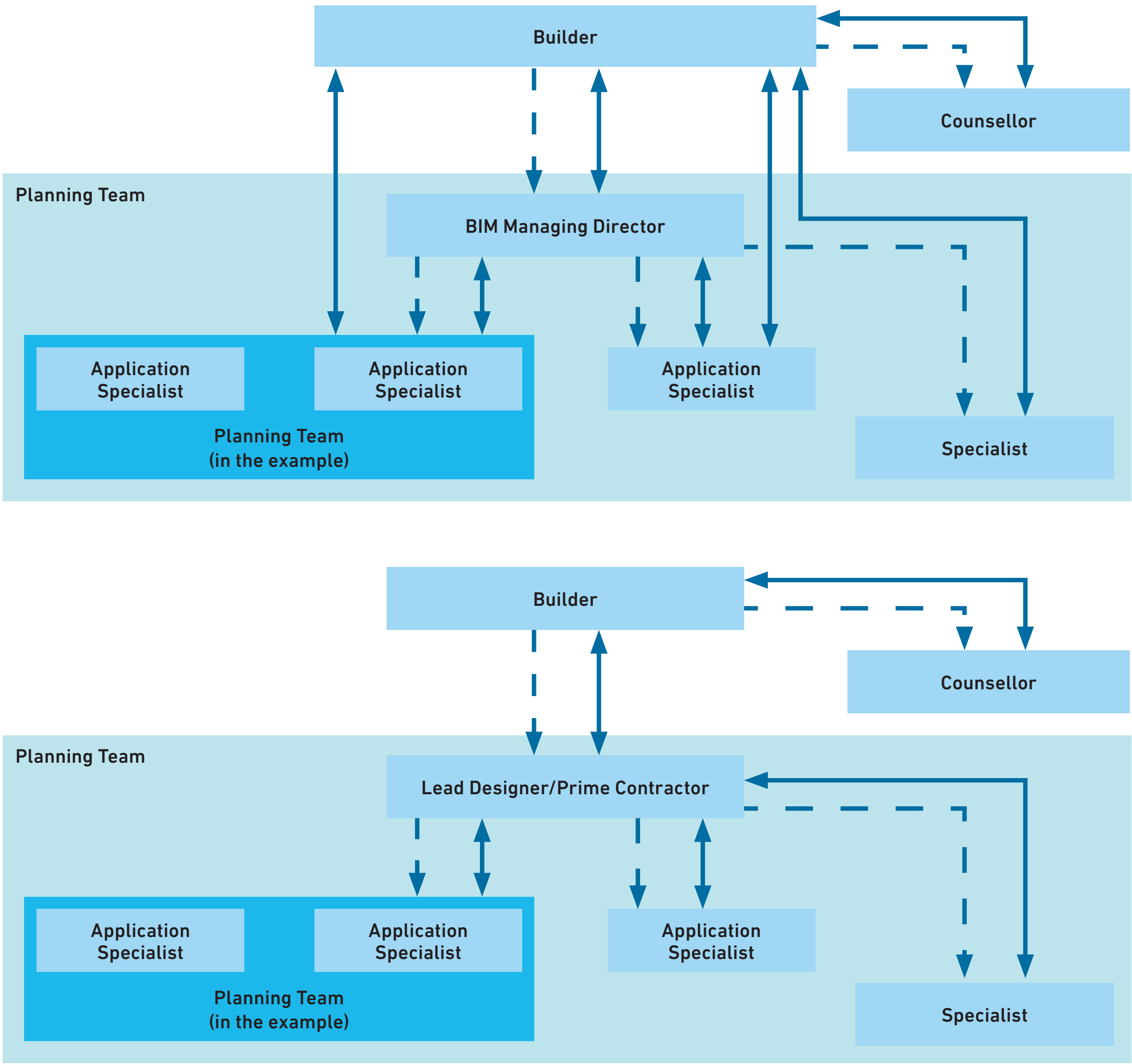
Installer
The installer processes the planned installation system according to the manufacturer's instructions and the design provided by the Application Specialist. Therefore, the Project Consultant is accountable to the builder for the processing, assembly and warranty.

2.2 Forms of organisation

Linking of the various roles, institutions and persons that are relevant in a construction project in its entirety is referred to as a **form of organisation**.
This form of organisation, in which the different roles with their respective tasks are converted into a functioning network, is represented in the example that follows.

> § **Country-specific divergent forms of organisation**
> The forms of organisation may vary depending on the country and depart from the descriptions given in this manual.

GII.3
Overview – Forms of organisation



Symbol	Meaning
– – →	Management, coordination and authority
⟷	Contracts

2.3 Planning phases in detail

Ideally, the planning phases can be broken down in detail (without claim to completeness) as follows.
This ideal type representation includes further aspects, for example, the selection procedure of the bidders and the call for tenders are not presented here in detail. The reason is that the positioning of these facets is widely depending on the planning process used. These are controlled by country-specific regulations, the local building standards that must be taken into account, the country-specific practices and the dimension and complexity of the construction project.

GII.4
Planning phases in detail

Plan	Idea/Concept	**Strategic planning** • Determining needs, objectives, framework requirements • Defining solution strategies
		Preliminary studies • Defining procedure and organisational form • Verifying feasibility • Defining the project
	Project planning	**Feasibility analysis/construction project** • Optimising the design • Optimising efficiency • Defining schedules **Approval procedure** • Approving project, costs, schedules
Build	Realisation	**Design** • Implementing the building according to planning, contracts and functional specification **Putting into operation** • Taking over the building, putting it into operation • Repairing construction defects
Operate	Operation/ Resources Management/ Preservation	**Operation** • ensure the operation is safe, optimise **Monitoring, installation, maintenance** • Monitoring the building's condition • Ensure to proceed with maintenance task **Maintenance, Repair** • Maintaining the value of the building's fabric • Maintain sustained usage

3 Digital Building – BIM

3.1 Our world is becoming increasingly digital – The future of building

+ Our world is becoming increasingly digital – this also presents a big challenge for the construction industry. The digital transformation is changing the way information is collected and intervenes in the basic planning and decision-making processes. Everything that can be digitised, will be digitised. The approach "Build digitally first - then real" is increasingly becoming mainstream. Building Information Modeling (BIM) is thus increasingly turning from an information standard to a building code.

The cooperation of all stakeholders – in addition to increasing demands on energy efficiency, CO_2 reduction and sustainability – is becoming increasingly complex due to ever larger planning teams and more specialists. This way, conventional methods quickly reach their limits: The consequences are inefficiencies in cooperating, longer planning and construction times as well as quality defects.

+ Building Information Modeling (BIM) is a method to reduce the complexity in the planning, construction and resources management processes and gain control of these procedures.

In the process, a building is virtually constructed and optimised before it is built or renovated. Optimisation can cover the entire service lifecycle, from primary, embodied and mobility energy needs to construction logistics to the utilisation, operation and maintenance. With the increasing use of dynamic simulation, decisions can be made much faster, more efficiently, and based on relevant information. The value added is not concluded after completion of the project. All digital elements and their information can continue to be used during the operation and the "real" experiences can be considered in the next "virtual" project.

At first, many trends – including digitisation – are viewed critically. This makes perfect sense, because not every trend moves a market in a sustainable way. While digitisation in other industries has already advanced or even revolutionised it, the construction industry is only really getting started.

Building Information Modeling (BIM) is a planning method used globally for digital construction. Building with BIM results in model-based planning in the early stages of the project. In principle, two buildings are constructed: first, the virtual design, which is optimised in the digital model and checked for errors. Subsequently, the physical counterpart, which, thanks to the previous quality inspections can be implemented without any errors. When utilising BIM, the knowledge of the participating (application) Specialists, the know-how of the implementing companies and the manufacturing industry can be incorporated into the planning and construction process at an early stage. This way, the planning achieves a quality that has never been achieved so far in the overall process.

+ When using BIM, a uniform information standard is implemented along the entire value-added chain – from ordering and planning to realisation and facility management of the building. Thus, BIM becomes the information standard for almost all stakeholders, including architects, engineers, contractors and manufacturers of the construction products.

The focus is on optimising the project. Without the use of new information technologies, the achievement of the goal – as well as the intelligent use of resources – is hardly possible, especially in view of the ever increasing demands and the growing number of stakeholders. Builders are increasingly calling for BIM, and designers, architects and engineers are changing their processes accordingly. All are using the potential of BIM as an opportunity.

3.2 Digital Data – The new Building Material

Today, building is no longer just a matter of joining building materials, but more and more it is considered the assembly of prefabricated components and specialised products.

Nowadays, the requirements and needs of the builder usually lead to a planning based on more or less neutral standard solutions. Only then are the matching construction products selected, mostly based on graphic visualisations and engineering data sheets.
The construction industry finds itself alone with this process sequence. In other industries, the available products are integrated earlier in the process.

+ **However, meanwhile, digitisation has also reached the construction industry: Architects and engineers are increasingly demanding digital data from construction product manufacturers, and request this data to be freely accessible and in good quality.**

Why are BIM data required?

The focus is on optimising the project along the value chain. Without the use of new information technologies, the intelligent use of resources is not possible. The consequence is that building projects are planned based on a model and objects and systems are integrated at an early stage. Digital data (BIM) is mandatory in many countries, including in Europe. The required access to objects (libraries) are established abroad and are able to provide the products in digital form.

Why do we need more information?

Building as a local and highly precise process is determined by increasing demands.
The structured data represents declared values that are critical to the evaluation, design, call for tender, processing, and utilisation.

+ **The digital data can be used multiple times – in different processes, by several stakeholders and in different locations.**

In the course of digitisation, the construction products will also be digitised: In the future, these components will be available as standardised Product BIM data. In the geometric and technical planning of building models, call for tenders, from the trades up to logistics, on the construction site, documentation and optimisation in operation, digitalisation influences our decisions. Increasingly, the construction product manufacturers demand arbitrary access to digital data and request these data to be of best quality.

BIM data as real digital representation helps to ensure that the knowledge of the implementing company and the manufacturing industry can be utilised early in the planning and construction process. When applying BIM, planning in the overall process achieves a quality that has never been attained before.

3.2.1 Digitisation implements the building industry

In the course of digitisation, the construction products will also be digitised: In the future, these construction products will be available as standardised BIM data and can be considered for the geometric and technical planning in the building models. Therefore, the virtual duplicates are much closer to the real component which will be produced later and thus increase the certainty during the planning phase. This changes the process fundamentally.

+ **Until then, the construction industry was rather "offline" with regard to the planning process. With this step, the construction industry is effectively "implemented" and placed "online" in the structures and process flows.**

Ultimately, the specific knowledge about products lies with the manufacturers. In order for BIM to work as an integral part and function consistently, it must be possible to incorporate this knowledge into the planning and in a phase-oriented and abstract manner.

+ **BIM changes from an information standard to a construction code and a construction product standard. If BIM is the information standard, then the construction products must also be "BIM-ready".**

Still, little of this change may be noticeable, but soon all suppliers of construction products will be affected: The progressive digitisation affects almost every company.

+ **The digital transformation is changing the way information is obtained and intervenes in well-founded planning and decision-making processes.**

3.3 BIM – From an information standard to a building code

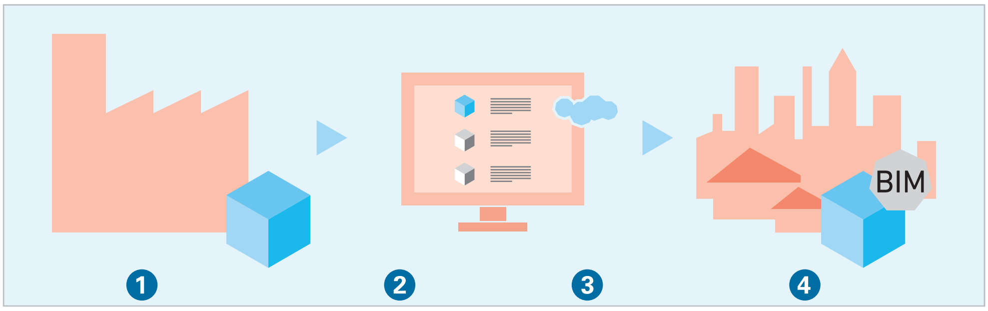
Projects implemented on an international level show that the utilisation of building information models (BIM methods) is indisputably responsible for improving quality and efficiency.

The availability of information on systems and products, including all data and properties that are relevant for the decision on what product to use, is of paramount importance for the success of construction projects. This definitely requires “laborious tasks” for all stakeholders in the planning process.

In the course of digitisation, the construction products will also be digitised: In the future, these construction products will be available as standardised BIM data and can be considered for the geometric and technical planning in the building models.

The digital data are part of the product, like the packaging or the accessories, but with the benefit, once they have been developed and are available on the platform, they can be used multiple times.

Principle: Build digitally first - then real.



GII.5
From the real to the digital construction product

1. Digitalisation
2. Provisioning
3. Linkage
4. Automatisation

From an international perspective, the process of providing BIM data is already in progress. Local industries, coupled with national political bodies, are driving the implementation forward and rolling out the “red carpet” for their industry (GB, NO, USA, etc.). Now the question arises as to what speed and efficiency the construction sector or industry will be able to keep up, take the necessary steps, adapt the tried and tested methods, and to put service benefits in the market.

+ **When speaking of Building Information Modeling (BIM), this does not mean to simply switch from the traditional 2D design to intelligent 3D planning, but rather it refers to the linking of the value chain: The transformation of an entire economic sector into the digital age is imminent.**

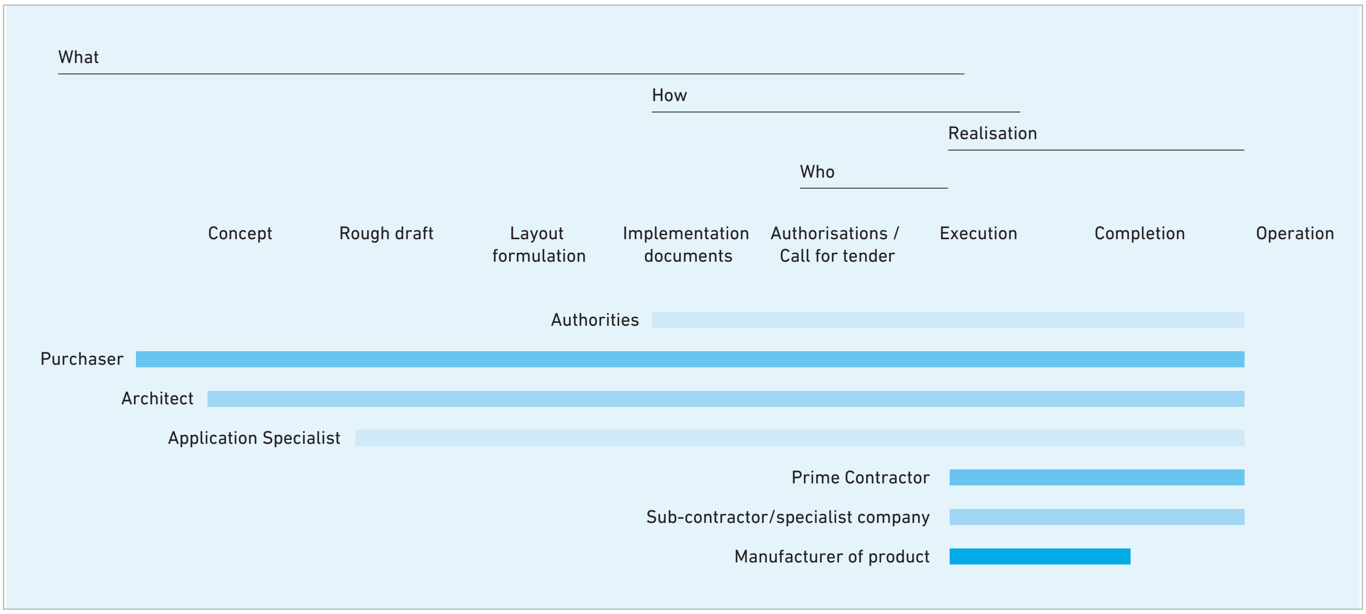
The rational transfer of real products and their often poorly structured product data into digital products plays an important role for both local and international manufacturers. However, at the same time this transfer presents a great challenge.

In some countries, **BIM libraries** have already made a significant contribution to realising the potential of digitisation for greater efficiency and added value. Everyone, from the builders, designers, architects, engineers, contractors, as well as the many smaller, medium and large component manufacturers can benefit from this development.

What does this transformation mean for the established processes?

The established processes pertaining to ordering, planning, executing and operating buildings are transformed and sustained by BIM.

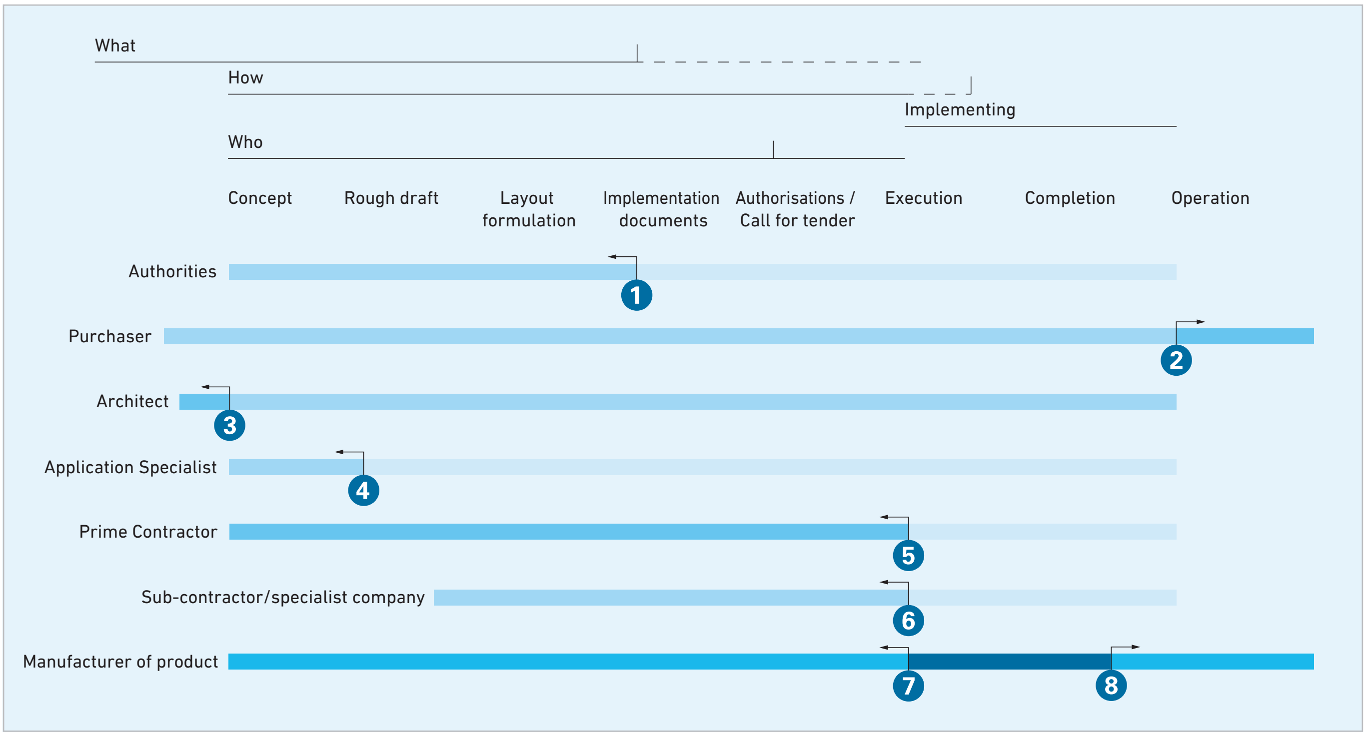
The added value is not finalised after the completion of the project. While being used, it shows whether the building meets the diverse requirements for the operation, maintenance, resource consumption, flexibility and logistics to its full extent. Prerequisite for this is the comparability and communication. When applying BIM, these different requirements can already be considered and optimised in the planning and construction process. After completion, the digital building models provide invaluable services over the entire service lifecycle.



GII.6
Shifting away from the "traditional" decision-making process

Completely new perspectives open up, when the "real" experiences from the operation of the building are being considered in the next "virtual" project and the buildings become thereby better and better.

Compared with the "traditional" decision-making processes, the requirements are increasing and with it so is the number of stakeholders in the project. The established roles and processes are beginning to change. Digitisation influences the type of evaluation and decisions and changes the established planning and construction processes.



GII.7
Shifting of the "Integrated" decisions

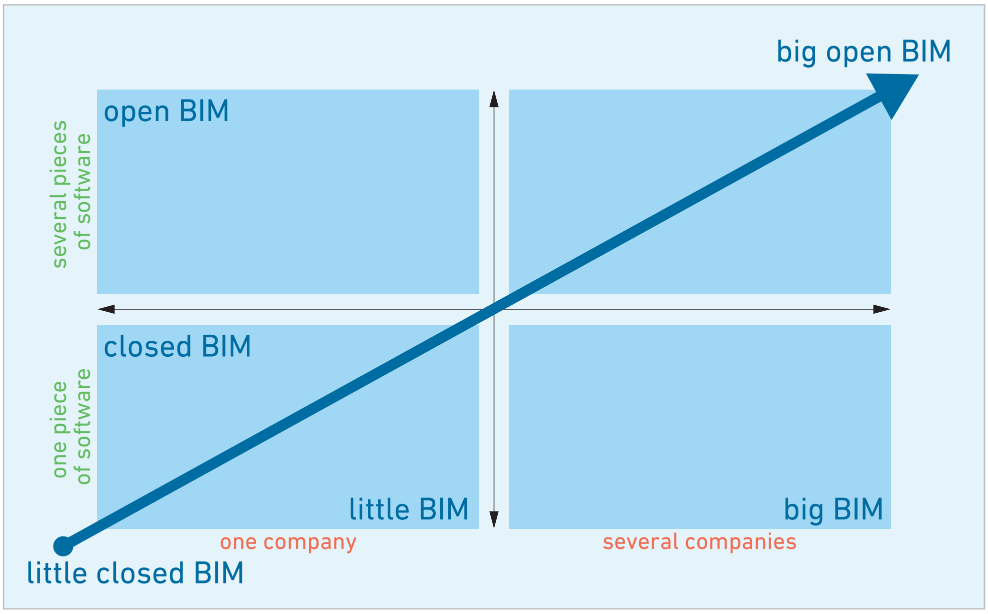
1. The **digitalisation** process also changes the procedure at the authoritative level and with the bureaucracies. Rules and regulations are available digitally, requests and petitions are processed digitally and online (e.g. digital building applications, publications, provision of basic plans, test procedures, etc.).
2. One of the major changes is that **digital building data** (a "**digital counterpart**") will be available to the companies in the future. This provides significant benefits for the operation and maintenance (and their optimisation). The digital data also increasingly represents an **integral part of the value of the building**.
3. In the context of **digital planning**, this presupposes that objectives and requirements are already defined and agreed upon at the beginning by the customer with the stakeholders. At this point, it is clarified for which objectives which applications are necessary.
   When using the **BEP**, the **BIM Execution Plan**, these objectives are laid down step-by-step with the stakeholders.
4. As for the architects, their **service provision** is also being shifted by the participating Application Specialist within the overall project: Design decisions are solved by all disciplines involved.
5. Contractors and Prime Contractors (depending on the model) are responsible for the **structural implementation**. If this is to be done economically and in compliance with quality, costs and deadlines for all stakeholders, they must be integrated into the planning implementation. This is the only way to ensure implementation in the later stages.
6. Depending on how the requirements are set and the systems have been evaluated, it is important that the **responsible sub-contractors and specialised companies** are involved. This is the only way to ensure that these systems can be installed efficiently and safely.
7. The construction industry (meaning the manufacturers and suppliers of building systems) knows the benefits and disadvantages of their **systems**, the **performance indices** and **dependencies** with regard to the **installation situation** and the **third-party systems** that must be connected. This applies also to GF Piping Systems with its system solutions and high-quality components for the safe conveyance of water and gas in industry, supply and building technology.
8. Upon completion of a project, the **installed systems** must increasingly be **documented** and the **data** must be **digitally available**. For the **operation of intelligent buildings** (SmartHome), these digital data on the components are an essential requirement (IOT).

3.4 BIM from the stakeholders' point of view

Currently, architectural drawings are being used – in the form of plan information – in order to convey information. This leads to the fact that the presentation must be massively reduced and standardised for readability and thus deviates significantly from the reality.
The stakeholders work separate from each other, so the information is also singled out (knowledge silos). Here, the informed, digital building models (BIM) are much closer to reality. However, consequently, one must depart from the usual presentation method of today and redefine the structure of the information (models) and thus also determine the exchange of information and cooperation.

+ The BIM planning method distinguishes between two implementation scenarios: The "Closed BIM" method versus the "Open BIM" method.

The following is characteristic of the Open BIM method: the provision and exchange of BIM files between the disciplines is independent of the BIM software used and the software's own file formats. This is done by using the open IFC interface as BIM standard.



GII.8
Forms of cooperation and type of information exchange with the BIM method

- **Open BIM**: A data exchange that is independent from the BIM software. It is a bi-directional data exchange of digital building models with open, non-native file formats such as IFC, COBie, CSV, gbXML, etc.
- **Closed BIM**: BIM application based on a closed (native) file format.
- **Little BIM**: BIM method, which is limited to one discipline and thus describes an isolated solution.
- **Big BIM**: Consistent and interdisciplinary application of the BIM method over the service lifecycle of a building.

The benefit of the **Open BIM** method is the neutral and open approach to the planning process and thus the use of neutral file and coordination formats. Another – not insignificant benefit – is that the market is not limited by the specification of the data format or even patronised. Moreover, building data will be better secured in the future, as it can be used by any software that supports the standard.

Here, the **Closed BIM** method varies. Here, the focus is on simple coordination of specialised models (collision analysis) as well as the use of an identical file format for planning purposes. Loss of information due to misinterpreted data can be excluded as far as possible due to the uniform data format for the project, as all project participants use the same software.

Furthermore, the **Little BIM** method describes the application of BIM, which is limited to a discipline, and is thus an isolated solution. A classic and often encountered example of this is the creation of a virtual architectural model, the load-bearing structure or building technology model. This BIM application creates added value within one's own discipline. For example, room data booklets or door and window lists can be created automatically from the virtual architecture model. The quantities and parts lists can be obtained from the load-bearing structure or building technology model.

When applying the **Big BIM** method, the focus lies in the interdisciplinary and consistent application of the BIM method over the entire service lifecycle of a building. The concept of Big BIM is based on the Open BIM method. The implementation requires the judicious preparation and coordination of all stakeholders. Devising the planning is an indispensable task that has to be done in advance. In reality, there are no pure Big BIM solutions. Within Big BIM environments there are always Little BIM applications. That is to say that the majority of the model information is only passed on within one discipline (e.g. building technology). Exchanges in the Big BIM environment are usually done through a central platform, where the responsibilities and rights have been regulated in advance.

3.4.1 Collaboration – Building is teamwork

One of the essential prerequisites for a good execution of a construction project is the prior clarification and definition of the expected objectives. There is no difference in a project based on BIM. The purchaser or client will also give an account of goals, expected results and information (LIA). On this basis, the contractors will explain which application of BIM they intend to fulfil and how they will utilise this application.

This is agreed by the acceptance of the **BIM Execution Planning** (BEP), also referred to as the **BIM Project Manual**, and the implementation and the functional specification. This manual sets out the objectives, organisational structures and responsibilities; it sets the framework for the BIM services and defines the processes and exchange requirements of all stakeholders involved.

+ **The BIM Execution Plan is the basis for determining BIM-based collaboration among stakeholders and is an agreement component between the contracting entities and the project participant.**

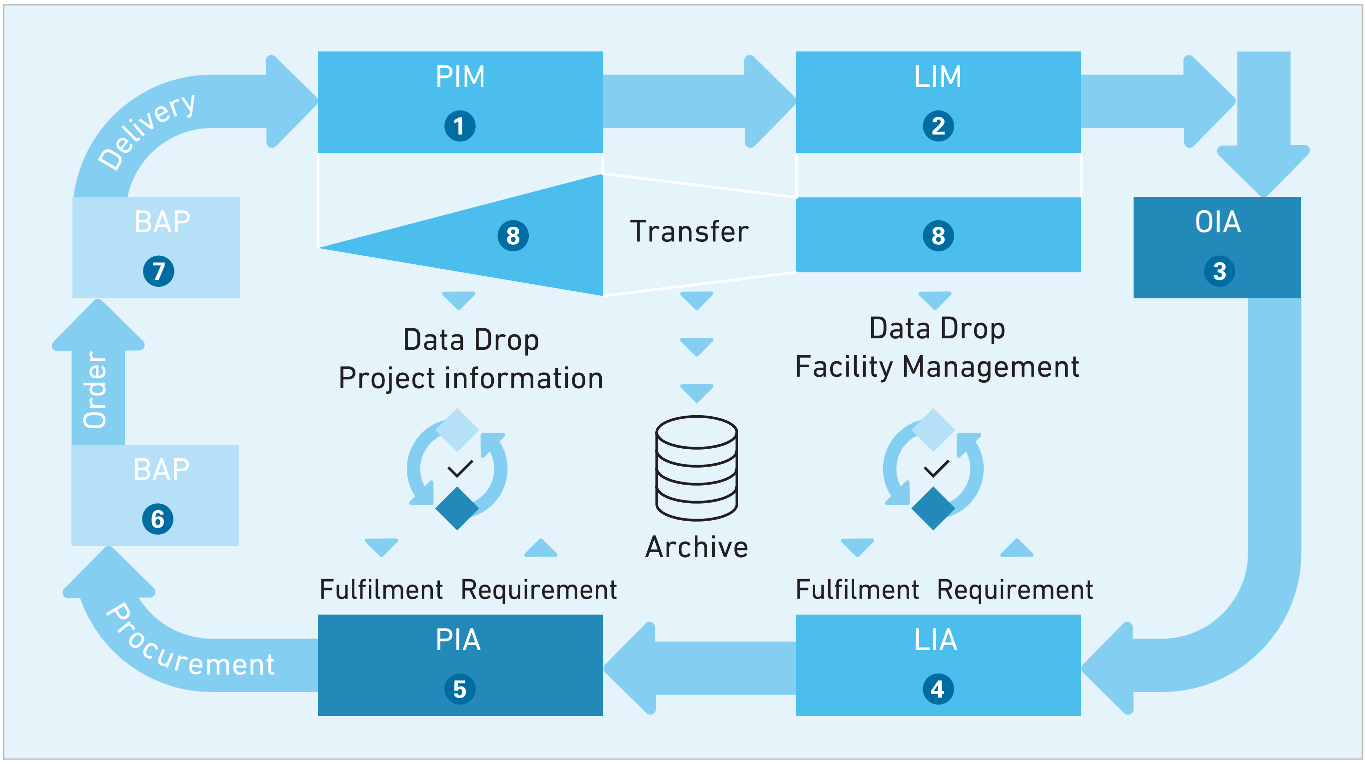
BIM Execution Plan Model

The process model represents the context of all control instruments of a BIM project.

When using the BIM Execution Plan Model (BEP) (implementation), the information from the functional specification is mapped out in detail (including revised utilisation plan, model plan and coordination plan). In the phase of procuring planning services, the stipulations of the purchaser are usually defined as a functional specification. In this functional specification, the customer formulates his objectives and his need for information. Here, BIM-relevant specifications can also be made unilaterally (e.g. requesting the use of the builder's own project space). Mostly, however, the specification describes what the client expects (for example, the requirement that a project space be used and that the builder always has access to it).

Figure [GII.9] shows the flowchart and the relationships of all control instruments in a BIM project.

GII.9
BIM Execution Plan Model



BIM Execution Plan

When using BIM, virtual building models aim to fulfil the purpose of performance prediction, better collaboration, and easy coordination. Even though BIM is not a completely new invention, working with this method has not yet fully established itself among all stakeholders. Today, great care needs to be taken to determine which tasks are to be assigned to a BIM project and when. Since individual tasks, such as coordination, are already fulfilled in the usual cooperation via digital models, there are some overlaps, while other tasks are new.

+ **Because the BIM method has not yet been standardised by country, generally valid models do not exist. And there are only a few service catalogues and fee calculation models for BIM services available.**

Therefore, these models must be described, offered and commissioned for each project. As a rule, the focus is on contractual freedom and it is up to each client to demand these services. Anyone assuming these tasks in the future (and for which fee) will be ultimately decided by the market. It is important that the utilisation of the model is determined and commissioned with the project objectives in mind. If a benefit cannot be elicited, it must be verified that these benefits are not ordered accordingly: BIM is not an end in itself.

TII.1 **BIM Execution Plan Model**

Position/ colour code	Designation	Explanation
	Purchaser	–
	Operation and Facility Management (FM)	–
	Designers and Contractors (of the AN)	–
1	Project Information Module (PIM)	meets the requirements of the PIA
2	Land Information Module (LIM)	meets the requirements of the LIA
3	Organisational information requirements	overall strategic issues and needs of a builder
4	Land Information Module (LIM)	Information requirements for the operation of a property
5	Project Information Requirements (PIA)	Functional specification of the client for a specific project
6	BIM Execution Plan, functional specification	The functional specification is the answer to the customer requirement specification PIA.
7	BIM Execution Plan, Implementation	Project manual for the organisation of a BIM project
8	2D diagram, 3D diagram, alphanumeric, documents	–
9	2D diagram, 3D diagram, alphanumeric, documents	–

Customer requirement specification and functional specification

The prerequisite for a favourable execution of a BIM project is the prior clarification and definition of the expected objectives. The purchaser or client must define in advance which objectives he wants to pursue with the application of BIM.

- Which data should be used during the operation of the building?
- In which form does he want to take over the data or the digital model from the planning?

The specifications and requirements of the purchaser are formulated by the contractor in the **functional specification** or in a BEP (**BIM Execution Plan**). The contractor explains how he intends to handle the project. From this, the individual functional specifications of the stakeholders in the project can be derived, agreed and commissioned. This makes the BIM Execution Plan a mandatory basis for implementation of the project.

The specifications and requirements of the purchaser are answered by the contractor in the **functional specification** or BEP (BIM Execution Plan), explaining how he plans to complete the project. This makes this offer a self-binding basis for the execution of the project.

- Functional specification (AIA) *: The client (AG) formulates objectives and/or requests specific applications (* AIA: "Client's Information Requirements")
- Functional specification (BEP): In it, the contractor (AN) describes how and what applications he will use in order to fulfil the project and submits this as an offer.

Typically, the following **topics** are defined:

- General project organisation, organisational chart
- Project phases and milestones
- Higher-level project goals
- BIM strategy
- BIM objectives of the client
- Required "end product" (digital model), with quality requirements
- Required data (contents, formats)
- Roles and responsibilities in the BIM process, BIM project organization
- Working method (model-based working)
- Technical aspects (managing data, software, interfaces)
- Platforms for model and data exchange
- Coordination, coordination systems
- Quality assurance and definition, handling of tolerances

In the pre-contractual phase, it is mandatory to clarify the questions regarding the allocation of planning and business services. In this context, it is recommended that BIM specifications be included in the call for tender documents transparently and in detail. In principle, it can be stated that the rules of public procurement do not conflict with the application of the BIM method.

BIM Project Organisational Chart – Roles, Responsibilities, and Services

When using the BIM method in order to implement a project, new roles are sometimes requires, even if the associated tasks can be handled in a convention manner. The client (AG) and the contractor (AN) need a common understanding of the different roles and related tasks. Therefore, the following explains the essential roles, the applicable responsibilities assigned and the associated services are described.

TII.2 **Roles, responsibility and tasks within BIM**

Role and synonyms	Responsibility and tasks
Client (AG)	
• Builder • Client • Purchaser	The client commissions the BIM services and specifies the BIM project objectives. The requirements are: • Formulating the information needs of its organisation and the operating company of the property. • In necessary, some standards shall be specified. • If necessary, providing a collaboration platform and prescribing the use. • If necessary, prescribing the target system ("Computer-Aided Facility Management") for the operating company and make it available.
Information Manager (IM) of the client	
• BIM Manager (of the AG) • Project Manager BIM (of the AG) • Project Manager • Trustee	The Information Manager organises the BIM on the client side and creates a BIM Execution Plan. The tasks include: • Aligning objectives, applications, model quality, and model depth with the contractor's BIM Manager. • Representing the client when dealing with the BIM Manager of the client. • Defining the information needs of the AG (referring to the digital Project Management). • Organising and supervising management processes of the client's digital project management. • Receiving results, checking and approving quality, internal forwarding and evaluation on the client's side. • Defining requirement profiles of all other stakeholders. • Organising standards and guidelines. • Organising or controlling the deployment of the collaboration platform for sharing information in the project. • Providing necessary data for the target system (e.g. CAFM), organising or controlling its further use. Within the organisation, the Information Manager is part of the functional level as the Project Board, Project Management or Trustee office of the client.

II

<table>
<tr><th>Role and synonyms</th><th>Responsibility and tasks</th></tr>
<tr><td colspan="2">BIM Manager (BM) on the contractor's side (AN)</td></tr>
<tr><td>

BIM Project Manager (of the AN)
BIM Lead Designer
BIM Manager (of the AN)
Project Delivery Manager

</td><td>
The BIM Manager organises all necessary steps for the BIM on the contractor's side. This means in detail:

Organising fulfilment of the information needs (according to the BIM Execution Plan of the client) in relation to the digital project management.
Being the primary contact for questions about digital project management between the Information Manager and the BIM Lead Coordinator.
Representing the contractor when dealing with the Information Manager of the client.
Implementing management processes concerning the entire digital project management.
Contact person for all stakeholders representing the contractor for all questions about BIM
Collecting all contractual and organisational contents of the digital project management and submit them to the Information Manager.
Ensuring all work is done consistently, model-based.
Setting up the necessary communication strategy in the project and organising the task management system.
Demonstrating the team's skills. If necessary, organising training for stakeholders to obtain the required knowledge for the project.
Responsible for compliance with standards and guidelines.
Coordinating and organising the collaboration platform for information sharing in the project.
Providing models, data and documents for the target system (e.g. CAFM) and coordinating and organising their further use.

Within the organisation, the BIM Manager is part of the functional level as the Designer, Lead Designer or Full Service Contractor and the Project Management.
</td></tr>
<tr><td colspan="2">BIM Lead Coordinator (GK)</td></tr>
<tr><td>

Space Manager
ICT coordinator
Space Coordinator
BIM Coordinator (overall)
Lead Designer

</td><td>
The Lead Coordinator is responsible for merging the sub-models into an overall model. He is responsible for the following functions and tasks:

Primary contact for issues about digital planning between the BIM Manager and the BIM Coordinators of the individual stakeholders.
Representing the contractor when dealing with those stakeholders in the planning.
Responsible for the provision of the coordination model (made up of the individual subject-specific models) and its coordination across all trades.
Preparing regular reports on model planning progress.
Checking the planning content of the digital project handling and submitting it to the BIM Manager.
Verifying the services that must be provided.
Maintaining a list of the tasks resulting from the model coordination (he is responsible for their execution).
Conducting and monitoring training.
Monitoring compliance with required information qualities and standards.
Establishing a method ("best practice") among stakeholders.
Organising collaboration platform for information exchange and monitor its use.

Within the organisation, the BIM Lead Coordinator is part of the functional level as the Designer, Lead Designer or Full Service Contractor, the Lead Coordinator or the Project Manager.
</td></tr>
</table>

Role and synonyms	Responsibility and tasks
BIM Coordinator (CO)	
• Specialised Space Coordinator • BIM Coordinator • Task Manager • In-house Coordinator	For each participating company there is one BIM Coordinator who is responsible for the company's own structures within BIM. He is accountable for the tasks listed below and has the following responsibilities: • Primary contact for issues about digital planning. • Providing the necessary logic in the respective department. • Supporting the project-wide and model-based cooperation of the specialised departments. • Coordinating internal IT requirements with the needs of the project. • Coordinating project handling in your own planning discipline. • Responsible for quality assurance of all data before sharing the information with all stakeholders involved. • Supporting the BIM Lead Coordinator in training programs. Assigning appropriate training to your own employees. • Monitoring compliance with the required qualities of information, standards and established procedures ("best practice"). Within the organisation, there is one BIM Coordinator for all stakeholders. He is thus assigned to and is part of the functional level of a company-internal Project Manager or project-responsible Application Specialist.
Model Author (MA)	
• Designer • BIM Modeller • BIM Manager • Architectural Draughtsman • Modeller • Originator of the information	The model author creates the applicable subject-specific models. This means in detail: • Producing discipline-specific models. • Keeping his CO up to date on the status of the project, reporting any delay and problems. • Participating in training relevant to him. • Complying with guidelines and standards. • Contributing actively through insights on the topic of "Best Practice". Within the organisation, the Model Author is a designer or architectural draughtsman representing the individual stakeholders.

These roles must be reflected in the organisational chart of the project – below is a simplified presentation, illustrating the assignment to the usual performance diagrams.

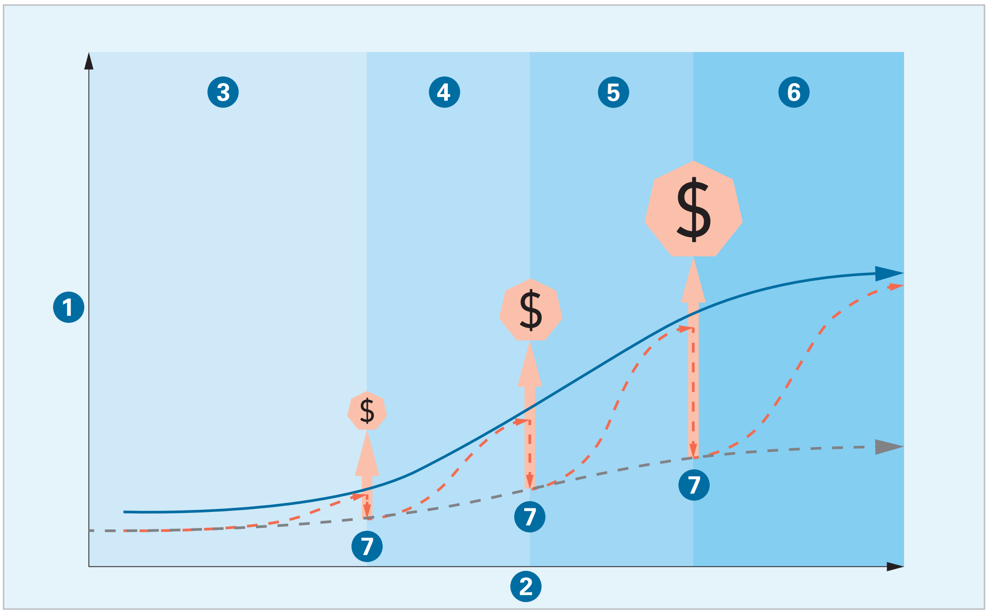
3.4.2 Architectural competition and overall performance competition

While digitisation in other industries is already well advanced, in the construction industry this process is only just beginning, and it is beginning right in the early stages of the project.

This becomes clear in the national and international context when awarding construction projects, which are increasingly tendered only with BIM, that is to say, quotations are requested based on building information modelling. At the international as well as the European level, the use of BIM in the planning and construction of public buildings has already been decided and various countries now request the BIM process by law. For both part and full-service competitions, BIM is an integral part that is explicitly required. The participants cannot avoid the topic anymore – on the contrary, they must be careful that they do not miss the connection in digital construction.

3.5 Workflow – From planning to execution

New technologies affect the established planning and construction processes. When new digital tools are integrated, existing processes, methods for the construction and exchanging information among the planning partners need to be reconsidered. It is necessary to establish a systematic process structure already in the early planning stages in order to ensure that there are no gaps in the information chain from the design through to construction and resources management. Breaks in the information chain are caused by the termination of stakeholders and changes of the infrastructures.



GII.10
Continuous structure of information (in comparison)

- blue line:
  BIM-based planning
- dashed lines:
  traditional planning method

1 Gaining knowledge
2 Process chain/time axis
3 Concept
4 Planing
5 Realisation
6 Operation
7 Information losses (cost factors)

Disruptive changes between process steps lead to massive information losses and drive up project costs.

In order to use the new tools and their added value, adapting the form of cooperation is a must. Introducing new methods does not primarily mean installing a BIM-capable CAD system, modelling it three-dimensionally (3D) and adapting a good IT solution. Above all, the structures and methods to be created provide the added value of realising and operating an optimised solution based on the formulated objectives of the client. The focus is on the interdisciplinary cooperation of all project participants and the resulting synergies. The result is first and foremost the creation and exchange of information in the right quality and at the right time.

3.6 BIM in the building technology

BIM places the planning and the coordination of the stakeholders on a new basis.
The reduction of information in the standardised, two-dimensional plan views is still possible, but is now created via a meaningful, three-dimensional modelling.

+ **Thus, two-dimensional engineering drawings will be a by-product of model-based planning in the future. The benefits are clear: The disciplines involved can tailor their areas and components to the neighbouring situation much earlier.**

The collision of components, the optimal course of the pipeline routing and the placement of the components is visible and comprehensible to all. Incorrect planning and time-consuming and costly corrections on the construction site are thus avoided. With the construction of the rooms and components, their quantity and location is determined. Gradually, these components are supplemented by the description of their properties and performance indices. In order to ensure that the right quality is installed in the right place, the components are expanded with the data provided by the manufacturer and product. This forms the basis for ensuring downstream operation and ensures that the information (certificates, operating and maintenance instructions, etc.) of the installed components is always available.

+ **With the use of new digital technologies, the entire work process is digitised and consistently designed. The building models are used to optimise planning from the construction site to operation and beyond.**

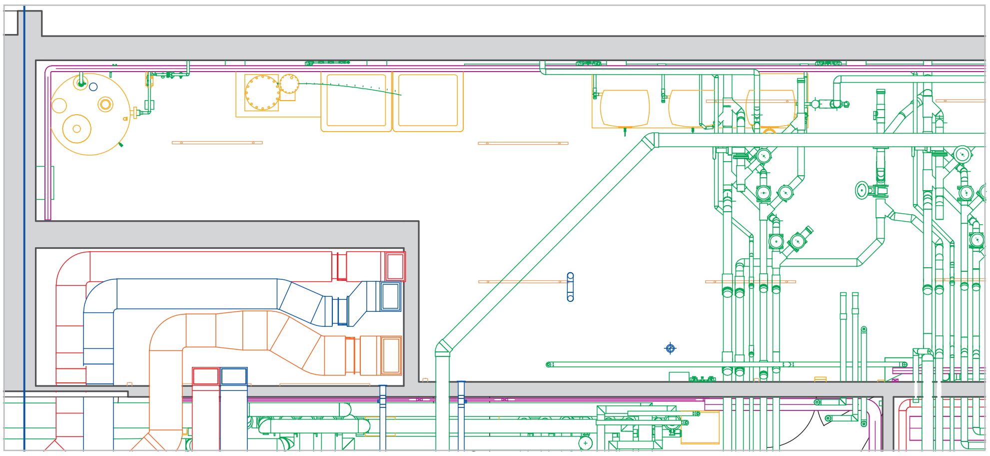
At the construction site, it is above all the coordination of logistics that is in the foreground, such as material, machinery and stakeholders within the timetable to increase prefabrication, quality and cost-effectiveness.

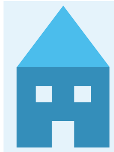
The data required for planning and preparing the work form the basis for the localisation of when, what and where to build on site. Similarly, exact measurements and incorporation of the data with the necessary control tools is made easier (scanning). Here, the components that have already been built (actual state) can be compared with those components that still need to be build (plan).

There is a growing demand to identify the quantity of materials actually used in the construction, and to ensure that the right products are used in the right place to guarantee quality. Here, it is important that every product is digitally integrated in the planning and that by equipping products with RFIDs as needed, further processes in logistics and quality assurance are supported.

Even after putting into operation, a building will continue to develop. The documentation of the installed components and products in the model and on the construction site ensures that the information about the routing of the pipeline or the location of certain components is also always available downstream during the operation and maintenance.

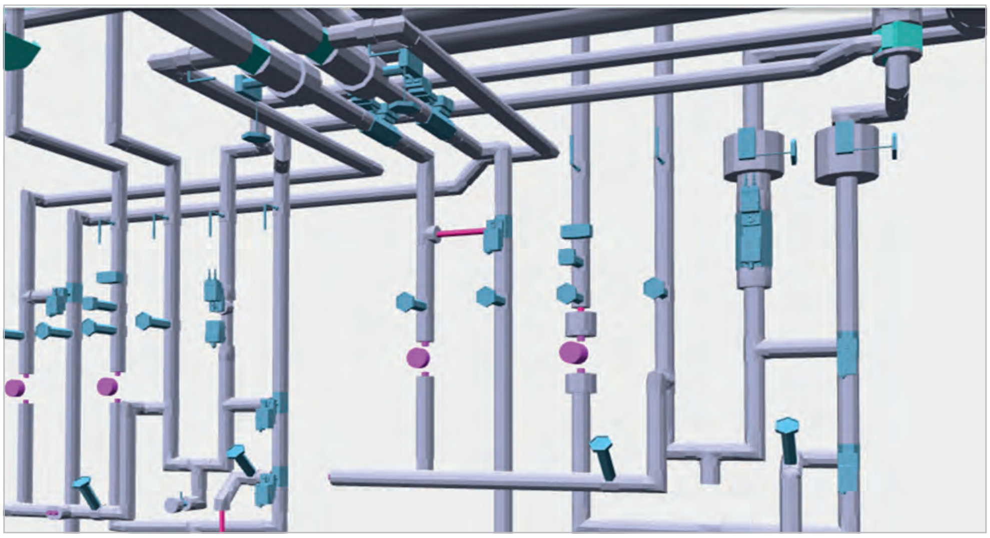
Planning





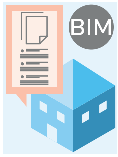
GII.11
Traditional planning method (2D)

- two-dimensional
- reduced to lines and text



GII.12
Model-based planning (3D)

- three-dimension-ally

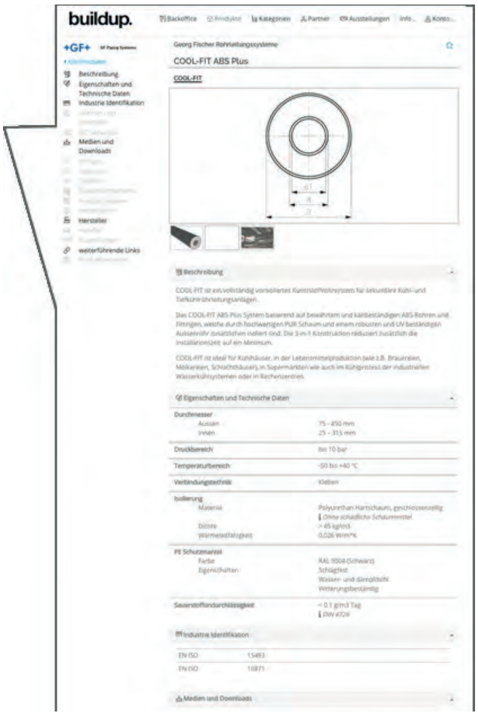


GII.13
Digital building product data

- augmentend with information

Construction site und planning – Examples

Actual building	Geometry (3D)	Information (BIM)



Which models generate which benefits?

The basis of the processes in the BIM are the **data models**. These models are populated with information (data), creating the digital **building models.** These data models can be used to create calculations and analyses and thus obtain information from which solutions are derived and designated. From the representations and products selected data (derived in certain file formats) can be passed on to third parties.

An important aspect of these digital building models is that the information gradually increases during the planning and construction process. The participants in the project build them together and use them for their respective tasks in order to optimise the final and project results.

However, an all-encompassing, virtual building model does not exist. The building model is composed of different **submodels**. These submodels are set up and maintained separately by the individual disciplines such as structural, electrical, heating, ventilation, sanitation, etc. The management and coordination, e.g. checking the models must be ensured in the project organisation (BIM coordinator).

In a building construction project, the **architectural model** is usually the reference model for all subject-specific models (e.g. building technology model or structural model). By default, the architectural model also contains the spatial model. The **spatial model** includes all indoor and outdoor spaces, including riser zones and shafts.

The **coordination model** is used to adjust the individual subject-specific models. The skeletal structure is recorded here. This includes the rooms and the basic parameters for the other submodels and components. Depending on whether the method **Big BIM** or **Little BIM** is specified, the categorisation of the submodels with the coordination model runs recurrently (semi) automatically or subsequently in a traditional way and predominantly manually. The cycles and the scope of this coordination are the project phases and the agreed milestones are crucial.

An application that is often carried out on the basis of the coordination model is, among other things, **clash detection** with the aim of being able to detect and solve possible conflicts at an early stage.

- **Coordination model**: The overall building model, which are merged from the subject-specific models for coordination in cycles. It serves to coordinate the trades involved and in particular assists during the clash detection function.
- **Architectural model**: It comprises model elements, such as walls, columns, doors, and forms the reference model for the other subject-specific models (partial models).
- **Discipline-specific models**: These are developed according to the discipline with their model elements (elements) by the Application Specialist.
- **Model element** (element): refers to the individual digital components in the digital building model, such as walls, columns, pipes, doors.

Prefabrication and machine-aided fabrication (robotics)

The modularisation and prefabrication approach to machine-aided fabrication (robotics) can significantly improve the quality of design and construction by simplifying and increasing repetition rates in a reduced timeframe. The building model offers a better insight into the project for all involved in the project.

This way, the stakeholders, in combination with the modularisation, can get a better understanding of the complexity and better coordinate the interplay of the disciplines on the basis of the virtual building model. If there are specialist building skills available and if they use these methods, simple, but also demanding construction tasks can be solved better by teams, and above all, the tasks can be solved more efficiently.

This can be achieved through better collaboration on a consistent database, which allows networking and automation of data processing. One of the fundamental approaches is BIM (Building Information Modeling).

3.7 Logistics and Production Processes

Operation and Facility Management – Smart Buildings

There are plenty of challenges: We have to build denser and better, use our resources and energy more effectively, traffic should flow and we do not want to spend time stuck in traffic. To achieve all that, intelligent solutions are needed. To find the solutions, a better picture of our world is needed, deeper insights and smart models. This is made possible through better collaboration on a consistent database, which allows networking and automation of data processing. One of the fundamental approaches is BIM (Building Information Modeling). In order to better control the logistics between the processor and the construction site, as well as controlling the construction site better, information is needed: A building model provides a view of what needs to be built when and where, and how much is required at this location. This is the only way to ensure the delivery to the construction site in even more complex situations (**just in time**).

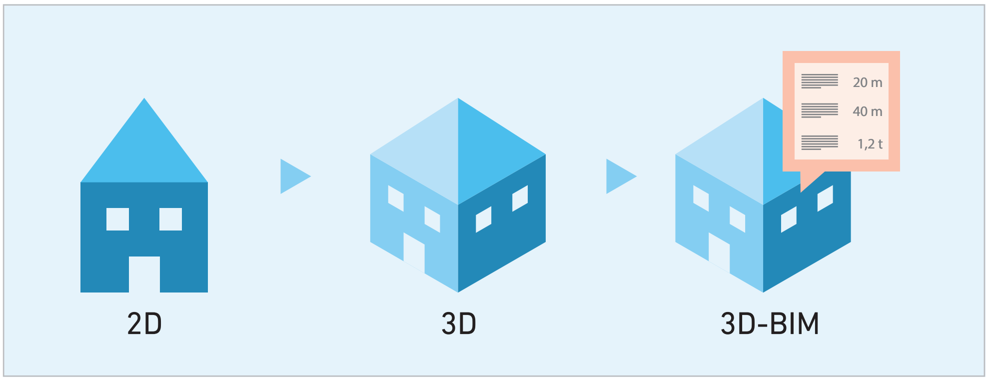
Networking – A prerequisite for success

Our world is becoming increasingly digital: By the year 2020, around 50 billion objects will be interlinked. The Internet of Things is becoming real and our buildings are starting to communicate and becoming increasingly intelligent (**Smart Home**). The prerequisite for such structures to be able to emerge from the design stage and not to form isolated solutions is the placement on a building information model that is recognised and widely used: This is where BIM comes in, where the data is consistently built up in a standard by all stakeholders, right from the start.

3.8 How is product information integrated into the model?

It quickly becomes clear that BIM is more than a 3D CAD design or mere geometry. BIM creates a digital representation of the real world. It is more than an enriched 3D representation of rooms, components and construction products.

+ The core of BIM is the letter “I”, so it's about the information - and it does not matter if it describes the space, the component or the building product in the entire model.



GII.14
Enrichment of digital building product data with Information

The geometric information is accompanied by the description, e.g. material, requirement classes for fire and sound insulation, energy values, manufacturer information, product information and its identification. The format of the further information can be very comprehensive, structured or less structured. The objective is to provide the stakeholders with the necessary information for planning (technology), construction (logistics) and operation (maintenance).

The non-structured data are vendor-specific information that is important but not stored in the BIM data. These may be technical fact sheets, processing or care guidelines, certificates, price lists or websites. The nice thing is that for this information, the BIM data provides unique links (technical links) that lead to those sources – and it's fast, easy, and highly efficient.

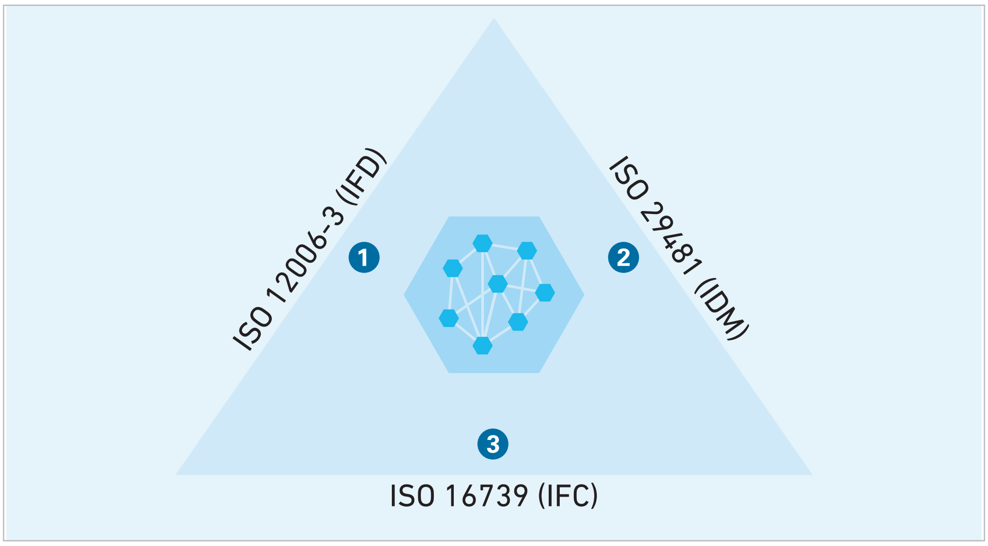
3.9 National and international regulations and standards

Regulations and standards represent the rules of technology in practice – and this is a more important topic than ever, also for the digitisation of our economy and thus of construction. In the “Informatisation of Processes” in construction, digital building is increasingly being shaped by Building Information Modeling (BIM).

There are already a number of national, and in particular also international standards for both processes and data. However, this development is far from over.

+ At the international level, it is the "International Organization for Standardization" (ISO) which is in charge. At the European level, it is the “European Committee for Standardization” (CEN). At the CEN level, since 2015, it has been CEN/TC 442. It publishes uniform European standards for BIM, which will be adopted by all member states downstream.

Rules and standards serve the stakeholders to communicate with each other. The digital models are an anticipation and simplified approach to the construction reality. When using BIM, the reflection of the existing, spatial component structure for the operation and the building in the inventory takes place.



GII.15
Central BIM Standards
1 Terms
2 Processes
3 Data

The central standards in the digital design, construction and operation of buildings (BIM) are:

- Data model: One of the main subjects is the open model and data exchange between the designers, contractors and operating companies. This requires standardised rules for the standardised component properties and the link to the IFC elements of ISO 16739. The Industry Foundation Classes (IFC), as a general data schema, ensures that the exchange of data between different proprietary software applications is possible (IFC – EN ISO 16739, 2016).
- The data dictionary of the buildingSMART (bSDD, formerly IFD) is a reference database and supports interoperability in construction. The database provides a flexible and reliable method for linking terms and expressions, their dependencies and definitions (data type, units, value ranges, etc.) across different languages, and serves as an extension and namespace for the IFC Data model (IFD – EN ISO 12006-3, 2016).
- Description of the work processes: The data exchange requirements are generally summarised in the IDM descriptions. They fundamentally describe the scope and specifications of the information that a particular role (user) needs to provide at a particular point in time or work process in a BIM project (IDM/MVD – EN ISO 29481-1, 2016).

4 The Hycleen Concept
– Only 4 steps to drinking water hygiene

4.1 Introduction

In many countries, quality drinking water is the norm – but it cannot be taken for granted. Although water suppliers check the drinking water quality at frequent intervals, pollution and biological contamination can significantly and adversely affect the drinking water quality and hygiene on the way to the consumer. Especially pathogenic microorganisms in drinking water are a health risk. Knowing this, drinking water installations in buildings must be carefully designed, constructed and operated.

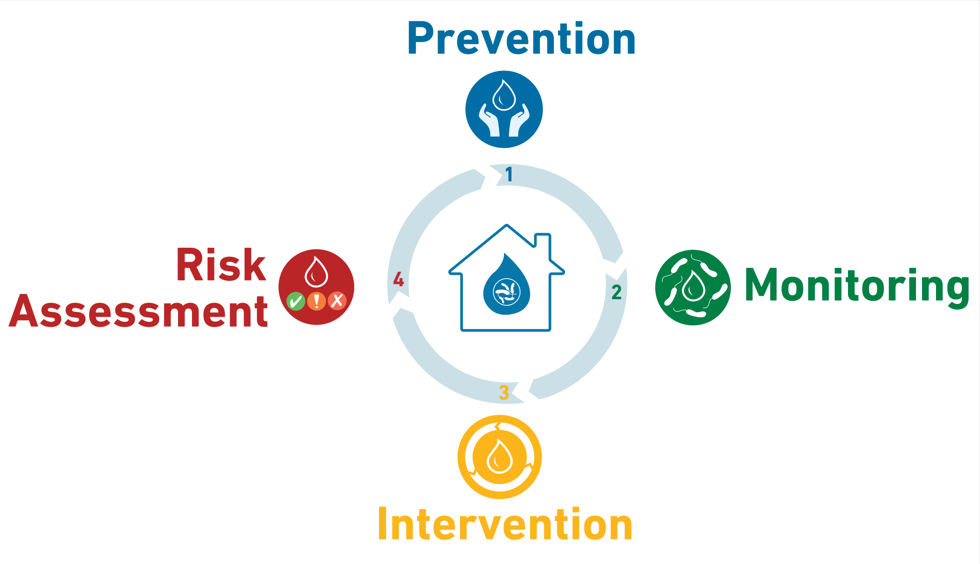
Drinking water installations in large building complexes (e.g. in multi-family dwellings, hotels, hospitals or nursing homes) require special attention. Incorrect operation or designing inappropriate operation or design errors can lead to a microbiological contamination of the drinking water by legionella and other pathogens.

+ **In order to prevent a long-term contamination of drinking water installations, a systematic approach of the "integrated drinking water hygiene concept" is required over the entire service life of a drinking water installation.**

The following Hycleen Concept by GF Piping Systems is predicated on the risk-based approach of the **Water Safety Plan** of WHO. The concept consists of four steps, which are to be regarded as a self-contained process in the designing, putting into operation and operation of a drinking water installation.

The first three phases, namely **prevention**, **monitoring** and **intervention** form the starting point for ensuring high drinking water quality. They focus on preventive measures that must be consistently implemented during the design, installation and use of drinking water installations. This can already eliminate many negative influencing factors such as stagnation, critical temperatures and a lack of water exchange. In the last phase, the **risk assessment**, changes to the use of the objects can be made quickly and effectively in order to carry out possible re-evaluations of the measures taken.

Thus, a sustainable investment protection for the property operator and a hygienic drinking water supply for the user can be guaranteed.



GII.16
The Hycleen Concept – In four steps to drinking water hygiene

1. Prevention
2. Monitoring
3. Intervention
4. Risk assessment

4.2 Prevention

In order to ensure a high drinking water quality up to the tap, rethinking the distribution of drinking water is necessary. Until a few years ago, the drinking water installation was considered maintenance-free. Today, increasingly new installation concepts and preventive measures are required during use. These measures prophylactically promote the drinking water quality in the installation and thus ensure a high level of drinking water hygiene.

The following measures are recommended for successful prevention, from designing through installation to use:

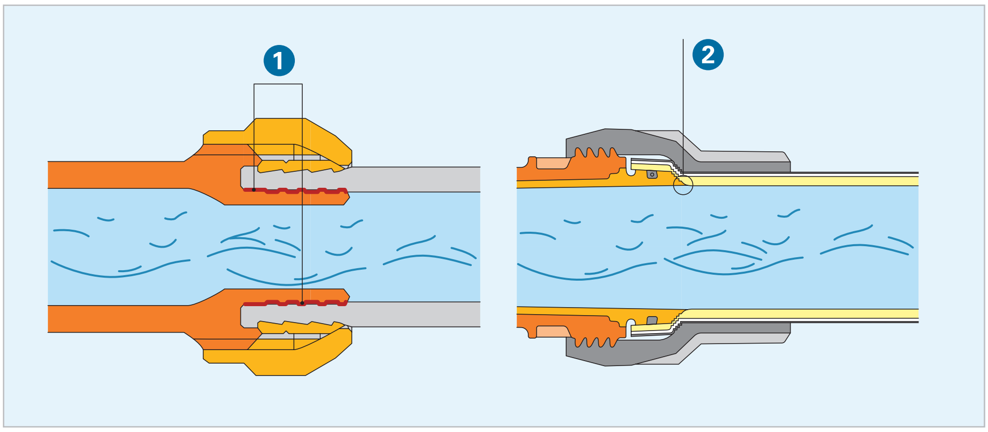
- Installation concept, fittings and pipe system without dead spaces
- Setting the proper drinking water temperature
- Ensuring hydraulic balancing
- All taps must be flushed regularly
- Preventing the formation of limestone, biofilm and corrosion

Installation concept, fittings and pipe system without dead spaces

A piping system inside a building generally entails the risk of microbial contamination, since the drinking water comes into intensive contact with the system's surfaces (unfavourable ratio of the surface to the drinking water). Unused pipe installation sections are at particular risk. They lead to long **stagnation times** of drinking water and provide an ideal habitat for bacteria. The following precautions provide a remedy:

☑ Disconnect unused installation sections.
☑ Empty and shut off all taps used infrequently.
☑ Those pipes used only seasonally require special attention (used only in the summer or only in the winter time).
☑ When converting rooms: If necessary, remove, drain and close the taps.

Even dead spaces – that is to say, those pipes filled with water and cavities hardly ever flushed – harbour dangers and should be avoided: Bacteria multiply very well in these dead spaces. Dead spaces can be found especially in connections of pipe installation systems and sealing points of fittings.



GII.17
Pipe connections without dead space

1. Dead space
2. Sealing edge, no dead space (this example shows a clamping connection with JRG Sanipex MT)

Ensuring the correct drinking water temperature

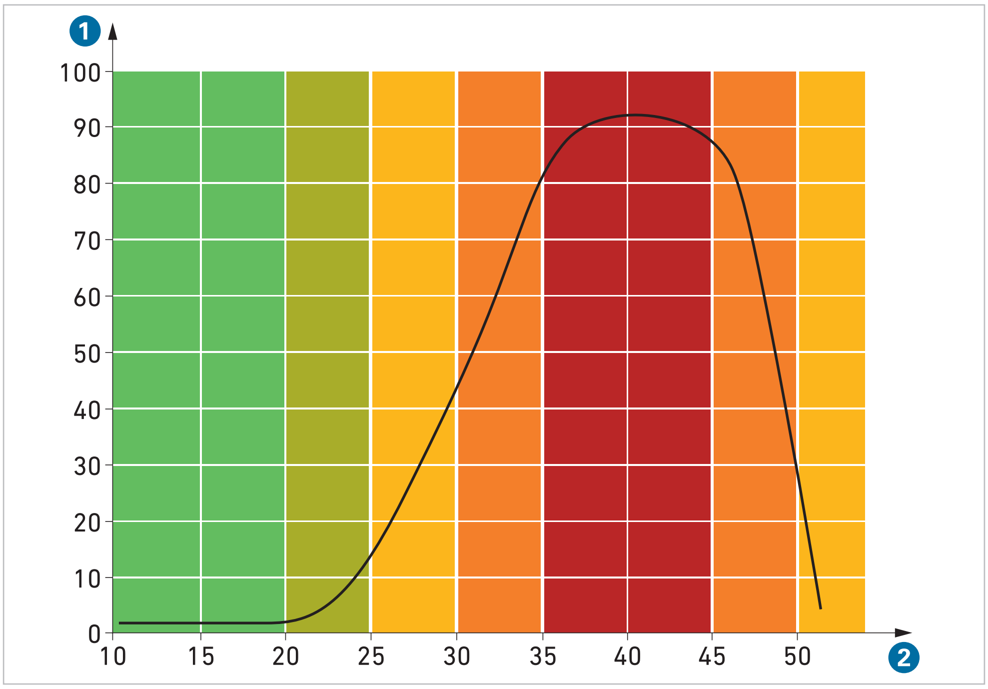
Bacteria multiply more or less depending on the **water temperature**. Therefore, the temperature of the water in a drinking water installation is of great importance.

+ **The temperatures of cold water must be below 25°C. This will keep the risk of microbial contamination low. However, the temperatures of hot water should always be above 50°C.**

Legionella multiply particularly in the temperature range between 25°C to 50°C. At 37°C, the growth rate reaches its maximum: At these temperatures, the number of legionella doubles within three hours.

To ensure the correct water temperature, compliance with the following conditions is mandatory:

- ☑ The cold and hot water installation requires 100% thermal insulation.
- ☑ The control of the hot water circulation must ensure the heat is distributed evenly, the hydraulic balancing must be given.
- ☑ At elevated cold water temperatures, cold water circulation is recommended, but at least one suitable flushing device must be installed.
- ☑ In the cold water distribution, flushing of the pipes must be carried out at least every 72 hours or they must be automatically flushed.
- ☑ The hot water volume of the storage tank must be changed daily to keep stagnation times in the critical temperature range between 25°C and 50°C. The temperature of the storage tank must never drop below 50°C.



GII.18
Temperature-dependent legionella growth

The critical range is between 25 und 50°C.

1. Legionella growth rate (%)
2. Drinking water temperature (°C)

Ensuring hydraulic balancing

The topic of **energy efficiency** is increasingly anchored in the public's awareness today. Therefore, the generation of hot water in building technology is receiving much more attention than in the past. However, only in the installation of the hot water distribution there are still large knowledge gaps. Thus, for convenience, usually all taps are supplied with hot water, although this is not necessary for the use.

In order to meet the high comfort demands, the circulation in the hot water distribution is part of the design, however, during the operation no more attention is paid to the hot water distribution. This is a big mistake – because for a high drinking water quality, a consistently high hot water temperature in the entire hot water installation is crucial. This hot water temperature must always remain above 50°C. If several circulation lines are present in a building, hydraulic balancing must be carried out.

+ **The aim of hydraulic balancing is that the hot water of the entire distribution remains at a temperature of at least 50°C and in addition to the drinking water hygiene ensures the comfort of the hot drinking water.**

If hydraulic balancing is omitted, critical hot water temperatures will set in and the water will only flow through lines that have the lowest pressure drop. This leads to a smaller volume flow and unfavourable temperatures in the more distant circulation lines. The requirement of at least 50°C in the entire hot water installation cannot be met under these conditions.

Preventing the formation of limestone and corrosion

The water composition plays an important role in drinking water hygiene. **Hard drinking water** leads to excessive limestone formation, creating ideal conditions for microbiological growth. For medium-hard to hard water, it is advisable to consider a **limestone protection** at the inlet of the domestic water installation.

When adding **protective coating forming auxiliaries,** old galvanised steel pipe installation systems are protected from corrosion. However, these should be kept to a minimum as these auxiliaries promote the growth of bacteria and biofilm.

All taps must be flushed regularly

If water stagnates over a longer period of time, bacteria can multiply freely and exponentially, until a dangerous concentration of bacteria is reached. Object assessments in recent years show that 95% of all bacteria in a drinking water installation adhere to the surfaces, forming a **biofilm**. Bacteria prefer to colonise in cavities and niches.

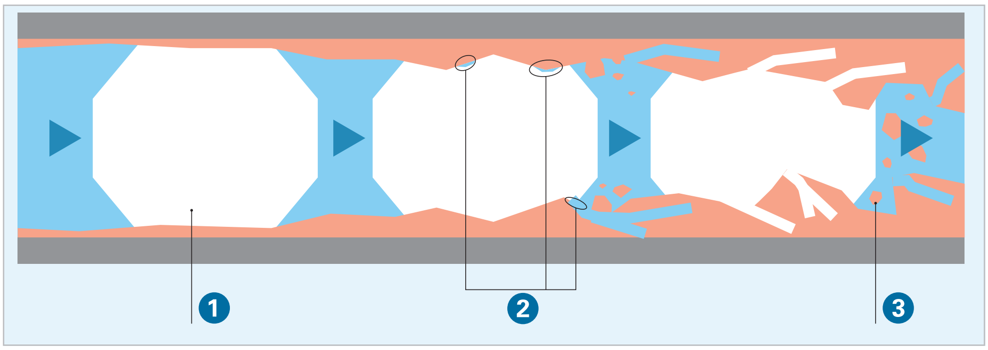
These include:

- Nutrients from the surfaces that are in contact with the drinking water
- Grease chambers in fittings
- Diaphragms in solenoid valves (tie rods with trapped water)
- Flushing zones in filters that can be backwashed

✚ **In order to maintain drinking water hygiene, the simplest measure of regular flushing of all taps at maximum flow is recommended.**

If, in addition, the cold and hot drinking water distribution lines are cleaned once a year using **air impulse flushing**, strong bacterial growth is effectively and preventively reduced.

The air impulse flushing method generates large turbulences on the surfaces. This minimises biofilm. Water and air work together: in a turbulent, but controlled manner.



GII.19
Air impulse flushing processes

1. Bubbles of exactly calculated dimension are on their way.
2. At the interfaces of air and water, large turbulences are created.
3. Deposits are gently and effectively removed.

4.3 Monitoring

The changes in drinking water quality at the domestic water inlet and the consumer's use of drinking water can rarely be determined in advance today. It is therefore important that drinking water quality is monitored before putting the drinking water installation into operation and during the use of the object.

While in many places the chemical composition of the drinking water changes little over longer periods of time, the number of bacterial cells show large seasonal differences, which are already detectable at the domestic water intake. If a legionella sampling is prescribed, this can by no means ensure the monitoring of drinking water quality, since the time intervals are twelve or more months apart. On the other hand, continuous monitoring ensures that drinking water hygiene remains at a high level during the object's operation. The monitoring process takes into account both the existing drinking water quality and the type of the building.

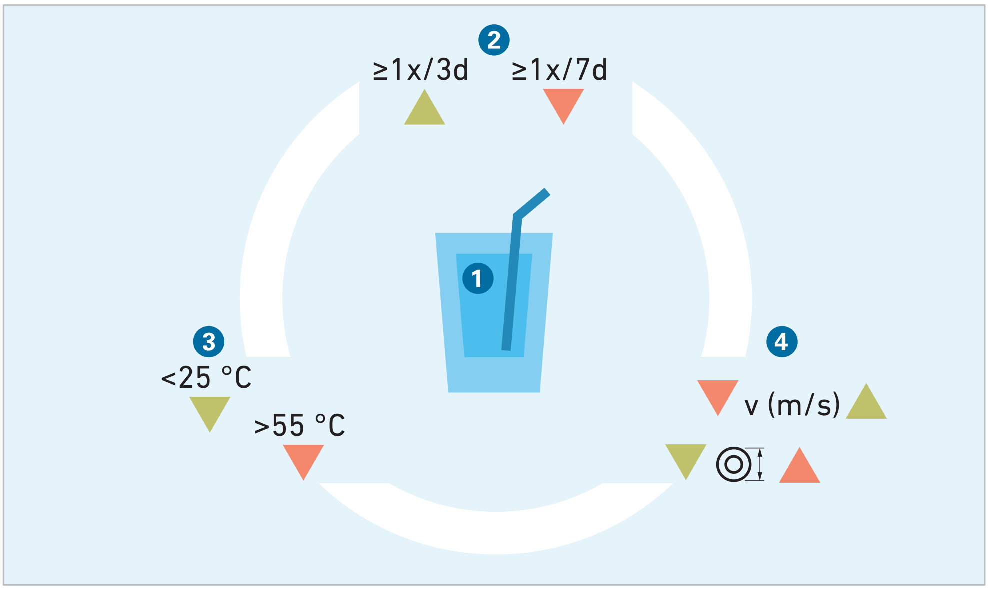
The following measures are recommended for successful monitoring:

- Monitoring the cold and hot water temperature.
- Microbiological sampling must be carried out in which the germ count and pathogenic bacteria such as legionella, pseudomonas, E. coli or enterococci are recorded.

Monitoring the temperatures

+ The simplest approach to reducing the risk of contamination in drinking water hygiene is the constant monitoring of cold and hot water temperatures.

Although the temperature is an indirect parameter, however, it is directly related to the risk of contamination: If the cold drinking water does not exceed 25°C, the risk of microbial contamination is low. If temperatures above 50°C are measured in the hot water distribution – especially in the circulation return line – hardly any germs are to be expected there as well.



GII.20
Relationships between temperature, flow rate and water exchange

(simplified representation)
Source: Thomas Kistemann: "Für den dauerhaften Erhalt der Trinkwassergüte", 2014 (available only in German)

Green Drinking water, cold
Red Drinking water, hot

1. Drinking water quality
2. Water exchange
3. Temperatures
4. Flow (depending on pipe diameter)

Carrying out microbiological sample analysis and evaluation

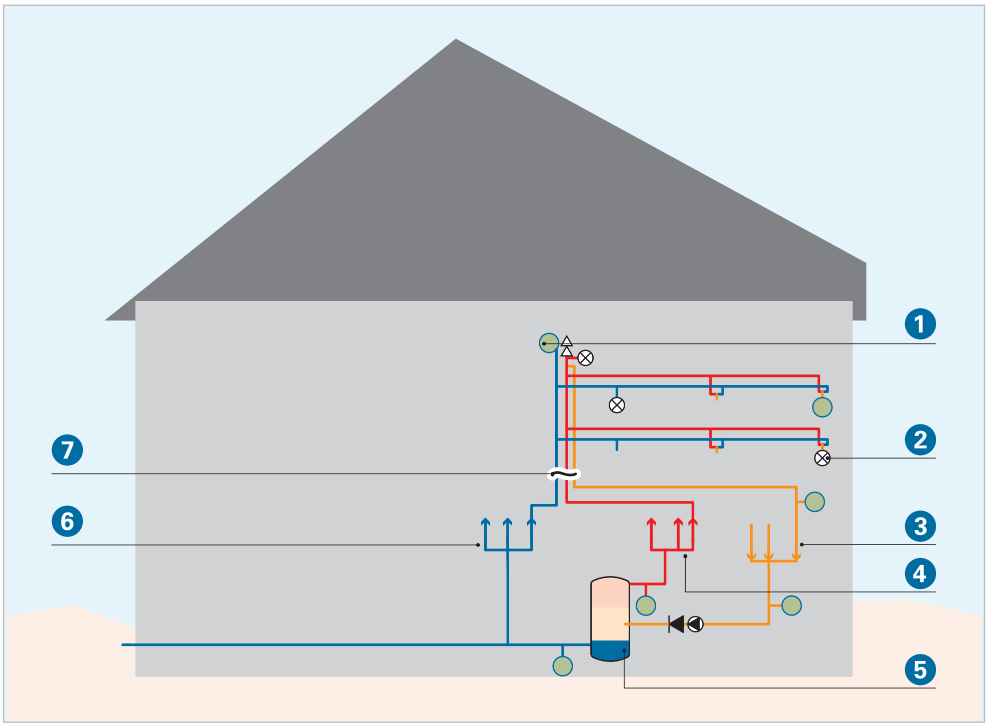
Sampling is necessary to ensure the water quality and to check the bacteria concentration in drinking water. This allows operating companies to identify problems early and respond to them. The following aspects must be taken into account during the sampling:

☑ During the sample analysis and evaluation for legionella: Not only the legionella pneumophila, but also the legionella species (spp.) (totality of all legionella) must be recorded.

☑ When sampling for legionella in cold drinking water: It is also recommended to co-determine pseudomonas aeruginosa, since this bacterium has a high contamination in drinking water hygiene.

Specifying sampling points

Determining the sampling points is always considered a team effort. Here, it is recommended to cooperate with **designers**, **staff of the engineering department**, **microbiologists** and **medical specialists**. This is the only way in order to cover all aspects of sampling, technology and users satisfactorily. It is important to sample the hot and cold drinking water.



GII.21
Sampling points inside the house

1. Sampling point
2. Additional sampling points ⊗, if further investigation is considered
3. Circulation
4. Hot water
5. DHW heater
6. Cold water
7. Pipelines on individual floor levels

When determining the sampling points, the following aspects should be considered:

☑ Defining sampling points in both hot and cold drinking water.

☑ Determining sampling points in the cold water distribution according to the distribution concept.

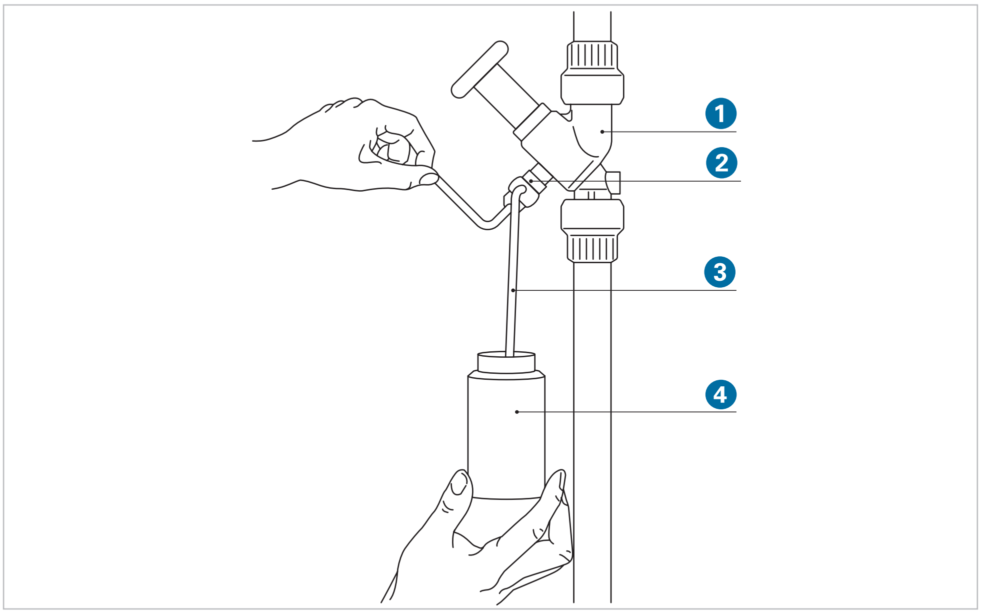
☑ Sparsely used taps and their distribution (washstand in the Installation room, shower for caretaker, garden tap in objects without garden, etc.) require special attention.

☑ Installing more sampling points in areas with sensitive use, (kitchen, operating equipment, etc.).

The installation of sampling angle valves in wash basins has the benefit of systemic sampling without involving the fittings of the washbasin. Sample analysis and evaluation of single-lever mixing valves is problematic, since fats in the mixer unit can lead to severe microbial contamination. The disinfection of a mixer unit is only possible if it is disassembled and cleaned in advance.

Ensuring regular sample taking

In order to maintain a safe condition of drinking water quality today, increased emphasis is placed on **regular measurement of the bioburden.** Changes in the number of bacteria provide insight about the stability of the drinking water and point to taps with high concentrations of germs.



GII.22
Sampling at the JRG Legiostop valve
1. JRG Legiostop
2. JRG Sampling valve
3. Discharge tube
4. Container for collecting the sample

☑ Depending on the object type, sample analysis and evaluation of the cold and hot drinking water must be carried out.
☑ It is essential to include critical building areas in the sampling.

One of the major sources of error is found in the sampling process itself, since the disinfection of the sampling point is often performed insufficiently. A remedy is provided by **sampling valves** with temperature indicators or sampling angle valves with sterile disposable parts.

4.4 Intervention

If the drinking water sample analysis and evaluation detects a **high concentration of bacteria or pathogens**, this points to the fact that preventive measures were neglected in most cases. It is therefore important – especially in existing buildings – to ensure that the preventive measures are implemented, at least in the basement distribution lines and in the riser pipes, before intervention measures are taken.

If the drinking water installation is still contaminated, intervention will help.
The implementation of interventions should be kept as minimal as possible and used only as a last resort to ensure a high drinking water quality. Particular attention should be paid to an overall view of the drinking water installation.

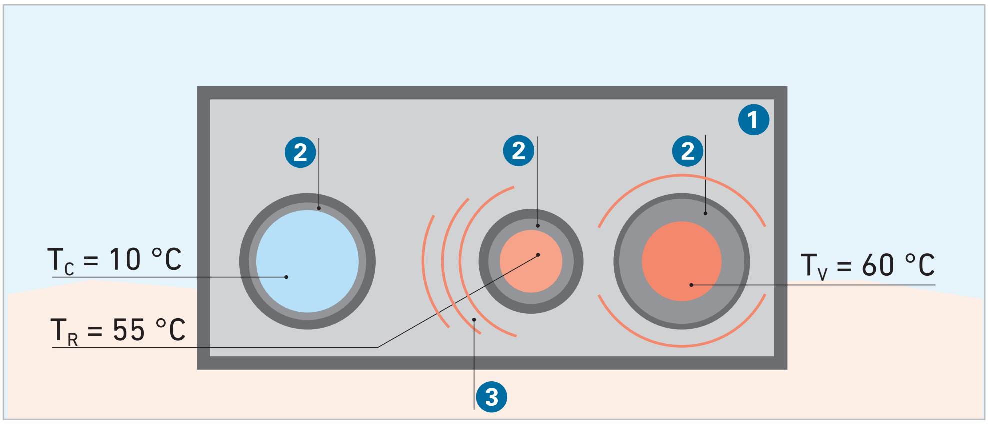
In order for an intervention to be successful, the following measures are recommended:

- Proceeding with thermal disinfection
- Proceeding with chemical disinfection

Proceeding with thermal disinfection

If applying thermal disinfection, each tap must be flushed for at **least three minutes** with hot water exceeding 70°C, as legionella can be quickly killed at these temperature ranges. However, this time span of three minutes should not be exceeded because the cold drinking water otherwise warms up to the critical temperature zone, which in turn triggers a counterproductive effect – namely microbiological growth in the cold water.

It is recommended that the hot water flushing be switched individually in series, so that the heating of the shaft distribution can be limited. The thermal disinfection is often carried out during the night in times when taps are rarely used.



GII.23
Heating the cold water

Cold water can warm up to over 25°C within a few hours.

1. Shaft layout with pipelines, T = 22 to 28°C
2. Insulation
3. Thermal radiation

T_C Temperature, cold water
T_R Hot water temperatures, return line
T_V Hot water temperature, supply line

Proceeding with chemical disinfection

In contrast to the thermal process, chemical disinfectants inject **substances** into the water that fight germs and bacteria in the water. It is important that the disinfectant can reach all areas of the contaminated system in order to be able to act directly on the microorganisms. Therefore, hydraulic balancing is of the utmost importance.

Germinating in drinking water installations is usually detected during periodic sampling and only affects part of the installation. If a further sample analysis and evaluation is carried out, it may be that the contamination is partly at a lower level, but spreads across the **entire drinking water distribution line**. As a result, an intervention not only in hot water, but also in cold drinking water is necessary because a microbiological base load of cold water enters the hot water.

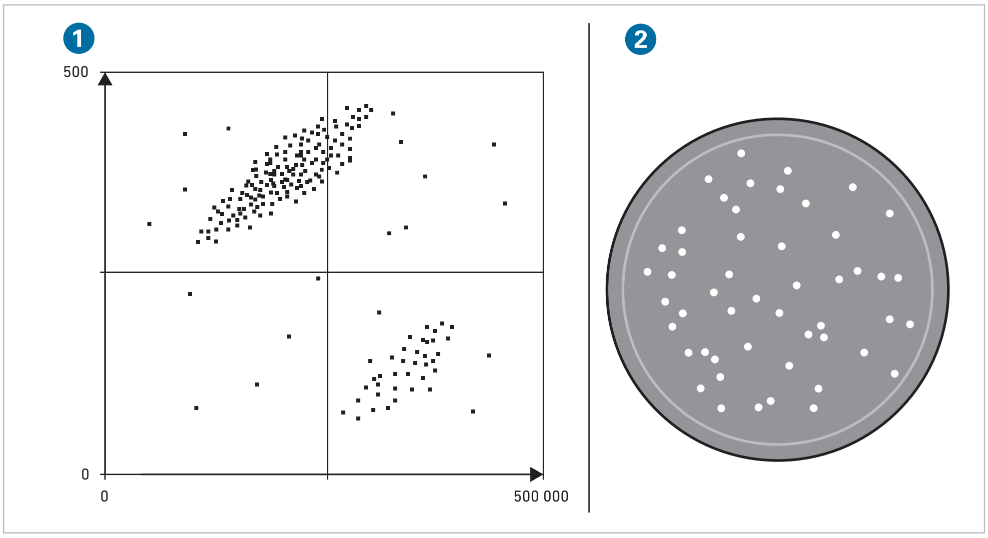
+ **Preventive measures must be taken before the disinfection method is introduced – hydraulic balancing in the pipes and periodic flushing are mandatory.**

When using the chemical disinfection method it is recommended to create a **hygiene plan** that includes periodic sample analysis and evaluation. Before a chemical disinfection is initiated, some points must be clarified. Chemical disinfection is only successful if the following particular points are observed:

- ☑ Analysing the drinking water quality (chemically and microbiologically)
- ☑ Recording the various materials that come in contact with drinking water
- ☑ Determining the hydraulic states of the cold and hot water
- ☑ Recording operating conditions and critical connections of the installation
- ☑ Recording existing water treatments at the domestic water inlet
- ☑ Assessment of the "intended operation" of the drinking water installation (no stagnation longer than three days)

Bacteria detection

Most bacteria cannot be detected by using the culture method. State-of-the-art methods like flow cytometry are more accurate and faster.



GII.24
Bacteria detection

Comparison of the detected cells in the drinking water with the cultivation method and with flow cytometry

1. Flow cytometry (FCM)
2. Cultivation method (HPC)

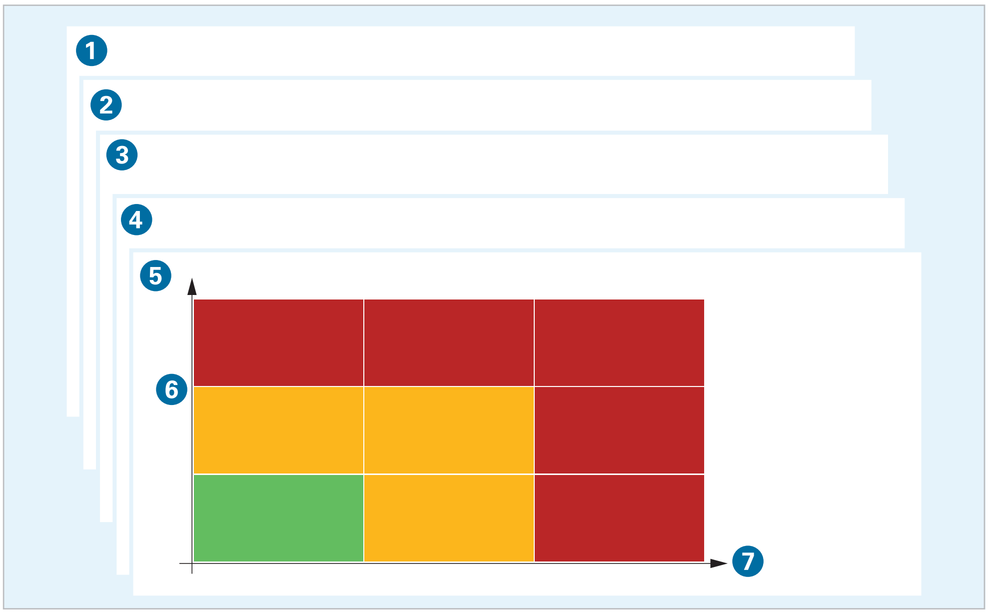
4.5 Risk assessment

The measures taken in the three steps **prevention, monitoring** and **intervention** form the cornerstones to ensure a high level of drinking water quality from the feed-in point to the tap.

✚ **The risk assessment of the drinking water installation is an important process, especially in larger buildings, since the state of drinking water quality can change rapidly due to numerous influencing factors.**

However, changes in the use of the objects as well as adjustments in the water utility companies necessitate a **re-evaluation** of the measures taken from time to time. And this is not because the energy and drinking water prices will continue to rise and thus the operating costs will also gain in importance. The operating companies of the object carry out this risk assessment on an ongoing basis and develop **emergency scenarios** in the event of limited drinking water quality at the domestic water inlet.

In the risk assessment, all relevant influencing parameters are assessed together. During this assessment, microbiological analyses and the recorded temperature values are examined in order to determine how often deviations occur in the critical temperature ranges. This risk assessment can be carried out using the recorded temperature values as well as the microbiological analyses.



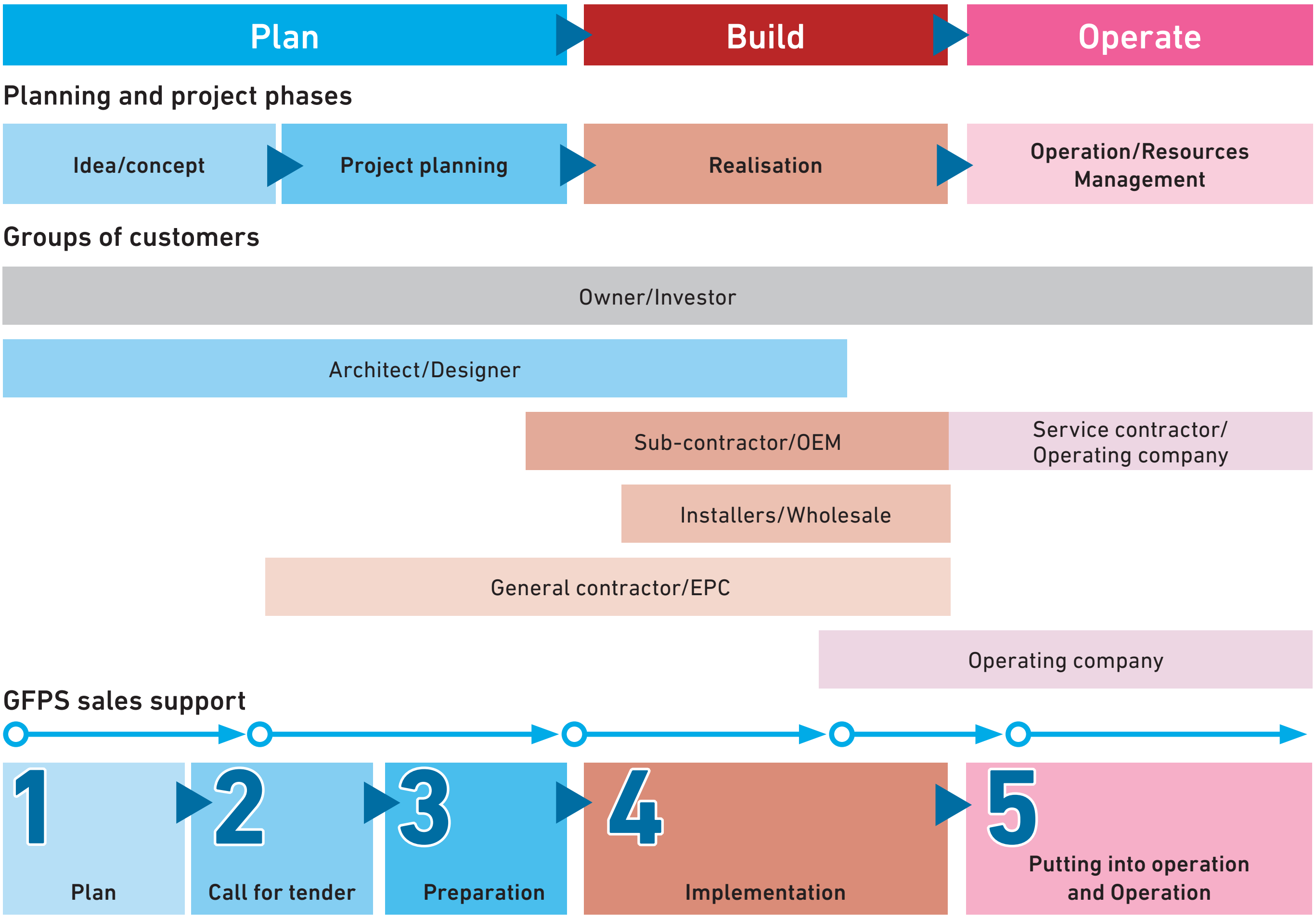
GII.25
Parameters of a risk assessment

1. Drinking water consumption
2. Microbiological drinking water analyses in cold water
3. Microbiological drinking water analyses in hot water
4. Cold water temperatures
5. Hot water temperatures
6. Germination potential
7. Probability

5 Services

The key task of generating more added value for individual product solutions is met by GF with a carefully coordinated and flexible service portfolio. In close cooperation with the sales companies, market segments and product managers and sales colleagues, solutions are found for the customer's challenges and new business opportunities are developed to complement the existing products. During the design and planning, the realisation and the operation, GF will support the clients, architects, designers and installers in all project phases.

GII.26
Sales support and service solutions from GF in all project phases



Planning: Specifications and call for tender

☑ **Efficiency and innovation right from the start**

Our engineers will assist you with practical solutions, comprehensive technical know-how and expert advice on using our products for your applications.

We calculate and simulate installations and support you throughout the call for tender phase.

Engineering Services

- Technical presentations/evaluation
- Complete solution for material, product and size
- Material selection vs. chemical analysis vs. service life
- Pipe class documentation and specification
- Specification design, testing and compliance
- Assistance during the calculation for pipe hangers and their layout
- Metal-to-plastic drawing adaptation
- Hydraulic calculations and modelling
- Dynamic-mechanical stress analysis
- Structural analysis
- Seismic calculations
- Finite Element Analyse (FEM)
- Standard details
- CO_2 sustainability calculations
- Regulated testing laboratories

Technical draughting

- CAD drawings
- CAD Design libraries

Software, Tools and Training

- Consultation on our systems

Offers and Cost Estimates

- Procurement and implementation of third-party products

Specialised engineering services

- Quality Control: “Fit-for-Service” NDT
- Individual product solutions
- Prefabrication
- “Track and Trace” platform
- Asset Management

Call for tender: Project preparation

☑ **Effective and straightforward right from the start**

Equipped with the right know-how, the risk of faulty design and incorrect construction is practically eliminated.

We support you with the project-related documentation of our products, help you with the correct dimensioning and thus help to avoid unnecessary costs.

Engineering Services

- Technical presentations/evaluation
- Complete solution for material, product and size
- Material selection vs. chemical analysis vs. service life
- Specification design, testing and compliance
- Seismic calculations
- CO_2 sustainability calculations

Software, Tools and Training

- Technical advice on our systems

Preparations of the construction sites

- “Track and Trace” platform
- Asset Management

Tender documents

Easy download of the tender texts for our systems in various formats, for interested planners, building authorities, architects, etc.

- Various data formats can be selected: Word, Excel, RTF, PDF, Text, GAEB XML, GABE 90, DATANORM 5, ÖNORM
- Select the relevant assortment. (Other assortments can be added to the expert area in the same way).
- Klick the **Export** button.
- Select the output format.
- Choose between download or delivery by e-mail.

➨ www.ausschreiben.de

Preparation: Material, order and delivery

☑ **Perfection guaranteed, from planning to implementation**

We check the feasibility with you, verify all project details and support you in all phases of preparation.

We assist you in the preparation of parts lists, material excerpts and in the accurate calculation.

We verify availabilities, suggest the best possible procedures and organise low-cost rental equipment that can be returned after completion of the construction phase.

Engineering Services
- Technical evaluation of the applicable documentation

Warehouse management
- Global and local inventory
- Management of products with long lead times and forecasts
- Logistic support of products up to the construction site

Preparations of the construction sites
- “Track and Trace” platform
- Asset Management
- Rental pool for welding machines and tools

Implementation: Execution of the project

☑ **In situ safety and technical know-how**

We walk you through the installation process and ensure it smooth and compliant with the rules and regulations.

Focusing on the on-time completion of your project, we train the local staff and certify your employees after the successful training.

We inspect welds and provide assistance in documenting and ensuring the traceability of installed components.

Training
- GF certified training of the installation team
- On-site support

Documentation
- Technical documentation
- Inspection certification

Specialised engineering services
- Individual product solutions
- Prefabrication

Warehouse management
- Inventory on-site and out-of-town
- Rental pool for welding machines and tools

Construction Management
- “Track and Trace” platform
- Asset Management

Putting into operation and Operation: Testing and evaluation

☑ **In-situ safety and technical know-how**

We confirm the proper and professional implementation, conducting professional tests and analyses.

We check and record the installation work carried out in cooperation with the responsible on-site staff and ensure that the hygienic conditions of the installation are flawless.

We train the entire staff so that they can comply with the intended and safe operation.

Engineering Services

- On-site welding inspection
- On-site assistance with pressure tests

Specialised engineering services

- Quality Control: “Fit-for-Service” NDT

Maintenance and Repair

- Spare parts management for valves, sensors and machinery

Construction Management

- “Track and Trace” platform
- Asset Management

The basics

Media

III

Media

1 Water

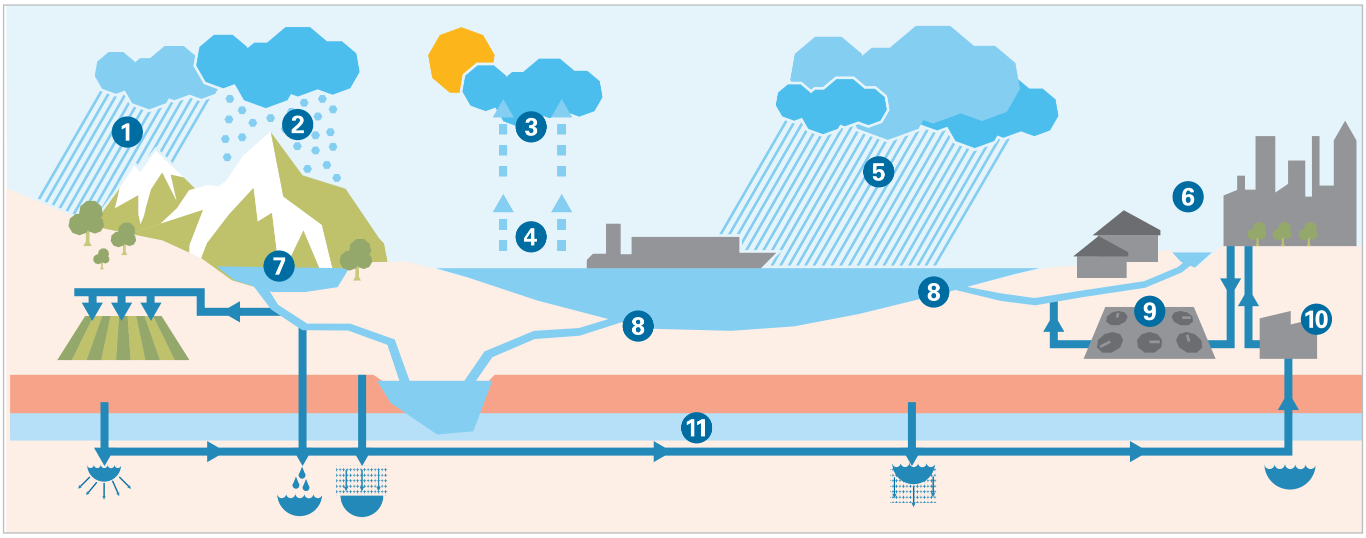
1.1 Introduction

Water is the basic requirement for all life on earth. It is our most important food and cannot be replaced by anything else.

1.1.1 The blue planet and the water cycle

We call earth the blue planet, shaped by the vast expanse of water in the oceans. These cover about 70% of our earth's surface. An almost unchanging and unimaginable amount of water. Most of it is salt water (sea water), only about 2.5% of the existing water on the ground is fresh water. Therefore, we can only use a small fraction of this supply, as more than three-quarters of freshwater is bound as ice in glaciers and the polar regions.

Only a small amount of fresh water is available to us, which is why careful and sustainable handling of this water is extremely important.



Colour	Meaning
	Groundwater recharge
	Surface water
	River bank filtration
	Groundwater
	Raw water

1. Rain
2. Snow
3. Condensation
4. Evaporation
5. Precipitation
6. Consumer
7. Dam
8. Return to the sea
9. Sewage plant
10. Water works
11. Groundwater table

GIII.1
The water cycle

Water circulates in large cycles on earth. The heat radiation of the sun constantly causes water to evaporate into the atmosphere, the dissolved components, especially salts, are left behind. Aqueous vapor condenses in colder altitudes to clouds. Part of it returns to earth as “sweet” rainwater or as snow. The precipitation wets the plants and partly evaporates again, fills lakes, feeds the springs of the streams and lets rivers flow (surface water), soaks in the soil and feeds the underground water supply (groundwater). Rivers carry the water to the sea (runoff), from where it evaporates again and thus closes the cycle.

Water greatly influences our climate and is responsible for the formation of weather – above all caused through its capacity as a heat energy storage. The incoming solar energy is stored in the oceans. This regionally different warming of the oceans, as well as the concentration gradient (salinity), create global ocean currents that transport very large amounts of energy (e.g. the Gulf Stream). Without the Gulf Stream, the climate in Central and Western Europe would be more like in the Arctic.

1.1.2 Cultural historical background

From the first nonnomadic people to the high cultures of antiquity to modern times, the conflict always focussed between too much and too little water. This conflict was always present, whether a harvest was lost due to a drought or floods threatened life and property. Water became the subject of mythology and natural philosophy. Even today, water has a special place in most religions of the world, especially where the question of survival depends on solving the numerous water problems.

Importance of water for economy and development

Water is a very important factor in economic development. Most major cities border on rivers, lakes or seas. Water is not only needed to supply people with drinking water. Waters for transporting goods, bathing waters for tourism and fish-rich waters for the distribution of food also play a large, economic role. Rainfall is also crucial for the agricultural use of land. In many developing countries too little or only polluted water is available. The industrial nations are characterized by sufficient water reserves of good quality.

But water can also have a negative impact on the economy and development: As a result of its geological destructive power, water can cause great economic damage and accelerate the spread of pathogens immediately after such catastrophes.

Technical significance of water

In many machines and power plants, water has always been used to generate energy or do mechanical work. Water is used in power plants due to the high heat of vaporization for cooling.

An old example where water was used to do mechanical work is the watermill. Hydroelectric power plants also use running water to work in turbines. Steam is used in technology to drive steam engines and steam turbines.

Water in religion

Water is the epitome of life. Due to the great importance of water, it was no coincidence that the earliest philosophers counted it among the four primitive elements. Water is often a high priority in religions. Often the purifying power of the water is invoked; for example, Muslims use water for the ritual washing of feet before entering a mosque, or in the Hindu faith, the ritual bath in the Ganges river is regarded as purifying. In the Christian church, holy water and immersion in water at baptism play a special role.

1.1.3 The sanitary revolution

At the end of the 19th and the beginning of the 20th, recurring epidemics in European cities led to the improvement of drinking water and sanitation. These measures improved life expectancy and quality of life to a sustainable level. It is referred to as the **Sanitary Revolution**.

The drinking water supply, drinking water hygiene and wastewater treatment are still of the highest political importance today.

In countries where the sanitation infrastructure has been destroyed or is non-existent, the recurrence of threatening diseases such as cholera and typhus must be reckoned with.

For a long time, there was need for action in the field of drinking water hygiene in the public perception due to the good sanitary infrastructure, since potential risks seemed to be under control through a reliable system of risk regulation. New pollutants, in particular micropollutants and pathogens, which were not covered by the previous risk-management procedures, have now proved to be relevant for close monitoring.

1.2 Water chemistry

Water consists of the elements hydrogen **H** and oxygen **O**. In its pure state, water does not have any taste or odor. The physical properties of the water are highly dependent on temperature and pressure. It is the only chemical compound that can occur in nature in parallel and in all three states of matter, liquid, solid and gaseous. At 20°C water is liquid, at 0°C it freezes and at 100°C it becomes gaseous.

Water has unique physical and chemical properties. These qualities determine its role as a carrier of life and make water the starting point of a multitude of interactions that shape our "Blue Planet".

The special properties of water are due to the structure of the water molecule and the nature of the **covalent bonds** (also referred to as atomic bonding or electron pair bonding) that are linked between oxygen and hydrogen atoms. The resulting concatenation of water molecules by means of hydrogen bonds leads to the high melting and boiling point of the water as well as the density anomaly (water has the highest density at 4°C).

Another feature is its ability to dissolve an extremely wide range of substances. Therefore, on earth, water cannot be found in its pure state. Depending on the origin, water has dissolved the most varied substances in more or less large concentrations. When substances are dissolved in the water, the physical properties of the water change considerably. This property should be considered especially in the treatment of drinking water.

1.2.1 Temperature

The water's temperature influences the speed of chemical and biological processes. Likewise, the solubility of solids and gases in the water depends on the temperature. The hotter water is, the more salts it can dissolve. Conversely, with gases, the colder a gas is, the more gas the water can absorb.

For example, the surface tension and viscosity of the water decreases with increasing temperature.

1.2.2 pH value

The pH value is a measure of the acidic or basic character of an aqueous solution. When calculating the value, it is represented as a negative ten-logarithm of the hydrogen ion activity (H^+) and is a dimensionless number.

$$pH = -\log_{10} (\alpha(H^+))$$

The pH scale ranges from pH 0 to pH 14. A pH value of pH 0 to pH 7 is referred to as acidic and from pH 7 to pH 14 it is referred to as basic (alkaline). In pure water, there are no hydrogen ions, so the pH value is 7 (pH neutral).

Since the scaling is logarithmic, a change from pH 7 to pH 6 corresponds to a tenfold increase in the **H^+** ion concentration.

Acids

Acids are chemical compounds that can transfer protons **H^+** to a reaction partner (proton donor). These acids react with water to form oxonium ions (**H_3O^+**) – these acidic ions lower the pH value of the solution. Depending on the concentration and strength of the acid, the pH value drops (< pH 7).

Bases

In chemistry, bases are referred to as compounds which are able to form hydroxide **OH^-** in aqueous solutions and releasing **H^+** ions. Thus, a base is the counterpart to an acid and is able to neutralize the latter. Depending on the concentration and strength of the base, a pH value of > pH 7 is established.

1.2.3 Water hardness

Water hardness is a measure of the concentration of hardness ions, which mainly include calcium **Ca^{2+}** and magnesium **Mg^{2+}**. These hardness ions can form water-insoluble lime (calcium carbonate **$CaCO_3$**). This reduces the heat transfer, for example in the water heater, it leads to a blockage of pipes and increased hygiene problems (**biofilm**).

Definitions	
Total hardness	Sum of alkaline earths, carbonate hardness and non-carbonate hardness
Carbonate alkalinity	Calcium and magnesium are combined to carbonic acid (bicarbonate **HCO_3^-** and carbonate **CO_3^{2-}**).
Non-carbonate alkalinity	Compounds exist as sulfates, chlorides or nitrates.

The majority of the water hardness is caused by the infiltration of rainwater in the soil. Depending on the type of rock in the subsoil, minerals in the water dissolve. Lime is practically insoluble in pure water. Nevertheless, lime can be dissolve in water, which is attributable to the carbon dioxide. Carbon dioxide forms carbonic acid with water, which in turn is able to dissolve lime (calcium hydrogen carbonate **$Ca(HCO_3)_2$**).

The amount of hardness ions dissolved in the water depends on the concentration of carbonic acid in the water. If a given amount of carbonic acid cannot dissolve lime any more, it is called a saturated solution. With respect to the lime-carbonic acid ratio, the water is now in equilibrium. However, if the lime-carbonic acid ratio is upset, usually by increasing the temperature and the resulting reduced solubility of carbonic acid in the water (outgassing as **CO_2**), precipitate the hardness ions and form insoluble compounds (**lime**).

The total hardness is calculated from the sum of the concentrations of hardness ions. Drinking water with little lime is considered soft and drinking water with lots of lime is considered hard.

1.2.4 Electric conductivity

Electric conductivity is a physical quantity that describes the ability of a substance to conduct electrical current. The unit for the conductivity is µS/cm (microsiemens per cm). Absolutely pure water is dielectric with a conductivity of 0 µS/cm. In water treatment (for example, cooling water), the conductance is used primarily to estimate the amount of dissolved ions. The lower the value of the conductivity, the lower the salinity of the water.

1.2.5 Turbidity

The turbidity of water depends on the content of undissolved substances in the form of minute particles. The turbidity, also called cloudiness or haziness of a fluid, gives a subjective visual impression of a liquid.

Qualitatively, a distinction is made between clear and opaque. The turbidity can also be determined quantitatively by visual measurements (turbidity meter). Normally, turbidity is expressed in **NTU** (Nephelometric Turbidity Units).

1.2.6 Volumetric mass density

The volumetric mass density ρ of a substance is its mass per unit volume. Thus, the volumetric mass density is the quotient of the mass m of a body and its volume V.

$$\rho\ [kg/m^3] = m / V$$

Which is the volumetric mass density is the quotient of the mass m of a body and its volume V.

In general, substances expand with increasing temperature, which reduces their specific gravity or their density. An exception are substances with an anomalous decrease in density, such as water. Water has its maximum density at 4°C. Below 4°C water expands again.

This anomalous decrease in density of water is vital to life on earth. As water at 4°C has the highest density, colder water floats on top it. In winter time, the temperature at the bottom of a lake is thus not colder than 4°C. The lake freezes from above and not from below. Therefore, it is possible for fish to survive the winter at the bottom of a lake or river.

1.2.7 Viscosity

The viscosity is a measure of a liquid's (fluid) resistance to motion. The greater the viscosity, the thicker or less fluid the liquid is. The lower the viscosity, the more fluid or flowable the substance is. A liquid with comparably low viscosity can thus flow faster under the same conditions. In drinking water, the viscosity decreases accordingly with increasing temperature, that is to say, the water can flow faster.

The particles of high viscosity liquids are more strongly bonded to each other and are more immovable due to this internal friction. Viscosity (more precisely: dynamic viscosity) is given as η viscosity at 20°C in milli-pascal seconds [mPa $\times$ s].

The viscosity is based on the internal friction of the fluid. The temperature influences this friction strongly, which is why the viscosity must always be mentioned with the associated temperature.

1.2.8 Reduction potential

The reduction, or redox, potential describes the ability of a solution to acquire electrons and thereby being reduced. (oxidation-reduction potential, also known as **ORP**). The ORP expresses how much one substance is either oxidized or reduced with another.

During the oxidation, electrons are released. This reaction releases energy and thereby increases the redox potential. A high redox potential is therefore an indication of a high oxidation power of a solution. During the reduction process, an electron is absorb and its energy is removed from the environment. The redox potential of the solution decreases.

The redox potential of a liquid can be measured with a redox meter and is measured in millivolts [mV]. A positive redox potential means that a compound can be oxidized by releasing electrons. A negative redox potential describes the reducing power of a solution. A negative redox potential describes the reducing power of a solution.

1.2.9 Surface tension

The surface tension is the reason that liquids tend to keep their surface area as small as possible. It is a force due to molecular cohesive effects whose direction of action is parallel to the surface of the liquid. Thus, the surface of a liquid is always under tension. Therefore, raindrops form spheres and some insects can run across the water.

For example, the surface tension can be reduced by adding a detergent. The molecules of the detergent settle on the water surface, so that the high surface tension of the water molecules is lost.

1.3 Drinking water

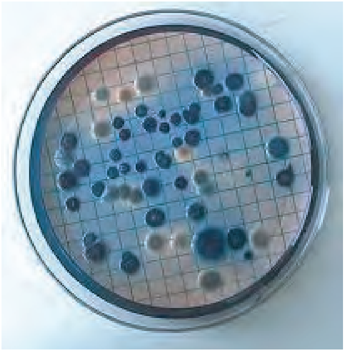
1.3.1 Microbiology: There is life in the water

Drinking water is extracted from natural waters such as groundwater or surface waters. The number and type of naturally occurring microorganisms can be very different. After treatment in the water works, drinking water still contains countless, different microorganisms. These microorganisms are usually harmless marine life and pose no danger to human health.

The term microorganisms includes unicellular organisms such as bacteria, algae, protozoa and viruses. All of these microorganisms are so minuscule that they are invisible to the naked eye.

A bacterium can be observed under a microscope or visualized after propagation on special nutrient media in a **Petri dish**.

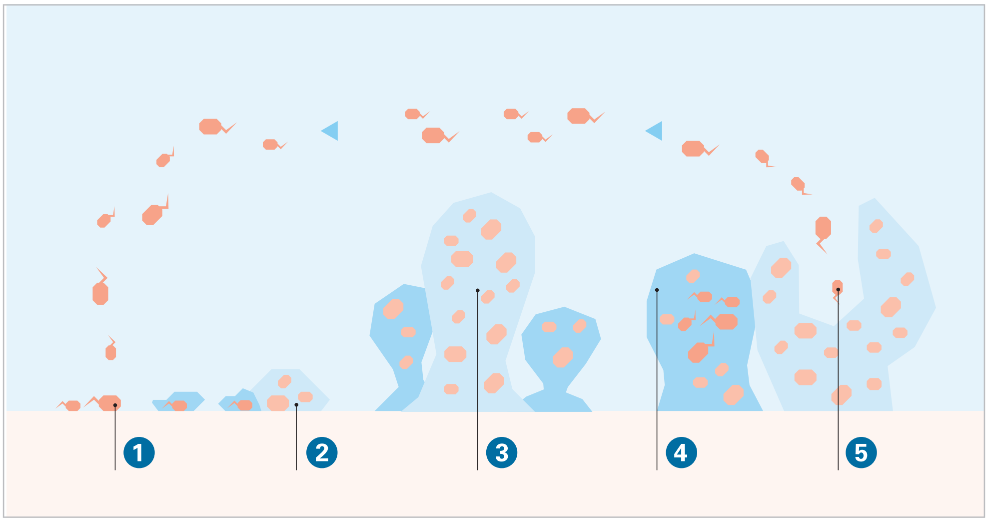
GIII.2
Petri dish with culture



1.3.2 Biofilm

Bacteria live in biofilms to better withstand changing environmental conditions. It is a survival strategy that bacteria have been using for about 3.5 billion years.

On water-contacting surfaces (e.g., pipe walls, interior surfaces of containers), bacteria and other microorganisms (single-celled organism and fungi) form slimy substances (extracellular polymeric substances), especially under stress. These substances provide excellent protection for the individual microorganisms (including pathogens such as legionella and pseudomonas) and enable them to survive despite altered conditions such as drought, elevated temperature, or the presence of a disinfectant. Several hundred million bacteria per cm^2 live in a biofilm.



GIII.3
Formation of a biofilm

1. Attachment
2. Settlement
3. First growth
4. Increased growth
5. Replacement and propagation in the system

1.3.3 Pathogens

In addition to microorganisms in drinking water, which are absolutely harmless to humans, there are also disease-causing agent, called pathogens. Fecal matter is the most common cause for these pathogens to enter the water. In natural waters fecal matter is only present in small numbers.

The quality of the drinking water is affected by the bacteria **Legionella**, **Escherichia coli** and **Pseudomonas**, as these can seriously endanger human health if drinking water management is not properly managed.

Especially, the distribution of drinking water in the last meters of the building causes more and more problems. The increasing comfort in the buildings and the simultaneously decreasing consumption of drinking water strongly promotes bacteriological growth and can lead to a proliferation of pathogens. Especially very young or elderly as well as immunocompromised persons can fall ill with inadequate drinking water hygiene.

Legionella

Legionella are waterborne bacteria. There are many different species in the legionella family. Especially the Legionella pneumophila is dangerous for humans, as this is the causative agent of "legionellosis", a serious form of pneumonia. Another illness caused by legionella is the "Pontiac fever". This is much more common, but this flu-like illness take a less serious course of disease than legionellosis.

Legionella are comfortable at temperatures between 30°C and 45°C which also provides them with optimum conditions for reproduction. Whenever possible, this temperature range in drinking water should be avoided.

Pseudomonas aeruginosa

Especially the species **pseudomonas aeruginosa** is very dangerous to humans. This species comes mainly from the sewage, but unfortunately finds its way into drinking water more often. It is a rod-shaped, actively moving bacterium. Pseudomonas aeruginosa can cause pneumonia, blood poisoning and wound infections. Persons with a weakened immune system are particularly affected. Therefore, pseudomonas are classified in clinics and other medical institutions as extremely critical.

Escherichia coli

The E.coli bacteria (also called **coliform bacterium**) are intestinal bacteria. Because of this, they are also considered a fecal indicator. Often deposits in drinking water are triggered by pollution, be it by storms, wastewater from farms or industrial facilities. It is one of the most frequent causative agents of human infectious diseases. The result is nausea, vomiting, fever and diarrhea.

GIII.4
Pathogens

1 Legionella

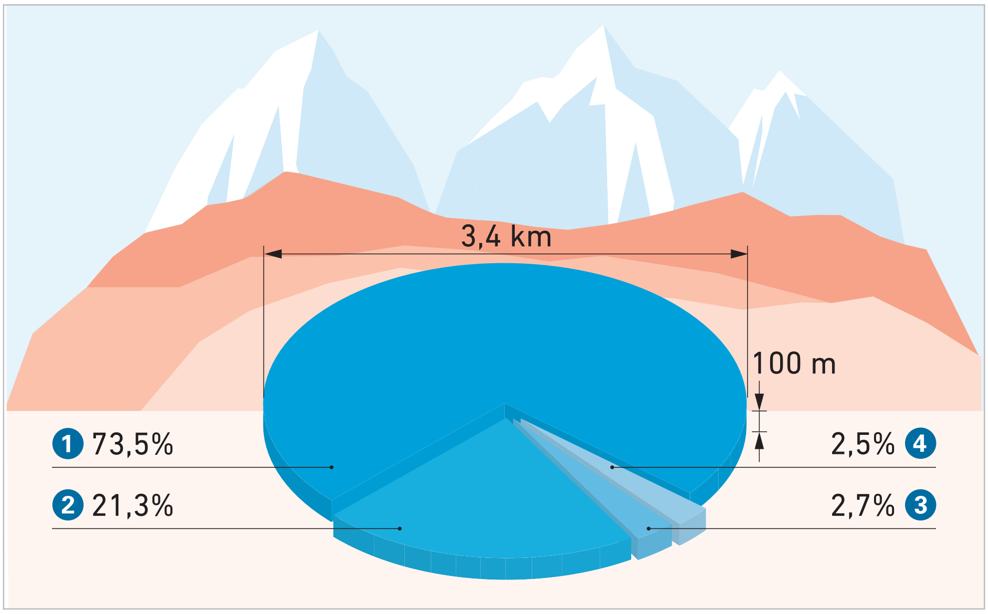
2 Pseudomonas aeruginosa

3 Escherichia coli

1.3.4 Production of drinking water

Clean drinking water is a very valuable resource. The drinking water supplied to the customers must be free of pathogens and must not contain any harmful substances. Every water supplier must check the quality of his drinking water. If the removal drinking water does not meet the chemical, microbial and organoleptic requirements, it must be treated.

The extraction of drinking water is highly dependent on the available water quality and therefore varies widely in different regions.



GIII.5
Different origin of the drinking water

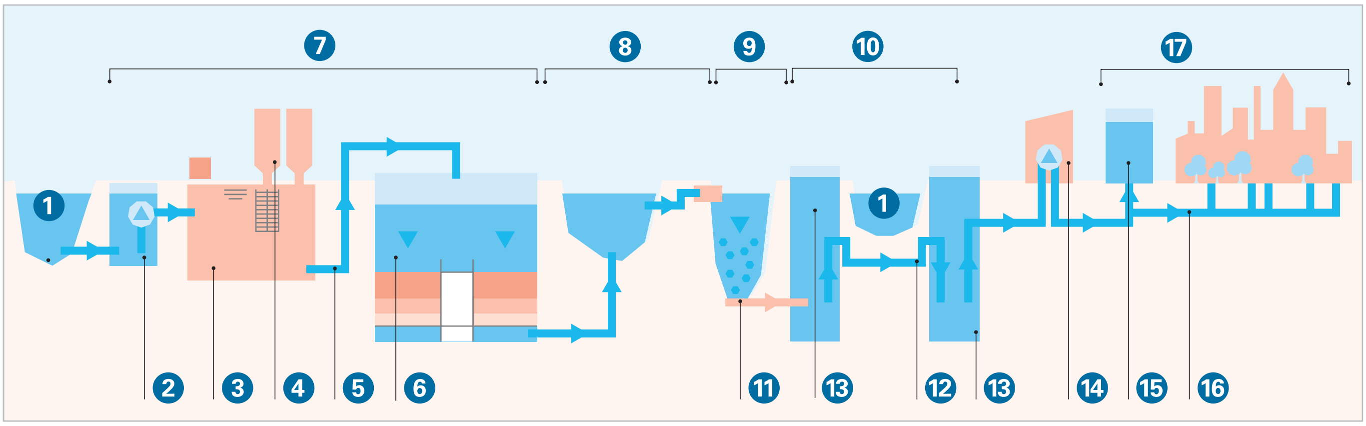
1. from the groundwater
2. from springs
3. from river bank filtration
4. from surface water

The path of drinking water begins with the removal of ground, spring or surface water by the water supplier. From there it is pumped into waterworks for the treatment of drinking water. Immaculate drinking water is stored by the water suppliers in a reservoir, from where it is distributed via a pipe system to the house connections.

Groundwater is caused by the seepage of precipitation and the seepage of water in the banks of rivers and lakes. It is the most significant reservoir of rain. During the seepage, the soil purifies the water naturally. Physical, chemical and biological processes take place.
After a transit time of 50 to 100 days, the water is not only clean, but usually also hygienically immaculate. The groundwater sinks through the different soil layers until it encounters water-impermeable layers. In order to extract the drinking water, the groundwater is pumped up again or it comes to the surface through natural sources.

When using **river bank filtration**, more and more drinking water is drawn in the nearby bank area of a river, which means that more and more of the river water trickles away and is purified in a natural way.

In river bank filtration and groundwater recharge, water suppliers use the natural filtering action of the soil to cleanse the water. In artificial groundwater recharge, pre-purified surface water (e.g., river water) is seeped into a large area. The groundwater produced in this way can thus be used to produce drinking water. Polluted wastewater can also be cleaned after intensive pre-cleaning with the help of the filter effect of the soil and used again as drinking water.



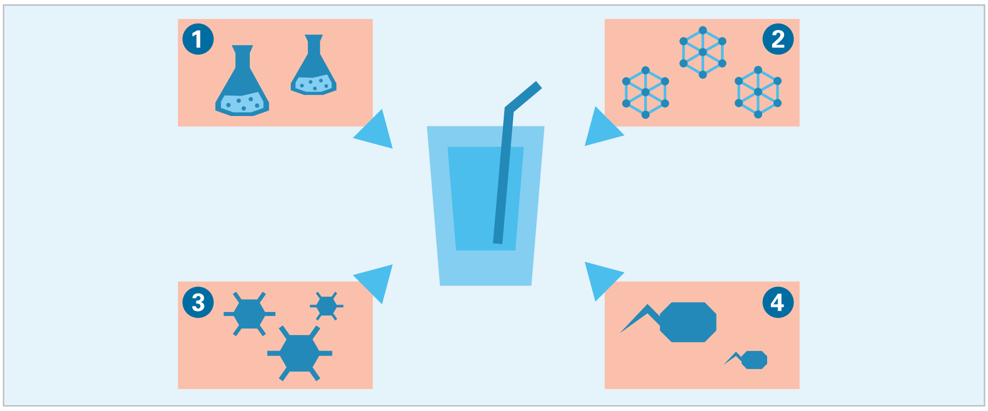
1 River
2 Pump station: Removal of surface water
3 Ozonation
4 Flocculation (here: storage tanks)
5 Addition of activated carbon powder
6 Quick filters, filter carbon, sand, gravel
7 Water treatment plant
8 Temporary storage
9 Slow sand filters
10 Collector wells
11 Water collection lines
12 Culvert in lifting operation
13 Fountain
14 Pumping station: Neutralization, disinfection
15 Water tanks
16 Pipes to the consumer
17 Drinking water supply

GIII.6
Drinking water production from rivers (as an example)

1.3.5 Drinking water quality and drinking water hygiene

Drinking water is an indispensable commodity that needs to be available to people in sufficient quantity and quality. It must be fit for human consumption and pure. In addition, it must be such that its consumption or use does not give rise to any risk of damage to human health, in particular due to pathogens.

The drinking water quality is judged by the drinking water hygiene, the chemical composition and the organoleptic properties such as smell, taste, appearance and colour. The requirements for the quality's consistency of the drinking water are usually regulated by law.



GIII.7
Requirements regarding drinking water quality and hygiene

1 Organoleptic parameters: Turbidity, taste
2 Chemical parameters: Hardness, salts
3 Pathogens: Legionella, pseudomonas, E.Coli
4 Indicator parameters: Colony count/germ count (sum of all microorganisms)

III

Organoleptic parameters

The decisive organoleptic parameters for drinking water are odor, taste, colouration and cloudiness. These parameters must be regarded as a warning sign, since these properties represent sensory perceptible characteristics.

Chemical parameters

The chemical substances in drinking water may only be present in concentrations that do not result in damage to human health.

Natural water also contains a diverse mixture of foreign substances. These enter the surface and groundwater through solution processes or biological activity. The composition varies greatly, depending on the source of the water. Some of these substances (e.g. heavy metals such as arsenic) can naturally reach levels that pose a threat to humans.

However, many substances only enter the water cycle through human activities. These are, on the one hand, naturally occurring substances (e.g. table salt), but their concentration is greatly increased, and, on the other hand, synthetic substances (such as pesticides, pharmaceutical residues) that are released into the environment solely as a result of anthropogenic activities. Many of these ingredients can have an adverse impact on human health.

Microbiological parameters

In order to assess the quality of drinking water today, the colony count (germ content) of the water is increasingly determined. This records all bacteria in the drinking water and proves the quality of the drinking water. Elevated colony counts indicate increased biofilm growth as most bacteria are present in the biofilm at the installation surface (only a fraction are found in the water). With increased colony count values, the causes must be determined and appropriate hygienic measures must be taken. A direct correlation between the colony count values and the detection of pathogenic bacteria is not necessarily given.

Assessment of the microbiological burden of pathogens in drinking water is often based on the concept of indicator germs. The idea behind this is, that with the investigation of a few, representative germs a reliable statement can be made about the general stress and possible health hazards of humans. For example, E.Coli bacteria indicate contamination of the water with fecal matter.

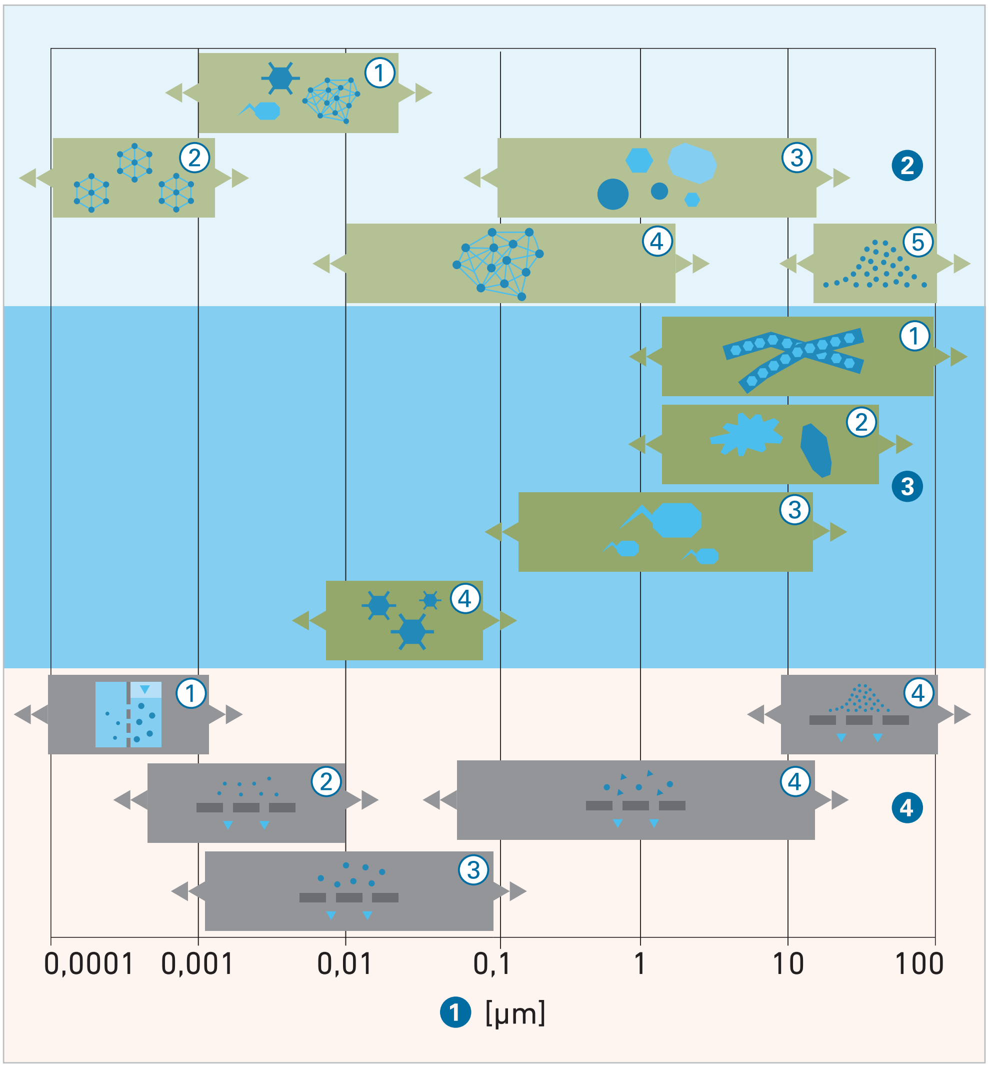
1.3.6 Treatment of drinking water

Very high demands are placed on the quality of drinking water. The water from the ground and surface cannot always meet these requirements, which is why it has to be treated.
Important treatment processes for drinking water are:

- Filtration
- Softening
- Disinfection

Filtration

In drinking water treatment, filtration is used to separate solids (particles). During **filtration**, a liquid penetrates the pores of a membrane that holds back the particulate solids. Depending on the pore size, particles are retained accordingly. The product is called **filtrate** or if membrane filtration is used, it is also referred to as **permeate**. Depending on the size of the particles that must be separated, the pore size of the membrane filter is selected.
For a coarse filtration of the water, a fine filtration is sufficient. If smaller particles must be separated, a distinction is made between microfiltration, ultrafiltration, nanofiltration and reverse osmosis.



GIII.8
Treatment of drinking water

1 Particle diameter

2 Water constituents
1. Organic components
2. Dissolved salts
3. Colloids
4. Organic macromolecules
5. Sand

3 Microorganisms
1. Algae
2. Protozoa
3. Bacteria
4. Viruses

4 Separation methods
1. Reverse osmosis
2. Nanofiltration
3. Microfiltration
4. Ultrafiltration

Fine filtration

Fine filtration is mainly used in building technology in order to protect the in-house piping network from contamination. The drinking water from the water supplier is usually impeccable. However, foreign particles often enter the drinking water during its distribution. A fine filter at the water inlet with a pore size of 5 to 100 µm protects against negative effects of foreign particles.

Microfiltration

The pore size in the microfiltration is between 0.1 to 10 µm. In particular, undissolved particles are retained. There is also a slight reduction of dissolved organic carbon and retention of certain larger microorganisms (bacteria, viruses, protozoa).

Ultrafiltration

The pore size in the ultrafiltration is approximately between 0.01 to 0.1 µm. Thus, higher molecular, dissolved and suspended components are retained. Parasites, bacteria and viruses can also be largely retained. Therefore, ultrafiltration can be used to produce virtually germ-free water (disinfection process).

Nanofiltration

During nanofiltration, membranes with a pore size of <0.001 µm and an additional, electrostatic surface potential are used. Thus, as in organic contaminants (micropollutants), ions can be successfully separated.

Nanofiltration requires high pressures. The separation is based on sieving effects as well as on electrostatic interactions. Due to the charge on the membrane surface, bivalent ions are better retained than monovalent ions. This makes it possible to selectively remove ions with specific membranes (e.g. heavy metals).

Reverse osmosis

In reverse osmosis, the natural osmosis process is reversed at very high pressures. Osmosis is based on a fundamental natural law. This states that two different concentrations always want to balance each other out. If two saline solutions of different concentrations are separated by a semipermeable membrane (membrane that lets only water penetrate), water will enter the solution with the higher salt content until the salinity is balanced on both sides. Since there is more water on the side that was balanced, there is a pressure difference between the two sides. This pressure difference is referred to as osmotic pressure.

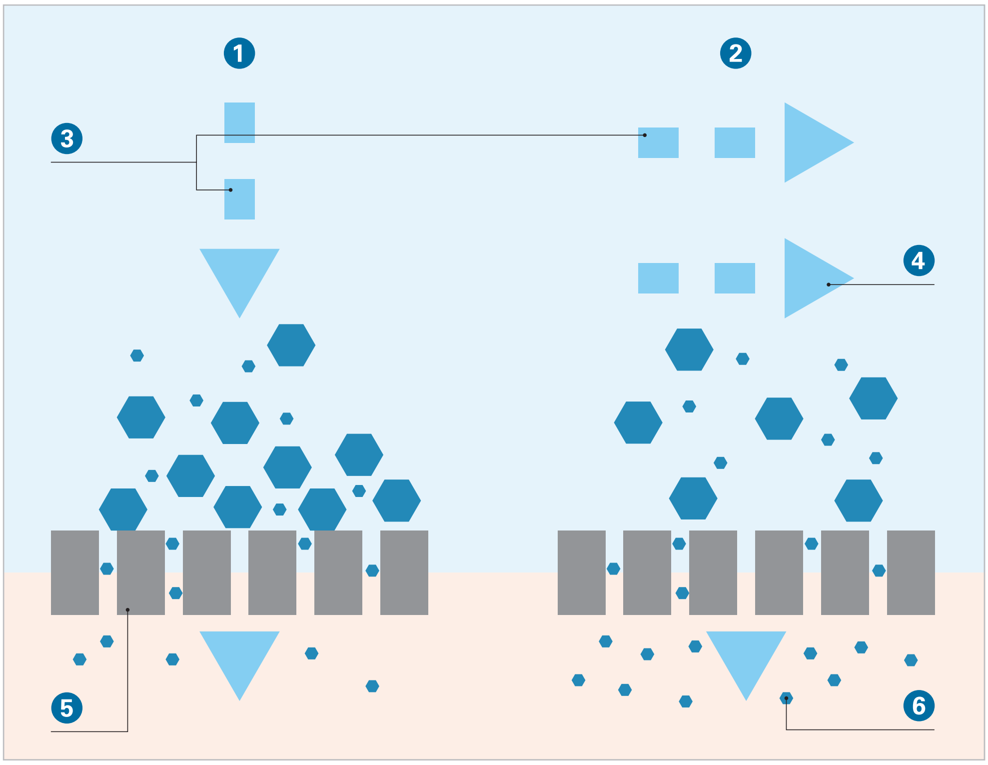
Often the reverse osmosis is used for desalination of seawater or for water recycling. The water to be treated is first completely softened, otherwise the semi-permeable membrane will become clogged. Subsequently, a pump is used to overcome the osmotic pressure and the water flows in the opposite direction through the semi-permeable membrane. Salts and dissolved organic ingredients can be completely separated.

Filtration can be done in two different ways:

- Dead-end filtration (frontal filtration)
- Crossflow filtration

The **dead-end-filtration** is the historical form of filtration. In this filtration method, a feed stream is pumped against the filter membrane. Due to the permanent drainage of the permeate, a filter cake accumulates on the membrane's surface. The filter cake increases the filtration resistance and thus causes a pressure loss across the membrane. Depending on the composition of the liquid, this cake must be removed at regular intervals by backwashing (pumping back already separated medium) and/or by chemical cleaning.

When using **crossflow filtration**, the liquid to be filtered is pumped at high speed parallel to a membrane or to a filter medium and the permeate is drawn off transversely to the flow direction. The shearing forces occurring due to the turbulent flow at the filter surface can be varied depending on the volume flow. The high speed of the flow prevents a filter cake from building up.



GIII.9
Types of filtrations

1. Frontal filtration
2. Cross-flow filtration
3. Feed stream
4. Retentate
5. Membrane
6. Permeate

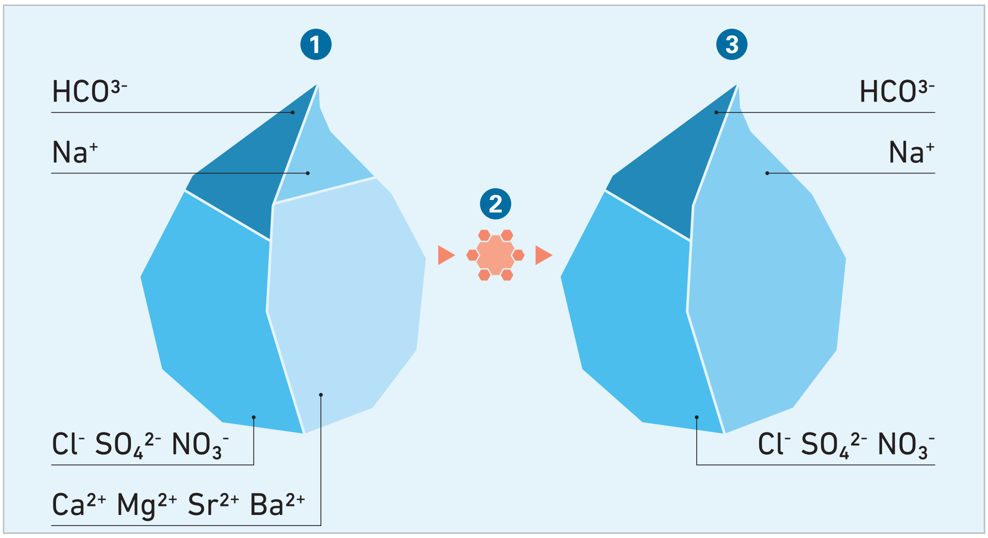
Lime protection

The most common methods for the effective removal of lime are ion exchange and nanofiltration. However, if only the deposit of lime is to be prevented, the method of biomineralization is often used. Also, the precipitation of lime can be prevented by CO_2 stabilization or the use of polyphosphates.

Ion exchange

When softening the water by using the ion exchange method, calcium Ca^{2+} and magnesium Mg^{2+} ions are exchanged for sodium Na^+ ions. This way, the precipitation of insoluble calcium carbonates and calcification can be prevented.

During an ion exchange a strongly acidic cation exchange resin is present, which absorbs the hardness ions calcium and magnesium from the water and releases sodium into the water in exchange. The salinity of the water is not changed by such an ion exchanger, only the type of dissolved cations.



GIII.10
Ion exchange
1. Composition before the exchange
2. Ion exchange
3. Composition after the exchange

The exhausted ion exchange resin is regenerated with sodium chloride (NaCl). The resin is again charged with Na^+ ions – while the calcium and magnesium ions are washed out.

It can be operated with one bottle or cartridge discontinuously or with two bottles in pendulum softening mode. In the pendulum softening mode, the regenerations of the two bottles alternate, allowing continuous operation to produce softened water.

Biomineralization

The principle of biomineralization is copied from nature, in which lime dissolved in water is transformed into the smallest calcium crystals. Shells and corals use this biomineralization process to build their limestone skeleton.

The process of biomineralization takes place through a granulate that triggers a catalytically induced nucleation. The calcium and carbonate ions in the passing water are combined from the surface of this granulate into small calcium crystals. The crystals formed this way are returned to the water stream after reaching a certain size.

If lime precipitates by altering the lime-carbonic acid balance in the installation system, it is deposited on the crystallization centers floating in the water. The grown lime crystals, which are a few thousandths of a millimeters in size, no longer adhere due to their size and are flushed out of the installation with the removal of water. This prevents any further calcification process and protects the drinking water installation from deposits.

1.3.7 Disinfection

The disinfection of drinking water is a hygiene measure, which is used to kill pathogens, or inactivate and thereby reduce their number so far that a transmission or infection is no longer possible. Drinking water must never contain pathogens that can be hazardous to human health.

A disinfection can also be applied for technical or economic reasons, for example, in order to make a biofilm reverse the reduced heat transfer in the heat exchanger.

There are different disinfection techniques:

- Physical disinfection
  - Thermal disinfection
  - UV disinfection
- Chemical disinfection

The choice which disinfection method to use depends on the given conditions (materials) and on the desired effect. Only by selecting the correct application of the disinfection measure can the method's full effect be achieved. Furthermore, when choosing the disinfection process, it must be ensured that the disinfection method is gentle on the material and harmless in terms of safety and, on the other hand, does not pose a risk to the environment.

In order to safely destroy or inactivate microorganisms, it must be guaranteed that the disinfectant can act directly on the microorganisms. Another prerequisite for a successful disinfection is the removal of turbidity and particles to the highest degree possible.

Physical disinfection

Thermal disinfection

Thermal disinfection of microbiologically contaminated drinking water is the fastest, easiest and most effective method in terms of disease hygiene, even in an emergency.

Boiling

In order to kill all potential pathogens, a boil-off time by prolonged heating at the boiling point of the water for at least 3 minutes is required, taking into account the air pressure.

The disadvantages of boiling compared to other disinfection methods are the high energy consumption and the risk of scalding. For these reasons, boiling should be limited to small amounts of water needed to drink and in order to prepare food.

Application in building technology

When using hot water for the thermal disinfection, the entire system, i.e. pipelines, fittings and equipment, must be heated to temperatures above 70°C. At each sampling point 70°C water must be present for at least 3 minutes. This ensures that most of the microorganisms in the drinking water will die off.

It is important that during normal operation a minimum temperature of 50°C (better yet 55°C) is available in the entire hot water system. This will ensure that contamination of the pipeline network is prevented. However, for this purpose, the hot water must circulate continuously and the hot water pipes must be well insulated. Effective insulation of the cold water pipes and a spatial separation from the hot water in order to protect the cold water from warming is mandatory.

III

UV disinfection

When using the UV disinfection method, the drinking water is intensively irradiated with UV light, whereby the microorganisms are so badly damaged that they are no longer viable. UV disinfection is a highly effective and easy-to-use technology. The use of UV disinfection is particularly useful to prevent microorganisms from entering the water (entrance barrier). Therefore, this method is often combined with other disinfection procedures to guarantee the protection of the water network.

In order for the disinfection with UV radiation to be successful, the water must be largely free of turbidity, otherwise the radiation cannot act directly on the microorganisms. A wave range of 240 to 290 nm and an intensive radiation dose of at least 400 J/m^2 are required.

UV disinfection is only effective on incoming bacteria and is not very successful in a biofilm-contaminated piping system. In this case, only a chemical disinfectant, which is distributed with the drinking water in the network (depot effect), helps.

Chemical disinfection

The action principle of chemical disinfectants, using chlorine, ozone, chlorine dioxide or hydrogen peroxide is mainly based on their oxidative properties. Higher organic compounds, as well as microorganisms, are thereby oxidized. This process changes the microorganisms' structure. These changes cause microorganisms to rapidly, lethally damage or destroy their ability to multiply.

The advantage of chemical disinfectants is their extremely efficient action. In principle, an effective killing or inactivation of microorganisms is only possible if the disinfectant can act directly on the microorganisms. Therefore, the disinfectant must reach all areas of the drinking water installation in sufficient concentration. Chemical disinfectants also have the advantage that they maintain their disinfecting effect after dosing. The term **depot effect** or **disinfection capacity** describes the period over which a disinfectant retains its disinfecting effect. The depot effect depends on the composition of the water, the disinfectant and the dosed amount.

The chemical-oxidative disinfectants are often based on chlorine. These can be in the following forms:

- Free chlorine (oxidative form): sum of the mass concentration of elemental dissolved chlorine (Cl_2), hypochlorous acid (HClO) and hypochlorite (ClO^-), expressed in mg/L.
- Bound chlorine (already reacted form): Mass concentration of inorganic and organic chloramines, calculated as chlorine in mg/L.
- Total chlorine: The sum of mass concentrations of free and bound chlorine in mg/L.

Chlorine gas (Cl_2)

Chlorine is the oldest disinfectant in the history of drinking water treatment. If the chlorine gas is dissolved in drinking water, the hypochlorous acid or its salt, the sodium hypochlorite, forms, depending on the pH value.

The disinfection with chlorine gas is a cheap and well-tried, but safety-critical procedure. Gaseous chlorine **Cl_2** is a toxic and strongly corrosive compound. It is 2.5 times as heavy as air, therefore sinks rapidly to the ground and can accumulate in depressions.

Sodium hypochlorite

Due to its dangers, gaseous chlorine is no longer used frequently in the disinfection of drinking water. Nowadays, chlorine already dissolved and stabilized in water is mostly used as sodium hypochlorite.

Sodium hypochlorite **NaClO** is the sodium salt of hypochlorous acid. It is a strong oxidizing agent that is added to drinking water as a finished solution. It is intended primarily for the disinfection of small amounts of water, and used as a temporary or emergency disinfection (**shock dosing**).

Sodium hypochlorite solutions of at least 120 g/L free chlorine are commercially available. In order to stabilize the sodium hypochlorite, the solution is kept strongly alkaline. Nevertheless, the solution decomposes and thus decreases its effectiveness. The danger of the formation of decomposition products increases. Therefore, the containers must be kept in the dark, remain cool and well sealed. Sodium hypochlorite solution is also commercially available under the obsolete names of chlorine liquor, sodium hypochlorite, sodium hypochlorite or "Javel water".

Calcium hypochlorite

Calcium hypochlorite is the calcium salt of hypochlorous acid and is used as a solid. As with sodium hypochlorite, it is a strong oxidizing agent, which is mainly used as emergency disinfection for drinking water.

Calcium hypochlorite is available in the form of white granules or in tablet form. For an effective disinfection, the calcium hypochlorite must first be dissolved in water.

Electrodiaphragmalysis

Electrodiaphragm analysis, also known as **Electro-Chemical Activation** (ECA), is a gentle and safety-friendly way of producing a highly effective disinfectant on site.

The transport of large amounts of disinfectant is eliminated and it is ensured that always fresh and highly effective disinfectant is available.

In electrodiaphragmanalysis, a saline solution **NaCl** is activated in a reactor. Inside the reactor, a semi-permeable membrane separates the anode and cathode. Activation of the saline results in a mixture of reactive oxidants from the hypochlorous acid and sodium hypochlorite. The disinfecting effect is based on the interaction of all these factors and therefore has a very strong disinfecting effect.

Chlorine dioxide

Chlorine dioxide $\mathbf{ClO_2}$ is a highly oxidative gas and therefore an effective disinfectant. At room temperature, $\mathbf{ClO_2}$ is a toxic gas with a pungent, chlorine-like odor. Since gaseous chlorine dioxide is not stable and can even decompose explosively, it is used in aqueous solution.

Chlorine dioxide is usually produced locally during drinking water disinfection and added directly to drinking water. The most common method is the acid-chlorite production process in which sodium chlorite and hydrochloric acid react with each other to chlorine dioxide. The gaseous chlorine dioxide is dissolved immediately in water. The resulting solution has a concentration of 1 to 3 g $\mathbf{ClO_2}$ per liter.

Chlorine dioxide is very stable in the water and after completion of consumption, a depot effect can be maintained for a long time. Recontamination of the water can be prevented.

Compared to chlorination with sodium hypochlorite, chlorine dioxide has the advantage that the disinfecting effect is largely independent of the pH value and therefore also suitable for the disinfection of waters with pH values above 8.5. Also, during the disinfection of waters with a very high organic content, halogenated disinfection by-products do not form. However, chlorine dioxide reacts during its oxidation to chlorite and partly to chlorate. Both substances are undesirable in drinking water and, therefore, the maximum allowable addition of chlorine dioxide into drinking water is limited.

The corrosive property of chlorine dioxide in the pipeline network is problematic, especially in hot water, since due to the reduced gas solubility at elevated temperatures the outgassing and accumulation of chlorine dioxide is promoted.

Ozone

Ozone is one of the strongest oxidants, making it an extremely efficient disinfectant. Ozone consists of three oxygen molecules O_3 and is industrially produced from oxygen O_2.

Due to its instability, ozone cannot be stored for a long period of time. Therefore, it is produced on-site and added directly to the drinking water. Because of the technically complex production, the ozonation is mainly used by large water suppliers. In water, ozone is relatively unstable and decomposes to form hydroxyl radicals **OH•**. In the presence of organic contamination in the water, the ozone is consumed within seconds, so ozone has a bad depot effect in the system and is mainly used as a selective disinfection measure.

The big advantage of ozone is that it produces little unwanted by-products and the ozone molecule itself decomposes into oxygen. However, the resulting, oxidized degradation products (often short-chain hydrocarbons) can serve as a food source to microorganisms and is readily available. There is a risk of rapid re-germination of the drinking water and therefore the ozonation is usually combined with another process stage (usually with activated carbon).

Hydrogen peroxide

Just like ozone, hydrogen peroxide H_2O_2 is a very strong oxidizer. Due to the rapid decomposition and the lack of depot effect, it is mainly used for the selective disinfection of system components and not for entire pipeline networks. Quiet frequently, hydrogen peroxide is used for surface disinfection of fittings and pipeline systems that have not yet been filled with potable water.

Disinfection with hydrogen peroxide does not produce any harmful disinfection products. However, when disinfecting the pipe networks with hydrogen peroxide, the problem as with ozone arises. Namely, the oxidized degradation products are used after disinfection as an ideal food source for bacteria and there is a risk of recontamination. When disinfecting water with a higher pH value, it should be noted that the disinfecting effect decreases sharply at a pH value above 8.

Hydrogen peroxide is usually used in diluted form as a 1.5 to 5% hydrogen peroxide solution. Solutions above 5% H_2O_2 cause severe burns to the skin and solutions exceeding 20% H_2O_2 are fire-promoting.

Even in dark and cool storage, hydrogen peroxide decomposes slowly to water and oxygen. Therefore, the solutions must be consumed relatively quickly.

1.4 Wastewater

Wastewater is not as bad as its reputation: In addition to plenty of water, it contains valuable resources and energy. These include, for example, nutrients such as nitrogen, phosphorus and potassium. Of course, wastewater also contains substances that are hazardous and dangerous to health, such as residues of drugs, cleaning agents or pathogens.

So we have to learn to use the "raw material wastewater" better and better: Complex technical systems are already taking over this task of clarification, processing and separation of substances. Unfortunately, in many parts of the world, wastewater is still more or less released into the environment, the rivers and seas without treatment.

In the future, however, the systems that collect and channel wastewater to the sewers and the water treatment techniques will need to be more effective in order to meet the growing resource needs of civilization to provide people with clean drinking water.

1.4.1 Cultural historical background

The history of the wastewater reflects a substantial part of the cultural history of man. From a very early stage, more developed cities and city-states have recognized the necessity of transporting sewage resulting from our “daily business” safely out of the homes, streets and settlements. The emergence of connected settlements created the problem of disposing the waste and wastewater.

In the earliest alluvial sewers, waste and sewage were washed away by water (rainwater, natural waters and flood levels).

The first records of a toilet (with continuous water flushing) date back to around 5000 BC. The Sumerians already had clay sewer pipes in their homes. The oldest testimonial in Europe is the water closet in the palace of Knossos in Crete dating back to 2000 BC. Greek cities had sewer systems and public toilets. Around 600 BC, Rome channeled its wastewaters through the Cloaca Maxima (the world's earliest sewage systems), which measured about 3 × 4 meters, directly into the Tiber river – as was done in most other early cities as well.

In Europe, it was only much later that these achievements of the antiquity were reactivated. The first water closets were used in England and France in the 16th century. Still, fecal waters often ended up directly in canals, pits, streams and rivers – although the latter were the source of the daily drinking water. Feces were also "disposed of" by transporting the waste by waggon from the cities to the countryside, where they were used as fertilizer in the fields.

Around the middle of the 19th century, the hygienic conditions in the cities were catastrophic, also due to the industrialization and crowded towns. Typhoid and cholera epidemics frequently occurred, and eventually this led to the use of the first toilet and sewerage systems. However, the first systems were far from perfect: In Hamburg, for example, a system was implemented in 1843, but since the discharge of sewage was too close to the city (at the piers), cholera epidemic broke out in 1892, resulting in the deaths of tens of thousands of people. Wastewater discharge and drinking water abstraction were too close to each other, so that with the drinking water (at that time unfiltered water of the Elbe river) the germs returned directly to the households.

The first sewage treatment plant was built in England around 1892, in Frankfurt around 1895. Only from the 1930s, the number of sewage treatment plants increased. In Berlin at that time, serious empirical investigations – led by Rudolf Virchow, a German physician – avoided severe engineering errors in the design and construction of the sewage system and thus prevented huge bad investments.

The development of biological wastewater treatment and the activated sludge process followed in the years 1900 to 1940. Today, many sewage networks are rehabilitated to better enable the purification of small amounts of wastewater.

Many domestic sewage canals with leaching cesspools and septic tanks existed in Germany and Austria until the 1960s (in rural areas until the 1990s). In recent decades, however, municipalities invested a great deal to consolidate these facilities into local sewerage systems and to deliver the sewage to treatment plants. The public sewer system consists of canals, shafts, special structures (stormwater overflow basins, sewage pumping stations, water pumping stations, curved structures, outlets) and, depending on the statutes, connecting lines up to property boundaries or inspection shafts.

1.4.2 Typology of wastewater

Wastewater is not necessarily sewage. In essence, locally the wastewater that occurs on the outside of a building can be distinguished from the wastewater that occurs inside a building.

In general, it is possible to differentiate between building and property drainage, for which country-specific regulations may exist.

Today, the wastewater collected from the sewerage system is the wastewater from household and small-scale municipal and, to a large extent, the rainwater discharged from roof surfaces and sealed surfaces.

These so-called property drainage is nowadays still mostly via a mixing system, whereby the requirement for a necessary separation of the wastewater increases. In general, surface water that does not require treatment should seep away.

Roof drainage

Rainwater or precipitation water is drained from roofs. The water drains via a system of eaves troughs and downpipes to the connection point of the public sewage system. Small quantities can also be routed directly to the seepage site.

To some extent, preferably in residential buildings, rainwater and precipitation water can be used for garden irrigation.

Soil drainage

The surface water that occurs on sealed and unsealed surfaces is fed to the seepage. But it is also drained partly – similar to the roof drainage – over some open, semi-closed gutters of either naturally or man-made form for drainage into the public (mixed) sewage. In rural areas, it is drained rather unregulated into streams, rivers, ponds or on natural or agricultural land.

Domestic wastewater

Domestic wastewater is divided into two distinct categories: Gray water and back water.

Industrial wastewater

In some cases, industrial wastewater enters the sewage system. Industrial wastewater is usually pre-treated in company-owned sewage treatment plants or separator plants. Because of the very special contamination by mineral oils, salts or other chemicals, special cleaning requirements arise before the water can be introduced into larger (public) systems.

1.4.3 Wastewater in buildings

Domestic wastewater consists mainly of wastewater from the drinking water supply and wastewater from toilet facilities.

Therefore, wastewater is not the same as wastewater. Depending on the origin of the wastewater, it can be enriched and contaminated with chemical substances and biologically active substances in very different ways.

Gray water

Gray water does not contain feces, it is a slightly polluted wastewater from showering, bathing or washing hands, but also comes from the washing machine. After special treatment, this wastewater can be used as service water or process water. If this gray water is drained into the sewage system, it becomes wastewater.

Part of the domestic water can be used twice in the building: If the gray water is collected in the building, it can be fed back into the system for flushing the toilet. However, for use in the washing machine, this water is not usable because it is contaminated. Gray water plants also need space: A storage system and its own pipe network are absolutely necessary, since gray water must never be linked with the drinking water pipeline.

The pollutant load of gray water consists mainly of soaps, detergents (cleaning, washing, rinsing, personal care products, etc.), fats and phosphates derived from detergents.
Gray water usually contains only small amounts of the following substances:

- organic nitrogen compounds (proteins, urea)
- Residues of drugs (estrogen, antibiotics)
- organic phosphorus compounds of metabolic origin

Black water

The **fecal water**, which comes from toilet facilities, is certainly the most problematic wastewater in the building. Wastewater from buildings can therefore be a mixture of gray water and black water if both wastewater are combined in the drainage system. Since the 1970s, drainage systems have increasingly focused on the separation system.

The “pollution” of the effluent essentially refers to nitrogen, which contributes to nitrate pollution after the treatment.

- 98% of the nitrogen in domestic sewage comes from the flush toilets
- Gray water contains 10,000 to 100,000 times less pathogenic bacteria than black water.

1.4.4 Drainage systems

In a building, the wastewater is routed through a drainage system, a system of pipes and ancillary structures for the discharge of wastewater and/or rainwater, to the sewer or other disposal facilities. The systems can be differentiated according to the type of drainage or also according to the size of the sewage system.

Until today, the **mixed sewerage system** predominates in Germany. About 60% of the settlement areas of all inhabitants are drained. The German Federal Water Act stipulates that the construction of new facilities must include a sewer separation. Also, the drainage concept has changed in recent years. From a discharge-oriented point of view and in the sense of an economic and ecological perspective, the decentralized local rainwater infiltration is becoming increasingly important.

Systems downstream of the drainage

Mixing system (combined sewerage)

In a mixed system, domestic wastewater as well as industrial and rainwater are discharged together.

Modified combined sewerage

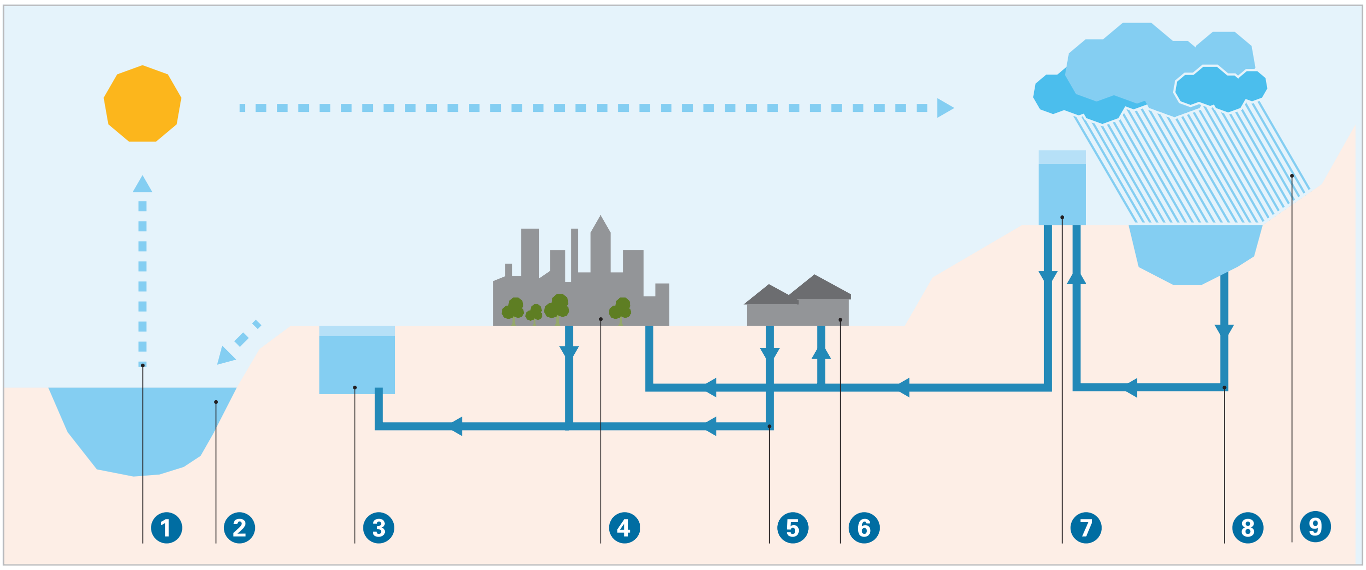
Polluted water as well as wastewater requiring treatment are discharged together. Precipitation wastewater that is not in need of treatment is seeped in on-site or channeled directly or indirectly into a body of water.

Separation system (separate sewerage system)

Wastewater is drained away in a sewer, rainwater discharged in a separate sewer. Because of the usually low pollution of rainwater, it is usually directly or indirectly (in rainwater retention basin) introduced into the water and not treated in sewage treatment plants.

Extended separation sewerage

Wastewater and treatment wastewater are discharged in separate channels. Precipitation wastewater that is not in need of treatment is seeped in on-site or channeled directly or indirectly into a body of water.



1 Evaporation
2 Receiving waters
3 ARA
4 Industry
5 Wastewater
6 Household, trade
7 Water works
8 Surface, ground or spring water
9 Precipitation

GIII.11
Water cycle with drainage

Special procedures

For remote buildings or settlements, depending on the wastewater and condition, pressure or vacuum drainage and storage in no-waste collection pits with removal by vehicles may be used to dispose of the wastewater. In local wastewater treatment by small wastewater treatment plants (trickling filter, activated sludge process, plant treatment systems and trickle fields (wastewater trickling) supply ducts are also required. Sometimes, additional canal systems for drainage or extraneous water are available, which discharge directly into a receiving water course.

Systems by size

Domestic sewers

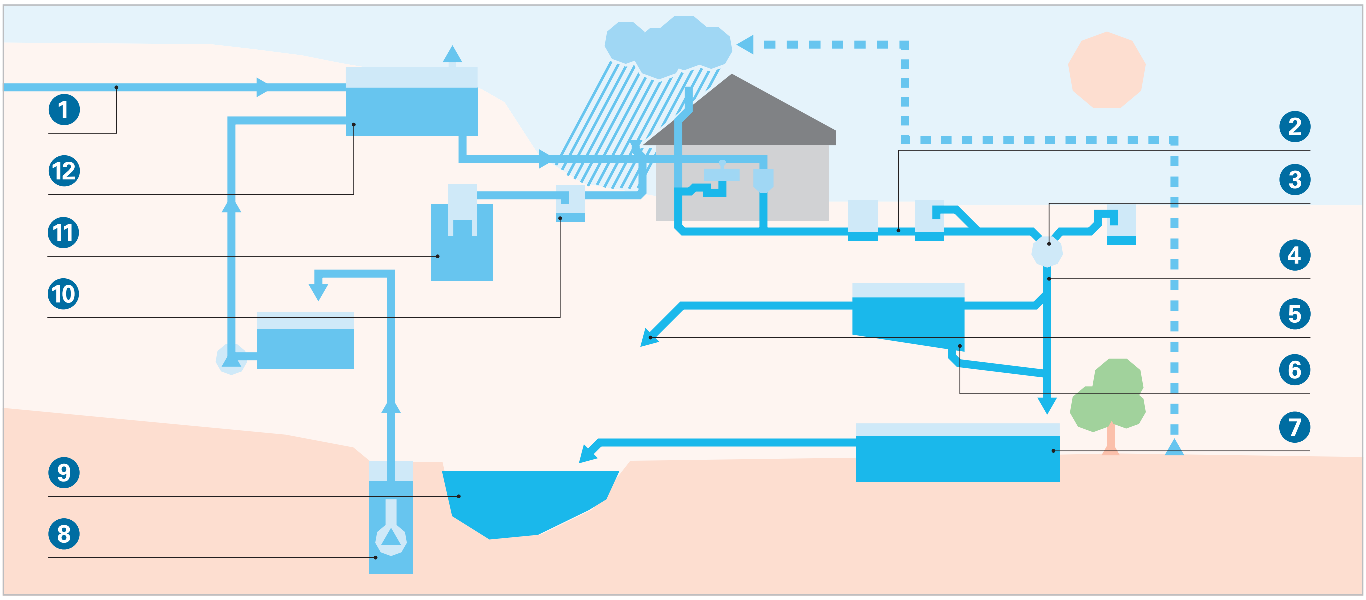
In this case, pipes with the nominal width DN100 (pipe diameter 10 cm) up to DN200 (20 cm) are typically used. Domestic sewers include sinks, toilets, roof vents and in-house gullies.

The drains in the building are connected via odor traps (siphons) and drained to downpipes. The downpipes open into the base channel, which directs the wastewater to the service connection shaft. The domestic sewerage system is disposed of in the public sewer system or flows into wastewater treatment plants or collection pits in the immediate vicinity.

In order to avoid damage due to backwater from the sewer network and resulting flooding, all drainage should be above the backflow level (at least at the top of the road).

Since the drainage in a building has to be done downstream the separation system, the down-pipe of the gutters must not be closed to the underground line. This is best done in an inspection shaft. The downpipes must be vented via the roof in order to prevent odor traps from being sucked empty and to allow the removal of odors from the sewer system. For this reason, no odor traps should be provided even in basic channels.

Cleaning openings should be provided in the service connection shaft and in the drainage network. The material used in house sewerage is mostly plastic, gray cast iron or stoneware. The choice of material depends on the aggressiveness of the sewage (in small businesses), the pipe diameter, the processing and the costs.



1 Spring water
2 Sewerage (combined systems)
3 Storm water drainage
4 Property drainage
5 Rain overflow
6 Rainwater basins
7 Wastewater treatment system
8 Groundwater
9 Receiving waters
10 Sludge collectors
11 Weeping tile system
12 Reservoir

GIII.12
Typical drainage system

Local sewerage

This includes the connecting canals that lead to street canals, which are merged to secondary and main collector pipes. Today, pipes with the designation DN250 (pipe diameter 25 cm) up to DN800 (80 cm) are mainly used. The main collector pipes route the wastewater to a wastewater treatment plant. In addition to the pipeline network, there are reservoirs as well as rain overflows and rain basins, which flow directly into receiving water. If longer distances – as is the case in rural areas – or height differences must be overcome, additional pumping stations are used. Gray cast iron or stoneware was the material used in the past. Since the end of the 20th century, plastic is increasingly used in the course of technical development.

1.4.5 Disposal and treatment of wastewater

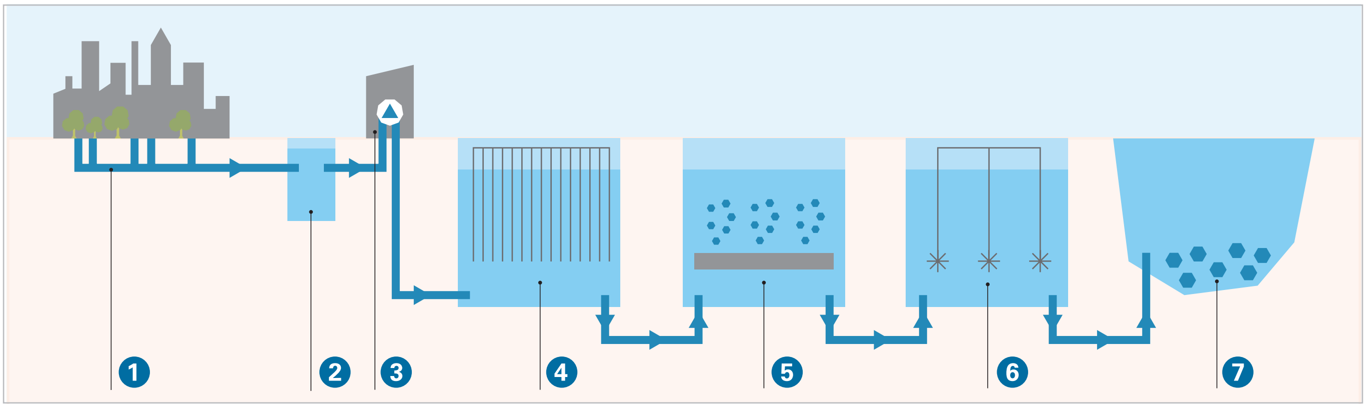
Today, most households use a sewerage system that is connected to a sewage treatment plant. Plant construction in wastewater treatment is now very modern and knows many different processes. Efficient wastewater treatment is also an essential component of a good drinking water supply.

However, globally, there are significant differences, especially within countries between urban, developed areas and rural, agricultural areas. There are still too many people dying from polluted water. A significant proportion of diseases in countries of the South could be prevented by adequate sanitation. 90% of wastewater worldwide still goes untreated into rivers and lakes, from which people then take their drinking water.

Decisive for the discharge and disposal of waste water in buildings is the safe separation of the drinking water supply and the technically faultless supply line to the sewer outside the building or to the public sewer.

Technical wastewater treatment

Today, the wastewater treatment in sewage treatment plants is high technology. It accomplishes the mechanical, chemical and biological cleaning of the merged wastewaters from the sewerage with different technical methods. From this, clean water is gained again and can be channeled back to the drinking water supply system.



1 Drain
2 Stormwater management pond
3 Pumping station
4 Mechanical wastewater treatment
5 Biological wastewater treatment
6 Secondary sedimentation
7 Pond systems, sludge treatment

GIII.13
Wastewater treatment, schematic

2 Air

2.1 Introduction

When we speak of air, we mean the atmosphere around the planet Earth. The word comes from the Greek and refers to both the gas envelope ("Atmos") as well as the various globular enclosing spherically presented "spheres" – hence "atmosphere".

All living things with lungs require the oxygen in the air, because oxygen is metabolized by the body. Its proportion is 20.5% at moderate altitudes. Nitrogen holds the lion's share with 77.6%. This substance is inhaled with, but is unusable.

The farther we get away from the earth's surface, or the more altitude we reach, the air gets "thinner". Technically, this means: The atmospheric pressure decreases and the concentration of major and minor components diminishes. The barometric altitude formula describes an exponential pressure loss. Following this logic, however, the underlying temperature must theoretically remain the same at all altitudes. The normal hydrostatic pressure, i.e. the weight of one column of air that rests on a body, is about 1,000 hPa at sea level. This is equal to 1.0 bar and thus 1.0 atmospheres.

2.1.1 The blue planet – air to live

It is safe to assume that our blue planet already had an "air envelope" in its earliest formation phase, presumably from hydrogen and helium (as well as a little methane, ammonia and noble gases). However, this original atmosphere was soon lost. As a result of the earth's cooling, the first atmosphere was formed. About 4 billion years ago this atmosphere probably contained about 80% of water vapor (H_2O), 10% carbon dioxide (CO_2) and 5 to 7% of hydrogen sulfide (H_2S) and traces of nitrogen (N_2), hydrogen (H2), carbon monoxide (CO), helium, methane and ammonia.

The second atmosphere is associated with the formation of the oceans, whereas the light gases of hydrogen and helium evaporated into space. However, carbon dioxide and hydrogen sulfide have were bound in significant quantities in the oceans.

But it is only with the third atmosphere that oxygen production, driven by oxygen photosynthesis, plays an increasing role: Until 1 billion years ago, the oxygen concentration of the atmosphere rose to about 3%. At the same time, the concentration of carbon dioxide decreased as a result of its assimilation by creatures and the precipitation of carbonates.

Most recently, there has been an increase in the concentration of greenhouse gases. In particular, the concentration of carbon dioxide in the earth's atmosphere has increased by almost 50% in the last hundred years.

2.1.2 Cultural historical background

Air and atmosphere

The study of the air was closely associated with the development of modern physics and chemistry: Galileo Galilei discovered that air has a weight, Joseph Black found out that there was more than one type of "air" (i.e. "air" = gases), Antoine Lavoisier discovered the oxygen, John Tyndall and Svante Arrhenius described the role of carbon dioxide for the earth's climate and finally William Ferrel explained the wind systems of the earth.

Air pressure

The first documented proof of **air pressure** was provided in 1663. The experiment with the Magdeburg hemisphere proved that there is an atmosphere and changeable pressure. The procedure was very simple. A pump was used to remove the air within the space of the two hemispheres. This created a vacuum. As a result, the force of the much higher ambient pressure held the two halves of the sphere together. Two horse teams each with 16 draft animals were not able to separate the hemispheres. This proved, among other things, that a constant ambient pressure prevails and pressure changes the balance of power.

Pressure becomes measurable

The invention of the barometer made it possible for the first time to measure and illustrate the pressure of the air. A curved tube filled with mercury served to prove that air actually has a weight.

The Frenchman Blaise Pascal made experiments with his improved, but still simple "siphon barometer" at different altitudes. He was able to prove that the air pressure decreases with increasing altitude. The unit for pressure has later been named after the physicist. One Pascal equals one Newton per square meter.

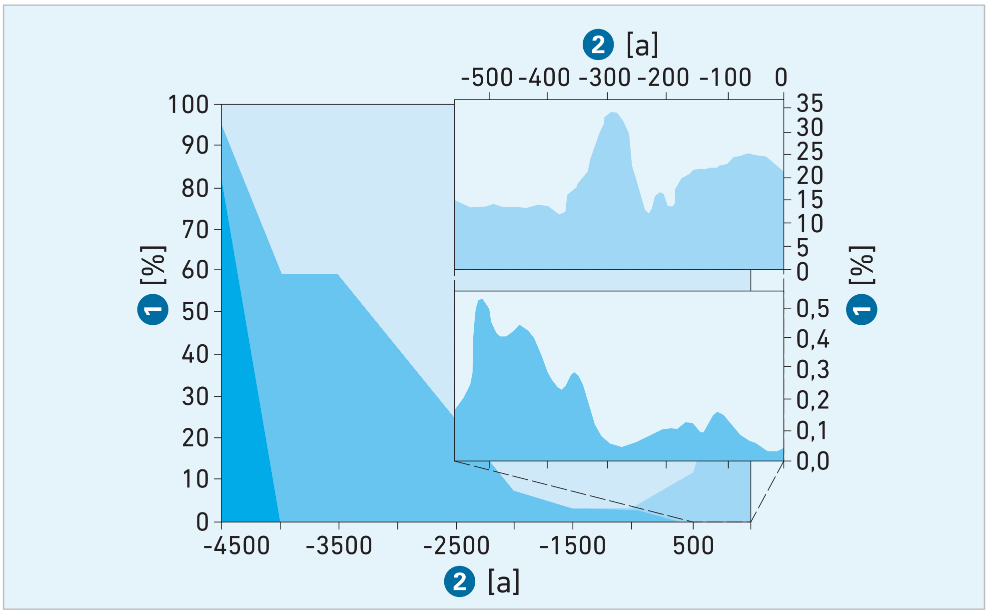
Today we know: In the earth's atmosphere there are different pressures. As the altitude increases, the density and air pressure decrease. At an altitude of 80 km, the end of the stratosphere, only 0.01 mbar prevails. On the earth's surface, this pressure is 1,013 mbar.

To measure air pressure today, an aneroid barometer is used. This method does not use liquid and is much more accurate than mercury barometers. Several "cavity cans" respond by deforming as a result of pressure changes in the environment. This mechanical change is transferred to a similar scale by means of a pointer, whereby a statement about the prevailing pressure conditions can be made.

In order to prevent material deformation due to temperature changes, various metal alloys are used, which compensate each other for temperature-induced elongations.

2.2 Air – chemical/physical aspects

If using a superficial approach, pure air consists of nitrogen and oxygen and other secondary components. Emissions from industrial plants, agriculture and combustion engines also contaminate the atmosphere with pollutants. Ozone, nitrogen dioxide, carbon monoxide and fine dust have been a problem for decades. In recent years, at least in Europe, air pollution has declined somewhat, but globally the issue remains controversial.



GIII.14
Components of the air

1. Amounts, percentage
2. Time in million years

Main components

Colour	Component	Proportion [%]
	Nitrogen	76.6
	Oxygen	20.5
	Steam	2.0
	Argon	0.9

Minor constituents

- Carbon dioxide: 0.034% (2004) to 0.0385%
- Neon, helium, methane, krypton, hydrogen, nitrous oxide, xenon, nitrogen dioxide, sulfur dioxide
- Carbon monoxide: 30 to 250 ppb
- Ozone: 10 to 100 ppb

2.3 Pressure – physical aspects

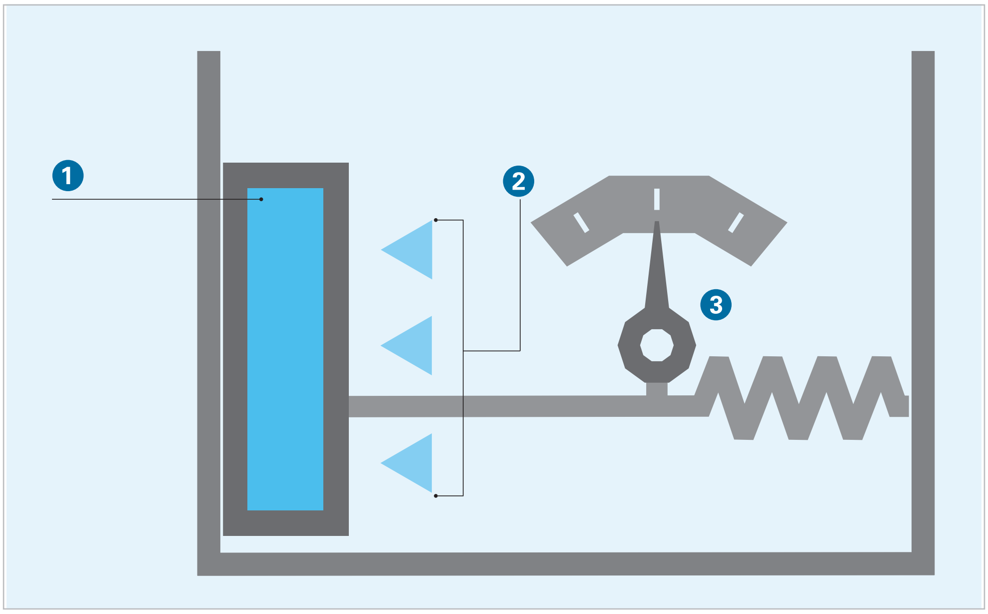
Physically, pressure is defined as force per unit area. Pressure p [Pa] is thus the ratio of a force F [N] to a surface. In physics, different expressions for the unit "pressure" are known.

The **absolute pressure** is the pressure related to the empty space (zero pressure) – here, the difference to the ideal vacuum is measured. Therefore, external factors such as the weather or the altitude above sea level do not have any influence on the result of the measurement. A globally standardized indication of an absolute pressure is the ambient pressure. This pressure is 10,1325 Pa.

The **relative pressure** is the pressure related to the respective atmospheric pressure (air pressure, weight of the atmospheric gases). However, this is influenced by the respective distance above the sea level and by weather changes and this pressure changes constantly. The relative pressure is therefore dependent on the current ambient pressure.

- Overpressure is the pressure that exceeds the ambient pressure.
- Low pressure (or vacuum) is the pressure that is less than the ambient pressure.

The measurement of the pressure can be represented in a simple form as follows:



GIII.15
Measurement of the pressure

1. Vacuum
2. Air pressure
3. Unit of measure

The relationships between pressure and the gas mixture of the earth's atmosphere, which we call air, have been described in a series of physical laws and formulas. The term "gas law" encompasses a series of physical laws which, among other things, establish a relationship between the state variables pressure, volume, temperature and substance quantity and describe the properties or the behavior of the gases thereunder. Theoretically, two types of gas are distinguished, which are then described with special formulas:

- ideal gas: general gas equation (theoretical assumption: no intrinsic volume, no interactions)
- real gas: Van der Waals equation

2.4 Compressed air

To generate compressed air for technical use, compressors are used. From a gas, e.g. air, the volume is reduced, thus increasing the pressure. The compressed medium is stored in a kettle or a cartridge.

The systems that generate compressed air are called **fluid energy machines**. Pressure can be generated with piston and screw compressors.

Compressed air is subject to quality criteria that are defined in ISO 8573-12010. Compressed air always contains particles of dirt such as oil, water and heavy metals. These substances must be filtered out to ensure the smooth functioning of a pneumatic system. The ISO standard is a combination of various international standards describing the purity of compressed air. The air is precisely classified by determining the concentration in which particles may be present in the gas. A distinction is made between solid particles, water and oil. It is measured in particles per square meter, temperature and milligrams per square meter.

The classification is from 0 to 9. Class 0 is a special case. Here, the user can determine for himself which particle concentrations are allowed as a maximum limit. However, the requirement is always stricter than the requirement specified in Class 1.

TIII.1 **Quality criteria of compressed air***

	Solid particles			Water			Oil
	Particle/m³ (maximum quantity) [µm]			Mass concentration [mg/m³]	Steam pressure dew point [°C]	Liquid [g/m³]	Total portion of oil (liquid, aerosol, mist) [mg/m³]
Class	0.1 – 0.5	0.5 – 1	1 – 5				
0	User-specified, stricter requirement than Class 1						
1	≤ 20,000	≤ 400	≤ 10	–	≤ –70	–	0.01
2	≤ 400,000	≤ 6,000	≤ 100	–	≤ –40	–	0.1
3	–	≤ 90,000	≤ 1,000	–	≤ –20	–	1
4	–	–	≤ 10,000	–	≤ +3	–	5
5	–	–	≤ 100,000	–	≤ +7	–	–
6	–	–		≤5	≤ +10	–	–
7	–	–		5 – 10	–	≤0.5	–
8	–	–		–	–	0.5 – 5	–
9	–	–		–	–	5 – 10	–
x	–	–		>10	–	>10	>10

* Classes pursuant to ISO 8573-1:2010

The basics

Materials and jointing technology

III

Materials and jointing technology

1 Plastics

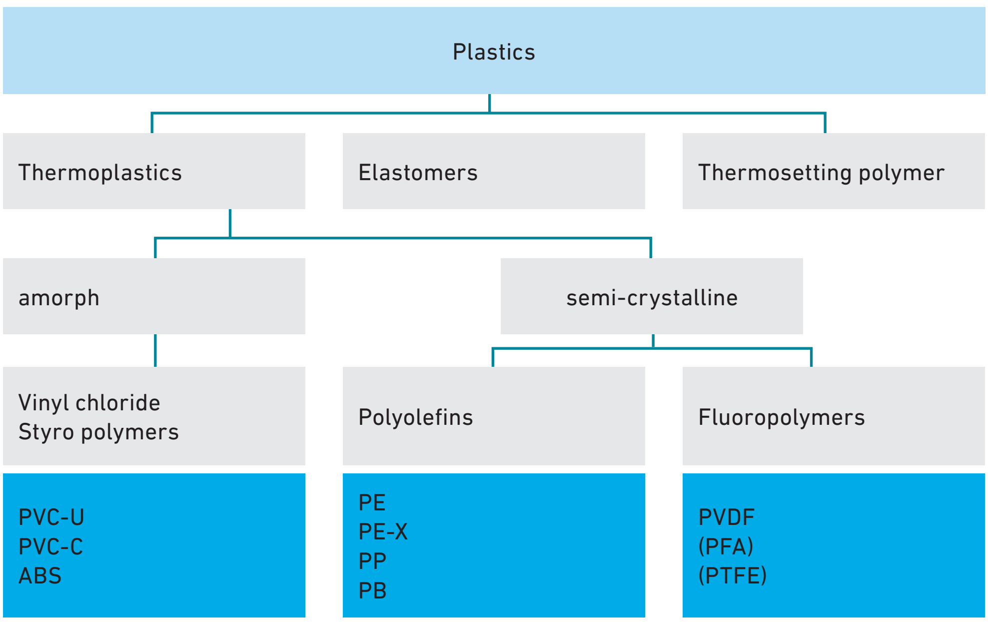
1.1 History

As early as 1838, Victor Regnault succeeded in manufacturing polyvinyl chloride in the laboratory by exposing vinyl chloride to sunlight. In 1912 Fritz Klatte discovered the fundamental principle for the technical manufacture of PVC. In their early years during the war from 1914 to 1918, the plastics had to replace other scarce materials and were thereby partly overwhelmed in terms of their applicability. Therefore, plastics had to be improved. To do this, it was necessary to investigate the inner structure of these new materials in more detail. After the versatile application possibilities were recognised, in 1938 the large-scale production of plastics began.

1.2 Structure and properties

Polymers are organic compounds that are obtained either by the conversion of natural products (e.g. natural rubber, cellulose), or by synthesis from petroleum derivatives. Polymer chains, together with additives such as stabilisers and processing aids, produce the actual material – referred to as plastic. These chains consist mainly of carbon and hydrogen. Depending on the type, halogens (chlorine, fluorine), oxygen, nitrogen and sulphur can also be incorporated into the polymer chain. Polymers are also referred to as macromolecules, that is to say, a single polymer chain consists of more than 1,000 basic building blocks, the monomers.

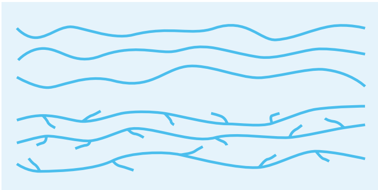
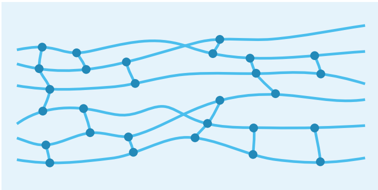
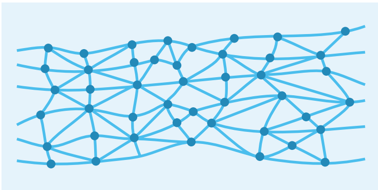
In piping system construction, mainly thermoplastics are used, which are processed into fittings and pipes with a technical processes referred to as **injection moulding** and **extrusion**. Elastomers are used as sealing material in screw, flange and plug-in connectors. For example, thermosetting polymer are used as insulation foams or in glass-fibre reinforced liners.



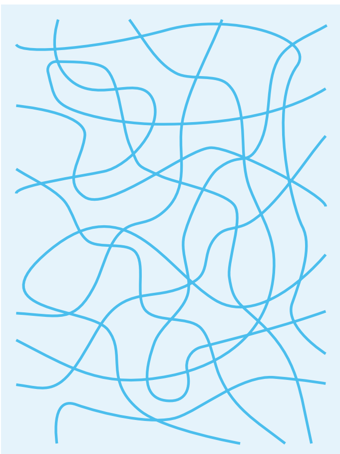
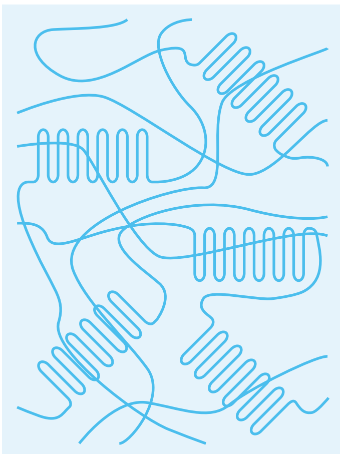
GIII.1
Materials for pipelines – Overview

The thermoplastics, the fusible agents of plastics, are subdivided into two groups:

TIII.1
Plastics – Main groups

Main group		Property
Thermoplastics for example: PE, PVC		• Linear or branched • Fusible • Soluble, swellable • Plastic mouldable
Elastomer e.g. NBR, EPDM		• Poorly linked • Not fusible • Not soluble, not swellable • Not plastically mouldable
Thermosetting plastics e.g. PUR, Epoxy		• Strongly linked • Not fusible • Not soluble, not swellable • Not plastically mouldable

TIII.2
Subdivision of the Thermoplastics

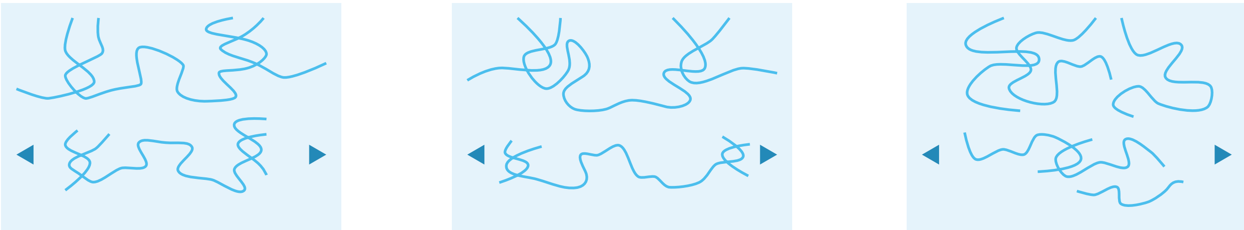
Amorphous thermoplastics	Semi-crystalline thermoplastics
In the case of the amorphous (Greek "without form") thermoplastics, the polymer chains are present as disordered, intertwined bundles. Typical representatives of this group are, for example, PVC and ABS. These plastics dissolve and swell easily by adding solvents and. Therefore, they are glued together when used in piping system construction.	The semi-crystalline thermoplastics contain not only the disordered, amorphous but also highly ordered regions in which the chains are arranged into crystalline structures. Representatives of this group are for example polyolefins such as polyethylene (PE), polypropylene (PP) and polybutene (PB). Due in part to the semi-crystalline structure, these plastics do not swell and are not as soluble easily in solvents. Pipes made of semi-crystalline materials are therefore usually connected using a particular welding method.
	

1.2.1 Mechanical properties

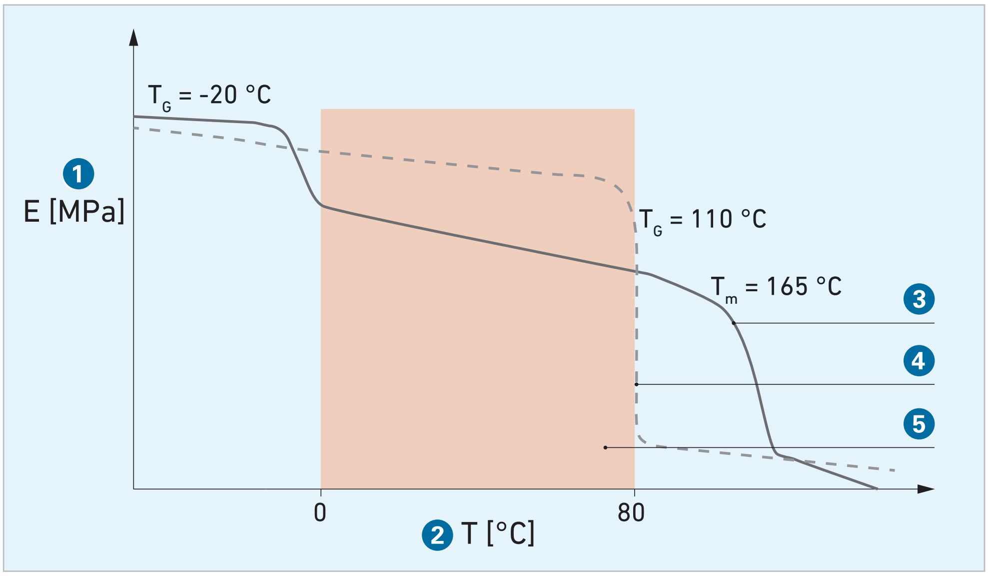
The mechanical properties of plastics, especially thermoplastics, are temperature-dependent. At low temperatures below the glass-transition temperature T_g the chains become immobile and brittle, which leads to increased fragility. At higher temperatures ($T_g < T < T_m$), the chains become more mobile, causing semi-crystalline materials to gain toughness, but lose strength and rigidity. At this stage, amorphous plastics are already softening. Both the embrittlement and softening temperatures are characteristic of the individual types of plastic and dependent on their molecular structure. If the temperature continues to rise ($T > T_m$), the semi-crystalline thermoplastic is also present as a melt.

TIII.3 **Mechanical properties**

Glassy state (energy-elastic)	Rubber-elastic state (entropy-elastic)	Melt (liquid)



⇒ Rising temperature⇒



GIII.2
Application temperature

1. Modulus of elasticity (rigidity)
2. Temperature
3. Semi-crystalline, here PP-H
4. Amorph, here PVC-C
5. Application temperature

The application temperatures for semi-crystalline and amorphous thermoplastics vary due to their different properties. Semi-crystalline materials are preferably used at temperatures above their glass transition temperature. However, amorphous thermoplastics are used below the glass transition point.

Plastics also tend to creep to progressive deformation under load. Their mechanical properties are not only temperature-dependent but also time-dependent. For use in piping system construction, the materials are therefore tested for their creep internal compressive strength in accordance with ISO 1167 and ISO 9080 in order to determine the maximum operating temperatures and voltages for a service life of 50 years.

The characteristic values for mechanical properties of GF pipe materials can be found in the relevant raw materials chapter.

1.2.2 Advantages

Compared to metallic materials, the following general advantages for plastics result:

TIII.4
Properties and advantages of plastics

Property	Advantage
Low density (Plastic: 0.9 to 1.8 g/cm^3)	Very light-weight
Chemical resistance	No corrosion as with metals
Low thermal conductivity	• Minimum heat loss • Low condensation • Plastics are poor heat conductors, but good insulators Thermal conductivity: • PB: 0,19 W/(m·K) • PE: 0,38 W/(m·K) • PVC: 0,15 W/(m·K)
Tight connections due to a variety of connection technologies	Plastics can be welded, glued and clamped. Weld connections can be made absolutely tight without additives.
Smooth surface	The smooth surface causes low pressure losses.

1.3 Plastics in the environment

The world is facing big challenges in the energy sector. These challenges include increasing energy consumption, the finite nature of fossil resources, rising energy prices and climate change. In order to satisfy the needs not only of today but also of future generations, sustainable development is essential. Plastics help to meet these challenges.

The products of GF Piping Systems are used by customers for years, sometimes decades. Even the smallest increases in efficiency – such as a suitable design – can significantly affect the environmental performance. GF Piping Systems therefore pursues a holistic approach in the development of piping systems. Sustainable solutions are only possible if the entire life cycle of the applications and products is considered.

Plastics save energy

In addition to the well-known technical advantages such as corrosion resistance, plastics also characterised by their ecological advantages. Its light weight and insulating properties make it suitable for a variety of energy-efficient applications: in vehicles, packaging, insulation and piping systems. Plastics are mainly made from crude oils. About four percent of the world's oil is processed into plastic. The efforts to reduce the consumption of oil and other fossil fuels, however, do not mean a renouncement of plastic – on the contrary: The use of plastics saves energy!

In a study, Plastics Europe has quantified how energy consumption and greenhouse gas emissions affect plastic products by replacing them with other materials.

Results

- Plastic products enable significant savings in energy and reduce greenhouse gas emissions.
- Replacing plastic products with other materials will in most cases increase energy consumption and greenhouse gas emissions.

Replacing as many plastic products as possible with other materials would require over 50% more energy than is consumed today throughout the life cycle of all plastic products. In other words: The plastic products on the market today have enabled energy savings of 2,400 million GJ per year. This is equal to an amount of 50 million tons of oil, spread over 200 very large oil tankers.

Sustainability and Life Cycle Assessment
Additional information on sustainability and life cycle assessment see:
➨ Part I 'Introduction'

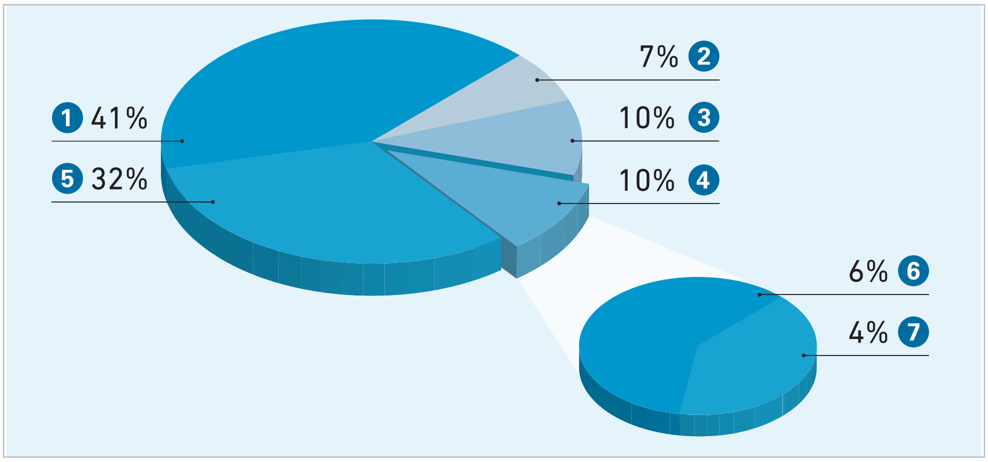
1.4 Manufacturing and processing methods

1.4.1 Raw materials

Raw materials required for the production of plastics are natural products such as cellulose, coal, crude oil and natural gas. At the refinery, crude oil is separated by distillation it into several components. It is separated into boiling ranges, distillation results in gas, petrol, petroleum and gasoil. The residue is bitumen. All components consist of hydrocarbons, which differ in size and shape of the molecules. The most important component for the production of plastics is naphtha. Naphtha is broken up and converted into ethylene, propylene, butylene and other hydrocarbon compounds in a thermal cracking process (cracking process).

1.4.2 Manufacturing

Plastics are formed by connecting a large number of similar basic building blocks (monomers), using a chemical bond. The majority of the raw materials required for this purpose comes from the processing of crude oil, but in some cases raw materials from renewable sources are also used. Contrary to expectations, only about 4% of crude oil products coming from the refinery go to the plastics industry. The chemical industry accounts for around 10% of total crude oil consumption in Germany, including 6% for plasticsproduction. In the production of plastics, three different methods are used.



GIII.3
Use of petroleum in production areas

1. Traffic
2. Miscellaneous
3. Industry
4. Chemistry
5. Heater
6. of this 6% plastic
7. Other materials

TIII.5 **Manufacturing of plastics**

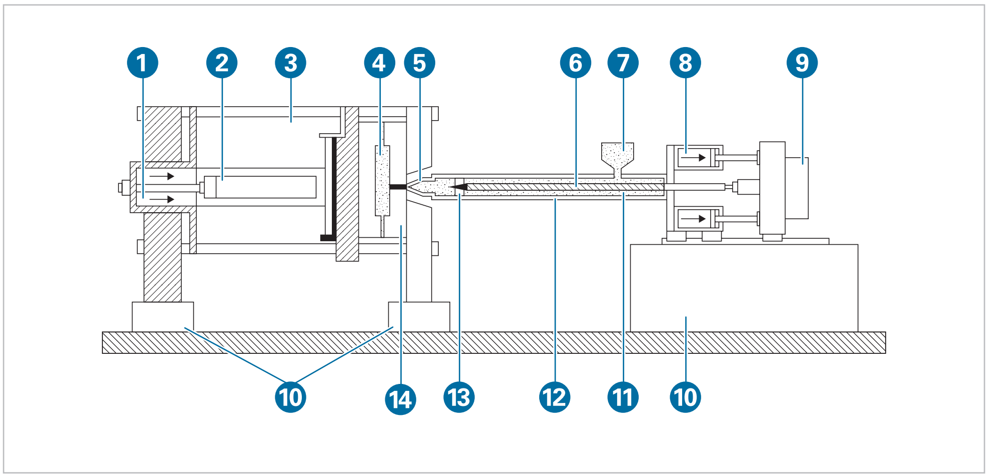
Polymerisation	Polycondensation	Polyaddition
Polymerisation is the most widely used process in the synthesis of plastics. Polymerisation refers to the attachment of monomers to macromolecule chains without elimination of foreign substances. When using polymerisation, polyethylene, polybutene, polypropylene, polyvinyl chloride and other plastics, for example, are formed.	In the polycondensation process, equal and dissimilar monomers are arranged in a macromolecule chain with simultaneous elimination of a by-product, e.g. water, hydrochloric acid. Polycondensation is used, for example, in the manufacturing of phenolic resins and polyamides.	When using polyaddition, macromolecules are formed from molecules of different chemical structure, but without elimination of a by-product. This process is used in the manufacturing of polyurethanes and epoxy resin, for example, araldite.

1.4.3 Processing

GF Piping Systems uses a variety of plastic processing techniques. A distinction is made between injection moulding, extrusion and foaming. The injection moulding process is used to produce fittings and valves. Pipes are extruded. Special fittings and pipes are foamed as well.

Injection moulding

An injection moulding machine is used to melt (plasticise) the respective material and injected into a mould – the moulding tool – under pressure. Inside the mould tool, the material is cooled and thus reverts to its solid state. The resulting volume shrinkage is compensated by very high pressures. By rotating the plasticising screw, material for the next component is added. After opening the tool, the finished part is removed. The void (the cavity) of the tool determines the shape and the surface structure of the finished part.



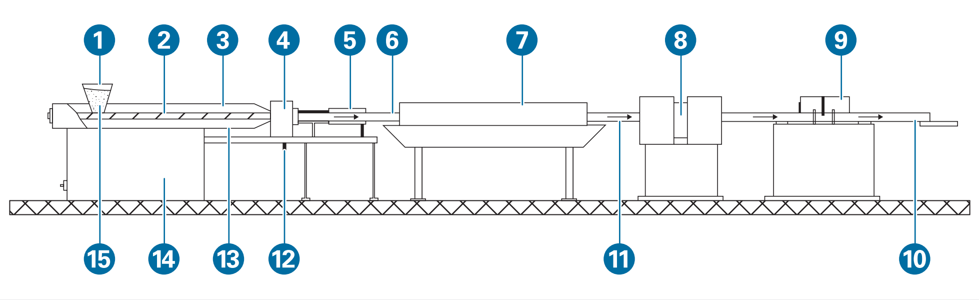
GIII.4
Components of a typical plasticising/injection unit

1. Locking cylinder
2. Opening cylinder
3. Opening and locking cylinder
4. Workpiece
5. Injection nozzle
6. Plasticising screw
7. Plastic pellets
8. Injection cylinder
9. Worm gear drive
10. Machine bed
11. Plasticising cylinder
12. Heater
13. Non-return valve
14. Moulding tool

Extruding

An extrusion machine integrates the following process steps:

- 1. Extruding
- 2. Shaping
- 3. Calibrating
- 4. Cooling
- 5. Removing
- 6. Separating



GIII.5
Components of a typical extrusion system

1. Hopper
2. Plasticising screw
3. Heater
4. Moulding tool (profile nozzle)
5. Calibration distance
6. Pipe
7. Cooling section
8. Haul-off/pulling machine
9. Device for cutting into lengths
10. Hollow section
11. Pipe
12. Compressed air
13. Plasticising cylinder
14. Extruder
15. Plastic pellets

The extruder system consists of the hopper, the plasticising cylinder, one or two plasticising screw(s) and the actuator. The tasks of the extruder's components are the same as in the injection unit during injection moulding.

The extruder tool rests directly against the extruder, guiding the mass around a mandrel and shaping the profile of the pipe. For pipes under d400, tools with sieve rings or multiple webs are used for fixing. For larger pipes over d400, spiral distribution tools are used. The cooling section and calibration section are connected in the manufacturing of the pipe. This is possible by using vacuum tank calibration with multiple water showers. A caterpillar haul-off/pulling machine is used to handle the pulling in pipe manufacturing. The speed of the haul-off/pulling machine is adapted to the performance of the extruder. The separating unit must move with the extrudate (pipe) during cutting process.

1.5 Plastics in piping system construction

The following detail illustrations refer to the plastics used in installation systems in the GFPS building systems.

These are:

Plastic	Acronym	Remark
Polybutene-1	PB-1	–
Polyethylene	PE	Type 3rd generation: PE100
	PE-RT	for elevated temperatures
Polyethylene, linked	PE-X	applicable variants: PE-Xa, PE-Xc
Polyphenylsulfone	PPSU	–
Polypropylene	PP	applicable variant: PP-R

TIII.6
Plastics in systems

1.6 Polybutene-1 (PB-1)

Properties

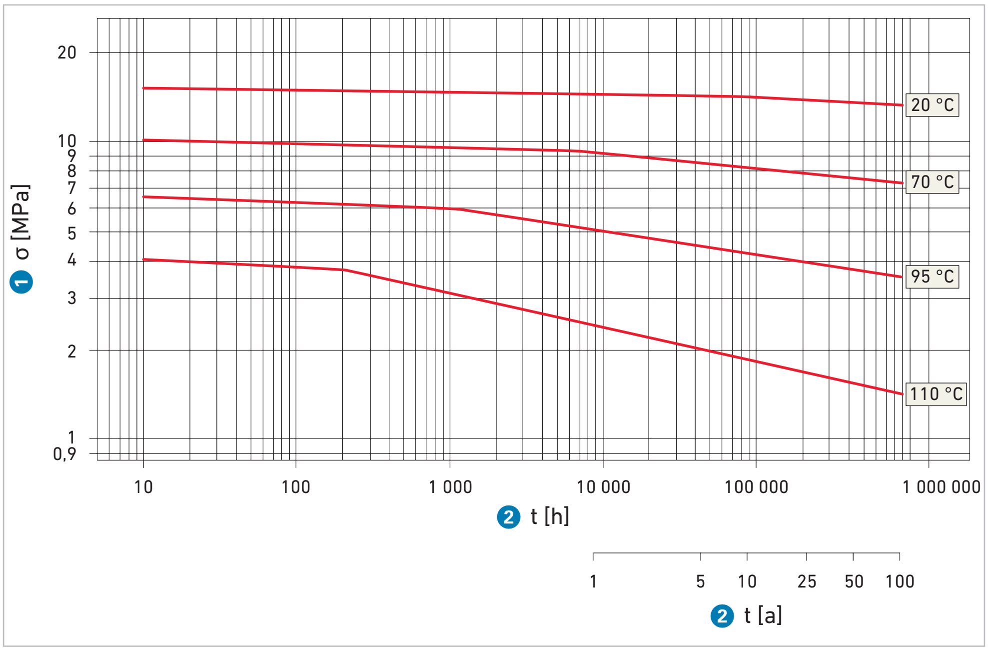
The table shows typical characteristic values measured on the material. These values should not be used for calculation purposes.

TIII.7
PB-1 properties (guidelines)

Property	Value	Unit of measure	Test standard
Density	0.925	g/cm³	EN ISO 1183-1
Yield stress at 23°C	20	N/mm²	EN ISO 527-1
Tension E-module at 23°C	450	N/mm²	EN ISO 527-1
Charpy impact strength at 23°C	20	kJ/m²	EN ISO 179-1/1eA
Thermal conductivity at 23°C	0.19	W/(m·K)	ASTM E1530
Oxygen Index (LOI)	19	%	ISO 4589-1

Internal pressure creep behaviour for PB

Minimum curves according to ISO 15874 (2013)



GIII.6
PB, long-term creep strength

1 Equivalent stress
2 Time to failure

General information

Polybutene-1 is a semi-crystalline, thermoplastic material and belongs chemically to the group of polyolefins. It consists therefore exclusively of carbon and hydrogen. PB-1 is catalytically synthesized from 1-butene. The material used by GF for the INSTAFLEX system is a homopolymer. Among other things, the material is characterized by excellent internal pressure resistance even at high temperatures. The application requirements of 10 bar at +70°C and 50 years can already be met with an SDR11 system, which is unique in the polyolefin field. In addition, the high degree of flexibility simplifies the installation. Furthermore, the low density of the material makes handling easier.

The material-compatible type of connection is either welding or using mechanical connectors. For both variants different methods are available at GF, for example, butt, socket welding and electrofusion with INSTAFLEX or iFIT push fittings can be used.

UV-repellent and resistance to atmospheric conditions

PB-1, like most organic materials, is inherently not UV- and weather-resistant. In favour of drinking water, an additional UV protection was not used, although the colour pigments provide some protection. However, unprotected storage or outdoor use is not recommended. For proper protective measures and the use outdoors, please contact the appropriate branch office at GF Piping Systems.

Chemical resistance

As with all polyolefins, there is a certain sensitivity to oxidative media, to which disinfectants from the field of water treatment and disinfection, such as chlorine dioxide and sodium hypochlorite belong. When used, compliance with certain rules and limits is mandatory to in order to prevent damage to the system.

For specific information on the durability of your application, contact your local GF Piping Systems branch office.

Limits of use

The limits of use of the material are based on the embrittlement and softening temperatures as well as the application classes defined in the relevant standards and regulations. For PB-1, these limits are between –10°C and 95°C. Details can be found in the applicable pressure-temperature diagrams for the respective system.

Fire behaviour

Polybutene is one of the flammable plastics. The oxygen index is 19% (below 21%, the plastic is considered flammable). When the flame is extinguished, PB continues to drip and burn without giving off sooty smoke. All combustion processes produce toxic substances, carbon monoxide usually plays a major role. Combustion of PB produces primarily carbon dioxide, carbon monoxide and water. Suitable extinguishing agents are water, foam and carbon dioxide.

Physiological properties

The PB-1 used by GF Piping Systems meets all requirements for the common European drinking water approvals as well as some non-European approvals. For details on existing approvals for the use with drinking water, contact the responsible branch office of GF Piping Systems.

1.7 Polyethylene (PE)

Properties

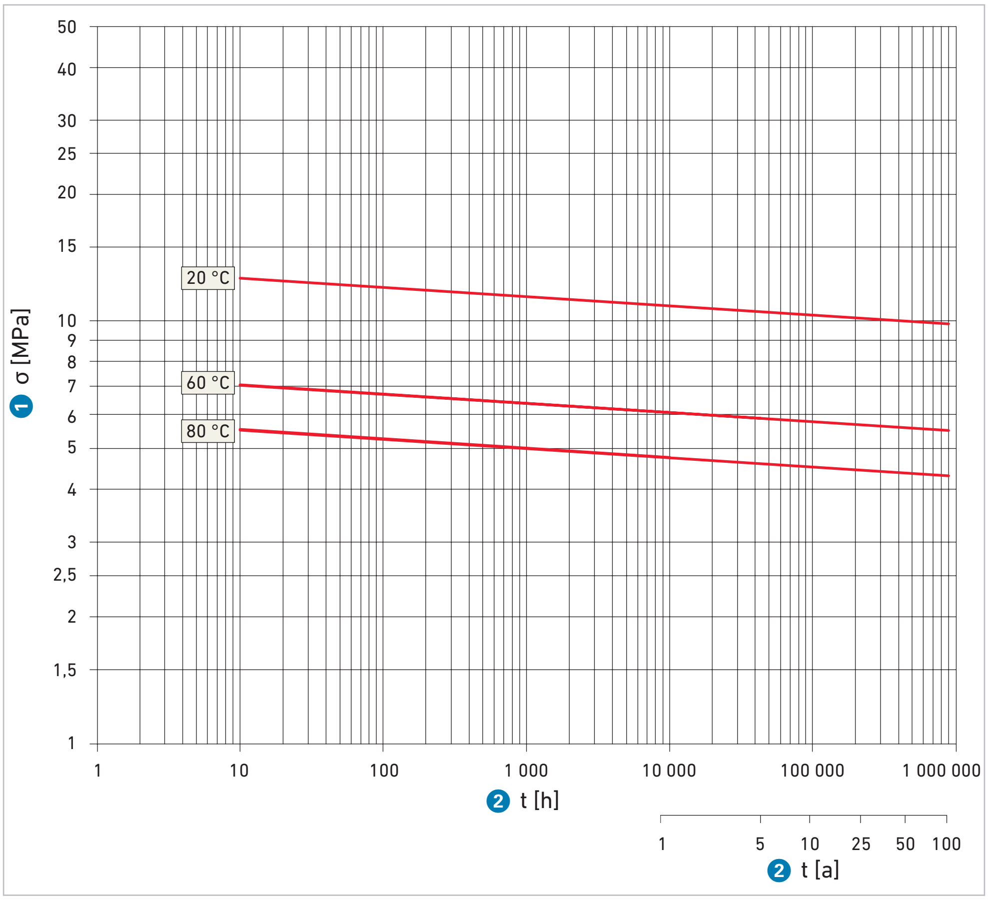
The table shows typical characteristic values measured on the material. These values should not be used for calculation purposes.

TIII.8
PE properties (guidelines)

Property	Value	Unit of measure	Test standard
Density	0.95	g/cm³	EN ISO 1183-1
Yield stress at 23°C	25	N/mm²	EN ISO 527-1
Tension E-module at 23°C	900	N/mm²	EN ISO 527-1
Charpy impact strength at 23°C	83	kJ/m²	EN ISO 179-1/1eA
Charpy impact strength at -40°C	13	kJ/m²	EN ISO 179-1/1eA
Crystallite melting point	130	°C	DIN 51007
Thermal conductivity at 23°C	0.38	W/(m·K)	EN 12664
Water absorption at 23°C	−0.04	%	EN ISO 62
Colour	9005	RAL	–
Oxygen Index (LOI)	17.4	%	ISO 4589-1

Internal pressure creep behaviour for PE100

Minimum curves according to DIN 8075 (2011)



GIII.7
PE100, long-term creep strength

1 Equivalent stress
2 Time to failure

General information

All polymers which are composed of hydrocarbons of the formula CnH_2n with a double bond (ethylene, propylene, butene-1, isobutene) are referred to by the collective term polyolefins. These include polyethylene (PE). This is a semi-crystalline thermoplastic. Polyethylene is probably the best known plastic. The chemical formula is: $-(CH_2-CH_2)n$.

Polyethylene is an environmentally friendly hydrocarbon product. PE, like PP, is one of the non-polar materials. It is therefore not soluble in common solvents and hardly swellable. Therefore, PE pipes cannot be joined by gluing with fittings. The material-appropriate and suitable connection method is welding.

In industrial piping system construction, high-molecular types of medium to high density have become established. The grades are classified according to their long-term creep strength in PE80 (MRS 8 MPa) and PE100 (MRS 10 MPa). They are also referred to as PE types of the third generation, whereas PE80 types are predominantly assigned to the second generation. Of the PE types of the first generation – according to today's classification PE63 – they are difficult to obtain on the market. The long-term creep strength was tested by applying long-term tests according to ISO 1167 and was calculated according to ISO 9080. PE has been widely used in piping system construction for the design of underground gas and water pipelines.
In this field of application, polyethylene has become the dominant material in many countries. However, the advantages of this material are also used in building technology and industrial piping system construction.

Advantages of PE

- Very light-weight
- Excellent flexibility
- Good abrasion resistance (the wearing down by friction)
- Corrosion resistance
- Ductile fracture properties
- High impact strength even at very low temperatures
- Good chemical resistance
- Easy to weld

UV-repellent and resistance to atmospheric conditions

Polyethylene is very resistant to atmospheric conditions due to the black pigment used. Even prolonged exposure to solar radiation, wind and rain will cause only minor damage to the material.

Chemical resistance

Polyethylene shows excellent resistance to a wide range of media. For detailed information, refer to GF Piping Systems' detailed list of chemical resistance, or contact the GF Piping Systems representative office directly.

Limits of use

The limits of application of the material depend on the one hand on the embrittlement and softening temperatures and on the other hand on the type and duration of the application. Details can be found in the respective pressure-temperature diagrams.

Fire behaviour

Polyethylene is one of the flammable plastics. The oxygen index is 17%. If the oxygen index is less than 21%, PE is considered flammable. When the flame is extinguished, PE continues to drip and burn without giving off sooty smoke. All combustion processes produce toxic substances, carbon monoxide usually plays a major role. Combustion of PE produces primarily carbon dioxide, carbon monoxide and water.

Physiological properties

The black polyethylene types used by GF Piping Systems are permitted under the food law. The fittings are odourless, tasteless and physiologically harmless. The use in all relevant areas is therefore possible. For details on existing approvals for the use with drinking water and food, contact the responsible branch office.

1.8 Polyethylene for elevated temperatures (PE-RT)

Properties

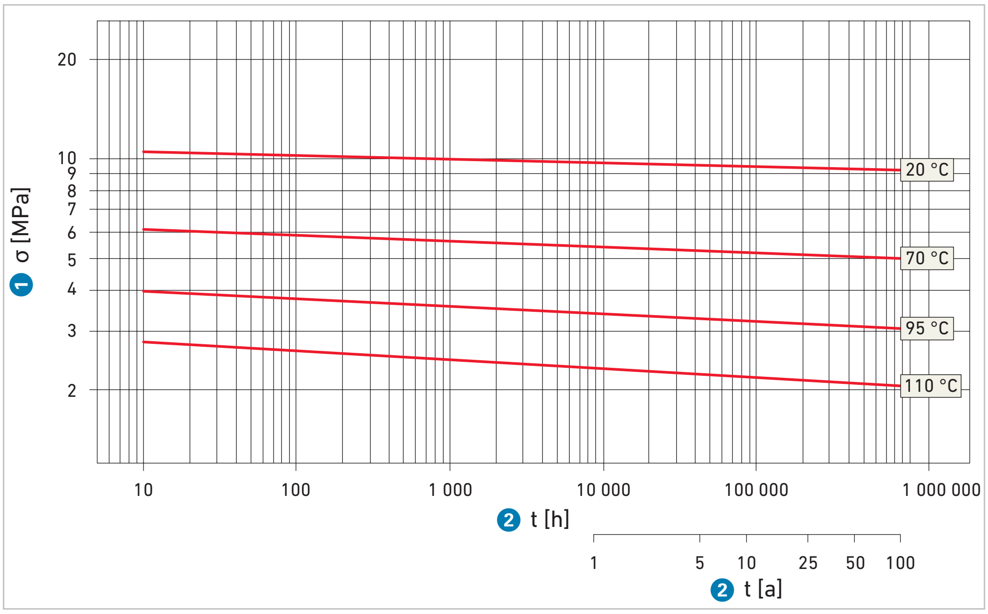
The table shows typical characteristic values measured on the material. These values should not be used for calculation purposes.

TIII.9
PE-RT properties (guidelines)

Property	Value	Unit of measure	Test standard
Density	0.947	g/cm^3	EN ISO 1183-1
Yield stress at 23°C	22	N/mm^2	EN ISO 527-1
Tension E-module at 23°C	850	N/mm^2	EN ISO 527-1
Charpy impact strength at 23°C	24	kJ/m^2	EN ISO 179-1/1eA
Thermal conductivity at 23°C	0.43	W/(m·K)	EN 12664
Oxygen Index (LOI)	18	%	ISO 4589-1

Internal pressure creep behaviour for PE-RT

Minimum curves according to ISO 22391 (2009)



GIII.8
PE-RT, long-term creep strength
1 Equivalent stress
2 Time to failure

General information

Like PB-1, PE-RT is a semi-crystalline, thermoplastic material belonging to the group of polyolefins. Like other PE types for the pressure pipe line market, the material is characterised by very high impact strength and is very robust. Due to its special molecular structure, which distinguishes it from other types of polyethylene, it is also suitable for use at elevated temperatures, such as those found in domestic installations. The internal pressure resistance is at the usual level that can be found in polyolefins. The density is low, which makes the material light and therefore easy to handle.

PE-RT is used almost exclusively in multilayer pipes (multi-layer composite pipes) at GF Piping Systems. A thin layer of aluminium acts as an oxygen barrier because polyolefins are not oxygen-tight. In other respects, the aluminium layer also significantly influences the mechanical behaviour of the pipes, such as their flexural rigidity, internal pressure and restoring behaviour. Multi-layer pipes are only linked by using mechanical connectors, in this case iFIT push fittings or iLITE compression fittings.

UV-repellent and resistance to atmospheric conditions

PE-RT, like most organic materials, is inherently not UV- and weather-resistant. In favour of drinking water, an additional UV protection was not used, although the colour pigments in the outer layer of the multi-pipes provide some protection. However, unprotected storage or outdoor use is not recommended. For proper protective measures and the use outdoors, please contact the appropriate branch office at GF Piping Systems.

Chemical resistance

As with all polyolefins, there is a certain sensitivity to oxidative media, to which disinfectants from the field of water treatment and disinfection, such as chlorine dioxide and sodium hypochlorite belong. When used, compliance with certain rules and limits is mandatory to in order to prevent damage to the system.

For specific information on the durability of your application, contact your local GF Piping Systems branch office.

Limits of use

The limits of use of the material are based on the embrittlement and softening temperatures of the material itself as well as of other components in the system as well as the application classes defined in the relevant standards and regulations. For PE-RT, these limits are between –10°C and 95°C. Details can be found in the applicable pressure-temperature diagrams for the respective system.

Fire behaviour

PE-RT is one of the flammable plastics. The oxygen index is 18% (below 21%, the plastic is considered flammable). When the flame is extinguished, PE-RT continues to drip and burn without giving off sooty smoke. All combustion processes produce toxic substances, carbon monoxide usually plays a major role. Combustion of PB produces primarily carbon dioxide, carbon monoxide and water.

Suitable extinguishing agents are water, foam and carbon dioxide.

Physiological properties

The PE-RT used by GF Piping Systems meets all requirements for the common European drinking water approvals as well as some non-European approvals. For details on existing approvals for the use with drinking water, contact the responsible branch office of GF Piping Systems.

1.9 Crosslinked polyethylene (PE-X)

Properties

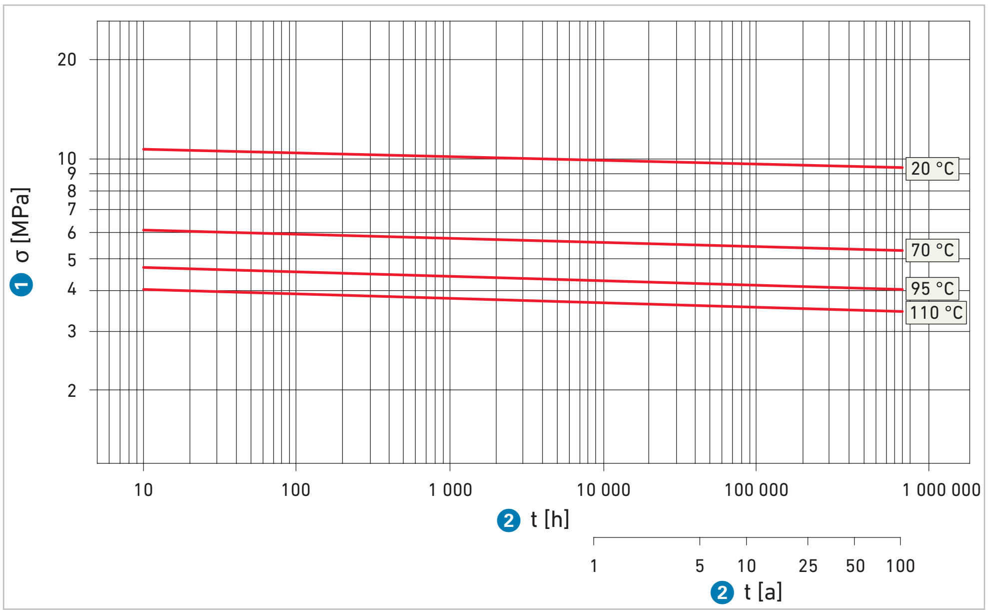
The table shows typical characteristic values measured on the material. These values should not be used for calculation purposes.

TIII.10
PE-X properties (guidelines)

Property	PE-Xa	PE-Xc	Unit of measure	Test standard
Yield stress at 23°C	>19	>22	N/mm²	EN ISO 527-1
Tension E-module at 23°C	>1000	<1100	N/mm²	EN ISO 527-1
Charpy impact strength at 23°C	Without breakage	Without breakage	kJ/m²	EN ISO 179-1/1eA
Thermal conductivity at 23°C	0.41		W/(m·K)	EN 12664
Oxygen Index (LOI)	19		%	ISO 4589-1

Internal pressure creep behaviour for PE-X

Minimum curves according to ISO 15875 (2003)



GIII.9
PE-X, long-term creep strength
1 Equivalent stress
2 Time to failure

General information

As PB and PE-RT, crosslinked polyethylene belongs to the group of semi-crystalline polyolefins. However, due to the crosslinking, polyethylene has lost its thermoplastic characteristic.

Based on the type of crosslinking, three different types of PE-X are distinguished. The peroxide-crosslinked PE-Xa, the silane-crosslinked PE-Xb and the radiation-crosslinked PE-Xc. In both PE-Xb and PE-Xc, the crosslinking step occurs separately from the actual pipe extrusion when the material is already completely cooled and has crystallised again. This leads to a slightly higher density and a slightly higher stiffness compared to PE-Xa, which is already cross-linked during the extrusion in the melt. The specified respective minimum value for crosslinking is standardised and is between 60% (PE-Xc) and 70% (PE-Xa). However, the long-term creep strength requirements do not differ for each type, so the materials can be considered equivalent to the user.

PE-Xa and PE-Xc are mainly used at GF Piping Systems. The PE-Xc is used both as a multi-layer composite pipe with a barrier layer made of aluminium, as well as a full plastic version. The pipes are connected mechanically, using connectors of the product groups JRG Sanipex and JRG Sanipex MT.

UV-repellent and resistance to atmospheric conditions

PE-X, like most organic materials, is inherently not UV- and weather-resistant. In favour of drinking water, an additional UV protection was not used, although the colour pigments in the outer layer of the pipes provide some protection. However, unprotected storage or outdoor use is not recommended. For proper protective measures and the use outdoors, please contact the appropriate branch office at GF Piping Systems.

Chemical resistance

As with all polyolefins, there is a certain sensitivity to oxidative media, to which disinfectants from the field of water treatment and disinfection, such as chlorine dioxide and sodium hypochlorite belong. When used, compliance with certain rules and limits is mandatory to in order to prevent damage to the system.

For specific information on the durability of your application, contact your local GF Piping Systems branch office.

Limits of use

The limits of use of the material are based on the embrittlement and softening temperatures of the material itself as well as of other components in the system as well as the application classes defined in the relevant standards and regulations. For PE-X, these limits are between –10°C and 95°C. Details can be found in the applicable pressure-temperature diagrams for the respective system.

Fire behaviour

PE-X is one of the flammable plastics. The oxygen index is 19% (below 21%, the plastic is considered flammable). When the flame is extinguished, PE-RT continues to drip and burn without giving off sooty smoke. All combustion processes produce toxic substances, carbon monoxide usually plays a major role. Combustion of PB produces primarily carbon dioxide, carbon monoxide and water.

Suitable extinguishing agents are water, foam and carbon dioxide.

Physiological properties

The PE-X used by GF Piping Systems meets all requirements for the common European drinking water approvals as well as some non-European approvals. For details on existing approvals for the use with drinking water, contact the responsible branch of GF Piping Systems.

1.10 Polyphenylsulfone (PPSU)

Properties

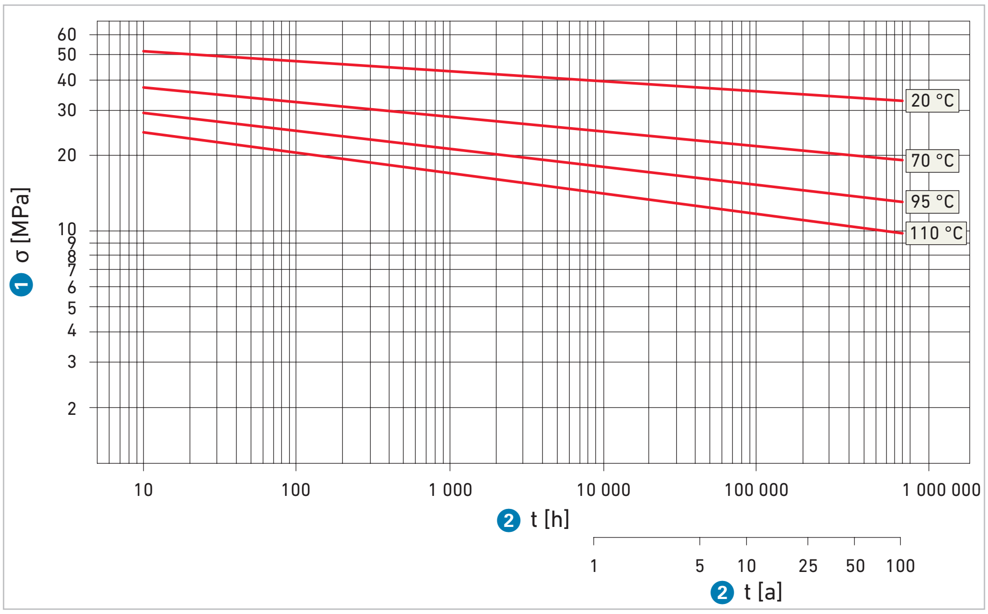
The table shows typical characteristic values measured on the material. These values should not be used for calculation purposes.

TIII.11
PPSU (guideline)

Property	Value	Unit of measure	Test standard
Density	1,29	g/cm³	EN ISO 1183-1
Yield stress at 23°C	≥74	N/mm²	EN ISO 527-1
Tension E-module at 23°C	≥2200	N/mm²	EN ISO 527-1
Charpy impact strength at 23°C	≥75	kJ/m²	EN ISO 179-1/1eA
Thermal conductivity at 23°C	0,26	W/(m·K)	ASTM E1530
Oxygen Index (LOI)	≥36	%	ISO 4589-1

Internal pressure creep behaviour for PPSU

Minimum curves according to DIN 16838 (2010)



GIII.10
PPSU, long-term creep strength

1. Equivalent stress
2. Time to failure

General information

Polyphenylene sulfone is an amorphous, high-performance thermoplastic. Unlike the polyolefins, in addition to carbon and hydrogen, polyphenylene sulfone also contains sulphur and oxygen in a complex molecular structure. It is characterized by high toughness combined with high strength and rigidity, making it an ideal material for mechanical connectors.
In addition, it has excellent internal pressure creep behaviour and excellent temperature resistance.

PPSU is used in three different systems at GF Piping Systems. Once in the iFIT connectors, as a part of the connectors that comes in contact with the media and the modules which are made 100% of this material. For the product JRG Sanipex MT, the inner lining of the fittings is made of this material. The product iLITE consists for the most part of PPSU, only the clamping elements are made of a different material.

UV-repellent and resistance to atmospheric conditions

PPSU, like most organic materials, is inherently not UV- and weather-resistant. In favour of drinking water, an additional UV protection was not used, although the carbon black in the black variants of the pipes provide some protection. However, unprotected storage or outdoor use is not recommended. For information on proper protective measures and the use outdoor use, please contact the appropriate branch office of GF Piping Systems.

Chemical resistance

PPSU has a very good hydrolysis stability in hot water and is also resistant to the most common water disinfectants. The material is sensitive to contact with solvents such as acetone; this can lead to stress cracks.

For specific information on the durability of your application, contact your local GF Piping Systems branch office.

Limits of use

The limits of use of the material are based on the embrittlement and softening temperatures of the material itself as well as of other components in the system as well as the application classes defined in the relevant standards and regulations. For PPSU, these limits are between –10°C and 95°C. Details can be found in the applicable pressure-temperature diagrams for the respective system.

Fire behaviour

By virtue of the sulphur bound in the molecule, PPSU is self-extinguishing, which also confirms the LOI index (limiting oxygen) of 44%. This means that the material does not burn on its own, but an external flame is needed which keeps the combustion going. According to UL (Underwriters Laboratories), the materials are classified as V-0 at a min. of 3 mm.

At temperatures of > 400°C carbon monoxide, sulphur dioxide can be released. Under certain fire conditions traces of other toxic substances cannot be excluded. The formation of further gap and oxidation products depends on the fire conditions.

Suitable extinguishing agents are water spray, foam and extinguishing powder.

Physiological properties

The PPSU grades used by GF Piping Systems meet all requirements for the common European drinking water authorisations as well as some non-European approvals. For details on existing approvals for the use with drinking water, contact the responsible branch office of GF Piping Systems.

1.11 Polypropylene (PP)

Properties

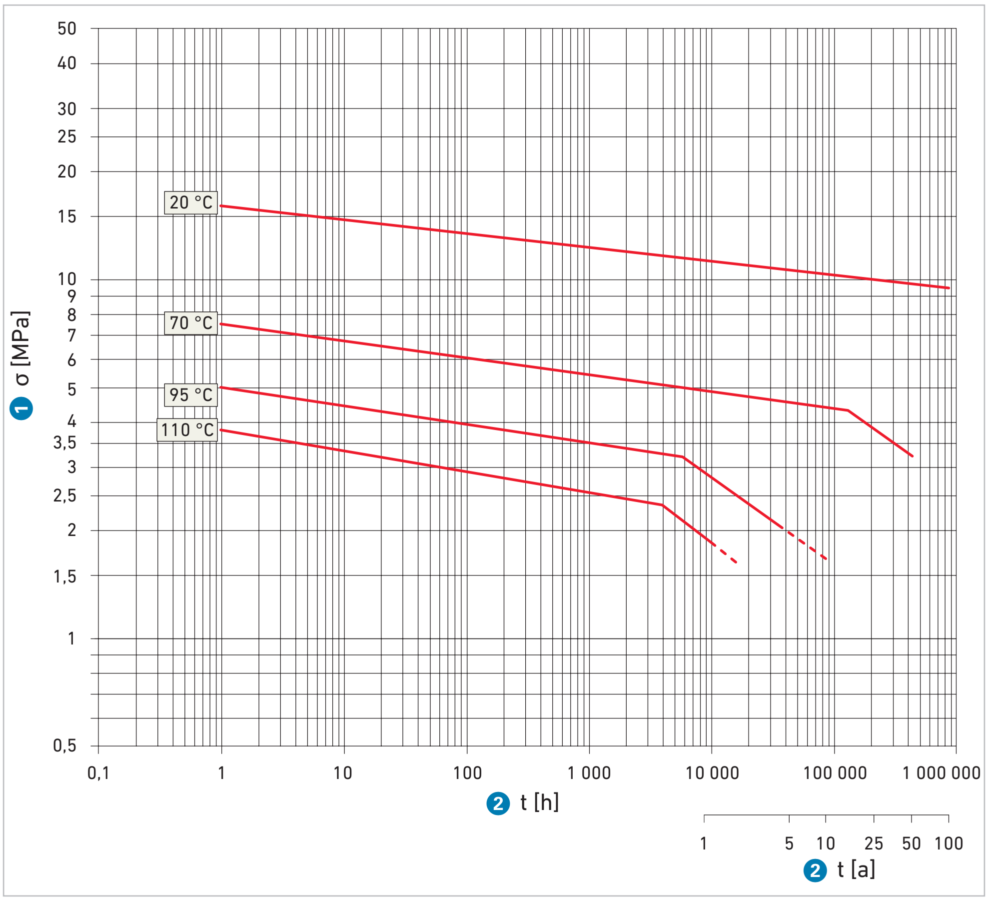
The table shows typical characteristic values measured on the material. These values should not be used for calculation purposes.

TIII.12
PP-R (guidelines)

Property	Value	Unit of measure	Test standard
Density	0.90 – 0.91	g/cm³	EN ISO 1183-1
Yield stress at 23°C	25	N/mm²	EN ISO 527-1
Tension E-module at 23°C	900	N/mm²	EN ISO 527-1
Charpy impact strength at 23°C	20	kJ/m²	EN ISO 179-1/1eA
Thermal conductivity at 23°C	19	W/(m·K)	ISO 4589-1
Oxygen Index (LOI)	19	%	ISO 4589-1

Internal pressure creep behaviour for PP-R

Minimum curves according to ISO 15874 (2013)



GIII.11
PP-R, long-term creep strength

1 Equivalent stress
2 Time to failure

General information

Polypropylene (PP) is a thermoplastic belonging to the group of polyolefins and thus is a semi-crystalline material. The density is lower than that of the other known thermoplastics. The mechanical properties, the chemical resistance and in particular the heat resistance have made polypropylene an important material in piping system construction as well. PP is formed by the polymerisation of propylene (C_3H_6) using, for example, Ziegler-Natta catalysts.

Three different material variants are common in piping system construction:

- Isotactic PP homopolymer (PP-H)
- PP block copolymer (PP-B)
- PP random copolymer (PP-R)

Due to the low modulus of elasticity and the high long-term creep strength at high temperatures, PP-R is predominantly used in the sanitary sector. PP-B is mainly used for sewage systems because of its high impact strength, especially at low temperatures, and the comparatively low temperature resistance. PP-H is mainly used for industrial applications.

The material is usually connected using butt or socket fusion.

UV-repellent and resistance to atmospheric conditions

PP-R, like most organic materials, is inherently not UV- and weather-resistant. In favour of drinking water, an additional UV protection was not used, although the colour pigments provide some protection. However, unprotected storage or outdoor use is not recommended. For proper protective measures and the use outdoors, please contact the appropriate branch office at GF Piping Systems.

Chemical resistance

As with all polyolefins, there is a certain sensitivity to oxidative media, to which disinfectants from the field of water treatment and disinfection, such as chlorine dioxide and sodium hypochlorite belong. When used, compliance with certain rules and limits is mandatory to in order to prevent damage to the system. For specific information on the durability of your application, please contact your local GF Piping Systems branch office.

Limits of use

The limits of use of the material are based on the embrittlement and softening temperatures as well as the application classes defined in the relevant standards and regulations. For PP-R, these limits are between –10°C and 95°C. Details can be found in the applicable pressure-temperature diagrams for the respective system.

Fire behaviour

PP-R is one of the flammable plastics. The oxygen index is 19% (below 21%, the plastic is considered flammable). When the flame is extinguished, PP-R continues to drip and burn without giving off sooty smoke. All combustion processes produce toxic substances, carbon monoxide usually plays a major role. Combustion of PP-R produces primarily carbon dioxide, carbon monoxide and water.

Suitable extinguishing agents are water, foam and carbon dioxide.

Physiological properties

The PP-R used by GF Piping Systems meets all requirements for the common European drinking water approvals as well as some non-European approvals. For details on existing approvals for the use with drinking water, contact the responsible branch office of GF Piping Systems.

2 Metals

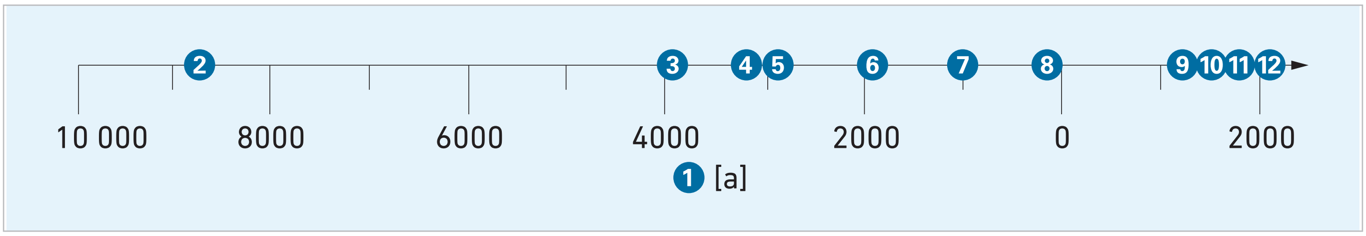
2.1 History

The metal age is the general term for the Copper, Bronze and Iron Age.

Metal was discovered in prehistoric times, probably by accident, when metal-bearing rock came into contact with fire. Due to the excessive heat, the liquefied ore dissolved from the material and formed shiny metal beads. Through experimentation, it was found that these beads could be deformed.

According to archaeological findings, **copper** and **gold** were the first processed metals. These metals were primarily to maker jewellery and light tools. Only two thousand years later, the heavy metal **tin** was added. By mixing copper and tin, the **bronze** was discovered, which was much harder than the metals known at the time. With the discovery of this resilient material, a new epoch in the history of humanity began – the Bronze Age.

At about the same time, around 3000 BC, according to archaeological findings, **iron** has already been processed in the present day Asia Minor. This was processed meteorite iron, which was used as jewellery. Officially, however, the Iron Age lasted from 500 BC to 400 AD, because at that time the iron was obtained in large quantities by blast furnaces and thus replaced the bronze.



1 Historical time (BC/AD)
2 Copper
3 Gold
4 Bronze
5 Lead, silver
6 Iron
7 Tin
8 Brass
9 Zinc
10 Nickel
11 Aluminium, magnesium
12 Titanium

GIII.12
Use of metals from a historical perspective

Many the metals we know today were discovered much later. For example, platinum in 1557, nickel in 1751, titanium in 1797, and the now ubiquitous aluminium in 1825.

2.2 Manufacturing and processing methods

2.2.1 Raw materials

The precious ore hides in mineral deposits in the earth's crust or just below the earth's surface. In nature, the deposits of these different metals rarely occur in pure form.

Ore genesis is a sub-discipline of geosciences and deals with the geology of ore deposits in the rock bed. The aim is to promote the raw ores and make them economically viable.
A distinction is made between black metal, non-ferrous metal, light metal and precious metal ores.

2.2.2 Manufacturing

The extraction and manufacturing processes of metals are very complex and vary from material to material. Excessive heat is always needed to extract the ore. In addition to the high energy consumption, auxiliary materials which serve, among other things, the reduction, are necessary. For example, ordinary **iron** is obtained by a reduction process in the blast furnace. Pig iron is extracted from the iron ore with the aid of the reducing agent called coke. This takes place at a temperature exceeding 2000°C. Similarly, steel can be produced in a more advanced and complex process.

The manufacturing of **aluminium** is significantly more complex and above all extremely energy-intensive. In order to extract one tonne of aluminium from bauxite ore, about 16,000 kWh has to be used. In addition, depending on the origin of Bauxite ore, between 1.5 and 3 t of red mud are produced, which due to its ingredients is harmful to the environment and must be stored in special landfills.

2.3 Metals

2.3.1 Copper (Cu)

History

Copper is one of the oldest metals used by humans. It was used more than 10,000 years ago in the Stone Age. Crucial to its early use was that larger amounts were readily available in many places due to natural erosion on the surface of the earth. Over time, people learned how to process this metal. By mixing the copper with other metals, alloys were created that gave their name to an entire epoch: the **Bronze Age**.

It was only in Egypt where the state permitted to mine copper from 3200 to 1160 BC. At that time, copper was used to produce weapons, tools and jewellery. Around 2500 BC a 400 m long water pipe made of copper was already installed in the temple of Sahure. The Romans also used copper in their days, however, they called it "aes cyprium" (ore from Cyprus).

Due to the growing industrialisation in the 19th century, copper consumption rose dramatically. Among other things, this can be attributed to the invention of the dynamo, with which electricity could be produced cheaply. The deposits in Europe were no longer sufficient to meet the demand. In 1866, 100,000 tons were produced worldwide; within a hundred years (until 1976), this value increased by more than 75 times (7,854,100 tonnes of copper).

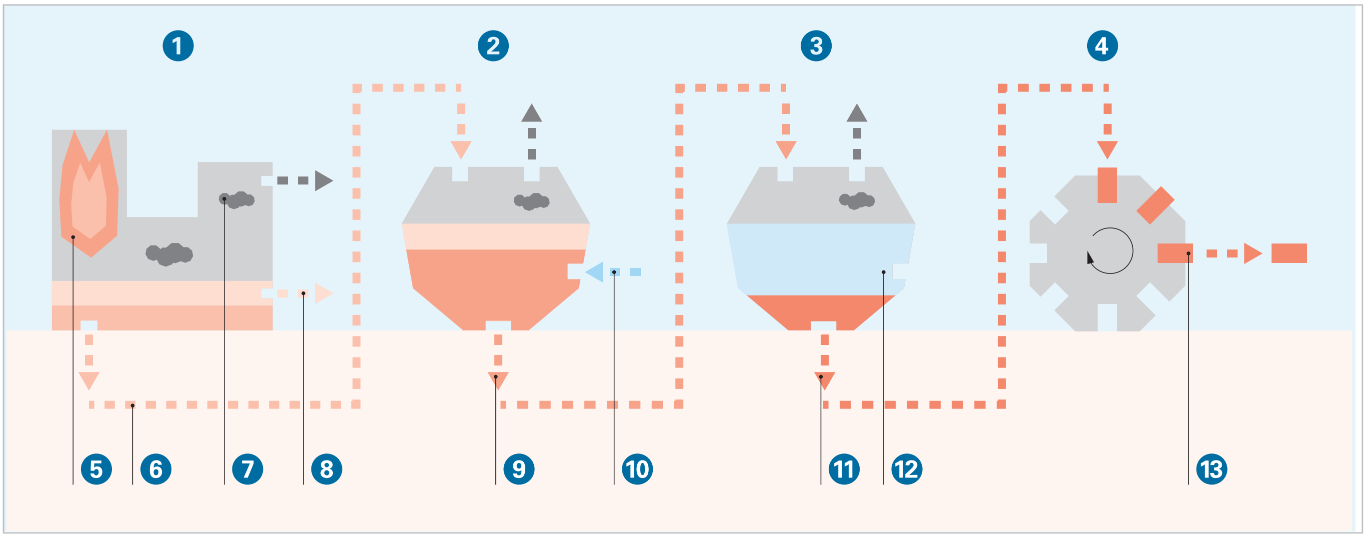
Manufacturing

The raw material can exist in different forms: Either as oxidic or sulfidic ore. Accordingly, copper is obtained in two different ways.

The **oxidic ores** are leached in sulfuric acid and then cemented out (cement copper) or a step called electrowinning (electrolytic copper).

Sulfuric ores are fused with coal and blown in the converter.

The purity of this crude copper is about 99%. When using an electrolysis, in which the copper is deposited cathodically, this degree of purity can be increased again.



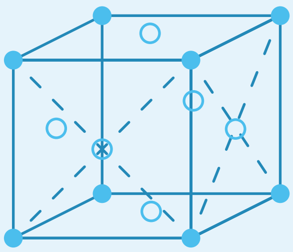
1. Flash smelting furnace
2. Converter
3. Anode furnace
4. Anode casting machine
5. Ore concentrate and hot blast
6. Copper matte
7. Exhaust gas
8. Slag
9. Blister copper
10. Air
11. Fire-refined copper
12. Natural gas
13. Anode for copper electrolysis

GIII.13
Manufacturing process (for copper)

Properties

Copper has a density of 8,920 kg/m^3 and thus belongs to the heavy metals. It melts at a temperature of 1,083.4°C and is present in solid form as a face-centred cubic crystal system. In addition, copper has a high electrical and thermal conductivity.

As a bare metal, copper has a bright red colour. When coming in contact with air, the metal turns reddish brown. During corrosion, a weathered surface is formed. As a result, the metal loses its shine, it discolours and shows a bluish green.



GIII.14
Copper crystal system

Use

Copper is an indispensable part of today's life. It is used, among other things, in power cables, jewellery, fittings, piping, coins and much more. Due to its good physical and chemical properties, it can be used almost anywhere.

As an alloy component for the manufacturing of brass, bronze and nickel silver, it is indispensable. Depending on the concentration of the alloy components, even the reddish colour of the copper can be eliminated.

TIII.13 **Alloys – Basic characteristics**

Name	Alloy material	Colour	Properties	Use
Bronze	Tin (Sn)	reddish-brown	High strength, ductility, cold hardening, corrosion resistance, good sliding properties	Sheets, bars, wires, pipes
Brass	Zinc (Zn)	golden yellow	High strength, ductility, cold hardening, corrosion resistance, good sliding properties	Fittings, pipe connections, bearings, cartridge cases, antennas
Nickel silver	Nickel (Ni) Zinc (Zn)	silver	High strength and corrosion resistance	Tableware, musical instruments, fittings, jewellery
Red bronze	Tin (Sn) Zinc (Zn)	golden yellow	Good sliding properties	Fittings, pipe connections
Constantan	Nickel (Ni) Mangan (Mn)	silver	Approximately temperature-independent specific electrical resistance	Precision and measuring resistors

Economics

Even today, the demand for copper wire is enormous – especially in China, demand has risen sharply due to the increasing automation of the industry. Due to the increased demand, the copper price continues to rise. The high value of copper also makes a mining ore containing small amounts of copper economically viable.

Recycling

The recycling of copper-containing electronic parts is playing an increasingly important role due to the high demand and the raising price.

Ecology

Copper and its alloys have always been returned to the machining process by smelting. About 45% of global annual production is recycled copper scrap. The mining of ore pollutes the environment enormously. Especially in developing countries, there are significant ecological and social problems associated with mining. Often, biodegradation takes place in ecologically sensitive regions, which leads to significant environmental and human impacts if environmental protection laws are lacking or not complied with.

2.3.2 Zinc (Zn)

History

Already in 3000 BC zinc was known for manufacturing brass to the Babylonians and Assyrians. Homer first wrote in the 8th century BC about zinc-containing copper alloys and the Romans (from about 20 BC) used the metal for the manufacturing of brass coins. With the discovery of the metal's rollability at the beginning of the 19th century, the first rolling mills were built. The panels produced this way were used in construction and roofing.

Manufacturing

First step: Zinc roasting

In order to gain zinc, you first have to separate it from its accompanying elements. In addition to its natural occurrence as a trace element, zinc is also found in what is referred to as zinc blende. This is a mineral which contains, among other things, about 20% sulphur. The zinc blende is roasted at over 900°C so that ZnS (zincblende) combines to ZnO (zinc oxide). The sulphur also combines with oxygen to SO_2 (sulphur dioxide), which is converts into sulfuric acid when processing it further.

Second step: Hydrometallurgical zinc production

In the hydrometallurgical process, the roasted concentrate is dissolved in sulfuric acid and subsequently zinc is recovered by electrodeposition in an electrolytic process. More than 90% of the total amount of zinc produced worldwide is produced in this way.

Properties

Zinc has a bluish white colour and is brittle at room temperature. However, between 100 and 200°C, it is very ductile.
As a base metal, zinc reacts with oxygen. It forms a weather-resistant protective layer of zinc oxide and carbonate. It also dissolves in acids. In powder form, zinc is a self-ignitable (pyrophoric) solid. At room temperature, zinc can heat up in the air without energy and finally ignite. Zinc powder forms flammable gases on contact with water, which may ignite spontaneously.

Use

Zinc is mainly used in alloys with copper or aluminium. In addition, almost half of the zinc produced today is used for corrosion protection in iron and steel production. Furthermore, zinc is still used today in construction and in coinage.

Economics

Since the 60s, the range of zinc is given at about 20 years. This refers to the reserves, that is to say, those known mining areas, which can still be economically viable with the current state of the art and considering the demand. Experts estimate the availability of the resources to be actually much higher, so that zinc will be available until the mid of the 22 century.

Ecology and recycling

Zinc is found in roofing, in facade construction or as galvanizing layer on steel. If zinc-plated parts are no longer needed, they can be recycled – an important addition to zinc extraction from ores. Every year more than 4 million tonnes of zinc are produced. As a non-toxic and ecologically harmless product, zinc is widely used, especially in the construction industry. There is no guideline or limit value for zinc in drinking water. Rainwater drained from zinc roof surfaces can be safely used, for example, for garden irrigation.

The zinc production, however, is less environmentally friendly. Due to its "impure" occurrence in connection with lead and sulphur, these substances are produced during its extraction. If the sulphur enters the atmosphere, it can cause significant environmental damage.

2.3.3 Lead (Pb)

History

Lead is considered one of the first metals that has been melted by humans. Originally, it gained importance through its association with silver, which is obtained by burning blue lead (galena). Since the early Bronze Age it is used together with copper to produce bronze.

Only later did it find application in pottery due to its good ductility. The Romans used it in drinking water pipes or added it as a sweetener and preservative to their wine. Historians compare the use and distribution of lead in ancient Rome to our plastic of the modern age. Lead pipes were still used in Germany until the 1970s.

Throughout history, lead has been used in many other areas, such as printing (lead letters), cosmetics (white complexion) and paints.

During the Industrial Revolution, it was widely used, especially in the chemical industry, for example in the manufacturing of sulfuric acid or for the refractory lining of explosives production plants.

Manufacturing

There are various methods on how to manufacture lead.

Roasting reduction
In a first step, the finely crushed lead sulphide is placed on a moving grate and pressed through hot air, heated to 1,000°C. After a reaction with the oxygen to lead oxide (PbO) it is liquid and flows down. In a subsequent step, lead oxide can be strengthened and reduced to metallic lead with the help of coke.

Roasting
Here, the lead ore is roasted only incompletely and then further heated under the exclusion of air. The lead oxide reacts with the remaining lead sulphide to form lead and sulphur.

Direct smelting process
This process has been optimised for environmental compatibility and cost-effectiveness. The reactors have only one reaction space and both the roasting and the reduction take place in parallel. Since the reactor is slightly inclined, lead and lead-containing slag flow off. This passes through the reduction zone, blown into the coal dust and the lead oxide is reduced to lead.

The "work lead" produced by one of these three processes still contains other metals (between 2 and 5%), including copper, silver and gold. Only after a final refining, either by smelting or by an electrolytic process, the product is called “lead”.

Properties

Physically
Lead is a base metal. It is particularly malleable and can already be scraped or scored with a fingernail. Similar to zinc, it can be rolled, but due to its low hardness, the resulting pieces are less resistant.

It is a bluish-white colour and leaves a grey line on paper. Nevertheless, pencils are not and were never made of lead, today, graphite is used. It is further characterized by a particularly high density and a low melting point (327°C). Compared to other metals, the conductivity of lead is very poor.

Chemically
Similar to zinc, lead also forms a layer of oxide, which protects it from further corrosion. It dissolves only in nitric acid, concentrated sulfuric acid or in acetic acid when air is introduced. Lead is soluble in water and therefore poses a health risk in drinking water lines.

Use

Lead is still used today in manufacturing cartridges and in alloys. Due to its high corrosion resistance, it is used to protect submerged and high-voltage cables. Thanks to its high density, it is used, among other things, in sound insulation and radiation shielding, for example in order to protect from X-rays.

One of its most important applications in the 21st century, however, is the lead-acid battery as starter battery in motor vehicles or as energy storage for electric vehicles.

Ecology and recycling

Today, it is possible to recycle 95 to 99% of the lead scrap. Modern electro-chemical processes achieve a high level of recovery and hardly pollute the environment as CO_2 emissions are not generated and all waste created in the process can be recycled.

Despite the now very good recycling possibilities, lead still heavily pollutes the environment, be it during manufacturing or disposal. For example, lead processing in Roman times led to an environmental burden that can still be detected in ice cores from Greenland.

Lead dust used to be released into the air by the combustion of lead-containing fuels (traffic). Furthermore, the air-born lead particles precipitate, contaminate fertilizers and enter into the soil.

The exposure to high levels of lead can have fatal consequences to living organisms (causing lead poisoning). According to WHO (World Health Organization), a blood sample should not exceed the value of 100 µg/L.

2.3.4 Tin (Sn)

History

As early as 5400 to 4800 BC there are records of the first melting processes of tin in the Balkans. Only through the alloy bronze (copper and tin) it became more important in the Bronze Age. The Romans used the metal for tinning copper coins as well as for manufacturing mirrors. Around the time of the High Middle Ages (about 1100 AD), tin was introduced to the general public. Here, the people gradually replaced their dinnerware with the more stable tin version. The mechanical processing of the tin began in 1200 AD in the larger cities with the construction of pewter foundries. Not until the middle of the 19th century tin again became more important. Tinplate was first produced industrially and is still used today in tin cans and spray cans.

Manufacturing

In the first step, the ore is crushed and then suspended in a liquid to give it a sludge-like consistency or it deposited in an electro-magnetic process. This reduction by carbon is followed. The metal is heated just about its melting point, so impurities can flow off. However, most of the tin produced today is obtained electrolysis or recycling.

Properties

Physically

Tin is a soft, malleable metal. He does not have a uniform appearance. Depending on pressure and temperature, it can take on different modifications:

TIII.14
Tin – and its properties

Modification	Crystal structure	Property
α-Tin	diamond's cubic structure	• it is stable below 13.2°C • It is classified as semi-metal or semiconductor, depending on one's interpretation • grey colour
β-Tin	distorted octahedral geometry	silver-white, shiny surface
γ-Tin	rhombic grid	from 162°C or under high pressure

If pure β-tin is bent, it makes a characteristic noise – referred to as the team cry or tin screen. Contaminated or alloyed tin does not have this property.

Chemically

Tin reacts with oxygen to form an oxide layer on its surface. This layer is very stable. However, it is decomposed by concentrated acids and bases with evolution of hydrogen gas, which in turn is easily flammable.

Use

Tin is used in many applications, for example organ building, as part of amalgams in tooth feelings or in the alloy of the Euro coin. For the manufacturing of components, single crystals of high-purity tin are used. It used to be found on the Christmas tree – as tinsels.

Thanks to its property of forming a protective oxide layer, it is also used as a protective coating. Various methods are being applied: Galvanic tinning, the reflow process or chemical tinning. Tinning is mainly used in the electrical and electronics industry and the packaging industry. The latter contains tin as tinplate used in beverage cans or tin cans for food.

Economics

Every year about 300,000 tonnes of tin are used. Since lead is harmful to health, more and more unleaded solders are needed with a tin content of more than 95%. It is estimated that the annual demand will grow by about 10%.

Ecology and recycling

In the reprocessing of tin, it is deposited electrolytically in hot caustic soda. Tin (tinplate) has the largest recycling rate among packaging materials. In 2014, the recycling rate was about 93%.

There are problems with recycling when contaminants enter the process, for example paints and scraps. In addition, tin can only be recovered if the tinplate does not contain any aluminium.

As a single atom or molecule tin is not very harmful to organisms. It only becomes toxic in organic forms. These organic forms are poorly biodegradable and persist, especially in upper water layers. Micro-organisms can hardly break down these tin compounds and so its concentration is constantly increasing.

Long-term consequences of poisoning by tin are, among other things, liver damage, depression, malfunction of the immune system and even damage to the chromosomes. The raw material is still mined under the most adverse ecological and social conditions.

2.3.5 Iron (Fe)

History

The first man-processed iron was made from meteoric iron. This is especially rare and, accordingly, it is very valuable. It was mainly used for manufacturing cult objects and jewellery. In the earth naturally occurring iron was already forged in 3000 BC in Mesopotamia. In Egypt, however, the iron smelting was only known starting around 1000 BC. Much later, in the 13th century, cast iron was developed in Sweden.

Manufacturing

Magnetite is mainly used for iron production, a mineral that consists mainly of Fe_3O_4.

The production of iron that is as pure as possible takes place in the blast furnace at about 2,000°C. Here, the oxygen is removed from the iron oxide by carbon through, what is referred to as redox reaction. Subsequently, the iron is melted and withdrawn through a tap hole. The whole process takes up to 8 hours. The iron produced during this process has an iron content of around 95%.

Today, methods and furnaces used for iron extraction are, among other things, the shaft furnace, rotary vessels, a fluidised bed reactor and the electric furnace. Compared to the traditional blast furnace, an electric furnace has the advantage that it can be switched on and off as needed. The traditional blast furnace, on the other hand, must be constantly in operation.

Properties

Physically
Iron has a Mohs hardness of 4 to 5 at room temperature, so it is easy to score with the pocket knife. Its colour is steel grey to black and, like lead, it has a grey streak colour. Its melting point is 1,538°C. It is also ferromagnetic. Like tin, iron does not have a uniform appearance. Depending on the pressure and temperature, it can take different modifications:

TIII.15
Iron – and its properties

Modification	Property	Pressure [GPa]
α-Iron	it is stable below 910°C	–
γ-Iron	above 910°C	–
δ-Ferrit	it is stable between 1,390°C to 1,535°C	–
ε-Iron	* at most a few hundred degrees°C	10 – 15

In the form of steel, it is characterised by a high strength, but at the same time still tough enough to be used for the construction of skyscrapers.

Chemically
Iron is resistant to dry air. However, if the air is wet or iron comes in contact with water, it oxidises quickly – in other words, it rusts. In hydrochloric acid or dilute sulphuric acid, iron dissolves with the evolution of hydrogen. Fine, powdered iron is pyrophoric and reacts at room temperature with oxygen under the fire phenomenon.

Incidentally, the typical "smell of iron" on contact is caused by a chemical reaction with organic substances of the skin, e.g. with sweat and grease. Iron itself is odourless.

Use

Iron is classified according to its degree of purity:

- Pig iron – contains 4 to 5% carbon, different amounts of phosphorus, sulphur or silicon.
- Cast iron – contains more than 2.06% carbon and alloying elements (e.g. silicon, manganese and other elements)
- Steel – contains a maximum of 2.06% carbon

As the main constituent of cast iron and steel, it is one of the world's most widely used metals. It can be found, among other things, in the manufacturing of vehicles, ships and in the construction industry, in cans, pipelines and pressure vessels. Due to its magnetic properties, it serves also as a core material for guiding or shielding magnetic fields. As a powder, it is used in some tape formats for data recording.

Economics

Iron is a widely used metal. At 28.8%, it is (by mass) the second most common metal in the world. It is obtained in mining, but also in open-pit mining. In 2011, nearly 630 million tons of pig iron were produced in China.

Ecology and recycling

Iron and steel scrap are heavily recycled. Every year, around 650 million tonnes (as of 2016) are returned to the production cycle. The pure metal scrap can even be fed directly to the blast furnace. This is even more economical than the extraction from ore. The recycling of steel scrap in Germany covers 45% of the production.

Iron is an important trace element for many creatures as it is a key component of blood formation. However, it is found oxidised in the body as iron (II) and iron (III).

An overdose may be detrimental. Some people suffer from a regulation disorder of iron absorption. They are particularly affected. In the course of the illness, the iron accumulates in the liver and leads to organ damage. Nevertheless, iron supplements are recommended as a food supplement, if an iron deficiency is medically diagnosed.

2.3.6 Aluminium (Al)

History

The first known aluminium object today is the belt buckle of the Chinese General Chou-Chou (265-316) around 300 AD.

Aluminium was discovered in Europe as an independent element late in the 18th century. Since about 1830, the manufacturing method using metallic potassium was used, whereby the yield increased significantly. Since 1889, a procedure called the "Bayer process" is used, an electrolysis process for the isolation of pure aluminium oxide.

Manufacturing

In order to produce aluminium, the rare bauxite ore is used. It is obtained electrolytically from an aluminium oxide melt. First, it is digested with sodium hydroxide solution (for the purification of impurities) and then burned mainly in rotary kilns to alumina.

During further processing, a distinction is made between cast and wrought alloys:
- Cast alloys are cast in shape and already largely correspond in shape to the final product.
- Wrought alloys are cast into billets in ironworks, then rolled and put into the shape of plates, sheets or rods.

Properties

Physical properties
Aluminium is relatively soft and tough. It is a typical light metal and has about 1/3 the density of steel. It is also one of the lightest materials. Due to its relatively low melting point (660.2°C), it is considered a good casting material and conducts heat well. Its excellent electrical conductivity has made it the most important conductor material in electrical engineering, especially in power engineering, alongside copper.

Chemical properties
Aluminium quickly forms a thin layer of oxide in the air and then changes its colour to a dull silver grey. It is very corrosion resistant, but only at pH values of 4 to 9.
The oxide layer can be reinforced by anodising (electrical oxidation).
The violent reaction that occurs when sodium hydroxide solutions are added, it is utilised in cleaning chemical pipes. In hydrochloric acid, the metal reacts violently and hydrogen is formed while it is passivated in nitric acid. As a powder, it is very reactive.

Use

Its particular light-weight makes it widely used in many areas of the building industry and civil engineering. Also frequently used in vehicle design. Thanks to its high conductivity, it has become indispensable in electrical engineering. Furthermore, it is used for packaging and containers.

Economics

After steel, aluminium is the second most important metallic material, with around 115 million tons produced in 2016.

After oxygen and silicon, aluminium is by weight the third most common element of the earth's crust. However, since it is a base metal, it occurs almost exclusively in bound form, for example in aluminosilicates, which occur in clay and granite. For the aluminium production, however, only bauxite is of economic importance. It can be found in places like southern France, Guinea and Russia.

Ecology and recycling

Across Europe, about 67% of the aluminium is recycled and only 5% of the energy is needed for recycling compared to the initial manufacturing process.

Therefore, the aluminium must be cleaned and strictly separated from other residues.

Unfortunately, the production of aluminium is very energy intensive and always associated with the high manufacture of CO_2, which aversely affects the ozone layer. The manufacturing process also generates alkaline, iron-rich red mud, which can be difficult to recycled. Also for the mining of bauxite, large areas are destroyed, which only become usable again after intensive re-cultivation.

Aluminium is controversial in its effects on the human body. Especially as an additive in deodorants and foods, its impact is widely discussed and it is linked to Alzheimer's disease. In people with impaired kidney function (including dialysis patients), a high intake of aluminium leads to memory and speech disorders, brain cell death and associated dementia, osteoporosis and even anaemia.

2.4 Materials and alloys for pipes, fittings and instruments

For pipelines, and in particular for the moulded parts (fittings and fixtures), different metallic materials are available. These materials are available as alloys. The materials used for moulded parts (pipes, fittings, fixtures) are metallic alloys which, in addition to a range of metals, may also contain other substances such as arsenic, manganese, phosphorus or silicon (other substances may also be found in small quantities).

Not every material is equally suitable for all requirements. This holds especially true for metals used in an installation system. On the one hand, the medium that is being transported plays an essential role; on the other hand, the location of use is very important. A pipe, which is placed under the basement ceiling, is exposed to entirely different loads and influences than a pipe laid in the ground or in a concrete ceiling.

For the use of metals in particular the corrosion resistance of the material is a crucial aspect. Depending on the installation, an external corrosion protection may be necessary. It is imperative that steel pipes for drinking water pipes use water-side corrosion protection, but copper pipes are inherently resistant.

Conventional installation systems made of metallic materials, such as steel, galvanized steel, copper and (with smears) made of stainless steel, are no longer used in many areas and regions because of constantly changing water qualities.

The interaction of various factors (too high or too low pH values, chlorides, free carbonic acid, corrosive nitrate and sulphate concentrations) leads to increasingly aggressive waters and thus to an increased risk of corrosion in metallic materials.

2.4.1 Brass

Brass is a copper-rich, copper-zinc alloy. It is considered a corrosion resistant and erosion resistant material. In the field of drinking water distribution, brass is predominantly used for moulded parts that do not come into contact with the medium.

In soft, chloride-containing waters, brass tends to deplete. For such waters, dezincification-resistant **CR brass** is used. The dezincification resistance of CR brass is demonstrated in ISO 6509.

Apart from the dezincification, stress corrosion cracking can still occur with brass. This can occur if there are three conditions at the same time:

- a material that is susceptible to stress corrosion cracking
- internal/external tensile stresses on the component
- corrosive medium, e.g. ammonia

In order to reduce stress corrosion cracking, brass can undergo a thermal relaxation process (stress relieved annealing). Dezincification resistant brass is significantly improved not only against dezincification but also against stress corrosion cracking due to its material composition to brass.

2.4.2 Red bronze

Red bronze is a copper-zinc-tin alloy and, like brass, is considered a corrosion and erosion-resistant material. It is used, among other things, in the drinking water sector (standardised fittings and installation material according to DIN 50930-6 / DIN EN 1982) and, due to its good malleability, is ideal in many ways for moulded parts and fittings, valves (such as shut-off, safety and control valves), and as a construction material in water, filter, and reprocessing technology. The red bronze alloy CC499K in particular is also popular for direct contact with the medium, because red bronze is considered to be particularly low in dezincification due to its high copper content. It can be used for all water qualities of the drinking water regulations as well as according to all European standards. It can also be used in conjunction with seawater or process water and has a very wide range of applications in terms of pressure and temperature.

2.4.3 Malleable cast iron

History

Already on 01.12.1670 Prince Ruprecht of the Palatinate was granted the English patent for **malleable cast iron**. These are the oldest records of the material. However, it was only in 1722 that René-Antoine Ferchault de Réaumur described the technical process in a scientific paper.

In 1844, Johann Conrad Fischer undertook a study trip to England and visited a cast iron foundry. Using the experience gained there, he was able to produce malleable iron himself for the first time in 1827. To do this, he used a Siemens Martin furnace and subsequently opened a production facility in Austria.

Manufacturing

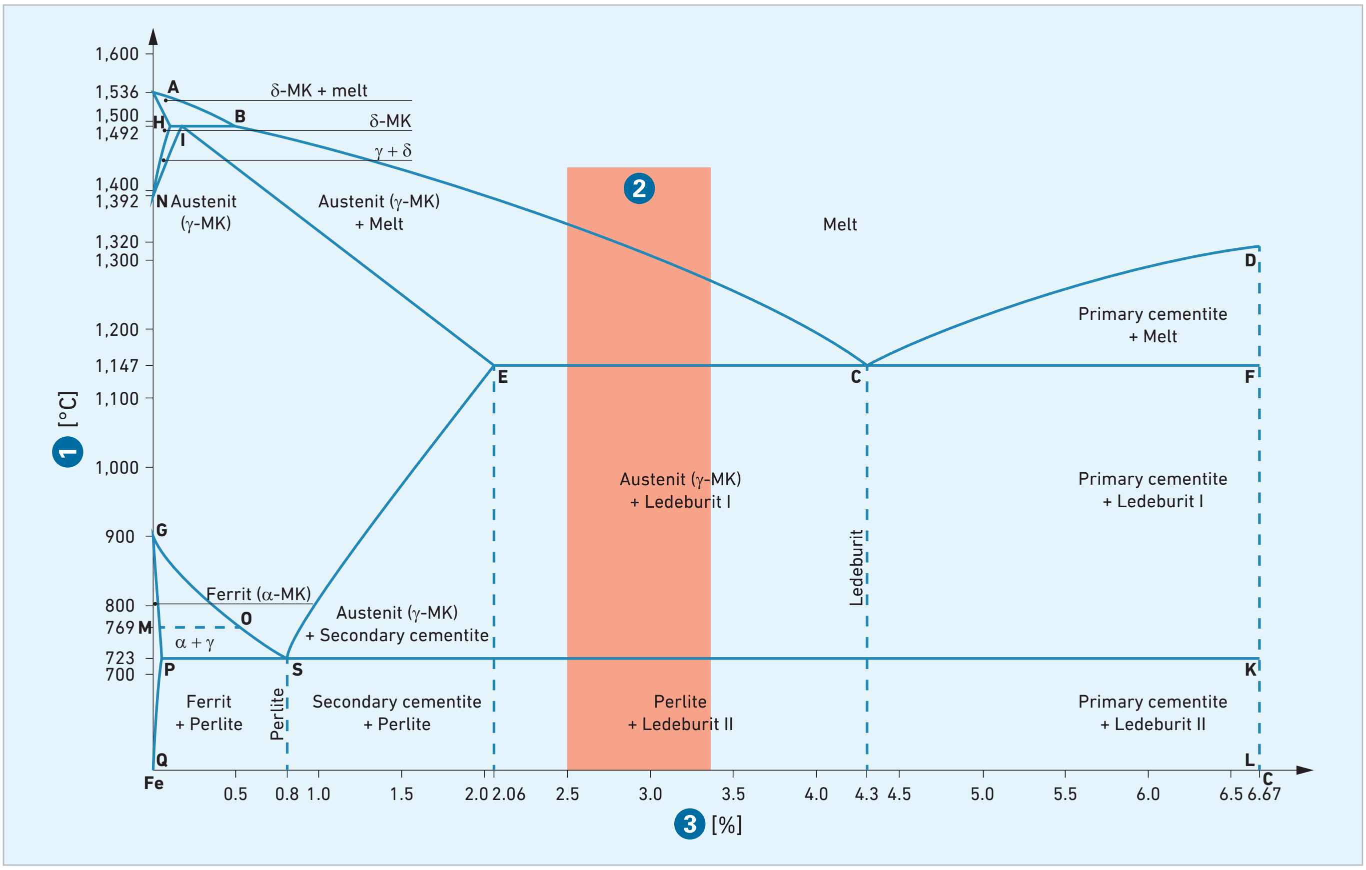
The melt has a carbon content of about 2.5 to 3.4 wt -%. In metastable cooling, it reaches the liquidus line (B-C). At this point, the first γ-crystals form in the melt. These crystals continue to grow if cooling continues. At the Solidus line (E-C), the melt is completely solidified. The raw casting now consists of γ-crystals and Ledeburite. If cooling continues, the raw casting reaches the eutectic transition temperature (S-K) at which point a phase transition into the solid state occurs. Perlite and Ledeburite are formed.

This raw casting is hard and brittle and unworkable. It receives its final structure only following a subsequent heat treatment. This long-term annealing treatment (called “tempering”) achieves a very good machinability as well as very good toughness properties combined with sufficiently high strength. Depending on the duration of the annealing process, the mechanical properties can be influenced.

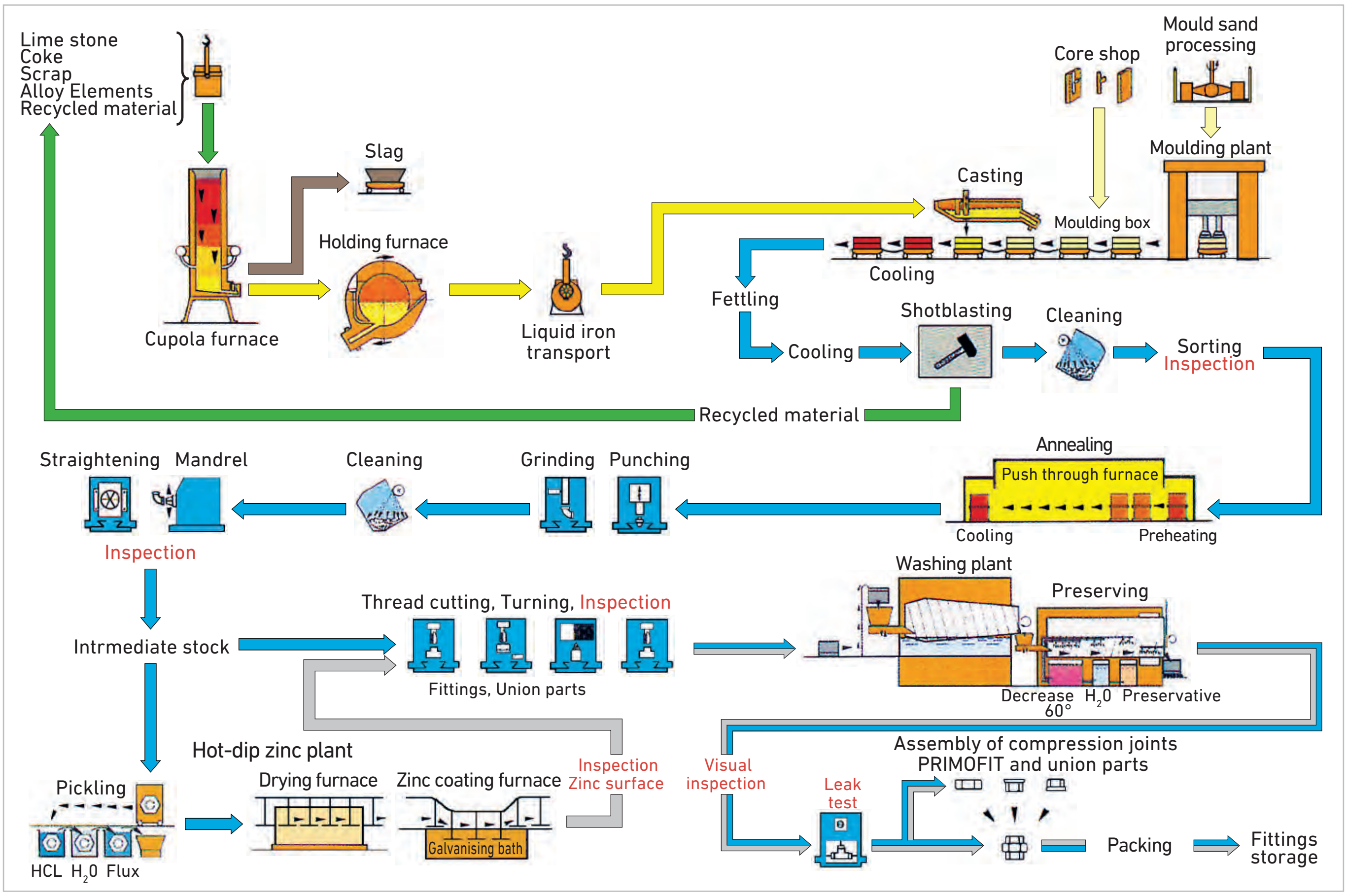
GIII.15
Iron-carbon phase diagram

1. Temperature
2. Tempered cast iron
3. Carbon content, weight percent

Manufacturing



Production



GIII.16
Production of malleable iron

Properties

Malleable iron is an iron-carbon alloy that achieves a combination of the outstanding properties of cast iron (castability) and steel (strength and toughness properties).
The chemical composition of the melt causes excellent forgeability. For example, malleable cast iron is ideally suited for manufacturing of complicated shapes and for the production of parts with a very small wall thickness.
Malleable varieties are much tougher than cast iron with lamellar graphite. They are more resistant to vibrations and can withstand excessive forces. In addition, they have a high pressure tightness, heat resistance, dimensional accuracy and wear resistance. Malleable cast iron can be easily machined and even welded if the composition is right. Depending on the type of heat treatment, a distinction is made between **two types of malleable cast iron** whose designation can be attributed to the respective appearance of the fractured surfaces. The schematic diagram illustrates the manufacturing of **malleable cast iron fittings** and **PRIMOFIT** compression joint.

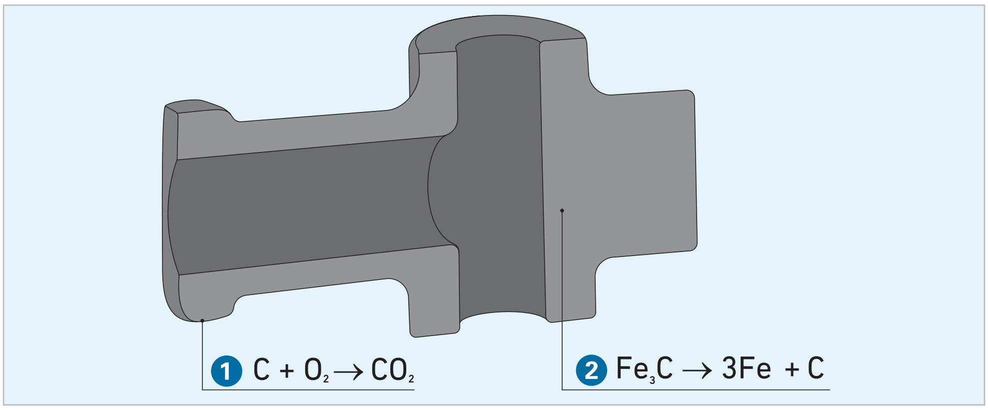
White malleable iron

During manufacturing of white malleable cast iron, the heat treatment takes place in an oxidising atmosphere. This causes decarburisation of the surface layer (the carbon content is greatly reduced). Due to the concentration gradient, carbon diffuses from the interior towards the surface layer. This creates a micro-structure of perlite and tempered charcoal inside. The boundary area consists of ferrite.

The decarburisation of the structure is crucial for the advantages of the white malleable cast iron compared to the black malleable cast iron:

- it is easier to galvanise (more homogeneous formation of the iron zinc alloy on the fitting's surface)
- higher strength at equal elongation
- by additional, factory heat treatment, a conditional weldability and solderability can be achieved

From a chemical point of view, this change is as follows:



GIII.17
Processes in the casting during tempering; micrograph

Black malleable iron

Black malleable iron is annealed in an inert atmosphere (inert gas or vacuum) and has a uniform structure with a higher carbon content. The production of black malleable iron proceeds similarly. However, a neutral (low-oxygen) atmosphere is used. As a result, the carbon in the boundary region cannot oxidise. Tempering coal forms, which has an effect on the properties of malleable cast iron depending on the cooling rate.

Use

Malleable is mainly used in vehicle manufacturing, for example, producing connecting rods and steering columns. However, this material is also used in the building industry for fittings and locks or in the installation technology for fitting and valves.

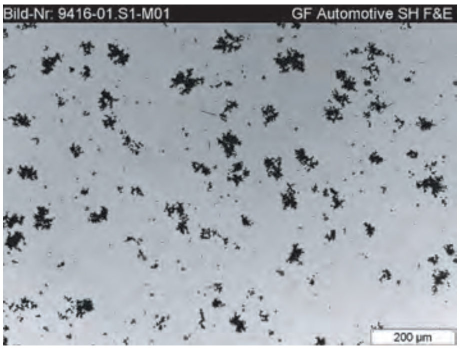
Economics

The production and processing of cast iron materials is economically priced. For economic profitability, malleable cast iron requires the production in series.

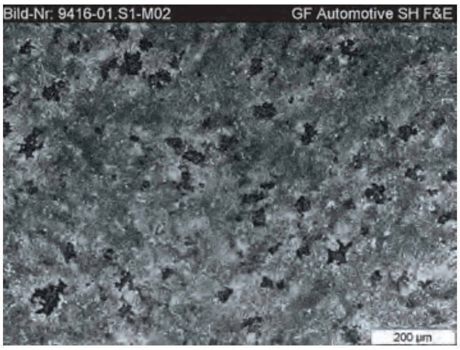
Ecology and recycling

In order to produce from natural resources, a very high energy consumption is required. When extracting cast iron from recycled material, this energy consumption is much lower. The dusts and fumes generated during the manufacture of metals causes a strong environmental impact. However, complex exhaust gas treatment plants can lower this adverse effect to an environmentally acceptable level. Iron materials are recycled almost 100%. By remelting the cast materials, they can be fed into the production process and reused without any loss of quality.

GIII.19
Black malleable iron, micrograph (unetched)



GIII.18
Black malleable iron, micrograph (etched)



2.5 Continue to applicable alloys

Abbreviation for the state

In the following detail representations of the alloys, abbreviations for the state are used in the “Mechanical Properties” tables. These abbreviation are taken from DIN EN 12168:2011-08.

TIII.16
Abbreviation and state

Acronym	State
M	State for the product "as manufactured" without specified requirements for the mechanical properties
R	State referred to as the minimum tensile strength requirement of the product with prescribed requirements for the tensile properties
H	State referred to as the minimum hardness requirement value for the product with prescribed hardness requirements
S	State for a product that is relaxed.

Note

Products in state M or H etc. may be specially treated (i.e., mechanically or thermally relaxed) in order to reduce residual stresses to improve stress corrosion cracking resistance and dimensional stability during machining.

The state is only indicated by one of the above-mentioned abbreviations. However, several abbreviations can be used only with the abbreviation **S**.

2.6 Thermoforming brass – CW617N – CuZn40Pb2

The alloy with the material number **CW617N** belongs to the CuZn family (**thermoforming brass**). In addition to copper and zinc, it contains a small amount of lead. The material is a wrought alloy and cannot be hardened. High hardness and strength characteristics can only be achieved by cold forming. The thermal conductivity and the electrical conductivity are lower than the conductivity of **CuZn40**. However, the addition of Pb improves the machinability. The corrosion resistance to water, various salt solutions and organic liquids is also lower than for lead-free alloys with the same high zinc content.

Processing properties

- Hot forming: very good
- Cold forming: poor
- Machinability: very good
- Brazing: medium
- Soft soldering: very good
- TIG welding: poor
- Polishing: very good

Chemical analysis

TIII.17
Alloy components
Mass percentage in %

Cu	Zn	Pb
57.0 – 59.0	Remainder	1.6 – 2.5

TIII.18
Permitted admixtures
Mass percentage in %

Ni	Fe	Sn	Al	Others, combined
0.3	0.3	0.3	0.05	0.2

Physical and mechanical properties

TIII.19
Physical properties

Property	Value	Unit of measure
Density (at 20°C)	8.44	g/cm^3
Coefficient of linear expansion (from 20 - 300°C)	21	$10^{-6} \cdot K^{-1}$
Thermal conductivity (at 20°C)	123	W/(m · K)
Electrical conductivity (at 20°C)	15	$(10^6 \cdot S)/m$

TIII.20
Mechanical properties

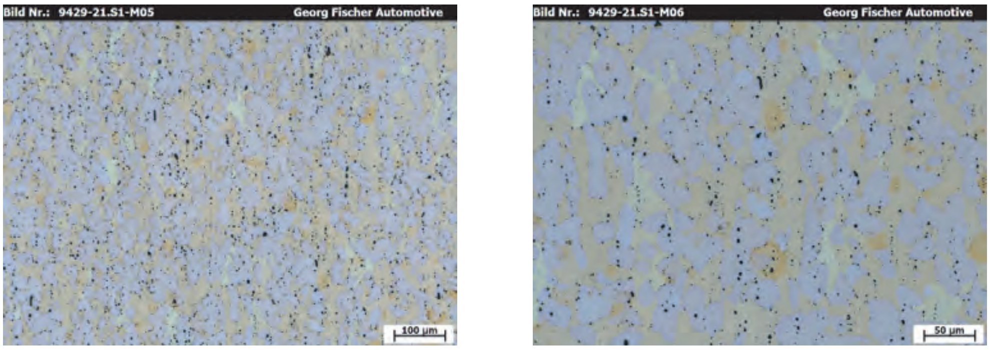
State	Tensile strength [N/mm²]	0.2% creep limit [N/mm²]	Elongation at break A [%]	Hardness HB
R360	360	<320	20	
H090				90 – 125
R430	430	>220	10	
H110				110 – 160
R500	500	>350	8	
H135				>135

Corrosion

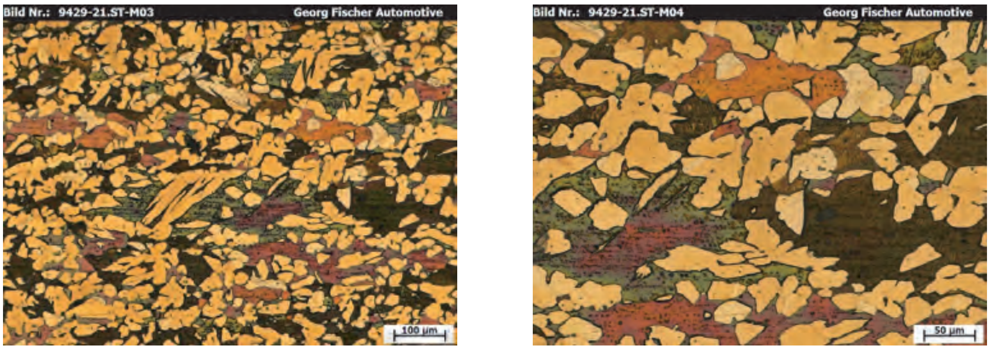
Thermoforming brass (CW617N, CuZn40Pb2) does not achieve the high stability of a homogeneous α-brass compared to water, various salt solutions and organic liquids, as the zinc-rich β-phase in the heterogeneous microstructure is preferentially attacked. In addition, under certain conditions (waters with high Cl content and low carbonate hardness), corrosion may occur in the form of “dezincification”.

Furthermore, while in the cold-worked state under external and/or internal tensile stresses and with simultaneous exposure to certain attacking agents (ammonia, amines, ammonium salts), this material tends to lean towards “stress corrosion cracking”. Tensile stresses can also be introduced later during the installation or further processing. When using a heat treatment, a stress corrosion cracking can be avoided. Products that are already semi-finished, can be obtained in the relaxed state. Components can be subjected to stress relief or soft annealing.

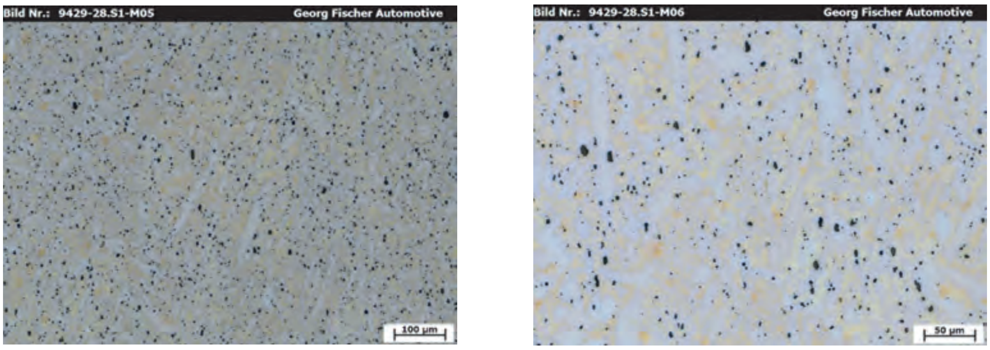
Micrographs



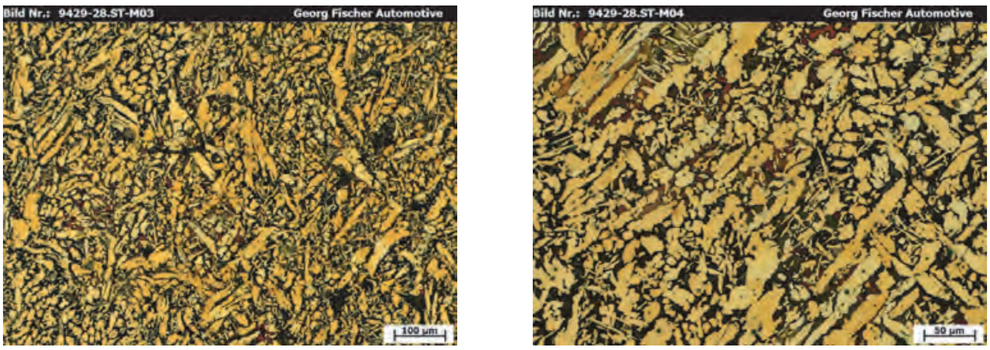
GIII.20
unetched



GIII.21
etched



GIII.22
Pressed brass, unetched



GIII.23
Pressed brass, etched

(from components provided by GF JRG)

2.7 Aqcuarin – CW725R – CuZn33Pb1AlSiAs

Aquarin is a **dezincification-resistant special brass**. Due to the addition of arsenic (As) in combination with a special heat treatment, **Aqcuarin** is suitable for applications where increased dezincification resistance is required.

Chemical analysis

TIII.21
Alloy components
Mass percentage in %

Al	As	Cu	Zn	Pb	Si
0.1 – 0.4	0.05 – 0.08	64 – 67	Remainder	0.4 – 0.9	0.1 – 0.3

TIII.22
Permitted admixtures
Mass percentage in %

Fe	Mn	Ni	P	Sn	Others, combined
0.3	0.1	0.2	0.2	0.3	0.2

Physical and mechanical properties

TIII.23
Physical properties

Property	Value	Unit of measure
Density (at 20°C)	8.5	g/cm^3
Coefficient of linear expansion (from 0 - 300°C)	20	$10^{-6} \cdot K^{-1}$
Thermal conductivity (at 20°C)	101	$W/(m \cdot K)$
Electrical conductivity (at 20°C)	12.8	$(10^6 \cdot S)/m$

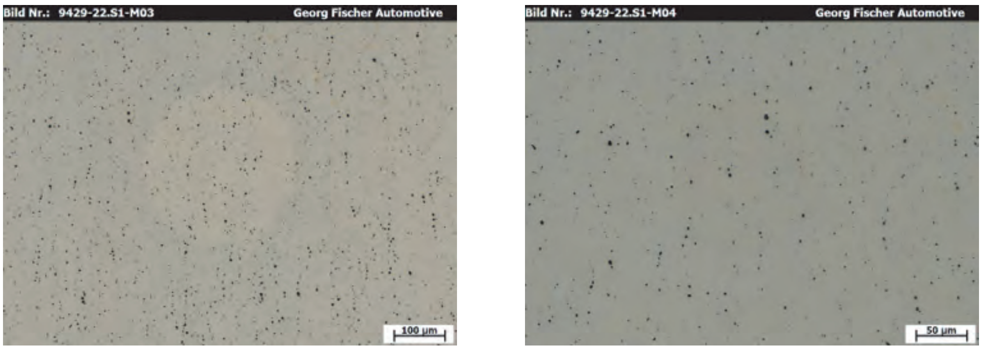
TIII.24
Mechanical properties

State	Tensile strength $[N/mm^2]$	0.2% creep limit $[N/mm^2]$	Elongation at break A [%]	Hardness HB
H060				60
R280	280	120	20	80

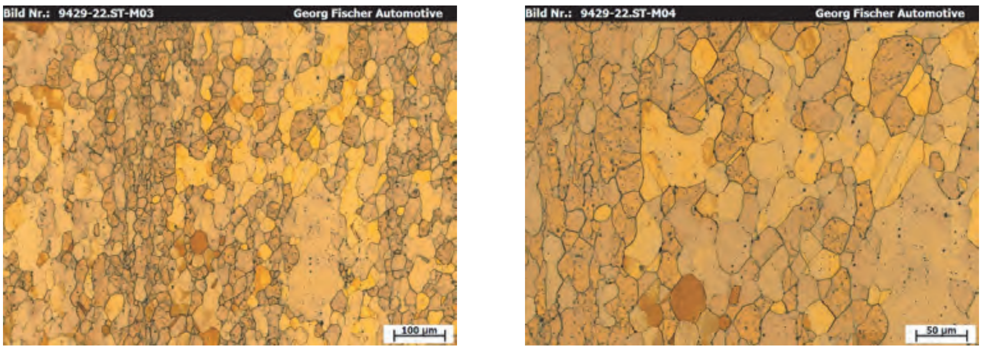
Corrosion

The material has good general corrosion resistance due to its aluminium content.
In the simultaneous presence of mechanical stresses and corrosive media (especially ammonia-containing environment) there is a risk of stress corrosion cracking.

Micrographs



GIII.24
unetched



GIII.25
etched

(from components provided by GF JRG)

2.8 Cuphin – CW724R– CuZn21Si3P

Cuphin is a **silicon-containing special brass**. Due to its good machinability, the material is suitable for manufacturing of turned parts, for example for plumbing, automotive and electrical industry.

Chemical analysis

TIII.25
Alloy components
Mass percentage in %

Cu	Zn	Si	P
75 – 77	Remainder	2.7 – 3.5	0.02 – 0.1

TIII.26
Permitted admixtures
Mass percentage in %

Al	Fe	Mn	Ni	Pb	Sn	Others, combined
0.05	0.3	0.05	0.2	0.1	0.3	0.2

Physical and mechanical properties

TIII.27
Physical properties

Property	Value	Unit of measure
Density (at 20°C)	8.3	g/cm^3
Coefficient of linear expansion (from 20 - 300°C)	19.7	$10^{-6} \cdot K^{-1}$
Thermal conductivity (at 20°C)	33	$W/(m \cdot K)$
Electrical conductivity (at 20°C)	4.5	$(10^6 \cdot S)/m$

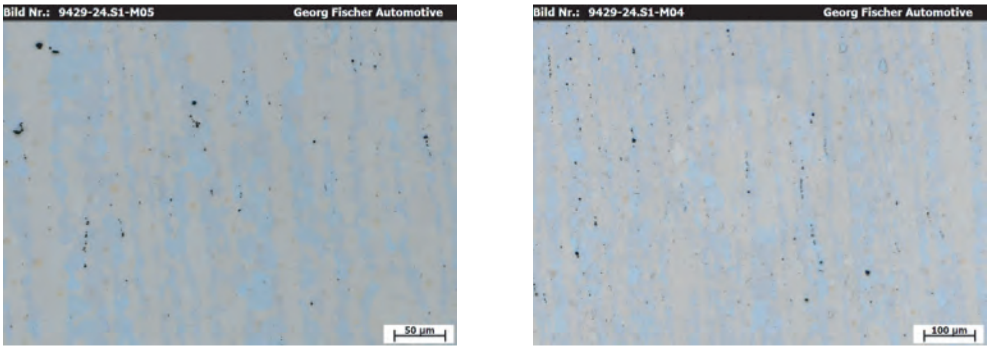
TIII.28
Mechanical properties

State	Tensile strength [N/mm^2]	0.2% creep limit [N/mm^2]	Elongation at break A [%]	Hardness HB
R500	500	<450	15	
H110				110 – 170
R600	600	350	12	
H130				130 – 190
R650	650	400	10	
R150				150 – 210

Corrosion

Cuphin has good corrosion resistance for use in sanitary applications. The addition of Si improves the dezincification and stress corrosion cracking resistance.

Micrographs



GIII.26
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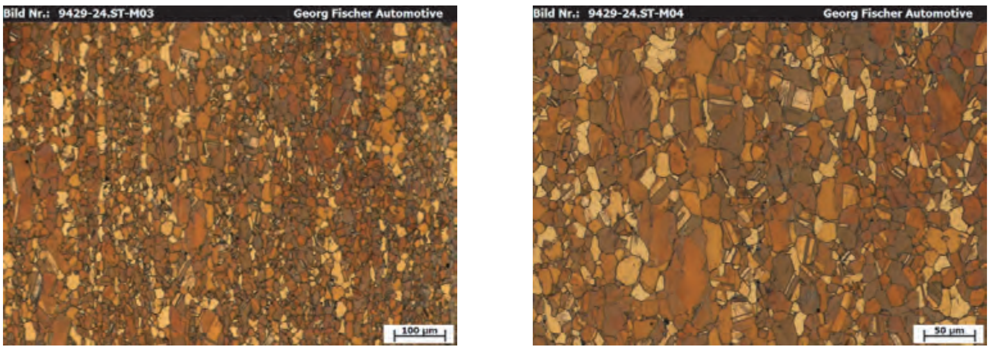


GIII.27
etched

(from components provided by GF JRG)

2.9 Red bronze RG5 – CuSn5Zn5Pb5-C

The **red bronze alloy CuSn5Zn5Pb5-C** is characterized by a favourable combination of a good castability with optimum machinability and high strength. **Red bronze RG5** has good corrosion resistance, even in sea water and is also suitable as a construction material for general applications.

The main areas of application are water and steam fitting housings, pump housings and thin-walled, intricate castings as well as turned parts for machine, instrumentation and shipbuilding.

Processing properties

- Machinability: very good
- Soft soldering: very good
- Brazing: conditionally
- Gas fusion welding: poor
- Inert gas welding: poor
- Polishing: good
- Galvanizability: good
- Suitability for dip-tinning: good

Chemical analysis

TIII.29
Alloy components
Mass percentage in %

Cu	Sn	Zn	Pb
83 – 87	4 – 6	4 – 6	4 – 6

TIII.30
Permitted admixtures
Mass percentage in %

Ni	Sb	Others, combined
2	0.25	0.25

Physical and mechanical properties

TIII.31
Physical properties

Property	Value	Unit of measure
Density (at 20°C)	8.74	g/cm^3
Coefficient of linear expansion (from 20 – 300°C)	18.5	$10^{-6} \cdot K^{-1}$
Thermal conductivity (at 20°C)	72	W/(m · K)
Electrical conductivity (at 20°C)	8.8	$(10^6 \cdot S)/m$

TIII.32
Mechanical properties

Tensile strength [N/mm^2]	0.2% creep limit [N/mm^2]	Elongation at break A [%]	Hardness HB
250	110	13	65

Corrosion

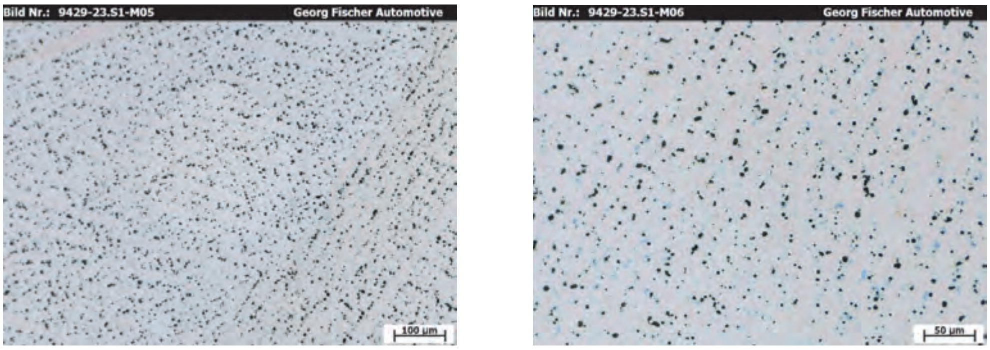
Red bronze RG5 has a good corrosion resistance against atmospheric influences (also industrial atmosphere) and covers itself with a firmly adhering, tight protective layer.

With regard to the fields of application, its resistance to drinking and service water (including aggressive water), condensation water, water vapour, non-oxidizing acids, neutral salt solutions and above all to seawater is of particular importance. Even if impurities in sulphur dioxide and carbon dioxide occur, the corrosion behaviour is not significantly impaired.

Red bronze RG5C is preferably used as a dezincification-resistant material and is practically insensitive to stress corrosion cracking.

However, this alloy is not resistant to solutions containing cyanides and halides, to oxidizing acids, higher concentration of ammoniacal solutions and halogen-containing gases, and to hydrogen sulphide or sulphides, respectively.

Micrographs



GIII.28
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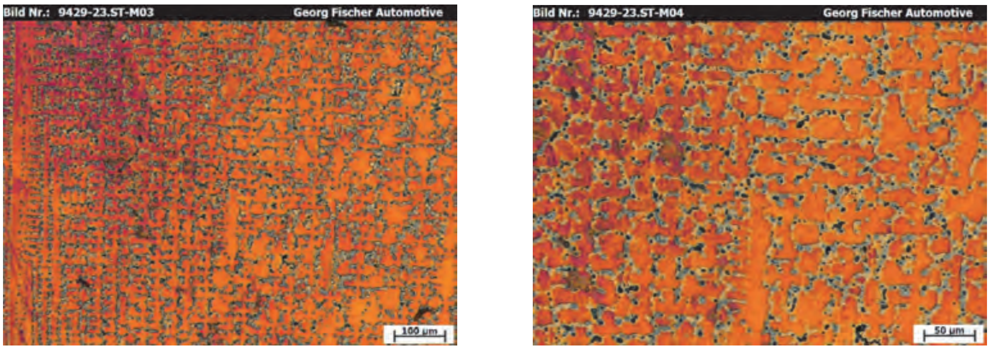


GIII.29
etched

(from components provided by GF JRG)

III

2.10 CW602N – CuZn36Pb2As

The alloy **CuZn36Pb2As** belongs to the **free-machining brass** family. This material has good corrosion resistance in aggressive waters and seawater as well as medium strength and good toughness and is used as a construction material. Main areas of application are fittings and pipe connectors use in the industry and households.

Chemical analysis

Cu	Zn	Pb	As
61 – 63	Remainder	1.7 – 2.8	0.02 – 0.15

TIII.33
Alloy components
Mass percentage in %

Ni	Fe	Sn	Al	Mn	Others, combined
0.3	0.1	0.1	0.05	0.1	0.2

TIII.34
Permitted admixtures
Mass percentage in %

Physical and mechanical properties

Property	Value	Unit of measure
Density (at 20°C)	8.45	g/cm^3
Coefficient of linear expansion (from 0 – 300°C)	20	$10^{-6} \cdot K^{-1}$
Thermal conductivity (at 20°C)	110	W/(m · K)
Electrical conductivity (at 20°C)	15	$(10^6 \cdot S)/m$

TIII.35
Physical properties

State	Tensile strength [N/mm^2]	0.2% creep limit [N/mm^2]	Elongation at break A [%]	Hardness HB
R280	280	<200	30	
H070				70 – 110
R320	320	>200	20	
H090				90 – 135
R400	400	>250	8	
H105				>105

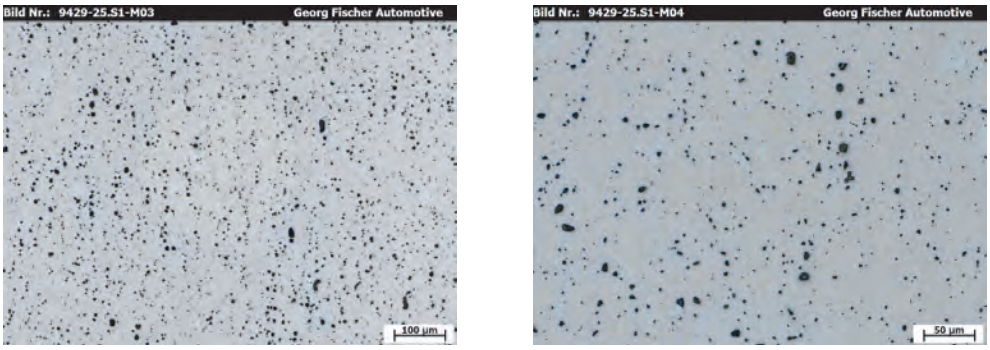
TIII.36
Mechanical properties

Corrosion

CuZn36Pb2As has good resistance in all drinking and service waters, steam, various salt solutions and many organic liquids. The material is approved by Lloyd's Register for certain shipbuilding components. This alloy is classified as dezincification resistant.

In the cold-formed state under external and/or internal tensile stresses with simultaneous exposure to certain attacking agents (ammonia, amines, ammonium salts), this material tends to lean towards stress corrosion cracking. Tensile stresses can be introduced later during the installation or further processing. Heat treatment (stress relief annealing) largely prevents stress corrosion cracking.

Micrographs



GIII.30
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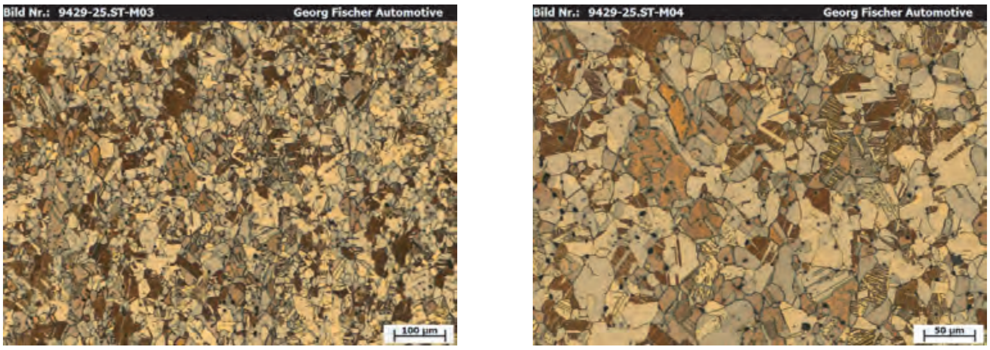


GIII.31
etched

(from components provided by GF JRG)

2.11 GJMW 400-5

GJMW 400-5 belongs to the family of **white malleable castings**. It is particularly suitable for thin-walled components and can be machined very well.

Processing properties

- Tight dimensional tolerances
- Great freedom in component design
- Great variety of applications
- High toughness
- Good corrosion resistance
- Very good machinability

Chemical analysis

(Mass percentage in %)

C	Si	Mn	S
≈3.31	≈0.62	≈0.46	≈0.13

TIII.37
Alloy components

Physical properties

Property	Value	Unit of measure
Density (at 20°C)	7.4	g/cm^3
Coefficient of linear expansion (from 0 – 300°C)	13	$10^{-6} \cdot K^{-1}$
Thermal conductivity (at 20°C)	0.5	W/(m · K)
Electrical conductivity (at 20°C)	3	$(10^6 \cdot S)/m$

TIII.38
Physical properties

Mechanical properties

Tensile strength [N/mm^2]	Yield strength [N/mm^2]	Elongation [%]	Hardness HB
>400	>220	>5	≈147

TIII.39
Properties – Sample steel with 12 mm

Corrosion

In many cases, special measures for corrosion protection can be dispensed with, since the metal forms a protective oxide surface layer. However, if corrosion protection measures are still necessary, metallic or non-metallic protective coatings such as hot dip galvanising, electroplating, paint coatings or plastic coatings are available.

3 Jointing technology

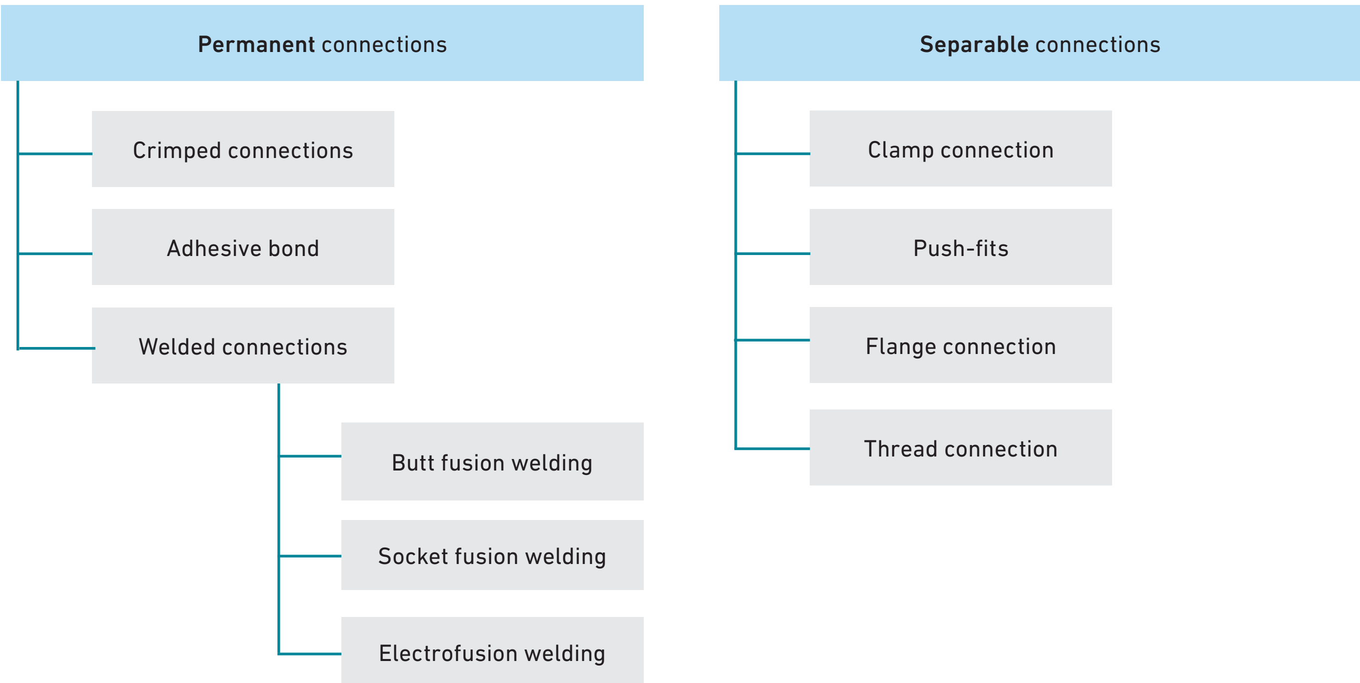
The following chapters contain basic information on the jointing technology of the piping and system components used in building services engineering.

> **System and product-specific information**
> The system- and product-specific information on the respective systems and products are presented in the individual chapters of the part V 'Build'.

In the field of plastic piping system construction, the following jointing technologies are predominantly used for the application of drinking water pipes, cold and hot:

- Thread connection
- Mechanical connection
  - Crosslinked polyethylene (VPE, PB, PE, ML, PP)
- Push-fits
- Crimped connections
- Welded joint (polyolefinic materials)
  - Polyethylene (PE)
  - Polybutene (PB)
  - Polypropylene (PP
- Adhesive bond (vinyl chloride materials)
  - Polyvinyl chloride (PVC)
  - Post-chlorinated polyvinyl chloride (PVC-C)
- Flange connection

Overview of the connection types

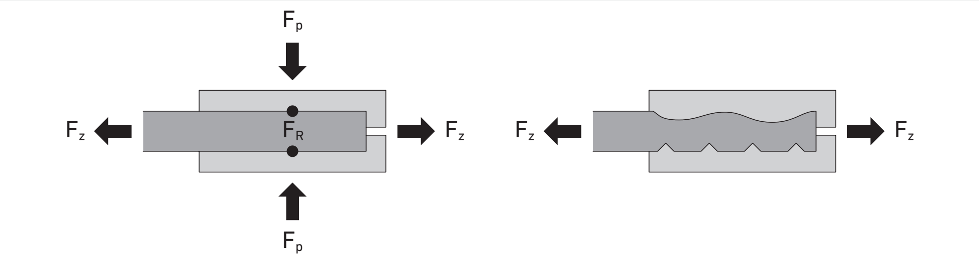


4 Clamp connection

The basics

A mechanically acting connection between plastic pipe and connecting body can be described physically as follows:

The plastic pipe is enclosed by two pressing surfaces, which exert a pressing force onto the pipe's surface. The pressing force that acts on the pipe prevents friction between the pipe and the pressing surfaces, thus preventing the pipe from slipping out of the connection. The friction can be increased by a rough surface, by grooves, notches or waves in the surfaces that press onto the pipe.



GIII.32
Effect of forces in a clamp connection

F_p Pressing force
F_R Friction
F_z Pipe slipping out

The gasket between the pipe and the connecting body is achieved with most compression joints via elastomer seals (e.g. O-rings).

Connector types

This type of connection of plastic pipes currently uses these types of connectors:

- All-plastic connectors
- Metal connectors
- Cutting ring or crimp connector
- Compression fittings
- Push-in compression fittings
- Push-in fittings
- Flared fittings
- Sleeve connectors

When connecting pipes that carry hot and cold media, **metal** connectors are used predominantly in drinking water installation systems today. Cutting ring or crimp connectors are used in industry (for testing equipment, automation, etc.).

The "permanently sealed" connection

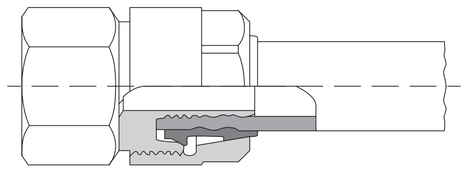
When mentioning mechanical connectors, it is still often referred to as **separable** and **permanent** connections. Both terms are confusing and can be understood differently, depending on the interpretation. Today, mechanical connectors are therefore referred to as permanently sealed.

GF only considers fittings with compression joints **permanently tight** if they comply with the following criteria:

☑ The fittings have been tested according to applicable regulations and standards.
☑ The fittings have been certified by one of the authorities responsible for drinking water installations through either registration or approval.
☑ The connectors produce a permanent gasket between the connecting body and plastic pipe without elastomer seal.

Compression joint made of metal

Metal compression joint have become established in the market for the jointing of plastic pipes. The main components of a connector are a base body with insert, a clamping ring or clamping segments and a coupling nut or a tightening strap. The materials used are predominantly brass, CR brass (CR = Corrosion Resistant, with increased resistance to corrosion and dezincification) and red bronze.



GIII.33
Compression joint, example: d16 to d20

The design of the compression joints varies greatly depending on the system.

The main application areas for compression joints are:

- Connectors for PB and VPE (PE-X) pipes
- Transitions from plastic pipe to metal systems (pipes or fittings)

Compression joints are also used when a line is pressurised and temperature is increased immediately after the installation (e.g. during a repair or overhaul).

Requirements

A compression joint must be plastic-compatible, operationally reliable and priced economically.

Plastic-compatible design

Compliance with the plastic-specific properties is of great importance in the clamp connection technology:

- Notching and creep behaviour
- Flexural strength
- Thermal expansion

Only if taking these criteria into account, a **permanently tight** connection can be achieved.

An edged, saw-like profile can be found in the **sealing area**. This profile cuts itself into the pipe and thus ensures a permanent seal.

If using a long insertion depth, a compression joint mainly prevents the **creep behaviour** of the plastic pipe. Because long insertion depths produce large pressing surfaces and large pressing surfaces result in small surface pressures.

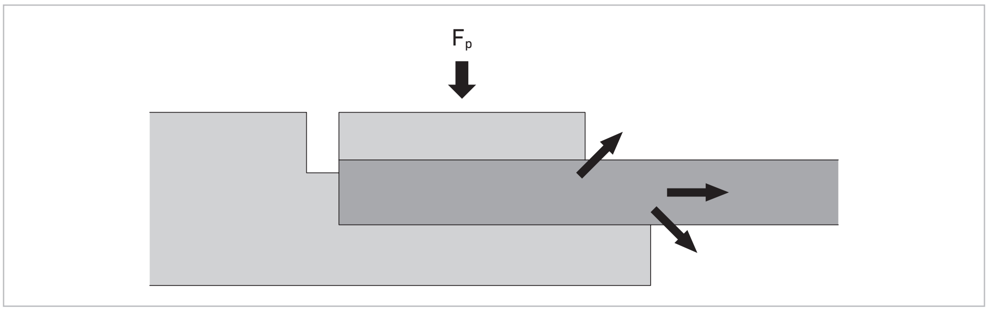
Operational reliability

Operational reliability includes the permanently tight connection between the plastic pipe and the clamping connecting body, based on a fictitious system life of 50 years at 70°C and 10 bar pressure according to Class II.

However, operational reliability also requires that the clamping connection is easy to install without having to use special tools (e.g. torque wrench). In this case, the coupling nuts or screws of the band clamps are tightened using a ring spanner, open-end or ratchet key in accordance with the system specification. Damage to the plastic pipe due to excessive tightening of the clamping elements is not possible.

However, the following aspects can be **disadvantageous** for the **quality of the connection**:

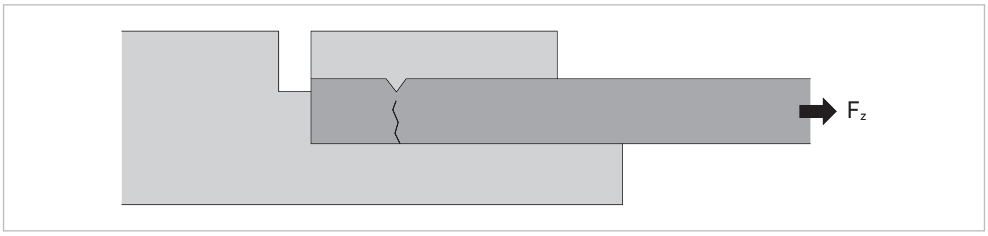
- **Short clamping lengths** cause high surface pressures and thus promote creep.



GIII.34
Case in point: short clamping length

F_p Applied pressure
1 Pipe slipping out

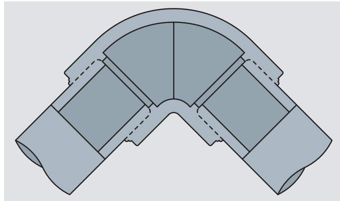
- **Constrictions** or **the formation of notches** have negative effects on the long-term behaviour of the connection.



GIII.35
Case in point: Constriction and notching

F_z Pipe slipping out
1 Formation of notches or cracks

5 Welded connections



When using fusion connections in the piping system construction, **only polyolefinic thermoplastics** must be used:

- Polybutene (PB)
- Polyethylene (PE)
- Polypropylene (PP)
- Polyvinylidene fluoride (PVDF)

5.1 Overview

A **weld** in the plastic sector is a cohesive connection of two similar materials, that is to say, it is a direct joint of two parts of the **same material** without the addition of compounding agents, as they are used for example when gluing is needed.

- Welding joints are permitted, for example, when jointing PB and PB pipes
- Welding joints are not permitted, for example, when jointing PP and PE pipes

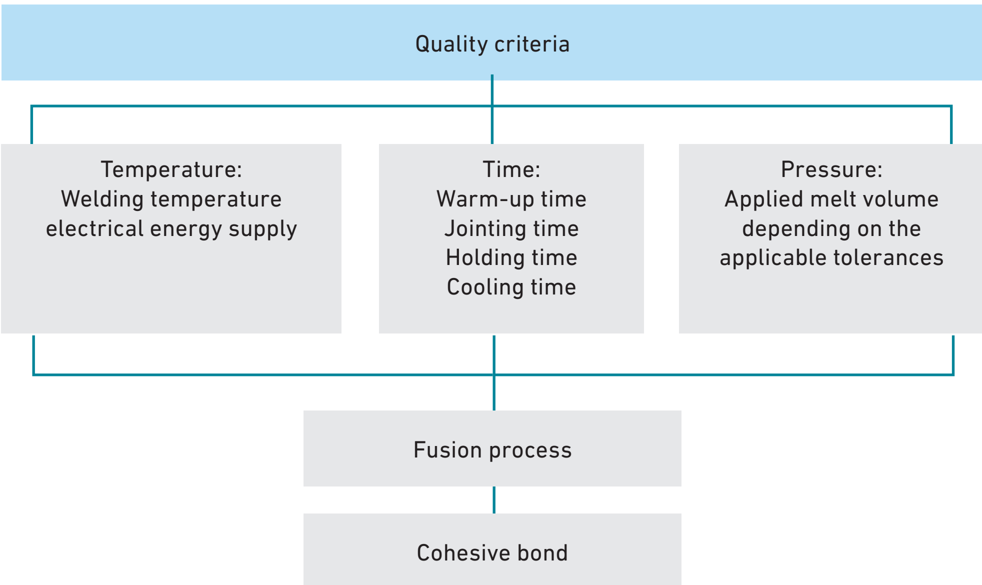
Each weld joint depends on three factors that affect the welding process:

- Temperature
- Time
- Jointing pressure

The optimal interaction of these three factors creates a welded joint between two similar plastic materials. This joint achieves it full strength after cooling.

Quality criteria

The quality criteria of a welded joint relate to the above-mentioned factors temperature, time and pressure.



5.2 Welding processes

Three welding processes are used in the drinking water installation in order to connect the pipes and moulded parts made of thermoplastics.

- Butt fusion welding
- Socket fusion welding
- Electrofusion welding

The individual welding process may be subject to local regulations, for example, in Germany the provisions of the DVS 2207 standard apply. If a standard for a specific material is not available, the information provided by the system manufacturer must be taken into account.

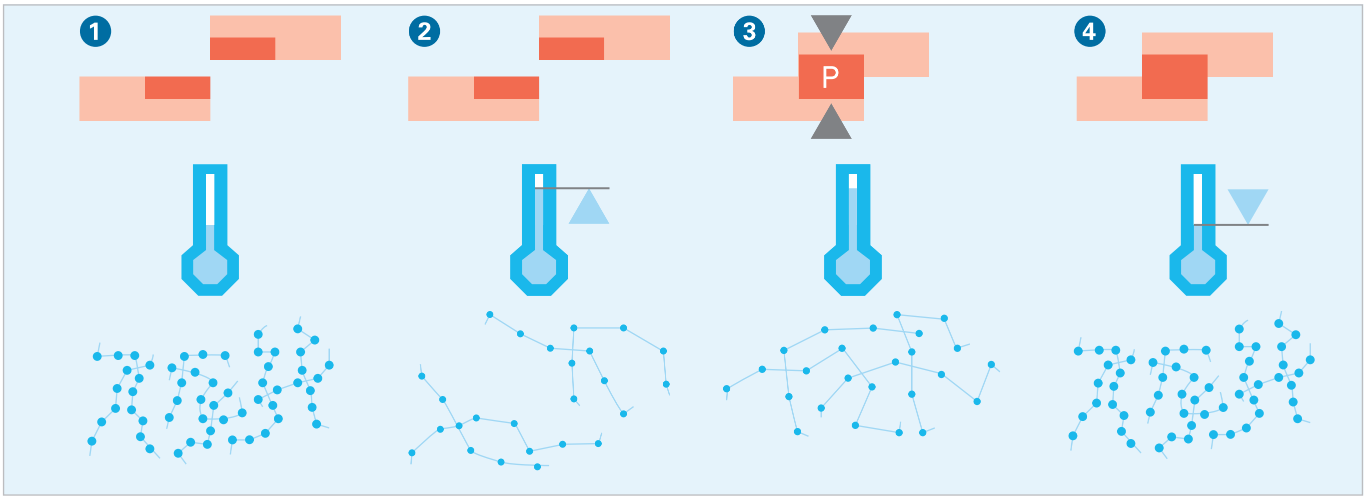
5.2.1 Fusion process

The process sequence during welding can be displayed in a simple way as follows.

- In **Step 1**, the pipe ends and the fitting are heated.
  - When warming up, the molecules of the originally solid plastic are melted and bifurcate. The temperature of the material rises.
- In **Step 2**, the warmed parts are joined together, while the required jointing pressure is built up and held.
  - After the warm-up time, both parts are assembled immediately and held together, so that the jointing pressure can build up in the fusion zone. Due to this jointing pressure, the molten molecular chains begin to connect.
  - **Holding time**: During this time, the joined parts (moulded part and pipe) must be held in place in order to avoid rotation.
- In **Step 3**, the connection cools and the integrity of the material is established.
  - During the cooling phase, a firm and cohesive connection between the two plastic parts is formed.
  - **Cooling time**: Stress, which may be caused by the installation work of other fittings, may only be applied to the welded parts (moulded part and pipe) after the cooling time has expired.
- In **Step 4**, the joint has reach its full strength.

Temperature limits for welding
Welding can be carried out while maintaining the required fusion parameters at different ambient temperatures.

GIII.36
Fusion process
1 Starting position
2 Warming up: Rise of the temperature
3 Jointing: Pressure
4 Cooling: Lowering of the temperature



Welded connection test

When testing welded joints, two different test methods can be used, as shown here in the directive pursuant to DVS 2203, taking into account the requirements and the options available:

- Non-destructive testing
- Destructive testing

Non-destructive testing covers:

- Dimensional check and visual inspection
- Leak testing
- Ultrasonic and X-ray tests

Destructive testing covers:

- Tensile and impact tests
- Creep tests
- Demolition tests

Qualification

Every welder should be trained accordingly. The necessary **qualification** can be obtained by passing a test as a plastic welder at a subject-specific institute, such those associations described DVS 2212.

Welder examination

→ Contact your local GF sales company for more information.

Tools

Welding tools

Welding tools and equipment, especially those used for heating element socket fusion, must comply with the applicable guidelines; in Germany these guidelines are listed in DVS 2208.

5.2.2 Welding report

In general, it is recommended to document the main fusion parameters in a welding report.

Welding report ☐ Heating element socket fusion ☐ Electrofusion welding ☐ Heating element buttwelding

Order No.: .... Welder, Name: .... Fusion device, company: ....

Object: .... Executing company: .... Type/No.: ....

Manufacturer, system: .... Material: ....

1	2		3					4				5
Ser. no.	Workpiece		Weather					Welding data				Remarks
Date	Dimension [mm]	Wall thickness [mm]	Sun	Wind	dry	moist	Temp.	Warm-up time [s]	Holding time [s]	Cooling time min.	Welding tempera-ture [°C]	
Example:												
1/21.4.88	d 32	2,9	x		x		26 °	8	20	4	265 °	

5.3 Butt fusion welding

Principle of the welding process

When using heating element butt fusion, the welding quality required in the design of pressure pipelines depends very much on the compliance with all fusion parameters, for example:

- Parallelism of the pipe and moulding ends
- Offset of the two ends that must be welded
- Differences in wall thicknesses
- Beat up and jointing pressure
- Warm-up and jointing duration
- Heating element temperature

Parameter

- Welding temperature: depends on the material
- Ratio of the welding surface to the annular surface of the pipe: 1:1.

The **welding surface** corresponds to the annular surface of the pipe, that is to say, the strength of the pipe corresponds to the strength of the weld. As a result, only slight deviations of the fusion parameters, the weld seam loses its strength compared to the pipe. In this context, this is referred to as the welding factor, which must be ≥0.7 if welded properly.

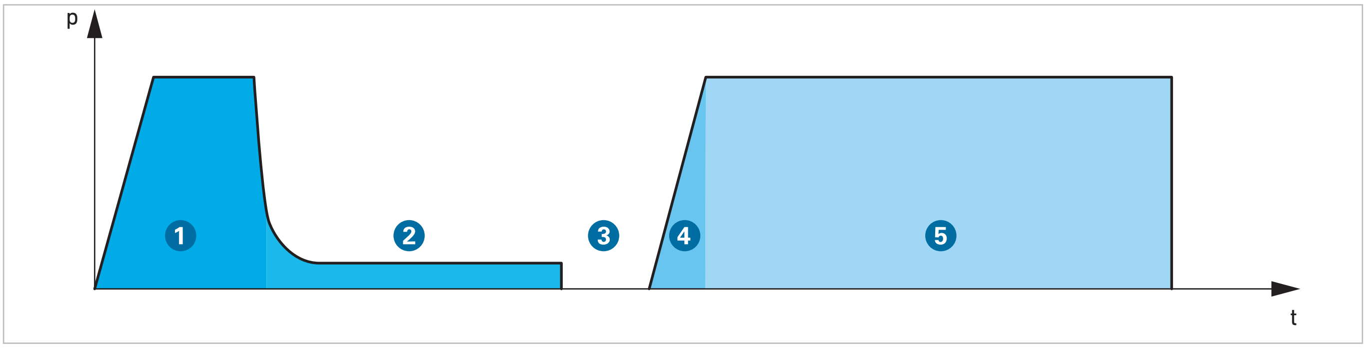
Application areas

Butt fusion weldings during the construction of **pressure pipelines** (water and gas supply), must be carried out with a fusion machine in order to be able to meet the required fusion parameters.

In the **wastewater area**, butt fusion welding can be done manually, since in this industry branch the requirements for the welding quality are much lower than in the construction of pressure pipelines.

Phases in the fusion process

The phases in the welding process are – depending on pressure and temperature – schematically represented as follows:



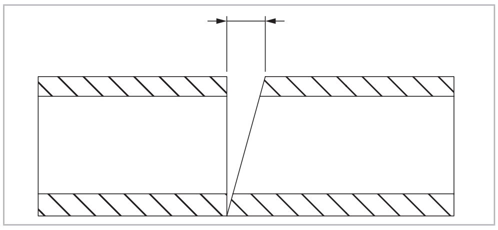
GIII.37
Phases of the welding process

1. Adapting
2. Warming up
3. Adjusting
4. Jointing
5. Holding

Process and control

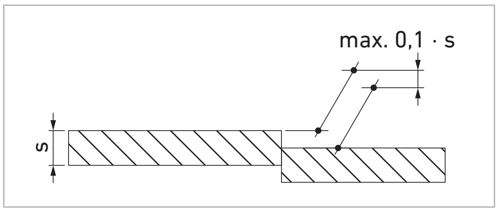
1. Planing the end of the pipe.

☑ Gap: max. 0.5 mm

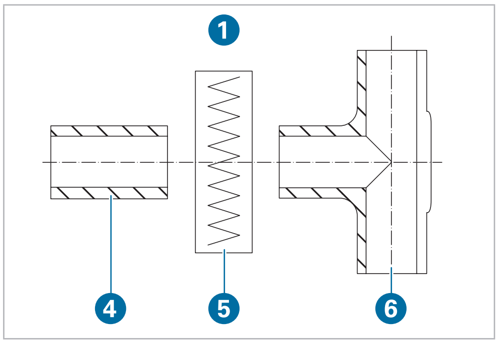


2. Check the offset on the pipe:

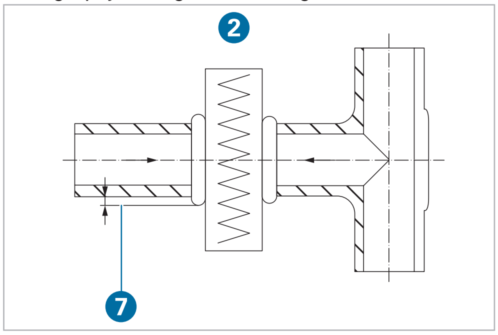
☑ Offset: max. 0.1 × s



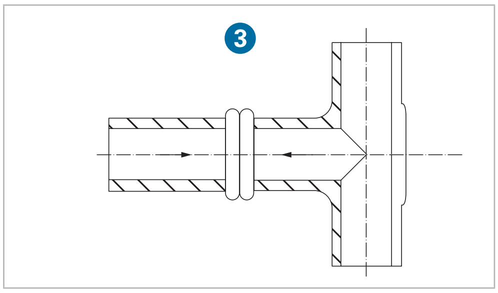
3. Preparing details ❶:
   - Clean pipe ❹ and end of pipe ❻.
4. Preparing heating element ❺.



5. Determining the settings for adjustment, warming up, jointing and cooling.
6. Aligning and warming up ❷.
7. Adjusting.
8. Jointing and holding.
   - When doing so, the aligning time for the formation of the fusion bead ❼ must be observed.
9. Cooling.

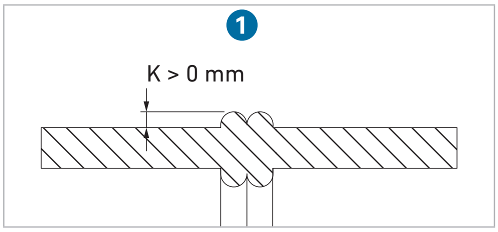


10. Cooling ❸.
11. Inspecting the weld seam.



Weld seam inspection

☑ Along the entire circumference of the weld, two uniform fusion beads ❶ must be present inside and outside at the weld location.



5.4 Socket fusion welding (HMS)

Principle of the welding process

In socket fusion welding, the pipe and pipe parts (mouldings) are welded together overlapping and without the use of welding additives. In order to warm up the pipe and the moulding, a heating element is required. The pipe end and moulded sleeve are heated to welding temperature, using a heating element that has the shape of a sleeve or nozzle. Subsequently, the pipe end and moulded sleeve are connected. The dimensions of the pipe, moulded sleeve and heating element are co-ordinated. This ensures that during the jointing process a jointing pressure is generated.

During the construction of pressure pipelines, socket fusion welds are carried out with a fusion machine (fusion jointing machine), but can also be done manually. The connection of two pipes always takes place with a moulded part, for example a sleeve, an elbow, a tee, etc. The moulding, the pipe and the heating tools must be dimensionally coordinated with each other. This is guaranteed by the relevant standards.

Socket fusion welding can be performed manually up to an outside diameter of the pipe including d63 with **bevelled pipe ends**.

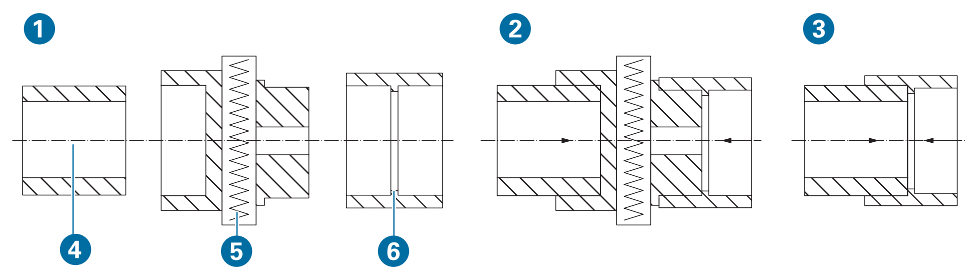
Compliance with the following fusion parameters is mandatory:
- Welding temperature (voltage, current)
- Warm-up time, jointing time, holding time, cooling time

Parameter
- Welding temperature: depends on the material
- The weld area is greater than the circular area of the pipe due to the length of the moulded part's overlap and based on the pipe required by Directive DVS 2207.

Required tools

The equipment and machinery required to make socket fusion welding seams, similar to those required during electrofusion, must comply with the guidelines of DVS 2208 Part 1. In addition to the plastic pipe cutter for welding preparation, a pipe chamfering device and/or a pipe peeling tool is needed. Socket fusion welding requires an electrically heated and electronically controlled hand-held welding device and/or a fusion machine (fusion jointing machine). The heating bushes and heating spigots used for socket fusion welding are diameter-dependent and interchangeable. The heating elements must have an anti-adhesive coating and compliance with the standard is mandatory.

Process and control



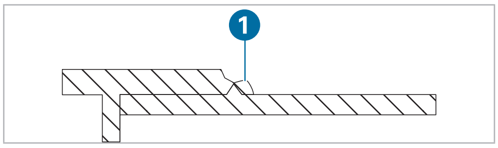
1. Clean the heating element ④, moulded part ⑤ and pipe end ⑥.
2. Warm up the moulded part and pipe.
3. Jointing, holding in place and cooling.
4. Inspecting the weld seam.

GIII.38
Fusion process

① Details
② Jointing, holding in place and cooling
③ Finished joint

Weld seam inspection

☑ A fusion bead ① that is as uniform as possible must be present along the entire circumference of the fusion zone.



III

5.5 Electrofusion welding (HWS)

At first glance, the electrofusion welding is always judged to be the simplest of the three types of welding. This may apply to the unpressurised piping system construction (wastewater), but in the field of pressurised pipeline construction (drinking water) different criteria have to be met more precisely.

Principle of the welding process

During electrofusion welding, the jointing pressure builds up during the course of the fusion process, as long as the moulded part and the pipe are dimensionally exactly matched to one another. During this fusion process, the moulded part and the pipe must therefore not move against each other along their common axis: The moulded part and pipe must be secured, using a clamping device.

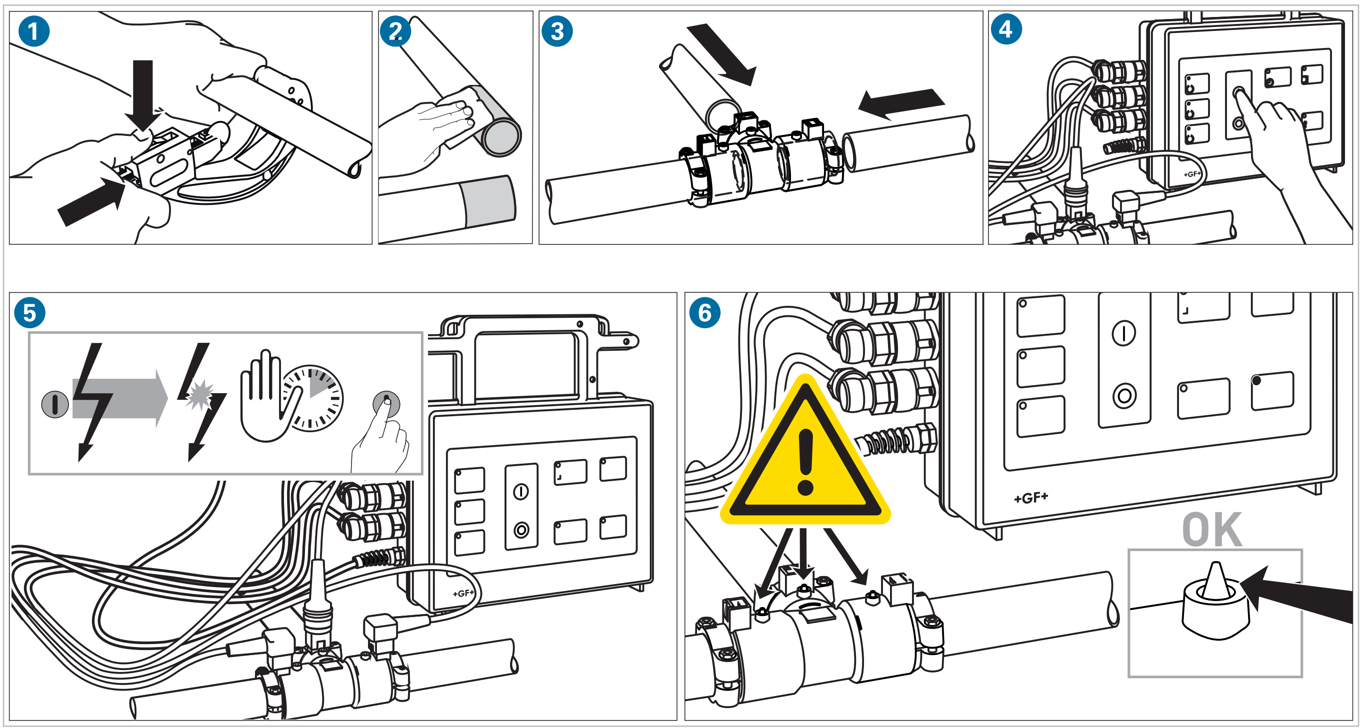
Electrofusion welding is a connection in which the contact surfaces of the moulding and the pipe are joined in a pool of melted material. The heat of the fusion is achieved by using an electrically heated coil that is inserted in the moulded part. Contact bushes or plugs are used to connect the fusion device.

The voltage required for heating the coil depends on the make and ranges between 16 V and 220 V. The fusion parameters pre-programmed in the fusion device and depend on the material and the make.

Compliance with the applicable fusion parameters are:

- Welding temperature (voltage, current)
- Warm-up time, holding time, cooling time
- Jointing pressure

Process and control



GIII.39
Fusion process

1. Cut pipe 1 and prepare pipe ends 2.
2. Insert the pipe ends 3 into the moulded part according to the specified insertion depth.
3. Connect fusion device 4 and start fusion process.
4. Proceed with fusion steps 5 and monitor the process.
5. Inspect weld 6.

Inspection of the weld

The proper course of an electrofusion welding process is indicated by indicators attached to the moulded part. Only if the indicators (discharging melt, colour change of a display) are fully recognizable, this can be referred to as the completed fusion process. However, the fusion indication (indicator) itself does not allow any statement about the quality of a weld.

The weld area and the weld seam strength can be compared with the socket fusion.

5.6 Weld defects

An optimal fusion joint is, with a few exceptions, always dependent on the capabilities of the fabricator. A well-trained and meticulous user automatically achieves optimal weld joints.

The most common imperfections in welded joints are binding defects due to insufficient fusion. Possible causes for these errors are:

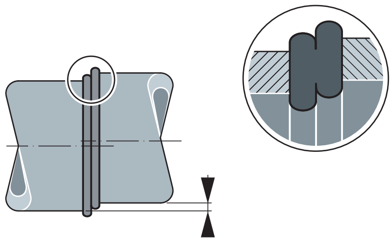
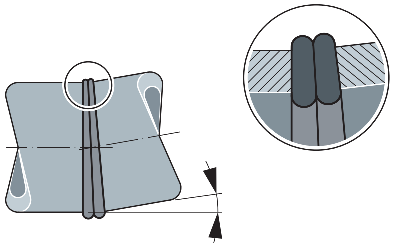
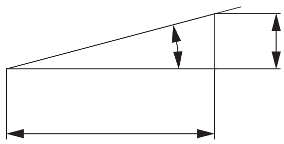
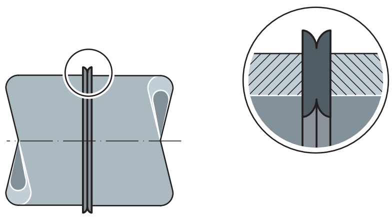
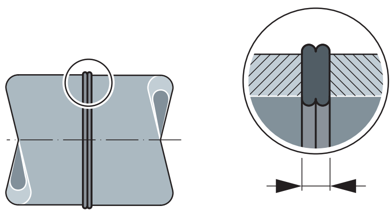
- Failure to maintain the warm-up, jointing and holding times
- Non-compliance with the welding temperature (too high or too low)
- contaminated jointing surfaces
- wrong material pairing
- Material residues on the heating element

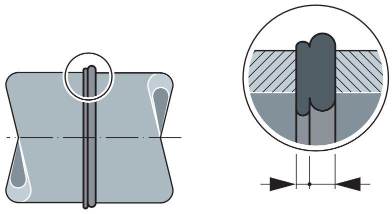
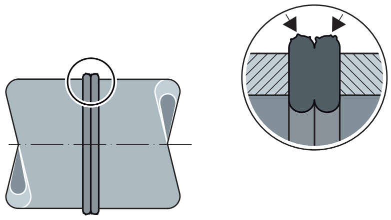
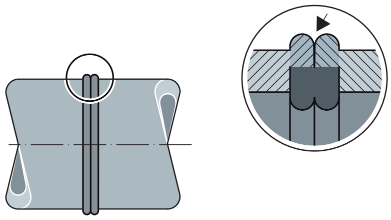
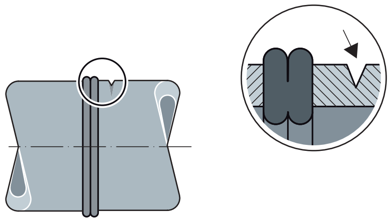
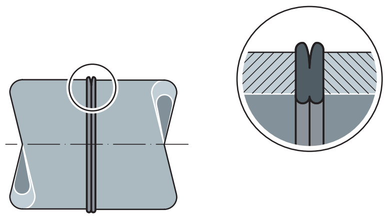
Characteristics of welding defects

- Other typical characteristic of weld joint imperfections of thermoplastics are listed in DVS 2202, Part 1.

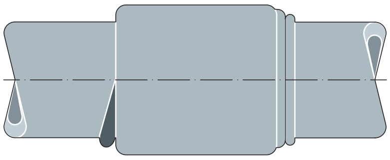
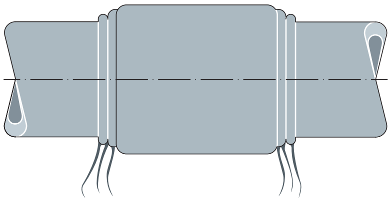
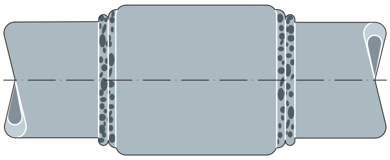
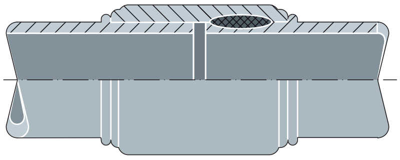
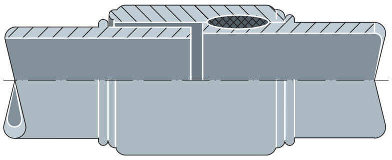
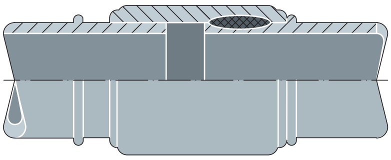
Evidence of the quality of welded joints can be found on the construction site by applying a pressure test and visual inspection.

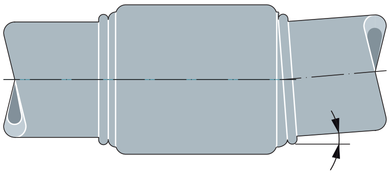
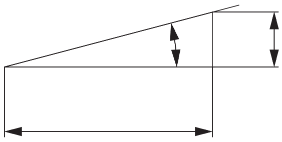
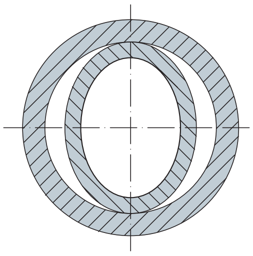
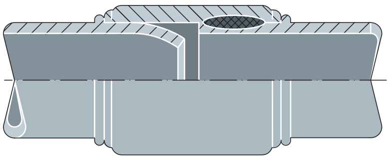
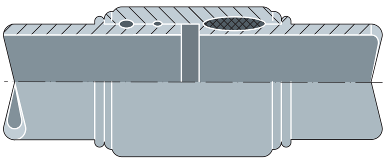
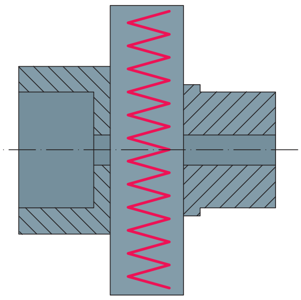
Welding defects and their correction during heating element butt fusion

Characteristics	Description and cause	Remedy
1. Offset of the jointing surfaces 	Jointing surfaces are offset from each other. • Set-up error • Clamping devices • Pipe section not perfectly round	→ Setting up the machine. → Checking the clamping devices. → Making pipes round again.
2. Angular deviation 	• Set-up error 	→ Setting up the machine.
3. Narrow, excessively high bead 	• Excessive jointing pressure	→ Check the set-up of the machine. → Verifying conversion. → Check the jointing pressure of the machine.
4. Poorly formed welding point 	Fusion bead too wide or too narrow • Incorrect warm-up time • Incorrect temperature on the heating element • Incorrect jointing pressure	→ Check the warm-up time. → Check the temperature at heating element. → Check the set-up of the machine.

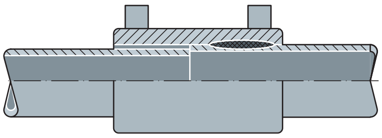
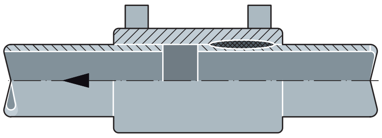
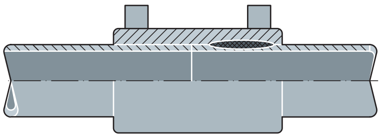
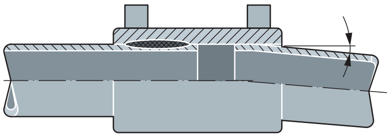
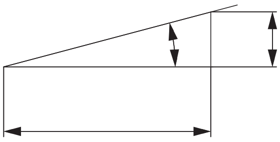
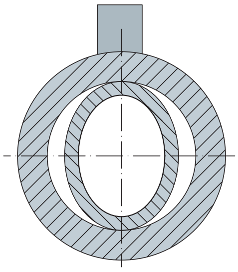
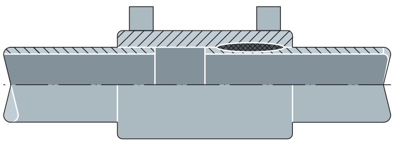
Characteristics	Description and cause	Remedy
5. Fusion bead uneven 	• Defective fusion devices • Error occurred while preparing the seam	→ Check the set-up of the machine. → Cut pipe at right angle. → Plane jointing surfaces.
6. Thermal damage 	high-gloss surface with bladder or nodule formation • Excessive temperature at heating element • Warm-up time too long	→ Check the temperature at heating element. → Check the warm-up time.
7. Binding error in the plane of the joint 	insufficient local or planar binding • Warm-up time too short • Insufficient jointing pressure • Temperature at heating element too low	→ Check the warm-up time. → Check the set-up of the machine. → Check the temperature at heating element.
8. Notches and grooves on the pipe, running longitudinally or transversely to the weld 	• Clamping device of the machine • Improper transport • Error when preparing the weld	→ Check clamping tool. → Ensure proper transport. → Check pipe edge before welding. → Use only suitable tools.
9. Binding error due to bead notches 	local notch in the fusion bead • Insufficient jointing pressure • Warm-up time too short • Cooling time too short • Error when preparing the weld	→ Check the set-up of the machine. → Check the warm-up time. → Holding time and cooling time must be maintained. → Use only suitable tools.

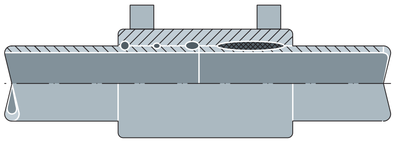
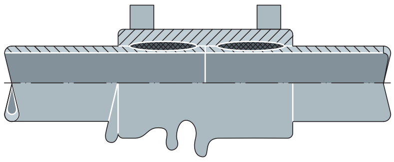
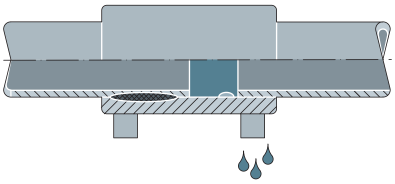
Welding defects and their elimination in heating element socket fusion welding

Characteristics	Description and cause	Remedy
1. Faulty formation of fusion beads  Different bead formation or non-existent beads	• Impermissible tolerances or obliquely joined • Warm-up time too long • Temperature during welding too high or too low	→ Check the dimensions of the pipe, fitting, heating sleeve and socket. → Check the warm-up time. → Check temperature on the heating sleeve.
2. Thread formation at the fusion bead 	• Temperature during welding too low • Warm-up time too short • Removing the heating tools too fast	→ Check temperature on the heating sleeve. → Check the warm-up time. → Pull off parts more slowly from the heating tools.
3. Contaminated fusion bead  Discolouration of sweat bead	• Warm-up time too long • Contaminated heating sleeve and socket (burnt material) • Contaminated jointing areas	→ Check the warm-up time. → Clean the heating bushing and heating mandrel before each welding process. → Clean pipe and moulded part before welding.
4. Binding error due to insufficient fusion  Local or planar incomplete welding causing separation in the joint surface	• Wrong material pairing • Contaminated heating sleeve and socket (burnt material) • Contaminated jointing surfaces • Temperature too low	→ Only join similar materials. → Clean the heating bushing and heating mandrel before each welding process. → Clean pipe and moulded part before welding. → Tighten the heating bushes.
5. Binding error due to inadequate positive locking  Local, planar, axial or circumferential channelling	• Notches in the pipe surface • Inadmissible tolerances • Incorrect mechanical processing • Pipe not aligned properly when inserted	→ Check pipe prior to welding. → Check the dimensions of the pipe, moulded part, heating sleeve and heating spigot. → Check processing tools. → Check the clamping device of the machine.
6. Binding error due to incomplete tube insertion  Insufficient weld length with insufficient binding	• Pipe was not inserted far enough • Axial movement during the holding time • Change-over time too long • Warm-up time too short • Temperature on heating element too low	→ Mark insertion depth on the pipe and maintain this depth. → Maintain holding time. → Secure pipe and fitting in order to prevent axial movement. → Join the pipe and moulded part immediately after removing the heating tools. → Check the warm-up time. → Check the temperature of the heating sleeve.

Characteristics	Description and cause	Remedy
7. Angular deviations (permitted up to 1°)  Local or planar binding incomplete	• Set-up error of the fusion welding machine • Pipe ends nor perpendicular 	→ Check the set-up of the machine. → Use a pipe cutter to cut pipe ends at right angles.
8. Binding error due to deformation  If pipes are not perfectly round, they do not close tightly	• Oval pipes due to incorrect storage • Radius of curvature in coils is too small or clamping device unsuitable • Squeezing of pipe ends when cutting	→ Before welding, check the pipe ends for out-of-roundness and calibrate or make them round again. → Avoid compression loads. Store pipes properly. → Use system-compatible tools (machine/devices). → Check cutting tools.
9. Constricted pipe cross-section 	• Excessive temperature during welding • Warm-up time too long • Jointing pressure too high • Tube inserted too far during warm-up or jointing	→ Check the temperature of the heating sleeve. → Check the warm-up time. → Check the dimensions of the pipe, moulded part, heating sleeve and heating spigot. → Mark insertion depth on the pipe and maintain this depth.
10. Pores due to the effects of foreign objects  Local or planar binding incomplete	• Steam formation during welding (wet pipes) • Contaminated heating tools • External influences	→ Clean pipes before welding. → Clean heating spigot and heating sleeve before welding. → Protect fusion zones in order to prevent external influences during the fusion process.
11. Temperature too high or too low 	• Temperature too high or too low • Heating tools are not com-pletely flush with the surface • Heating tools are loose • Voltage fluctuations in the mains • Contaminated heating tools	→ Correct the temperature. → Check the surfaces of the heating tools and the heating blade. → Tighten the heating tools. → Connect fusion device to separate supply line. → Clean heating spigot and heating sleeve before welding.

Welding defects and their removal during electrofusion welding

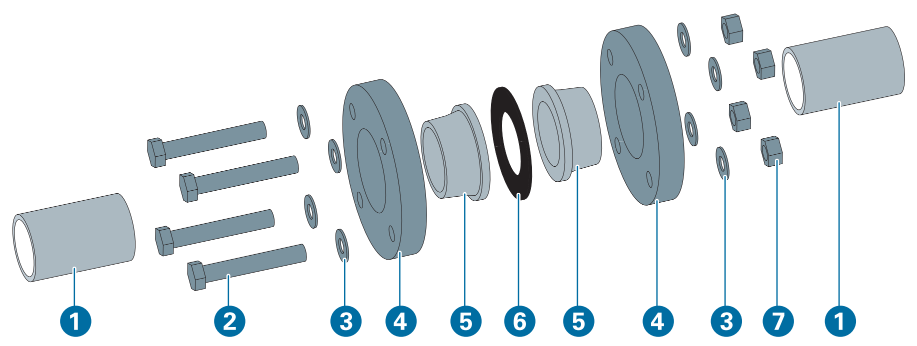
Characteristics	Description and cause	Remedy
1. Binding error due to inadequate positive locking  Local, planar, axial or circumferential channelling	• Notches in the pipe's surface or in pipe severely out-of-round • Inadmissible tolerances • Incorrect mechanical processing	→ Check pipe prior to welding. → Check dimensions on pipe. → Check processing tools.
2. Binding error due to insufficient Positive locking  Pipe slipping out	• Pipes are not fixed inside the socket or welding pressure is not available	→ Ensure the pipes are fixed in place and verify again.
3. Binding error due to insufficient fusion 	• Wrong material pairing • Contaminated weld areas • Fusion device defective or not compatible	→ Only join similar materials. → Clean pipe and moulded part before welding. → Check the equipment. → Use system-compatible equipment.
4. Angular deviation (permitted up to 1°) 	• Set-up error • Stress during the fusion process 	→ Check clamping tool. → Use a pipe cutter to cut pipe ends at right angles. → Avoid any stresses during the welding process.
5. Binding error due to deformation  If pipes are not perfectly round, they do not close tightly	• Oval pipes due to incorrect storage • Radius of curvature in coils is too small or clamping device unsuitable • Squeezing of pipe ends when cutting	→ Before welding, check the pipe ends for out-of-roundness and calibrate or make them round again. → Avoid compression loads. → Store pipes properly. → Use system-compatible tools (machine/devices). → Check cutting tools.
6. Binding error due to incomplete tube insertion  Pipe ends are not adjacent to each other or do not touch the end stop	• Tube insertion inadequate • Pipe ends are oblique	→ Mark insertion depth on the pipe and maintain this depth. → Use a pipe cutter to cut pipe ends at right angles.

Characteristics	Description and cause	Remedy
7. Binding error due to inclusion of foreign matter  Accumulation of pores, separation in the joint surface	• Contaminated surfaces • Formation of water vapour or gas during the welding process	→ Clean pipes and moulded part before welding. → Only weld dry pipes and moulded parts. → In case of repair: Drain all pipes before welding and protect fusion zone from moisture and dirt build-up.
8. Fusion indication not visible	• Tolerance error of pipe or moulded part • Jointing pressure is not available • Pipes are out-of-round • Insertion depth insufficient due to inadequate positive locking • Fusion device defective	→ Check the dimensions of the pipe and moulded part. See miscellaneous features - Cause - Remedy → Check fusion device.
9. Thermal damage  Excessive material discharge on the moulded part, deformations on the moulded part and/or on the pipe	• Welding time excessive • Wrong choice of dimension on the device • Immediately repeat the fusion process	→ Check the equipment. → Check the set-up, see above. → Repeat welding only according to the recommendation of the manufacturer.
10. Fault display or messages on the fusion device	• Fusion device defective	→ Observe the information on the device or documents provided by the manufacturer. → Ask GF Piping Systems or service centre to repair the equipment.
11. Plug-in connector is leaking  Medium is discharging at the plug	• Insertion depth of the pipe in the sleeve is not maintained or • Resistance wire melts to the core and comes in contact with the medium. This creates a capillary action.	→ Mark insertion depth on the pipe and maintain this depth. → Use a pipe cutter to cut pipe ends at right angles.

6 Flange connection

6.1 Overview

It is imperative to use flanges with sufficient thermal and mechanical stability for all connections. The seal dimensions must match the outside and inside diameter of the flange adapter. If the difference exceeds 10 mm between the inside diameters of the gasket and the collar, this may cause interference with the flange connection.



GIII.40
Flange connection

1. Pipe
2. Screw
3. Washer
4. Flange
5. Flange adapter
6. Flange seal
7. Nut

More information:

➨ DVS 2210-1 Supplement 3

There are 2 types of pipe connections:
- Plastic pipe to plastic pipe
- Plastic pipe to metal pipe

6.2 Plastic pipe to plastic pipe connection

Detachable fittings or flange connections with a gasket are used to connect plastic pipes and plastic pipes with fittings (valves, pumps) of various dimensions:

When manufacturing flange connections with O-rings, the screw tightening forces that are required are minimum. In order to avoid excessive torque on the screws, it is recommended to use a torque wrench and to follow the manufacturer's instructions for the system.

Flange seal

GIII.41
Gasket with steel insert

1. Gasket
2. Steel insert

The outside diameter of the gasket is centred around the screws. This ensures that the gasket is always installed around the centre. Screws, nuts, washers (commercially available). Washers must always be used.

6.3 Plastic pipe to metal pipe connection

When transitioning from plastic to metal sealed flange connections are used with gasket.
→ Use a torque wrench to bolt flanges to flange adaptors.

6.4 Comparison of flange connections

TIII.40 **Flange connections**

PP-V flange	PP-steel flange
• Corrosion-free all-plastic polypropylene flange PP-GF30 (glass-fibre reinforced) • High chemical resistance (hydrolysis resistant) • Maximum possible resistance to breakage due to elasticity (deforms when torqued excessively) • Can be used at ambient temperature up to 80°C • UV-stabilised • With integrated bolt fixation • Centring aid for the flanges on the flange adapter • Symmetrical design allows assembly on both sides: The flange can never be installed "upside down". All important information is easy to read • V-groove (patented) • Uniform force distribution on collar (protects components) • Supports a more sustainable torque for a secure connection	• Due to the steel insert, it is very robust and rigid • Corrosion-free plastic flange made of polypropylene PP-GF30 (glass fibre reinforced) with steel insert • High chemical resistance (hydrolysis resistant) • Maximum ambient temperature 80°C • UV-stabilised

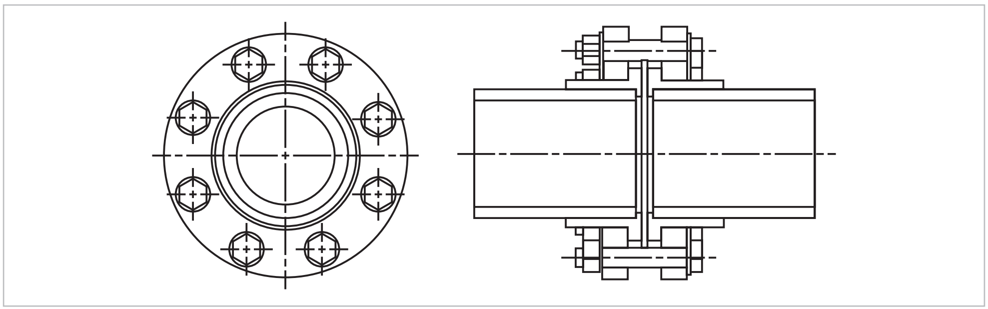
6.5 Assembly

NOTE! Leaks due to the bending stress
→ Do not use bolted connections or flange connections in the area of flexible sections and expansion bends.

→ When manufacturing flange connections, compliance with the following instructions is mandatory.

Alignment of the screws outside the two main axes

- If the pipelines are installed horizontally, the indicated orientation of the screws outside the main axes is advantageous, since in the case of possible leaks at the flange connection, the medium does not run directly across the screws.



GIII.42
Alignment of the screws

- Flange adapter, or fixed flange, gasket and backing flange must be aligned along the centre of the pipe axis.
- Before pre-loading the screws, the jointing faces must be aligned plane-parallel to each other and fit tightly against the gasket. Torqueing of badly aligned flanges results in tensile stresses must be avoided at any rate.

Selection and handling of screws

→ Select the length of the screws as shown in the delivery program. Washers must always be placed underneath the screw's head and the nut.
  - When using screws that are too long, the subsequent mounting option of the insulation half-shells is not guaranteed.

→ For example, thread must be coated with molybdenum sulphide. This makes it easier to tighten the connecting bolts and release them after a long period of operation.

- Always use a torque wrench when tightening the screws.
- First, tighten the screws evenly crosswise by hand, so that a uniform contact of the jointing faces is achieved. Subsequently, tighten all screws diagonally to 50% of the required torque, then to the final value.
- In practice, deviations may result, for example when using stiff screws or if the pipe axis are not aligned properly. The Shore hardness of the gasket also influences the necessary tightening force.

Follow-up inspection

→ Check torques 24 hours after the assembly according to the specified values and tighten again, if necessary. Always tighten screws crosswise.

→ After the pressure test: Check tightening torques and tighten again, if necessary.

6.5.1 Screw lengths

In practice, it is often difficult to determine the correct screw length for flange connections. The length is derived using the following parameters:

- Thickness of the washers (2x)
- Height of the nut (1x)
- Thickness of the gasket (1x)
- Thickness of the flange (2x)
- Collar thickness (flange adapter) (2x)
- Installation length of the valve, if applicable (1x)

"Screw Lengths and Tightening Torque" can be found online at www.gfps.com/tools

Screw length pursuant to DVS 2210-1

The screw length for flange connections should be such that 2 to 3 threads pass through the nut or as indicated in the respective product range.

Due to the insulation used, it must be ensured that the screws used are not too long, otherwise the insulation shells cannot be mounted.

Plan

Drinking water installation

Drinking water installation

1 Introduction

This chapter explains the basic requirements and technical relationships that must be observed during the stages Plan, Build, Operate. This also applies to maintenance tasks as well as servicing a drinking water installation.

The requirements described here regarding the quality of the drinking water, the hygienic conditions and the service life of the system, its functionality and suitability for use, ensure the economic and the long-term safe operation of the system, provided compliance with all of the above requirements is met.

i The requirements for the installation of drinking water installations outside of buildings, for example, those that are laid as a service line underground, are **not** covered in these fundamentals.

i If piping systems for drinking water are used in areas other than those defined here, the installation system for the extended area of application must be expressly approved by the manufacturer.

§ **Application of national laws, regulations, directives and rules of technology**
In addition to the requirements for planning and designing of drinking water installations within buildings described in this chapter, the applicable national laws, regulations and accepted rules of technology must be known and available to the user and compliance with these rules and regulations is mandatory.

§ **Sources**

The following fundamentals have been taken into account during the compilation of this information.

- This summary was compiled on the basis of the generally accepted rules of technology, meaning, in accordance with the European basic standards DIN EN 1717, the series of standards DIN EN 806 (Part 1 to Part 5) as well as the national supplementary standards of the series of standards valid in Germany DIN 1988 (Part 100 to Part 600).
- The fundamentals of the Drinking Water Ordinance were evaluated for the information on compliance with the impeccable drinking water condition.
- For the presentation of the hygienic aspects to be taken into account during planning, design, operation and maintenance, the relevant VDI guidelines and DVGW worksheets were used.
- With regard to the practical application of the generally accepted rules of technology, the bulletins and information leaflets published by the Zentralverband Sanitär Heizung Klima - ZVSHK (German Sanitation, Heating and Air Conditioning Association) have been taken into account.

IV

Identification

For the graphical representation of pipelines, the following symbols are used in this chapter:

Designation	Abbreviations	Colour of the pipeline	
Drinking water pipelines, cold	PWC	Green	solid line
Drinking water pipes, hot	PWH	Red	dash-dot line
Drinking water pipeline, Hot water circulation	PWH-C	Orange	dash-dot line
Drinking water pipeline, Hot water, mixed water	PWH-M	Purple	dash-dot-dot line
Heating, supply line	H-SL	Red	solid line
Heating, return line	H-RL	Blue	dashed line

TIV.1
Labelling of pipelines

2 From concept to operation – An overview

The life cycle of an installation does not start where, for example, a homeowner removes drinking water from a tap for the first time, but much earlier and involves several phases. The life cycle begins with an idea that is worked out during the conception and planning, implemented in the realisation with an installation and then transferred to the actual operation via acceptance and putting into operation. During operation, inspections, maintenance and, if necessary, repairs and revisions are required. At the end of the long life cycle is the proper disposal of an installation and the recycling of its components and materials.

More information on planning and operating phases

➨ Part II 'Plan – Build – Operate'

2.1 Procedure

For all drinking water installations, the following basic procedures must be followed. Compliance with these procedures contributes to the safety of the drinking water installation.

Basically, the process of creating a drinking water installation can be subdivided into a series of operating phases with specific tasks. These essential tasks are briefly described below and discussed in more detail in the following chapters.

2.2 Concept – Planning

For environmental reasons, appropriate measures to save water and energy as well as to meet the hygienic requirements that demand a regular, complete exchange of water in the drinking water installation, must be taken into account during the **planning** stages. Key planning criteria include the regular operating costs that are incurred throughout the life of the increasingly complex technical building equipment.

The essential aspects are in detail:

- ☑ **Create a concept** for the construction and maintenance of the drinking water installation.
- ☑ **Select materials** according to water quality and expected operating conditions.
- ☑ **Provide safeguards** in order to prevent backflow and to protect the drinking water.
- ☑ Proceed dimensioning and calculating the installation.
- ☑ Avoid oversizing.
- ☑ **Carry out hydraulic balancing**.
- ☑ Keep **individual supply lines** (for cold water pipes and non-circulating stub lines with hot water) as short as possible and do not exceed a maximum water volume of 3 litres.
- ☑ Avoid stagnation of drinking water.
- ☑ Avoid **temperature ranges** which promote bacterial growth.

2.3 Installation

- ☑ Ensure clean conveyance, proper storage and processing of products and materials.

More information on the installation of piping systems, controls and instruments as well as meeting individual products and other components

➨ Part V 'Build', Sections about the systems

2.4 Acceptance – Putting into operation

The **acceptance** and **putting into operation** is subject to stringent demands so that the health and hygiene requirements for a drinking water installation can be met.

Especially in buildings where the demands on hygiene are the greatest (such as in hospitals, doctor's offices, retirement homes or food businesses), careful and professional putting into operation is of great importance.

More information on leak and pressure tests as well as for flushing
➨ Part V 'Build', Section 'Putting into operation'

Leak and pressure test

During the **acceptance** a **leak** and a **pressure test are carried out** – often as a combined method.

Pipelines convey all types of media and must be tight at all times. During normal operation, pipelines and their connections are exposed to loads which the pipes must withstand.
In concrete terms, this means: The **theoretical** service life is 50 years, during which time the pipeline must always be leak-proof.

Leak tests are used here to demonstrate sufficient strength and tightness.

☑ According to the protocols, water, compressed air or chemically inactive gases (referred to as "inert gases") are used to implement a leak test.

Flushing

Flushing of the drinking water installation fulfils many tasks: It serves to safeguard the drinking water quality, corrosion damage and malfunction of controls & instruments and equipment are avoided and the inner surfaces of the pipes are cleaned, so that the specified requirements for hygiene are met. For a flushing process to work effectively, a specified flushing sequence must be maintained.

Observe the following instructions before the first **filling** of the domestic service line and the installation of a drinking water pipeline in buildings:

☑ **Thoroughly flush the house connection line** before installing the residential water meter.
☑ **The residential water meters** must be flushed before filling the drinking water installation.
☑ Subsequently, fill the drinking water installation, vent it at the taps and flush again. Change over to permanent operation shortly after the first **filling** is completed.
☑ **Start the intended use** after 72 hours or at the latest after 7 days after the installation.
☑ **Perform regular water exchange** on installations that are not commissioned within 7 days of completion or that have been shut down for more than 7 days.
☑ For **buildings with special use and higher standards** of hygiene: Repeat the procedure every 3 days.

Handover

§ **Responsibility for drinking water quality**
After putting into operation and handover, the operator is responsible for the water quality.

When **transferring** the installation to the operator, compliance with the following instructions is mandatory:
- ☑ **Familiarisation**: Instruct the operator in the operation of the drinking water installation and hand over the necessary operating instructions to the operator.
- ☑ **Create a maintenance schedule** in which all relevant inspection, maintenance and improvement measures are listed.
- ☑ Call attention to the fact that only proper operation based on the intended use and regular inspection and maintenance ensures safe use.

If sampling is required
- ☑ When proof of a perfect microbiological condition of the drinking water must be provided to the client: **Before handover,** samples must be provided to the operator.
- ☑ Samples must be taken downstream the water transfer point (e.g. at the water meter) and, depending on the size of the building, at several points of the cold and hot water installations.
- ☑ Samples must be taken to a recognised water laboratory.

2.5 Operation

+ **The manufacturer of the system must instruct and familiarise the operator with the system's mode of operation so that the operator can fulfil the obligations and due diligence requirements for the proper operation of the drinking water installation.**

Upon acceptance and handover, the system designer must pass the most important documents that are suitable for his installation to the operator.

These documents include:
- Inventory plans
- Operating and operating instructions
- Installation and maintenance instructions

2.6 Inspection – Maintenance – Repair

If the drinking water installation is not operated as intended or if subsequent modifications have been made, this can have adverse effects on the water quality.

+ **The operating company is responsible for ensuring that inspection and maintenance are carried out in accordance with all specifications specified in the documents. To ensure proper operation, compliance with the requirements for carrying out the various inspection and maintenance activities and, in particular, the associated test times, is mandatory. For this purpose, maintenance contracts between operators and specialist companies can be concluded.**

If regular inspections, maintenance and repairs are necessary to ensure the long-term operational safety and function of the system, this must be explicitly stated.

More information on the inspection as well as sampling and disinfection measures
➨ Part VI 'Operate'

Inspection – Monitoring

If the drinking water installation is not operated as intended or if subsequent modifications have been made, this can have adverse effects on the water quality.

Principle for monitoring drinking water installations
→ The technical condition of the installation must be verified by an expert technician **once a year**.

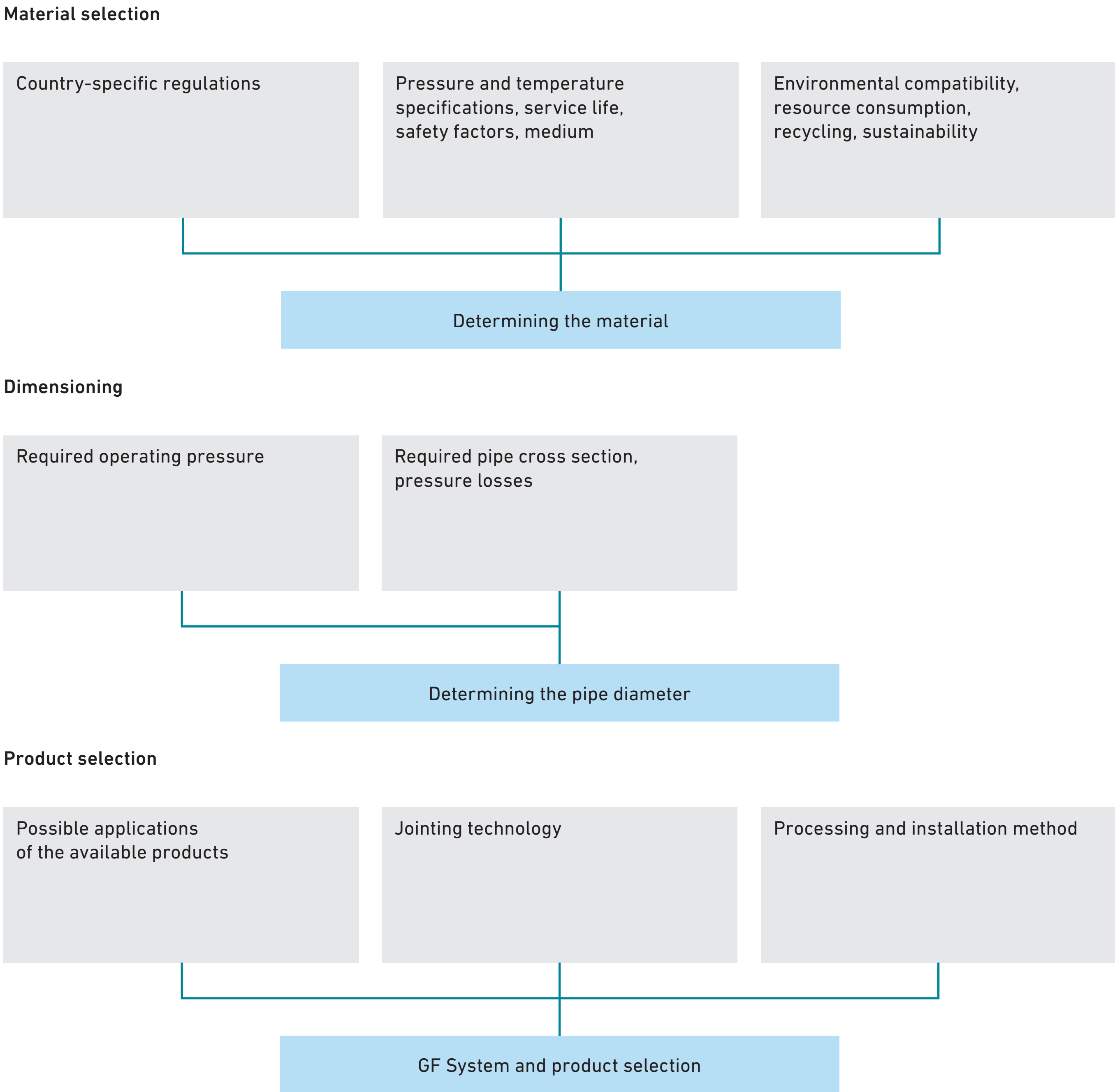
Disinfection

Drinking water installations can become contaminated: Repairs, microbial contamination or deposits that build up over time in the piping are just a few possible causes. In these cases, the drinking water installation must be cleaned. If the contamination cannot be cleaned by flushing or other measures, resort to disinfection.

However, chemical substances must not be present in drinking water to the extent where the concentrations are harmful to human health. If drinking water installations are disinfected, the concentration of chemical substances must therefore be kept as low as is possible under the generally accepted rules of technology (with reasonable effort and taking into account individual cases).

2.7 Planning criteria – Example based on the material selection

The following illustration shows how the **planning criteria**, based on the material selection, can organise the planning process.



3 Design and components of a drinking water installation

The illustration shows a complete domestic drinking water installation with its different components.

Today, water pipes in buildings essentially consist of the following components:

- House connection with domestic water intake and first shut-off valve
- Water meters and drinking water filters
- Pipelines in the building with pipes, fittings as well as pipe and tap controls and instruments

GIV.1
Drinking water installation
(exemplary, typical representation)

4 Fundamentals of a safe drinking water installation

A functioning and safe drinking water supply within buildings has to meet a number of requirements, which are described in the generally accepted rules of technology.

In general terms, these requirements can be described as **fundamental principles**:

- The drinking water must be such that its consumption or use cannot affect or harm human health.
- The drinking water must meet the requirements for the physical, chemical and microbiological water conditions at the taps.
- To protect the drinking water, appropriate measures must be taken to prevent contamination by backflow.
- Appropriate measures must be taken which lead to a regular exchange of water and prevent stagnation.
- In the piping system, the cold water temperatures must not exceed 25°C and the hot water temperatures must not fall below 55°C.
  - Exception: 50°C for DHW heaters with high water exchange and decentralised DHW heaters: ➨ Chapter [9.1] 'Central DHW heaters'
- The installation must not jeopardise the health for the period of its calculated lifetime, cause any material damage and must comply with all functional requirements.
- The serviceability must be permanently ensured by maintaining the required flow and pressure at all taps.
- Excessive flow velocities and pressure surges must be avoided and noise reduced to a tolerable level.
- Damage caused by the formation of scale, corrosion or degradation must be avoided.
- Negative repercussions on the public water supply are to be ruled out.
- All necessary maintenance measures in the context of inspections, maintenance, repairs and improvements must be available.
- The operator must be instructed in the intended use. Upon handover, the operator must be provided with all operating and maintenance instructions.

4.1 Protection of the drinking water

The **protection of drinking water** forms the core of the above mentioned principles.

✚ **Therefore, it must be ensured that contaminants cannot enter into the drinking water installations of buildings or public water supply systems. Impurities can be caused by mixing with harmful liquid, solid and gaseous substances or by damaging contamination of drinking water by microorganisms.**

In addition to such impurities, **unsuitable conditions** and **undesirable changes** in the installation can have a negative impact on drinking water quality:

- unsuitable **materials** that react undesirably on contact with drinking water
- **Temperature ranges** in which microorganisms are growing
- long **stagnation periods**
- missing or wrong choice of **safety devices**
- Contaminations at **taps**, e.g. jet regulator
- immediate **connections** of drinking water taps with drainage systems
- Use of unsuitable **auxiliary or operating materials**
- improper **operation**
- improper or lacking **inspection, maintenance and repair**

IV

4.2 Hygiene requirements

According to the Drinking Water Ordinance, drinking water must generally be such that its consumption or use precludes damage to human health, in particular due to pathogens. The limit and guideline values have therefore been set so that drinking water can be consumed and used by all persons, including infants and toddlers, for a lifetime in all conditions without any adverse health effects.
These requirements are considered to be met if, at least, the recognised rules of technology, the microbiological and chemical requirements and the indicator parameters are complied with during the extraction, treatment and distribution of the water. In order to meet these high hygienic and health requirements regarding the drinking water quality, compliance with all necessary procedures and measures is mandatory by all parties involved in the stages Plan, Build, Operate and maintenance tasks.

4.2.1 Domestic and non-domestic use of drinking water

+ Domestic use

In general, **domestic use** exists when drinking water intended for human consumption in residential buildings or buildings of comparable use, e.g. hotels or washrooms and toilets of industrial and commercial buildings, is utilised.

Experience shows that the potential dangers for drinking water in the domestic sector can be considered significantly lower. Only in domestic use it is therefore possible for certain taps to lower the classification of risks.

+ Non-domestic use

In contrast to domestic use is the **non-domestic use**. This includes all devices, equipment and machines that are connected to drinking water installations in industry, trade, commerce, agriculture and health care systems.

Because the risks in the non-domestic area are elevated due to the allocation to the possible fluid categories, the taps and connections are generally rated more stringent and must be connected with higher-quality safety devices.

4.2.2 Buildings with increased hygiene requirements

In buildings where, due to their use, particular sensitive health needs must be considered – such as hospitals, retirement homes, kindergartens or food processing companies – higher demands are made on hygiene.

In addition, the following planning and operating principles are required for such buildings:

- ☑ **Create room data booklet**, from which the design of the drinking water installation and a description of use is illustrated.
- ☑ **Submit a hygiene plan** coordinated with the client, the operator, a hygienist of the health authority and the local water utilities company.

Furthermore, compliance with the following **procedures** is mandatory:

- ☑ When **testing for leaks,** only use inert gas.
- ☑ **Initial hygiene inspection** should only be carried out by qualified persons with additional hygienic training.
- ☑ After putting into operation: At the essential points during the installation, **water samples** must be taken, evaluated and the perfect condition of the drinking water must be verified.
- ☑ During operation: **Operational parameters** must be monitored regularly, preferably by an adequate building automation system.

4.2.3 Adverse effects of the drinking water quality

Contaminations

To protect the drinking water, no **contaminants** must be introduced into the drinking water installations of buildings or public water supply systems. Impurities can be caused by mixing with harmful liquid, solid and gaseous substances or by damaging contamination of drinking water by microorganisms.

Backflow of non-potable water

The quality of drinking water can also be severely soiled by the backflow of non-potable water into the drinking water installation. This backflow can occur under the following circumstances:

- Due to geodetic height differences, when the pressure in the drinking water installation drops
- If the pressure in an equipment is greater than the operating pressure in the drinking water installation (back pressure)
- If a negative pressure occurs in the connecting line or in the drinking water installation (e.g. sucking back due to sudden emptying of the supply lines in case of a pipe fracture)

External influences

In addition to the harmful effects caused by the backflow of contaminated water, external influences can adversely affect the quality of the drinking water.

Such **external influences** must already be excluded during the planning and then during the installation, using suitable measures:

- Unsuitable installation paths and too short distances to drainage pipes: Underground drinking water pipes must be installed at safe distances away from drainage pipes and must not lead through faeces or septic tanks, drainage channels and their shafts.
- Contaminated soils: Contaminated soil can diffuse substances through buried pipes into the drinking water.
- Flood: Flooding can lead to the contamination of open discharges or vents in the affected areas.
- Emissions from laboratories and animal sheds: If plastic pipes are used, gases or chemical substances can diffuse through the pipe material.
- UV radiation: If pipes are made of UV-translucent plastics, algae growth or biofilm can occur on the inner surface of the pipe.
- Ventilation openings in laboratories: If installed in laboratories, safety devices with ventilation openings are not permitted.

4.2.4 Fluid category

The quality of the drinking water will be categorised depending on the substances or micro-organisms that can enter the drinking water, and regardless of their concentration in terms of possible adverse effect or hazard are divided into five**fluid categories**. If several different types of hazard exist at the same time, the higher category is selected.

The **fluid category I** to **IV** cause only material contamination. The **fluid category V** includes not only material but also microbiological contamination.

TIV.2 **Fluid categories***

Category	Type of hazard	Cause/example
I	Drinking water that does not endanger human health but can cause discomfort through temporary cloudiness caused by air bubbles	high pressure, caused by a pressure booster system
II	Drinking water that does not lead to hazards, but causes averse effects such as changes in taste, smell or colour, e.g. due to stagnation	higher temperatures, caused by drinking of the water heating
III	Liquid presenting a hazard from one or more poisonous or particularly toxic substances	Heating water without inhibitors or rinsing water from dishes and kitchen appliances
IV	Liquid which represents a high risk of poisonous, very toxic, carcinogenic, teratogenic and mutagenic substances	Heating water with inhibitors or chemical mixing systems
V	Liquid that poses a fatal danger from microbial or viral agents of communicable diseases	Water from swimming pools, washing and dishwasher water

* Source: DIN 1717

These fluid categories form the basis on which the required safety devices in a drinking water installation are derived and correctly applied.

4.3 Post-treatment of drinking water

The drinking water distributed by the water utility companies to the public water supply lines must comply with the requirements of the national regulations, such as the Drinking Water Ordinance. The same requirements apply to drinking water distributed from private water supply systems.

4.3.1 Treatment of raw water

In order to meet these drinking water requirements, the raw water must be treated by the water utility company in the waterworks of the water treatment systems. Depending on the condition of the raw water, different treatment methods must be used, which also use chemical substances. For water conditioning and water treatment, however, only substances may be used which are included in a list of the Federal Environmental Agency.

4.3.2 Post-treatment of drinking water inside buildings

If the drinking water is treated in well-founded cases in the drinking water installation of a building, a water analysis must be requested by the water utility company. This will also show whether a water treatment takes place in the waterworks and which chemical substances are used. This water analysis is one of the most important principles for selecting a suitable post-treatment process with the appropriate substances.

The substances used in the treatment of water and the subsequent post-treatment in the drinking water installation inside the building must never negatively influence each other and lead to health problems for humans and/or corrosion-related problems in the domestic installation.

Further decision criteria for the **selection of a suitable post-treatment process** are, for example, technical needs or requirements that an operator places on the condition of the drinking water. Likewise, compliance with the different materials used, the operating conditions and the legal requirements is mandatory.

Avoiding the permeation of solid particles

Solids or **suspended matter** of any kind can deposit in pipelines and thereby cause particle-induced pitting corrosion. As a result, the growth of microorganisms can be significantly promoted. Under certain circumstances this may lead to a microbiological contamination of the drinking water.

Solid particles can cause malfunctions on controls and instruments having narrow flow channels, jet regulators, control valves and devices.

4.3.3 Water treatment systems – Planning, Installation and Operation

In general, **water treatment systems** must fulfil their intended purpose during normal operation.

> **Principle**
> Only qualified personnel shall be permitted to install, maintain and repair water treatment systems.

Place of installation

For hygienic reasons, the ambient temperature inside water treatment system installation rooms must not exceed >25°C and must be frost-free.

Planning and setup

When setting up a water treatment system, in addition to the current water analysis, the materials of the piping installed in the system must be taken into account. The size and output of the system depends on the peak volume flow, the pipe dimensioning and the respective conditions of use.

Bypasses are generally not permitted for hygienic reasons.

If continuous operation cannot be interrupted during a regeneration phase, maintenance or repair, parallel systems must be installed according to the capacity.

In order to proceed with flushing and regeneration processes, or maintenance tasks, drainage processes must be arranged in the vicinity of the water treatment system.

Sampling points

It is recommended to allow for sampling points in upstream and downstream of the water treatment system so that operational inspections can be carried out.

Shut-off devices

For maintenance and repair tasks sufficient shut-off valves must be incorporated in the pipeline.

Safety devices

According to the hazard category, safety devices must be installed to protect the drinking water.

Obligations of the operating company

In order for a water treatment system to remain operational for years to come, the operator must be instructed in the functionality of the system and must be made aware that regular inspections and maintenance tasks must be carried out by specialised companies. Only this will ensure the long-term normal operation of the system.

In addition, the substances used for water treatment must be authorised by the manufacturer of the equipment concerned. Moreover, the operating company shall not store the substance for more than six months before use.

4.3.4 Equipment types

For drinking water installations inside buildings, the following types of equipment are used for the treatment of the water.

Mechanical filters

Although mechanical filters belong to water treatment systems, they are indispensable regardless of the pipe material used. The filters are always installed immediately downstream of the water meter system before filling the drinking water installation for the first time.

If existing drinking water installations are renewed during building extensions or during repair work, mechanical filters should also be used at the connection point of the new system. The nominal size of the filter depends on the peak flow according to the pipe sizing.

Depending on the requirements, **backwash filter** or **replacement filter** can be used. Backwash filters require a drainage connection for the backwashing process. In the case of replacement filters, hygiene requirements must be met when replacing the filter cartridge: Thus, the new filter may only be touched by hand and inserted if using a protective gloves.

Maintenance intervals

For hygienic reasons, a maintenance interval of 6 months must be observed for both types of filter.

Dosing devices

Dosing devices are used to continuously add chemical substances to the drinking water in order to prevent the formation of scale and corrosion and to protect the surface of the pipe materials.

If drinking water installations are contaminated, temporary chemical disinfection measures can be used until the cause has been remedied.

Water softeners

Water softeners use sodium ions to replace calcium and magnesium ions in drinking water. This ion exchange produces a **fully softened water**, which is no longer prone to the formation of scales. Fully softened water is needed in industrial or commercial applications for a variety of applications.

For domestic applications in drinking water installations, bypass mixing valves are incorporated into the pipeline in order to adjust **partially softened drinking water** with a residual hardness as required.

For galvanised piping materials and copper materials with pH values <pH 7.3, dosing systems with orthophosphates are necessary to form protective layers on the inner pipe surfaces.

Lime protection devices

Limescale protection devices work on the principle of seed crystal formation. The hardeners form on the seed crystals when adjusting the lime-carbonic acid equilibrium, the hardeners remain in the water and are flushed out with each tapping process. Softening does not take place. These devices are therefore not suitable for all applications where fully or partially softened water is required.

Lime protection devices reduce the formation of scale on heating coils, inner pipe surfaces and controls and instruments.

IV

Membrane systems

When using membrane systems, a reduction of salts, microorganisms and organic molecules dissolved in the water is achieved by semipermeable or osmotic membranes. Such systems are essential, for example, in glass washer machines, for heating water treatment or in steam systems.

UV disinfection systems

In UV disinfection systems, drinking water is exposed to intense ultraviolet radiation using a wavelength range from 250 nm to 260 nm. Drinking water installations inside buildings use this type of water treatment less, since these systems are very maintenance and care intensive.

Effectiveness of UV disinfection
Experience has shown that **inactivation only takes place in the UV device**. The latter has no controlled sustained release effect for the subsequent, widely branched pipe systems and therefore offers no real protection to prevent the formation of microorganisms in the drinking water installation.

4.4 Protection against corrosion and formation of scale

A drinking water installation always consists of several different **materials**. Therefore, not only the pipe material used must be taken into consideration – even if it has the largest share of the water-wetted surface – but also the materials of all other components integrated into the system must be considered.

In an installation the following materials can be part of the various components, such as:

- Pipe installations made of different plastics
  - for example: PB, PP, PE-X, Multi-layer composites, copper or stainless steel
- Pipe connectors made of plastics, copper, brass, gunmetal or stainless steel
- Gaskets made of different elastomer materials
- Shut-off valves made of plastics, brass, gunmetal or stainless steel
- DWH heaters made of stainless steel, copper, steel (coated or enamelled) or steel storage tanks with plastics in the continuous flow principle
- Circulation pumps
  - for example, housings made of gunmetal, rotors made of stainless steel, gaskets made of elastomers
- Brass sanitary fittings with ceramic washers or elastomer seals

4.4.1 Corrosion

+ Corrosion is the reaction of a metallic material with its environment, which causes a measurable change in the material and can lead to an impairment of the function of a mechanical component or the whole system. In most cases, this is an electrochemical reaction, but in some cases it may also be a metal-related chemical or physical reaction. (DIN EN ISO 8044)

Corrosion can occur in drinking water installations when using **metallic materials** or may be caused by the degradations (decomposition of chemical compounds) in **plastic materials**. Corrosion can adversely affect the function of the installation and its components, cause malfunctions and also lead to considerable damage, which eventually necessitates extensive repair.

The **corrosion resistance** in flowing waters is generally relatively high, while in stagnation phases the probability of **pitting corrosion** increases. Therefore, in addition to hygienic reasons, it is also important from the point of view of corrosion technology that drinking water installations are always operated according to their intended use.

The **materials** used in a drinking water installation must be corrosion-resistant to the condition of the drinking water that exist at the time of the design. In order to achieve this consistency, **water treatment systems** should not be required for new installations.

The **quality of the drinking water** can be affected by the influence of the material's parameters and the operating conditions when it comes into contact with metallic materials. The resulting corrosion products or the reaction products formed with the ingredients in the water can lead to unacceptable health-related issues and may exceed impermissible values of the drinking water.

Corrosive influences

In order to be able to plan and design a drinking water installation in such a way that corrosion-promoting influences are avoided as far as possible, compliance with a wide range of criteria is mandatory when selecting suitable materials. Only then can the theoretical service life of the system be achieved without damage.

These criteria include:

- Material properties
- Condition of the water
- Environmental effects
- Temperatures
- Further criteria in the individual operating phases, for example during installation and maintenance

Table [TIV.3] details the criteria to be considered when weighing the effects of corrosion.

Metallic materials

Types of corrosion

When using metallic materials in drinking water installations, the following types of corrosion can occur:

- Uniform surface corrosion
- Outside corrosion
  - due to moisture on the outside surface
  - due to incompatibility of the insulating material with the pipe material
- Corrosion caused upstream
  - Pitting corrosion, crevice corrosion, selective corrosion, knife-line attack, bimetallic corrosion, erosion corrosion, stress corrosion cracking, fatigue corrosion
- Corrosion due to improperly mixed installations in case of non-compliance with the rule of fluid flow

Protection by passive layers

✚ **Depending on the respective conditions, surface layers and passive coatings can also be corrosion-resistant .**

In the case of metallic materials, however, downstream corrosion does not fundamentally lead to corrosion damage, but can also lead to the formation of **surface layers and passive coatings** of corrosion products on the inner surfaces of the pipes. Favourable conditions – in particular during the first period of operation – can lead to the formation of such protective surface layers, so that a subsequent critical deviation of the water quality or the general operating conditions has little or no corrosive effects.

Plastics

Plastics are subject to both **degradation processes**, which can be triggered by mechanical and thermal loads, as well as **aging processes**, which can be advanced by the following factors:

- Heat due to higher temperatures
- Light due to ultraviolet radiation
- chemical effects due to disinfection chemicals
- mechanical stresses due to notch effect and impact
- in mixed installations with metallic materials: Ingress of metal ions that can affect the pipe material
  - Especially when using PB and PP, aging processes are catalysed, i.e. accelerated, when mixing in copper-iron ions under certain conditions.

These aging processes must be considered when selecting materials in order to achieve the theoretical life span of 50 years for pipelines, with no damage or functional limitations occurring during this period.

TIV.3 **Corrosion-promoting influences - material criteria**

Criteria	Parameters	Reasons for a higher probability of corrosion

Material properties	Physical and chemical composition due to
	• Design
	• Surface finishing
		• Material alloys, compositions and qualities,
		  • which are not suitable for distributed drinking water,
		  • which do not comply with the generally accepted rules of technology.
		• Components, e.g. controls and instruments that are not designed and processed according to the material, promote erosion corrosion or knife-line attacks during operation.
		• **Unsuitable surface properties** of components that come in contact with water can lead to increased deposits and formation of corrosion products.

Condition of the water	Physical and chemical parameters • Total hardness: 1.5 – 2.5 mmol/l, min. 1.0 • Acid consumption (pH 4.3): 1.0 – 4.0 mmol/l • pH value: 6.8 – 8.2 • Oxygen saturation: 30 – 100%	• Deviation from the given parameters
	• free, excess carbon dioxide	• has a corrosive effect
Environmental effects	Physical and chemical composition due to • External influences	• External influences, e.g. in animal sheds or laboratories, individually installed **pipelines without protection** can be damaged. • Manufacturing influences due to **impact or notch effects** or **high ambient temperatures**, e.g. in commercial or industrial buildings, can affect individual materials of the installation.
Temperatures	Physical and chemical qualities due to • adverse operating conditions and malfunctions	• For some materials, e.g. galvanised threaded pipes can be damaged by corrosion, and degradation can occur in plastic pipes if the **operating temperatures exceed >70°C**. • **Malfunctions** can lead to faster aging and degradation of materials (especially joints and components with non-metallic materials). (Example: in DHW heaters with temperatures >95°C, if the **temperature controller fails** and the **safety temperature limiter is missing or incorrectly set**)

TIV.4 **Corrosion-promoting influences after operating phases**

Operating phase	Parameters	Reasons for a higher probability of corrosion
Plan Installation	Physical and chemical qualities due to:	
	• Flow conditions	• Incorrectly selected material-specific flow velocities in the design of the nominal pipe sizes lead to flow conditions that promote erosion corrosion.
	• Flow rules	• Non-compliance with the flow rule can trigger electrochemical processes due to different levels of the electrochemical potentials of the individual materials, which lead to pitting corrosion. • Copper pipes installed in the direction of flow upstream of galvanised steel pipes or galvanized steel tanks.

	• Contact corrosion caused by
	  • Pipelines
	  • DHW heaters
		• Mixed installation and connections: When using shut-off valves made of brass or gunmetal in pipe sections made of galvanised steel pipes, there is only a small probability of corrosion for the steel pipes due to the lower surface area.
		• Installation of brass or gunmetal controls and instruments at the joints to steel pipes may (depending on water quality) lead to contact corrosion.
		• When drinking water hardness levels reach >150 dH, contact corrosion and encrustations at the connections may occur when connecting pipes and DHW heaters with different materials.
		☑ To avoid this, insulated fasteners shall be used on the connections.

Transport Storage	Physical properties influenced by: • Dirt particles	• Ingress of dirt particles on the water-contacting inner surfaces of pipes, fittings and controls and instruments can lead to corrosion.
Putting into operation	Chemical properties influenced by: • Leak tests	Partial draining may occur following a water test. • At the three-phase boundary (water/material/air), corrosion of metal materials can occur leading to wall penetrations.
	Physical properties influenced by: • Flushing	During installation, dirt particles can get into the pipeline and deposit on the pipe's surface. When using metallic materials, this can lead to pitting corrosion where the particles settled.
	Chemical properties influenced by: • Disinfection	The different chemical disinfectants with the respective concentrations of the application and exposure times can lead to corrosion in the case of metal materials and to degradation in plastics.
Intended use	Physical properties influenced by: • Stagnation	If longer downtimes are required, during which water is not removed, corrosion of metallic materials can occur. As a result, metal ions can lead to the exposure to corrosion of the water, whereby the water quality is adversely affected.
Inspection Maintenance Repair	Physical properties influenced by: • Malfunctions • Poor design	• Leaks, excessive temperatures, changed environmental influences or hydraulic changes ☑ If inspections and maintenance tasks are carried out regularly, damage can be detected well ahead of time and prevented through repair or improvement measures.

4.4.2 Scale formation

The function of a drinking water installation is determined by the transported **medium**, e.g. drinking water can be influenced and also adversely affected due to unfavourable conditions.

+ Scale is formed in drinking water installations and results, in simplified form, by exceeding the solubility product for calcium carbonate. When water is, what is referred to as lime-carbonic acid balance, all ions are present in dissolved form. Higher temperatures and/or pH values cause a shift in this equilibrium and deposits can form.

The tendency of water to deposit lime increases with rising temperature and is stronger, the higher the mass concentration of calcium and hydrogen carbonate ions. Therefore, scale formation occurs primarily in hot water systems where higher temperatures are needed, such as in DHW heaters and connected pipe systems and in commercial or domestic washing machines. Scale formation usually does not occur in cold water pipes.

Such deposits on the water-contacting surfaces of heating walls or heating coils, e.g. of DHW heaters, can lead to an energy consumption of up to 10%. In the hot water system, scale formations can cause build-up in the pipes and the deposits can adversely affect the function of controls and instruments, shower heads, devices and equipment.

How to avoid scale

The **measures** used to reduce or avoid scale formation depend on the available calcium carbonate mass concentration and temperature. The following procedures are available:

- Softening by ion exchange
- Stabilisation by limescale protection devices
- Dosage polyphosphates
- Membrane filtration

When dosing combination products of polyphosphates and orthophosphates, a build-up of protective layers and hardness stabilisation can be achieved.

The measures to avoid such formation of scale in hot water systems, are used in DHW heaters or other devices, such as commercial dishwashers, and incorporated into the respective **cold water supply lines**.

However, if other devices or equipment connected to the cold water pipe must be protected against formation of stones or corrosion, it may be necessary to treat the entire drinking water. Because the hot water would be mixed with the cold water at the taps, and thus a large proportion of untreated water would be added. In addition, other household appliances, such as dishwashers and washing machines, would supplied with untreated water.

Depending on the mass concentration of calcium carbonate and the temperature, **water treatment systems** are recommended or even necessary in order to avoid adverse effects during operation.

TIV.5
Measures to prevent the formation of scale

Mass concentration (Calcium carbonate) [mmol/l]	Measures to be taken at temperatures...	
	.. up to 60°C	exceeding 60°C
<1.5 (equals to <8.4°dH)	none	none
≥1.5 to <2.5 (equals to ≥ 8.4°dH to <14°dH)	stabilisation or softening does not occur	Stabilisation or softening **recommended**
≥2.5 (equals to <14°dH)	Stabilisation or softening **recommended**	Stabilisation or softening

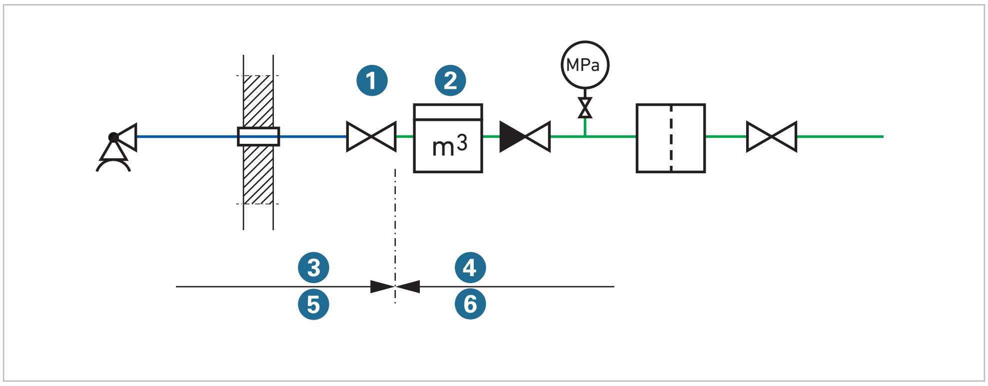
For calcium carbonate mass concentrations above 2.5 mmol/l(14 °dH), all connections on the water side and on the heating side should be electrically nonconductive with "**insulation fittings** for different materials of pipes and DHW generators. This will prevent contact corrosion and incrustations at the connection points of the DHW heaters.

The required **protective equipotential bonding** must be connected before the **insulation fitting** in order to ensure that the DHW heater is not included in the protective equipotential bonding.

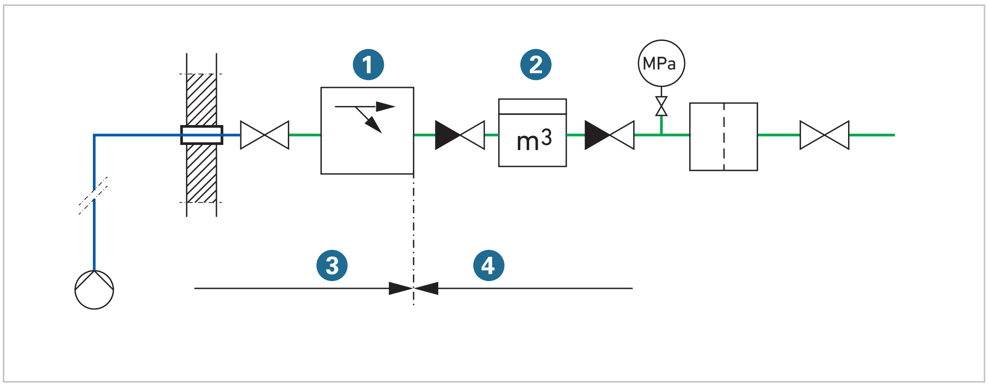
5 Application technology

The following definitions apply to the planning, design, maintenance and intended use of drinking water installations inside buildings as well as buried pipes behind the main shut-off valve on properties. The requirements described here also apply to the professional allocation of all components in a drinking water installation that is part of a sanitary, hygienic, functional and economic supply of drinking water.

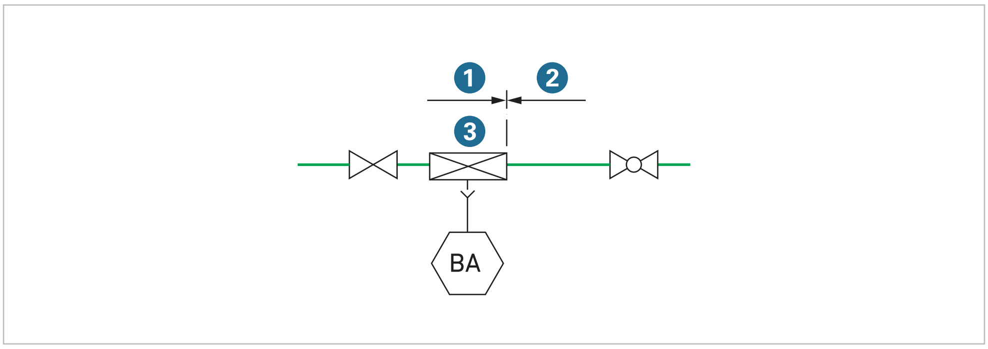
- In **public water supply systems , the drinking water installation** begins downstream of the main shut-off device (MSD).
- If **private water supply systems** are used on the property, the drinking water installation behind the water treatment system begins at the point where the water quality must be of drinking water quality.
- The **taps for drinking water** (cold and warm) define the point up to which all requirements for drinking water quality must be met. For devices, equipment or machines that are directly connected, this point is located immediately downstream of the installed safety device. At this point, the drinking water installation ends.



GIV.2
Public water supply systems
1 Main shut-off device (MSD)
2 Measuring device
3 Water utility company
4 Connecting customer
5 public water utility company
6 Customer's system (drinking water installation)



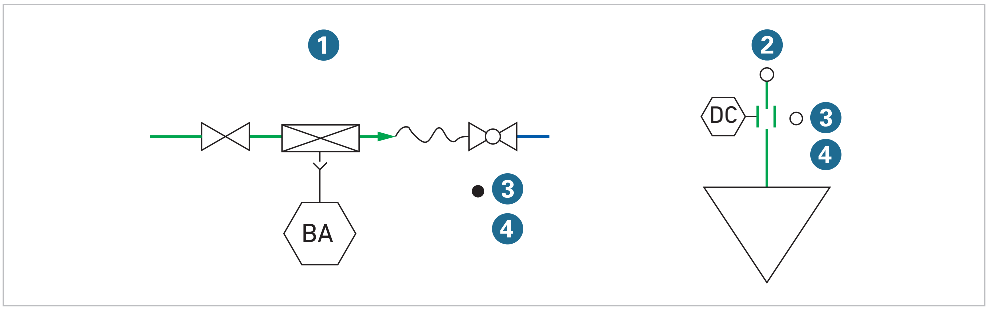
GIV.3
Private water supply systems
1 Water treatment system
2 Measuring device
3 Raw water
4 Drinking water installation



GIV.4
Scope of validity of the drinking water ordinance
1 Scope of validity of the drinking water ordinance
2 no drinking water (e.g. heater filling device)
3 safety device
BA Pipe divider with controllable medium pressure zone

5.1 Safety point and installation matrix

To protect the drinking water, for each **tap** the **safety point** must be determined. In this case, the corresponding liquid category, the atmospheric pressure or the maximum operating water level must be determined.



GIV.5
Safety point

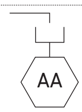
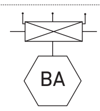
1 Heater filling device
2 WC flush valve
3 Safety point
4 p > atmospheric pressure
BA Pipe divider with controllable medium pressure zone
DC Pipe interrupter with permanent connection to the atmosphere

At the safety point of a heater filling connection, the atmospheric pressure is below the operating water level; at the safety point of a WC flush valve, the atmospheric pressure is above the operating water level.

In order to determine the necessary safety devices, the drinking water installation including all its devices and equipment is recorded during planning in an **installation matrix**.

- **Intrinsically safe taps**, such as vanity unit or toilet cisterns, which are directly connected to a sanitary facility (meaning, it has an open drainage), must **not** be included in the installation matrix.
- In **industry and commerce**, however, all connected equipment, devices, machinery and medical equipment must be included and evaluated in the installation matrix.

TIV.6 **Installation matrix (table of list and forms with examples)**

Installation location of the tap, the device, equipment	Type of tap, the device, equipment	Safety point p = atm (above the max. operating water level)	Safety point p > atm (below the max. operating water level)	Category 1 – 5	Required safety device: Installation at the tap or on the inlet to the equipment	Required safety device: built into the equipment (direct connection possible)
Example: Designation of the room						
Canteen kitchen on the ground level	Water tanks	–	x	5		–
Boiler room KG	Heater filling device with inhibitor	–	x	–		–

5.2 Safety devices

As a rule, safety devices must always be part of the taps or equipment. If, for technical reasons, this is not possible with equipment that may jeopardise the drinking water, then the safety devices for the **liquid categories** I and V are installed at the starting point of the individual feed line to the respective equipment. For fluid categories I to III, the safety devices are installed immediately upstream of the equipment or fitting.

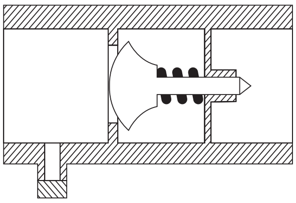
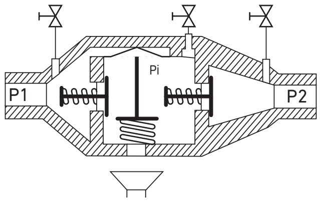
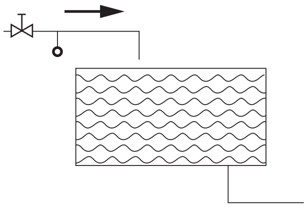
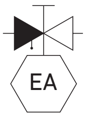
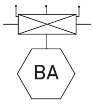
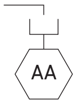
In order to safeguard the public water supply **in the domestic area,** a controllable Return flow inhibitor must be installed downstream of the water meter device.

In the **non-domestic area** where – due to the complexity of a complete review of drinking water installation is not always possible – a safety device must be installed according to the maximum risk occurring.

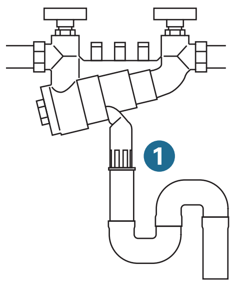
Bypass lines of safety devices are inadmissible and, in principle, not permitted for all other devices, equipment, water meter systems, etc.

Safety devices can consist of one or more safety valves or shut-off and drain valves. Their function can be assigned to the fluid categories as follows:

TIV.7 **Safety devices**

Mechanically separating	Mechanically separating	"Unobstructed drainage"
Return flow inhibitor, type EA	Pipe/system separator, type BA	"Unrestricted drainage", type AA
		
		
• Protection against **liquid category** I or II	• Protection against **liquid category** III or IV • with additional ventilation	• Protection against **liquid category** V Only with the "unrestricted drainages" (AA, AB) and "unrestricted drainage with injector" (AD), which is used especially for washing machines/dishwashers

In contrast to the "unrestricted drainage" (AA), which is placed at the end of a drinking water installation and represents a path of unobstructed free flow between the tap and the maximum operating water level, the "unrestricted drainage" is the open outlet from an equipment that ends above a drainage point. The "unrestricted drainage" above a drainage device must be through separation or relief or ventilation openings.



GIV.6
Pipe/system separator (BA)
with discharge openings as "unobstructed drainage"
1 Relief openings

5.3 Backflow of non-potable water

If the **installation matrix** is created incorrectly, causing the safety points not to be set at all or set incorrectly, non-potable water can be returned to a drinking water installation under the following circumstances:

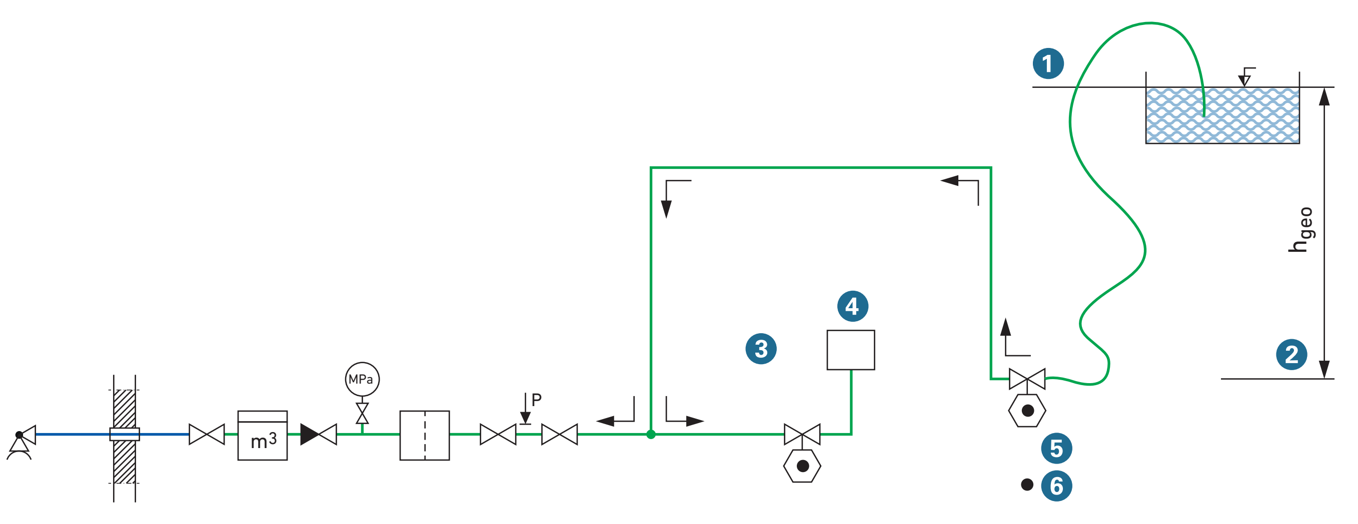
- Due to **geodetic height differences**, when the pressure in the drinking water installation drops
- If a pressure occurs in an equipment where this pressure is higher than the operating pressure in the drinking water installation (referred to as **backpressure**)
- If a negative pressure occurs in the connecting line or in the drinking water installation (e.g. **sucking back** due to sudden emptying of the supply lines in case of a pipe fracture)

In order to take appropriate **measures** to prevent this backflow of contaminated water, the following questions must be answered:

- Are there any potentially hazardous fluids (according to the five **fluid categories**) that may come into contact with drinking water?
- Where is the **safety point**: Above or below the maximum operating water level? Does the geodetic height difference lead to a back pressure?
- Is it a **domestic** or **non-domestic** area?
  - If it is the non-domestic area, an installation matrix shall be prepared.

According to this assessment, suitable **safety devices** can then be planned and installed during the planning phase.

In the following illustration, the **safety point is below the maximum operating water level**.



GIV.7
Assessment of the safety point
according to DIN EN 1717

1. maximum operating water level
2. static pressure
3. System pressure
4. Equipment
5. Safety point
6. p > atmospheric pressure

MPa Mega pascal (1 MPa = 10 bar)
h_{geo} Height

A direct connection between the drinking water from the public water supply and another drinking water supply, such as a private water supply system, is generally inadmissible.

The protection must be installed indirect in a drinking water tank through unrestricted, free discharges of type AA or AB.

5.4 Protection matrix for safety devices and assigned fluid categories

Safety devices	Signs	1	2	3	4	5
Free run, unobstructed	AA	×	1	1	1	1
Free outlet, with non-circular overflow (unrestricted)	AB	×	1	1	1	1
Unobstructed discharge	AC	×	1	1	–	–
Unobstructed discharge	AD	×	1	1	1	1
Unobstructed discharge	AF	×	1	1	1	–
Unobstructed discharge	AG	×	1	1	–	–
Pipe network isolator, Medium pressure zone controllable	BA	1	1	1	1	–
Pipe isolator, Pressure zones different, not controllable	CA	1	1	1	–	–
Pipe aerators in flow through design	DA	2	2	2	–	–
Pipe breaker, with moving parts	DB	2	2	2	2	–
Pipe interrupter with permanent connection to the atmosphere	DC	2	2	2	2	2
Return flow inhibitor, controllable	EA	1	1	–	–	–
Return flow inhibitor, not controllable	EB	only for certain domestic use				
Double return flow inhibitor, controllable	EC	1	1	–	–	–
Double return flow inhibitor, not controllable	ED	only for certain domestic use				
Pipe isolator, not flow-controlled	GA	1	1	1	–	–
Pipe isolator, flow-controlled	GB	1	1	1	1	–
Hose connection, with backflow preventer	HA	1	1	2	–	–
Pipe aerator for hose connections	HB	2	2	–	–	–
Diverter, automatic	HC	only for certain domestic use				
Fuse combination: Pipe aerator for hose connections, combined with return flow inhibitor	HD	1	1	2	–	–
Aerator, pressurized	LA	2	2	–	–	–
Aerator, pressurized; combined with down-stream return flow inhibitor	LB	1	1	2	–	–

TIV.8
Protection matrix
according to DIN EN 1717
1 Covers risk
2 covers risk only, if p = atm
– Does not cover risk
× does not apply

If there is a risk of flooding, do not install equipment with atmospheric ventilation (e.g. AA, BA, CA, GA, GB, etc.).

IV

6 Shut-off areas

+ As a rule, shut-off areas should be chosen in order to ensure that the required maintenance and repair task can be carried out without affecting other users or closing off temporarily unavailable areas.

All pipeline controls and instruments shall be equipped with **discharging devices** for emptying or depressurising the pipeline.

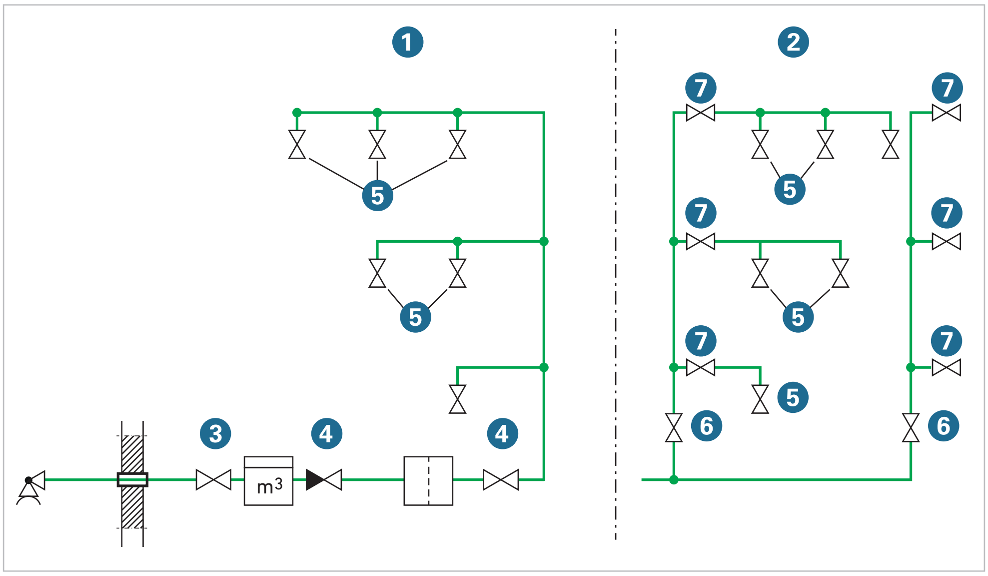
6.1 Shut-off areas

The following **shut-off areas** may be required:

- Main shut-off valve in water meter shaft or at the entrance to the building
- when pipes leave and re-enter a building
- downstream of the water meter system
- upstream and downstream of filters or water treatment systems
- when using central DHW heaters
  - in the cold water supply with a 2nd shut-off valve downstream of the safety group (but upstream of the safety valve)
  - at the hot water outlet of the circulation water inlet, if necessary upstream and downstream of the circulation pump
- at branches of distribution lines and consumer lines
- at branches of riser pipes, individual supply lines and pipelines on individual floor levels of consumer or distribution lines
- at branches of individual connecting lines or pipelines on individual floor levels for a unit of utilisation within the same storey
- for connections to devices, equipment, machinery, washing machines and dishwashers
- for connections of fixtures, such as vanity units, bidets, cisterns and kitchen fittings, except bathtubs and shower fittings
- for connections to safety valves
- at external taps, which must be protected against frost

In single-family dwellings or similar buildings, where usually only one user is affected, at least one shut-off valve with drainage device must be installed downstream of the water meter.

For maintenance purposes, additional shut-off areas may also be necessary in these type of buildings.



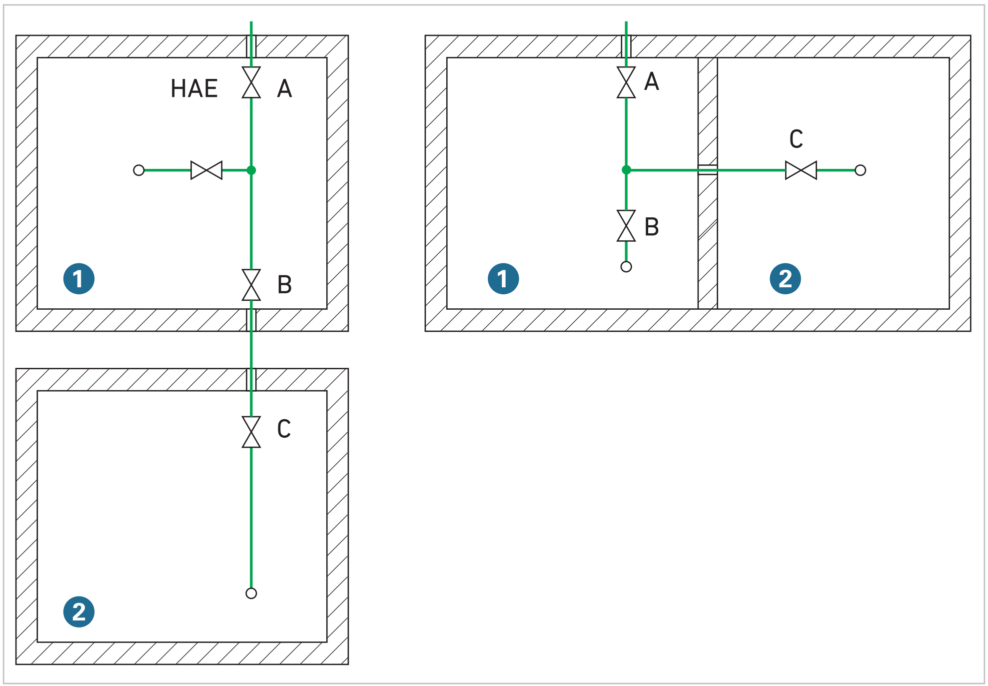
GIV.8
Shut-off areas in a single-family and multi-family dwelling

1. Single-family dwelling
2. Multi-family dwelling
3. Main shut-off valve (HAE)
4. Shut-off valve with integrated Return flow inhibitor
5. Individual shut-off areas of instrumentations and equipment
6. Shut-off valve in vertically installed main pipes
7. Shut-off valve for individual storeys

6.2 Installation locations

+ If a domestic service line is installed in order to supply several buildings, it must be possible to shut off the drinking water installation for each building independently of the water supply to the other buildings.

These shut-off valves must be installed at the exit and entry into another building, such as at a front and rear of the building. Signs must clearly indicate which buildings are being supplied and which building is supplying these dwellings.



GIV.9
Arrangement of shut-off valves and signage

1 Building 1
2 Building 2
HAE Main shut-off device
A Sign: "Main shut-off device for drinking water also shuts off building 2"
B Sign: "Main shut-off device for drinking water also shuts off building 2"
C Sign: "Main shut-off device for drinking water originates in building 1"

Similar to taps, the shut-off valves for the cold water must be installed on the right-hand side or bottom and for the hot water on the left-hand side or on the top. Within flats, the individual or storey shut-off valves for hot water are red and blue for cold water.

7 Pressure and temperature

The basic parameters for a drinking water installation are clearly regulated:

- The components of drinking water installations must be designed for a permissible operating pressure of 1 MPa (10 bar) according to their intended service life and for a maximum temperature of 95 °C when used in hot water areas.
- Pipes and their pipe connectors, which are usually installed in difficult to access areas, are designed to expect a service life of 50 years. For components that are installed with sufficient access, such as DHW heater, water treatment equipment or taps, other service life spans are required.
- For example, when calculating the durability of hose connections to controls and instruments, a 20 year service life must be taken into consideration. When designing hoses for washing machines and dishwashers, a service life of 10 years must be considered.

7.1 Operating pressures

+ For strength reasons, all components, such as pipes, such as pipes, pipe connections, controls & instruments and taps, must be designed for a permissible operating pressure of 1 MPa (10 bar).

Exceptions apply to **DHW heaters** which must be designed for an operating pressure of at least 0.6 MPa (6 bar). Equipment, devices and machinery may also be designed for a lower operating pressure.

Protection in order to prevent excessive pressure

In these exceptional cases, the connected components are protected by a **safety valve** with the same or a smaller nominal setting pressure. The maximum pressure in the drinking water line must be at least 20% below the nominal setting pressure of the safety valve. Otherwise, a pressure reducer must be installed and regulated to its appropriate pressure.

In high-rise buildings with pressure zones of more than 1 MPa (10 bar) higher pressures may be necessary. In this case, components are integrated which are suitable for these pressures and are designed with nominal pressures of PN16.

7.1.1 How to avoid pressure surges

Quick-closing controls and instruments, such as single-lever mixers, solenoid valves or ball valves, can produce pressure surges that are many times higher than the maximum permissible operating pressure of 1 MPa (10 bar). These pressure surges, which are briefly up to 6 MPa (60 bar) when suddenly closing controls and instruments, can cause damage to the components of the drinking water installation.

Therefore, only controls and instruments, equipment and devices should be installed for which the manufacturer can verify that during the operation pressure surges will not occur which are higher than the permissible operating pressure of 1 MPa (10 bar).

7.1.2 Pressure reduction

In order to ensure that approximately the same pressure conditions prevail in both the cold water and in the hot water pipe, pressure reducers should be installed in the cold water pipe downstream of the water meter system.

☑ An overflow segment shall be installed downstream of the pressure reducer. The length of this overflow segment shall be five times longer than the inside diameter (or DN) of the pressure reducer.
☑ Install a mechanical filter upstream of the pressure reducer must be installed. This will prevent contaminants from penetrating the control channels.
☑ The nominal diameter of the pressure reducers must be determined according to the required calculated flow. The nominal diameter may therefore deviate from the nominal diameter of the connected pipeline.
☑ If there are components on the output side that are overloaded by an impermissibly high pressure in the event of a malfunction of the pressure reducer:
  - A safety valve must be installed.
  - The output pressure of the pressure reducer must be set to least 20% below the set pressure of the safety valve.

7.1.3 Design and arrangement of safety valves

Safety valves are incorporated to **protect the pipeline from** excessive pressures.

☑ Equip all connected DHW heaters with at least one safety valve.
  - Exceptions: Flow water heater with a nominal volume of ≤3 litres.

The **nominal sizes of the safety valves** for closed DHW heaters are:

- up to ≤200 L nominal volume and a max. heating output of 75 kW: **DN15**
- from >200 L to ≤1,000 L nominal volume and a max. heating output of 150 kW: **DN20**
- from >1,000 L to ≤5,000 L nominal volume and a max. heating output of 250 kW: **DN25**

Installation criteria for diaphragm safety valves:

☑ A safety valves must be installed in the cold water lines.
☑ Shut-off valves, constrictions or sieves must not be installed between the connection of the safety valve and the DHW heater.
☑ Safety valves must be installed near the DHW heater.
☑ The length of the supply line should be less than (10 · DN) of the safety valve and its design must be at least of the same nominal size.
☑ Safety valves must be installed above the DHW heater so that it can be replaced without draining the tank.
☑ The maximum pressure in the supply line must be at least 20% below the nominal setting pressure of the safety valve.
  - If the maximum pressure exceeds this value: A **pressure reducer** must be installed.
☑ At the safety valve or at the outlet of the pressure relief pipeline, a **sign** with the following inscription must be installed:

> i **While heating is in progress, water can escape from the pressure relief pipeline for safety reasons.**
> → Do not close the pressure relief pipeline.

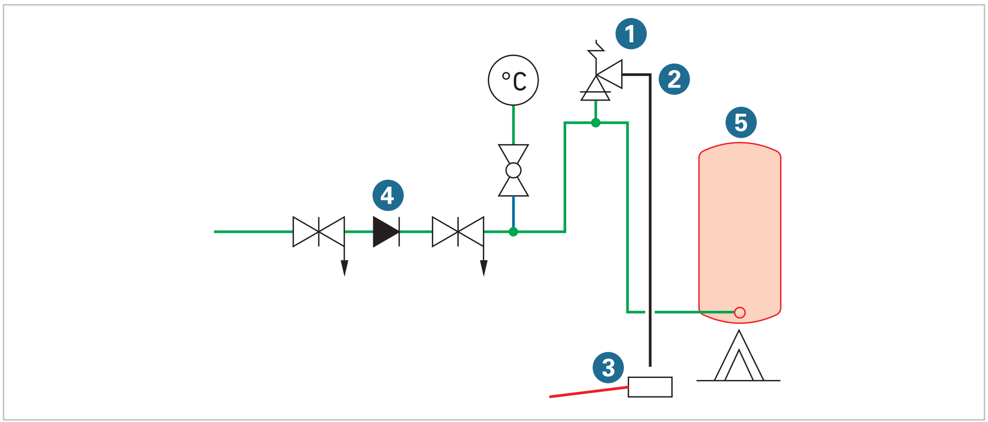
Pressure relief pipeline

+ Each safety valve and each thermal discharge safety device requires a pressure relief pipeline consisting of heat- and corrosion-resistant material. The discharge of the pressure relief water must be designed to prevent injuries to persons, and avoid damage to components or building facilities.

The following **requirements**apply to these pressure relief pipelines:

- ☑ The nominal size of the pressure relief pipeline must be at least equal to the nominal size of the safety valve.
- ☑ The discharge water of the pressure relief pipeline must be run down an unobstructed drain through a funnel or drainage object that is in the same room and its vertically installation is not more than 0.5 m away from the valve.
- ☑ The pressure relief pipeline must be installed with a gradient.
- ☑ Up to a pipe length of 9 m, the nominal diameter of the drainage pipe downstream of a funnel must be at least one nominal size larger than the valve outlet opening.
  - If the pipe length is 9 m to 18 m: two nominal diameters larger
  - If the pipe length is 18 m to 27 m: three nominal diameters larger
  - For each pipe 9 m long: one nominal size each larger

The illustration shows the arrangement of a safety valve and the discharge of the pressure relief pipeline down a floor drainage pipe.



GIV.10
Safety valve and pressure relief pipeline

1. Safety valve
2. Pressure relief pipeline
3. Floor drainage pipe with siphon
4. Return flow inhibitor
5. DHW heater

7.2 Operating temperatures

+ For drinking water hygiene reasons, the operating temperatures are binding.

7.2.1 Temperatures

Cold water

The temperature of the cold water must not be exceeded:

- The temperature must not exceed 25°C for 30 seconds after fully opening of a tap. In intended use, the operator can meet these requirements by ensuring a regular water exchange.

This can also be made possible by using technical devices: When the temperature limit is reached, built-in **temperature sensors** allow a defined amount of water to flow through an automatically controlled valve until the cold water temperature returns to a safe range below 25°C.

Hot water

The temperature of the hot water must not drop below:

- Thirty seconds after fully opening a tap, the water temperature must not drop below 55°C. An **exception** to these limitation applies to DHW heaters with a high level of water exchange.

This limitation of the hot water temperature can also be achieved with larger drinking water systems, utilising technical pipe calculation programs and **hydraulic balancing**.

The hot water and the circulation systems must be designed and constructed in such a way that a thermal disinfection at 70°C can be carried out.

7.2.2 Discharge times

+ The discharge times (tapping times) indicate the time span until a specified temperature is reached at the tapping point and thus signal the beginning of usability. These discharge times apply to fully opened taps set to maximum “hot”. In the interests of economical water and energy consumption, these discharge times should not be set too high.

In order to keep the discharge losses within economically reasonable limits and at the same time to meet the comfort requirements of the hot water user, predefined requirements apply for output times. A fitting installed at the installation site is used to carry out the measurement.

If it is not possible to choose a distribution system that conveys the hot water from the hot water storage tank to the tap within a reasonable time (discharge time), a **circulation pipeline** or **auxiliary heating system** must be planned and installed, or the disposition of the sanitary appliances and riser zones must be optimised.

For the discharge times, there are **different calculation paths**, depending on which standard is chosen as the starting point for the analysis:

- Simplified calculation method
- Differentiated calculation method

Both calculation methods are briefly described below.

Simplified calculation method

For a **simplified calculation** see [TIV.9]. The approximate discharge times (tapping times) are given in seconds for the withdrawals to bath or shower fittings with a volume flow Q of 0.15 L/s.

These maximum discharge times may be necessary until the hot water temperature of 55 °C or the cold water temperature of 25 °C is reached at the tap.

TIV.9 **Discharge times (tapping times) (approximate values*)**

Flow pressure upstream of the discharge valve pFl [bar]	Volumetric flow rate Q at the tap [l/min]	Water volume in the flow path [l]					
		0.5	1.0	1.5	2.0	2.5	3.0
		Tapping times [s]					
1.0	6.6	4.5	9.1	13.6	18.2	22.7	27.3
1.5	8.1	3.7	7.4	11.1	14.8	18.6	22.3
2.0	9.3	3.2	6.4	9.6	12.9	16.1	19.3
2.2	10.4	2.9	5.7	8.6	11.5	14.4	17.2
3.0	11.4	2.3	5.2	7.9	10.5	13.1	15.7
3.5	12.3	2.3	4.9	7.3	9.7	12.1	14.6
4.0	13.2	2.1	4.5	6.8	9.1	11.4	13.6
4.5	14.0	2.0	4.3	6.4	8.6	10.7	12.9
5.0	14.8	2.0	4.1	6.1	8.1	10.2	12.2
5.5	15.5	1.9	3.9	5.8	7.8	9.7	11.6
6.0	16.2	1.9	3.7	5.6	7.4	9.3	11.1

* according to DIN 1988

Differentiated calculation method

The basis for the **differentiated calculation** of the discharge times is the flow path of the water in the non-circulating part. The ambient temperature is assumed to be 20°C.
The discharge times indicate the time span until a temperature of 40°C is reached at the tap (in accordance with SIA 385/2, 2015 edition). For this calculation, the requirements defined in [TIV.10] apply to the discharge times.* The measurement itself is carried out with the fitting installed at the installation site.

TIV.10
Requirements for the discharge times according to SIA 385/1
* Excerpt from SIA 385/1

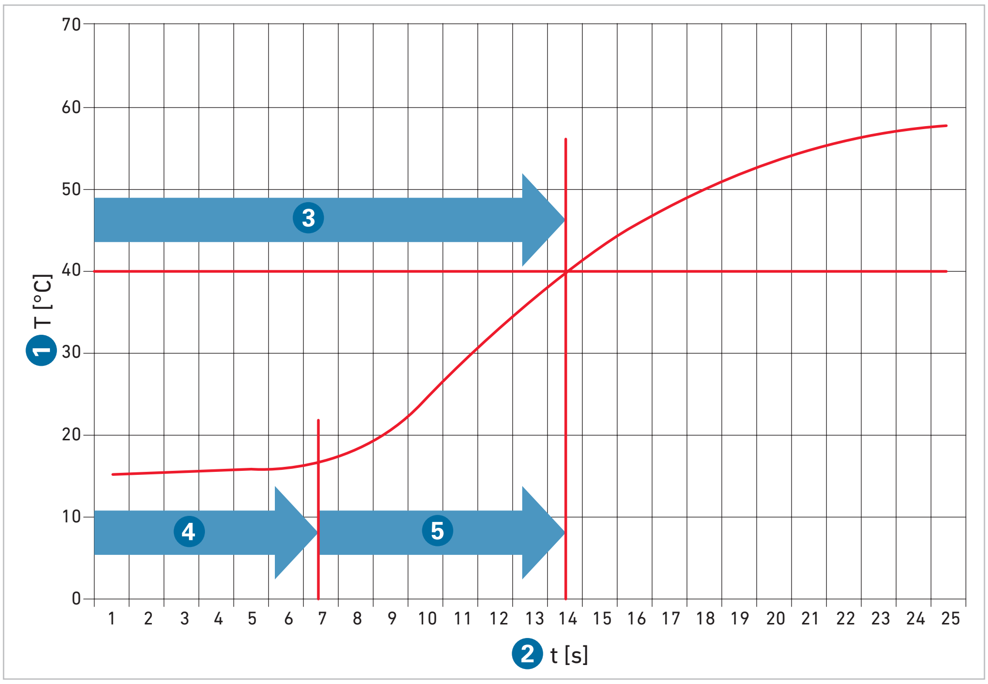
Sanitary fixtures	Discharge time t [s]	
	without keeping warm (e.g. without circulation)	with keeping warm (e.g. with circulation)
Vanity unit, wash-hand basin, bidet, showers, bathtubs, sink (kitchen), utility sink	15	10

Definition

The discharge time comprises two phases:

- **Cold phase**: Cold water in the pipeline is discharged.
- **Warm-up phase**: Pipelines, fittings and distributors heat up to 40°C at the tap.

The illustration shows the temperature profile at a tap when drawing hot water for the first time, based on a useful temperature of 40°C.



GIV.11
Diagram
1 Temperature
2 Time
3 Discharge time
4 Cold phase
5 Warm-up phase

Calculation

The discharge times must be matched to the pipe dimension, the pipe length and the volume flows. This applies in particular when using energy-saving mixers (flow restrictors). Here, the effective volume flow must always be determined and converted (in accordance with SIA 385/2, 2015 edition, Annex G), as the reduced flow rate results in a longer discharge time.

The basis of the calculation is the SIA 385/1 standard, which contains the fundamentals and requirements for systems for domestic hot water, as well as SIA 385/2, which describes the hot water requirement, the overall requirements and the design, such as the calculation of the discharge times.

Calculation of the discharge time during the cold phase

Cold phase = output content [L] / volumetric flow rate Q [L/s]

In order to obtain the total discharge time ❸, the value for the cold phase is multiplied by a factor of 2, regardless of the piping system and diameter of the pipe.
The cold phase is calculated as follows:

$$\Delta t = \frac{V \cdot l}{Q}$$

Symbol	Meaning	Unit
Δt	Duration of cold phase	[s]
V	Volume per pipe length	[l/m]
l	Pipe length	[m]
Q	Volumetric flow rate	[l/s]

The **warm-up phase** takes approximately as long as the **cold phase** and is therefore multiplied with a **factor of 2**.

Discharge time = cold phase · 2

7.2.3 How to prevent scalding

➕ **If hot water temperatures of more than 50°C to 55°C are required for drinking water hygiene reasons at the tap, users must be protected in order to prevent the risk of scalding.**

This is especially true in hospitals, schools, retirement homes or similar institutions where there are people of particular vulnerability. In order to mitigate the risks, thermostatic mixing valves with a limitation of the upper temperature to 43°C shall be installed. In kindergartens and retirement homes, the discharge temperature of shower facilities should be limited to 38°C.

Due to the rather low risk situation and the higher self-responsibility, single lever mixer may be installed in residential units and similar dwellings. Here, the addition of cold water can be selected by the individual user and the mixing tap can be locked by a safety stop.

7.2.4 Monitoring the energy supply

➕ **For heating sources, where temperatures over 95°C must be expected, a monitoring unit is necessary.**

Hot water storage tanks are protected by the following monitoring and safety devices:

☑ Each heater must be equipped with an independent thermostat with safety temperature limiter.
☑ Each heater must have an instrument installed in the form of a thermal discharge safety device which dissipates the introduced energy.

If temperatures exceeding 95 °C cannot be achieved, monitoring the heat sources is not required for the following types of DHW heaters:

- Flow DHW heaters fired by gas or electricity
- Gas-fired or electric hot water storage tanks
- Gas combination boiler units

Flow water heaters with continuously open discharge and open storage tanks with a capacity of up to 10 litres do not require any safety-related equipment (such as Return flow inhibitor and safety valve) in the cold water supply line.

7.2.5 Expansion tanks

When heating a DHW heater, **expansion water** accumulates, which can be collected in closed, flow-through membrane **expansion tanks.** This prevents any water losses due to dripping safety valves. These membrane expansion tanks are suitable for drinking water and are installed in the cold water supply line to the DHW heater, using a safety valve.

Gas inlet pressure

☑ In order to check the gas pressure in the membrane expansion tanks, a valve with a drainage feature that prevents accidental closure must be installed.

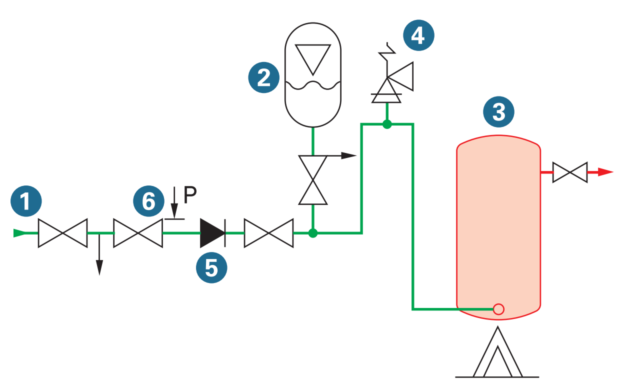
The gas inlet pressure in the membrane expansion tank is set to 0.02 MPa (0.2 bar) below the stagnation pressure.

☑ In order to ensure a constant stagnation pressure: A pressure reducer upstream of the expansion tank must be installed.

Sizing

The size of the expansion tank depends on the volume of the DHW heater.

☑ Determine the size of the membrane expansion tank according to the manufacturer's instructions.



GIV.12
Membrane expansion tank in the cold water line to the DHW heater

1. Cold water supply line
2. Membrane expansion tanks
3. DHW heater
4. Safety valve
5. Return flow inhibitor
6. Pressure reducer

When using **pressure booster systems**, the nominal volume of the membrane expansion tanks should not exceed 10 litres. The gas inlet pressure should be set to 0.005 to 0.1 MPa (0.5 to 1 bar) below the start-up pressure of the pressure booster system. In order to dampen pressure surges, the installation of membrane expansion tanks or water hammer arresters is not suitable.

8 Pressure boosting systems

Pressure boosting systems (DEA) are used to ensure the minimum flow pressure for all discharge points in the drinking water pipeline and extinguishing water areas. At present, the DEAs have to meet a multitude of requirements that have to be taken into account during planning, during operation and during maintenance.

Requirements
- ☑ Pressure boosting systems must be always ready.
- ☑ Compliance with they intended use is mandatory.
- ☑ Other drinking water installations (e.g. from neighbouring properties) or the public water supply must not be adversely affected.
- ☑ Hygienic changes in drinking water quality must be excluded.

Pressure boosting systems with variable speed pumps meet these requirements and also meet today's increased demands for comfort, hygiene, energy efficiency and cost-effectiveness.

8.1 Operating conditions

Pressure boosting systems are only necessary if the minimum supply pressure downstream of the residential water meter is insufficient to ensure the minimum flow pressure at the (usually highest) discharge point.

A pressure boosting system is also required if the following proof is provided by a **differentiated calculation** of the pipe diameter:

Minimum supply pressure of the public water supply	<	Sum of the pressure dlosses in the pipeline
	<	geodetic height difference
	<	Minimum supply pressure at the highest discharge point

If necessary, a pressure boosting system can be omitted. This requires that some nominal pipe diameters on the top floor – at the point where the hydraulic conditions are most unfavourable, on an individual floor level and on single connections – must be enlarged.

8.2 Plan

The components of pressure boosting systems are subject to certain requirements that must be taken into account during the planning phase:

Requirements
- ☑ Pipe materials must have low pipe friction losses.
- ☑ Pipe connections and shut-off valves must have low resistance coefficients.
- ☑ The pressure loss in residential water meters, devices, equipment and DHW heaters must be kept to a minimum.
- ☑ Taps must have low requirements for the flow pressure.

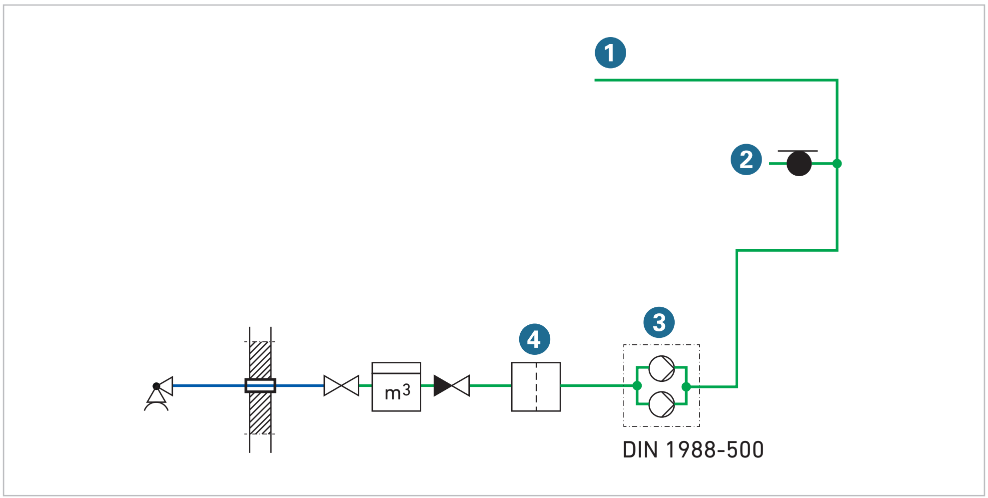
Pressure boosting systems for drinking water installations must be designed quite differently than **pressure boosting systems for fire extinguishing systems**. In a drinking water installation very different volumetric flows are needed than those required for extinguishing water purposes. The volumetric flows required for extinguishing water are usually significantly greater than those flows demanded for drinking water installations. Merely adding up volumetric flows in drinking water and extinguishing water installations is no longer permitted for hygienic reasons.

If the volumetric flows of the extinguishing water were used as the basis for the drinking water installation, the pipelines for the drinking water requirement would be much too large. For hygienic reasons, the frequent water exchange required in the pipes could no longer be guaranteed. Because the actual requirement for fire extinguishing water is only needed in case of fire; fortunately, this does not happen too often.

Larger buildings in particular, place different requirements on the pump technology. For example, drinking water installations always require a standby pump, while one pump suffices for extinguishing water. Also, the necessary minimum flow pressures at a discharge fitting and at a fire extinguisher are very different.

Exception

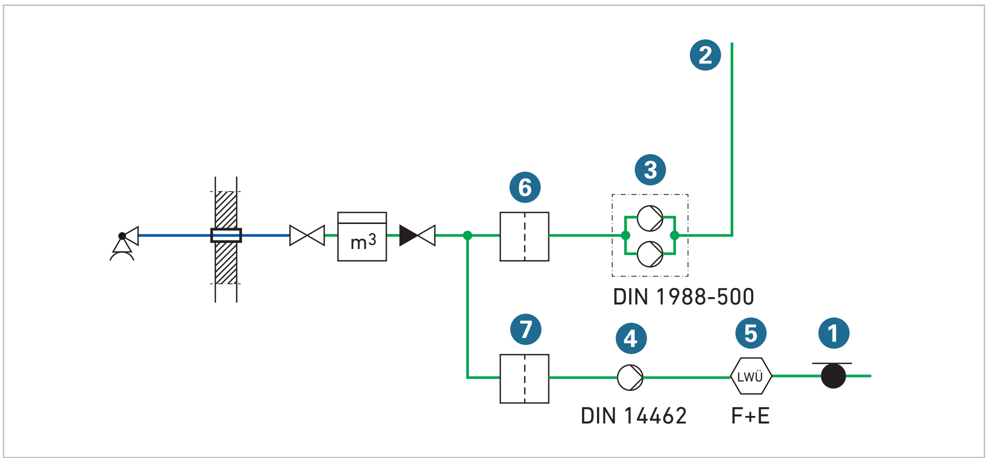
- Fire hydrants with self-service equipment, type S
- A common pressure boosting system is only permissible if the peak volumetric flow in the drinking water installation is greater than the requirement for fire extinguishing water.



GIV.13
Drinking water installation with wall hydrant type S

1. PWC to the drinking water taps
2. Wall hydrant, type S
3. Pressure boosting system (PBS)
4. Filters

If the water demand in the fire extinguishing system is greater than the peak volumetric flow in the drinking water installation, separate pressure boosting systems are used for drinking water and extinguishing water. This applies to all types of hydrants and fire extinguishing systems, including hydrants of type S. The separation between drinking water installation and fire extinguishing water system takes place at the extinguishing water hand-over point (LÜW).



GIV.14
Separate pressure boosting systems for drinking water installation and wall hydrants type F (for fire brigade)

1. Wall hydrant, type F
2. PWC to the drinking water taps
3. Pressure boosting system (BPS) for drinking water installation
4. Pressure boosting system for fire extinguishing water pipelines
5. Fire extinguishing water hand-over point as a filling and emptying station
6. Filters
7. Stone trap

LWÜ Fire extinguishing water hand-over point
F+E Filling and emptying station

8.3 Installation

When considering the installation of pressure boosting systems, compliance with some basic principles is mandatory. This concerns factors such as the flow rate and head of the pumps, the division into pressure zones and various requirements for the way pressure boosting systems are connected.

Flow rate

The flow rate is the usable volume per unit of time, flowing through the pump's discharge nozzle. In order to optimise the design of a pump, the flow rate must be determined as accurately as possible.

☑ The flow rate of the pumps must be designed according to the differentiated calculation method and the peak volumetric flow derived from this computation.

Pump head

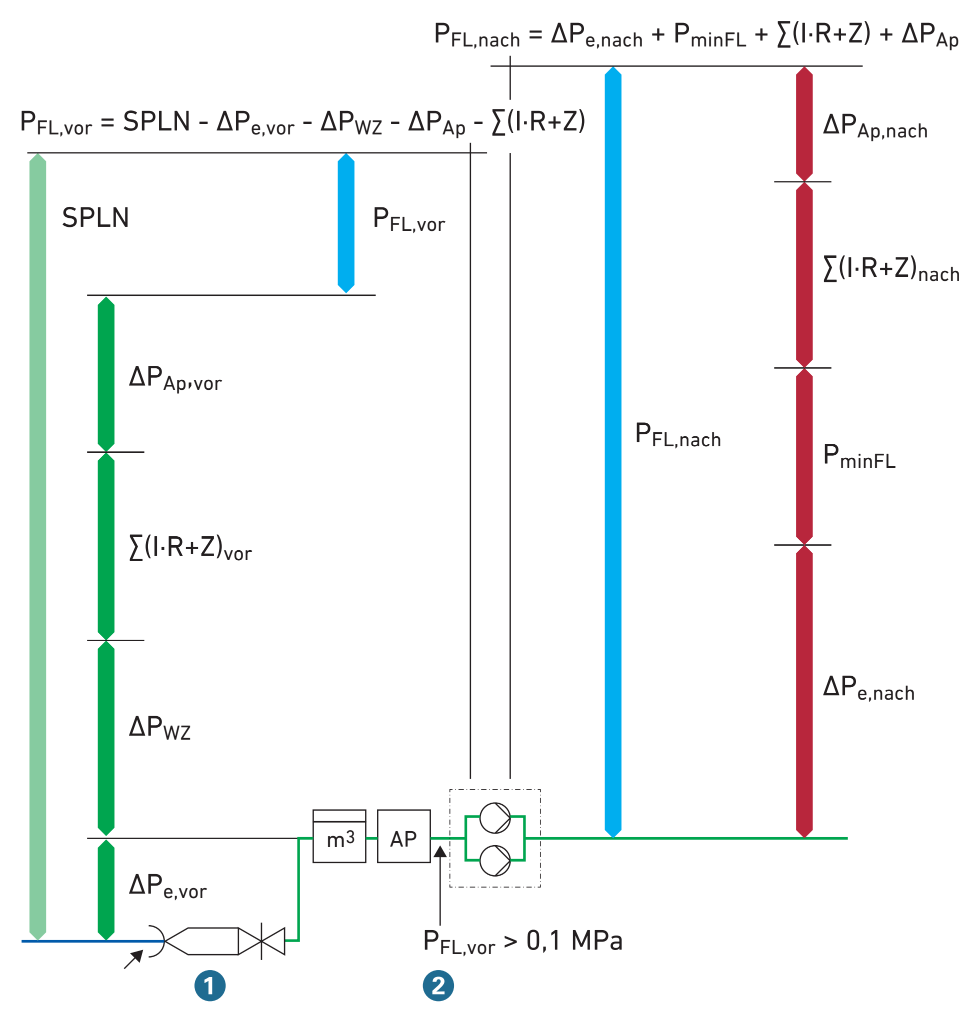
The pump head is required to overcome flow resistances. The head of the pumps is calculated as the sum of the following values:

Pump head [1 bar]	=	
	+	Pressure loss due to the geodetic height difference
	+	Minimum flow pressure at the hydraulically most unfavourable tap
	+	Pressure loss from pipe friction and individual resistances
	+	Minimum supply pressure (static pressure of the water supply)

The total head of the pump is calculated from the difference between the static pressures in the inlet or outlet nozzle of the pressure boosting system. The necessary head of the pump is applied to the pressure side (outlet nozzle) of the pressure boosting system. However, upstream of the pressure boosting system (inlet nozzle) a minimum flow pressure can still be present from the public water supply, which is subtracted from the pump head.

☑ Ensure that the minimum flow pressure at the inlet nozzle of the pressure boosting system is 0.1 MPa (1 bar).

☑ If the minimum flow pressure does not match the specified value: The indirect connection via the upstream tank must be selected.



GIV.15
Pressure conditions upstream and downstream of a pressure boosting system

1 Distribution line
2 indirect connection via a depressurised upstream tank
DEA Pressure boosting system

Abbreviation	Meaning
AP	Equipment
DEA	Pressure boosting system (PBS)
SPLN	Minimum supply pressure
$\Delta P_{e,vor}$	Difference in height from the connecting device to the installation location of the DEA
$\Delta P_{e,nach}$	Difference in height between the connector nozzle on the DEA's discharge side, up to the highest tap installation
$P_{FL,vor}$	Flow pressure at the inlet nozzle
$P_{FL,nach}$	Flow pressure at the DEA's discharge nozzle
ΔP_{WZ}	Pressure loss inside the water meter
P_{minFL}	Minimum flow pressure at the discharge valve located hydraulically most unfavourably
$\Delta P_{Ap,vor}$	Potential pressure losses in equipment upstream of the DEA
$\Delta P_{Ap,nach}$	Potential pressure losses in equipment downstream of the DEA, e.g. in water meters installed inside a flat
$\Sigma(l \cdot R+Z)$	Sum of the pressure losses due to pipe friction and individual resistances in the flow path, from the connection device to the DEA's inlet nozzle
$\Sigma(l \cdot R+Z)_{nach}$	Pressure losses due to pipe friction and individual resistances in the flow path from the outlet side of the DEA's connection nozzle to the hydraulically most unfavourable discharge valve

Pressure zones

In order to save energy, it is necessary to divide the drinking water installation into different **pressure zones**.

☑ Pressure boosting systems shall only connected to areas that cannot be supplied with the minimum supply pressure.

☑ For energy reasons, pressure zones of pressure boosting systems must be selected such as to ensure that pressure reducers are not necessary.

The maximum height extension of the pressure zone of a pressure boosting system can be calculated using the following formula.

$$\Delta h_{max} = \frac{p\,①-p\,②-p\,③-p\,④}{100}$$

1. Minimum flow pressure at the most unfavourable tap location
2. Flow pressure
3. Pressure loss in the riser pipe
4. Pressure losses in the pipe, the piping network, on equipment etc.

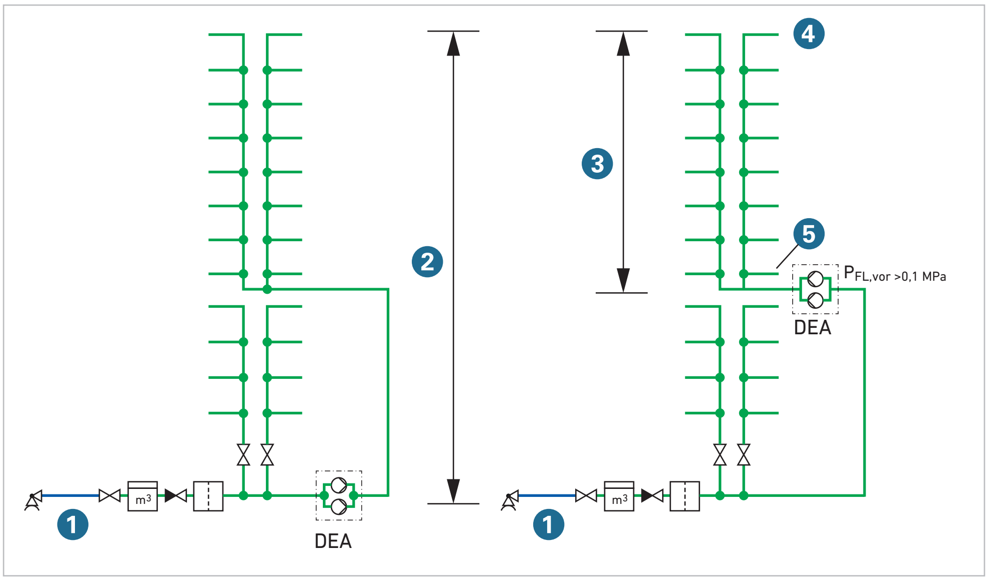
The following criteria must be taken into account for the calculation (the brackets contain the values for the calculation example):

- Minimum flow pressure at the hydraulically most unfavourable tap location (e.g. 700 hPa)
- Stagnation pressure at the most favourable tap location (e.g. 5,000 hPa)
- Low pressure losses in the pipeline (e.g. 1,000 hPa)
- Low pressure losses in the pipelines on individual floor levels (e.g. 300 hPa)
- Pressure loss in equipment (e.g. 0 hPa)

Sample calculation: Height expansion of a pressure zone

$$\Delta h_{max} = \frac{5000-700-1000-300-0-0}{100} = 33\ m$$

The height expansion of a pressure zone according to this example is 33 m. At a floor height of 3 m, the pressure zone may comprise 11 storeys. The following diagram shows the example.



GIV.16
Pressure levels and possible installation locations

1. Distribution line
2. Height difference, total
3. Pressure zone 33 m, 11 storeys
4. Minimum flow pressure
5. Stagnation pressure

DEA Pressure boosting system (PBS)

☑ Compliance with the pressure zones indicated is mandatory. This ensures that the pipe materials, connections, controls and instruments and equipment designed for operating pressures of 1 MPa (10 bar) can be used as is customary in drinking water installations.

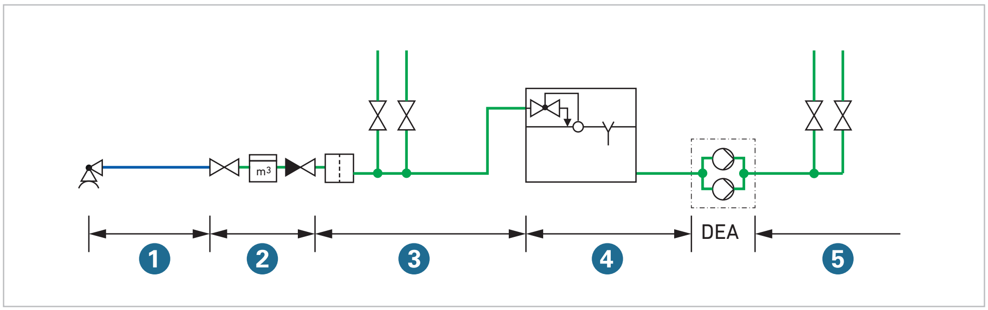
☑ In pressure zones exceeding 1 MPa, components designed for these pressures (e.g. PN16) must be used.

Types of connections

There are two types of connection for pressure boosting systems: **direct** and **indirect**.
From an energy point of view, the direct connection is more economical, because the supply pressure from the pressure boosting system is applied.

The indirect connection is necessary in the following scenarios:

- The required delivery rate cannot be provided.
- The minimum flow pressure at the inlet nozzle of the pressure boosting system falls below 0.1 MPa (1 bar).
- The flow velocity in the connecting line is greater than 2 m/s at peak flow.
- When switching the pressure on and off, the flow velocity changes in the connecting line and is greater than 0.15 m/s.
- If all pumps are switched off (e.g. during a power failure), the change of the flow velocity in the connection line is greater than 0.5 m/s.



GIV.17
Indirect connection with an upstream tank

1. Connecting pipeline
2. Water meter system
3. Supply line upstream of the DEA
4. Indirect connection to the upstream tank
5. Supply line downstream of the DEA

DEA Pressure boosting system

Useful volume of the upstream tank

☑ Upstream tanks with "unrestricted drainage AB" and vented into the atmosphere must be used exclusively for an indirect connection.

If the peak flow from the supply line is not available, the useful volume is calculated according to the summed curve method.

When using pressure boosting systems with variable speed pumps, pre-pressure or pressure vessel are not required and undesirable for hygienic reasons.

For minimum tapping and temperature-dependent volume changes, flow-through membrane pressure vessels with a maximum capacity of 10 L are suitable, which are designed for drinking water installation.

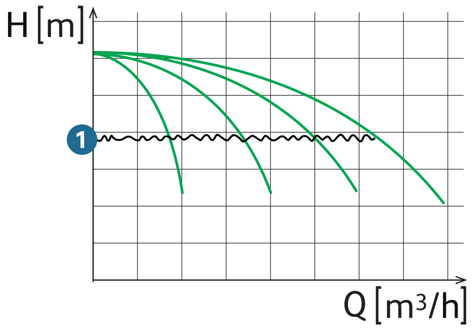
Pump requirements

The **delivery rate of the pumps** is essential for the pressure boosting system. To ensure the pump's delivery rate, the following requirements must be met.

Requirements

- ☑ The pressure boosting systems must be equipped with at least one standby pump (except for small objects).
- ☑ Make sure that the peak volume is 100% covered by the other pumps if one pump fails.
- ☑ All pumps must be secured in order to prevent dry running.
- ☑ When using an indirect connection to an upstream tank, a self-priming pump must be installed.
- ☑ In order to maintain the control quality of the flow pressure, the permissible flow velocities and the flow rate, centrifugal pumps with speed control, flow control and stable characteristic curve must be installed.

The illustration shows the behaviour of pumps that are speed-controlled and equipped with frequency converters.



GIV.18
Behaviour when using variable speed pumps equipped with frequency converters

1 Pressure fluctuations: <0.15 bar
H Height
Q Displaced volume

Requirements for the installation site and putting into operation

Pressure boosting systems cannot be installed arbitrarily. Here too, compliance with legal and safety requirements are mandatory.

Requirements

- ☑ The place of installation must be frost-free, ventilated and lockable.
- ☑ The place of installation must not be used for other purposes.
- ☑ Drainage connection is available.
- ☑ The place of installation must be selected such so that possible noise transmission to adjacent living spaces is avoided.

The following aspects shall be noted during **installation**:

- ☑ If the installation takes place in district heating stations, it must be ensured that the cold water temperature does not exceed 25°C due to increased ambient temperatures (e.g. by insulating the pipes on the heating side against heat emission, and insulating the pipes on the cold water side against heating).
- ☑ Shut-off valve must be installed upstream and downstream of each pump.
- ☑ Before putting the system into operation, disconnect the pressure boosting system from the pipeline on the pressure side and flush separately.

8.4 Installation and maintenance

- ☑ Pressure boosting systems must be inspected regularly every 6 months.
- ☑ The pressure boosting systems must be maintained by a specialist company or by the manufacturer.

9 DHW heaters

+ The devices for heating the drinking water inside a building can be distinguished according to the operating mode and the energy sources used. Supply types are differentiated as single (decentralized), group and central supply unit.

The DHW heaters must work with as little heat loss as possible and must be easy to regulate, must be hygienically flawless and easy to operate. The hot water shall be available in sufficient quantity and with the desired temperature at all times.

Energy sources for the direct heating can be solid, liquid or gaseous fuels or electric energy. For indirect heating, steam, heating water and exhaust gases are used; however, solar systems are being used more and more frequently.

The design of the **storage size** of single and group DHW heaters depends on the respective conditions, such as the type and number of taps.

The **heat requirement** and the **storage size** of central DHW heaters in residential buildings are determined according to the following parameters:

- Size of flat
- Assignment number
- Number of taps

Operating modes

DHW heaters can be differentiated according to their operating modes as follows:

TIV.11
DHW heaters: Operating modes

Category	Operating mode
Function	• Flow DHW heater • Storage DHW
Design	• open DHW • closed DHW
Heating method	• direct heating – gas, oil, electric energy • indirect heating – heat transfer, steam, heating water

Hygienic requirements

Practical experience has shown that the increase of Legionella can be observed especially in large DHW heaters with a large storage volume and long, widely branched piping systems with larger pipe diameters and resulting, larger surfaces that can be easily colonised by bacteria.

Soil biofilms can form on the wet surfaces of drinking water pipelines. Under favourable temperatures, with sufficient food supply and certain surface conditions (such as incrustations), biofilms can develop in storage tanks and other components. Permanent bacteria and pathogens, such as Legionella, can be passed on from the biofilms and released to the passing drinking water.

Principle
Unfavourable hygienic conditions can be effectively counteracted by using DHW heaters with low storage volumes and storage outlet temperatures of ≥60°C.

Exceptions to these two principles for DHW heaters can be the following supply and operating modes:

- **Decentralised systems** with individual and group supply lines
- **Flow-through DHW heater** with a pipeline volume ≤3 litres in the downstream flow path
- **Central DHW heaters** with a high level of water exchange

9.1 Central DHW heaters

+ In central drinking water heating systems inside a building, all drinking water taps (hot) are connected to a common pipe system. Here, storage, flow and storage charging systems are used.

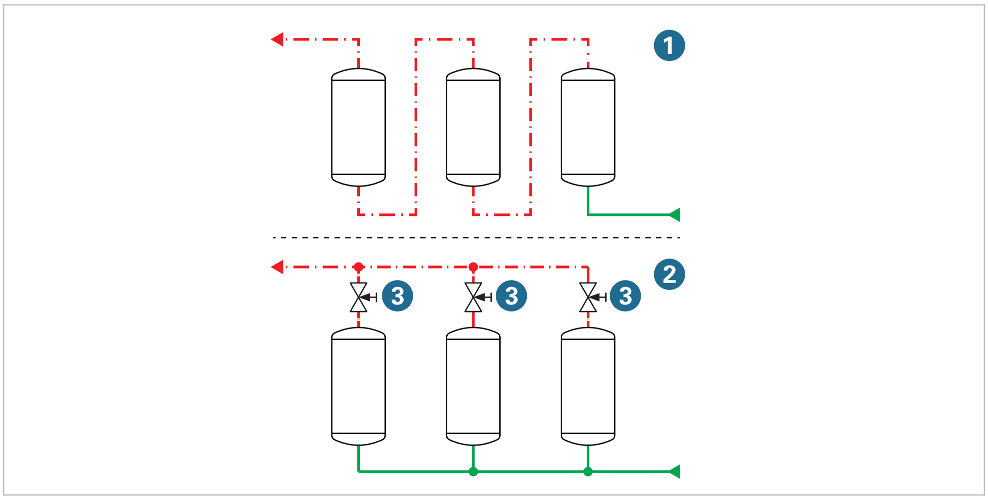
The heating is usually indirect, that is to say, the heat energy is a heat transfer medium, e.g. the heating water, delivered to the drinking water to be heated. The DHW heater temperature at the outlet of the DHW heater must be ≥60°C and may only drop below this limit in the case of peak volume flows in the minutes range.

Storage DHW heaters

A storage DHW heater always incorporates a heat exchanger in the lower part of the tank. The incoming drinking water (cold) is heated there, using the full available heating power. The heated, lighter drinking water rises due to the difference in density up to the outlet nozzle and, thus, spreads evenly throughout the storage tank. The design goal is that there are no mixing zones in the storage tank. The storage system can heat and store large amounts of hot water for peak demand with a relatively low heat output.

From a drinking water hygiene point of view, the storage is evaluated as critical if a frequent water exchange cannot be guaranteed at the latest after 7 days in storage.

If several DHW storage tanks are required, the individual tanks should not be connected in parallel, but in series because of the effort required for hydraulic balancing.



GIV.19
Drinking water storage: Series and parallel connection

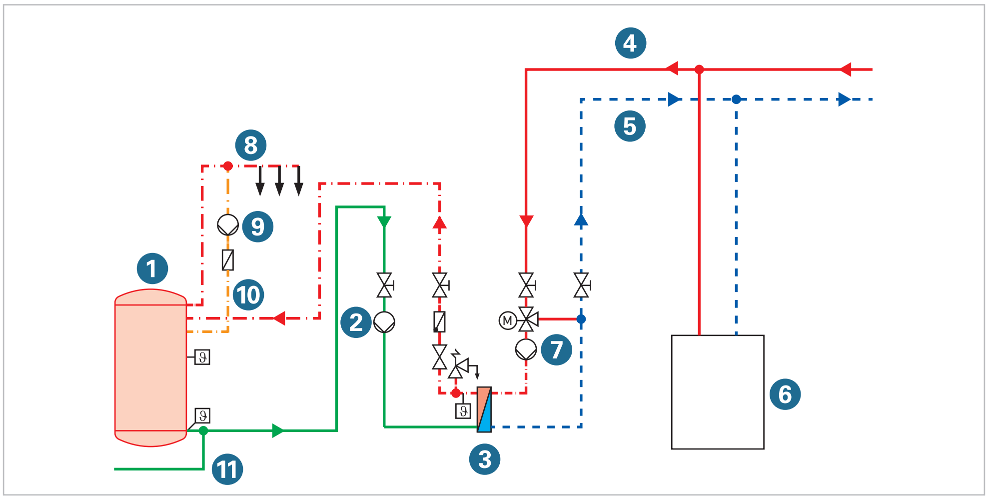
1. Series connection of storage tanks
2. Control valves for hydraulic balancing purposes
3. Parallel connection of storage tanks

Storage charging systems

In a storage charging system, the heat exchanger is located outside the storage tank. A storage charging pump is used to "charge" the storage tank from top to bottom and then heated.

Storage charging systems represent a combination of flow and storage DHW heaters. The 10-minute peak demand is usually covered by the storage tank and the continuous output of a performance-related plate heat exchanger.

From a drinking water hygiene point of view, when using storage charging systems, large quantities of heated drinking water can be provided even with small storage tanks.



GIV.20
Storage charge system

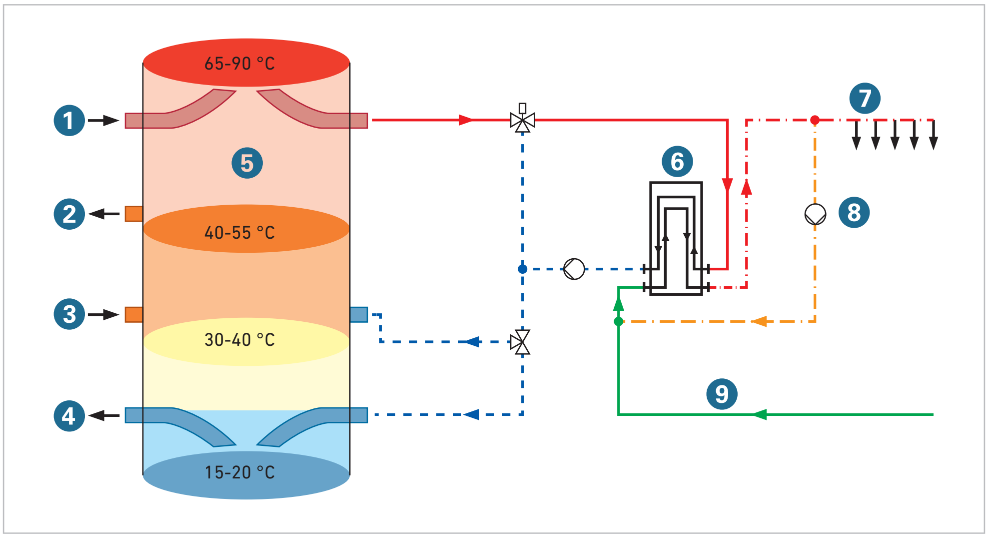
1. Storage DHW heater, outlet: ≥60°C
2. Storage charge pump
3. Heat exchanger
4. Heating supply line
5. Heating return line
6. Boiler
7. Heat exchanger charge pump
8. PWH: ≥60°C
9. Circulation pump
10. PWH-C: ≥55°C
11. PWC

H-SL Supply line
H-RL Return line

Flow DHW heaters / Fresh water stations

When flow systems, also referred to a **fresh water stations** are installed, no or only small amounts of drinking water are stored. The drinking water is heated to the required temperature (≥60°C) only when it flows through a heat exchanger. If the heat output is sufficient, the heat exchanger is powered directly by the heat generator. However, usually the heat output is supplied to the heat exchanger from a heater buffer with a charge pump.

Due to the lower water volumes, the flow DHW heaters are considered to be more hygienic than storage DHW heaters.



GIV.21
Flow DHW heaters / Fresh water stations

1. Boiler supply line
2. Boiler return line
3. Alternative heat, supply line
4. Alternative heat, return line
5. Buffer tank
6. Fresh water station
7. PWH: ≥60°C
8. PWH-C: ≥55°C
9. PWC: approx. 10°C

DHW heaters with high level of water exchange

An **exception** to the above-mentioned principles allows the use of regenerative heat generators for domestic water heating, such as air or water heat pumps, with lower storage outlet temperatures (but at least ≥50°C).

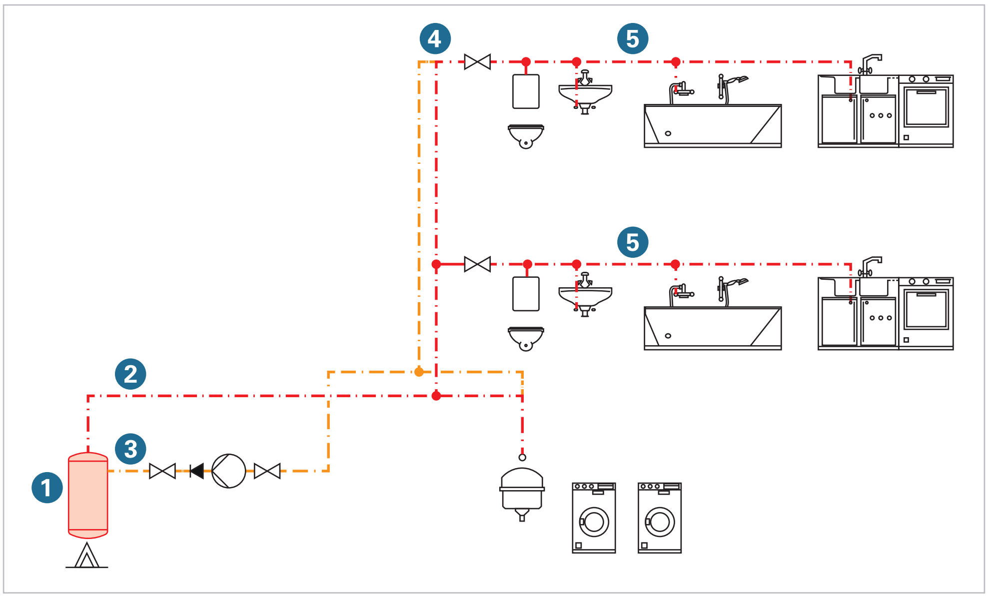
However, compliance with the following **requirements** is mandatory:

☑ The drinking water system must be planned and designed in such a way that the controller setting at the outlet of the DHW heater is ≥60°C and at the inlet of the circulation pipe ≥55°C are possible.

☑ A high water exchange must be guaranteed: Every 3 days, the volume in the storage and piping must be renewed.
- In consultation with the operating company, the DHW heater's temperature may then be set to ≥50°C.

☑ The operator must be informed during the briefing about the possible health risk caused by a Legionella contamination.

In single- and two-family dwellings or buildings with comparable use, it is quite realistic that a high water exchange within 3 days can respected.



GIV.22
Two-family dwelling with central DHW heater and high level of water exchange

1. DHW heater
2. PWH: permissible operating temperature: 50°C
3. PWH-C: ≥50°C
4. Connecting the PWH-C line to the PWH line of the circulation system
5. Pipelines on individual floor levels

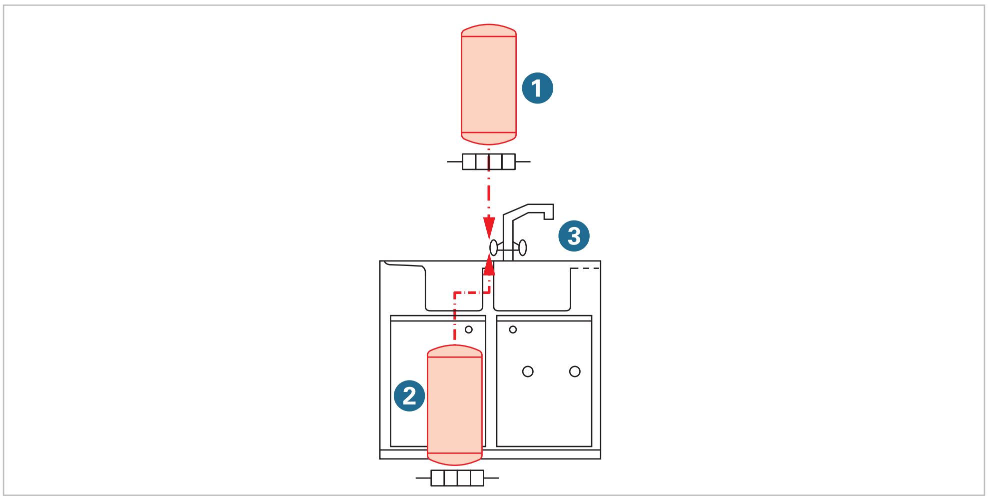
9.2 Decentralised DHW heaters

+ Decentralised DHW heaters are ideal where only small amounts of drinking water (warm) are needed. As a rule, heating is provided indirectly by a heating block integrated in the DHW heater, which directly heats the drinking water.

Storage and flow systems are available as open and closed versions and are used for single or group supply purposes.

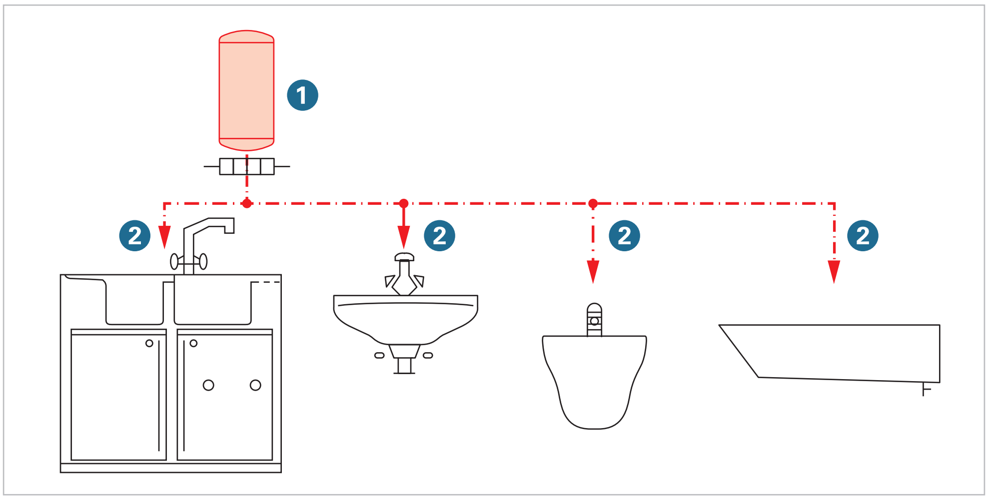
When using decentralised DHW heaters, the following **exceptions** to the above-mentioned principle with regard to the temperatures are permissible.

Individual supply line
The individual supply line includes cooking water appliances, open and closed under the counter or over the counter storage. These DHW heaters for single supply can be operated without temperature requirement.



GIV.23
Individual supply (without temperature requirement)
1. Above-counter storage tank
2. Below-counter storage tank
3. Kitchen sink

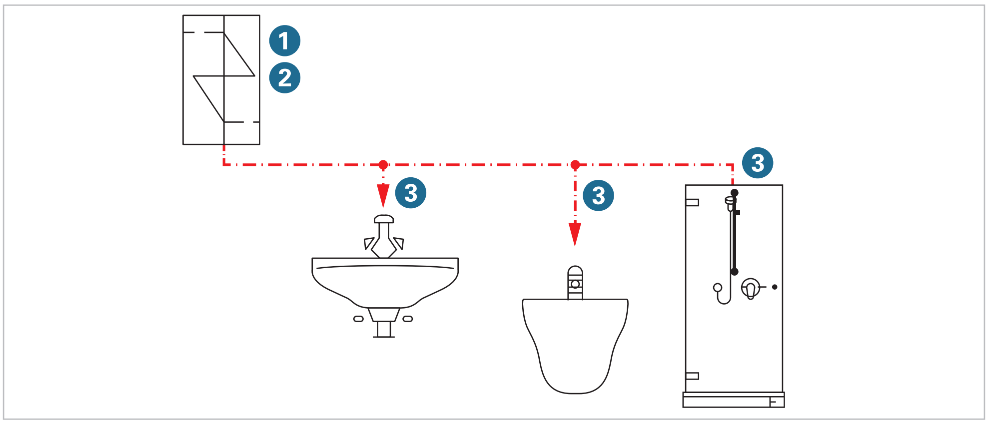
Group supply
If using a group supply, closed storage DHW heaters must be included. These heaters can be located within a flat and supply, for example, a bathroom, possibly with adjoining kitchen, or a shower room. When using this group supply, the outlet temperature of the DHW heater must be ≥50°C.



GIV.24
Group supply
1. Storage, electrically heated (≥50°C)
2. Taps

9.3 Flow DHW heater

Flow DHW heaters can be operated without further temperature requirement if the downstream pipeline volume of 3 litres in the longest flow path is not exceeded.

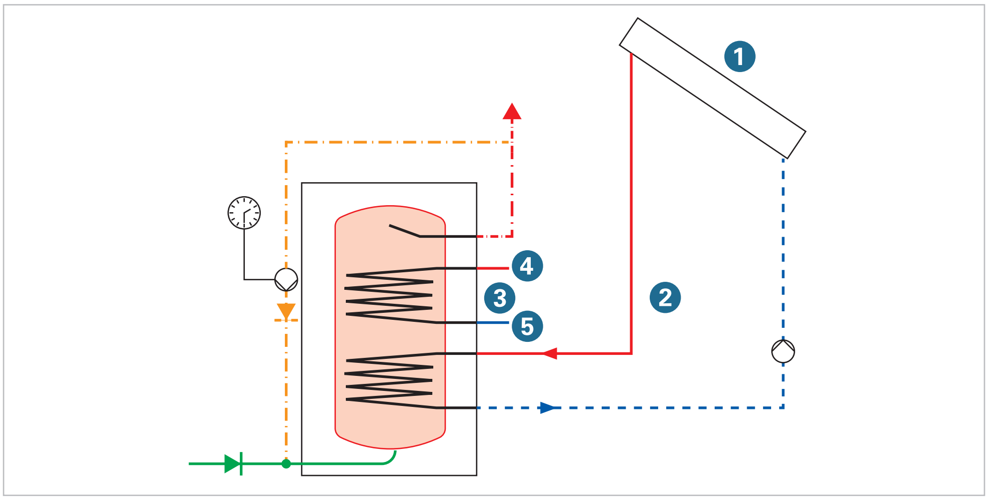


GIV.25
Flow DHW heater

1. Flow DHW heater
2. Pipeline volume max. 3 l
3. Taps

9.4 Preheating stages

All drinking water in a pre-heating stage or in a bivalent DHW heater must be heated once a day to ≥60°C without a specific time limit.



GIV.26
Bivalent drinking water storage tank with charge pump

1. Collector
2. Solar circuit
3. Heating circuit
4. Supply line
5. Return line

9.5 Heating buffer tanks

When using regenerative heat sources, the use of heater buffer tanks is recommended and available as an option. DHW heating based on alternative energies is possible with heat exchangers that receive the heat output from the heating buffer tank and, if necessary, are supported by a conventional heater (to achieve the required drinking water temperature of ≥60°C).

Principle
Here, the **basic principle** is to design the drinking water storage tank only for the drinking water requirement and not to use it as energy storage unit.

9.5.1 DHW heater with district heating supply system

When designing DHW heaters in combination with a district heating supply system, the following agreements must be made with the supplier with regard to compliance with hygienically correct hot water temperatures:

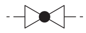
- Covering the peak demand according to the calculation basis
- Continuous temperature of drinking water (hot) of ≥60°C
- Covering the circulation requirement of ≥55°C
- Thermal disinfection option with temperatures of ≥70°C

10 Controls and instrument

10.1 Shut-off valves

+ A shut-off valve blocks a flow rate in a pipe. Normally, a shut-off valve is set to allow an unobstructed flow and is closed only before proceeding with maintenance or repair tasks.

GIV.27
Straight seat valve



Flow-optimised **split-flow or angle seat valves** should be installed as pipe line fittings. The pressure drop in these type of valves is very low. This prevents noise emissions, which may even occur at nominal flow.

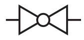
Straight seat valves shall only to be used for the storey shut-off areas.

☑ The gaskets on the shut-off cone must be suitable for both applications (cold and hot water).
☑ Shut-off valves are to be equipped with drain valves.

10.2 Maintenance fittings

Ball valves with one closing operation open/close and with 90 ° rotation are only permitted as maintenance fittings.

GIV.28
Ball valve

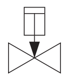


☑ The on/off rotation must be carried out slowly in order to avoid pressure surges.
☑ Ball valves are **not** suitable as taps.

10.3 Circulation control valves

+ Control valves operate the essential parameters of a piping system, e.g. pressure, flow, etc.

GIV.29
Mixing valve



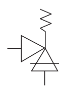
For the necessary hydraulic balancing in hot water circulation systems, either static or thermostatic circulation control valves must be installed at each connection of the circulation line to the hot water supply line.

☑ Static control valves must be manually adjusted at the valve's gate to the calculated K_v value.
☑ Thermostatic regulating valves usually need not be pre-set.

10.4 Safety valve

+ Safety valves are used to prevent dangerous operating conditions. These valves react to a state deviating from the nominal state or setpoint in the system, and restore the setpoint or set a system, e.g. to "malfunction".

GIV.30
Safety valve, spring-loaded



For example, **safety valves** or **pressure reducers** are used to prevent excessive pressure. Safety temperature limiters are installed in order to prevent an excessive temperature rise in central DHW heaters. For example, thermal safety valves are installed in solid fuel boilers in order to prevent excessive temperatures.

When temperatures exceed 95°C, the heat dissipation is initiated by draining hot water and running cold water by opening the thermal safety device until the temperature has dropped below the critical value.

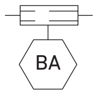
10.5 Safety devices

+ Safety devices are designed for the essential function of preventing adverse effects of the quality of the drinking water.

Safety devices are part of a safety device. This usually includes other controls and instruments, such as shut-off valves, strainers and drain valves.

☑ Safety devices must be used upstream of the taps, devices, equipment or machinery in accordance with their category and geodetic height difference in order to prevent backflow of contaminated water into the drinking water installation.

GIV.31
Backflow preventer with controlled medium pressure zone

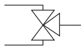


10.6 Mixing valves

+ Control valves are part of the mixing valve. and operate the essential parameters of a piping system, e.g. pressure, flow, etc. However, they also control the mixing tap on a bathtub or in a shower stall, where hot and cold water are mixed during the discharge.

Mixing valves can be used as a single fitting for cold water and hot water, as a two-handle mixer or as a single-lever mixer.

GIV.32
Three-way valve used as a mixing valve



10.7 Taps

+ Taps are used to withdraw the drinking water from the piping system. They are usually in the closed position. Normally, they are used in combination with sanitary fixtures and are installed for body care and personal hygiene purposes.

With regard to the flow calculations and the minimum flow pressures, the taps have a major influence on the dimensioning of the pipe diameters and, therefore, their selection must be taken into account accordingly.

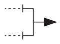
Tap aerators and flow restrictors are part of the valve and influence the volume flow of the withdrawn water, the flow pressure and the noise behaviour.

Taps should be "intrinsically safe" in order to protect the drinking water, that is to say, they must be equipped with safety devices against backflow.

☑ Taps must be attached to the connection point with cleanliness and proper hygiene in mind.
☑ If the taps for cold and hot drinking water are installed side by side or one above the other, the connection for the hot drinking water must be installed to the left or above the cold water tap.
☑ The hot water tap shall be identified with a **red** mark and the cold water tap shall be identified with a **blue** mark.
☑ Except for bathtub and shower fittings, shut-off valves must be installed upstream of the taps.

Another principle states that there must be a drainage unit under each tap. Washing machines and dishwasher as well as fire extinguishing equipment are exclude from this principle.

GIV.33
Wall-mounted mixing valve



Hoses for connections to controls and instruments

Hoses for controls and instruments are part of the tap. For hygienic reasons, the hose length is limited to a maximum of 2.00 m and couplings are not permitted to extend the hose.

☑ Because the connecting hoses for controls and instruments have a theoretical service life of 20 years, they must be replaced when the taps are exchanged and inspected regularly for their condition and leaks.
☑ When connecting washing machines and dishwashers, only hose sets in which the screwed connections are firmly attached to the hoses at the factory must be used.

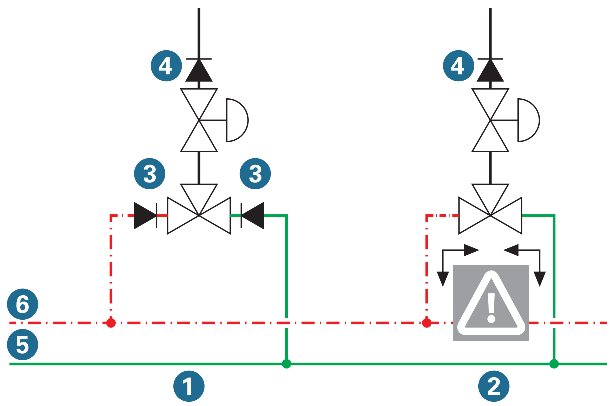
IV

10.8 Thermostats

+ Control valves, such as the thermostatic mixer tap on a bathtub or shower mixes hot and cold water at the time of withdrawal according to an adjustable value.

☑ In order to prevent overflows in self-closing mixing valves or thermostatic valves, **Return flow inhibitor** must be installed in the cold and hot water connection of the equipment.

☑ When planning and dimensioning the pipelines, it must also be ensured that the pressure conditions in the cold and hot water systems are approximately the same. The integration of a Return flow inhibitor into the cold and hot water connection is correct.



GIV.34
Prevention of incorrect flow direction in the cold and hot water connection

1. correct
2. wrong
3. Return flow inhibitor, prevents overflow
4. Return flow inhibitor, prevents backflow
5. Cold water connection
6. Hot water connection

☑ If central thermostatic mixers must be installed for central DHW heating then, the mixing temperature at the outlet from the valve must be set so that a temperature is at least 55°C at all subsequent taps for drinking water hygiene reasons.

10.9 Sampling points

In order to verify a perfect drinking water quality, sampling valves must be integrated into the drinking water installation. The sampling points are located at the outlet of the DHW heater, at the entrance of the circulation in the DHW heater and at least one representative sampling point in the periphery.

☑ For larger drinking water installations, several sampling points must be provided corresponding to the size of the system.

11 Pipelines

Distributing drinking water effectively in a house is a demanding discipline. Today, various pipe systems made of metal, plastic or multilayer composite pipes in coils or with pre-cut pipes 5 m long, for example, can be used to design a piping installation. Here, it is irrelevant whether the pipe-in-pipe system or the traditional installation method is used, provided that the required rules are observed.

11.1 Storage and transport

The correct handling of pipelines begins before the actual assembly: during transport to the construction site and during storage of the pipes before further processing.

☑ In general, the **on-site installer** is responsible for the careful storage, proper installation, and proper provisioning until putting the pipeline into operation.

☑ All parts of a piping system, such as pipes, fittings, controls and instruments, devices and equipment must be protected and carefully handled, transported, stored and, in particular, protected against dirt during installation.

In addition to the hygiene aspects, there may be special requirements for storage and transport for certain materials.

☑ For example **plastic materials** must be shielded against the influence of ultraviolet radiation and protected against excessive temperatures.

11.2 The basics

+ It is recommended to separate all parts of a building's structure and construction-relevant installation. Here, the in-wall installation method is preferred.

Pipelines must be installed expertly, and compliance with the following requirements is mandatory:

☑ All pipe and jointing materials must ensure the safe, hygienic and economical use throughout the service life of the building.

☑ The components used must comply with the recognised rules of technology. The basis for this compliance can be standards, approvals or a manufacturer's declarations.

Identification

Pipelines of various supply systems in a building are colour-coded, using a tape or label identifying the media being conveyed.
The following abbreviations can also be used for the graphic representation:

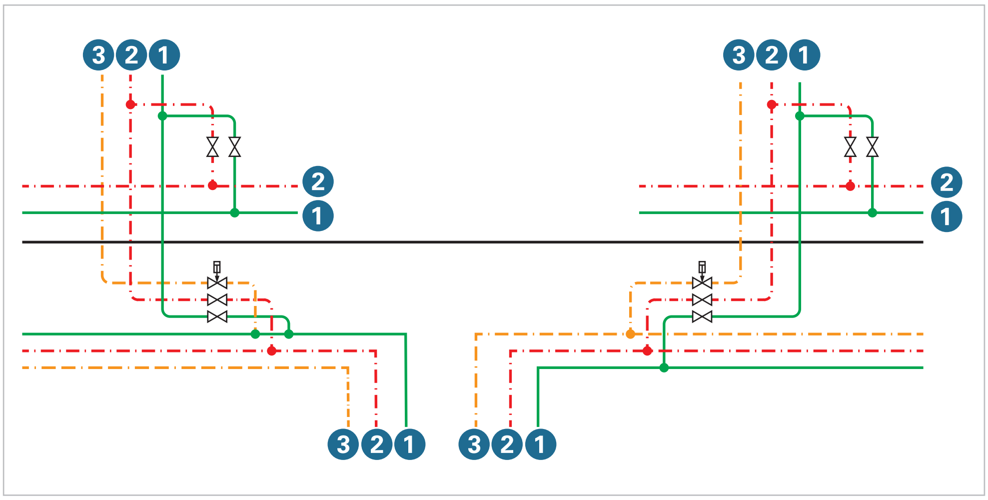
TIV.12
Labelling of pipelines

Designation	Abbreviations	Colour of the pipeline	
Drinking water pipelines, cold	PWC	Green	——●——
Drinking water pipes, hot	PWH	Red	-·-·-●-·-·-
Drinking water pipeline, Hot water circulation	PWH-C	Orange	-·-·-●-·-·-
Drinking water pipeline, Hot water, mixed water	PWH-M	Purple	-··-●-··-
Heating, supply line	H-SL	Red	——●——
Heating, return line	H-RL	Blue	- - - -●- - - -

IV

Arrangement of the distribution lines for cold and hot water

When running several pipelines parallel to each other, they must be installed in the direction of flow as explained below, so that incorrect connections are avoided.



GIV.35
Arrangement of cold, hot and circulation pipelines, running parallel to each other

1. Cold water supply line (right)
2. Hot water line (centre)
3. Circulation pipeline (left)

If, for structural reasons, cold and hot water pipes are installed **on top of one another**, the hot water pipes must always be positioned **on top**. This method prevents that the cold water pipes are heated due to convection, which is not permitted.

Hot and cold water taps that are used infrequently must not be connected to the end of a long pipe. This ensures the exchange of water in this flow path with taps to another, more frequently used tap.

11.3 Design of an installation on an individual floor level

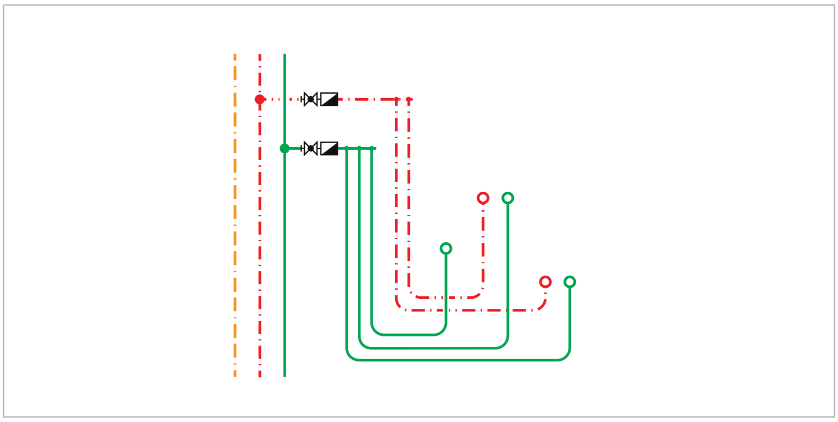
An optimal distribution of drinking water on individual storeys is made possible by applying different installation procedures: Single line, serial line, tee installation as well as vertically installed main pipes with offset in connection with the applicable, system-specific fittings.

11.3.1 Installation Method – Overview

The application of a certain type of installation is intended above all to ensure the frequent exchange of water, in particular in individual supply lines or pipelines on individual floor levels.

Individual pipeline

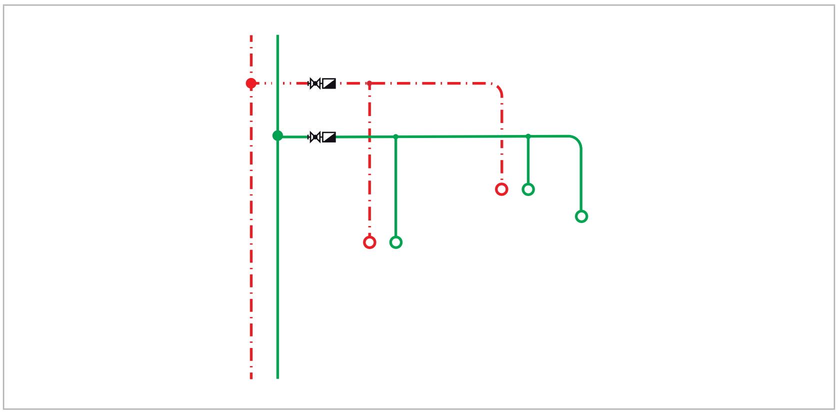
- Easy planning
- Easiest pressure loss determination and dimensioning
- Single supply of the tap with separate line
- Low pressure losses
- Economic discharge times and high comfort
- Connections to single fittings
- The replacement of the medium pipe by using the pipe-in-pipe system is possible and easy to do
- No joints in the floor structure



Tee installation

These types of installation are suitable if the use of regular water exchange takes place, e.g. in residential buildings or hotels.

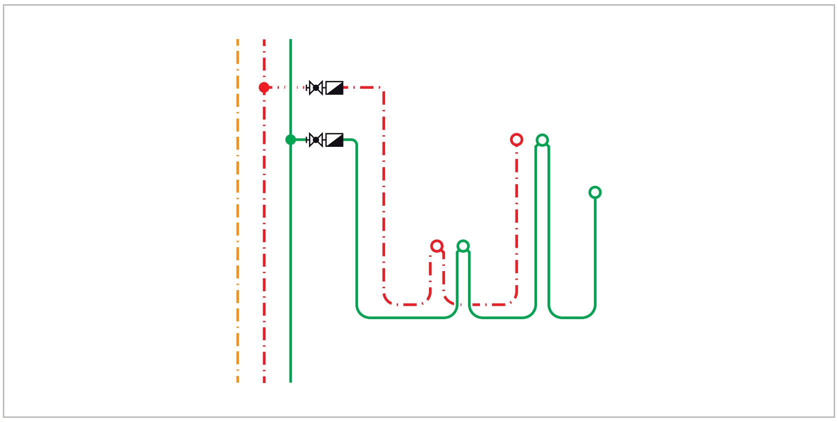
- Supplying several taps with a single pipe
- Small space requirement for pipe installation
- When refurbishing installation in existing slots
- Fittings in welding and/or clamping design
- Connections to single fittings
- Reduced pipe usage



Pipeline in series

In buildings with special use, e.g. hospitals, senior residences and comparable types of buildings, or where a frequent water exchange cannot be ensured, for example outside taps, these types of installation should be selected.

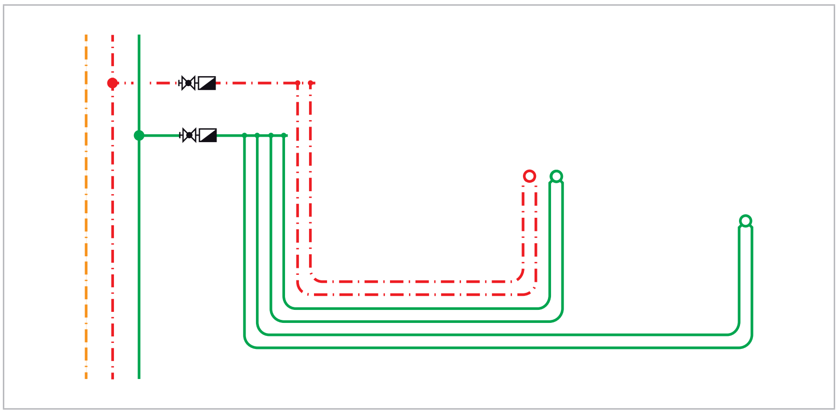
- Supplying several taps with a single pipe
- Reduced pipe usage
- Connections to single and dual fittings



Pipeline routing for large taps

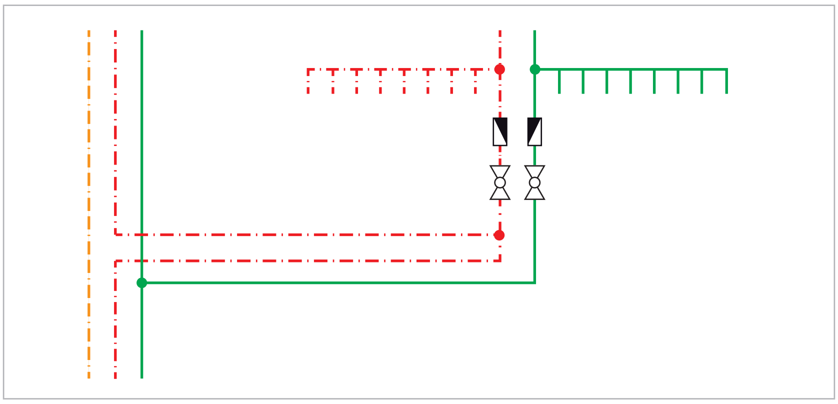
Taps with a volumetric flow rate of VR >0.4 L/s can be connected with a parallel installed supply line with a d16. The parallel running supply line (2 × d16) has approx. 20% lower pressure losses compared to the single line with the next highest dimension (d20).

Therefore, the parallel line is advantageous wherever only low supply pressures are available.



Vertically installed main pipes with offset

- Possibility of legionella-safe operation
- High comfort
- Hot water up to immediately upstream of the tap

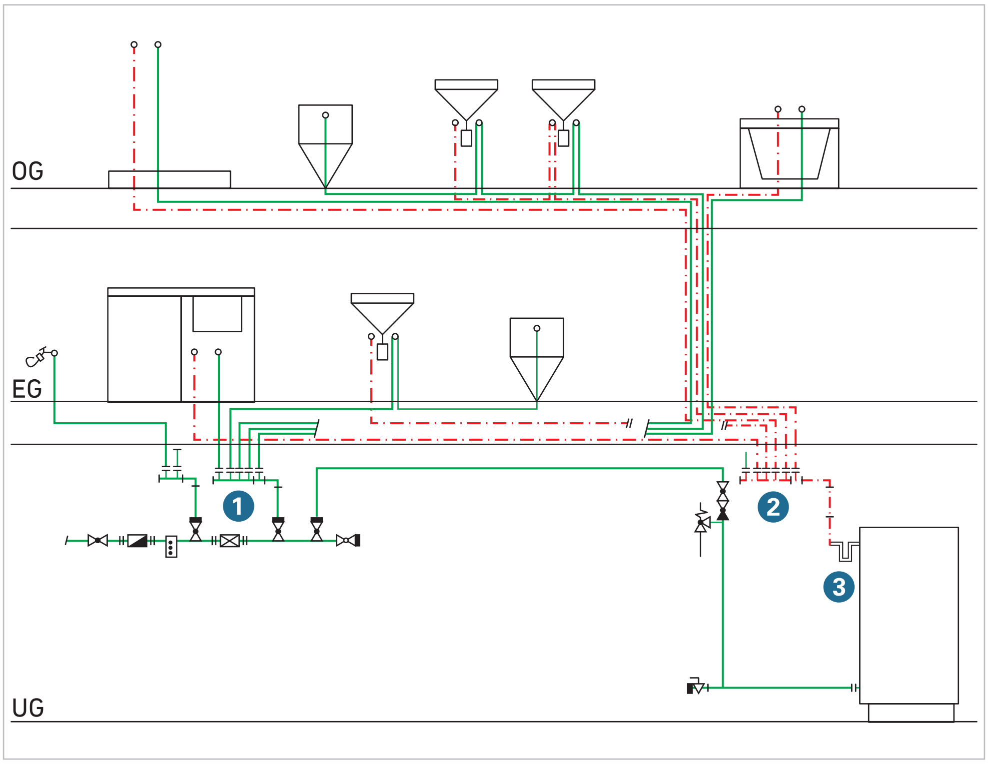


11.3.2 Design of the distributors on each floor

In **single and two-family dwellings** it is advantageous to use a pipe-in-pipe system and install the distributor in the basement. The hot water distributor should be placed as close as possible to the drinking water (DHW) heater. The shorter the connecting pipes between the distributor and the DHW, the shorter the discharge time of the cooled stagnation water. This reduces water and heat losses.

Multi-family dwellings or similar buildings with distributors within the dwellings or premises, the hot water is usually supplied from central location. We therefore recommend placing the distributors as close to the consumer as possible. The hot water circulation can also be installed close to the consumers.

The installation of branch lines from the distributor to the consumer must be kept as short as possible. This shortens the discharge times and reduces water and heat losses.



GIV.36
Distributor on individual storeys

1 Cold water distributor
2 Hot water distributor
3 Thermo siphon
EG Ground floor
UG First floor
OG First floor

11.4 Cold water distribution

+ In order to keep the chilled water cold and to be able to comply with the requirement of 25 °C, the cold water pipes must not be installed next to hot pipes in a shaft or pipe duct if possible.

Supply line to an external tap

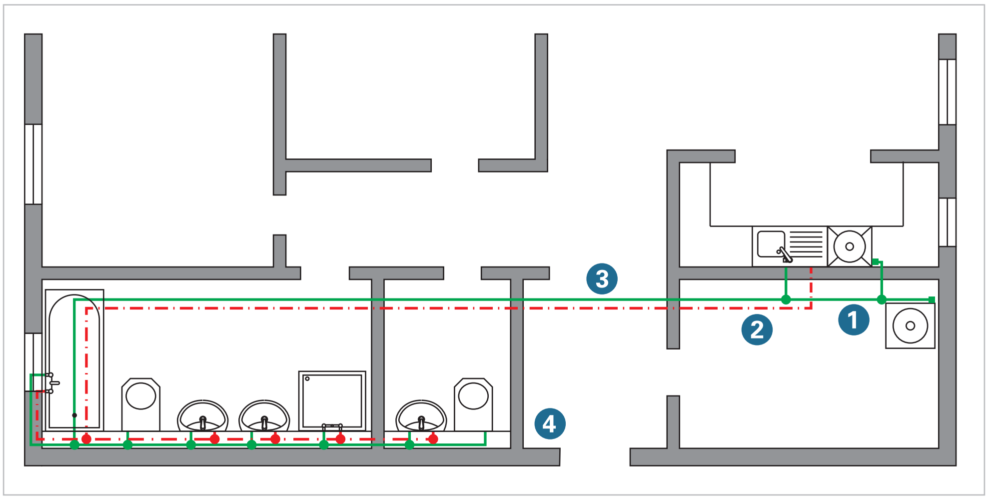
Cold water single connection lines, in particular those that are rarely used (such as an outside tap), should be as short as possible. In this case, the upper limit of the water volume shall not exceed 3 litres.
Longer individual connection lines must be connected via a series or ring line, which supplies a downstream, frequently used discharge point.

Rarely used pipelines – Risk of frost

Pipelines that are used only occasionally or rarely or that are exposed to a risk of frost must be equipped with a shut-off valve and a drain directly at the connection to a regular flow-through consumption line.
For example, such pipelines may lead to unheated adjoining rooms, gardens or supply pipelines in areas located outside of the building.

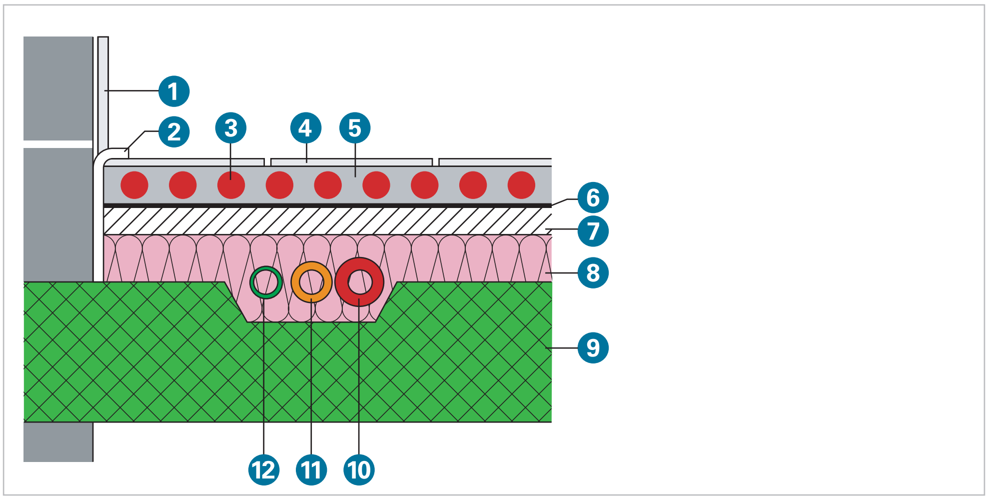
Pipelines in the floor structure

Pipelines on individual storeys and single connection lines can also be installed in the floor structure (with an insulation layer thickness of 13 mm). These pipes may be run next to warm circulating pipelines, e.g. in under-the-floor heating systems. However, this implies that after opening a tap completely, the cold water temperature must not exceed 25 °C within 30 seconds.



GIV.37
Floor plan of a flat with cold water pipe in the floor structure and underfloor heating

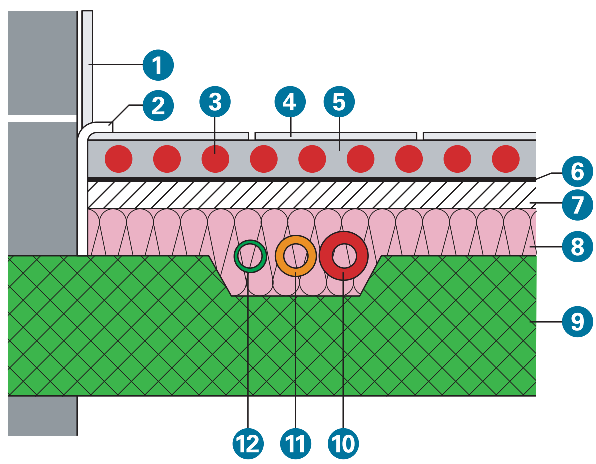
1. Cold water supply line (PWC)
2. Hot water line (PWH)
3. Pipelines in the floor structure
4. Pipelines integrated into in-wall installations



GIV.38
Floor structure

1. Wall tiles
2. Insulation strip along edge
3. Floor heating pipes
4. Top floor covering
5. Floating screed
6. Screed foil
7. Heat and impact sound insulation
8. Levelling layer, up to the top of piping
9. Concrete ceiling
10. Hot water line (PWH)
11. Circulation (PWH-C)
12. Cold water supply line (PWC)

IV

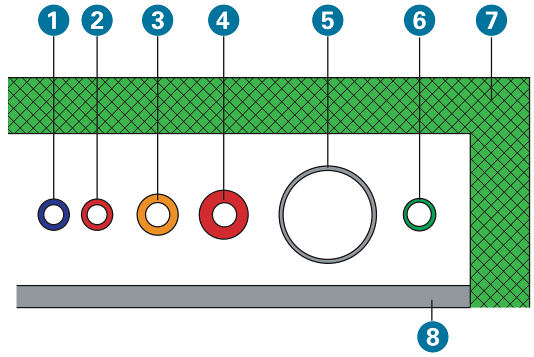


GIV.39
Floor structure
1. Wall tiles
2. Insulation strip along edge
3. Floor heating pipes
4. Top floor covering
5. Floating screed
6. Screed foil
7. Heat and impact sound insulation
8. Levelling layer, up to the top of piping
9. Concrete ceiling
10. Hot water line (PWH)
11. Circulation (PWH-C)
12. Cold water supply line (PWC)

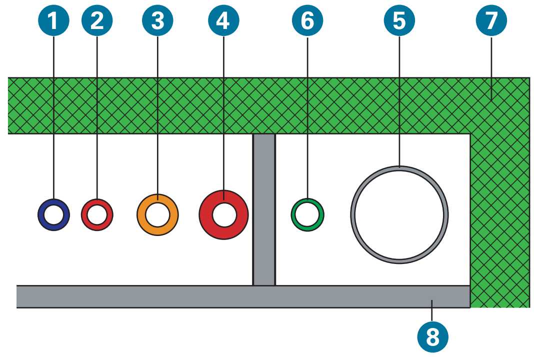
Lines in the shaft

Installation shafts for drinking water pipes (cold) must be planned and laid out in such a way that a drinking water temperature of 25 °C is not exceeded if possible.

Drinking water pipes (cold) must be designed and constructed in such a way that they are thermally decoupled from hot pipes.



GIV.40
Lines in the shaft
1. Heating, return line
2. Heating, supply line
3. Circulation (PWH-C)
4. Hot water line (PWH)
5. Waste water / Sewage
6. Cold water supply line (PWC)
7. Wall (concrete)
8. Wall (masonry)



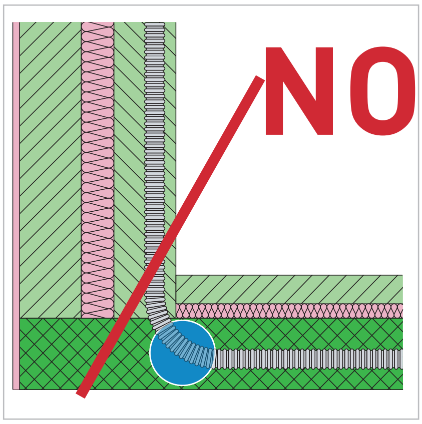
GIV.41
Lines in the shaft
1. Heating, return line
2. Heating, supply line
3. Circulation (PWH-C)
4. Hot water line (PWH)
5. Waste water / Sewage
6. Cold water supply line (PWC)
7. Wall (concrete)
8. Wall (masonry)

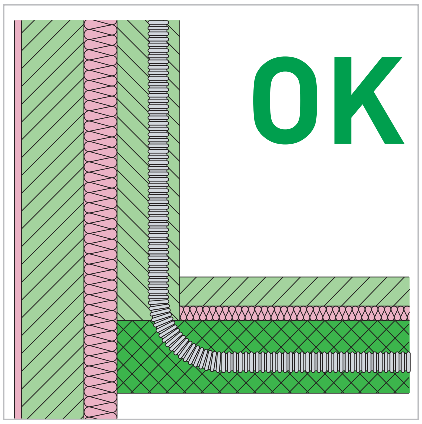
11.5 Frost resistance pipeline design

An important principle of frost-proof installation in sanitary facilities of heated buildings is the placement of the pipelines in areas of the building construction where the temperatures are always expected to exceed 0°C. Non-compliance with this principle, even only partially, there is a risk of the pipes freezing due to water stagnation.

In some areas of the construction, e.g. edge zones of basement ceilings, garages, driveways, etc., temperatures below 0°C are most likely. Here, the appropriately designed installation of the pipelines in the frost-free area of the construction of a building will prevent the risk of freezing.

Wrong	Correct
• Wrong solution from an installation point of view	• Correct installation solution
The inserted pipeline is frost-prone due to the cold bridge.	The pipeline is installed in the warm area.





TIV.13
Frost resistance pipeline design
NO wrong
OK correct

Emptying pipelines

☑ Installations subject to the risk of freezing must be emptied well ahead of time if the temperatures are expected to drop below 0°C.

If pipes are **threatened by frost**, the affected pipes can be installed as a single, full-length supply line with **reversed gradient** to the discharge fitting or to the pipe connection, which makes possible to empty the pipe.

In order to clean the**dead ends of a pipe** compressed air can be used to blow them out or suction may be used to empty them.

11.6 Hot water distribution

+ The hot water supply inside a building includes the DHW heaters and the distribution via a piping system as well as the taps, including any necessary circulation pipes.

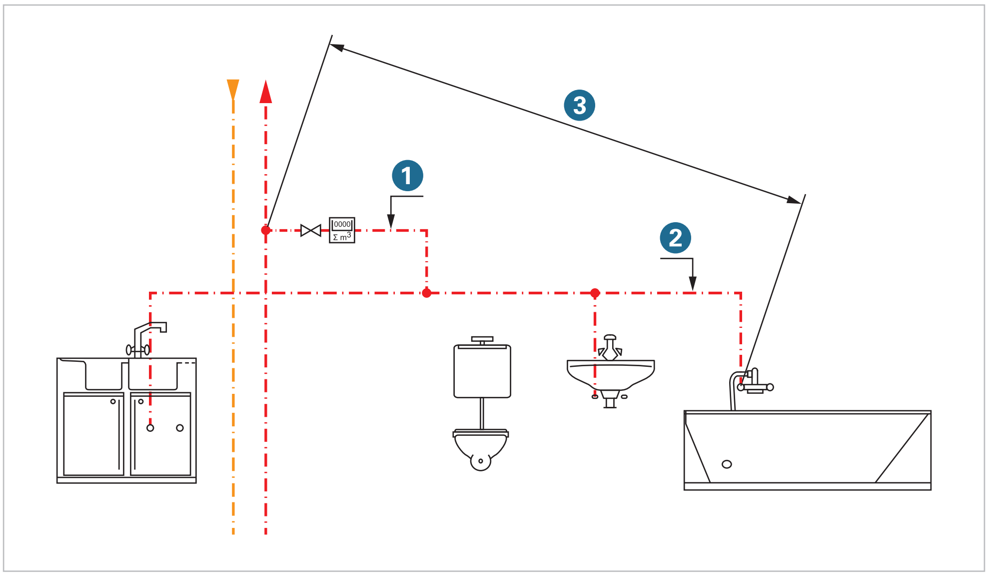
Compliance with a series of basic rules for the distribution of hot water inside a building is mandatory.

Outlet temperature and temperature drop

For hygienic reasons, the outlet temperature at the storage tank must be 60°C for central DHW heaters with circulation. In drinking water installations, the temperature drop within the circulating system must not exceed 5 K.
An exception to this principle applies only to DHW heaters with high level of water exchange. Here, the discharge temperature must be at least 50°C.
If the volume of a pipe exceeds 3 litres, circulation pipes or self-regulating heating cables must be installed and the temperature must be kept at a minimum of 55°C.

Storey and individual connection lines

Pipelines on individual storeys and single connection pipes, in which the water volume in each flow path exceeds 3 litres, must be integrated into a **circulation circuit**.



GIV.42
3-litre rule for pipelines on individual storeys and single connection lines

1. Pipelines on individual floor levels
2. Individual supply line
3. Longest flow path at the floor level: Water volume <3 litres

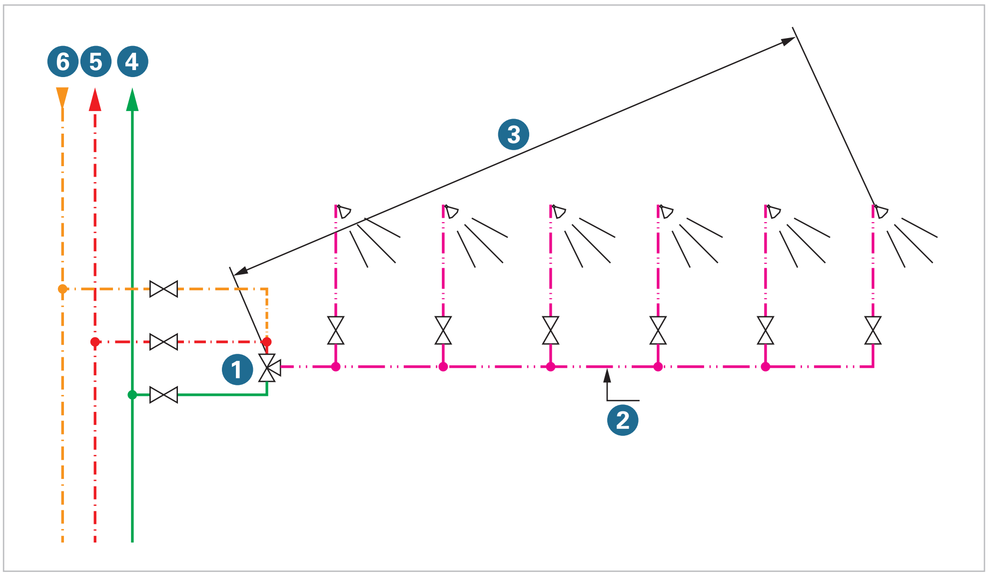
Circulation pipes and water meters inside the flat
Circulation pipes must not be installed downstream of **water meters inside the flat.**

Components that dissipate heat as intended (such as **towel dryers**) must **not** be used in hot water or circulation pipelines.

Rows of shower stalls and thermostatic mixing valves

If central **thermostatic mixing fittings**, such as a row of shower stalls used in public swimming pools are installed, the circulation line must be led immediately to the mixing valve.
The mixed water pipe from the thermostatic mixing valve to the farthest shower stall fitting or overhead shower must not contain more than 3 litres of water.

If, for example, the water volume of 3 litres, is exceeded in a row of shower stalls, either single thermostats are provided at each shower or the row of showers is to be supplied with two group thermostats from both sides.



GIV.43
Thermostatic mixing valve in a row of shower stalls

1. Group thermostat
2. Mixed water 39 °C
3. Water volume in the longest flow path: <3 l
4. Cold water (PWC)
5. Hot water (PWH)
6. Circulation (PWH-C)

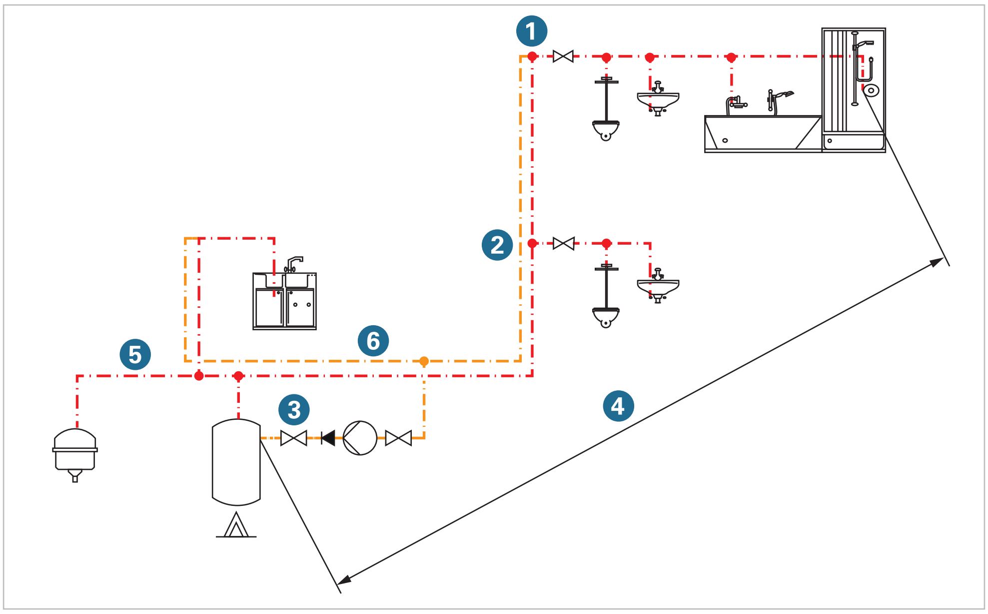
11.7 Circulation systems

A circulation system is the part of a pipeline in which the hot water circulates in the hot water pipes (PWH), is circulated through the circulation pipes (PWH-C) and kept at a certain temperature.

The circulation system begins at the outlet of the DHW heater's hot water pipe and leads through the connection point until it re-enters the DHW heater.

Using circulation systems

If the longest flow path of the hot water pipe between the outlet of the DHW heater and the farthest tap contains more than 3 litres of water, circulation systems must be installed to ensure the regular replacement of the water.
This requirement applies to all drinking water installations even in buildings with high water exchange, e.g. in a single-family dwelling.



GIV.44
Single family dwelling with a water volume of>3 litres in the longest flow path

1. Connecting points of the circulation line
2. Circulation system
3. Re-entry of the circulation
4. Water volume in the longest flow path >3 l

Temperatures in system

The temperature of the drinking water must not drop 5 K below the discharge temperature of 60 °C at the DHW heater and at all points in the hot water and circulation pipes. Consequently, the circulation lines and pumps must be sized in order to ensure that the temperatures never drop below 55 °C within the circulating hot water system. In this case, static or thermostatic **circulation regulating valves** must be installed to produce the hydraulic balancing.

Gravity circulations are not permitted because they cannot meet the temperature requirements.

Circulation pumps may be disconnected for a maximum of 8 hours within a period of 24 hours, but only if hygienically perfect conditions exist.

Hygienically perfect conditions exist under the following conditions:
- The system is planned, built and operated according to the current recognised rules of technology.
- Regular microbiological tests with water samples must be verified.

12 Dimensioning

The **pipe diameter calculation** aims to achieve the required minimum flow and minimum flow pressure at all available drinking water taps (cold and hot) with the available **minimum supply pressure**. Thus, the serviceability is ensured, taking into account a defined simultaneous use. If compliance with the intended use is met, the design principles ensure the safe use and long-term functionality.

Simplified calculation method
A **simplified calculation method** can be used for smaller drinking water installations where frequent water exchange takes place due to the use and where common taps are available. Residential buildings with up to six flats or other buildings in which comparable use takes place usually fulfil these requirements. The simplified calculation method can be performed "manually" with a selection of table values.

Differentiated calculation method
A **differentiated calculation method** can be applied to all drinking water installations in single- and two-family dwellings, residential buildings, hotels, retirement homes, hospitals, schools, administrative buildings and the like, as well as commercial and industrial buildings. Although the differentiated calculation method can also be carried out "manually", however, it is very time-consuming. Needless to say, a calculation software is more useful for the practical and economic application.

12.1 Simplified calculation method

✚ **In order to calculate the nominal pipe sizes for standard installations, the simplified method can be applied on-site, using simple table values.**

The **standard installations** apply to smaller residential buildings with up to six flats, or buildings of similar design. A **frequent or regular water exchange** in smaller drinking water installations is to be expected and assumed in this type of building.

In particular, it is important that **taps** in conjunction with furnishings such as vanity units, bidets, toilets, shower and bathtubs, kitchen sinks or household washing machines or dishwashers are connected. Because for these types of taps and buildings, in which a similar use is expected, the table values have been identified and determined. In order to proceed with the simplified calculation – apart from the **calculation flows** – the **minimum flow pressures** of the taps are also important.

The hygiene requirements for drinking water are ensured if proper operation is possible at the point of use and the functionality is guaranteed with regular maintenance.

✚ **One of the most important requirements for using the simplified calculation method is that the minimum supply pressure downstream of the residential water meter is sufficient in order to ensure the minimum flow pressure at the most unfavourably tap location.**

Based on experience, this requirement can be met if the computational proof has been carried out and a **pipe friction gradient** of at least 10 hPa/m is available in the least favourable flow path.

However, if this value drops below 10 hPa/m or if other types of buildings and uses exist, these are to be regarded as "special installations". In this scenario, the nominal pipe sizes must be determined using the differentiated calculation method.

12.1.1 Design fundamentals and procedures

§ **The calculations must be made so that the results can be verified for plausibility.**

Before a simplified calculation is carried out, the following information must be available:

- The **maximum** and the **minimum supply pressure** are known.
- The assumed **pressure loss** for a house service connection and residential water meter is 850 hPa.
- The pressure loss due to the **geodetic height difference** was determined.
- The **minimum flow pressures** of the taps are defined.

The following aspects must be considered during the calculation:

☑ The type and operating mode of the DHW heating must be specified.
☑ Thermostatic mixing valves must be considered separately since higher pressure losses must be taken into consideration.
☑ Low-pressure devices, DHW heaters, water treatment systems, filters, water meters must be provided for the installation.
☑ The running time of the taps must not be “excessively long” (≥15-minute continuous discharge).
☑ A piping schematic must be generated for the dinking water installation.

Procedure

1. Check the ratio of peak volume flow to total flow using the tables (➨ Chapter [12.1.2] 'Tables for the simplified calculation') and the diagram (➨ [GIV.49]) for the simplified calculation.
2. Use the table to determine loading units.
3. Select the nominal pipe sizes according to the table for the applicable product and the respective material (e.g. PB pipes).
4. Defining the circulation pipelines.
5. After completing the calculation, the determined nominal pipe diameters must be entered into the piping schematic.

Results in the room data booklet
These specifications are best recorded in writing in a **room data booklet** by the client and the later operator.

12.1.2 Tables for the simplified calculation

Listed below are the **Standard Values** tables that are needed for the simplified piping calculation procedure.

Loading units for controls and instruments and equipment

TIV.14
Flows, minimum flow rates, loading units LU for taps

Tap	Flow rate Q_A [l/s]	Minimum flow rate Q_{min} [l/s]	Loading units LU
Vanity unit, wash-hand basin, bidet, cistern	0.1	0.1	1
Household kitchen sink, washing machine*, dishwasher, sink, shower head	0.2	0.15	2
Urinal flush valve	0.3	0.15	3
Bathtub drain	0.4	0.3	4
Tap for the garden or garage	0.5	0.4	5
Commercial kitchen sink DN20, commercial bathtub drainage	0.8	0.8	8
Flush valve DN20	1.5	1.0	15

* for commercial washing machines according to the manufacturer

Loading unit for pipelines

Loading unit for pipes
The loading unit for pipes are material-specific. Here, the values for polybutene (PB) are named as example. More loading unit are mentioned in the chapters for the respective systems.

➨ Part V 'Build', Sections about the systems

TIV.15 **Loading units LU, as an example for PB pipes**

Number of loading units LU (max.)	3	4	5	8	25	55	180	500	1100
largest single load value LU	–	–	4	5	8	–	–	–	–
Pipe ∅ $d_a \times s$		16 × 2.2		20 × 2.8	25 × 2.3	32 × 2.9	40 × 3.7	50 × 4.6	63 × 5.8
Pipe∅ d_i		11.6		14.4	20.4	26.2	32.6	40.8	51.4
max. pipe length [m]	9	5	4	–	–	–	–	–	–
Pipe volume [l/m]		0.10		0.16	0.33	0.53	0.83	1.31	2.07
Controls and instruments		½"		½"	¾"	1"	1¼"	1½"	2"

Calculation of the circulation lines

+ Circulation systems must be installed if the longest flow path between the outlet at the DHW heater and the farthest tap has a pipe volume of more than 3 litres.

The following applies to the circulation pumps:
Within 24 hours they may be disconnected within a maximum of 8 hours, but generally only if hygienic conditions exist. These are essentially defined by two requirements:

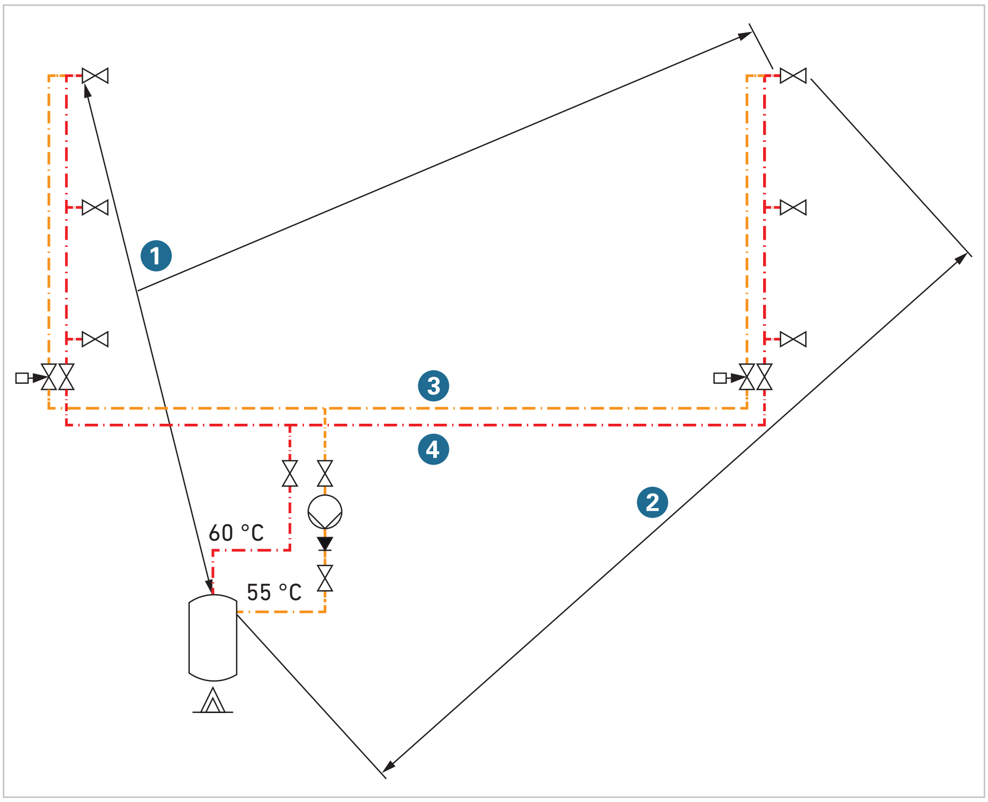
☑ The system was planned, built and operated according to the recognised rules of technology.
☑ Regular microbiological tests with water samples must be verified.

In the simplified calculation method, compliance with the following values is mandatory in order to ensure the functionality of circulation pipes:

- Requirements for the circulation pump
  - Nominal width: DN15
  - Flow rate: at least 200 l/h at 100 hPa
- Return flow inhibitor downstream of the circulation pump
  - Pressure loss: maximal 30 hPa
- Circulation pipelines
  - Nominal diameter: all DN12 or d16 × 2.2
- Longest flow path of the circulation line PWH-C: <20 m
- Circulating hot water lines PWH
  - Length of all flow paths: 20 m without circulation pipelines PWH-C

Hydraulic balancing

☑ Static or thermal circulation valves must be installed at the branches or riser pipes of the circulation lines.



GIV.45
Hot water/circulation pipelines: Length of flow paths

1. Length of all drinking water pipes connected to the circulation system, hot (PWH): <30 m
2. longest flow path of the circulation line (PWH-C): <20 m
3. Circulation (PWH-C)
4. Drinking water pipes, hot (PWH)

12.1.3 Sample calculation

In the following example, a typical drinking water installation was selected for the simplified calculation procedure: A residential building with six flats, each with a bathroom, a guest toilet with shower and a kitchen.

- There is a laundry room with washing machines and a sink in the basement. An outside tap for garden irrigation is available.
- For the hot water supply, a central drinking water heater is installed in a basement room. In order to maintain the temperature, a circulation line is required.
- A lower distribution with riser pipes and a Tee piece installation for the individual floor level is planned.
- A plastic pipe installation system (here: PB) was chosen for the cold, hot and circulation pipes.

The necessary **calculation tables** are used based on DIN EN 806-3. The calculation of the circulation pipes is based on the comments on DIN EN 806-3. The **forms** required for the calculation are based on the sample forms from the commentary.

Additional basics for the calculation example

- The minimum supply pressure is 4,000 hPa (4 bar).
- The assumed pressure loss for a house service connection and residential water meter is 850 hPa.
- The geodetic height difference from the entrance of the service connection to the building up to the highest point is 8.5 m.
  - This corresponds to a pressure loss of 850 hPa.
- Taps with a minimum flow pressure of 800 hPa
- Central drinking water storage tank with zero pressure loss
- A circulation is required if the water volume in the longest flow path of the hot water pipe is ≥3 litres.
- The longest flow path of the circulation pipe is 17.5 m. Thus, the maximum length of 20 m is maintained.
- The length of all hot water pipes connected to the circulation is 29 m. Thus, the maximum length of 30 m is maintained.

The **calculation example** has been divided into the following steps:

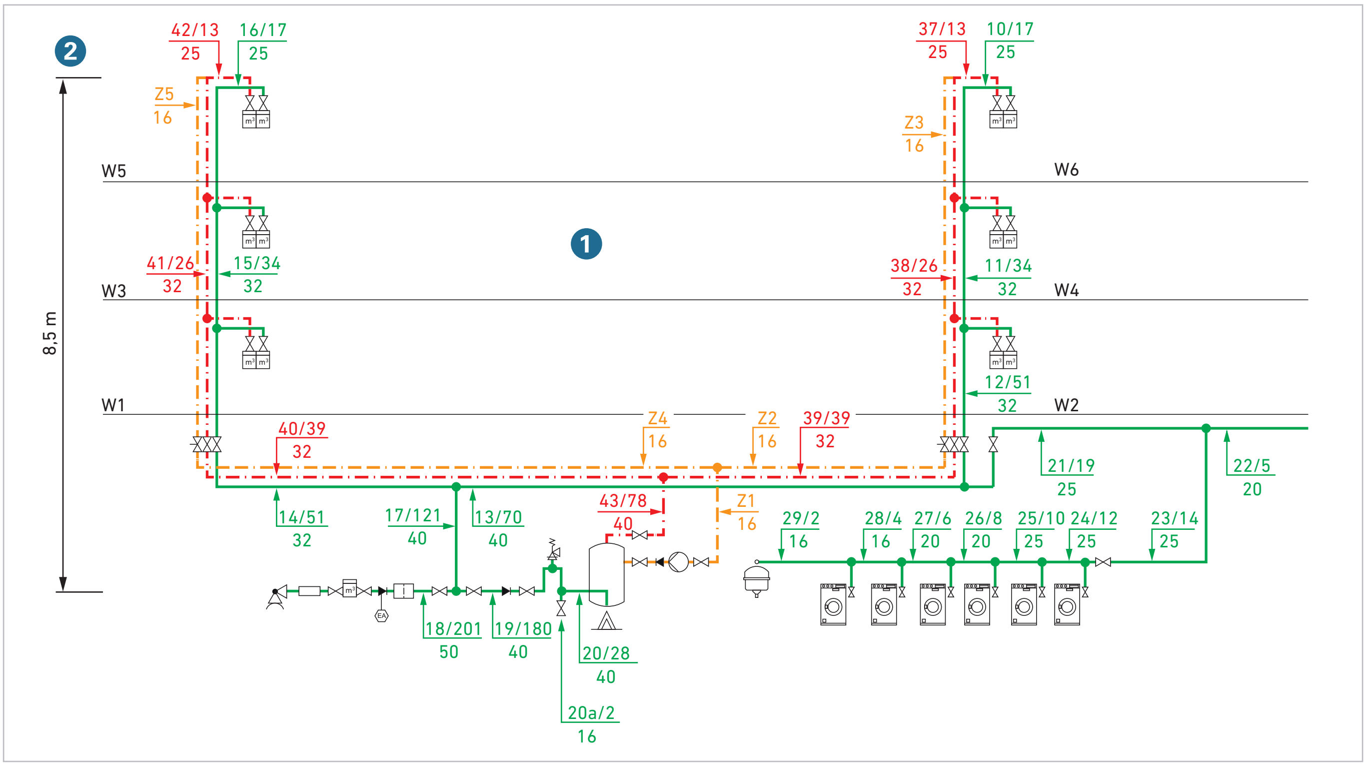
- Step a: Proof of minimum supply pressure
- Step ②: Single supply lines and pipelines on individual floor levels
- Step d: Determining the nominal pipe diameters

Piping schematic

The **piping schematic** [GIV.46] is the basis for the calculations. All information on the design, such as the numbers of the flow paths, the loading units and the result of the pipes' nominal widths to be used, are entered into this diagram.

This information and results are entered in the table and indicated on the schematic of the individual pipelines and individual floor levels. The proof that the **minimum supply pressure** is sufficient for the design was verified in table [TIV.16].

In the form **Determining the nominal pipe sizes** (simplified calculation method), all information and results of the calculation are documented (➨ Table [TIV.17]).



Detailed information in the sample calculation	Explanation
① / ② ③	① Number of pipe segment: Z1 – Z5 Circulation 1 – 9 Cold water (distribution per flat) 10 – 29 Cold water 30 – 36 Hot water (distribution per flat) 30 – 43 Hot water ② Sum of LU ③ External diameter

GIV.46
Sample calculation: Piping schematic

W1 – x Flat 1 – 6

1. Nominal diameter of all individual supply lines: DN16x2.2
2. geodetic height

Step ①

First, the form in Table [TIV.16] must be used to check whether the **minimum pipe friction pressure drop** of 10 hPa is available.

> **If the available pipe friction pressure drop is less, a differentiated calculation must be carried out.**

☑ The **minimum supply pressure** is sufficient if the available pipe friction pressure drop R is >10 hPa/m.

TIV.16 **Proof of minimum supply pressure (simplified calculation method)**

	Designation	Designation	Value	Unit
1	Minimum supply pressure	p_{minV}	4000	hPa
2	Pressure loss in the house connection line	Δp_{Hal}	200	hPa
3	Pressure loss inside the residential water meter	Δp_{WZ}	650	hPa
4	Minimum pressure downstream of the residential water meter	$p_{min,WZ}$	3150	hPa
5	Pressure loss due to the geodetic height difference	Δp_{geo}	850	hPa
6	Pressure loss inside the Return flow inhibitor	Δp_{RV}	100	hPa
7	Pressure loss in equipment			
	Water meter inside flat	Δp_{WZ}	200	hPa
	Filters	Δp_{FIL}	200	hPa
	Water softener system	Δp_{EH}		hPa
	Dosing system	Δp_{DOS}		hPa
	Group DHW	Δp_{TE}	0.0	hPa
	more equipment	Δp_{Ap}		hPa
	more equipment	Δp_{Ap}		hPa
	more equipment	Δp_{Ap}		hPa
	more equipment	Δp_{Ap}		hPa
8	Minimum flow pressure Tap: Mixing tab for vanity unit	p_{minFL}	800	hPa
9	Sum of pressure losses	$\sum \Delta p$	2150	hPa
10	available for pressure loss due to pipe friction and individual resistors value from line 4 minus line 9	$\sum(l \cdot R+Z)v$	1000	hPa
11	estimated portion for single resistances 40%	a	400	%
12	Available for pressure loss due to pipe friction Value from line 10 minus line 11	-	600	hPa
13	Length of the pipeline	l_{ges}	29.5	m
14	available pipe friction pressure drops Value from line 12 divided by line 14	R_v	20.33	hPa/m

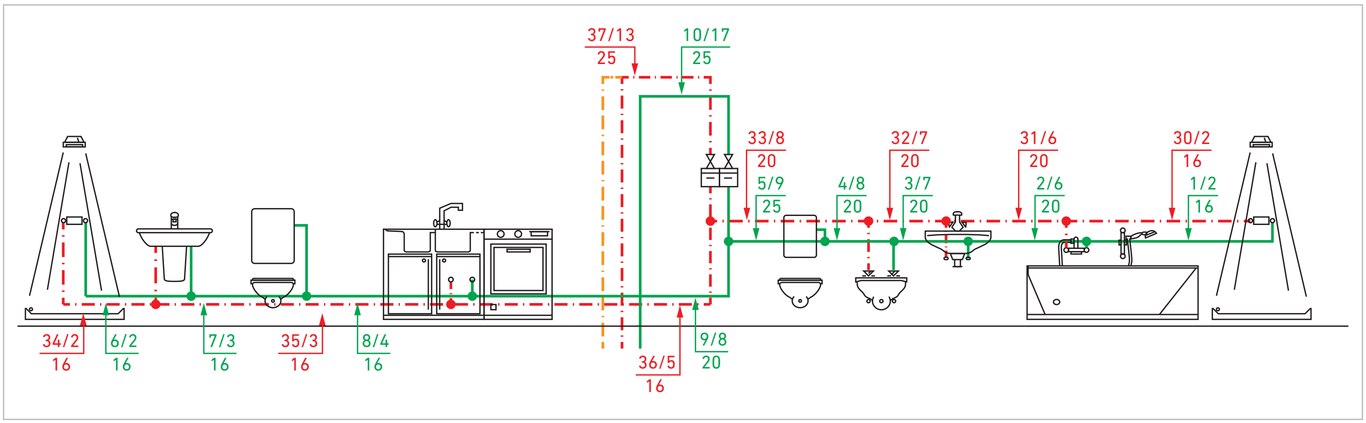
The result of this calculation shows that with the available pipe friction pressure gradient of 20.33 hPa/m, the design of the pipelines for this building can be carried out.

The **minimum supply pressure** of 4,000 hPa (4 bar) is sufficient for the supply of all taps.

Step ②

Subsequently, this exercise is continued with the calculation example for **single supply lines and pipelines on individual floor levels** in the longest flow path (apartment 6).

For the other flats 1 to 6, these basics are identical and are thus adopted.



GIV.47
Flat 1 – 6:
Single supply lines and pipelines on individual floor levels

Detailed information in the sample calculation	Explanation
① / ② ↓ ③	① Number of pipe segment: Z1 – Z5 Circulation 1 – 9 Cold water (distribution per flat) 10 – 29 Cold water 30 – 36 Hot water (distribution per flat) 30 – 43 Hot water ② Sum of LU ③ External diameter

Step ③

Subsequently, the calculation example for the riser pipes, the consumption pipes and the lines in the laundry room is continued until the start of the drinking water installation on the residential water meter.

TIV.17 **Determining the pipe sizes (simplified calculation method)**

Cold water PWC						Hot water PWH				
Pipe segment	Tap	Load value	Total	Length of the pipeline	Dimension of pipe	Pipe segment	Load value	Total	Length of the pipeline	Dimension of pipe
		LU	LU	mm	d		LU	LU	m	d
	Riser pipe 2									
10	Flat 6		17		25x2.3	37		13		25x2.3
11	Flat 4 + 6		34		32x2.9	38		26		32x2.9
12	Flat 2 + 4 + 6		51		32x2.9	39		39		32x2.9
	Supply pipeline									
13	Main pipe 2 + laundry		70		40x3.7					
	Riser pipe 1									
14	Flat 1 + 3 + 5		51		32x2.9	40		39		32x2.9
15	Flat 3 + 5		34		32x2.9	41		26		32x2.9
16	Flat 5		17		25x2.3	42		13		25x2.3
17	Main pipe 1 + 2 + laundry		121		40x3.7					
18	Total PWC + PWH		201		50 x4.6					
19	Supply line domestic drinking water+ heater (DHW) + heating filling valve		80		40x3.7					
20	Connection to TWE		78		40x3.7	43		78		40x3.7
20a	Heater filling valve		2		16x2.2					
	Laundry + external tap									
21	Laundry + 6W + discharge + external tap		19		25x2.3					
22	External tap		5		20x2.8					
23	6 WM + Discharge		14		25x2.3					
24	5 WM + Discharge		12		25x2.3					
25	4 WM + Discharge		10		25x2.3					
26	3 WM + Discharge		8		20x2.8					
27	2 WM + Discharge		6		20x2.8					
28	1 WM + Discharge		4		16x2.2					
29	Discharge		2		16x2.2					

Length of all pipes PWH connected to the circulation			
37	2.75		
38	2.75		
39	6.0		
40	6.0		
41	2.75		
42	2.75		
43	6.00		
Total	29.0		
longest flow path of the PWH-C circulation line			
Z 1		7.0	16 × 2.2
Z 2		6.0	16 × 2.2
Z 2		6.5	16 × 2.2
Total		19.5	<20 m

Circulation control valve DN15 in main pipe _1__
and main pipe _2__
Circulation pump DN15
Flow rate 200 l/h at 100 hPa

12.2 Sample forms for the simplified calculation method

The two forms for using the simplified calculation method are shown below:

- Proof of sufficient minimum supply pressure in the simplified procedure
- Determining the pipe diameter for the simplified calculation method

☑ The **minimum supply pressure** is sufficient if the available pipe friction pressure drop R is >10 hPa/m.

If the available pipe friction pressure drop is less, a differentiated calculation must be carried out.

TIV.18 **Proof of sufficient minimum supply pressure (simplified calculation method)**

	Designation	Designation	Value	Unit
1	Minimum supply pressure	p_{minV}		hPa
2	Pressure loss in the house connection line	Δp_{Hal}		hPa
3	Pressure loss inside the residential water meter	Δp_{WZ}		hPa
4	Minimum pressure downstream of the residential water meter	$p_{min,WZ}$		hPa
5	Pressure loss due to the geodetic height difference	Δp_{geo}		hPa
6	Pressure loss inside the Return flow inhibitor	Δp_{RV}		hPa
7	Pressure loss in equipment			
	Water meter inside flat	Δp_{WZ}		hPa
	Filters	Δp_{FIL}		hPa
	Water softener system	Δp_{EH}		hPa
	Dosing system	Δp_{DOS}		hPa
	Group DHW	Δp_{TE}		hPa
	more equipment	Δp_{Ap}		hPa
	more equipment	Δp_{Ap}		hPa
	more equipment	Δp_{Ap}		hPa
	more equipment	Δp_{Ap}		hPa
8	Minimum flow pressure Tap: Mixing tab for vanity unit	p_{minFL}		hPa
9	Sum of pressure losses	$\sum\Delta p$		hPa
10	available for pressure loss due to pipe friction and individual resistors value from line 4 minus line 9	$\sum(l \cdot R+Z)v$		hPa
11	estimated portion for individual resistances (40%)	a		%
12	Available for pressure loss due to pipe friction Value from line 10 minus line 11	-		hPa
13	Length of the pipeline	l_{ges}		m
14	available pipe friction pressure drops Value from line 12 divided by line 14	R_v		hPa/m

TIV.19 **Determining the pipe sizes (simplified calculation method)**

Cold water PWC						Hot water PWH				
Pipe segment	**Tap**	Load value	Total	Length of the pipeline	Dimension of pipe	Pipe segment	Load value	Total	Length of the pipeline	Dimension of pipe
		LU	LU	mm	d		LU	LU	m	d

Length of all pipelines PHW (hot water) connected to the circulation system			
Total			<30 m
longest flow path of the PWH-C circulation line			
Total		19.5	<20 m

- Circulation control valve DN15 in main pipe _1__ and main pipe _2__
- Circulation pump DN15/flow rate 200 l/h at 100 hPa

IV

12.3 Differentiated calculation method

+ The smallest possible pipe inner diameters for drinking water installations for the cold and hot water as well as for the circulation pipes can only be determined if using the differentiated calculation method.

In widely branched and higher buildings with many drinking water taps, a larger volume of water is contained in the pipelines than in smaller systems. For a drinking water hygiene harmless operation, the water volume in the drinking water system must be frequently replaced.

Due to the longer pipe runs, the higher proportion of individual resistors, the resistances inside devices, equipment and residential water meters and the often greater geodetic height, it is indispensable that the available minimum supply pressure, the hydraulically differentiated design of the pipe diameter is carefully carried out.

A differentiated calculation is also an absolute necessity for keeping the temperature in hot water and circulation pipes at 60 to 55 °C and the associated hydraulic balancing.

Especially in buildings with particular utilisation requirements, for example in hospitals, nursing homes and food businesses. Here, a differentiated design of the pipes' inner diameter is indispensable in order to maintain the drinking water hygiene and functionality in terms of hydraulics.

In principle, the differentiated calculation must be carried out using **calculation software** and, if possible, with the manufacturer's instructions regarding the pipe inner diameters, the resistance coefficients, the fittings, the controls and instruments, the devices and equipment.

Only by applying the differentiated calculation method can all influencing factors for an optimum of functionality in the intended operation of a drinking water installation under consideration of hydraulic, energetic, and economic concerns be achieved.

12.3.1 Design fundamentals

The **differentiated calculation** achieves a greater and more realistic approximation to the actual operating conditions, since the manufacturer's information on the resulting pressure losses in the respective design state is taken into account.

The pressure loss – apart from the pipe material, the diameter, the number of fittings of the pipeline equipment and devices, the length of the pipe, the geodetic height – also depends on the flow of the connected taps and their size, their number and use.

The calculation flow required for each tap must be determined in such a way that the use of all taps is taken into account during the determined peak flow in each flow path.

The minimum static overpressure at peak flow immediately downstream of the residential water meter, minus the total pressure loss in the least efficient flow path, shall be sufficient to ensure the minimum flow pressure at its minimum flow and at the most unfavourable sampling point.

Determining the available pressure gradient for the pipe friction

The calculation of a pipe network begins with the determination of the most hydraulically unfavourable flow path, that is to say the path with the smallest permissible pipe friction pressure drop of all flow paths.

Essentially, the available **pipe friction pressure drop** is determined by the pressure drop from the geodetic height difference and the minimum flow pressure at the taps.

The least favourable tap is usually found on the top floor with the highest minimum flow pressure.

Hydraulic balancing

After calculating the nominal pipe diameters for the worst-scenario flow path, all other flow paths are calculated in the order with the respective larger pipe friction pressure drop.

In principle, the smallest possible nominal diameter is to be determined for a pipe width calculation. Therefore, if more favourable flow paths exist, the available pressure differences can be optimised by possibly smaller nominal pipe sizes.

By optimising the pipe length calculation this way, it is already possible to realise a **hydraulic balancing** for cold and hot water pipes without additional throttling devices.

Pipe friction and individual resistances

The pressure losses in the pipelines must be determined on the basis of the actually installed pipe materials and pipe inner diameters according to the manufacturer's instructions.

The individual resistance coefficients provided by the respective manufacturers must be used for all fittings, controls and instruments.

Flows and flow pressures of taps and DHW heaters

When dimensioning the pipe diameter, compliance with the manufacturer-specific information on the calculation flows and minimum flow pressures is mandatory. The data provided in table [TIV.20] must be considered as reference values and may only be used if the manufacturers of the valves are not known and the specified conditions are met.

If taps are incorporated immediately downstream of a decentralised DHW heater, these must be used as equipment pressure loss.

- If **individual storages** are used, the pressure losses are negligible.
- For **decentralised storages** or **flow water heaters** for group supply, it is preferable to use the pressure losses of the respective manufacturers or the values from table [TIV.21].

Pressure loss in equipment

The pressure losses in equipment – this includes filters, water treatment systems, residential water meters and DWH heat exchanger – should always be determined according to the manufacturer-specific information, depending on the flow ratio.

Pressure loss due to the geodetic height difference

The pressure loss due to the geodetic height difference results from the height between the starting point of the hydraulic design, usually downstream of the residential water meter and the end point at the highest point of extraction. This height difference must be taken into account in the pressure loss calculation.

The height difference between the shower or bathtub fittings and the height of the overhead shower must be taken into account in the minimum flow pressure of the controls and instruments.

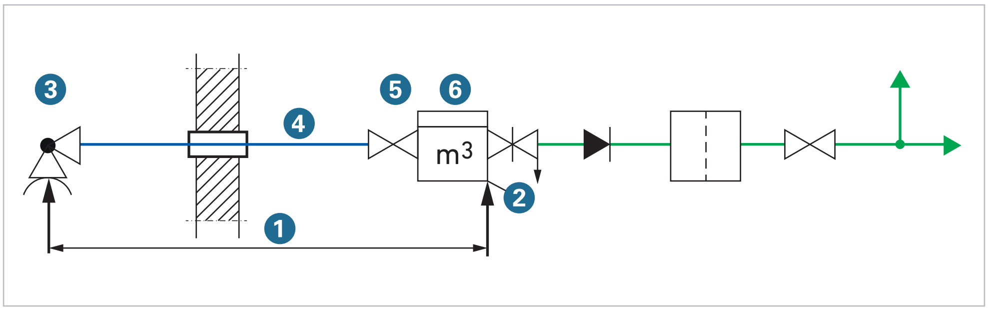
Minimum supply pressure

The calculation of the drinking water installation usually starts downstream of the residential water meter. Therefore, the minimum flow pressure for this site must be requested from the responsible water utility company.

If the water utility company only provides the minimum flow pressure at the supply line, then a pressure loss of 200 hPa must be assumed for the service line and a pressure loss of 650 hPa must be assumed for the water meter.

In pressure boosting systems, the sizing of the pipelines must be carried out separately from the residential water meter to the inlet nozzle, and from the discharge nozzle to the most unfavourable tap.

The following illustration shows the pressure losses up to the starting point of the drinking water installation.



GIV.48
Pressure losses up to the starting point of the drinking water installation

1. Total pressure loss: 850 hPa
2. Start of the hydraulic calculation of the drinking water installation
3. Connection device
4. House connection line: 200 hPa
5. Main shut-off valve
6. Residential water meter: 650 hPa

Total flow rate

The **total flow rates** are initially to be determined for the least favourable flow path in the opposite direction of the flow path. The addition begins at the farthest point and ends at the beginning of the design, usually at the residential water meter. For each additional flow path, the total flow rates are added in the same way.

At the connection point of the hot water supply line to the DHW heater, the total flow rates of the cold and hot water pipes add up.

Basically, all calculated flows of the installed taps are included in the sum of the total flows. Exceptions to the above statement can be taps, which are referred to as utilisation units, in residential buildings such as taps in bathrooms, guest toilets or kitchens.

When determining the total flow rate, the addition of calculated flows in the bathroom, e.g. a second vanity unit, an additional bidet and an additional shower to the bathtub can be omitted. For example, in the guest toilet, the addition of an extra urinal with pipes to the toilet cistern and the vanity unit can be omitted in the calculation. In a kitchen, next to a kitchen tap and a dishwasher, additional taps need not be considered.

Permanent flows

Continuous flow rates are available at taps that are open for more than 15 minutes. These locations must be indicated separately in the calculation.

The continuous flow rates are added to the other peak flows in the respective pipeline sections.

Flow velocities

When selecting the pipe diameter, compliance with the maximum calculated flow velocities for the applicable peak volume flows of 2.0 m/s is mandatory.

Exceptions for supply lines in individual sections must be observed. This applies to pipelines with a resistance coefficients <2.5, for individual resistances with flow times of <15 minutes at 5 m/s, for sections with resistance coefficients of ≥2.5, and for individual resistances with flow times of <15 minutes at 2.5 m/s.

Peak flow rate

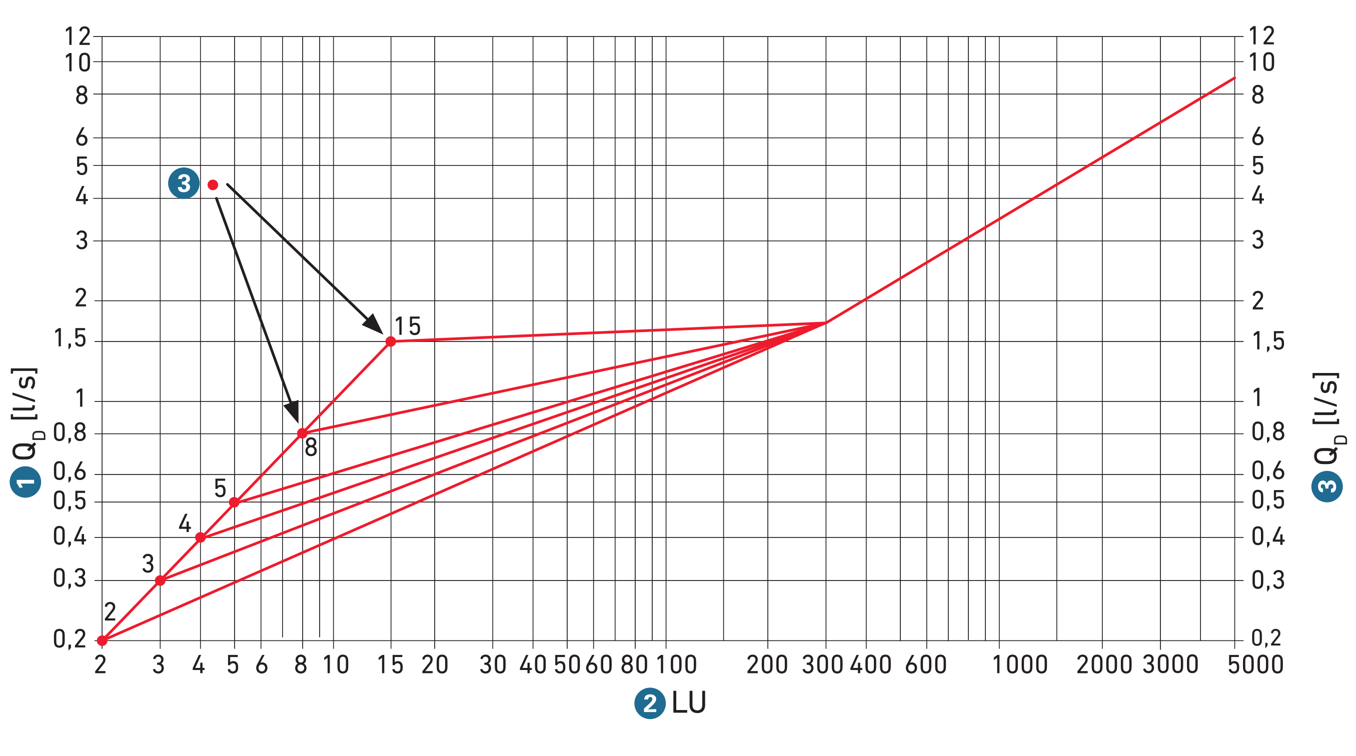
The peak volumetric flow takes into account the simultaneous use of the taps, based on the total flows. The concurrence of water being drawn varies depending on the type of building. Due to available system data is known that in residential buildings the use of water is different than in hotels or in hospitals.

In the formula for the peak volumetric flow, these different concurrences are considered by applying a constant listed in table [TIV.18]. For washing systems built in series or in special buildings, for example, commercial and industrial buildings, the concurrences must be discussed with the operating company.

The [GIV.49] diagram makes it possible to determine the **peak flow rate** (Q_D from $\sum$ LU) for standard installations. If confirmed by national regulations, additional diagrams (e.g. for different types of structures) can be applied.

GIV.49
Ratio of peak flow rate to total flow rate

1. Peak flow rate Q_D
2. Total flow rate, expressed as the sum of the LU of the connected load units
3. Example for highest individual values LU



12.3.2 Calculation procedure

✚ **The calculations must be made so that the results can be verified for plausibility.**

Before a differentiated pipe sizing can be carried out, the following requirements must be met:

☑ The **calculation software** is up to date.
☑ The **manufacturer data** for all planned components (e.g. pipe friction and individual resistances, pressure losses of the controls and instruments, devices and equipment according to the calculation flows) are entered directly into the calculation software.
☑ The type of **drinking water heating system** is known.
☑ It is determined which **taps** with which **minimum flow pressure** are installed.
☑ It is determined whether automatic valves, temperature sensors and electrical controls are provided to **comply with the temperature requirements** and for regular water exchange.
☑ The maximum and the **minimum supply pressure** downstream of the residential water meter is known.

Furthermore, answers to the following questions must be available:

- Are water meters part of the design?
- Are water treatment systems required?
- Must on-site machines, devices or equipment be connected; if yes, which?
  For this, minimum flow pressures and calculation flows must be available.
- What type of insulation should be provided?
- What ambient temperatures can be expected in rooms, pipe shafts or channels?
- To what extent should provision of drinking water for fire extinguishing and fire protection systems be ensured?
- Is a pressure boosting system required? if so: Which pressure zones must be provided?
- Are pressure reduction devices necessary?
- Which protection and safety devices are necessary?

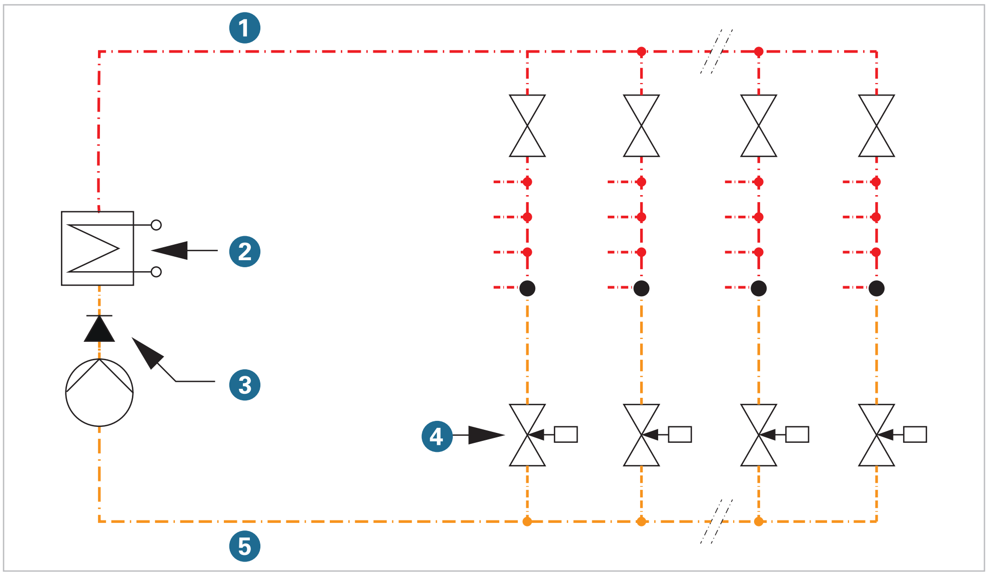
These specifications are best recorded in writing in a **room data booklet** by the client and the later operator.

Documentation of the results of the calculation

☑ The results of the calculation must be documented in such a way that the calculation can be traced without any gaps by other experts.

12.3.3 Dimensioning of circulation pipelines

Circulation lines must be sized so that the water temperature in the circulating hot water system does not drop by more than 5 K below the discharge temperature of 60 °C at the DHW heater.



GIV.50
Circulation system principle

1. Hot water line (PWH)
2. Equipment (e.g. heat exchanger of a system for heating drinking water)
3. Return flow inhibitor (gravity brake)
4. Circulation control valve
5. Circulation pipeline (PWH-C)

Flow rate

The volumetric flows in the circulation pipes must be determined in all sections by using the heat losses of the hot water pipes and the circulation pipes with a given water temperature from the discharge to the re-entry into the DHW heater.

Depending on the nominal diameters, the insulation and the ambient temperatures, the heat losses are calculated. From these calculated heat losses the required flow rate of the circulation pump is determined and adjusted hydraulically with circulation control valves for each pipeline sections so that the water temperature does not drops below 55 °C at any point in the circulating system.

☑ Accordingly, the maximum permissible temperature drop in the circulating hot water system must not be more than 5 K.

When calculating the heat losses and the resulting flow rates (along all flow paths in the hot water pipes from the outlet of the DHW heater at 60 °C to the connections of the circulation pipes in all pipe risers) a uniform pipe head temperature of 57.5 °C is assumed.

☑ For the circulation pipes, a temperature drop of 2.5 K is still available until the pipe re-enters the DHW heater (55 °C).

Pump head

In order to determine the pump head of the circulation pump, a differentiated pressure loss calculation must be carried out for the longest or worst-scenario flow path. The pressure losses from the pipe friction and the individual resistances in the hot water and circulation pipes, the opening pressure of a Return flow inhibitor downstream of the circulation pump, the circulation regulating valves and, if applicable, the pressure losses of the devices and equipment must be taken into account. The other, shorter flow paths with lower pressure losses must be throttled, using circulation valves or hydraulic balancing must be initiated.

The flow velocities in the circulation lines should be between 0.5 m/s and 1.0 m/s in lines close to the pump. In lines far from the pump must be 0.2 m/s and 0.5 m/s in order to facilitate hydraulic balancing.

Hydraulic balancing

Based on the differentiated design, hydraulic balancing must be carried out with either static or thermostatic circulation control valves.

If using a multi-stage adjustment in a flow path, the thermostatic valve must always be installed downstream of the consumption line. All other valves downstream of the flow path must have static functions.

12.4 Calculation tables for differentiated procedure

The following pages show the tables required for a differentiated calculation method.

- Minimum flow pressures and minimum values for the flow calculation of common drinking water taps acc. to DIN 1988-300
- Constants for the peak flow acc. to DIN 1988-300
- Reference values for pressure losses of group DHW heaters acc. to DIN 1988-300
- Comparable nominal widths for pipes made of different materials acc. to DIN 1988-300
- Pipe data
- Resistance coefficients for fittings and connection pieces made of plastic and for firmly bonded plastic pipes (material-specific)
- Resistance coefficients for fittings and connection pieces made of metal and for plastic pipes
- Resistance coefficients (standard values), for all controls and instruments made by GF
- Pipe friction pressure gradient and calculated flow velocity (material-specific, as a function of peak flow rate

§ **Important information**

The **manufacturer** must specify the **minimum flow pressure** and the **calculation flow rates** on the cold side and on the hot water side (for mixing valves).

In principle, the **specifications of the manufacturer** must be taken into account when dimensioning the pipe diameter. In some cases, these may differ considerably from the values provided in the following tables.

The procedure is as follows:

- **Scenario 1:** The manufacturer's specifications for the minimum flow pressure and the calculation flow are **below** the values listed in the table. In this case there are 2 options:
  - **Option 1:** If, for hygienic and economic reasons, the drinking water installation must be dimensioned for the lower values, this procedure must be agreed with the client. The design requirements for the taps (minimum flow pressure, calculation flow) must be included in the design.
  - **Option 2:** If the drinking water installation is not rated for the lower values, the table values must be taken into account.
- **Scenario 2:** The manufacturer's specifications are **above** the values listed in the table. In this case, the drinking water installation **must** be dimensioned according to the manufacturer's instructions.

TIV.20

Minimum flow pressures and minimum values for the calculation flow of common drinking water supply points (DIN 1988-300)

Type of tap	DN	Minimum flow pressure p_{minFl} [MPa]	Design flow Q_R [l/s]
Drainage valves			
without tap aerator[a]	15	0.05	0.30
	20	0.05	0.50
	20	0.05	1.00
with tab aerator	10	0.10	0.15
	15	0.10	0.15
Mixing tabs[b, c] for			
Shower tub	15	0.10	0.15
Bathtub	15	0.10	0.15
Kitchen sink	15	0.10	0.07
Washbasin	15	0.10	0.07
Bidet	15	0.10	0.07
Household equipment			
Washing machine (acc. to DIN EN 60456)	15	0.05	0.15
Washing machine (acc. to DIN EN 50242)	15	0.05	0.07
Toilet bowl and urinals			
Filling valve for cistern (acc. to DIN EN 14124)	15	0.05	0.13
Flush valve (manually operated) for urinal (acc. to DIN EN 12541)	15	0.10	0.30
Flush valve (electronically operated) for urinal (acc. to DIN EN 15091)	15	0.10	0.30
WC flush valve	20	0.12	1.00

a Without connected equipment (e.g. lawn sprinkler)
b The specified calculation flow must be taken into account for the cold **and** hot water connection.
c Angle valves, for example, as in vanity unit fittings and B-connections for shower and bathtub fittings are to be considered as individual resistors or dealt with in the minimum flow pressure of the tap.

TIV.21

Constants for the peak flow rate

Source: DIN 1988-300

Type of building	Constant A	B	C
Residential building	1.48	0.19	0.94
Inpatient ward room in the hospital	0.75	0.44	0.18
Hotel	0.70	0.48	0.13
School	0.91	0.31	0.38
Administration building	0.91	0.31	0.38
Equipment for assisted living facility, retirement home	1.48	0.19	0.84
Nursing home	1.40	0.14	0.92

TIV.22

Reference values for pressure losses of group DHW heaters

Source: DIN 1988-300

Equipment type	Pressure loss Δp_{TE} [hPa]
Electrical flow DHW heater	
• hydraulically controlled	1000
• electronically controlled	800
Electric or gas storage water heater Nominal volume up to 80 l	200
Gas flow water heater Gas/combination water heater acc. to DIN EN 297, DIN EN 625	800

TIV.23

Comparable nominal widths for pipes made of different materials acc. to DIN 1988-300

Pipe material	Hot-dip galvanised iron materials[b]		Copper		Stainless steel		Multilayer composite pipe PE-X		PP, PB, PVC-C	
DN (a)	d_a	$d_{i, min}$	d_a	$d_{i, min}$	d_a	$d_{i, min}$	d_a	$d_{i, min}$	d_a	$d_{i, min}$
10	17.2	11.5	12	10	12	10	12	8.6	12	–
12	–	–	15	13	15	13	15	11	16	11.6
15	21.3	15.2	18	16	18	16	18/20	14	20	14.4
20	26.9	20.7	22	20	22	19.6	25/26	17.6	25	18
25	33.7	26.1	28	25	28	25.6	32	22.5	32	23.2
32	42.4	34.8	35	32	35	32	40	28	40	29
40	48.3	40.7	42	39	42	39	50	36.2	50	36.2
50	60.3	51.6	54	50	54	51	63	45.8	63	45.8
60	–	–	64	60	64	60	–	–	–	–
65	76.1	67.2	76.1	72.1	76.1	72.1	75	60	75	54.4
80	88.9	70	88.9	84.9	88.9	84.9	90	73	90	65.4
100	114.3	103	108	103	108	104	110	90	110	79.8

a see DIN EN ISO 6708: 1995-9, Section 2, Remark 2 (3)
b only for drinking water (cold)

12.5 Change of length

All solid matter, including the materials of pipelines, expand more or less due to physical laws when heated and contract again when cooled. This thermally induced change of length is caused by changing ambient and operating temperatures.

A rod with the original length Lo shows an extension Δl when heated at a temperature difference of ΔT. The material-specific **coefficient of thermal expansion** α indicates the value of the extension of a 1 m long rod with a temperature increase of 1 K.

Due to heat and depending on the material, pipelines expand to varying degrees. Even if the temperatures of the medium (e.g. drinking water) exceeds room temperature, this causes a thermal expansion and must be taken into account in the design of the installation.

During the planning and installation of basement distribution pipes and riser pipes, in addition to the structural requirements, consideration must also be given to the **thermally induced change of length** and the occurring **expansion forces** .

Calculation of the change of length – Material constant and coefficient of thermal expansion
In order to calculate the change of length, product and material-specific values for the respective system are required:
➨ Part V 'Build', Sections pertaining to the systems

12.5.1 How to calculate the change in length

The change of the pipe's length (and also the corresponding design of the flexible pipe leg and the U-shaped expansion loops) depend, among other things, on the material used. When calculating the change of length, this is taken into account and the corresponding material-dependent parameters are taken into consideration.

Calculation of the change of length Δl

The thermally induced **length of change** Δl of the pipes is calculated (in non-resisting installations) from the **temperature difference** ΔT and the **pipe length** L, using the following formula:

$$\Delta l = \alpha \cdot L \cdot \Delta T$$

Symbol	Meaning	Unit	Note
L	Length of pipeline	[m]	–
α	Linear coefficient of thermal expansion	[mm/(m·K)]	product-/material-specific
Δl	Change of length	[mm]	–
ΔT	Temperature difference	[K]	–

Sample calculation using a plastic pipe (polybutene (PB))
The length of the pipeline is 5 m. The thermally induced change of length of this pipe section must be absorbed by a flexible pipe leg. The difference between the installation temperature and the maximum operating temperature is 60 K. For this sample calculation, a PB pipe d63 × 5.8 mm with an external diameter of 63 mm is used and a coefficient of thermal expansion $\alpha = 0.13$ mm/(m·K) is applied.

How to calculate the change in length

$$\Delta l = \alpha \cdot L \cdot \Delta T$$

$$\Delta l = 0.13\ [mm/m \cdot K] \cdot 5\ [m] \cdot 60\ [K]$$

$$\Delta l = 39\ mm$$

12.5.2 Change of length and compensation for expansion

This thermally induced change of length can be **compensated** during the installation and mounting of the pipe. Suitable measures are:
- Directional changes of the pipeline
- Providing expansion space
- Installation of expansion joints
- Setting the fixed points and floating points

The bending and torsional forces occurring during the operation of a pipeline are safely absorbed, taking into account the above-mentioned measures. The following parameters have a significant influence on the expansion compensation:
- Material
- structural conditions
- Operating conditions

Minor changes of lengths of the pipelines, especially when using smaller dimensions, can be compensated for by the elasticity of the piping system or with a corresponding **insulation**.

Expansion joint

For larger piping systems, the change of length must be absorbed by the **expansion joints**: Insulations, flexible pipe legs and U-shaped expansion loops compensate for the thermally induced change of length. Depending on the type of installation use, the necessary measures for the plastic piping systems are:

TIV.24
Measures for the expansion compensation for plastic pipelines

Medium	Cold water	Hot water/circulation/heater	
Dimension	d16 – d110	d16 – d26	d32 – d110
Length of the pipeline L ≤12 m	If the pipes are insulated, compensation of the change of length via floating points and fixed points is **not** necessary		
Length of the pipeline L ≥12 m	If the pipes are insulated, compensation of the change of length via floating points and fixed points is **not** necessary		Compensation of the change of length via floating points and fixed points is required

Flexible pipe leg and U-shaped expansion loop

The **calculation of the flexible pipe leg's length** depends on how the installation is carried out:
- If a **flexible pipe leg** or a branch line is used to compensate for the expansion, the bending length must be calculated.
- If a **U-shaped expansion loop** is used to compensate for the expansion, the length of the U-shaped expansion loop must be calculated.

12.5.3 Compensation of the change of length by means of insulation

If the insulation is used to compensate for the expansion, the minimum insulation thickness **s** must be at least 1.5 times the change of length.

In installations reaching temperatures up to 60 °C (ΔT = 50 K), a change of length Δl must be taken into account per meter of straight pipe length, the amount of which depends on the material-specific coefficient of thermal expansion.

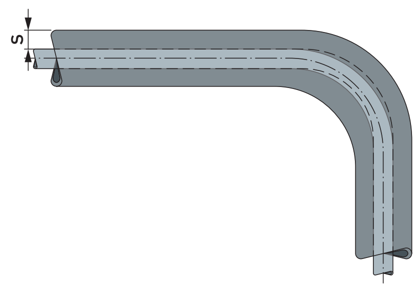
TIV.25
Coefficient of thermal expansion for pipe materials

Pipe material	Coefficient of thermal expansion α
PE	0.20 mm/(m·K)
PB	0.15 mm/(m·K)
PP	0.18 mm/(m·K)
CNS	0.01 mm/(m·K)

From the calculated amounts of the change of length, the insulation thickness per meter of straight pipeline length is calculated according to the following formula:

$$s = 1.5 \cdot \Delta l$$

s Insulation thickness, min.
Δl Change of length



Insulation
Information on the insulation of pipelines:
➨ Part IV 'Plan', Section 'Insulation, Fire protection'

12.5.4 Compensation of the change of length by installing expansion joints

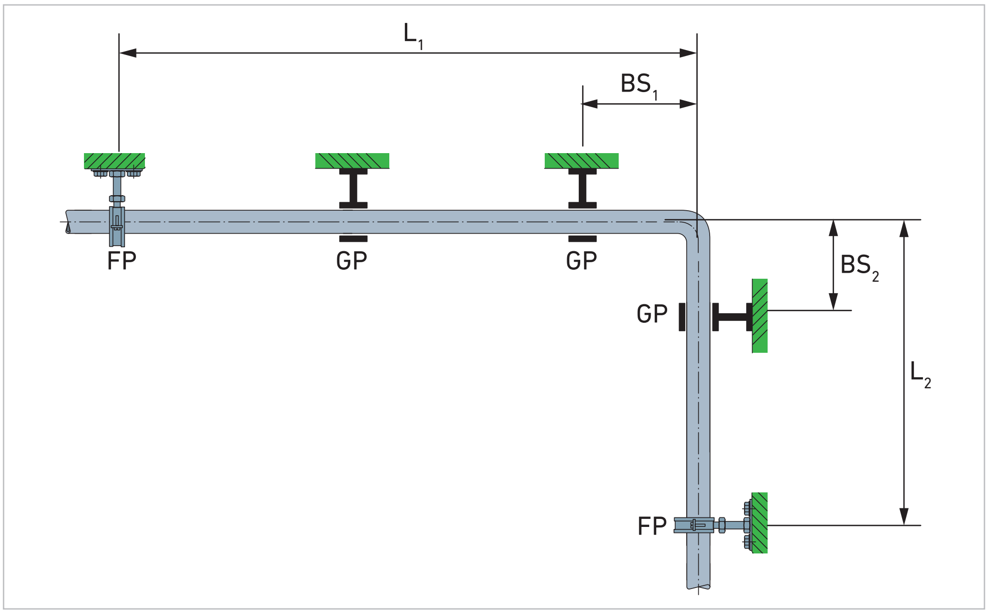
Flexible pipe legs and **U-shaped expansion loops** are used as **flexible pipe legs**. In order to ensure the function of the 2D expansion loop, **fixed points** and **floating points** (with sliding pipe clamps) are installed.

Fixed points can be created at a suitable location along the pipeline, using a commercially available, custom-fit fixed point clip or a system-specific solution (e.g. fixed point clip in combination with a fixed-point clip of the system used).

The **pipe clip** must assume the shape of the pipe and, when tightening the clip, the actual pipe diameter must not be constrict by more than 0.5 mm.

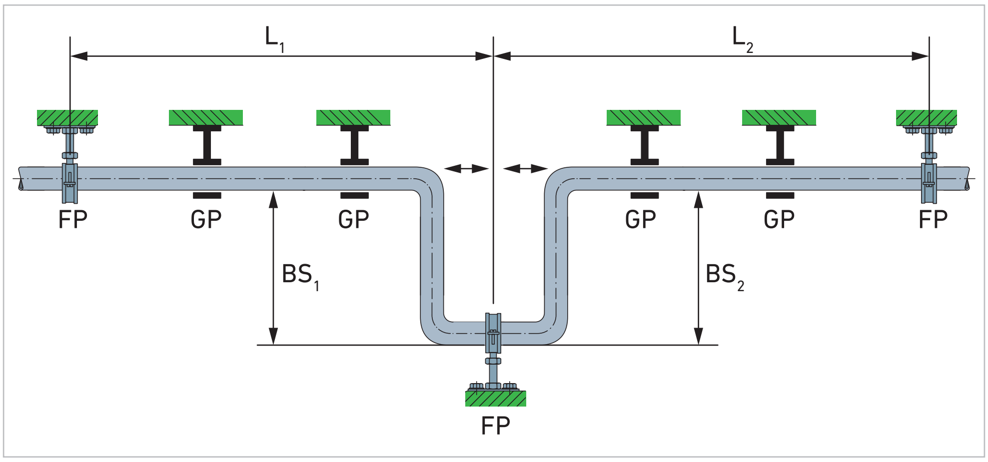
Examples – Basic design of a flexible pipe leg and U-shaped expansion loop

Examples – Basic design of a flexible pipe leg and U-shaped expansion loop



GIV.51
Flexible pipe leg

FP Fixed point
GP Floating point (with sliding pipe clip)
BS Flexible pipe leg
l Pipe length between fixed point and deflection



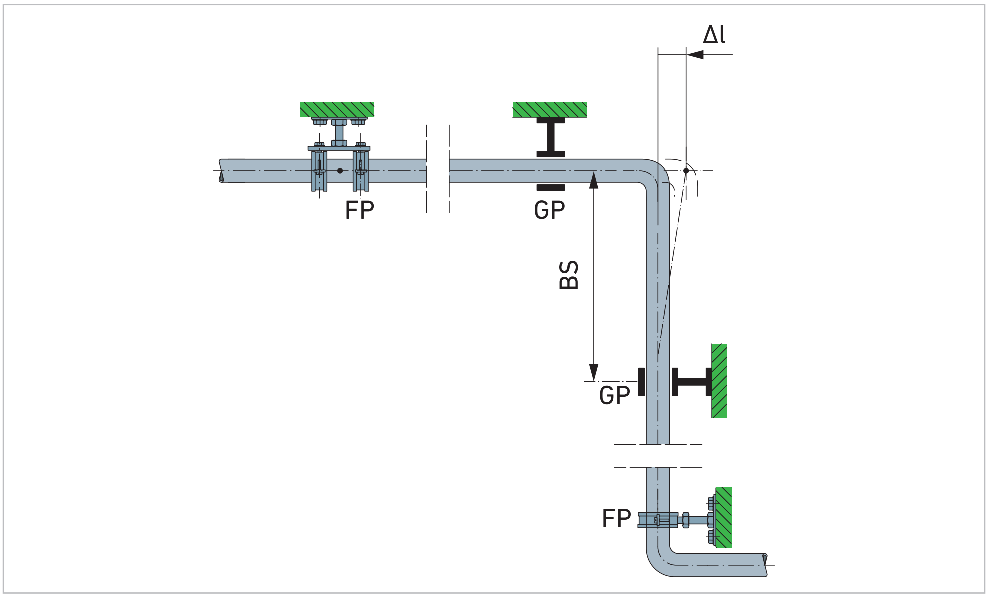
GIV.52
U-shaped expansion loop

FP Fixed point
GP Floating point (with sliding pipe clip)
BS Flexible pipe leg
l Pipe length between fixed point and deflection

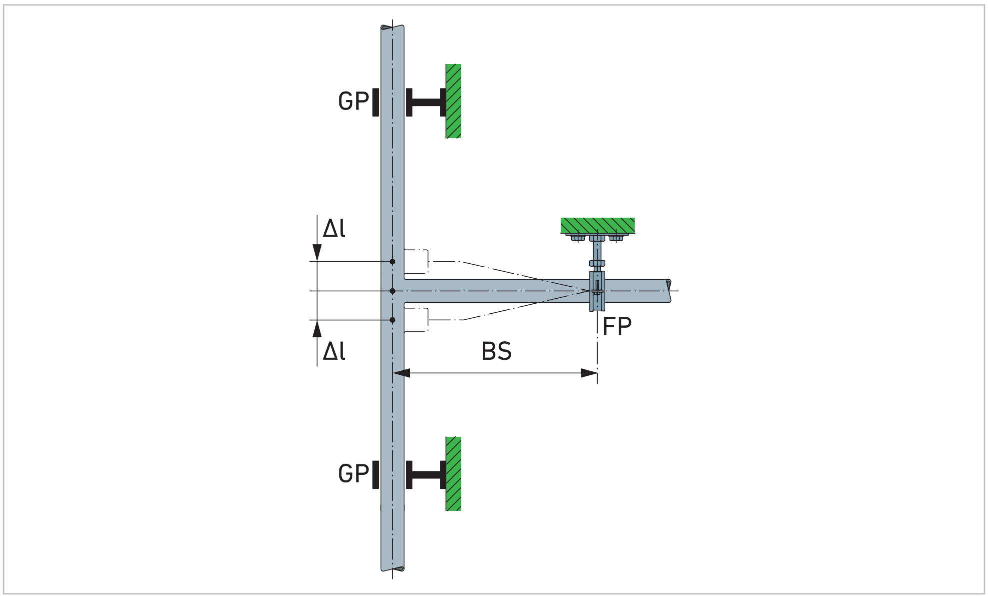
12.5.5 Calculation of the flexible pipe leg

Calculation of the length of the flexible pipe leg

Due to the thermally induced change of length, the 2D expansion loop **DS** of a pipeline causes a shift of the pipe's bend by a value of **Δl**. This change must be absorbed by a flexible pipe leg with the length **BS**.



GIV.53
Length of flexible pipe leg
GP Floating point
FP Fixed point
BS Length of flexible pipe leg



GIV.54
Length of flexible pipe leg
GP Floating point
FP Fixed point
BS Length of flexible pipe leg

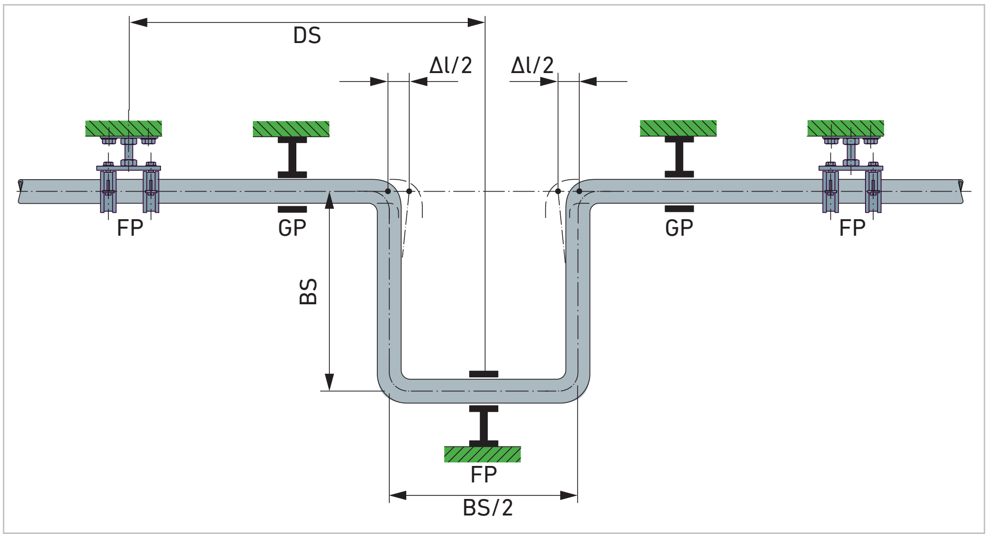
The length of the flexible pipe leg is calculated from the change of length Δl and the external diameter d of the pipe, using the following formula:

$$BS = C \cdot \sqrt{d \cdot \Delta l}$$

Symbol	Meaning	Unit	Note
BS	Length of flexible pipe leg	[mm]	–
d	External diameter of pipe	[mm]	–
Δl	Change of length	[mm]	–
C	Material constant	–	product-/material-specific

Calculation of the length of the flexible pipe leg in a U-shaped expansion loop

Due to the thermally induced change of length, a pipe **DS** shifts a U-shaped loop at both bends by half the value of **Δl**. This change must be absorbed by the two flexible pipe legs **BS**.
A U-shaped expansion loop is therefore considered a loop with 2 consecutive flexible pipe legs.



GIV.55
U-shaped expansion loop

GP Floating point
FP Fixed point
BS Length of flexible pipe leg
DS Length of the 2D expansion loop

The minimum length of the flexible pipe leg BS is calculated using the following formula.

$$BS = \sqrt{\frac{3 \cdot d_a \cdot \Delta l \cdot E_{mm}}{\sigma_b}}$$

Simplified formula

$$BS = C \cdot \sqrt{d \cdot \Delta l}$$

d_a	External diameter of pipe [mm]
Δl	Change of length [mm]
E_{mm}	average bending creep module [N/mm²]
σ_b	permissible proportion of bending stress [N/mm²]
C	Material constant

Sample calculation using a plastic pipe (PB)

The length of the pipeline is 5 m. The thermally induced change of length of this pipe section must be absorbed by a flexible pipe leg. The difference between the installation temperature and the maximum operating temperature is 60 K.

Example

Plastic pipe, PB, dimension	d63 × 5.8 mm
External diameter	63 mm
Change of length ΔL	39 mm
Material constant	10

Calculation of the flexible pipe leg

$$BS = C \cdot \sqrt{d \cdot \Delta l}$$

$$BS = 10 \cdot \sqrt{(63\ mm \cdot 39\ mm)}$$

$$BS = 495\ mm$$

A simple method on how to determine the required length of the flexible pipe leg, a material-specific diagram can be used.

When comparing this result with the result of a metal pipe – which the same dimension – the size of a flexible pipe leg made of metal will be significantly larger, since the material constant C of a metal pipe is much larger than the material constant of a plastic pipe.

13 Installation and attachment

There are different options for installing and attaching pipelines:

- Installation using rigid assembly
- Installation using flexible pipe legs
  - If the structural conditions allow for sufficient space in order to assemble the flexible pipe legs, this type of installation should be chosen.

If selecting these two types of installation, special attention must be paid when designing and calculating fixed points and floating points.

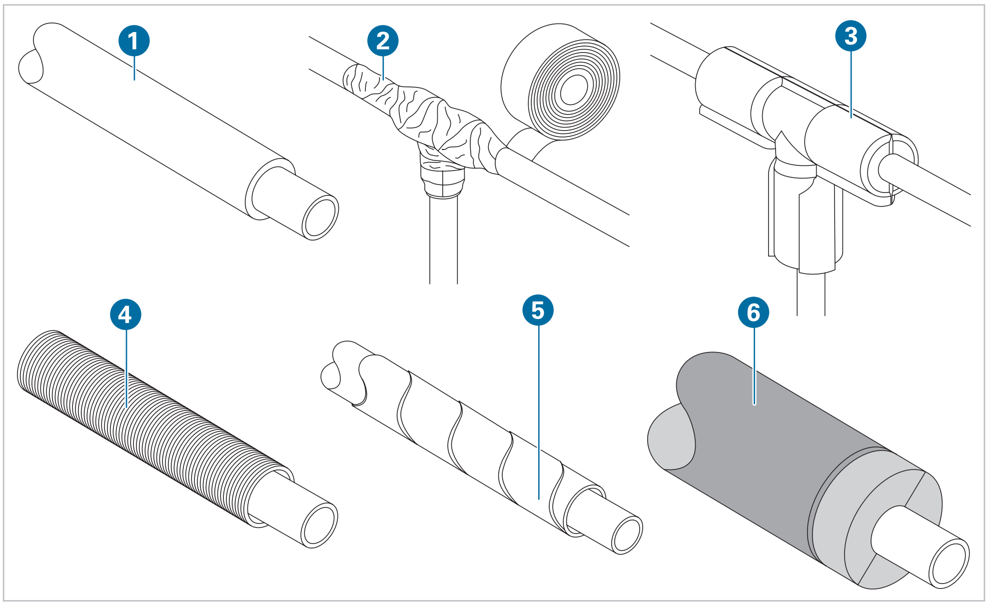
Furthermore, the following types of installation are also available:

- Installation in the building structure
- Installation in the raw concrete ceiling
- Installation on top of a raw concrete ceiling

> **Permissible installation types**
> The permissible installation types are product- and material-specific, depending on the **system** used and on the applicable valid **factory specifications**.

13.1 Protection against environmental influences and building materials

Depending on the type of installation, the system, the product- and material-specific properties, pipelines must be protected accordingly.



GIV.56
Safety measures

1. Pre-insulated pipe
2. Pipe with wrapping
3. Half shells
4. Protective conduit
5. Wrapping
6. Sheathing

System components flush-mounted or concealed behind a wall:

☑ In order to absorb thermally induced changes in length, to prevent the transmission of sound, to avoid the formation of condensation, to preclude heat dissipation, heat loss or to heat the medium and to protect from other building material influences, fittings or pipes must be covered with a suitable materials or they must be separated entirely from the structure of the building.

In permanently or periodically damp rooms, in areas subject to aggressive gases or other offensive environment and under uncontrollable environmental influences:

☑ Appropriate precautions must be taken to protect the installation, e.g. by using the following measures:
  - Use of suitable anti-corrosion tapes (e.g. supplied by KEBU, Gyso or DENSO)
  - Wrapping the pipe with heat-shrinkable materials.

☑ Ensure that pipes and fittings are dry when mounting.

☑ All system components must be protected from direct contact with oils, greases, solvents, solvent-based adhesives (adhesive tapes), foams, bitumen (also bituminous membranes). Furthermore, the components must not contact building materials such as screed, concrete, mortar or plaster.

☑ Separating the piping system from the building structure is mandatory. In this case, protective conduits made of PE, wrappings, insulating hoses or pipe saddles with and without sheathing or a combination thereof shall be used.

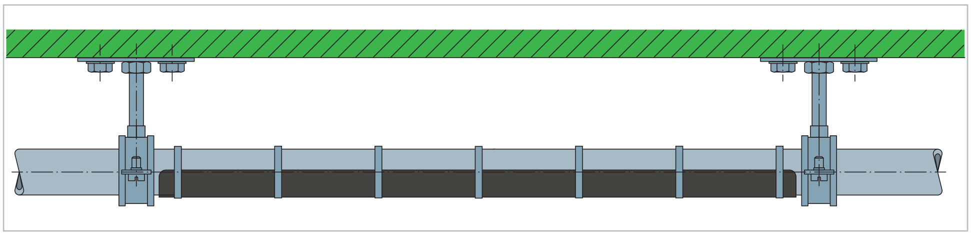
13.2 Pipe installation using a rigid assembly

A rigid assembly is a straight pipe between two fixed points in which the pipe cannot deflect laterally. The **temperature-related change of length** is absorbed in the plastic pipe.
The **thermally induced expansion forces** of the pipe are transferred into the structure via the **fixed points**.

The initial expansion forces that occur during a **rigid assembly** change over time to tensile forces, depending on the stress caused due to temperature changes. Therefore, when designing the fixed point attachment, care must be taken that not only expansion forces but also tensile forces must be absorbed.

The forces acting on the fixed point depend on the pipe's cross-section, the temperature difference and the pipe material. However, these forces are much higher than if a flexible pipe leg is incorporated within the assembly. Therefore, an additional support structure is required for larger spacings along the wall and ceiling.

In the case of **visible pipe routing**, straight routing is achieved with all-plastic pipes by using **support shells**.



GIV.57
Using pipe saddles

In the case of **invisible cable routing** in cavities (shafts, suspended ceilings, etc.), on the other hand, supporting shells can be dispensed with.

If the pipeline cannot be expand laterally when exposed to higher temperature (due to rigid insulation or structural limitations), the following rule applies: Any direct, straight, vertical or horizontal pipe installation running between two fixed points, the latter must be designed as a rigid assembly.

Information about plastic-compatible assembly using pipe saddles
On the one hand, the use of **pipe saddles** serves the aesthetics of the installation; on the other hand, the trays must specifically transfer the expansion force into the fixed points. If the overlap of the pipe saddles is too low, especially in the rigid assembly, it can happen that the force breaks out right there, namely at the weakest point and thus the pipe becomes crooked.

For the assembly with pipe saddles

☑ Horizontal pipelines which are in plain view must always installed using pipe saddles.

☑ Always overlap the pipe saddles by at least 25 cm and pipe ties (cable ties) to fasten them. This ensures stability and routing of the pipes in a straight line.

☑ Clip-on type support saddles must be attached flush with each other.

13.3 Pipe installation with flexible pipe legs

> **Pipe installation with flexible pipe legs**
> During the pipeline installation with flexible pipe legs, it is necessary to calculate the length change with product- and material-specific values in mind.

The flexible plastic pipes make it possible to absorb the thermally induced change of length of a hot water pipe by means of short **flexible pipe legs** or **U-shaped expansion loop**, that is to say, they are used as **expansion joints**. In order to ensure the function of the **2D expansion loop**, **fixed points** and **floating points** (with sliding pipe clamps) are installed.

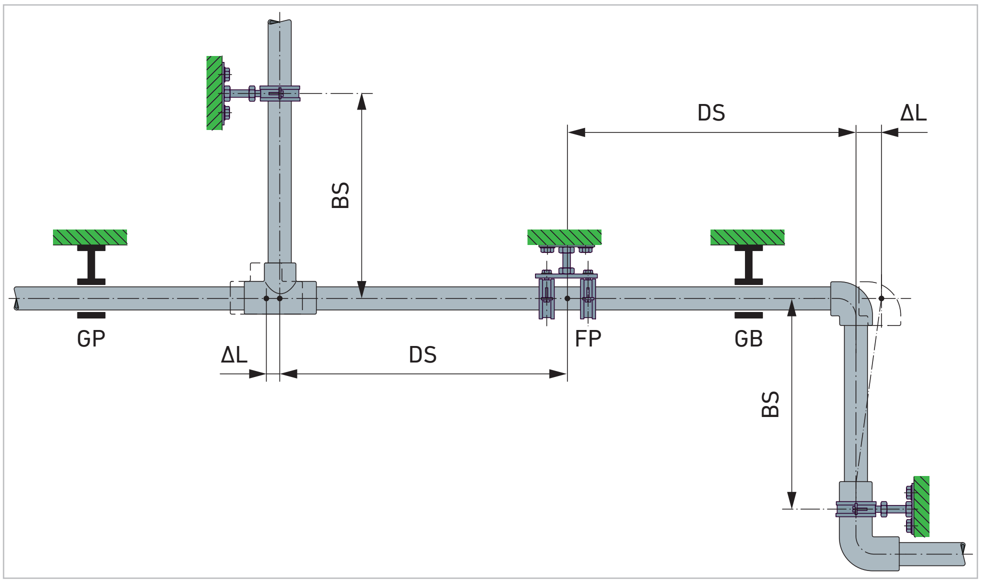
Fixed points can be created at a suitable location along the pipeline, using a commercially available, custom-fit fixed point clip or a system-specific solution (e.g. fixed point clip in combination with a fixed-point clip of the system used).

☑ The **pipe clip** must assume the shape of the pipe and, when tightening the clip, the actual pipe diameter must not be constrict by more than 0.5 mm.

Pipe saddles are not used during the installation of the **flexible pipe legs**. The pipe clips, which contact the pipe directly, come with an inserted tape.

Examples – Pipeline installation

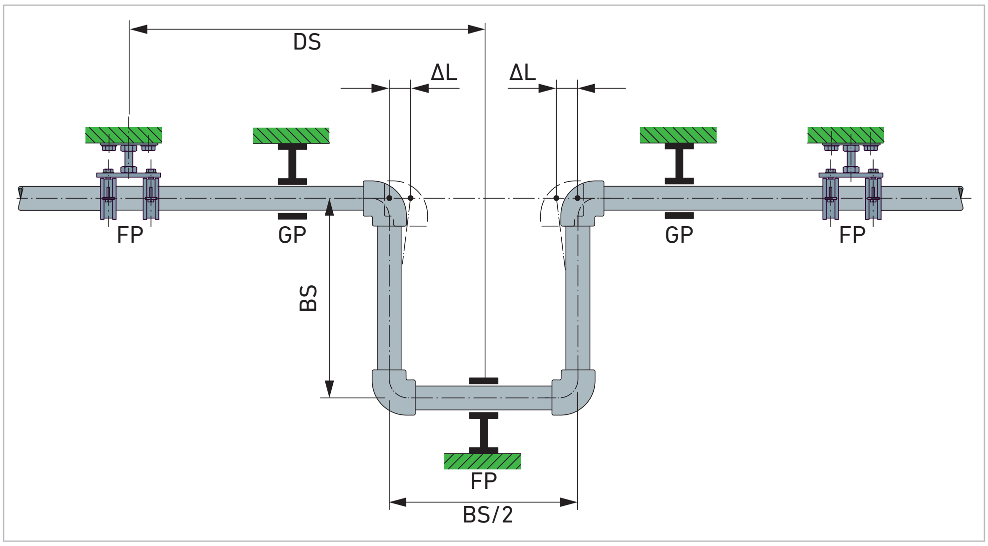
Flexible pipe leg



GIV.58
Flexible pipe leg

Δl Thermally induced change of length
DS Length of the 2D expansion loop
FP Fixed point
GP Floating point
BS Length of flexible pipe leg

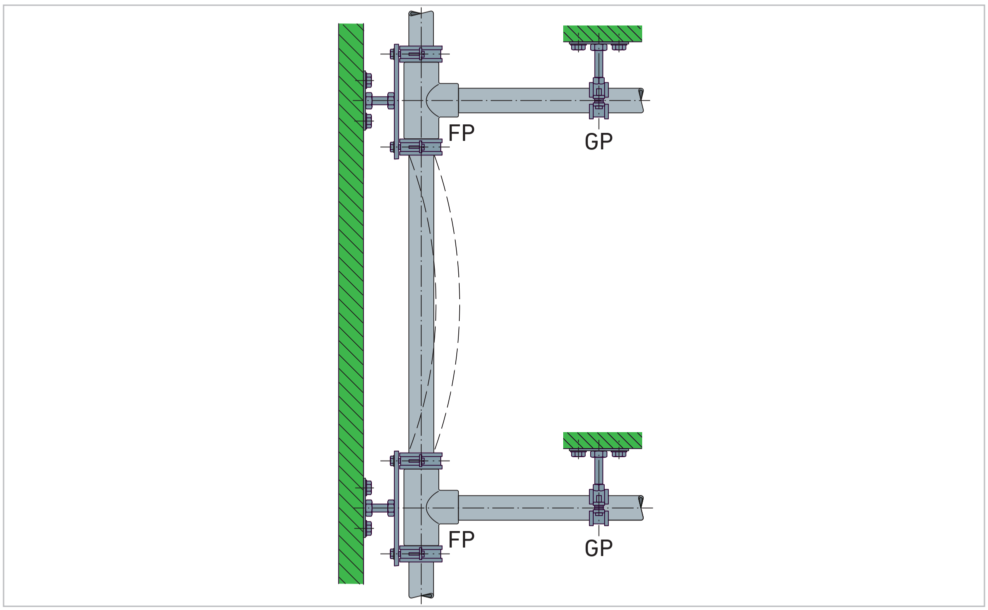
U-shaped expansion loop



GIV.59
U-shaped expansion loop

Δl Thermally induced change of length
DS Length of the 2D expansion loop
FP Fixed point
GP Floating point
BS Length of flexible pipe leg

Flexible pipe leg required for the lateral deflection of the pipe



GIV.60
Lateral deflection of the pipe

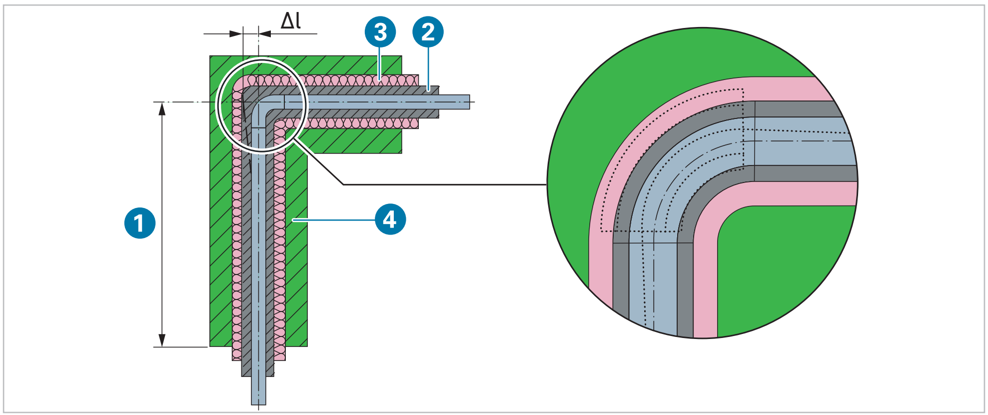
FP Fixed point
GP Floating point

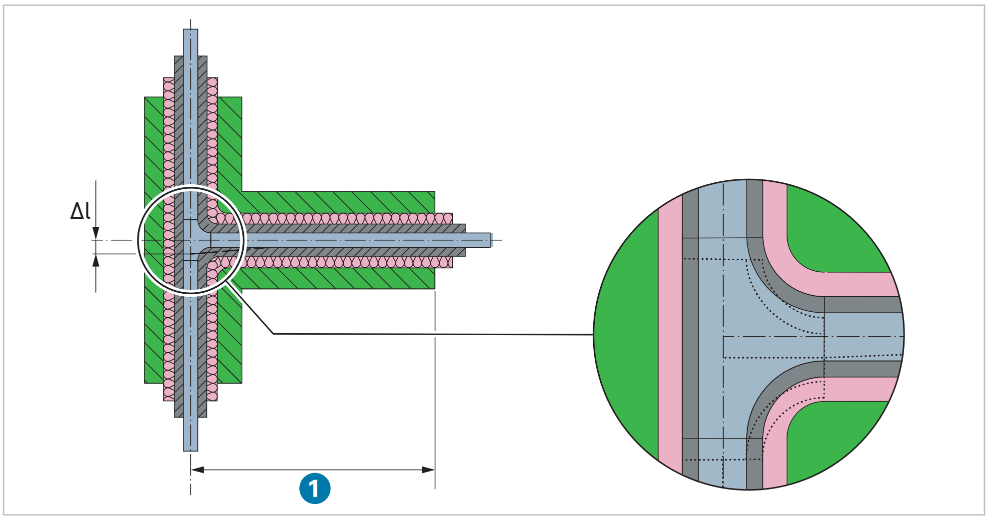
Flexible pipe leg with additional insulation for in-wall installation

☑ Pipelines that run their entire length concealed behind a wall must be insulated using commercially available materials.

☑ Flexible pipe legs must be wrapped with elastic material (mineral wool, foam or similar material) so that the change of length is not impeded.

As a rule, the required insulation thickness is sufficient for the change of length. An additional insulation to compensate for the change of length is required if the change of length would otherwise be impeded.





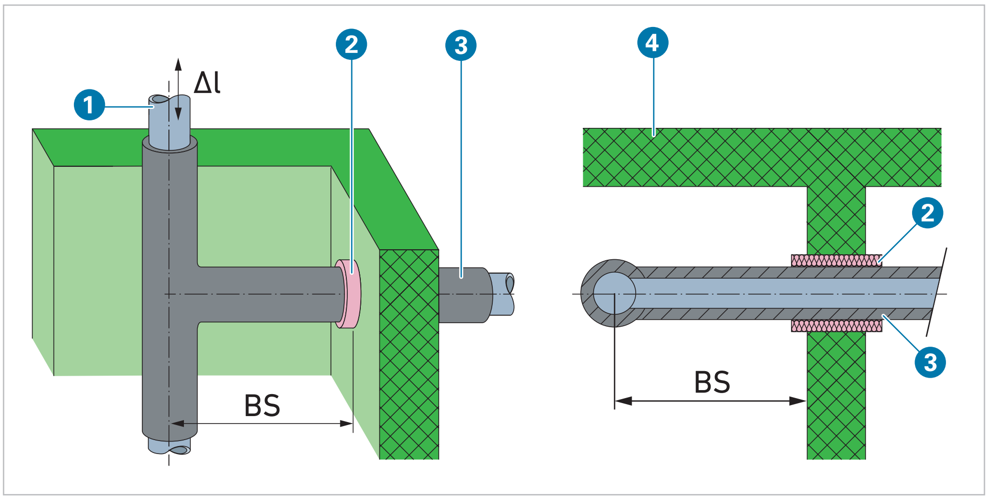
GIV.61
Flexible pipe leg with additional insulation for in-wall installation

1. Flexible pipe leg with additional insulation
2. Insulation (thermal)
3. Insulation, for expansion (to compensate for the change of length)
4. Wall

Arrangement of flexible pipe legs inside a pipe shaft

If **riser pipes** are installed inside shafts – required due to branches at individual floors – it must be ensured that the branching pipeline can adequately rebound according to the change of length of the riser pipe. To do this, several options are available:

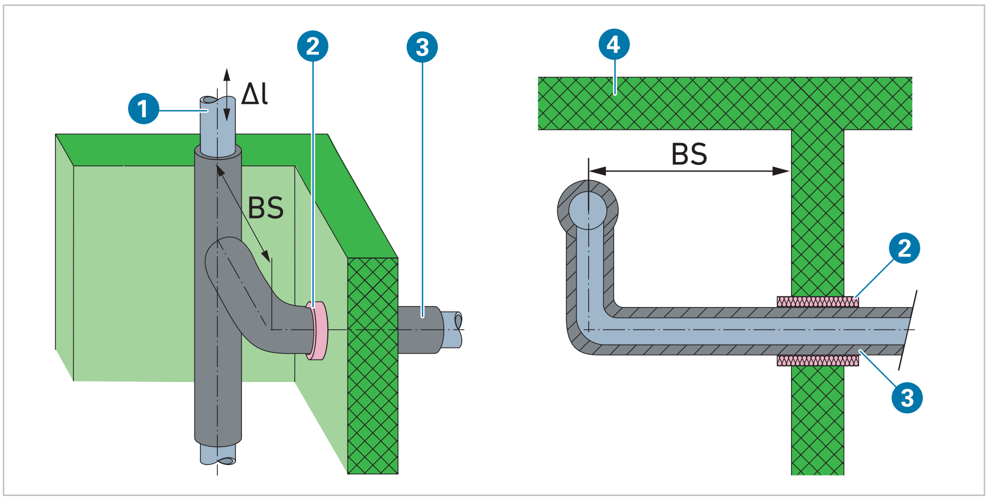
☑ A soft material shall be used in order to insulate the branches of riser pipes. This will absorb the thermally induced change of length of the riser pipe.



GIV.62
Flexible pipe leg

1. Pipe
2. Insulation, for expansion (to compensate for the change of length)
3. Thermal insulation
4. Wall

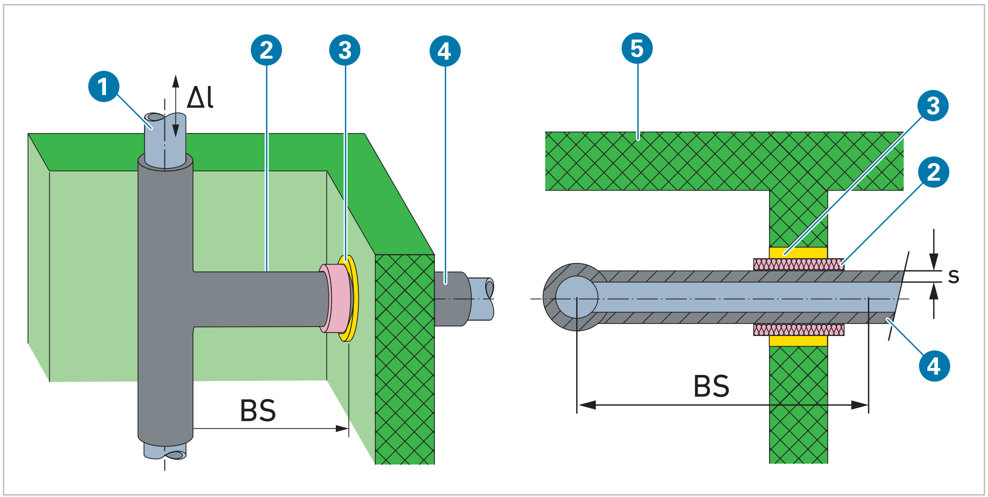
BS Flexible pipe leg
Δl Thermally induced direction of the pipe's expansion



GIV.63
Flexible pipe leg

1. Pipe
2. Insulation, for expansion (to compensate for the change of length)
3. Thermal insulation
4. Wall

BS Flexible pipe leg
Δl Thermally induced direction of the pipe's expansion



GIV.64
Flexible pipe leg with casing

1. Pipe
2. Insulation, for elongation
3. Casing
4. Thermal insulation
5. Wall

BS Flexible pipe leg
Δl Thermally induced direction of the pipe's expansion

13.4 Fixed points and floating points

- **The fixed point is an attachment that prevents axial movement of the pipe and pipe clip in any direction (impact and tensile forces). Fixed points divert the thermal expansion of pipelines in a specific favoured direction.**
- **The floating point allows the movement of the pipeline in the axial direction.**

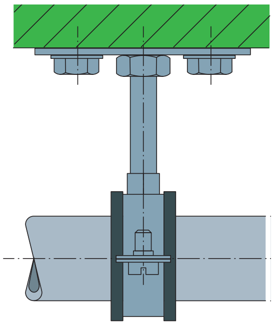
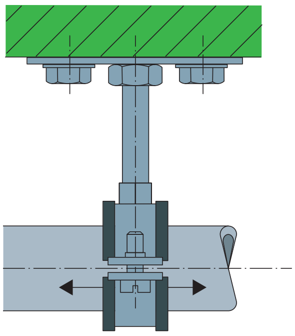
13.4.1 Pipe clips for fixed points and floating points

All commercially available pipe clips and fastening materials that are suitable for plastic piping system construction. These clips and materials can be used both for fixed point attachments and for floating point attachments. This facilitates the work on the construction site and reduces the amount of material to be stored. Pipe clips and fixing materials should have the following features:

☑ suitable for plastic pipes
☑ Pipe clips for fixed point and floating attachments must be provided with a (sound-absorbing) inserted tape.
☑ The size of the pipe clip must be selected in order to match the pipe dimension and to ensure smooth movement during operation. This prevents the tape that is inserted into pipe clips from slipping out.

If the pipe clips up to max. **d63** are firmly tightened, they counteract the expansion of the pipe. Given low expansion forces of the pipe, the parallelogram effect of the pipe suspension is large enough to prevent pipe expansion from occurring.

TIV.26
Fixed point attachment and floating point attachment

Fixed point attachment d63	Floating point attachment (sliding suspension bracket)
	
When using the pipe clip as the fixed-point attachment, the pipe clip must be closed and fit snug against the pipe. Thus, the sliding of the pipes is largely prevented.	A protective tape must be inserted into the sliding pipe clamps in order to prevent damage to the pipe. ☑ When using the floating suspension brackets, ensure that the pipe can slide inside the pipe clip. ☑ Make sure that the locking system is not completely closed. ☑ Ensure that the pipe guide is not canted.

13.4.2 Fixed points design

+ Fixed points must always be provided where there is a fitting and the fitting must always be supported on both sides.

☑ When using metal valves **up to d63**: Considering 2 clips for attachment purposes.

☑ When using metal valves **starting at d75**: Attachment connected directly to the valve.

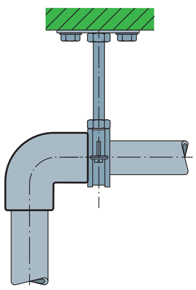
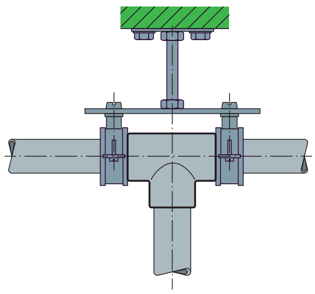
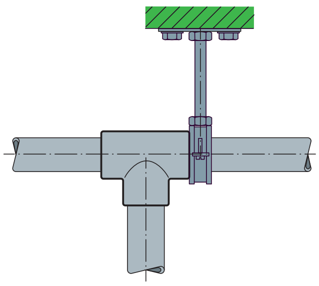
Fixed point attachment for pipes up to d63 and from d75

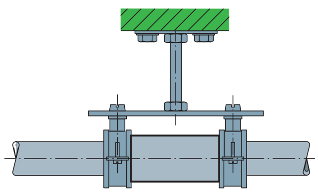
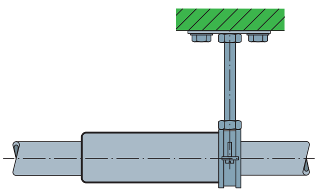
Polybutene (PB): Due to the low expansion forces, commercially available pipe clips with PVC insert tapes are sufficient for this plastic pipe **up to d63**.

TIV.27 **Fixed points design**

Dimensions
≤d63

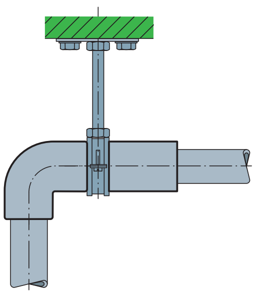
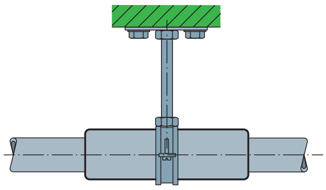
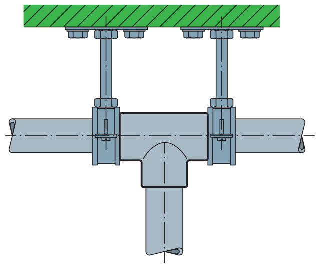
Variants

Variant A	Variant B	Variant C
		

Variant D	Variant E
	

Dimensions
≥d75

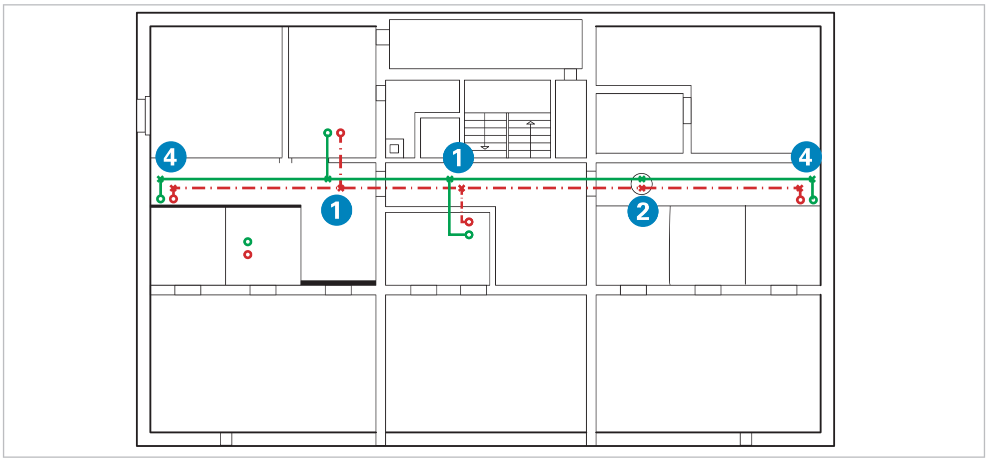
Variants

Variant A	Variant B	Variant C
		

13.4.3 Fixed points for the distribution lines in the basement

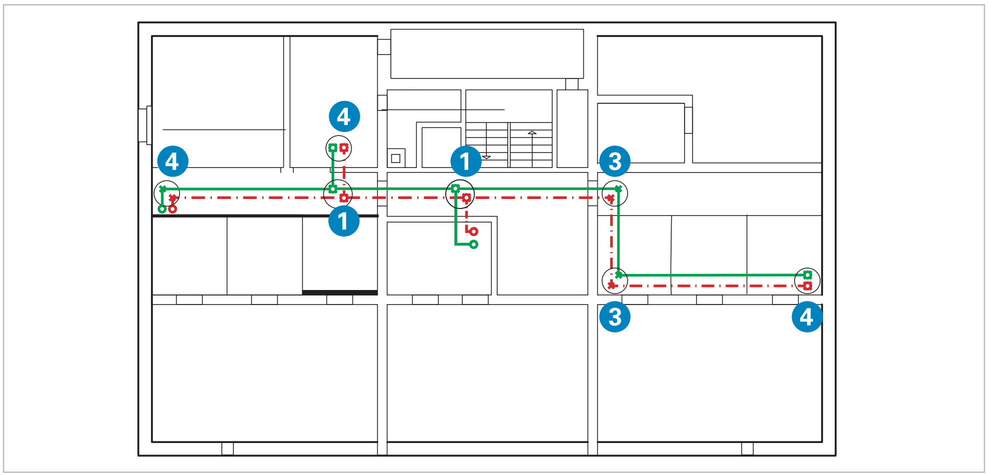
Rigid assembly

Rigid assembly and fixed point arrangement at pipe branches and along the length of the pipeline



GIV.65
Design of fixed points (FP)

1. FP on tee
2. FP in the pipeline
4. Fixed points in areas of directional change (depending on the expansion of the pipe riser zone)



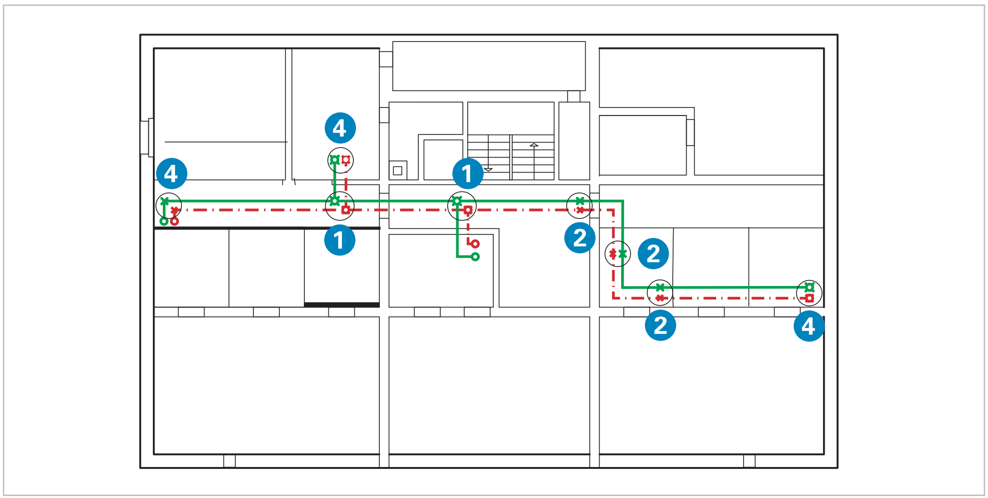
GIV.66
Design of fixed points (FP)

1. FP on tee
2. FP in the pipeline
3. FP if directional change
4. Fixed points in areas of directional change (depending on the expansion of the pipe riser zone)

Combined assembly (rigid/with flexible pipe leg)

Some segments of the pipelines can be assembled **partially rigid** and some segments can be assembled **partially as flexible pipe leg.** The fixed points are used at pipe branches and along the length of the pipeline.

→ In order to ensure the deflection of the pipeline: In the area of flexible pipe legs, pipe saddles must **not** be installed.



GIV.67
Design of fixed points (FP)

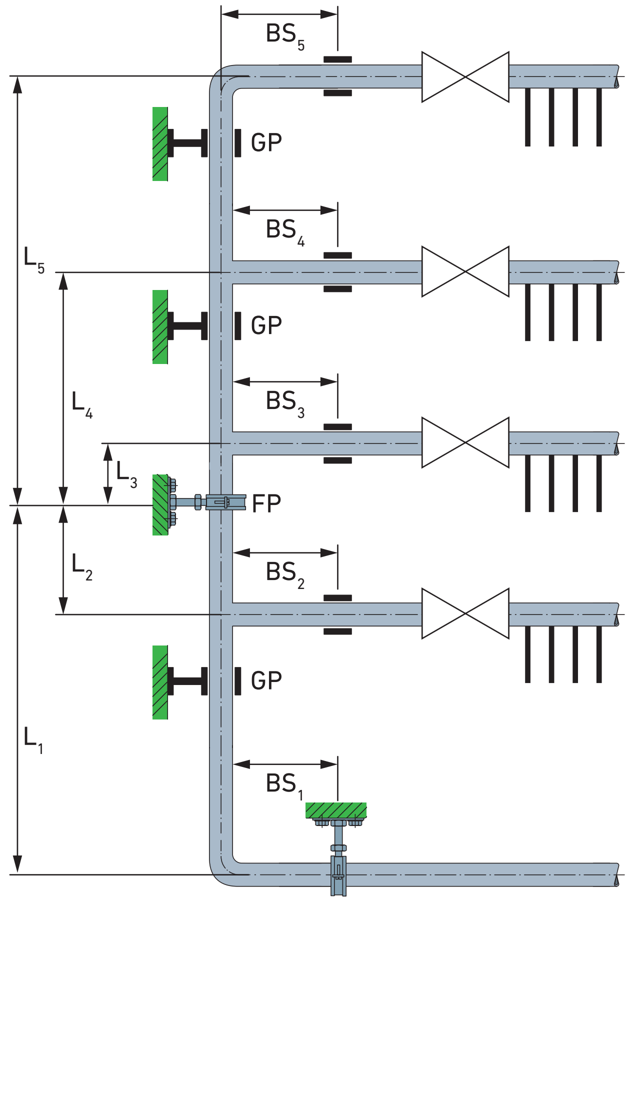
1. FP on tee
2. FP in the pipeline
3. FP if directional change
4. Fixed points in areas of directional change (depending on the expansion of the pipe riser zone)

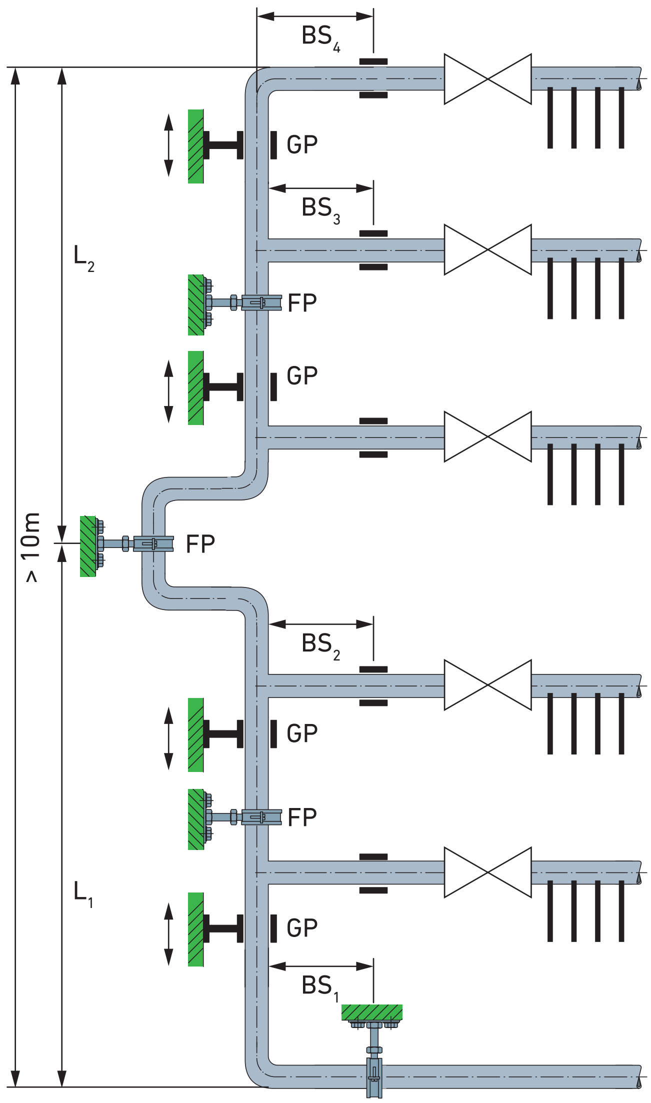
13.4.4 Fixed points and floating points when using riser pipes

If riser pipes are leading up to several storeys and accordingly have multiple fixed points (FP), the change of length between the individual fixed points must be absorbed by the flexible pipe leg (BS). The sliding pipe clamp mounted to the horizontal pipe affects the **vertical** expansion of the pipe similar to a fixed point (FP). Here, compliance with the spacing of the required flexible pipe leg is mandatory.

Examples – Basic design of fixed points and floating points

TIV.28 **Spacing of fixed points and floating points in a riser pipe**

<table>
<tr><th>Riser pipe
starting at a height of 10 m</th><th>Riser pipe
starting at a height of 10 m</th></tr>
<tr><td>


</td><td>


</td></tr>
<tr><td>Up to a riser pipe height of 5 m, neither a U-shaped expansion loop nor a fixed point shall be installed along the riser pipe.
Up to a riser pipe height of 10 m, a U-shaped expansion loop can be omitted. In the middle of the riser pipe, however, a fixed point (FP) must be installed.</td><td>Starting at a ascending pipe height of 10 m, a U-shaped expansion loop with fixed points (FP) must be installed at intervals of 10 m.</td></tr>
</table>

L_{1-5} Pipe length between fixed point and deflection
FP Fixed point
BS_{1-5} Flexible pipe leg
GP Floating point (with sliding pipe clip)

13.4.5 Fixed points when using riser pipes (plastic)

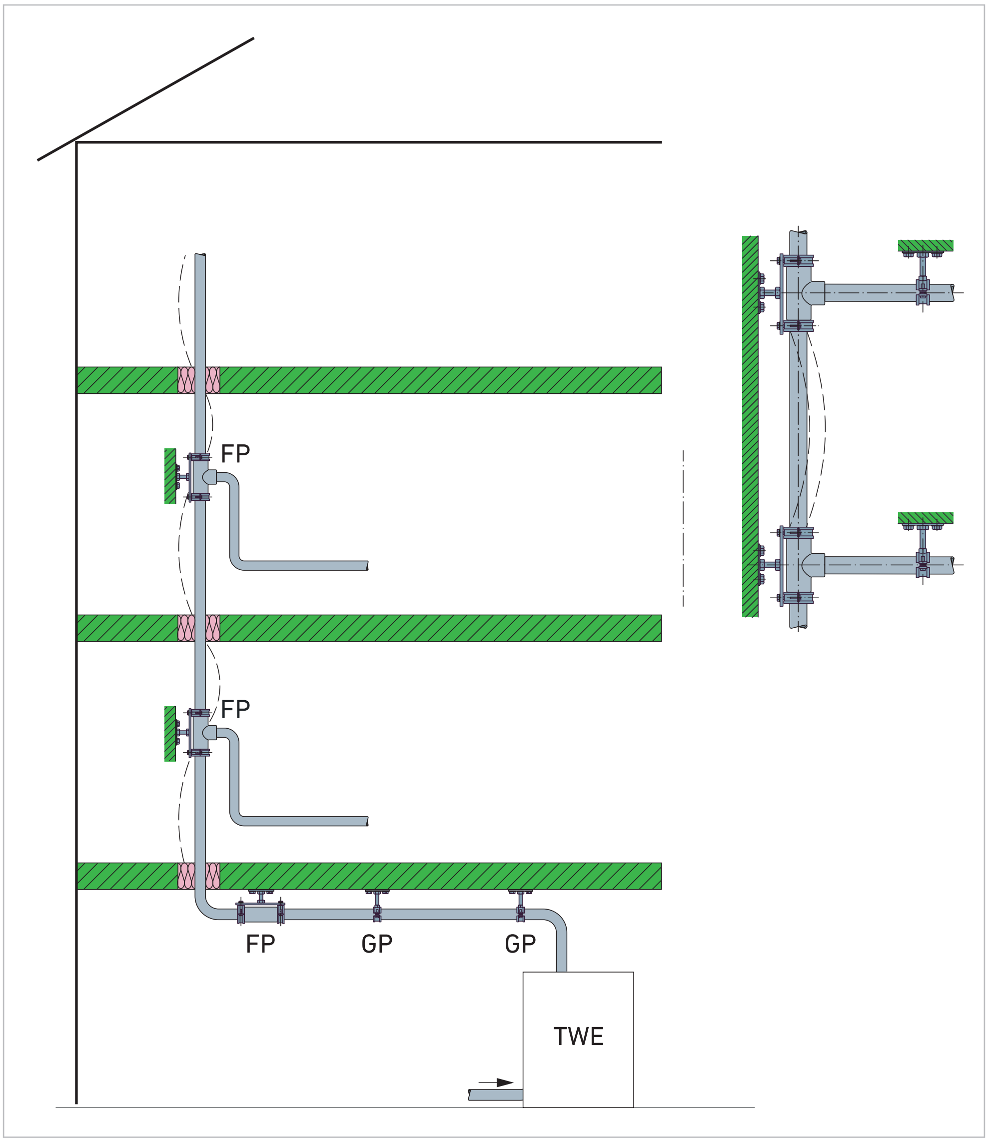
Pipes can be installed in a pipe shaft or flush with the wall **without pipe saddle**.

The **fixed point** is an attachment that prevents axial movement of the pipe and pipe clip in any direction (impact and tensile forces).

☑ Place pipe attachments immediately after leaving each floor (above or below the tee).
- If the storey outlet is at the level of the middle of the room (about 0.4 m):
  = 1 pipe attachment per storey
- If the tee is at the height of the top edge of the pipe ceiling:
  = 2 pipe fittings

☑ Only flexible insulation (e.g. Armaflex, glass or rock wool or the like) must be used for hot water riser pipes.

☑ Use suitable pipe attachments to ensure that a fixed point is created at the lowest and highest tee location (floor exit).



GIV.68
Attachment of pipelines (without tray)

TWE	DHW heater
GP	Floating point
FP	Fixed point

13.4.6 Expansion and fixed point forces

During the planning and installation of pipelines, in addition to the thermally induced change of length, the occurring tensile forces, in particular in the case of a rigid assembly, must also be taken into account. Depending on the pipe dimension, these forces can have a significant impact on the required fixed point attachment.

Fixed point forces if using a rigid assembly

In a rigid assembly, the forces acting on the fixed points are much higher than in the flexible pipe leg assembly. For larger wall and ceiling spacings, an additional support structure is required.

In a **rigid assembly,** the occurring expansion forces are transferred from the fixed point attachment to the structure. The initial expansion forces that occur during a **rigid assembly** change over time to tensile forces, depending on the stress caused due to temperature changes. Therefore, when designing the fixed point attachment, it must be ensured that not only **expansion forces** but also **tensile forces** can be absorbed.

$$F_R = A_R \cdot E \cdot \varepsilon$$

If the **load case thermal expansion is use**, the following applies:

$$\varepsilon = \alpha \cdot \Delta T$$

Force acting on fixed point:

$$F_{FP} = F_R$$

F_R	Expansion force of pipe [N]
A_R	Surface of the circular ring of the pipe wall [mm²]
E	Modulus of elasticity [N/m²]
ε	Component for the prevented longitudinal expansion of the pipe (dimensionless)
α	Coefficient of thermal expansion of the pipe material [mm/(m·K)]
ΔT	Temperature difference [K]
F_{FP}	Fixed point force [N]

Sample calculations for a variety of pipe materials

$$F_R = A_R \cdot E \cdot \varepsilon = \frac{(d_a^2 - d_i^2) \cdot \pi}{4} \cdot E \cdot \alpha \cdot \Delta T$$

F_R	Expansion force of pipe [N]
A_R	Surface of the circular ring of the pipe wall [mm²]
E	Modulus of elasticity [N/m²]
ε	Component for the prevented longitudinal expansion of the pipe (dimensionless)
α	Coefficient of thermal expansion of the pipe material [mm/(m·K)]
ΔT	50 K
d_a	External diameter of pipe [mm]
d_i	Internal diameter of pipe [mm]

TIV.29 **Expansion force and fixed-point force for different types of pipes**

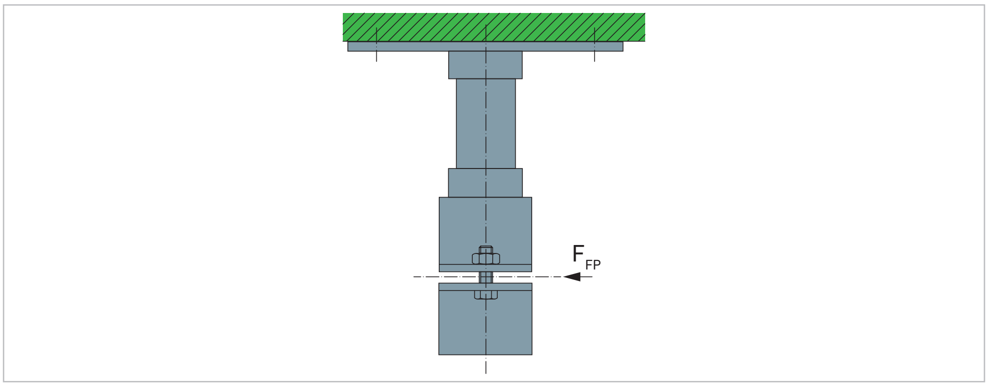
Expansion force of pipe F_R [N]	Fixed point force F_{FP} [N]	Type of pipe	Ratio factor	Pipe
3047	1185	INSTAFLEX, PB pipe	1.0	d63 × 5.8
8814	4407	PE-X pipe	2.9	d63 × 8.6
12462	6231	PP-R pipe	4.1	d63 × 10.5
17446	8723	PVC-C pipe	5.7	d63 × 7.1
52576	26288	Composite pipe	17.3	∅50 × 4
81808	40904	Steel pipe	26.9	2″ (60, 3/53)
35286	17634	Copper pipe	11.6	∅54 × 2
58290	29154	Stainless steel pipe	19.1	∅54 × 2

Fixed point forces when assembling the flexible pipe leg

+ In the flexible pipe leg assembly, the forces acting on the fixed point forces are much lower than in the rigid mounting.

$$F_R = \frac{12 \cdot \Delta l \cdot E \cdot J_R}{BS^3} \qquad J_R = (d_a^{\,4} - d_i^{\,4}) \cdot \frac{\pi}{64}$$

Δl	Length [mm]
E	Modulus of elasticity [N/m^2]
J_R	Area moment of inertia [mm^4]
BS	Length of flexible pipe leg [mm]



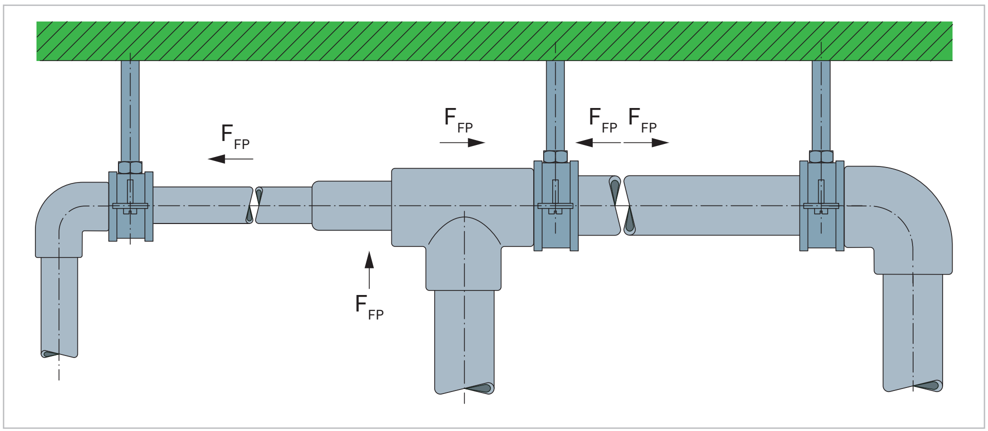
GIV.69
Determining the fixed point forces
F_{FP} Fixed point force

Fixed point forces occurring at the point of a pipe reduction

+ When reducing the pipeline's cross-section by two or more dimensional sizes, a fixed point must be installed at the location where the reduction takes place.

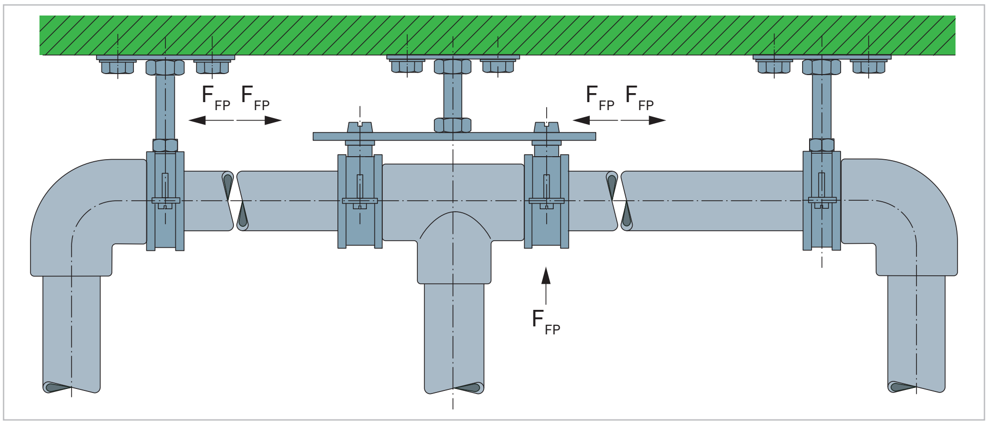
When determining the forces, the following formula applies:

$$F_{FP} = F_R$$



GIV.70
Fixed point if the pipeline's diameter is reduced
F_{FP} Fixed point force

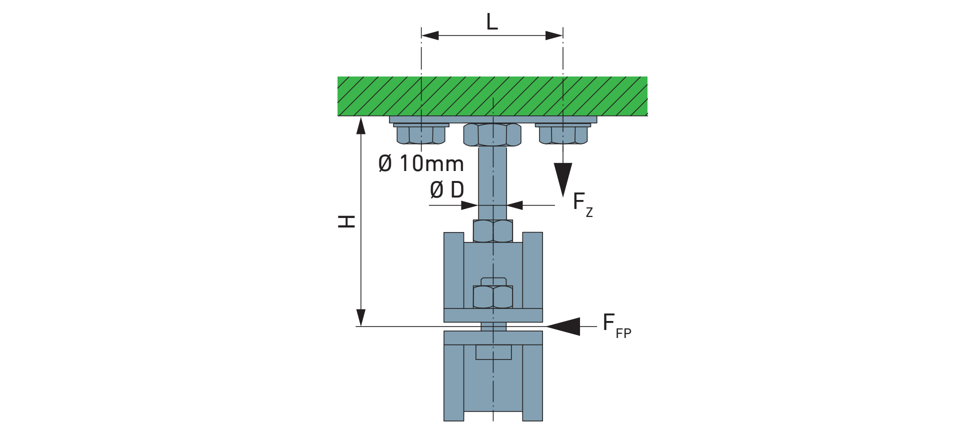
In a pipeline with several fixed points, only the two outer points are subject to load.



GIV.71
Variant
F_{FP} Fixed point force

Calculation of the retention force of screws

The mounting screws (or dowels) of a fixed point must withstand the occurring the forces. As an approximation, these forces are as follows:



GIV.72
Fixed point attachment

- D Diameter of the attachment
- H Pipeline spacing between ceiling and wall
- L Screw spacing
- X Number of tensioned screws
- F_{FP} Fixed point force
- F_Z Holding force of screws or dowels

Formula for calculating the retention force of screws

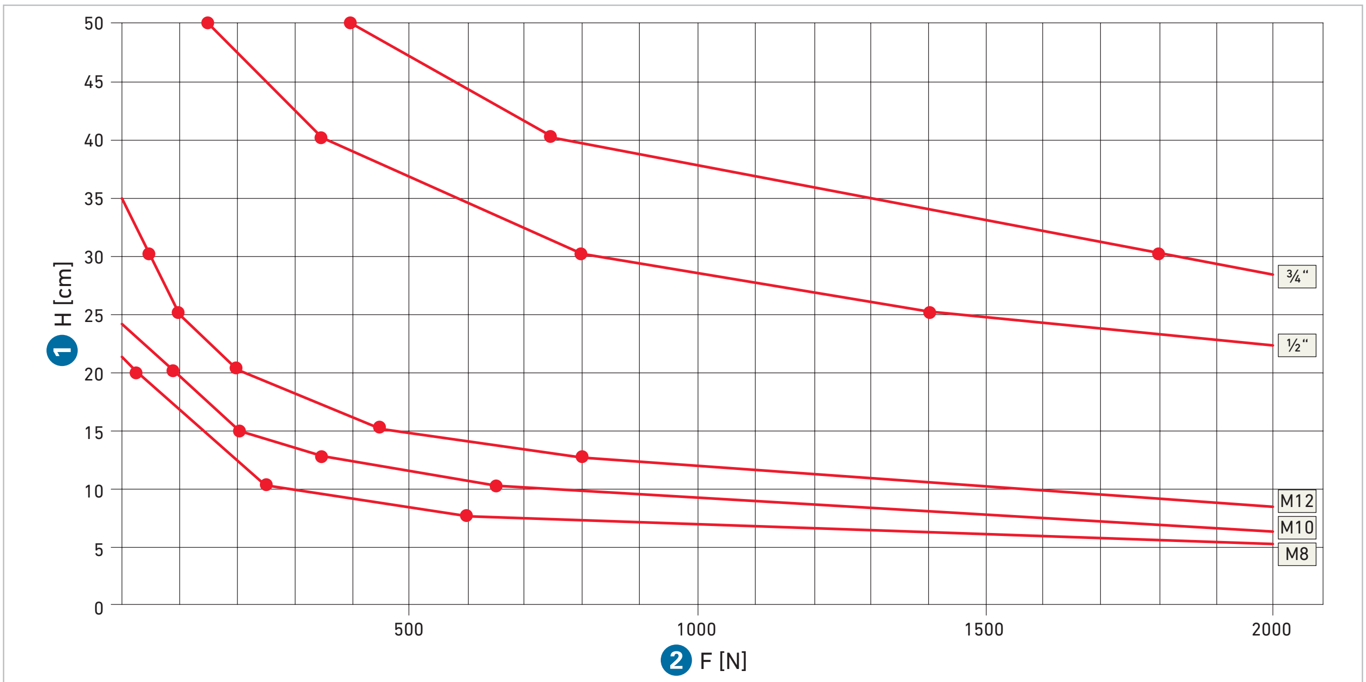
$F_Z = (F_{FP} \cdot H) / (L \cdot X)$

- X if using 2 hole base plate: 1
- X if using 4 hole base plate: 2

Mounting diameter of the pipe clip on the base plate

The diameters indicated in the diagram are **standard values** based on a deflection of approx. 5 mm.

☑ For exact calculations: Compliance with the information provided by the manufacturer of the pipe clips is mandatory.



GIV.73
Diameter of pipe clips

1. Ceiling/wall clearance
2. Tension/elongation force

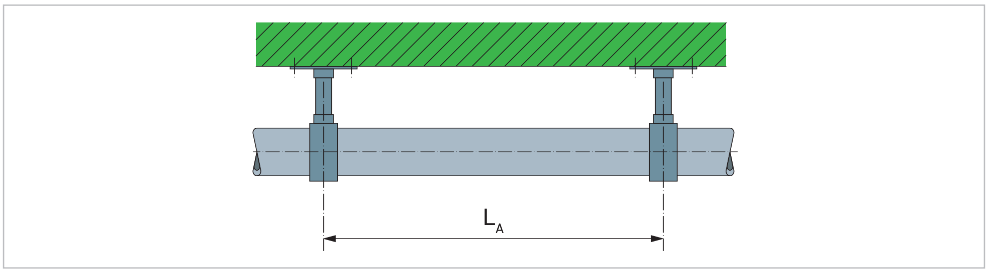
13.5 Calculations at the pipe

In order to optimise the support and direction of the pipeline, the spacing between the pipe support and the guides must be determined.

13.5.1 Width between pipeline spans

$$L_A = f_{LA} \cdot \sqrt[3]{\frac{E \cdot J_R}{q}}$$

L_A	Pipe span [mm]
E	Modulus of elasticity [N/m²]
J_R	Area moment of inertia [mm⁴]
q	Line load [N/m]
f_{LA}	Deflection component (guide value, selectable between 0.8 and 0.92)



GIV.74
Determining the pipeline span

13.5.2 Bending stress

$$\sigma_B = \frac{q \cdot L_A^2}{8 \cdot W_R} \qquad W_R = \frac{(d_a^4 - d_i^4)}{d_a} \cdot \frac{\pi}{32}$$

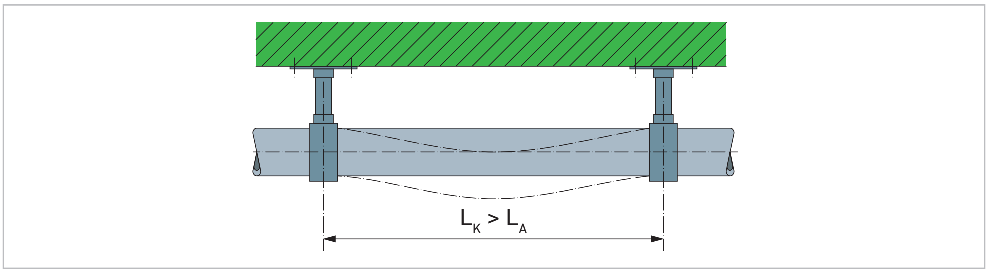
L_A	Pipe span [mm]
W_R	Resistance torque against the deflection [mm³]
q	Line load [N/m]
σ_B	Bending stress

13.5.3 Permissible buckling length when using a rigid pipe assembly

$$L_K = 3{,}17 \cdot \frac{\sqrt{J_R}}{\varepsilon \cdot A_R}$$

L_K	Permissible buckling length, calculated using safety factor SK = 2 [mm]
J_R	Area moment of inertia [mm⁴]
ε	Component for the prevented longitudinal expansion of the pipe (dimensionless)
A_R	Surface of the circular ring of the pipe wall [mm²]

If pipelines are installed rigid, that is to say, that an axial expansion is not possible, the determined pipe span L_A must be compared with the allowable buckling length L_K. L_A must not exceed dimension L_K.

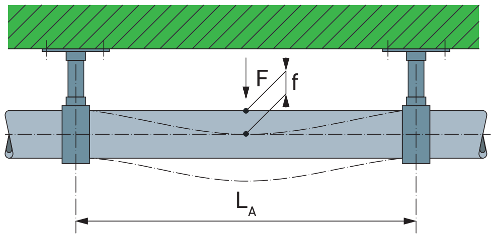


GIV.75
Pipe span and buckling length

13.5.4 Deflection of suspended pipes

$$f = \frac{F \cdot L_A^3}{48 \cdot E \cdot J_R}$$

f	Deflection [mm]
F	Acting force in the centre of gravity [N]
L_A	Pipe span [mm]
E	Modulus of elasticity [N/m^2]
J_R	Area moment of inertia [mm^4]



GIV.76
Deflection

13.6 Installation

13.6.1 Installation in the building structure

More information on installing the pipes in the building's structure and how to install controls and instruments
➨ Part V 'Build', Section 'Installation'

Mounting in slots

➕ **Although current regulations prohibit mounting in slots, it is still present in modernisation and refurbishment areas. In new buildings, this method is mainly used when installing pipes on top of or buried in the raw concrete floor. Here, an assembly in the wall slot or in the wall recess is recommended.**

Suitable assembly aids allow for the rational attachment of controls and instruments in the wall slot or in the wall recess. When using the pipe-in-pipe system, a subsequent protection of the pipe against the masonry is not necessary.
When using this installation method:

☑ Horizontal wall slots must be avoided.
☑ Compliance with the requirements for the relevant insulation regulations is mandatory.

Disadvantages and limitations

The disadvantages and problems of installations that are integrated into the building structure are briefly discussed here.
Recesses and slots weaken the cross-sections of any masonry and reduce a wall's load-bearing capacity causing stresses in the structural parts of a building. In particular, **chiseling out** such wall slots and recesses creates cross-sections and shapes that may be difficult to control. These adversely affect not only the statics of the masonry, but also the sound and heat protection.

☑ If recesses and slots must still be created to a limited extent, then they may only be **brick-walled** or created by using a **mortising** method.

Table [TIV.30] illustrates the **permissible sizes** of vertical wall slots and recesses in the masonry. These recesses may be produced without a structural analysis to be provided separately.

TIV.30 **Permissible sizes of vertical wall slots and recesses**

<table>
<tr><th rowspan="3">Wall thickness [mm]</th><th colspan="2">Subsequently made slots and recesses[c]</th><th colspan="4">Slots and recesses made during the erection of the masonry</th></tr>
<tr><th rowspan="2">Maximum depth[a] $t_{ch,v}$ [mm]</th><th rowspan="2">Maximum width[b] (Single slot) [mm]</th><th rowspan="2">Remaining minimum wall thickness [mm]</th><th rowspan="2">Maximum width[b] [mm]</th><th colspan="2">Minimum spacing of the slots and notches</th></tr>
<tr><th>of openings</th><th>among each other</th></tr>
<tr><td>115 to 149</td><td>10</td><td>100</td><td>–</td><td>–</td><td rowspan="7">≥2-times the slot width or ≥240 mm</td><td rowspan="7">≥ Slot width</td></tr>
<tr><td>150 to 174</td><td>20</td><td>100</td><td>–</td><td>–</td></tr>
<tr><td>175 to 199</td><td>30</td><td>100</td><td>115</td><td>260</td></tr>
<tr><td>200 to 239</td><td>30</td><td>125</td><td>115</td><td>300</td></tr>
<tr><td>240 to 299</td><td>30</td><td>150</td><td>115</td><td>385</td></tr>
<tr><td>300 to 364</td><td>30</td><td>200</td><td>175</td><td>385</td></tr>
<tr><td>≥365</td><td>30</td><td>200</td><td>240</td><td>385</td></tr>
</table>

(from DIN EN 1999-1-1)

a Wall slots up to max. 1 m above the floor surface are permitted if the wall thickness is ≥240 mm, the depth is up to 80 mm and the width is 120 mm.
b In a wall measuring 2 m long, the total width of slots shown in column "maximum width (single slot)" and the width shown in column "maximum width" must not exceed the dimension listed in column "maximum width". If the wall lengths are <2 m, the values in column "Maximum width" must be reduced proportionally to the wall length.
d Spacing of slots and recesses of openings ≥115 mm

13.6.2 In-wall installation

Advantages

In-wall installations can be utilised in **wet construction** or **dry construction**. The dry construction of in-wall installations has the advantage that any concerns arising at the interfaces between the building trades, interior design and building technology personnel are avoided.

☑ When using a dry construction, pipes should be mounted **to the in-wall construction,** if feasible.
- Thus, the introduction of structure-borne noise are reduced in the building.

If using light-weight in-wall installations

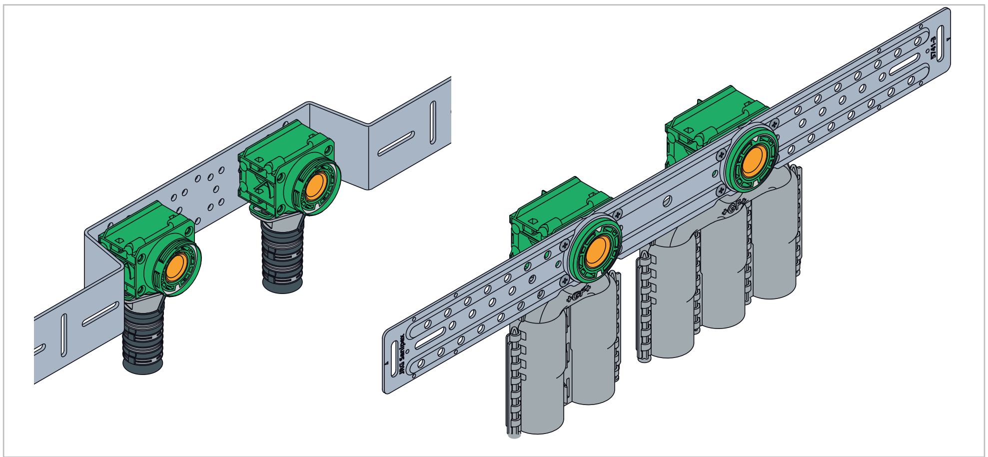
Incorrectly installed pipes can contact individual studs of the frame work during pressure surges and generate unwanted noise.

☑ The drinking water pipes must be installed in order to ensure that the spacing between the studs of the frame work and the pipe is sufficient to prevent such noises.

When installing pipelines on individual floor levels inside of lightweight walls or wooden panels, special care must be taken. Fittings generate forces that must be possible to efficiently induce or transfer through the fitting's attachment and into the framework. The pipe-in-pipe system must be appropriately secured in the cavities, using proper fastening material.

In-wall installations (conventional design)

When utilising a conventional in-wall installation, a protective conduit is used to sheath the pipes, which are then attached on the installation wall and fixed with appropriate material (brackets or similar attachment methods). The connections for the controls and instruments are attached flush onto the framework's installation wall, whereby these connectors must bridge the distance between the framework's installation wall and the in-wall panel. All mounting material is part of the system and is supplied.



GIV.77
Examples: Assembly with spacers/ mounting rails

13.6.3 Installation on top of a raw concrete ceiling

When installing on a supporting surface (concrete surface), which serves to accommodate a floating screed:

☑ Acoustic bridges and/or fluctuations in the screed thickness must be avoided.
☑ When installing pipelines on a supporting surface or inside the insulation:
  - Pipes must be installed to remain dimensionally stable, or they must be attached with fasteners.
☑ A level surface must be created in order to install the insulation layer; smoothing the surface may be necessary.

If two pipes are installed parallel to each other inside the insulation, using a dimensionally stable cover:

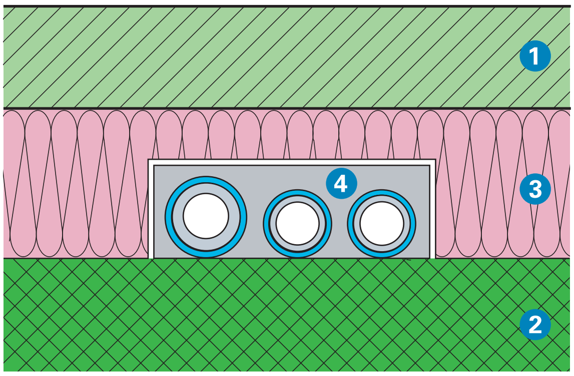
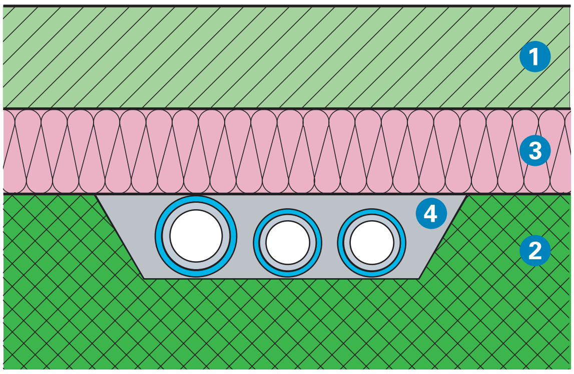
☑ Compliance with the requirements for **impact sound insulation** is mandatory.

The run of the pipelines can already be considered during the **planning phase** and prepared by providing throughs in the unfinished concrete floor for the planned routing of the pipes. The pipes can then easily cross the ceiling inside this trough.

When installing pipelines in the trough on the raw concrete ceiling or in the insulation:

☑ In this case, a protective conduit or a pipe with insulation must be used.
☑ The requirements for pipe insulations for cold water and the Energy Saving Ordinance (EnEV) for hot water acc. to DIN 1988-2 must be considered and compliance is mandatory.

TIV.31 **Installation on top of a raw concrete ceiling**

Installation on top of a raw concrete ceiling, in the insulation or compensation layer	Installation in a ceiling tray (ceiling slot)
	
Installing the pipes on the raw concrete floor in the insulating or levelling layer with dimensionally stable embedding	Installing the pipes in the ceiling trough with dimensionally stable embedding

1 Screed
2 Concrete ceiling
3 Insulating layer (thermal, impact sound)
4 Embedment

13.6.4 Installation in the raw concrete ceiling

+ New developments open up new doors for the planning engineer or pipe fitter. These developments not only contribute to the rationalisation, but also improve the efficiency. One example of this is the pipe-in-pipe system for raw concrete ceilings. It simplifies the installation significantly and thus shortens the assembly work. Inserting the pipeline into the raw concrete floor has proved to be one of the most advantageous methods.

The main advantage of the pipe-in-pipe systems is the separation of the medium-carrying pipe from the enclosing structure by using the protective conduit. If installed properly, the bending radii are observed and the installation aids provided are used correctly, mechanical damage to the pipes is ruled out. If a pipe must be replaced, this is possible at any time.

Safe assembly

- ☑ Compliance with the general requirements for installing pipes in concrete ceilings is mandatory.
- ☑ Do not exceed 6 directional change for one 90° turn.
- ☑ Bending radius R ≥ 8 · d must be observed.
- ☑ The protective conduits must cover the entire length of the pipe.
- ☑ If installing in a cavity: Pipes must be secured properly, especially in the areas where directional changes take place.
- ☑ Make sure to prevent dirt from settling between the protective tube and the inner pipe.
- ☑ Threaded connections installed flush with the wall must be protected from moisture and contamination.

Installation in the raw concrete ceiling
For detailed information on the installation with pipe transfer pieces and shuttering guides see:
➨ Part V 'Build', Section 'Installation'

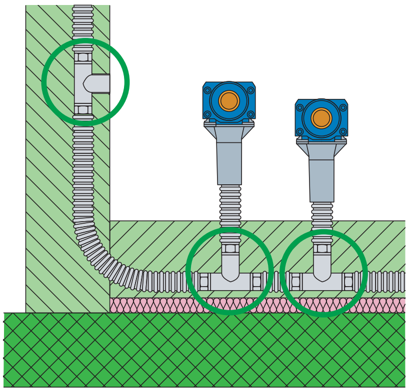
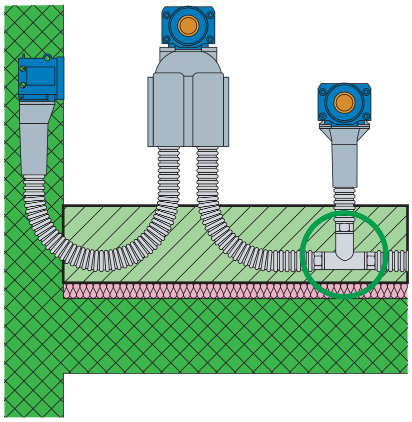
13.6.5 Interchangeability of pipelines on individual floor levels

In contrast to installations with rigid pipes, flexible plastic pipes offer the possibility of installing the flexible pipe-in-pipe pipelines in such a way that the medium-carrying pipe can be replaced in case of mechanical damage (e.g. drilled through).

If interchangeability is **not** important, normal pipe insulation can be used instead of the thermowell and the cover housing can be omitted at the valve connection if the component is otherwise protected against damage and external influences as well as for noise reduction.

☑ Valve connections in walls without reinforcement and in screed can be made with or without housing. However, valve connections without housing must be protected against mechanical and chemical damage in the same way as other connection points (see also ➨ chapter [13.1] 'Protection against environmental influences and building materials').

TIV.32 **Connections to controls and instruments**

Connections to controls and instruments without housing	Connections to controls and instruments with housing		
			Screed/wall **without** reinforcement
			Concrete wall/ceiling with reinforcement
			These components must be protected.

Information on the assembly

→ In order to guarantee exchangeability, compliance with the following instructions is mandatory.

☑ Dirt, stone chips, cement sludge, etc. must not penetrate into the annular gap between the medium and protective conduit.

Bend radii of a pipeline section

☑ **Bend radius** between two connections:
- Bending radius R ≥ 8 · d must be maintained.

☑ If more than 4 changes of direction are required:
- Larger bending radii must be selected in order to ensure exchangeability.

Pipe attachment in cavities

Adequate attachment of the pipes, especially in the area of elbows and in cavities, is a prerequisite for the exchangeable installation.

☑ Pipe elbows must be attached, using at least two to three pipe clamps.

☑ Fix straight pipes at a distance of 0.6 m.

Distributor

☑ Distributor must be installed with easy access in mind.

☑ If installed inside wall: **Provide access openings**.

14 The z dimension method

14.1 Introduction

For years, it has already proven itself in practice – the z dimension assembly method developed by GF in cooperation with designers experienced in the daily business of domestic and industrial pipe installations. As a basis for efficient planning, work preparation and prefabrication, this method makes work much easier for the forward-thinking fabricator and saves a lot of money:

- Reliable estimate of personnel requirement
- Simplified administrative processing
- Makes calculations and billing easier
- Optimised machine use
- In-house storage of fittings and pipes is drastically reduced
- Transport optimisation, elimination of material-related «distribution times»
- Comprehensibility of the system parts by representing them on 30° isometric drawing paper

Requirements

The z dimension method requires compliance with the following instructions:

- Exact explanation of the pipeline routing
- Knowledge of the design dimensions of controls and instruments, equipment and their locations
- Coordination with architect, planner, construction manager and other companies involved in the construction, whose work can influence the routing of the installation
- Utilisation of fittings with constant dimensional accuracy and axiality, as produced by GF
- Standard-compliant pipe connections, as they can easily be created with GF fittings and pipes.

14.2 z dimension and measurement method

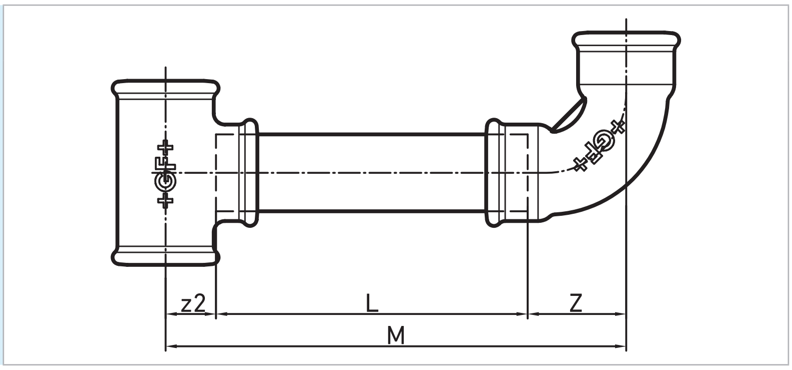
The uniform measuring method and the determined z dimension are the core of this procedure. The z dimension is the "design dimension" entered by the installer. With his help the installer calculates the exact pipe length between fitting and/or controls and instruments. All pipe parts are characterized by the following dimensions:

- Dimension M
- z dimensions for fittings and controls and instruments
- Design dimension h for fittings with external connection ends

Measurement method

The basis for determining and applying the z dimension is dimension M. The dimension M is the distance between the axes ("centres") of the fittings.

Uniform measurement	Pipe length
Centre – centre = M	$L = M - (z_2 + z_1)$



Determining the z dimensions

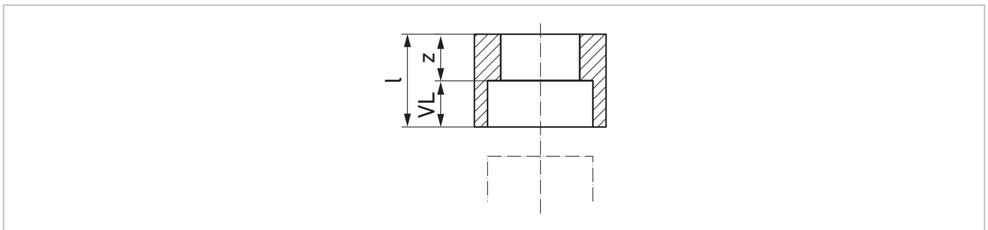
The **z dimension** – also referred to as **installation length** – is the mean distance between the installed end of the pipe and the axis of the fitting or the ends of two installed pipes. The z dimensions derive from the **installation length** minus the average **length of engagement**.

In order to determine the cutting lengths of the pipes, the z dimensions of the fittings are required. These dimensions can be found in the applicable delivery programs and in the online catalogue.

14.3 Dimensions on the fitting

Inner connection ends are referred to as **sockets** and external connection ends are referred to as **spigots**.

Fitting with internal connecting end



GIV.78

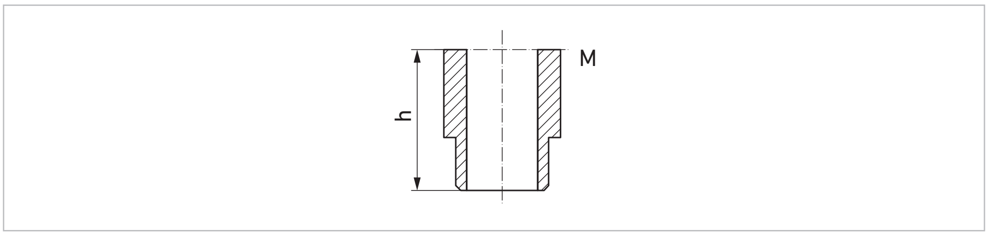
Internal connecting end

- l Overall length of the fitting with socket
- h Overall length of the fitting with spigot
- z **z dimension**
- VL Length of the connection

z dimension	$z = l - VL$

The z dimension is calculated as the difference between the length L minus the connection length VL.

Fitting with external connecting end

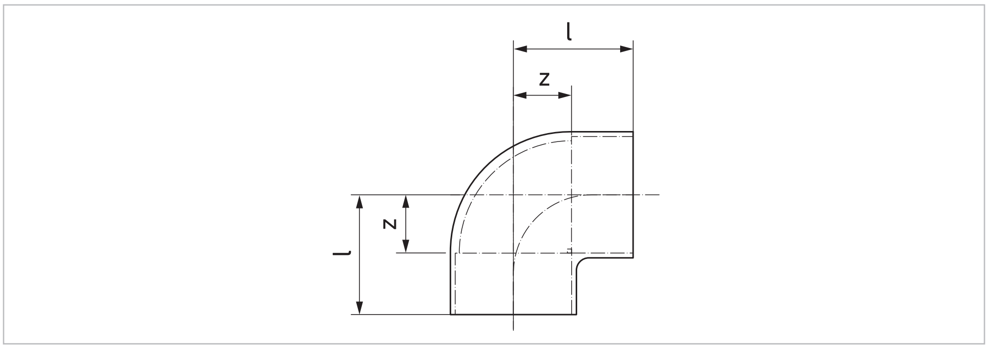


GIV.79
External connecting end

h Design height of fitting

90° angle

with two inner connecting ends (socket)

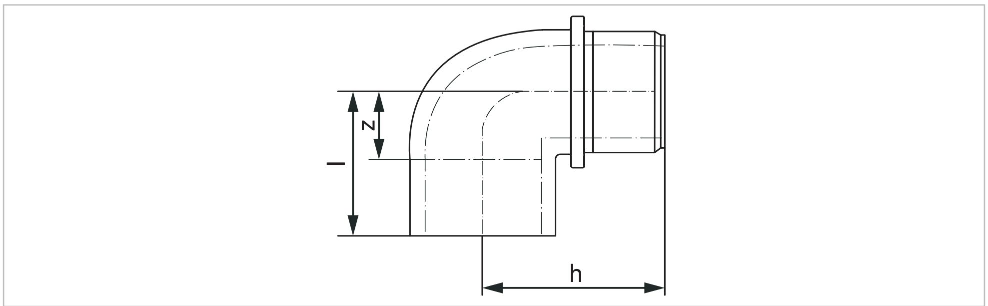


GIV.80
90° elbow (socket)

l Overall length of the fitting with socket
h Overall length of the fitting with spigot
z **z dimension**

90° angle

with internal and external connecting ends (socket – spigot)

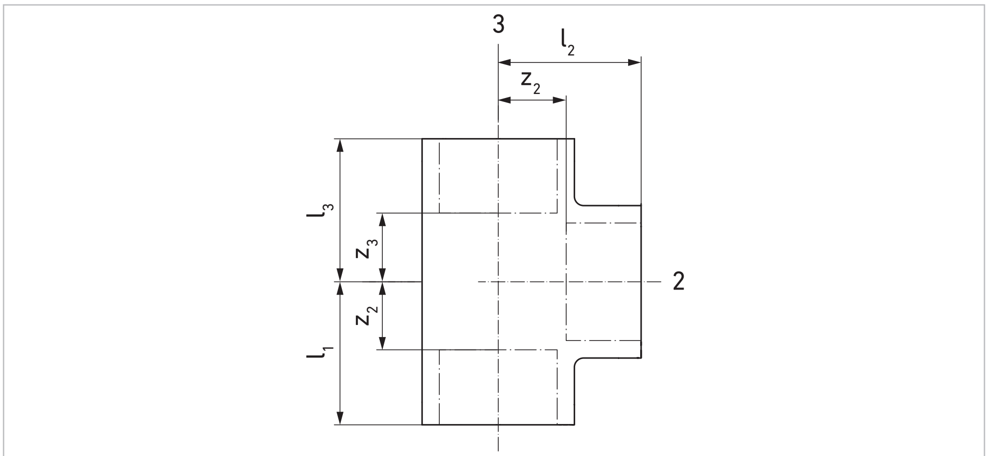


GIV.81
90° elbow (socket/spigot)

l Overall length of the fitting with socket
h Overall length of the fitting with spigot
z **z dimension**

Tee

equal on all sides, regardless whether on discharge side or transition



GIV.82
Tee (equal/reduced)

l Overall length of the fitting with socket
h Overall length of the fitting with spigot
z **z dimension**

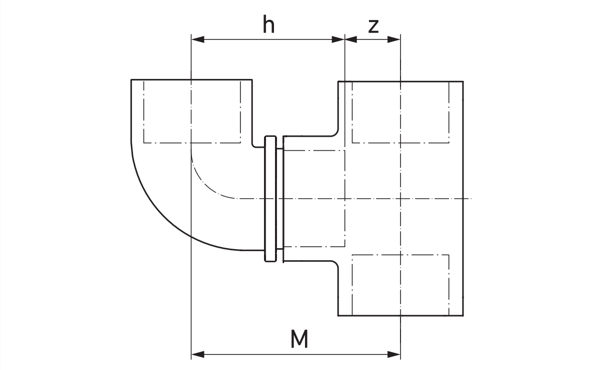
14.4 z dimension for fitting combinations

Application example: Dimension M as a mandatory or variable value

+ The direct connection of two fittings (socket/spigot) results in dimension M.

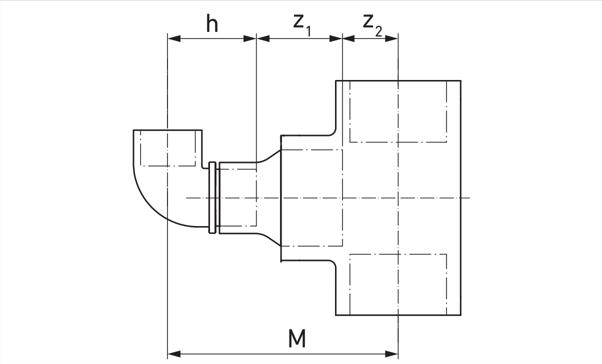
Dimension M if using socket/spigot

M = h + z



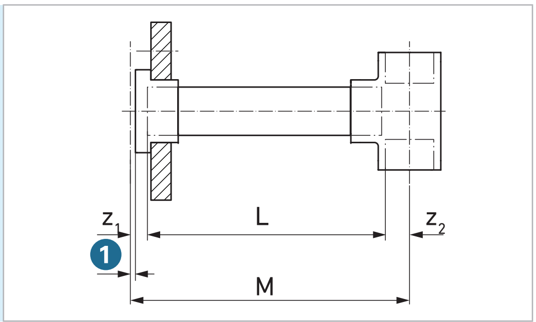
Dimension M if using socket/spigot

M = h + z1 + z2



Dimension M with gasket

M = l + z1 + z2 + ½ gasket



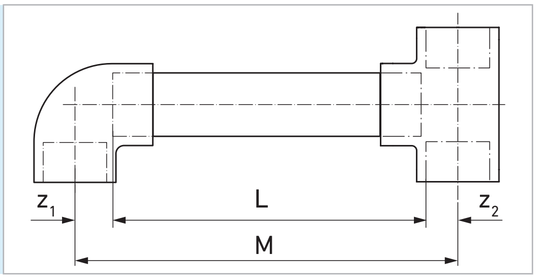
IV

Dimensions M and L

If **dimension M** is considered the system-specific dimension between centre lines, two fittings with a pipe segment length L, must be cut to the determined dimension.

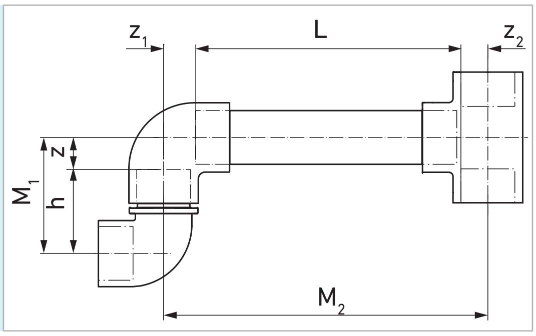
$M = L + z1 + z2$

$L = M - (z1 + z2)$



$M1 = h + z$

$M2 = L + z1 + z2$



Dimension M if using distributors

in image: Example of an INSTAFLEX distributor

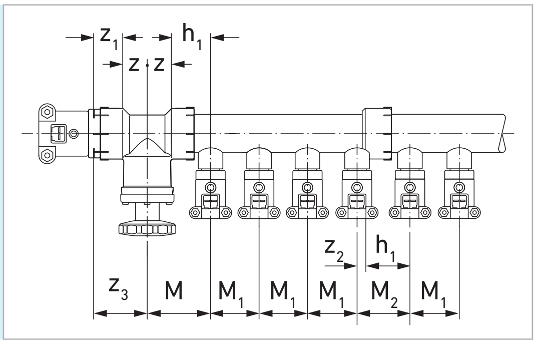
Dimension M1

- if d16 – d16 = 45 mm
- if d20 – d16 = 55 mm
- if d20 – d20 = 60 mm

$z3 = z1 + z$

$M = z + h1$

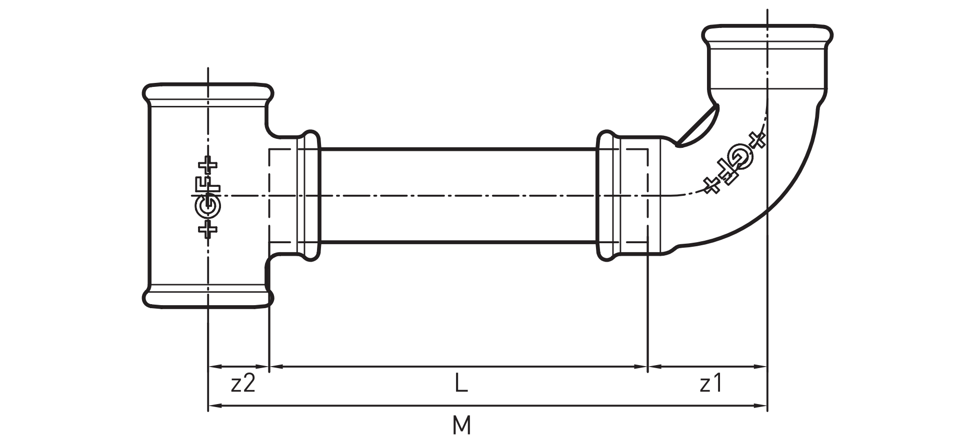
$M2 = z2 + h1$



14.5 Calculation of the length of straight pipelines

Since the length M is measured from centre to centre, it is possible to determine the exact **length of the pipe L** can be calculated, taking into account the standardised **connection length VL** (also referred to as the engagement length) for all pipe parts.

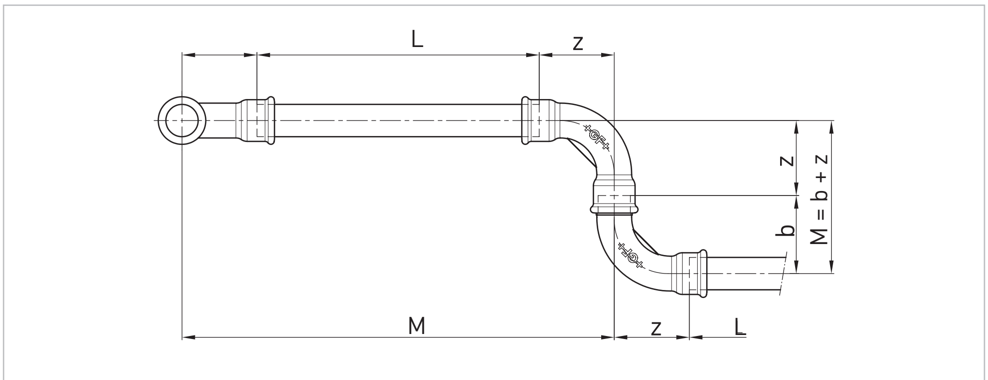
Pipe length	$L = M - (z1 + z2)$



GIV.83
Uniform measurement

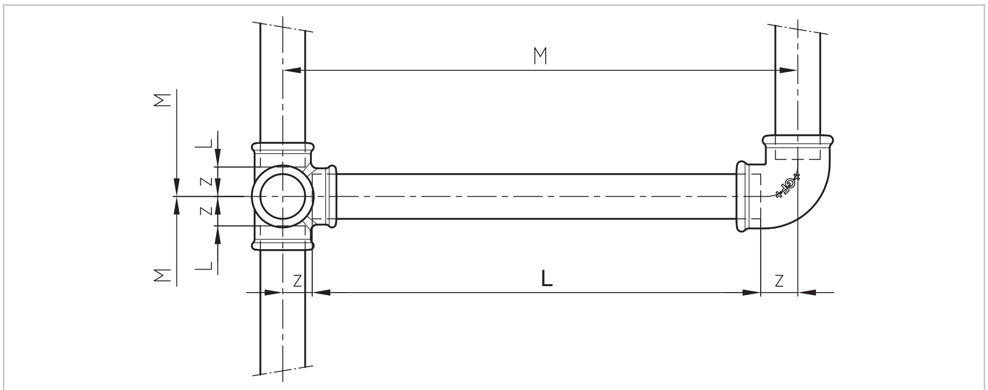
Application example

+ **Exact lengths of pipe threads (connecting or insertion lengths) provide accurate M dimensions.**



GIV.84
Determining the pipe length L

L Pipe length



GIV.85
Determining the pipe length L

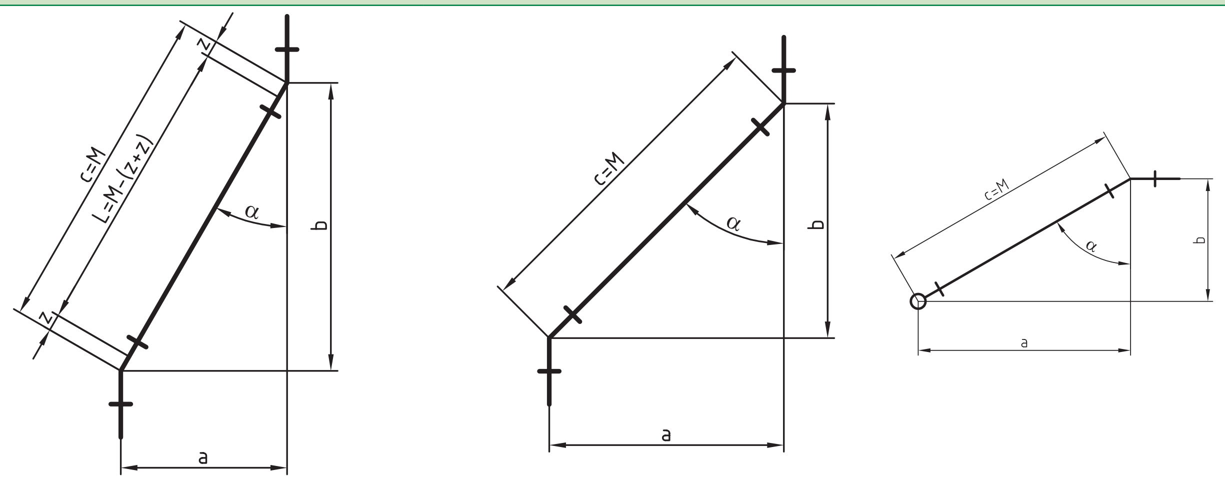
L Pipe length

14.6 Calculation of the length of oblique pipes

Parts of a pipeline that deviate from the vertical or horizontal plane can only be laid out precisely in a few cases. Exact results are obtained by measuring and determining the remaining (triangular) side lengths at right angles.

TIV.33 **Determining the lengths of the sides**

30 °	45 °	60 °



If **oblique segments** are used in the pipeline, the M dimension and the pipe lengths (with the z dimensions) can be determined with the **Factor table** or the **Number table**.

1. Factor table

Angular-dependent **factors** · **dimension a** or **b** (given)
= required **dimensions b** and **c** or **a** and **c**.

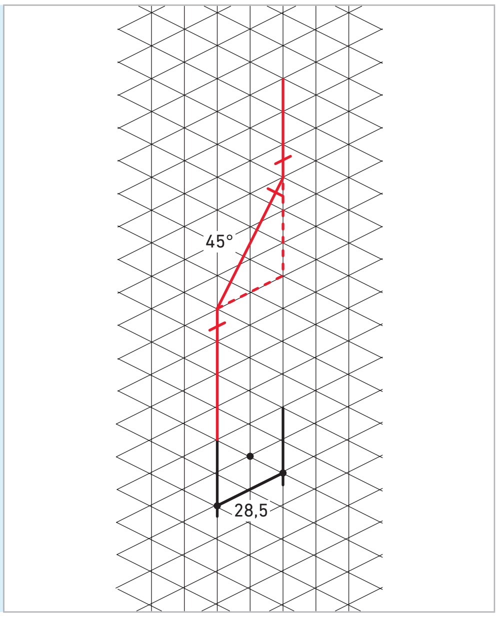
Angles		Dimension a		Dimension b	
		Factor for		Factor for	
α	β	b	c = M	a	c = M
75 °	15 °	0.268	1.035	3.732	3.864
60 °	30 °	0.577	1.155	1.732	2.000
45 °	45 °	1.000	1.414	1.000	1.414
30 °	60 °	1.732	2.000	0.577	1.155
15 °	75 °	3.732	3.864	0.268	1.035

Example

a = 28.5

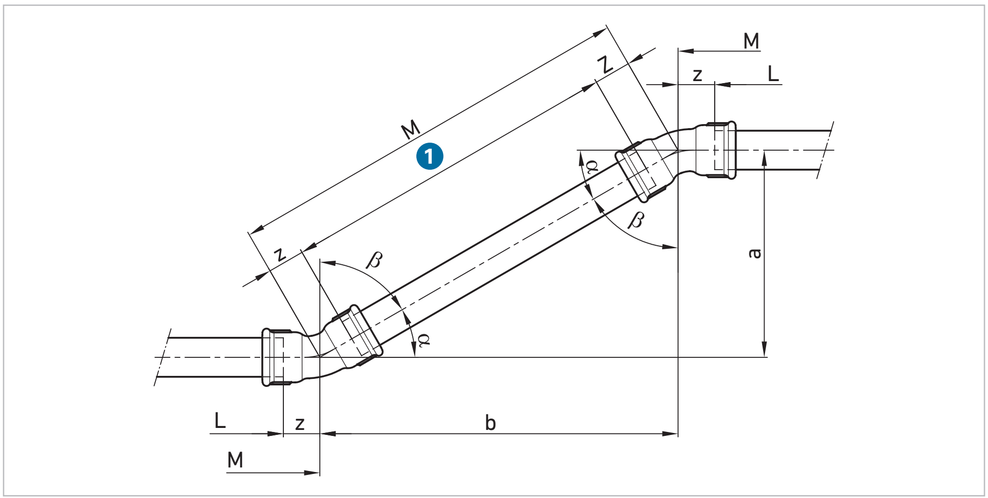
α = 45°

c = M = 28.5 · 1.414 = 40.3



GIV.86
Example

2. Numerical table



GIV.87
Dimensions M and L if using oblique pipelines

1 Pipe length L

The required dimensions b and c can be found in the table columns underneath a, α and β.

TIV.34
Lengths of oblique pipelines

α	45 °		30 °		15 °	
β	45 °		60 °		75 °	
a	b [mm]	c [mm]	b [mm]	c [mm]	b [mm]	c [mm]
1	1	1.4	1.7	2	3.7	3.9
2	2	2.8	3.5	4	7.5	7.7
3	3	4.2	5.2	6	11.2	11.6
4	4	5.7	6.9	8	14.9	15.5
5	5	7.1	8.7	10	18.7	19.3
6	6	8.5	10.4	12	22.4	23.2
7	7	9.9	12.1	14	26.1	27.0
8	8	11.3	13.9	16	29.9	30.9
9	9	12.7	15.6	18	33.6	34.8
10	10	14.1	17.3	20	37.3	38.6
20	20	28.3	34.6	40	74.6	77.3
30	30	42.4	52.0	60	112.0	115.9
40	40	56.6	69.3	80	149.3	154.5
50	50	70.7	86.6	100	186.6	193.2
60	60	84.9	103.9	120	223.9	231.8
70	70	99.0	121.2	140	261.2	270.5
80	80	113.1	138.6	160	298.6	309.1
90	90	127.3	155.9	180	335.9	347.7
100	100	141.4	173.2	200	373.2	386.4
200	200	282.8	346.4	400	746.4	772.7
300	300	424.3	519.6	600	1119.6	1159.1
400	400	565.7	692.8	800	1492.8	1545.5
500	500	707.1	886.0	1000	1866.0	1931.9
600	600	848.5	1039.2	1200	2239.2	2318.2
700	700	989.9	1212.4	1400	2612.4	2704.6
800	800	1131.4	1385.6	1600	2985.6	3091.0
900	900	1272.8	1558.8	1800	3358.8	3477.3
1000	1000	1414.2	1732.1	2000	3732.1	3863.7

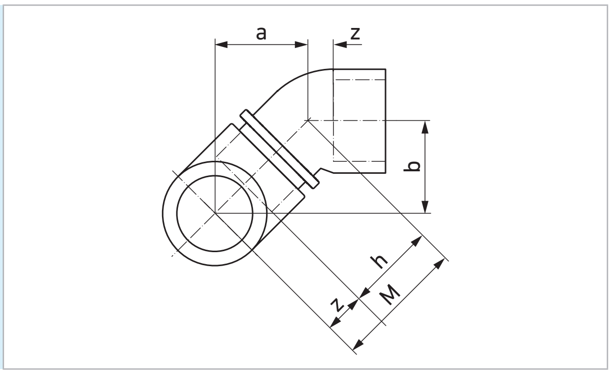
IV

At an oblique intersection, dimension M (M = z + h) can be used in order to determine dimensions a and b.

Dimensions a and b, 45° elbow

M = h + z

a or b = M · 0.707

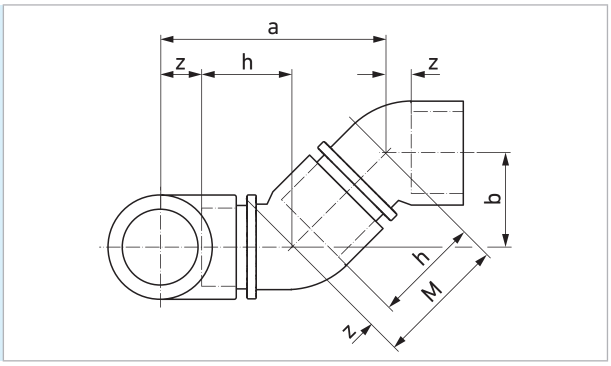


Dimensions a and b, 45° elbow

M = z + h

b = M · 0.707

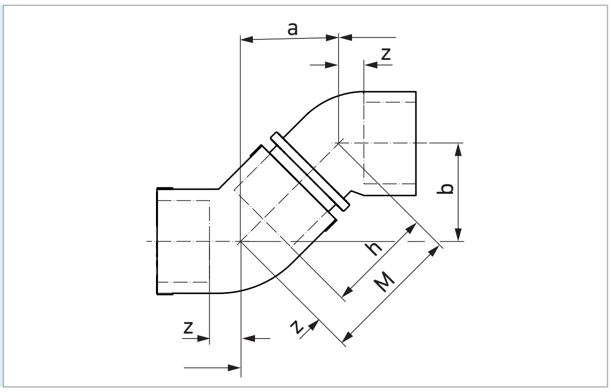
a = M · 0.707 + (z + h)



Dimensions a and b, 45° elbow

M = z + h

a or b = M + 0.707

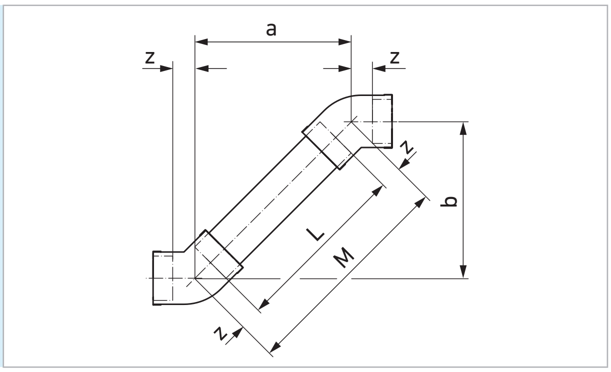


Dimensions a and b, 45° elbow

M = a or b · 1.414

M = L + 2z

L = M – 2z



14.7 Conclusions for the practice

The z dimension assembly method is the proven foundation of manual and automated prefabrication of pipe installations. The dimension's purpose is to combine repetitive, identical manufacturing processes to achieve a smooth flow of materials and work, avoid idling and duplication, so that economically and qualitatively optimal solutions are achieved.

This requires:

- Subdividing the piping systems into installation sections
- Subdividing the production into pre-assembly (in the workshop or at the construction site) and assembly stages. It is advantageous to prepare the largest possible portion of the installations in the workshop
- Summarised recording of all important structural dimensions in order to be able to prefabricate the installation sections in series

Here, the following **main rule** applies:

☑ Determine as many pipe sections as possible from the design documents.

☑ If pipeline sections must be determined on-site (compensation for dimensional deviations of the building's structure), the following instructions apply:
  - Always measure at the locations where the piping should be routed.

The z-dimension assembly method allows proceeding with the following aspects:

- Prefabrication in series
- Rational use of materials, labour and machinery
- Reducing assembly time
- Adaptation to the construction progress
- Mainly independent from construction schedules
- Better conditions for the implementation of out-of-town objects
- Better conditions for the refurbishment of old buildings
- More accurate work with less effort
- Consistent quality

In order to take advantage of these benefits, **the planning of the installation** – starting with the preliminary design – should be included equally to all other tasks when **designing the building**. A rational development of the installation requires a completed, coordinated implementation plan at the start of the construction that defines all essential details.

NOTE! Wrong prefabrication makes transportation and installation difficult.
Prefabricated pipeline combinations must never be too large or too heavy that they can no longer be easily transported and inserted at the installation site.

z dimension and prefabrication
The application of the z dimension method does not necessarily mean prefabrication. This method is basically suitable wherever pipes with fittings are assembled.

z dimension method for various materials

Taking into account the properties of other material systems (e.g. copper pipes with solder fittings, plastic pipes with clamps, welding or adhesive fittings), the z dimension method has similar applications.

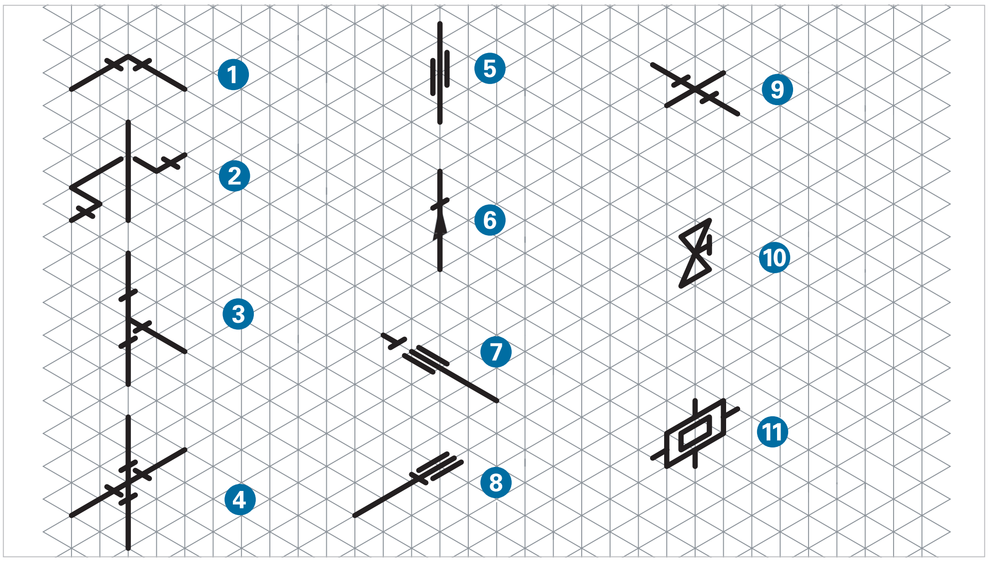
15 Pipeline sketches

A piping layout and floor plan are not suitable for the quick implementation of preparation and assembly work. For the effective planning and assembly, the course of the pipelines must be illustrated in a simple, but practical and unambiguous method. Such sketches should also be made on-site by the user (without any aids such as rulers, protractors, etc.) – either at the point of installation directly or based on an existing layout. This makes it possible to identify implemented piping system in a clear, recognisable manner, including all necessary fittings, controls and instruments, etc.

A **pipeline sketch made on 30° isometric drawing paper** (3D drawing) is deliberately **not** drawn to scale. On it, a long piece of pipe appears shortened, and short pipe segments are drawn a little longer. This enables the illustration of larger pipeline systems to be depicted on a DIN A4 sheet.

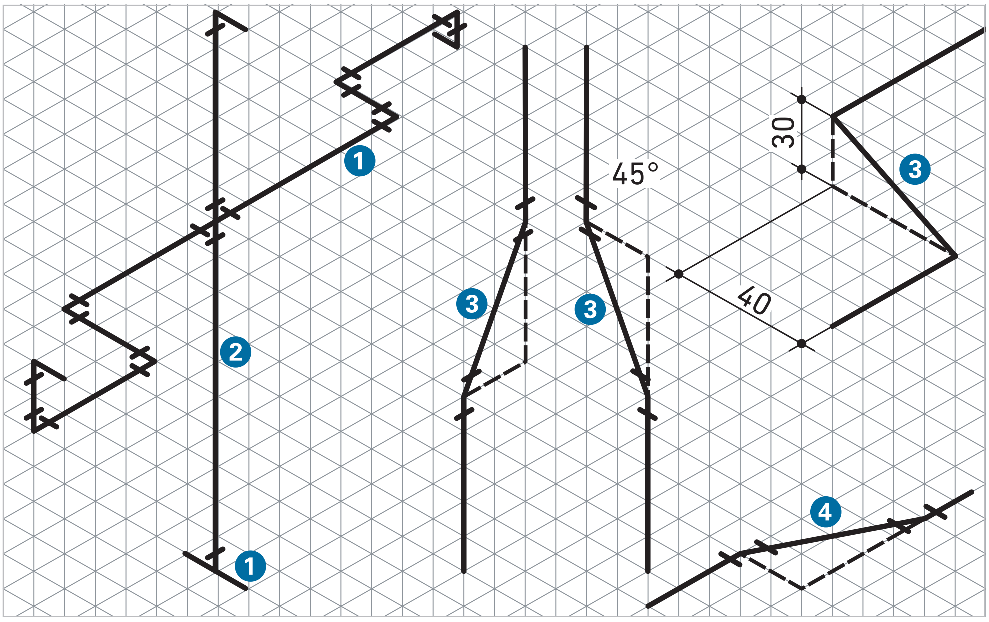
Regardless of angles and dimensions, the directional changes are always displayed at a ratio of 2:1 or 1:2. By adding the auxiliary triangle, the directional change is determined exactly. The line offset is determined by specifying the fitting type (figure number or angle) or by dimensioning the offset. Fittings or sealing points can be marked with a small cross bar, controls and instruments are indicated with the standard symbols.

Here, compliance with the following rules is mandatory:



GIV.88
Symbols used to represent the routing of pipelines

1. Elbow or bend
2. Crossover
3. Tee
4. Cross
5. Socket
6. Reduction
7. Plug
8. Long thread
9. Threaded connection
10. Shut-off device
11. Fitting flush with wall



GIV.89
Sketching directional changes

1. horizontal (to the left and to the right)
2. vertical
3. oblique (up and down)
4. oblique (in the horizontal plane)

15.1 GF isometric graph paper

The pipeline can be sketched on the **GF isometric graph paper**.

The selected landscape format is particularly suitable for use at the construction site. The available sketching area allows parts of pipelines or even more extensive partial installations (e.g. pipeline distributions in the basement, on individual floor levels) to be depicted.

The advantages of the GF isometric graph paper are obvious:

- subdividing the work flow
- quickly sketching the pipeline
- precise gathering of centre-to-centre dimensions
- easiest calculation of the pipe length
- basis for a material extract
- use as billing document

Thus, the GF isometric graph paper makes it possible to streamline the entire work processes:

- All pipes with the same diameter can be measured one after the other, marked, cut to length, and threads can be cut.
- If retained with the project documents, the isometric graph papers allow, even after years, to accurately trace the entire installation.
- This way, pipe extensions or repairs are much easier to do.

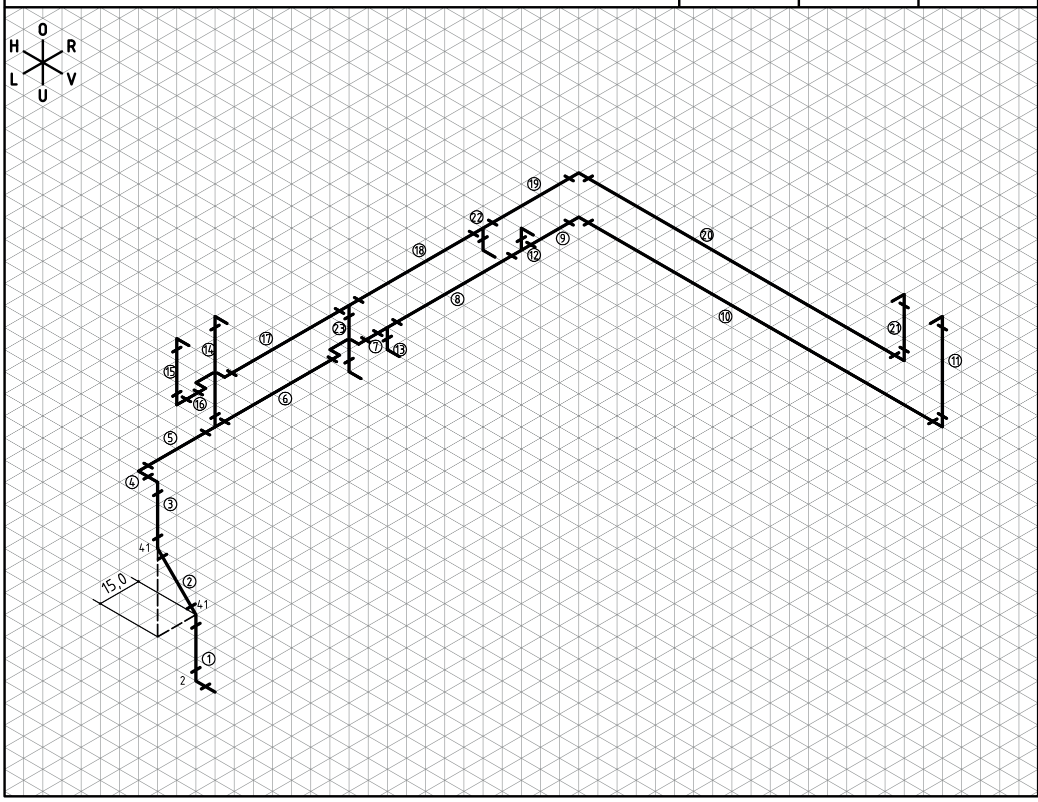
GF isometric graph paper with 30° parallel lines

A **sample** of the isometric graph paper can be found on the next page. Copy the sheet and use it for your own purpose.

GIV.90
Examples of the filled in GF isometric graph paper

+GF+ GEORG FISCHER PIPING SYSTEMS | Maßblatt für z-Maßmethode

Baustelle: | Datum | Anzahl Bl. | Bl.Nr.



Position	Maß M-M in cm	z-Maße in cm	Rohrlänge in cm	Dimension (Zoll)	
1	26,0	10,2	15,8	1	KW
2	21,2	6,8	14,4	1	KW
3	21,0	5,5	15,5	1	KW
4	7,3	-	90/92	1	KW
5	44,0	3,6	40,4	1	KW
6	62,0	5,5	56,5	3/4	KW
7	15,0	5,5	9,5	3/4	KW
8	48,0	3,0	45,0	3/4	KW
9	42,0	3,0	39,0	1/2	KW
10	205,0	3,0	202,0	1/2	KW
11	60,0	3,0	57,0	1/2	KW
12	5,5	-	130/92	1/2	KW
13	5,5	-	130/92	1/2	KW
14	62,0	3,6	58,4	1/2	KW
15	51,3	3,0	48,3	1/2	WW
16	10,0	4,7	5,3	1/2	WW
17	62,0	4,7	57,3	1/2	WW
18	48,0	3,0	45,0	1/2	WW
19	57,0	3,0	54,0	1/2	WW
20	190,0	3,0	187,0	1/2	WW
21	49,3	3,0	46,3	1/2	WW
22	5,2	-	130/92	1/2	WW
23	16,2	3,0	13,2	1/2	WW

+GF+

Building object:

Company:

Date:

Sheet No.:

Number of sheets:

Designation	
Dimension M-M [cm]	
z dimension [cm]	
Pipe length [cm]	
Notes	

Plan

Compressed air installation

Compressed air installation

1 Compressed air line and pneumatic system

1.1 Task and function of a compressed air line

A compressed air line is an energy line that is intended to transport compressed atmospheric air from the generator to the consumer and losing as little air as possible during the process.

Atmospheric air is a gas mixture consisting of nitrogen (78%), oxygen (21%) and argon (1%), as well as traces of carbon dioxide and other gases.

The pipeline must channel the compressed air from the generator to the consumer, without reducing:

- Air quality
- Air volume
- Operating pressure

1.1.1 Air quality

The air qualities have been specified in ISO 8573-1 since 2016. The quality requirements for the compressed air depend on the field of application. It must be ensured that the air quality from the fresh is not reduced while flowing from the intake point to the compressed air generator, through the distribution network and to the consumer.

TIV.1 **Classification of the air quality**

Class	Particle size (max.) [μ]	Particle density (max.) [mg/m³]	Pressure dew point Highest dew point value [°C]	Oil content (max.) [mg/m³]	Application area
1	0.1	0.1	−40	0.01	For example the photography industry
2	1	1	−20	0.1	Aviation
3	5	5	2	1.0	Packaging industry
4	40	not specified	10	5.0	General industry
5		not specified		25.0	Mining

TIV.2
Dew point and highest permissible water content of the air

Pressure dew point [°C]	Maximum permissible water content of the air [g/m³]
−40	0.117
−20	0.88
2	5.57
70	9.36

Air volume

The required air volumes are defined by the consumers. Compressed air should be transported from the generator to the consumer without any loss of air. This means that compressed air ductwork must be tight in order to avoid unnecessarily high costs.

Air and thus energy losses caused by leaks in the distribution network and on the machines lead to unnecessarily high operating costs.

1.1.2 Operating pressure

Each consumer (machine or equipment) using compressed air, requires a certain operating pressure in addition to the defined air quality and the air volume.

If the operating pressure is too low, for example 5 bar instead of 6 bar, this reduces the performance of a machine or a equipment by about 30%. If the compression is 1 bar higher, this creates additional costs of about 8%.

Too much pressure drop from the generator to the consumer are caused by pipe cross-sections that are too small and bottlenecks in the pipe. The pressure drop from the generator (boiler) to the consumer should not exceed 0.1 bar.

Each pipeline resists the air flowing through it in one way or the other. The resistance depends on the surface roughness of the pipe, the pipe length and the flow velocity.

Definition of pressure

The pressure is calculated according to the following formula:

$$p = \frac{F}{A} \qquad [p] = \frac{N}{m^2} = \frac{m \cdot kg}{m^2 \cdot s^2} = Pa$$

Size	Designation	Unit of measure
p	Pressure	Pa
A	Force	N
F	Area	m^2

TIV.3
Conversion: Pressure units

bar	Pa	MPa	psi	mm WS	mbar	Torr [mm Hg]
1.0	10^5	0.1	14.5	10197	1000	750

TIV.4
Operating pressures (examples)

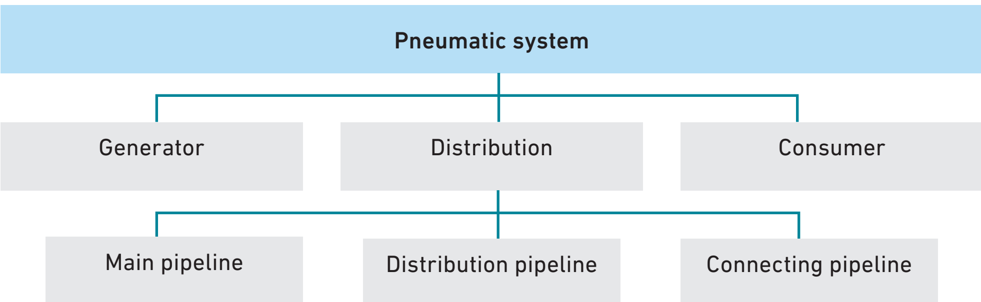
Business	Pressure [bar]
Paint shop	4
Pneumatic screwdriver	6
Lorry tyres	8
Hydraulic ramp	12

1.2 Pneumatic system

1.2.1 Construction and components

A pneumatic system is divided into three segments:
- Production
- Distribution
- Consumer

The distribution is divided into:
- Main pipeline
- Distribution pipeline
- Connecting pipeline



IV

1.2.2 Generator

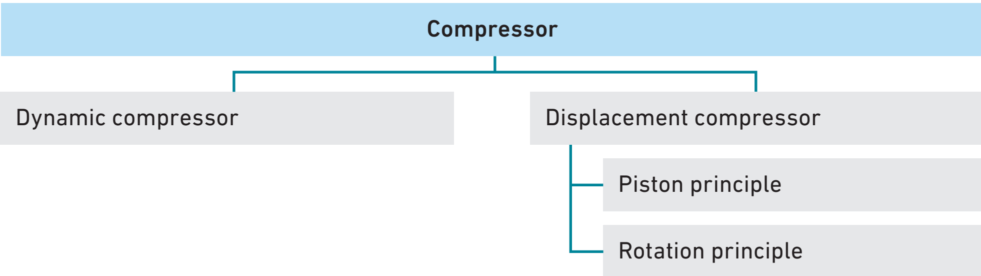
State-of-the-art generator stations are today offered as tailor-made complete solutions from various manufacturers. The systems take into account the requirements of all operating parameters (air quality, air volume, operating pressure).

The compressed air production is divided into the following parts:

- Manufacturing
- Processing
- Storage

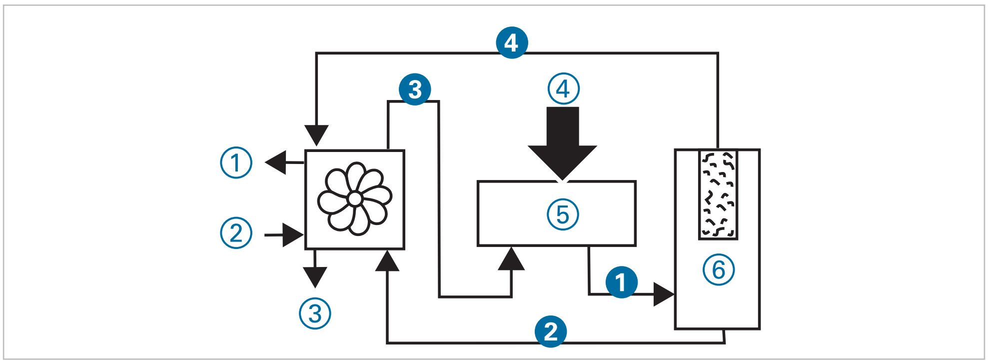
Manufacturing

The compressed air is produced by **air compressors** (compressors), which are subdivided into dynamic and positive displacement compressors. The positive displacement compressors are in turn divided into rotary and reciprocating compressors. In dynamic compressors kinetic energy is converted into pressure energy (aircraft engine).



GIV.1
Air compressor, types

Today, modern facilities are equipped with heat recovery systems. The electrical energy supplied to a compressor is almost completely converted into heat. If the heat optimised properly, around 90% of the electrical power supplied can be recovered.



GIV.2
Compressed air production with heat recovery

① Hot water
② Cold water
③ Compressed air 5 to 10 K above ambient temperature
④ Intake air
⑤ Compressor
⑥ Oil separator

❶ Air/oil mixture (80/20)
❷ Oil with compression heat
❸ cooled oil
❹ Air with compression heat

Processing

Depending on the required compressed air quality, a certain amount of processing is required. The processing comprises:

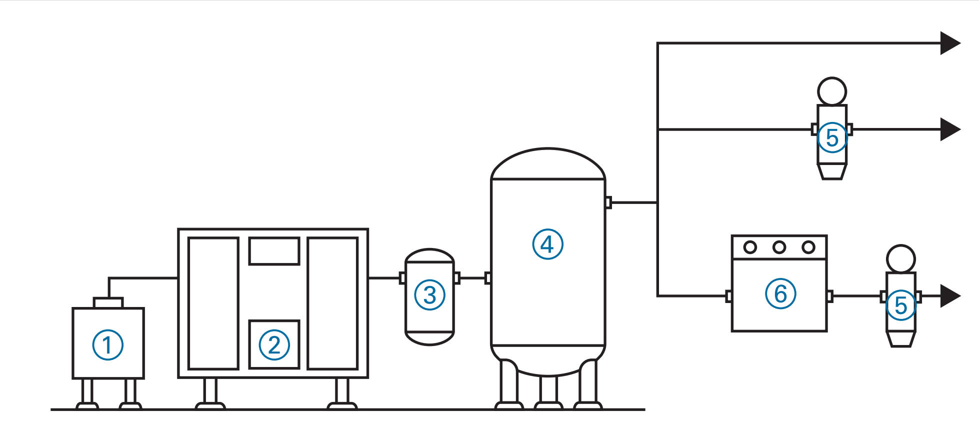
- Cleaning (filter)
- Drying
- Oil and water separation.

Storage

The compressed air tank is the buffer station between the compressor and the distribution network. The arrangement can be done before or after the preparation. It depends on whether the same or different air quality is required for all consumers.

Compressed air production – principal scheme

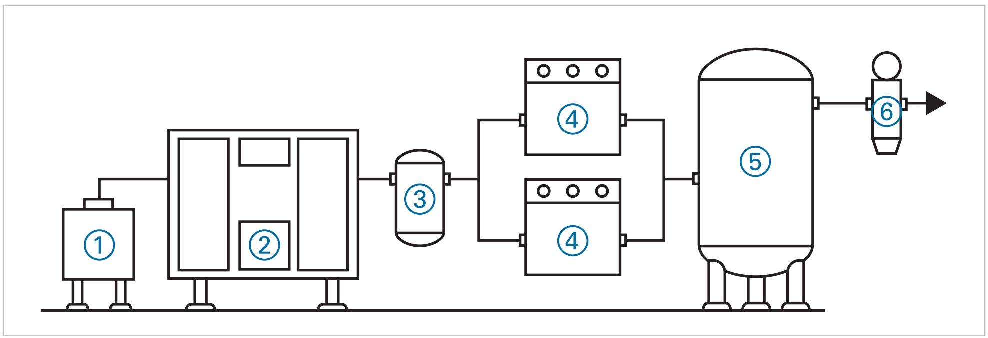
Generation and distribution of compressed air with different qualities



GIV.3
Compressed air with different qualities

1. Suction fan
2. Compressor
3. Cyclone separator
4. Pressure vessel
5. Filter
6. Drying

Generation and distribution of compressed air of a single qualities



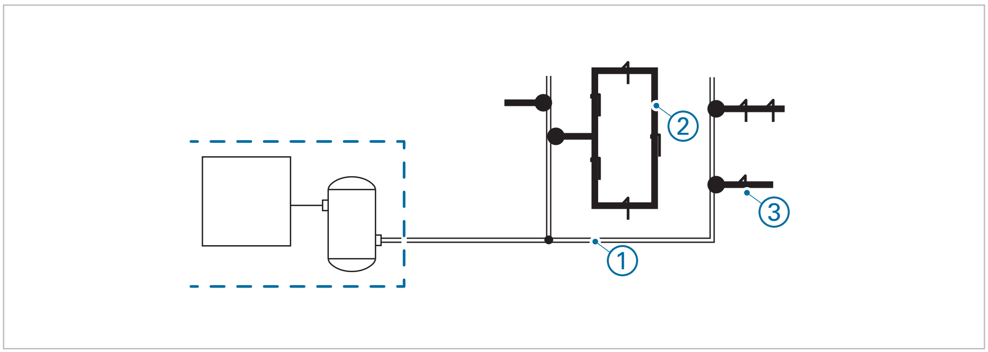
GIV.4
Compressed air with a single quality

1. Suction fan
2. Compressor
3. Cyclone separator
4. Drying
5. Pressure vessel
6. Filter

1.2.3 Distribution

The compressed air ductwork consists of the following components:

- Main pipeline (HL)
- Distribution pipeline (VL)
- Connecting pipeline (AL)



GIV.5
Layout of the compressed air ductwork

1. Main pipeline
2. Distribution pipeline
3. Connecting pipeline

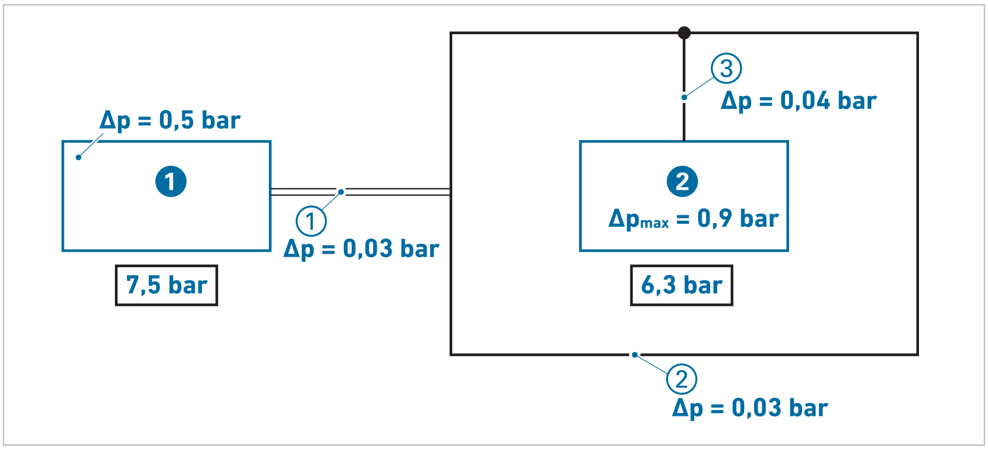
It is advisable to divide the pipe network according to the requirements, the function and application into segments.

In order to minimise leaks in the distribution line, pipe joints must be firmly bonded. Screw connections and flange connections should be avoided if possible. Clamping connections for plastic pipes should be designed to be pressure- and vacuum-tight and seal without the use of elastomer seals.

In a compressed air ductwork with an optimised design, the following pressure losses are to be expected for the pipeline sections:

- Main pipeline: 0.03 bar
- Distribution pipeline: 0.03 bar
- Connecting pipeline: 0.04 bar

The total pressure loss of the system including filters, separators, dryers, service units and connection hoses shall not exceed **0.1 bar**.



GIV.6
Total pressure loss

- ❶ Generator
- ❷ Consumer
- ① Main pipeline
- ② Distribution pipeline
- ③ Connecting pipeline

If the consumer operating pressure is 6 bar, the generator station must be operated at 7 bar.

Main pipelines

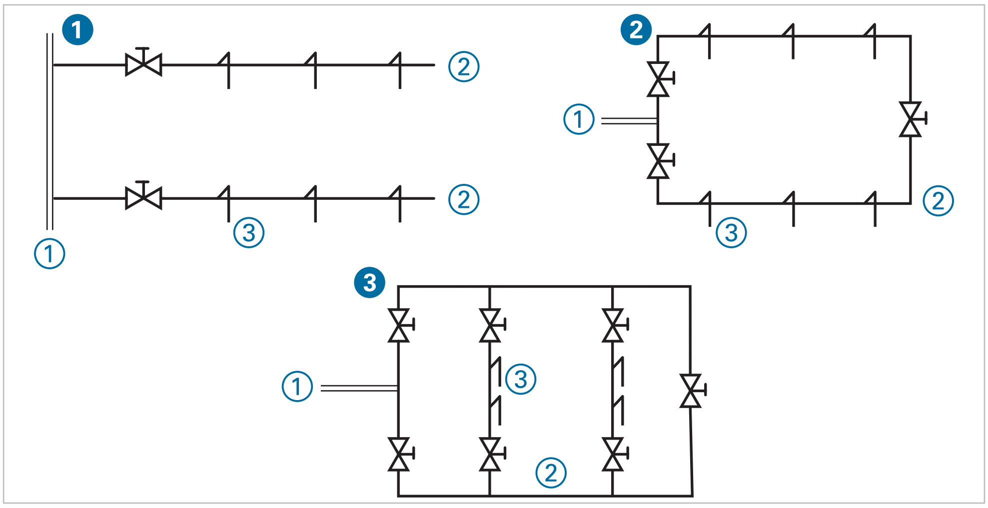
The main pipeline connects the generator station (compressor room) with the distribution network. The main pipeline should be sized so that reserves are available for future expansion.

The pressure drop in the main pipeline should not exceed **0.03 bar**.

Distribution pipeline

The distribution pipeline transfers the air within a consumer section. It can be designed as a stub or ring pipeline with integrated stub pipelines.

In machine shops without specific requirements for compressed air distribution, ring pipeline are preferred. It is advantageous to perform smaller ring pipelines that are designed for groups of machine or systems.



GIV.7
Types of pipelines

- ❶ Stub pipeline
- ❷ Ring pipeline
- ❸ Ring pipeline with stub pipeline
- ① Main pipeline
- ② Distribution pipeline
- ③ Connecting pipeline

Where this is not possible and only a large ring pipeline can be installed, it makes sense to incorporate stub pipelines. Through targeted use of shut-off valves, individual pipeline segments can be shut off for maintenance and extension tasks.

For pipelines with particular specifications for machine groups or production lines, individual stub pipelines are also incorporated. This is especially useful if production processes and systems (assembly lines) have to be changed more often, and thus the infrastructure also changes.

The pressure drop in the distribution pipeline **VL shall** not exceed **0.03 bar**.

TIV.5
Nominal widths of main pipeline/distribution pipeline VL

Q [L/s] / [m³/min]	**DN** [mm]	**Dimension d (PB/PE)** [mm]
233 / 14.0	90	110
135 / 8.1	75	90
100 / 5.0	63	75
53 / 3.2	50	63
30 / 1.8	40	50
15 / 0.9	32	40
10 / 0.6	25	32

(Length L: 100 m; operating pressure p: 6.0 bar)

Connecting pipeline

The connecting pipeline is the link between the distribution pipeline and the machine or system tap. The link to the connecting pipeline to the distribution pipeline depends on the air quality. If the air is not dry, the connecting pipeline should be led out of the top of the distribution pipeline. This will prevent condensate from escaping with the air. If the air is dry, the connecting pipeline can be led directly downwards.

Connecting pipelines should always be fitted with a shut-off valve at the end of the pipe. For individual connecting pipelines, the blocking can be integrated into the continuing connecting part. For group connections via distributors, it is recommended to integrate a separate blocking in the pipeline.

When connecting a machine or production unit directly to the distribution pipeline, it is advisable to provide the shut-off valve with an electrically operated actuator. When switching off the machine, the air supply is interrupted. This avoids air leakage through leaks inside the machine.

The pressure drop in the connecting pipeline **AL** should not exceed 0.04 bar.

TIV.6
Nominal widths (NW) of the connecting pipeline AL

Q [L/s] / [m³/min]	**DN** [mm]	**Dimension d (PB/PE)** [mm]
0.42 / 0.25	12	16
9.2 / 0.55	15	20

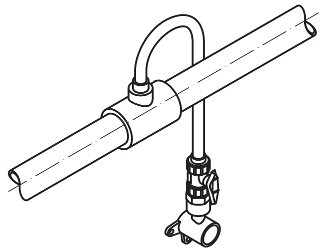
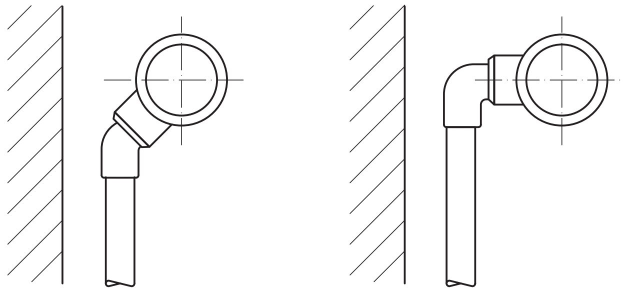
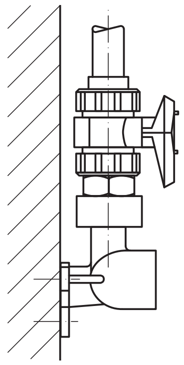
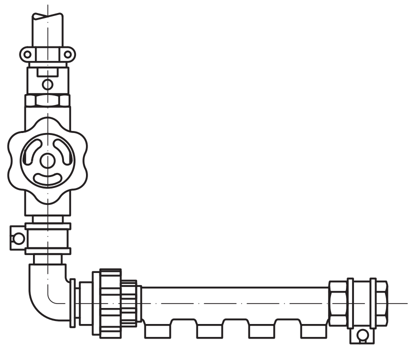
(Length L: 10 m; operating pressure p: 6 bar)

TIV.7
Nominal widths (NW) of the connecting pipeline AL

Q [L/s] / [m³/min]	**DN** [mm]	**Dimension d (PB/PE)** [mm]
16.6 / 1	20	25
33.3 / 2	25	32

(Length L: 10 m; operating pressure p: 6 bar)

TIV.8 **Link and connecting types**

Type of link if the air is not dry	Type of link if the air is dry
	
Single connection with integrated blocking	**Group connection with blocking**
	

2 Material selection

A compressed air line must be tight, maintenance-free and sufficiently dimensioned.

There is no ideal material for the compressed air lines. The increasing quality requirements in compressed air technology with regard to cleanliness, easy assembly and simple maintenance make plastic pipe systems more and more popular.

As a rule, only one pipeline system made of only one type of material shall be used when designing a compressed air installation. This will prevent, above all, the corrosion problems of metal systems. In this regard, mixing systems made of plastic and metal are trouble-free.

The respective requirement criteria determine the material.

These requirement criteria are:

- Place of use
- Pressure/temperature limits
- Service life
- Safety
- Jointing technology
- Installation technology
- Dimensioning
- Assortment

Recommendation
Based on decades of experience in piping system construction, GF recommends the following materials for compressed air lines:

- Polybutene (PE)
- Polyethylene (PE)
- Malleable iron fittings, galvanised

2.1 Place of use

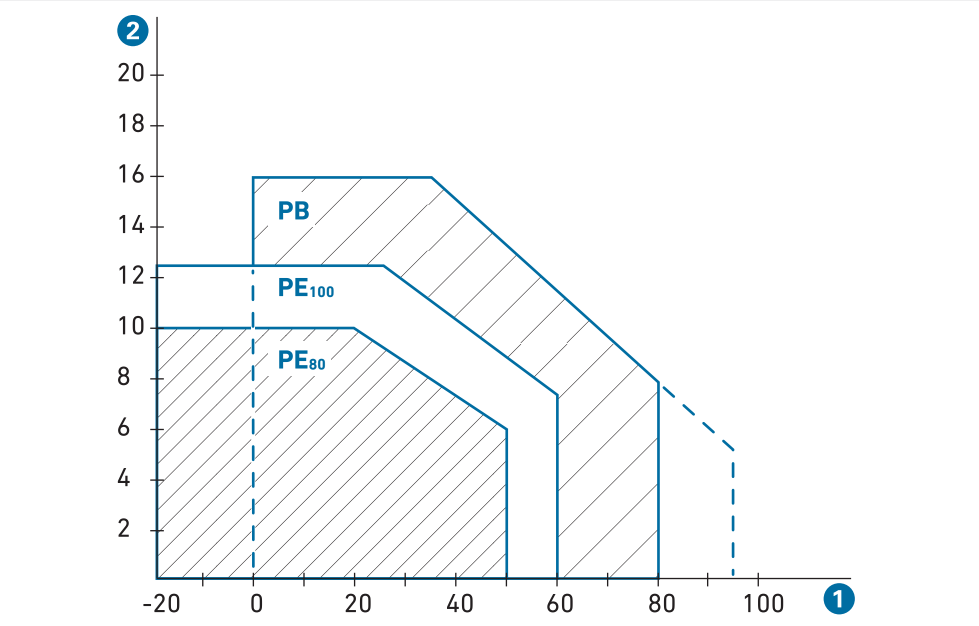
The majority of the compressed air ductworks, more than 80%, are installed in factories, production halls and other types of buildings. Thus, an ambient temperature of 15 to 25°C can be assumed. However, it should be noted that, if exposed to direct sunlight, temperatures of up to 50°C and higher can occur in factory halls with glass saw-tooth roof. For these locations, Polybutene (PB) is suitable.

- For pipelines that are installed outside at temperatures below 0°C, Polyethylene (PE) is suitable and will not be damaged.
- For pipelines subject to increased damage potential, such as in the mining and the steel industry, galvanised steel is recommended the material of choice.

2.2 Pressure and temperature limits – Service life

The limits of use were determined from the corresponding long-term creep diagrams of the individual materials. For Polybutene (PB) and Polyethylene (PE), the pipe series S5 pursuant to ISO 4065 was based on.

The diagram shows the limits of use applicable to the recommended materials.



GIV.8
Limits of use for plastics

1. Temperature [°C]
2. permissible operating pressure [bar]

This results in the following pipe dimensions:

- d16 × 1.5 (2.2)*
- d20 × 1.9 (2.8)*
- d25 × 2.3
- d32 × 3.0
- d40 × 3.7
- d50 × 4.6
- d63 × 5.8

* applicable only to PB pipes of the INSTAFLEX system

2.3 Safety

The term **Safety** includes several aspects, such as:

- Bursting behaviour
- Resistance to oil
- Environment effects depending on the application
- Corrosion
- Fire behaviour

Bursting behaviour

In contrast to water, compressed air is compressible. If a mechanical damage occurs, this causes a decompression and the pipeline will explode violently. Therefore, it is important that no harm is done to the environment due to the failure of a compressed air line that was mechanically damaged. In today's compressed air technology, only plastics with ductile fracture behaviour, even at temperatures below freezing, should be used.

By definition, a **ductile fracture behaviour** occurs, if during a violent damage of a pipe the associated explosive reaction of the compressed air does not produce any fragments and/or splinters from the pipe. Consequently, there is no immediate danger done to the environment.

Limit temperatures for ductile fracture behaviour:

- Polyethylene (PE): approx. −40°C
- Polybutene (PB): approx. −5°C

Resistance to oil

In a compressed air ductwork, traces of compressor oil and condensate must always be expected. In view of a long service life of the system and the associated reliability of the used pipe material must withstand the stresses of operation.

Mineral oils, ester-containing oils and oils containing aromatic amines have negative effects on the systems service life, depending on their concentration.

> i **Chemical resistance**
> Chemical resistance information is available through GF's Customer Service.

When using polybutene (PB) and/or polyethylene (PE), we recommend operating the distribution network as **free of oil** as possible.

Application

Depending on the application, for example indoors or outdoors, the installation must be protected from UV radiation.

Corrosion

The materials polybutene (PB) and polyethylene (PE) offer the advantage that they are resistant to corrosion attacks whether they are installed indoors and outdoors. Moist and corrosive atmospheres inevitably lead to external corrosion in steel pipes, residual moisture in the compressed air leads to corrosion from the inside.

Plastic pipe systems made of PB and PE are corrosion-resistant, and the quality of the air to be transported is not affected.

Fire behaviour

PB and PE are plastics of fire class B2 according to DIN 41 02 (normal inflammable). Under the influence of open flame, PB and PE burn with a bright flame. The fumes smell of wax and paraffin. The emergence of toxic and corrosive combustion products such as in PVC and PVC-C, is not given in polyolefins such as PB and PE due to the absence of halogens (chlorine).

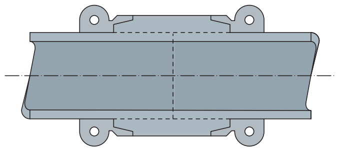
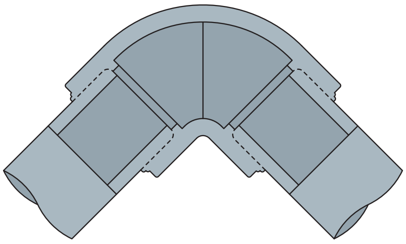
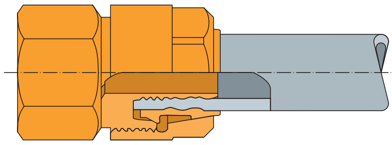
2.4 Jointing technology

Compressed air ductworks need to be tight to avoid lost volumes and associated costs.
Leakages occur in a compressed air ductwork mainly in the connection points.
☑ Pipes and fittings must be **bonded firmly**.

A **firmly bonded connection** refers to a direct homogeneous bond between the pipe and moulding, without additives, as those connections occur during fusion welding. A firmly bonded connection can only be broken by destroying it.

Clamping connections for plastic pipes must be permanently pressure- and vacuum-tight. The seal between pipe and moulded part must be achieved without elastomer seals.

TIV.9 **Jointing technology**

Electrofusion joint (HWS) for PB and PE	Socket fusion welding (HMS), firmly bonded, for PB and PE	Clamp connection for PB
		

Due to the usual “dry” compressed air being used today, the common method of metal pipe connections such as threaded connections with hemp seal, press joints with elastomer seal, fittings and flange connections with flat gaskets start leading after a certain number of operating hours.

Where fittings or flange connections are required (for example, for tank connections), these must be designed in order to ensure gaskets can be easily replaced.

Vibrations

Vibrations are the source of most imperfections in a compressed air ductwork. Therefore, it is meaningful to design the pipe system so that the transmission of vibrations is prevented.

Polybutene (PB) and polyethylene (PE) pipe systems are flexible compared to metal pipe systems and can therefore be described as vibration-free pipe systems.

2.5 Installation technology

In this text, the subject of installation technology is considered only under the aspect of **material selection**. The plastic pipes made of polybutene (PB) and polyethylene (PE) recommended by us in the compressed air sector are approx. 80% lighter than steel pipes according to DIN 2440. Due to the flexibility and the light-weight, new prospects in installation technology arise for the use of plastic pipes. Easy and quick installation, minimum mounting efforts and efficient prefabrication are crucial for low installation costs.

Due to the low weight of the pipes and fittings (the medium conveyed hardly weighs anything), compressed air pipes can be installed or fixed in or on existing cable ducts. Depending on the pipe dimension, the pipelines can be fastened using pipe clips or cable ties. Since plastics do not conduct electricity, **installation inside a cable duct** is an alternative that is particularly favourable.

When **installing under ground**, plastic pipes are particularly suitable since corrosion protection is not required.

☑ Compliance with the appropriate installation guidelines (sand bed, etc.) is mandatory.

Installation technology in explosion-proof rooms

§ **Installation in explosion-proof rooms**

→ When installing in ex-protected rooms, compliance with the country-specific rules, regulations and laws is mandatory.

When installing pipes in explosion-proof rooms, the fact that plastic pipes are statically discharged if the humidity is just right must be taken into account.

2.6 Dimensioning

An important value for the dimensioning is the roughness (k) of the material being used. Plastic pipes made of polybutene (PB) and polyethylene (PE) transport compressed air more economically than steel pipes. The smooth surface of the plastic pipes (k = 0.007 compared to k = 0.15 of steel pipes) allows a higher airflow at the same internal pipe cross section and at the same pressure ratios.

3 Dimensioning

The energy carrier "compressed air line" must be carefully dimensioned and calculated.

A compressed air line is not a water pipeline. A compressed air line, which is calculated according to the water pipe principles, has energy losses of about 50%.

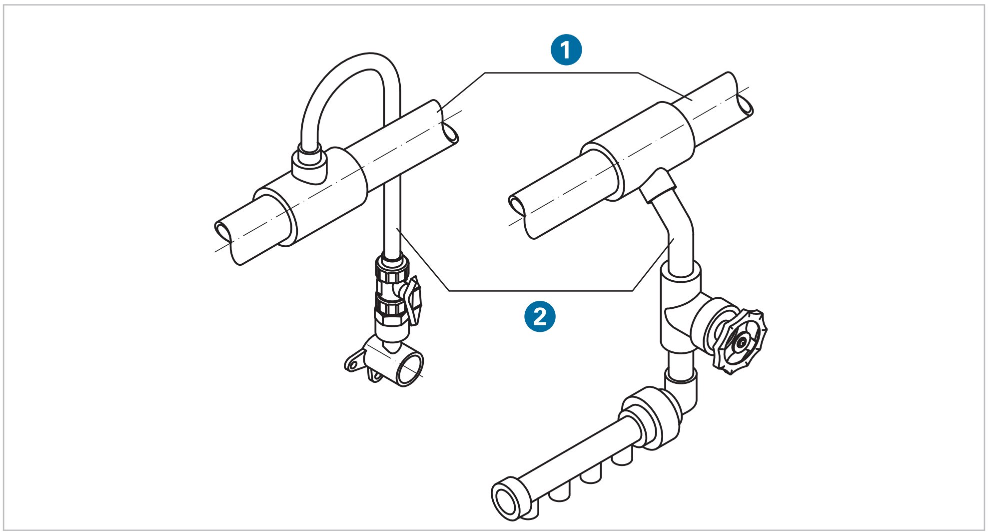
In order dimension the pipe properly, the following three main factors must be known:

- Network concept
- Pipeline material
- Total air requirement

3.1 Network concept

3.1.1 Connecting pipeline

The connecting pipeline may have a max. pressure drop of Δp ≤ 0.04 bar. This is the connection between the distribution pipeline and the link to the consumer.

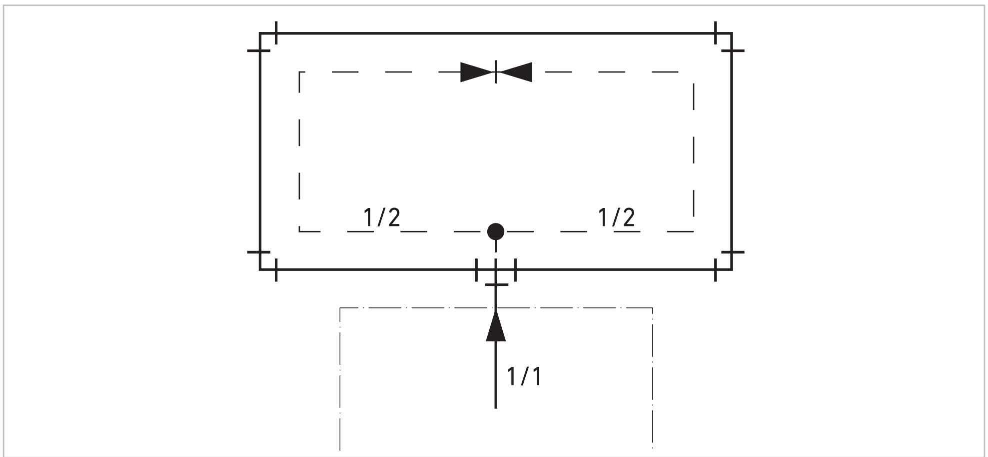


GIV.9
Consumer connection

Δp ≤ 0.04 bar
1 Distribution pipeline
2 Connecting pipeline

3.1.2 Distribution pipeline

The max. pressure drop in the distribution line may be Δp ≤ 0.03 bar. The distribution line can be designed as a loop or stub line. Ring lines have the advantage that they have twice the capacity of stub lines. They are particularly recommended if the consumers are distributed as evenly as possible. The calculation of ring lines is similar to the calculation of stub lines, that is to say, the ring is divided in the middle and calculated with half the nominal length and half the required air consumption.

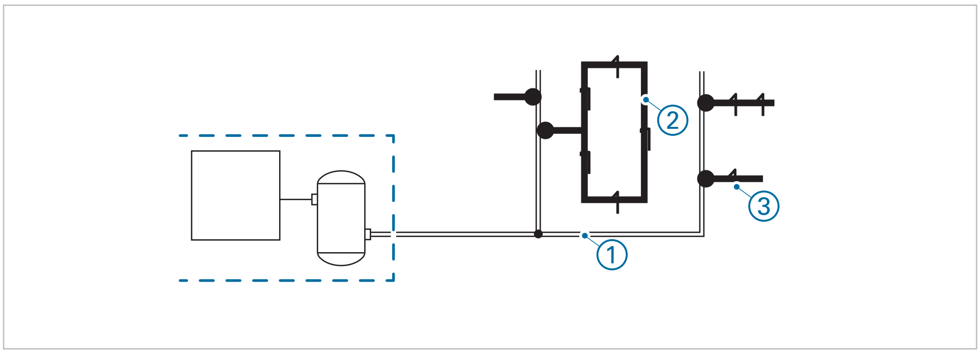


GIV.10
Calculation of the ring line

3.1.3 Main pipeline

The main pipeline may have a max. pressure drop of $\Delta p \leq 0.03$ bar. This is the connection between the pressure vessel and the distribution pipeline.

The total air volume of the connected distribution lines collects in the main pipeline. Main pipelines are usually not very long. It is therefore more economical to dimension this area a bit more generous and to incorporate reserves in order to catch any future extensions.



GIV.11
Main pipeline
① Main pipeline
② Distribution pipeline
③ Connecting pipeline

3.2 Pipeline material

The material selection must be made before dimensioning, as it is a decisive factor in the pressure loss calculation. For example, the inside surface of a steel pipe is rougher (k = 0.15) than the inside surface of a plastic pipe (k = 0.007).

The wall thickness(es) of plastic pipes depends on the material's strength under temperature load. Under the same conditions of use (e.g. 20°C / 16 bar / NW 25), a polybutene pipe has an outside diameter of d32, but a polyethylene pipe has a diameter of d40 due to the greater wall thickness.

3.3 Total air requirement

The air requirement is determined from the information of the connected equipment, devices and machines and then added. It is recommended to include surcharges and reserves when determining the required air requirement. However, in order to prevent oversizing the pipeline network, the degree of utilisation η must be determined and taken into account accordingly.

Surcharges for:

- Leakages: 10%
- False estimates: 10%
- Reserves: 20%

3.3.1 Determining the total air requirement

The total air requirement of a system can be determined by adding up the individual values.

Number of tools/machines	1	2	3	4	5	6	7	8	...
Distribution pressure $P_{ü}$									
Air requirement V [L/min]									
Number of machines									
Degree of utilisation η (in [%])									
Air requirement [L/min]									
Total air requirement [L/min]									

Example

Machine no.	1	2
Air requirement V [L/min]	300	500
Number of machines n	2	1
Degree of utilisation η [%]	50	25
Air requirement V [L/min]	300	125
Total air requirement [L/min]	**425**	

TIV.10
Examples for determining the total air requirement

$$V = \dot{V} \cdot n \cdot \eta$$

Air requirement including superchargers: V = 600 L/min

3.4 Pipeline dimensioning

The planning results in the lengths of the connection, distribution and main pipeline. The mouldings used (elbows, tees, etc.) and fittings shall be added to the pipe length according to their equivalent pipe length value.

TIV.11 **Equivalent pipe lengths for moulded parts and fittings made of plastic (PB/PE)**

Pipe, dimension d		**16**	**20**	**25**	**32**	**40**	**50**	**63**	**75**	**90**	**110**
Moulded parts							[m]				
Elbow 90°		0.30	0.40	0.50	0.60	0.80	1.00	1.25	1.50	1.80	2.50
Elbow 45°		0.15	0.20	0.25	0.30	0.40	0.50	0.60	0.75	0.9	1.25
Tee passage		0.10	0.15	0.15	0.20	0.25	0.35	0.45	0.60	0.75	1.00
Tee branch		0.50	0.65	0.80	1.00	1.25	1.50	1.90	2.30	2.90	3.50
Tee cut-off		0.65	0.80	1.00	1.25	1.50	1.80	2.10	2.50	3.10	3.80
Step-down		0.20	0.25	0.30	0.40	0.50	0.70	0.90	1.20	1.50	1.90
Gooseneck branch		0.70	0.85	1.00	–	–	–	–	–	–	–
Controls and instruments							[m]				
Ball valve		–	0.16	0.18	0.20	0.24	0.28	0.40	0.52	0.65	0.80
PB slider/diaphragm valve		–	0.90	1.20	1.60	2.10	2.60	3.30	4.10	5.00	6.20

The **pre-dimensioning** of the pipeline can be taken from the following table.
The maximum flow rates of the different pipe diameters at different operating pressures are based on:

- Pipe length L: 100 m
- Pressure loss Δp: 0.03 bar

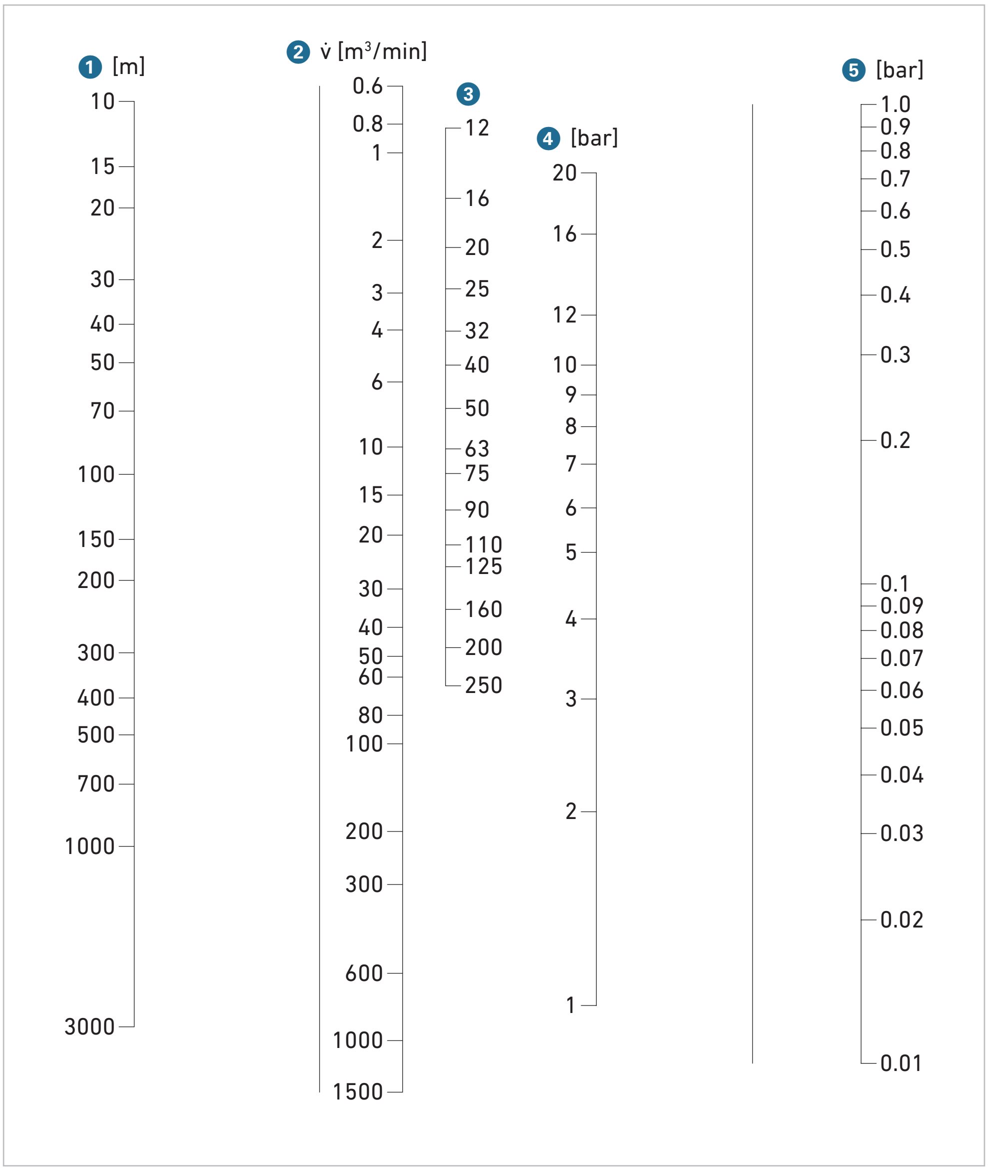
TIV.12
Maximum flow rate of different pipe diameters

Operating pressure [bar]	4	6	8	10	12	16
Pipe, dimension			Max. flow rate [m^3/min] *			
d16	–	–	–	–	0.10	0.15
d20	–	–	–	0.18	0.20	0.25
d25	0.20	0.28	0.30	0.34	0.38	0.45
d32	0.48	0.55	0.62	0.70	0.75	0.85
d40	0.78	0.90	1.00	1.30	1.50	1.70
d50	1.40	1.75	2.00	2.20	2.60	3.00
d63	2.50	3.25	3.80	4.20	4.60	5.20
d75	4.10	5.00	6.00	7.00	7.50	8.20
d90	7.00	8.10	9.95	11.00	12.50	14.00
d110	11.50	14.00	16.00	18.00	20.00	22.00

$1 m^3 \triangleq 1000$ l/min = 16,7 l/s

IV

Nomogram for determining the dimensioning of the pipeline

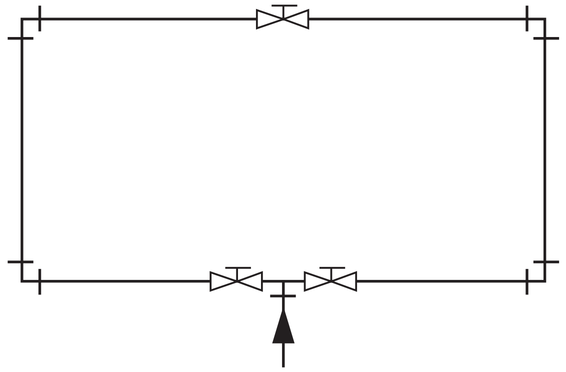


GIV.12
Nomogram

1. Networking length
2. Volume flow
3. Pipe outer diameter
4. Operating pressure
5. Pressure loss

Calculation example for sizing the pipeline

There are three different methods by which the size of the pipeline can be calculated. The compressed air ductwork in this example is designed as follows:



GIV.13
Example of a compressed air ductwork

Δp 0.03 bar		1 Tee:	2,5 m
P 6.0 bar		4 elbows 90°:	6,0 m
V 4500.0 L/min		3 ball valves:	approx. 1.6 m
L 110.0 m		**Total length:**	**120.1 m**

Using the table in order to determine the pipe diameter

At an operating pressure of 6 bar and an air requirement of 4,500 L/min (= 4.5 m^3/min), the result is a pipe diameter of d75:

TIV.13
Determining the diameter

Operating pressure [bar]	4	6	8	10	12	16
Pipe, dimension	Max. flow rate [m^3/min]*					
d16	–	–	–	–	0.10	0.15
d20	–	–	–	0.18	0.20	0.25
d25	0.20	0.28	0.30	0.34	0.38	0.45
d32	0.48	0.55	0.62	0.70	0.75	0.85
d40	0.78	0.90	1.00	1.30	1.50	1.70
d50	1.40	1.75	2.00	2.20	2.60	3.00
d63	2.50	3.25	3.80	4.20	4.60	5.20
d75	4.10	5.00	6.00	7.00	7.50	8.20
d90	7.00	8.10	9.95	11.00	12.50	14.00
d110	11.50	14.00	16.00	18.00	20.00	22.00

Using the approximation formula in order to determine the pipe diameter

The pre-dimensioning of the pipe can also be determined arithmetically and using the following formula:

$$DN = \sqrt[5]{\frac{1,6 \cdot 10^3 \cdot V^{1,85} \cdot L}{\Delta p \cdot p}}$$

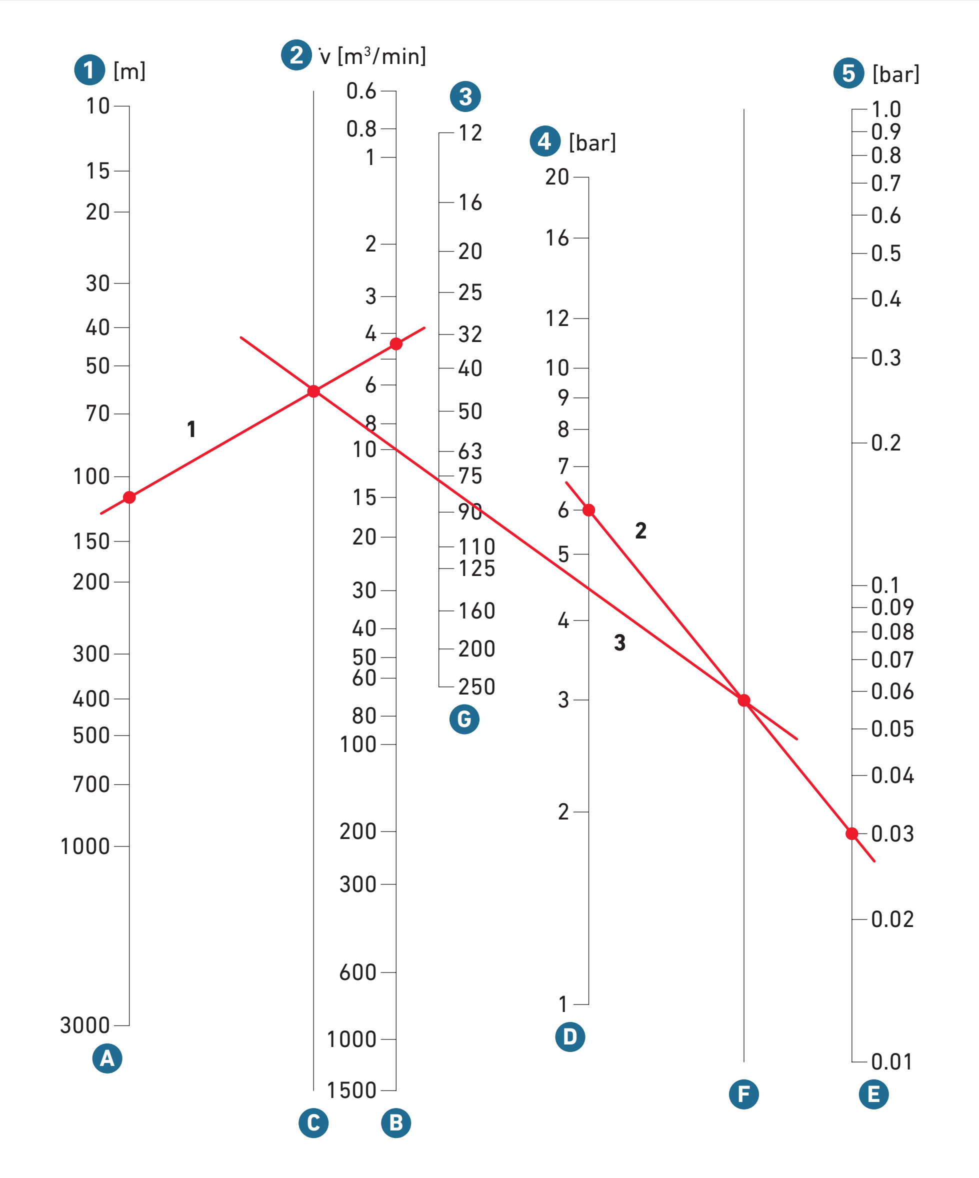
DN Nominal diameter of the pipe [m]
L Length of the pipeline [m]
V Volume flow [m^3/s]
Δp Pressure loss [Pa]
p Network pressure [Pa]

Using the nomogram to determine the pipe diameter

Procedure

1. Determine the pipe length (m) **A** and the flow rate (m^3/min) **B** and connect with line **1**.
2. Connect the pressure loss (bar) **E** and the operating pressure (bar) **D** with line **2**.
3. Connect both intersections 1/**C** and 2/**F** with line **3**.

↳ The intersection of line 3 and **G** indicate the dimensions of the pipe.



GIV.14
Nomogram

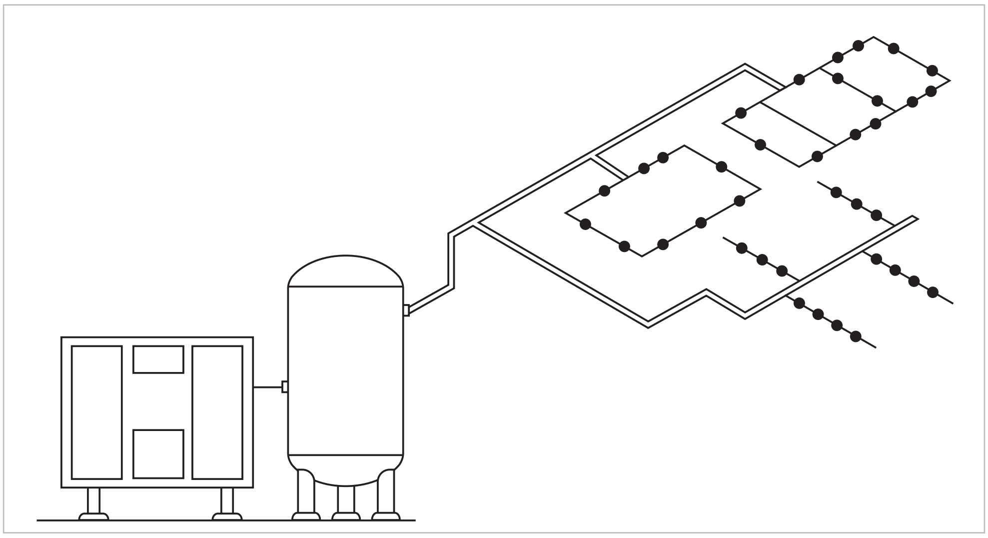
1. Networking length
2. Volume flow
3. Pipe outer diameter
4. Operating pressure
5. Pressure loss

4 Pipeline planning and installation

When planning the pipeline, it is important to know the on-site conditions exactly. The bundling of power lines into or onto common carrier elements reduces assembly times and costs.

Compressed air lines that are located in the area of passages, in the swivel area of suspended loads and similar danger zones, must be protected in order to prevent mechanical damage, shock or impact loads.

Furthermore, it should be noted that plastic pipes react to temperature changes with expansion or shrinkage. After compressed air lines have been installed, the temperature fluctuations are due only to the ambient temperature.



GIV.15
Pipeline planning overview

In general, two types of installations are common when using polybutene and polyethylene pipes:

- **Installation of flexible sections**
  - Here, the thermally induced change in the pipe's length is taken into account.
- **Rigid assembly**
  - In this scenario, the pipe must absorb the thermally induced change in length. When using long, **metal pipes**, flexible sections must be considered.

During the planning stage, the main, distribution and connecting pipelines must be considered separately. As a planning aid, a schematic, isometric drawing of the system should be created.

4.1 Main pipeline

When using main pipelines up to d63 (d75), we recommend the use of the **rigid assembly** method. When using dimensions from d75 onwards, the design should incorporate flexible sections.

Fixed points should be chosen to ensure that the outgoing tee to the distribution pipeline is permanently installed. A shut-off device should always be incorporated at the outlet of the main pipeline and at branches. This ensures that individual pipelines can be shut down without disrupting the overall operation.

Determining the flexible section

Determining the flexible section

$$L_{BS} = C \cdot \sqrt{\Delta l \cdot d}$$

How to calculate the change in length

$$\Delta l = L_{DS} \cdot \alpha \cdot \Delta T$$

L_{DS} Length of the expansion joint
L_{BS} Length of the flexible section
Δl Change of length
α Coefficient of thermal expansion
d Outside diameter of pipe
C Material constant
ΔT Temperature difference

Material	C	α
Polybutene (PB)	10	0.130 mm/(m·K)
Polyethylene (PE)	27	0.200 mm/(m·K)
Steel (St)	91	0.012 mm/(m·K)

TIV.14
Standard values

Determining the flexible section for PB

$$L_{BS} = C \cdot \sqrt{L_{DS} \cdot \alpha \cdot \Delta T \cdot d}$$

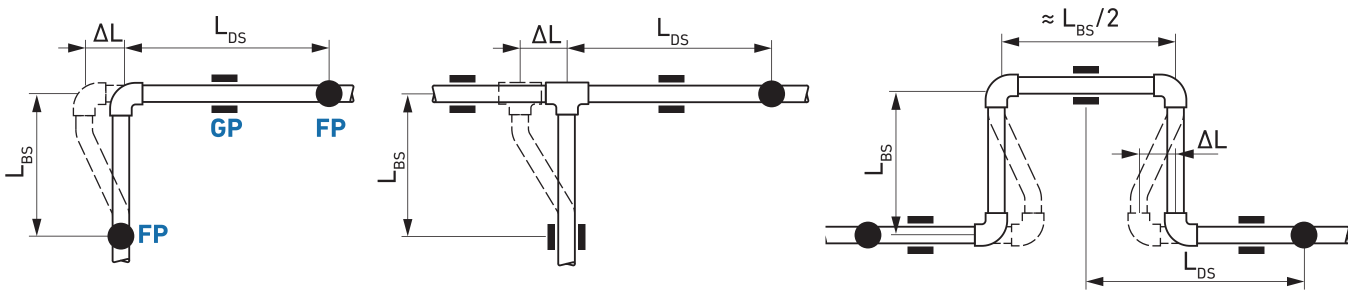
Calculation for PB

$$L_{BS} = 10 \cdot \sqrt{20\ m \cdot 0{,}130\ mm/mK \cdot 20\ K \cdot 32}$$

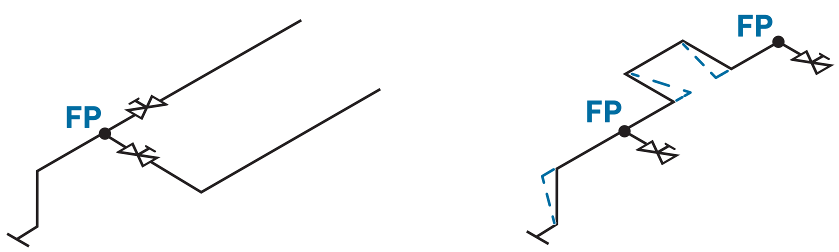
L_{DS} 20 m
ΔT 20 K
d DN32
L_{BS} for PB: 32 cm
L_{BS} for PE: 108 cm
L_{BS} for St: 91 cm

TIV.15 **Flexible section, expansion joint – Types**

Flexible section with directional change	Flexible section at a branch	Expansion joint



Main pipeline branch	Main pipeline outlets to branch



TIV.16
Branches – Types

FP Fixed point
GP Floating point attachment
ΔL Change of length
L_{DS} Length of the expansion joint
L_{BS} Length of the flexible section

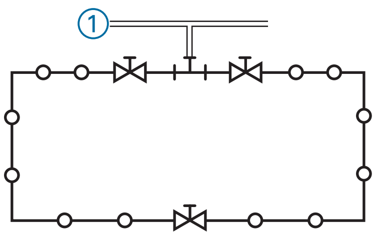
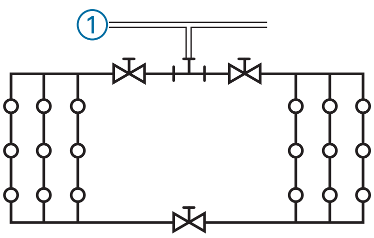
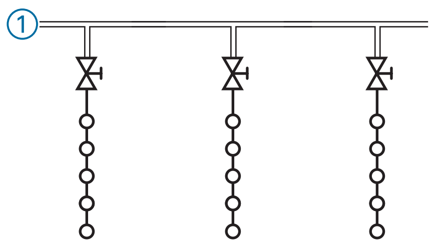
4.2 Distribution pipeline

When planning the distribution lines, three routing principles are used:

- Ring pipeline
- Stub pipeline
- Ring pipeline with cross strap

By limiting individual distribution pipeline zones by incorporating shut-off valves, individual distribution pipeline zones can be shut down without interrupting the operations. The sectioning of the distribution pipelines (ring and stub pipelines) must be adapted to the respective circumstances and requirements.

TIV.17 **Planning and distribution**

Ring pipeline	Ring pipeline with cross strap	Stub pipeline
		

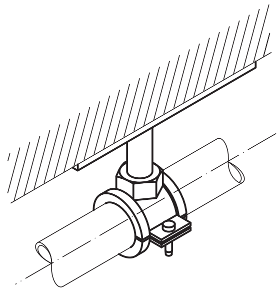
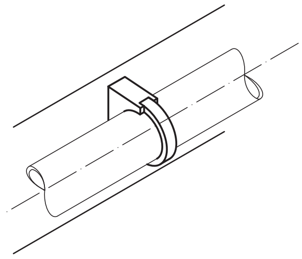
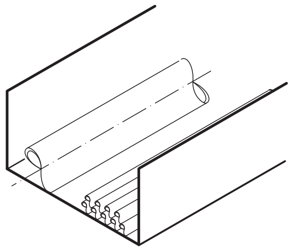
① Main pipeline

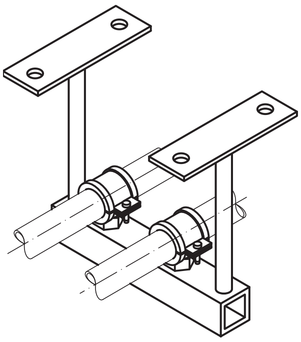
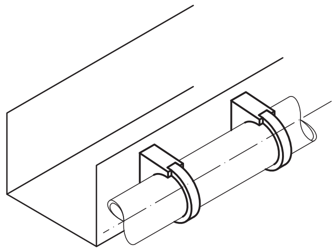
4.3 Pipeline installation

When installing the distribution pipelines, existing carrier systems of other energy lines should be used. Installing the distribution pipeline in or on electrical cable ducts is the simplest and most efficient way of installation. Since plastics are electrically non-conductive, there are no interferences.

> **i Potential equalisation**
> ☑ When using malleable iron fittings, potential equalisation must be observed.

TIV.18 **Pipeline installation – Attachments**

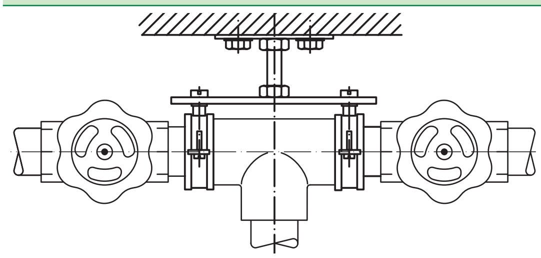
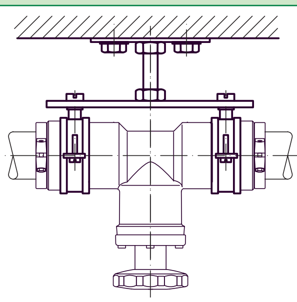
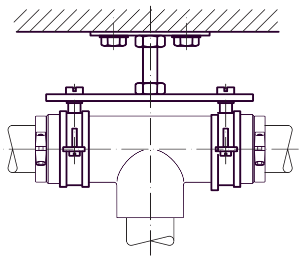
Standard attachment to ceilings, walls or other carriers using pipe clips	Attachment using pipe clips	Installation in the cable duct
		

Attachment on/to pipe routings using pipe clips	Attachment to cable duct using pipe clips
	

Layout of the fixed points when using a rigid or flexible assembly

- When stub pipelines are used, fixed points must be designed compliant with the local conditions.
- When ring pipelines are used, fixed points must be incorporated at the ring pipeline's point of entry. Fixed points must also be installed wherever shut-off devices are mounted and, depending on the circumstances, fixed points should be located at the nodal points of the cross straps.
- If heavy valves or instruments must be installed in the pipeline, these devices must be attached with separate fasteners.

TIV.19 **Fixed points**

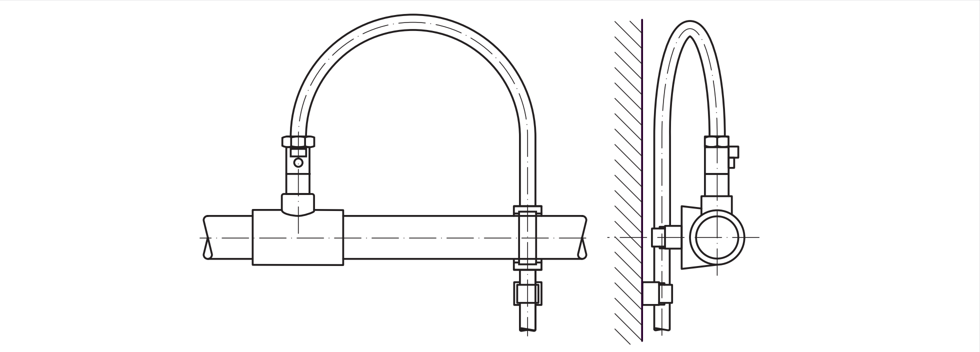
Fixed point at the ring pipe's entry	Fixed point when using shut-off devices	Fixed point when using T-branches
		

4.4 Connecting pipeline

Linking the connecting pipeline to the distribution pipeline depends on the air quality and on the dimension of the connecting pipeline.

- **If the compressed air is moist**, connecting pipelines must be connected from above onto the distribution pipeline.
- **If the compressed air is dry**, the attachment of the connecting lines to the distribution pipeline can be arbitrary.

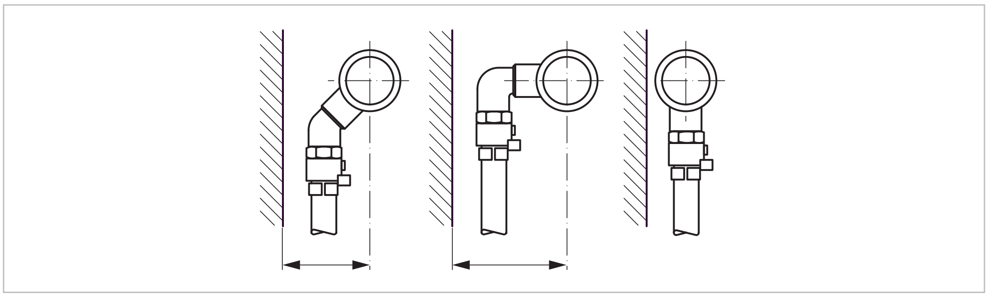
4.4.1 Link with gooseneck



GIV.16
Gooseneck with PB pipes d16 and d20

- Tee with HWS outlet
- When using a PB pipe d16 x 2.2 or d20 x 2.8 it can be bent to form a gooseneck (min. bending radius 8 x d)
- If using any other materials, the gooseneck must be assembled from moulded parts.

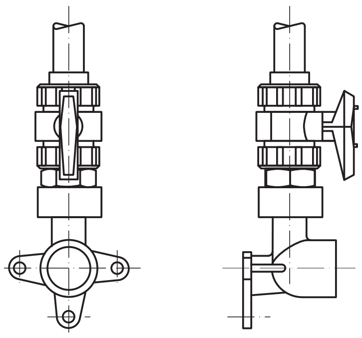
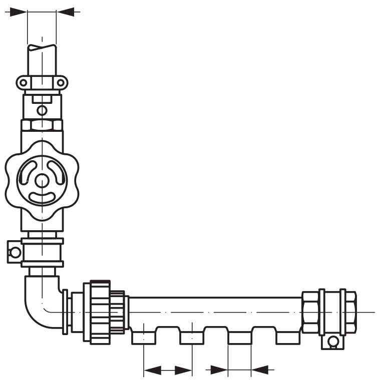
4.4.2 Link with single/multiple nodes



GIV.17
Link of the connecting pipeline with d16 and larger

The machine, device or equipment connection node at the end of the connecting pipeline can be implemented as a single or multiple node. Shut-off devices must always be incorporated into end nodes.

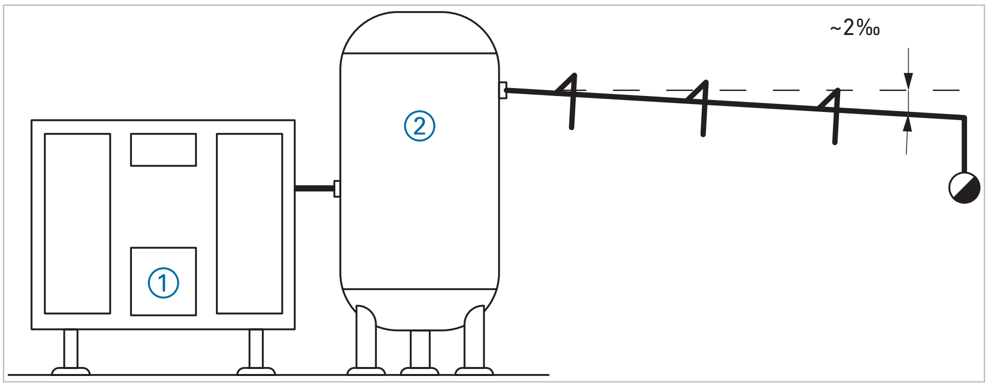
TIV.20
Link

Single nodes	Multiple nodes
	
	• Distributor made of non-ferrous metal with a G 1/2" connecting thread • Distributor attachment with pipe clamps or pipe clips

4.5 Special installation cases

4.5.1 Compressed air ductwork without dryers

When installing compressed air ductworks that do not incorporate dryers, the main and distribution pipes must be installed with a gradient of approx. 2 ‰. At the end of the pipeline, a condensate drain must be installed. When installing networks with dry compressed air, the lines can be installed horizontally.



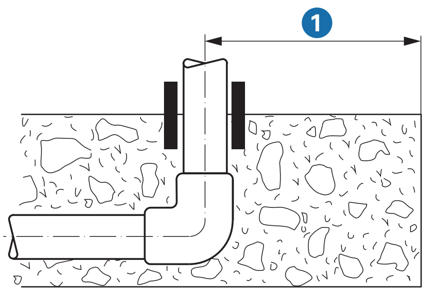
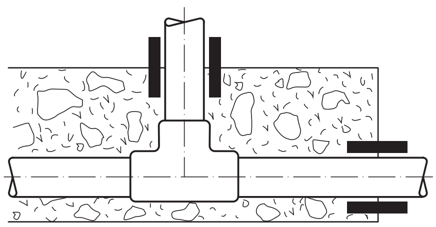
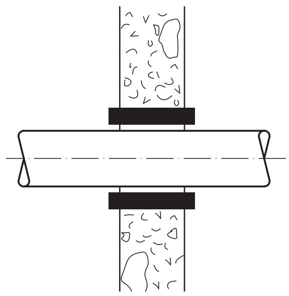
GIV.18
Installation with a gradient of approx. 2‰ and a condensate drain

① Compressor
② Pressure vessel

4.5.2 Duct installation

When installing the pipes in **floor ducts** which are closed and filled with concrete, it must be ensured that the pipelines are enclosed in a form-fitting manner. If the pipeline is intended to enter and exit a structure, proper measures must be taken in order to protected the pipes from damage.
If the pipeline must penetrate a **ceiling or wall duct**, a sleeve or insulation material must be used in order to separate the pipe from the surrounding structure. The sleeve must protrude on both sides of the structure.

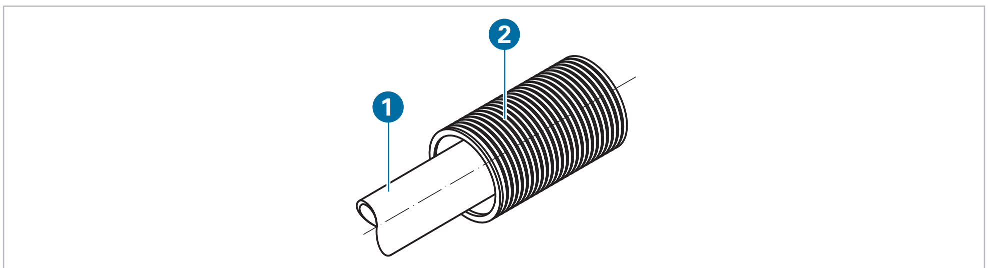
TIV.21 **Duct installation**

Installing in concrete	Protecting the inlet and outlet of the pipelines when installing in concrete	Wall duct with protective jacket
		

❶ min. 10–12 cm

4.5.3 Installation in a concealed area

If the installation of the pipelines must be concealed, for example, in laboratories, training and testing rooms, the pipe-in-pipe installation using polybutene (PB) pipes offers another advantage.
Whether the installation is carried out in the wall slot or behind a wall cladding, the protective pipe separates, isolates and protects the medium pipe from the enclosing structure.



GIV.19
Installation with protective pipe

❶ Medium-size pipe
❷ Protective pipe

4.6 Labelling

Pipelines and their components must be uniformly labelled.

Labelling according to the flow medium is essential in the interest of safety and crucial for effective fire fighting.

Labelling is carried out as follows:

- at the start and the end of the pipeline
- at branches and penetration points
- at fittings

Label, example 1	Label, example 2
	

GIV.20
Labelling of compressed air lines (examples)

5 Rehabilitation

For the operating company of a pneumatic system, the economic data of the plant are of essential. Here, two factors stand out:

- Pressure losses
- Leakages

5.1 Pressure losses

Increased pressure losses due to small dimensioning caused by calculation errors or questionable savings in investment costs, lead to increased energy costs in the supply of compressed air. The amount of leakage in pneumatic systems that are in need of rehabilitation are about 30% distributed across the network and about 70% is caused by hoses and equipment. The following example shows the increased energy costs for the compensation of the pressure loss:

- Operating pressure: 6 bar
- Networking length: 200 m
- Volume flow: 12 m^3/min

It is easy to calculate how long it takes for the slightly higher investment costs of the larger pipeline to be amortised by the increased energy costs caused by the smaller pipeline. Savings on the investment costs are quickly consumed by the high follow-up costs.

5.2 Leakages

It is important to know where and how much of the produced compressed air is lost between generator and consumer. Smaller leaks can usually only be discovered by using leak-detection sprays. In case of larger point of leakage, the hissing noises make it easy to locate the leak. The leakage volume is determined mainly by the pressure vessel discharge method or by measuring the switch on-time of the compressor.

Emptying the pressure vessel

In order to measure only the leakages of the network, it is important that the shut-off devices at the end of the connecting lines are closed. The pressure vessel (V_B) is filled using an arbitrary pressure (p_A). Subsequently, the time (t) is measured in which the vessel pressure drops to a pressure (p_E).

Sample calculation

$$V_L = \frac{V_B \cdot (p_A - p_E)}{t}$$

The 1000 litre pressure vessel is pressurised to 8 bar.
Then the time (5 min) is measured, in which the vessel pressure drops to 6 bar (p_E).

$$V_L = \frac{1000\ \text{l} \cdot (8 - 6)}{5\ \text{min}} = 400\ \text{l/min}$$

V_B	1000 l
p_A	8 bar
p_E	6 bar
t	5 min
V_L	Leakage volume [L/min]

Plan

Wastewater installation

IV

Wastewater installation

1 Introduction

The following technical information on the design of drainage systems within buildings has been prepared on the basis of the generally accepted rules of technology (DIN 1986-100) in conjunction with the standard series DIN EN 12056.

This chapter outlines and explains in particular the technical relationships that must be taken into account when planning and dimensioning in the defined area of application of the GF Silenta Premium drainage system.

The drainage capacity of the partially filled pipes, installed at an incline, was determined with a pipe inner diameter of the GF Silenta Premium drainage system for the filling grades $h/d_i = 0.5$ $h/d_i = 0.7$. These pipe had an operational roughness of $k_b = 1.0$ mm (Prandtl-Colebrook).

The following topics are **not** addressed in these basic principles:

- Drainage systems outside of buildings installed as underground lines
- Rainwater downpipes located outside the building
- Pipelines leading to light liquid separators
- Completely filled rainwater pipes with pressure flow according to schedule

Even though this information contains the most important principles for drainage systems inside buildings, it is essential that every operating company is familiar with and has access to the rules for building and property drainage. It is particularly important to have access to the series of standards DIN EN 12056 in connection with DIN 1986-100.

If the GF Silenta Premium drainage system is used in areas other than those explained here, the system requires the explicit approval for the extended application by GF.

2 The basics

2.1 Application technology

The information applies to the discharge of ordinary domestic wastewater and rainwater inside all buildings in conjunction with the standards DIN 1986-100, DIN 1986-3, DIN 1986-4, DIN 1986-30, DIN EN 12056-1 bis DIN EN 12056-4 as well as DIN EN 752 und DIN EN 1610, provided the pipes are installed underground.

The information applies to drainage systems operated as gravity-fed drainage with gravity lines. It must be ensured that only the planned wastewater types such as domestic, commercial and industrial wastewater or rainwater are discharged into the drainage points compliant with the intended operation of the drainage system.

Compliance with the system-specific technical contexts mandatory when using GF products, is covered in the following related chapter on the product system.

The criteria for installing the pipelines with regard to the compliance with the statutory requirements for fire behaviour and noise behaviour are covered in a separate brochure.

Prerequisite for a trouble-free operation of the drainage system is compliance with the planning and design based on the underlying operating requirements as well as regular maintenance according to DIN 1986-3.

When using coloured labelling, compliance with the specifications pursuant to DIN 2425-4 is mandatory:

- Rainwater pipes inside the building: Blue
- Wastewater and rain water pipelines: Brown
- Mixed water pipelines from the building to the connecting sewer: Purple

Harmful substances must not be introduced into the drainage system. These substances attack the building structures and pipe materials of the private and public sewage system or damage its functionality.

2.2 Labelling and approvals for construction products

Construction products for the erection, modification and maintenance of building structures may only be used if they are suitable for the intended purpose and if they comply with the requirements of the state building codes. Verification of the construction products' suitability with the recognised technology rules can be provided either by attaching a CE mark, if a particular standard is used, or as in the case of this drainage system, confirmation can be provided by the DIBt (Authority of the German State Governments) in form of a national technical approval.

These construction products receive a conformity mark ÜH-Z = German national technical approval.

2.3 Fire behaviour

When planning and designing drainage systems within buildings, compliance with the fire protection requirements is mandatory pursuant to the state building regulations and the technical building regulations or guidelines on fire protection requirements for pipeline systems in the federal states (LAR/RbALei).

The classification of the fire behaviour for this construction product Silenta Premium follows DIN EN 13501-1.

Separate information provides special requirements for the fire resistance duration including data for pipes penetrating walls and ceilings.

2.4 Noise behaviour

When planning and designing a drainage system in conjunction with the building, the noise behaviour of the drainage system must comply with the permissible noise levels pursuant to DIN 4109. If the sound insulation must be increased, VDI 4100 applies.

It is highly recommended that all contracting parties, clients and contractors include in writing the cost of their preferred sound insulation in the construction contract, whether the insulation is pursuant to DIN 4109 or VDI 4100 is irrelevant.

A separate information shall include references and examples of acoustically insulated wall and ceiling ducts.

2.5 Wastewater systems

Drainage systems for wastewater must comply with DIN 1986-100 system type 1, pursuant to DIN EN 12056-2. In this system, the drainage objects are linked with partially filled connecting pipelines that have a filling ratio $h / d_i = 0.5$. These pipelines are usually drained via waste water discharge lines into which main ventilation systems are incorporated into a collecting or underground pipeline. All pipelines must be installed with the pipe invert at an incline.

Trap inserts in odour traps are expected to remain stable as planned under all operating conditions so that unpleasant odours and noise transmissions are prevented.

For pressure equalisation and for the discharge of sewer gases, drainage systems for wastewater must always be ventilated via the roof.

For water-efficient lavatories with flushing water volumes of 4 to 6 litres, smaller nominal diameters than DN100 may have to be used for connection, drop, collection and underground pipelines.

If drainage points are removed or taken out of service, the connection points must be sealed gas- and watertight.

2.6 Rainwater drainage systems

Planning and design of rainwater drainage systems for buildings and properties covers the following aspects and requirements:

- Measures for rainwater management
- Discharge of rainwater into the sewer system with potential discharge restrictions (delay of rainwater drainage from the property)
- Preventing rain or surface water from entering the building
- Overload tests of the pipeline system and flooding test of rain catchment areas for specific rain events
- Proof that flooding of designated property areas does not cause damage.
- Protecting the areas below the backwater level in order to prevent inadmissible flooding.
- Roof drainage usually without rainwater retention on the roof.
- Securing the roof areas usually by means of emergency drainage against inadmissible flooding during heavy rain events up to the century rainfall expected at the building site;

Unless the sewer system operator provides any other specifications, drainage systems for the discharge of rainwater from small plots of land can be dimensioned without floodwater testing. Properties with a drainage area of up to 800 m^2, for which a DN150 connection duct is available, are considered small plot.

During the planning stage, it must be decided whether a gravity-fed system shall be used for the drainage of the roof or rainwater pipes with pressure flow that are fully filled and operated according to schedule.

Roof drains must comply with the requirements of DIN EN 1253-1 and a Certificate of Conformity must have been issued. A tight connection of the drains to the roof seal must be ensured.

Flat roofs must, in principle, have an emergency drainage, in which the difference between the estimated rain and a heavy rainfall event is drained via emergency overflows or emergency drains with free run-offs onto areas of a property that is designed for flooding purposes. The emergency drainage system must not be connected to the drainage system.

Departure from the principle of emergency drainage is permissible if a solid construction method is used, and if the potential accumulation of water levels on the roof is verified by the structural engineer in form of a structural analysis.

Flat roofs built as light-weight construction, must have emergency drainage. In this scenario the exemption does not apply.

When rehabilitating roof surfaces, it must be calculated on the basis of the latest rain events, whether the existing roof drains can discharge the current design rain and whether there is sufficient emergency drainage.

2.7 Safety and strength

The planning and design of drainage systems inside buildings must consider the following important safety aspects:

- Protection of health, hygiene and the environment
- Preventing the spread of fire
- Preventing leakage of wastewater and sewer gases into the building
- Ensuring backwater flow cannot occur
- Preventing the ingress of rain or surface water through the building's envelope into the building
- Preventing the spread of excessive noise
- Preventing deposits in the pipes and drainage blockages

In order to ensure the permanent stability of drainage systems, compliance with the following requirements and interactions is mandatory:

- Choice of material according to the planned service lifespan
- Stability of the building
- Fixing the drainage pipes to the structure
- Effects of alternating stress on the pipeline system due to temperature changes and internal pressure fluctuating excessively
- Consideration of mechanical stresses during the installation of the pipeline system until final commissioning
- Preventing electrolytic or chemical reactions
- Corrosion of metal components
- Formation of condensation
- The effects of frost

In order to comply with these requirements, professional planning, design, maintenance and proper operation is required.

2.8 Preventing flooding

In order to prevent buildings from flooding, the following measures are essential:

- Sufficient design of the drainage system.
- Preventing water leaks into the building (for example, due to leaky pipes).
- The installation of backwater safety devices.
- A favourable integration of the building into the terrain (surface water must not penetrate into light wells and through their windows into the building).
- Protecting storage places for substances hazardous to water or other goods from flooding and, for example, protecting these goods in the event of heavy rain falls.

2.9 Frost resistance

Drainage systems within buildings, for example, pipelines in underground car parks and outside of buildings must be installed in such a way as to avoid the risk of destruction or loss of function due to the effects of frost.

In ventilated drainage systems inside buildings it can be assumed that the warm sewer gases compensate for the frost effect.

In areas subject to frost, it is necessary to provide individual and collecting pipes or header pipes with thermal insulation. In exceptional cases, for example, in the connection area of roof drains, it may also be necessary to provide such pipeline areas with additional self-regulating, electric heating tapes.

Drains in areas subject to frost a odour trap must not be installed. This trap must incorporated in a frost-proof location within the building.

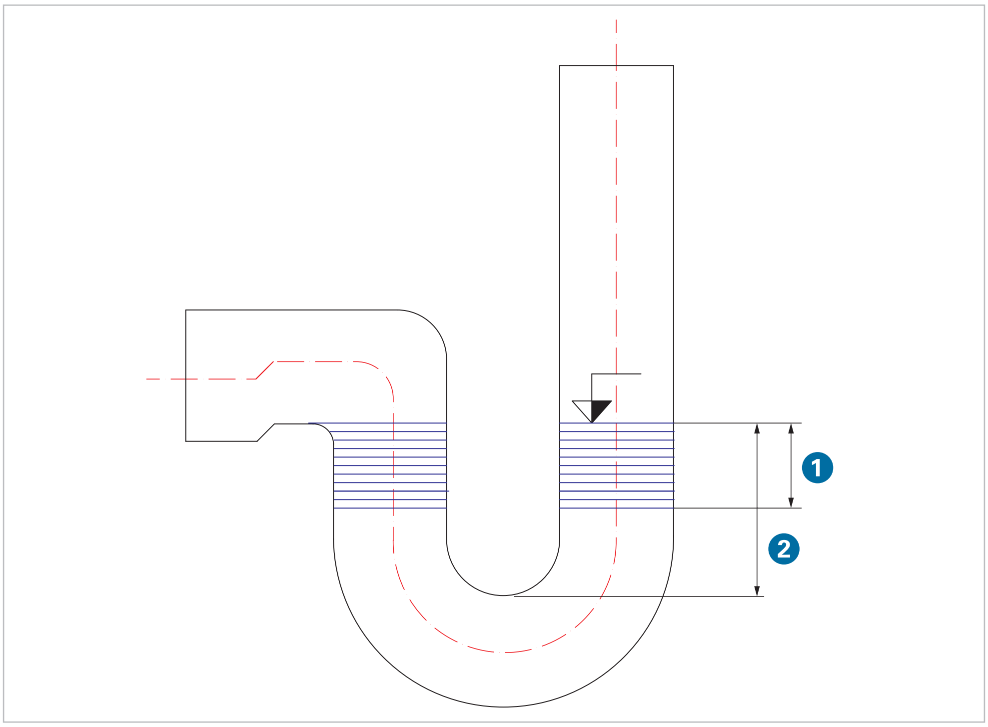
If the pipes are installed in ditches outside of buildings, the frost-free depth shall be considered the distance from the upper edge of the terrain to the top of the drainage pipe. In most areas, a frost-free installation can be assumed if the pipe is covered with at least 800 mm of soil. However, depending on the local climatic conditions, the required depth of the trench is set by the appropriate authorities at 1,000 mm or 1,200 mm.

2.10 Preventing the discharge of sewer gases

In order to prevent the escape of sewer gases from drainage systems into the building, an odour trap must be incorporated into each drainage point. Several drainage points of the same kind can be directed through a common odour trap.

The water seal head in the odour trap for wastewater drains must be 50 mm. In rainwater drains this water seal head must be 100 mm.

The leakage water loss caused by the drainage process must not reduce the water seal head in the odour trap by more than 25 mm.



GIV.1
Odour trap with water seal head

1. Permissible water seal head loss <25 mm
2. Water seal head >50 mm

This regulation excludes:

- Drain points for rainwater in the separation process
- Runoff points for rainwater in the mixing process, if distances of at least 2.0 m from doors and windows of common rooms are respected
- Floor drains that drain into light liquid separators
- Garages with floor drains, which are connected to mixed water pipes and drained via a central odour trap in a frost-free area

2.11 Self-cleaning capability

Drainage systems that are planned, constructed, maintained and operated according to the recognised rules of technology are self-cleaning.

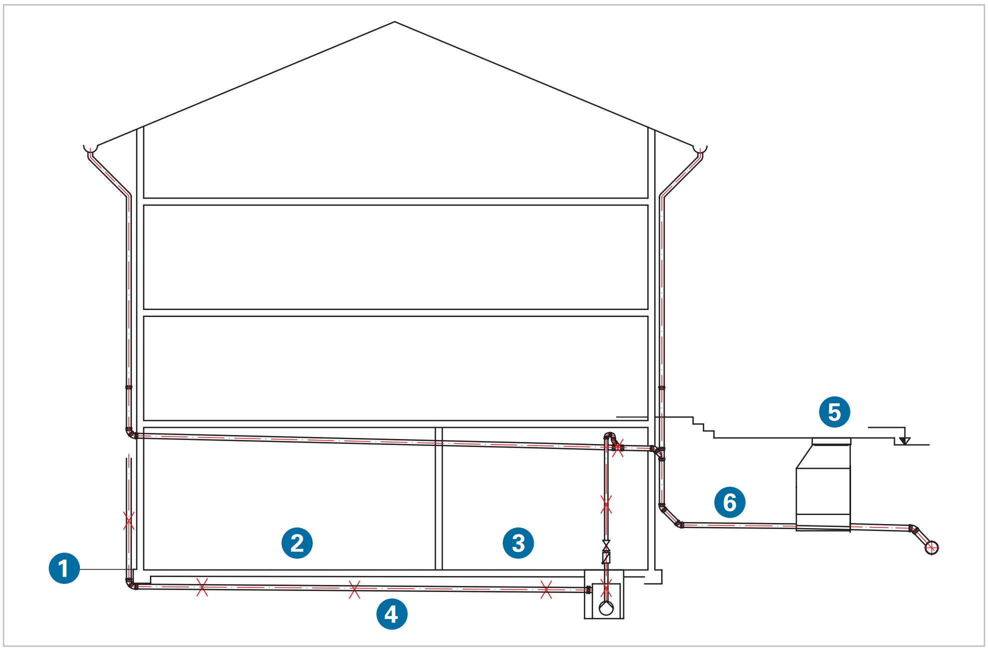
Compliance with following relevant criteria is mandatory:

- proper dimensioning of the pipelines
- adequate and uniform gradient of the pipe invert
- no discharge of hazardous and harmful substances
- no discharge or retention of coarse material and sediments that lead to deposits, growth and blockages
- no waste disposal via the drainage system

When using pipelines that carry greasy wastewater and if using single and multiple collecting pipes for urinals, special planning principles must be observed to avoid deposits.

2.12 Gravity-fed drainage systems/energy savings

Any wastewater above the backwater level must be drained into the sewage system using gravity. The wastewater must not be routed via lifting systems or a backflow trap (➨ [GIV.2]).



GIV.2
Connection to the sewage system with wastewater above the backwater level

1. Patio
2. Living quarters
3. Basement
4. Pipelines and sewage lifting units are prohibited
5. Backwater level upper edge of the road in the connecting point
6. Rain water

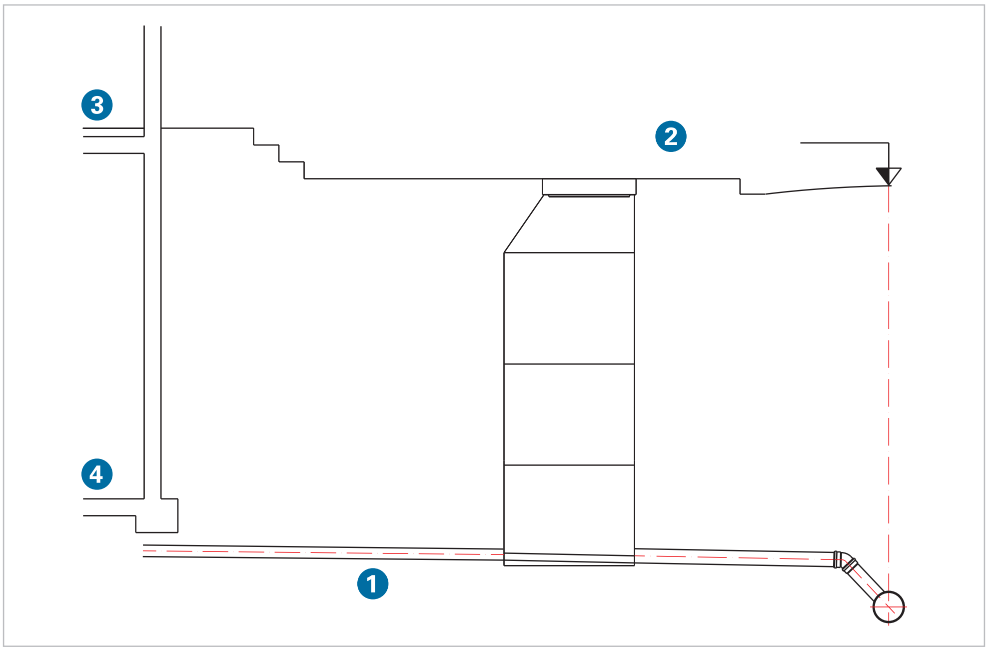
2.13 Drains underneath water intake points

There must be a drainage point underneath each water outlet inside the building if drainage cannot be done across a watertight floor without creating puddles until the water has reached a drainage point. This rule excludes tapping points for fire fighting purposes and for connecting washing machines and dishwashers.

2.14 Protection against backwater

The backwater level is the highest level up to which water inside the drainage system can rise. In the local sewage regulations, the uppermost edge of the road at the connecting point is usually specified as the backwater level (➨ [GIV.3]). Departures from this rule are possible depending on the topography of the terrain.

Drainage points, in which the water levels inside the trap are below the backflow level, must be drained reliably via sewage lifting units or backflow closures to prevent the backflow of wastewater from the sewer system.



GIV.3
Backwater level upper edge of the road

1. Wastewater
2. Backwater level upper edge of the road in the connecting point
3. Ground floor
4. Basement

Planning and dimensioning of safety devices against backwater must comply with DIN EN 12056-4. When considering specified limiting conditions, sewage lifting units can be used for special purposes pursuant to DIN EN 12050-3.

Rainwater from areas below the backwater level may only be discharged into the public sewage system if utilising sewage lifting units pursuant to DIN EN 12050-2; they must be separated from domestic wastewater. The lifting units must be located outside the building and the rainwater must be lifted above the backflow level pursuant to DIN 12056-4.

Drain effective surfaces below the backwater level must be kept as small as possible and evidence that flooding is prevented must be provided.

If buildings or property are at risk, the sewage lifting units must be designed for a once-in-a-century rain event $r_{(5.100)}$.

In exceptional cases, for example, on abutting properties or in underground car park entrances, the lifting system should be equipped with a double pump. The installation of the lifting unit is also possible within the building, however, the building must protected using suitable measures in order to prevent flooding.

Rainwater from small areas – up to 5 m^2 – of basement entrances and the like, can seep away in compliance with the specifications of DIN 1986-100, 13.1.3.

Pressure pipelines from sewage lifting units must be connected to ventilated collecting or underground pipelines. Connection to a downpipe is not permitted.

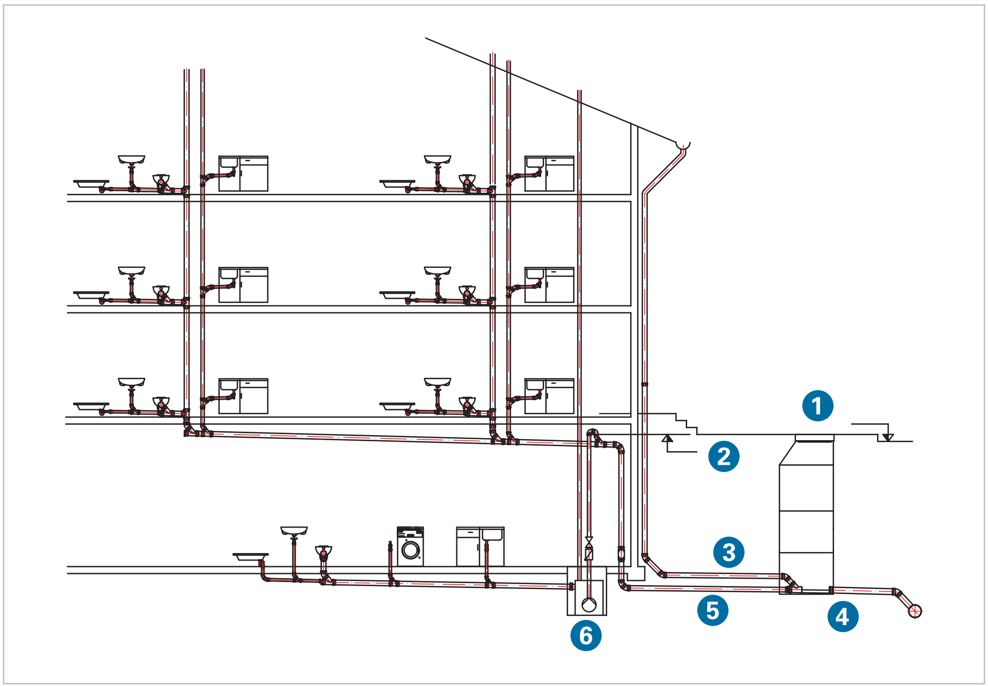
Anti-flooding devices must comply with DIN EN 13564-1 and must only be used if:

- there is an incline to the sewer system
- the rooms are of ancilliary importance; that is to say, any material assets stored here or the health of the residents are not adversely affected if the rooms are flooded
- the user group is small and if a toilet is available to this group above the backwater level
- in case of backwater, the use of the drainage point can be womitted

Pursuant to DIN EN 13564 -1, the following types of anti-flooding devices are permitted according to the stated application:

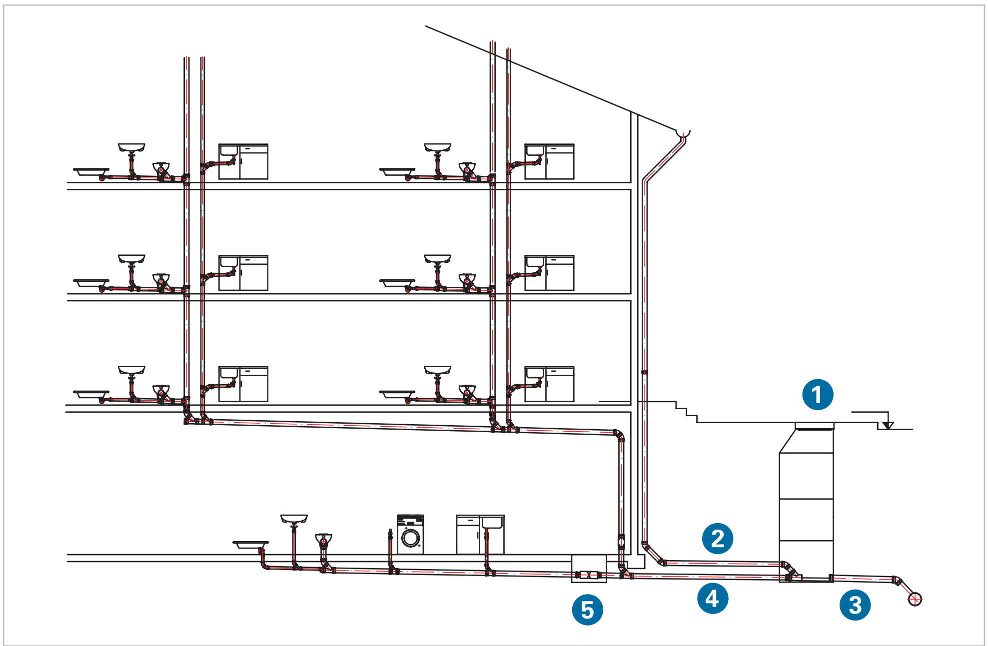
- Types 2, 3 and 5 for wastewater not containing faeces
- Type 3 with labelling "F" for wastewater containing faeces
- Types 0, 1, and 2 for earth tanks used in rainwater harvesting systems, if their overflows are connected exclusively to rainwater channels

The specifications for the operation, inspection and maintenance of sewage lifting units are provided in DIN 1986-3



GIV.4
Active backwater safety devices with sewage lifting units

1. Backwater level upper edge of the road in the connecting point
2. The pipe invert of the backwater loop must be above the backwater level
3. Rain water
4. Mixed waster
5. Wastewater
6. Sewage lifting unit for wastewater containing faeces



GIV.5
Passive anti-flooding device with central backwater stop

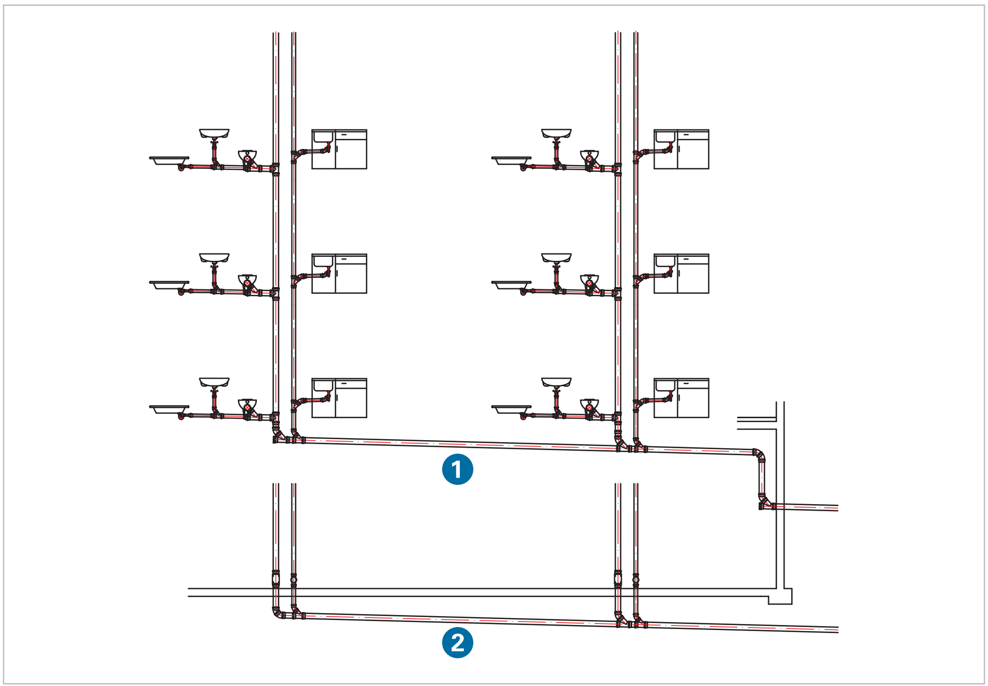
1. Backwater level upper edge of the road in the connecting point
2. Rain water
3. Mixed waster
4. Wastewater
5. Central anti-flooding device, type 3 with marking "F" for wastewater containing faeces

3 Pipeline installation

Omitting underground pipelines

In order to make inspections easier and providing simpler rehabilitation option, water collection pipelines should be installed under the floor slab of buildings and not underground (➨ [GIV.6]).

In buildings without basements or where drainage systems are located below the backwater level, underground pipes should be routed out of the building and kept as short and straight as possible.



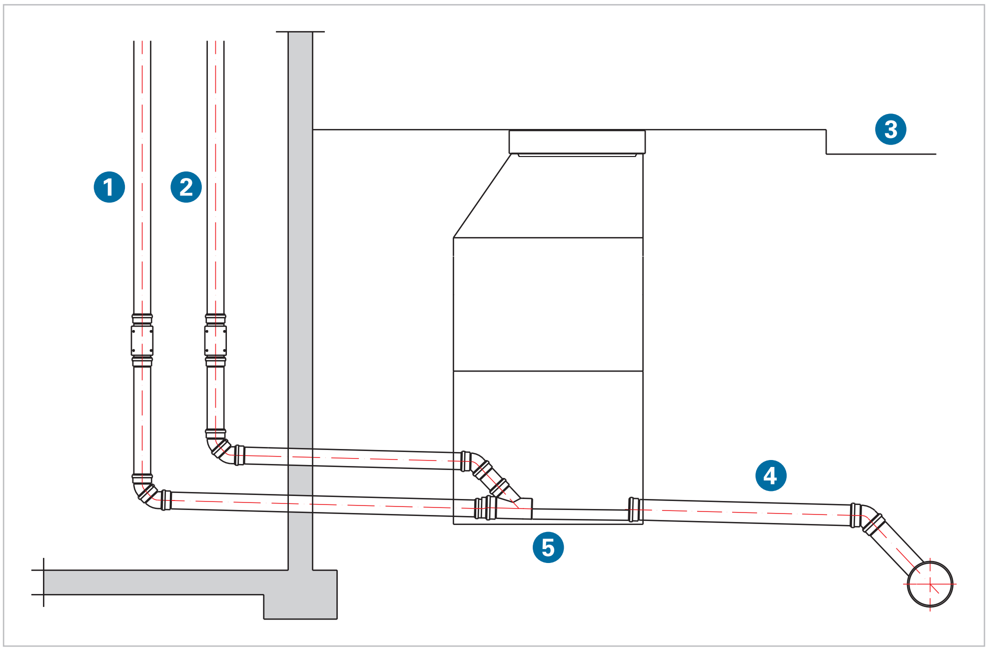
GIV.6
Collection pipelines instead of underground pipelines

1. Headers
2. Underground pipelines

3.1 Discharge of various types of wastewater

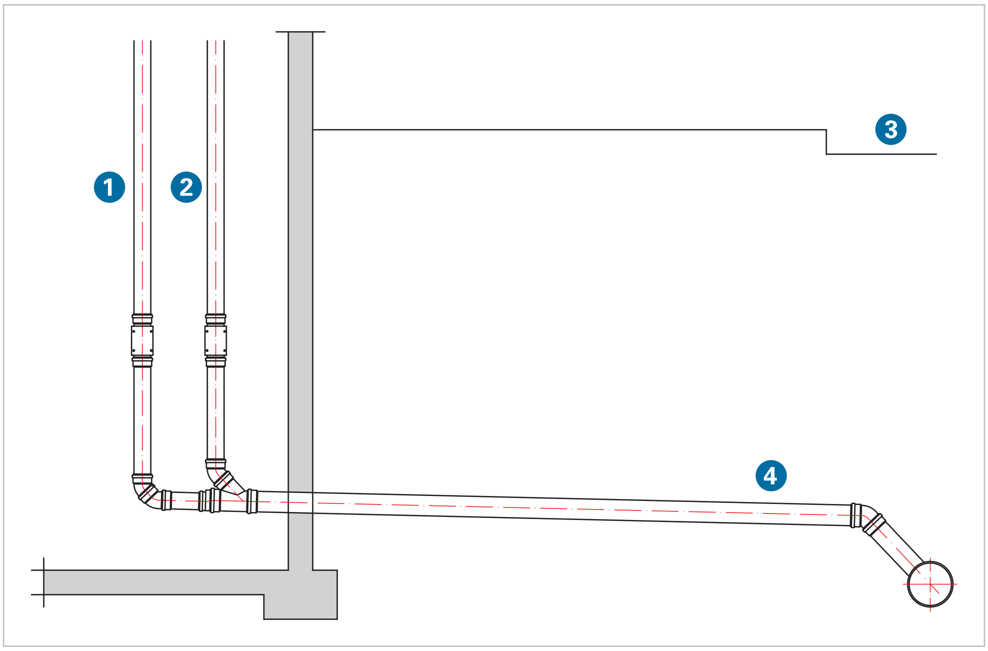
Inside buildings, rainwater and wastewater pipes must be routed separately (separation system) and, for hydraulic reasons, may only be brought together outside the building (outside the overload area) in an inspection chamber with an open-flow, if possible.

An exception exisist where properties are abutting; here, the wastewater and rainwater pipes may be brought together within the building, however, they must be routed directly along the building's outer wall.



GIV.7
Merging pipes outside the building (normal case)

1. Rain water
2. Wastewater
3. Street
4. Mixed waster
5. Inspection chamber with an open-flow



GIV.8
Merging pipes inside the building (with the exception of abutting properties)

1. Rain water
2. Wastewater
3. Street
4. Mixed waster

On abutting properties, underground rainwater pipelines or headers with nominal diameters ≥DN 150, should be connected to the public mixed water sewer using their own connecting line.

3.2 Proof of seal tightness of pipelines inside or outside of buildings

For all drainage pipes inside or outside buildings and their connections the following applies: Considering the interactions between the pipes and their environment, they must be permanently sealed at an internal or external pressure of up to 0.5 bar.

Buried sewers must be tested pursuant to DIN EN 1610 either using procedures "W" for water or "L" for leaks.

Drains that are difficult to access, such as pipes laid in concrete or pipelines that are installed in inaccessible floor ducts, manholes or intermediate floor should be tested immediately after installation for leaks – similar to the procedure for underground lines.

Drainage pipes, such as a single, collecting pipes, downpipes or headers, and which are installed above ground or are concealed within buildings, for example behind false walls, in pre-wall installations, brick partion brick walls, wall slits or suspended ceilings, must not be checked for leaks according to the generally recognised codes of practice.

The prerequisite for the above is:

- Only pipes, fittings, gaskets, etc., which comply with the generally recognised codes of practice (standards or test guidelines) and are labelled accordingly, shall be used.
- Only qualified personnel shall be permitted to install the pipeline.
- In contrast to buried pipelines, leaks can be detected.
- A repair is possible, even if it means an on-site effort (forcefully open suspended ceilings or false walls, etc.).

If, in individual cases, a leak test of drainage pipes inside buildings is considered necessary, a partial check with minimum overpressures must be realized.

In order to prepare for a leak test, all bypasses and end plugs of drainage points must be secured in order to prevent the pipes from slipping apart, considering the static overpressure expected in the pipeline. Experience shows that this additional testing effort stands in no economic relation to the benefits.

According to VOB DIN 18381, the leak test is an “additiona service” and must be tendered and remunerated in the specifications according to type, procedure and scope.

3.3 Preventing pipes from slipping apart

Sewer pipes and fittings with connections that are not force-fitted in the longitudinal direction must be secured in order to prevent the pipes from slipping apart and/or causing the misalignment of their mutual axes. This applies in particular to push-in fittings installed in areas where the internal design pressure prevails or may result due to overload, causing internal pressure. This can be done by selecting the proper attachment, using pipe clips and brackets or by additional safety clamps (claw fasteners).

Pipelines, such as rainwater downpipes, lines in the backwater area or pressure lines of lifting units, in which excessive internal pressure must be expected due to operational reasons, must be protected in terms of the requirements for the pipes, fittings, connections, fasteners and brackets. Here, special measures against the reaction forces caused by excessively high or low pressures must be considered.

The spacing between pipe fittings must be observed according to the installation instructions for the Silenta Premium pipe system. The same applies to the additional methods intended to prevent the pipes from slipping apart and/or causing the misalignment of their mutual axes.

3.4 Directional changes

Directional changes and branching of underground pipelines and headers may only be carried out with ≤45° elbows and branches. This requirement is to ensure the hydraulic performance and ventilation of the drainage system, as well as the use of cleaning equipment and the control of sewer television cameras.

3.5 Reductions and transitions to other nominal diameters

Nominal diameter changes and transitions to other materials must be made with transition fittings or transition seals. Fittings and gaskets must be tested and approved in order to ensure a permanently sealed connection.

It is not permitted to reduce the nominal diameters of sewer pipelines in the direction of flow, neither inside nor outside buildings.

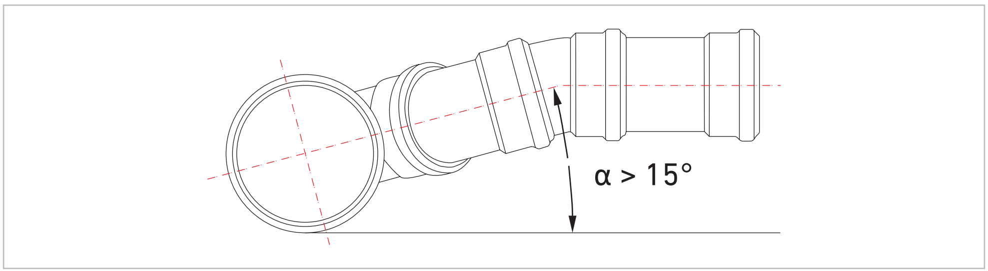
Mixed water pipelines may have different pipe cross-sections for the main pipe and the connecting pipe due to the different design regulation for private and public rainwater pipes required for private the property and for the public sewage system. In this exceptional case, the pipe's cross-section change outside the building should lead into an inspection chamber with an open-flow close to the property boundary.

This exeption also applies to rainwater pipelines which are operated fully filled and according to schedule.

3.6 Preventing flushing of external matter

3.6.1 Pipelines installed horizontally

When merging horizontal pipelines, a branch pipe measuting 15° or more must be incorporated at the junction. This prevents flushing of external matter and avoids deposits of solids as a result (➨ [GIV.9]). Therefore, double branch pipes must not be incorporated into horizontal pipelines.

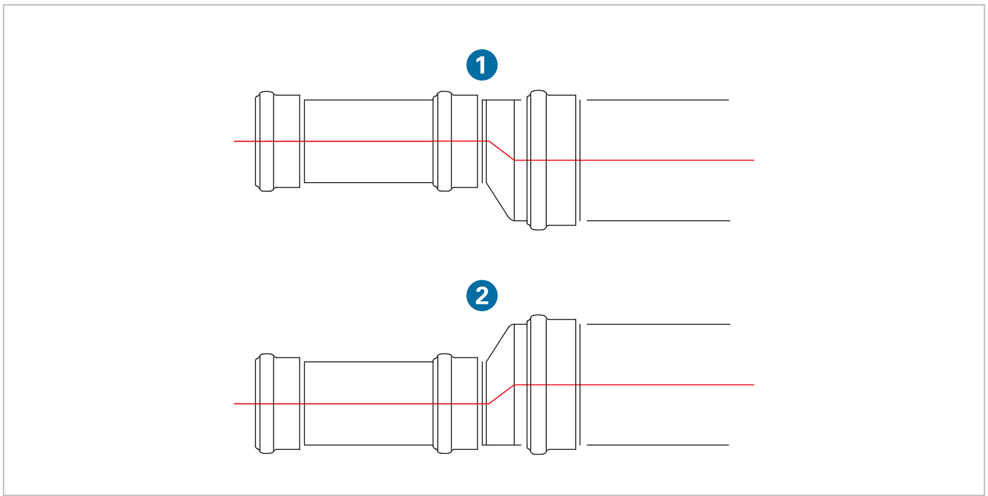


GIV.9
Alignment of branches connecting to underground pipes and headers

If the nominal diameters in collecting pipes, headers and underground pipelines must change, eccentric reducers must be used.

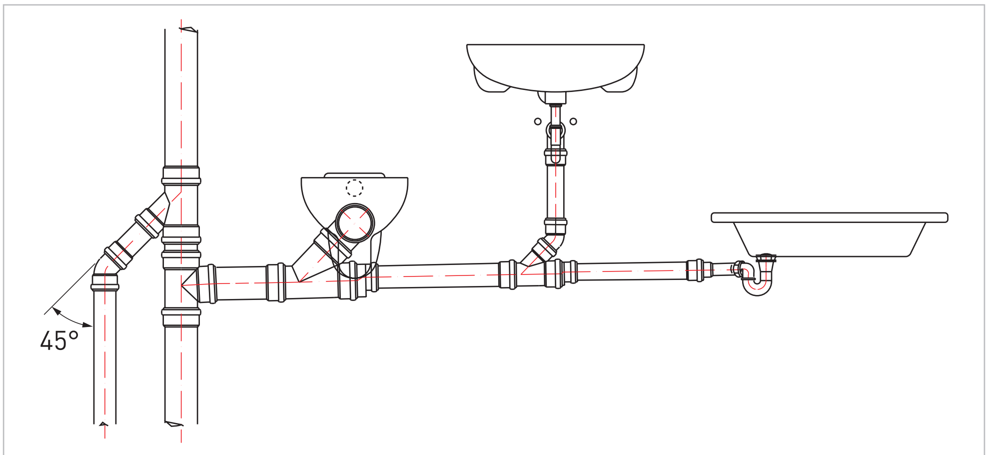
In collecting pipes and headers, the eccentric reducers must be installed at the same angle; this ensures better ventilation. At the same time, flushing external matter into the smaller nominal diameter pipes is prevented.

If the nominal diameter of an underground pipeline must be change, it is preferrd that this change takes place at the same pipe invert level. This will make cleaning and inspection tasks much easier (e.g. with sewer television systems).



GIV.10
Design of transitions in horizontal pipelines

1. Pipe crowns at same level
2. Pipe inverts at same level

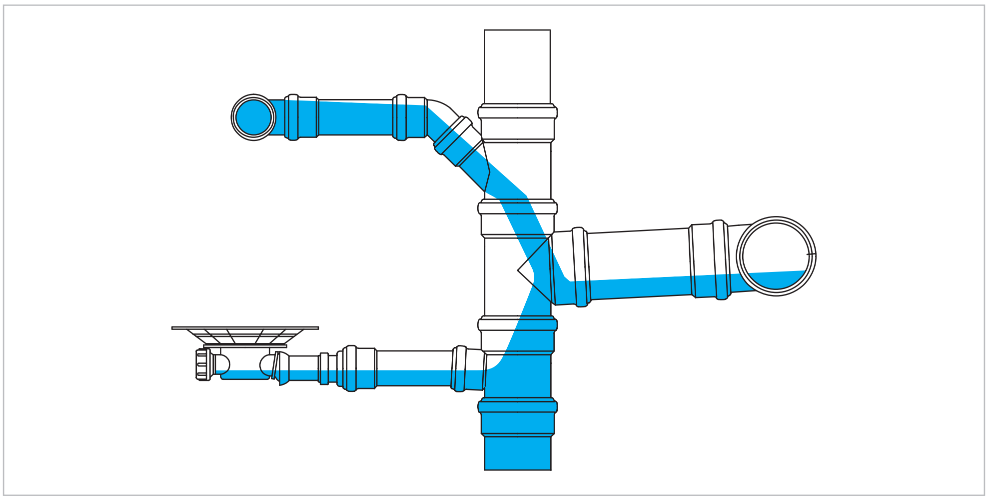


GIV.11
Overflow-proof collecting pipes

...ensuring the crowns of the eccentric reductions are at the same level

3.6.2 Downpipes

If the geometry of downpipe connections is unfavourable, wastewater can be flushed from one individual or collecting pipe into another pipeline. Fig. [GIV.12] illustrates how wastewater from the connecting pipe of a higher level drain can be flushed into the water seal head of a toilet bowl. When flushing the toilet, wastewater containing faeces get also enter into the water seal head of the floor drain.

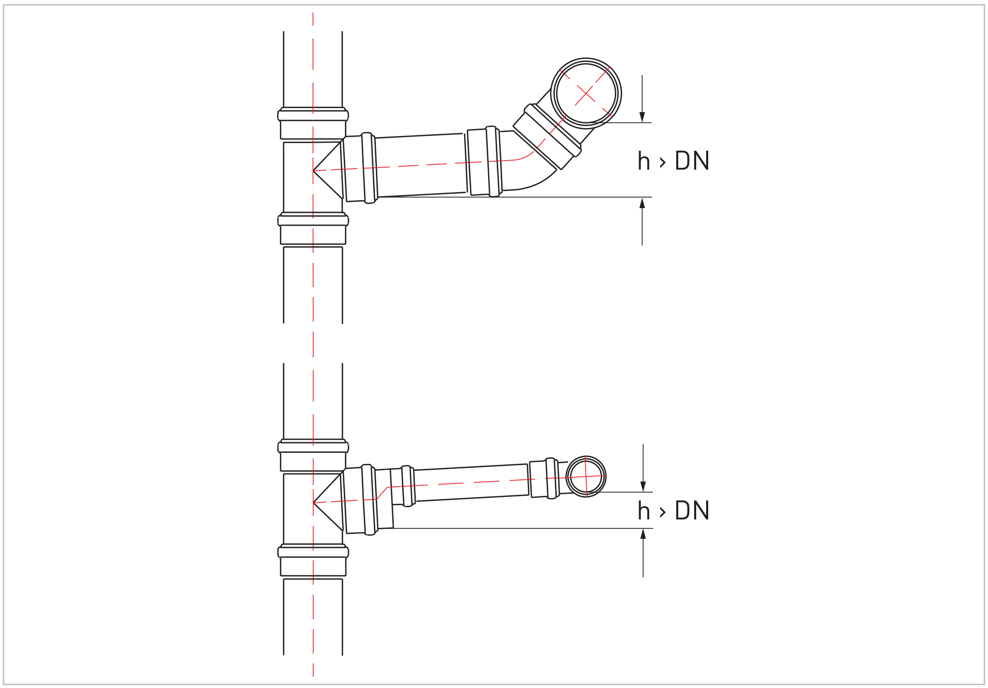


GIV.12
External flushing into single connection lines
...if the geometry of downpipe connections is unfavourable

Therefore, the connections of collecting pipes and single connection lines to the downpipe must be designed such as to avoid the flushing of wastewater – in particular faecal wastewater – into other single or collection pipelines.

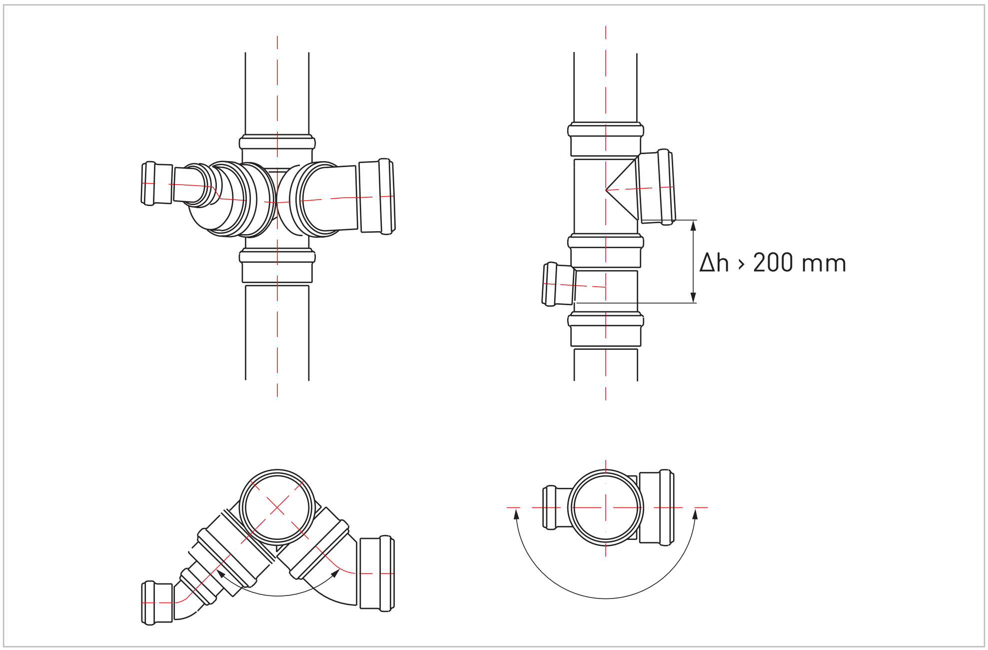
The following design principles must be taken into account:

- The minimum height difference "h" required between the water level in the odour trap and the bottom of the connection line at the downpipe branch (➨ Fig. [GIV.13]) must be greater than the nominal diameter of the collection or single connection line (h ≥ DN).
- Compliance with the height difference and/or the spread angle as seen in Fig. [GIV.14] is mandatory.
- For individual connecting pipes of toilets that are linked to the downpipe using an 87° double branch, the height distances shown in Fig. [GIV.17] should be taken into account.
- When installing single or multiple collecting pipes which carry sewage-free and faecal wastewater and are connected to the downpipe with a double branch having an inner radius or 45° inlet angle of the same diameter, the height distance shown in Fig. [GIV.16] must be maintained.



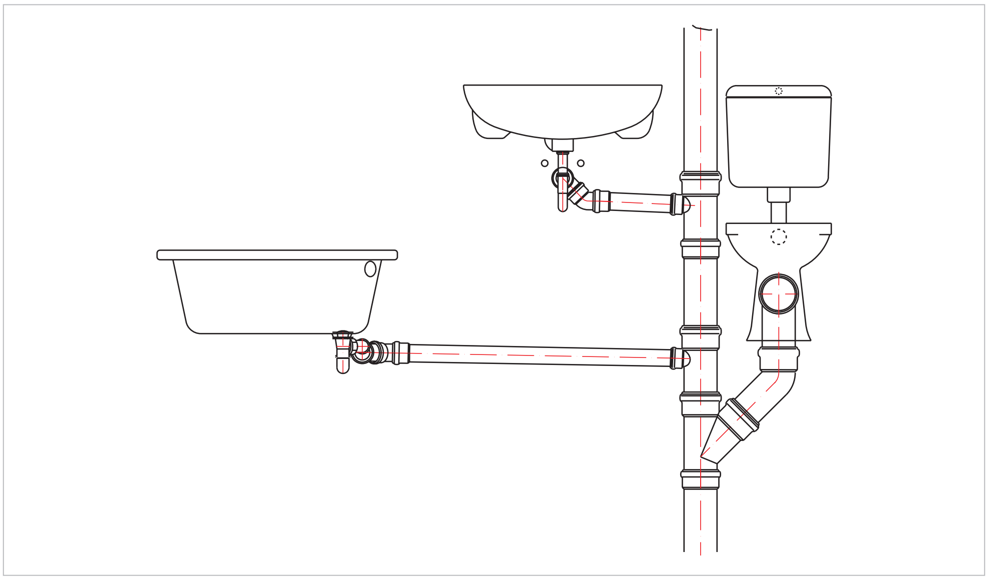
GIV.13
Minimum height difference "h" required

...between the water level in the odour trap and the invert of the connection line at the downpipe branch



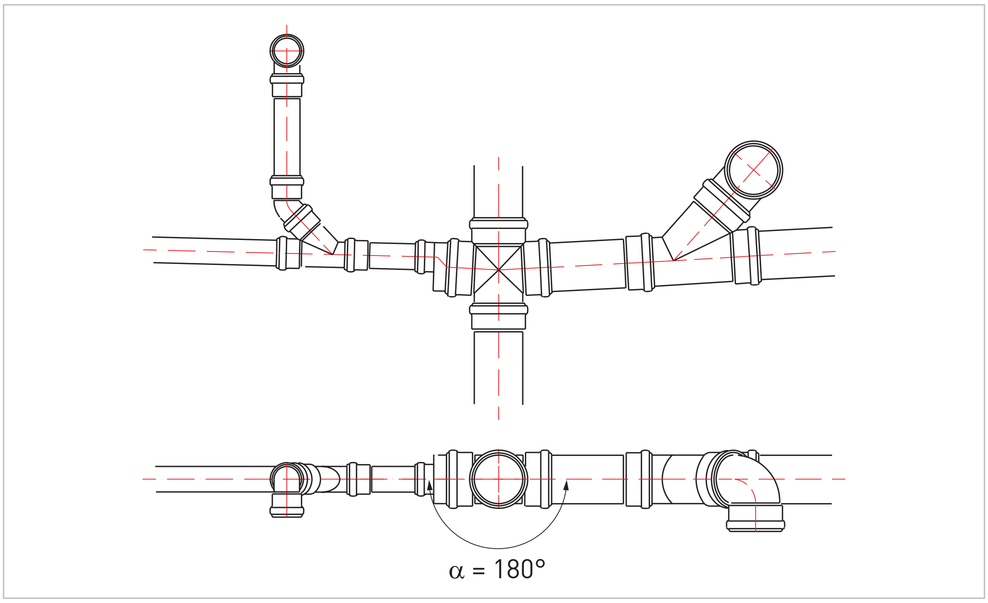
GIV.14
Overflow-proof connections to the downpipe

...if the pipe invert connection and the pipe diameter are the same
...by off-setting the inlet flows by 90° in a corner branch (right picture) and in connections on the opposite side by observing a minimum required distance (left picture)



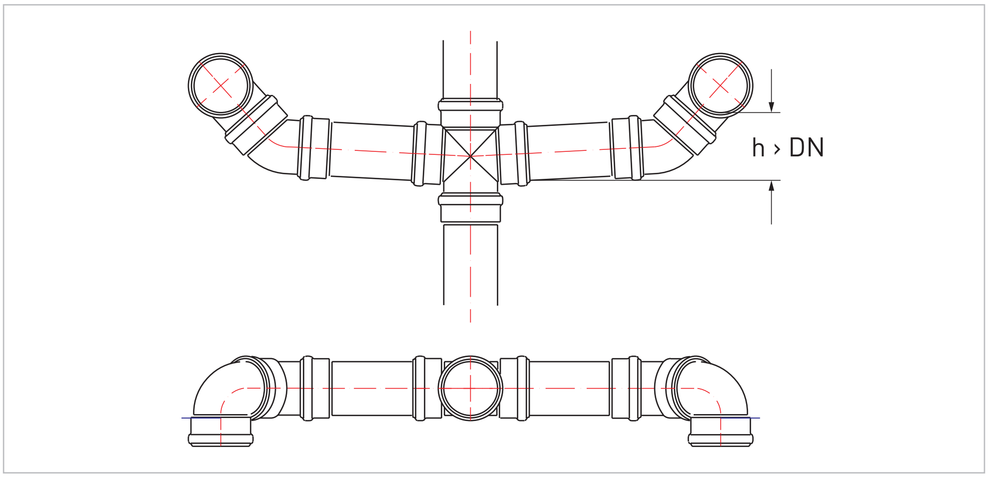
GIV.15
Overflow-proof connections of individual connection pipelines to the downpipe

...by adhering to minimum required distances required



GIV.16
Overflow-proof connection

...when using double branches of the same diameter with an inside radius or 45° inlet angle



GIV.17
Connecting pipelines from toilets located opposite to each other

3.7 Wastewater downpipes

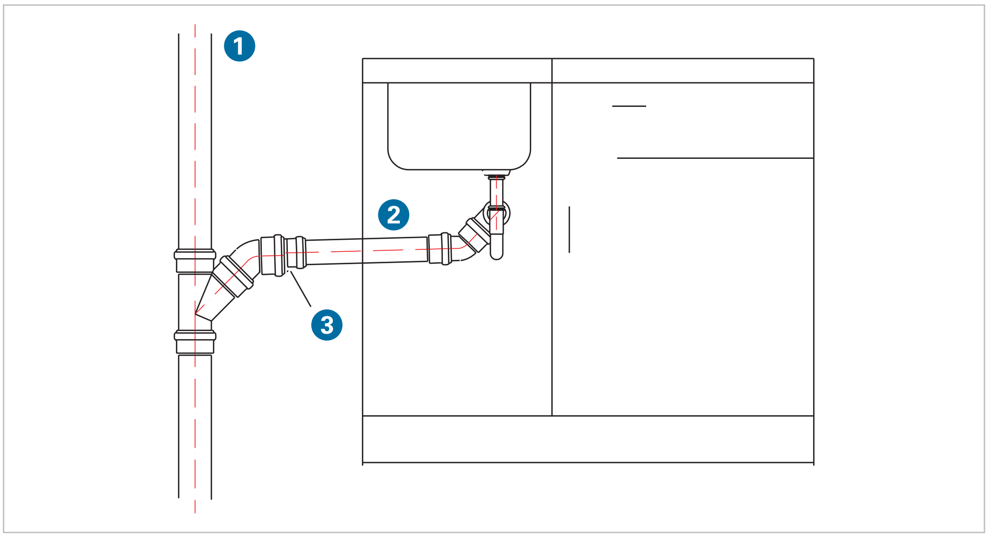
In order to keep the trap inserts inside the odour traps, pressure fluctuations caused by drainage processes in the drainage system must be limited. The expected pressure fluctuations are greatest in the area of the downpipes, as drainages are greatly accelerated or decelerated. The resulting low pressure or excessive pressure must be compensated or reduced by the unobstructed air flows in the entire drainage system.

The extent of the pressure fluctuations is strongly influenced by the resistance, which opposes the flowing air in the drainage system. All wastewater pipes in which not only wastewater but also air for pressure equalisation must be carried, require – among other things – a streamlined design. Therefore, it is preferred to resolve any flow deviation by installing at least 2x 45° elbows. The flow resistances in the downpipe are of particular importance for the functionality of the discharging unit. Downpipes and the associated main ventilation pipes should therefore be routed as straight as possible through the floors and extending above the roof. A constriction of the air flow by introducing cross-sectional reductions in the ventilation pipe or in the area of the end pipe of the ventilation duct is not permitted.

Adjacent flats may only be connected to a downpipe if noise and fire safety requirements are met.

The geometric shape of the branch, with which single or collecting pipes are connected to the downpipe, has an influence on the pressure conditions in both the connection line and the downpipe. Connections to downpipes ≤DN70 must therefore be made with branches having a connection pitch of 88° ± 2° (➨ [GIV.33]).

If only kitchen drains are connected to what is referred to as “kitchen waste pipes”, an exception to this basic rule is permitted for reasons of better cleaning options. Taking into account all aspects, in this case, connection branches with a slope of less than 45° are more suitable (➨ [GIV.18]).

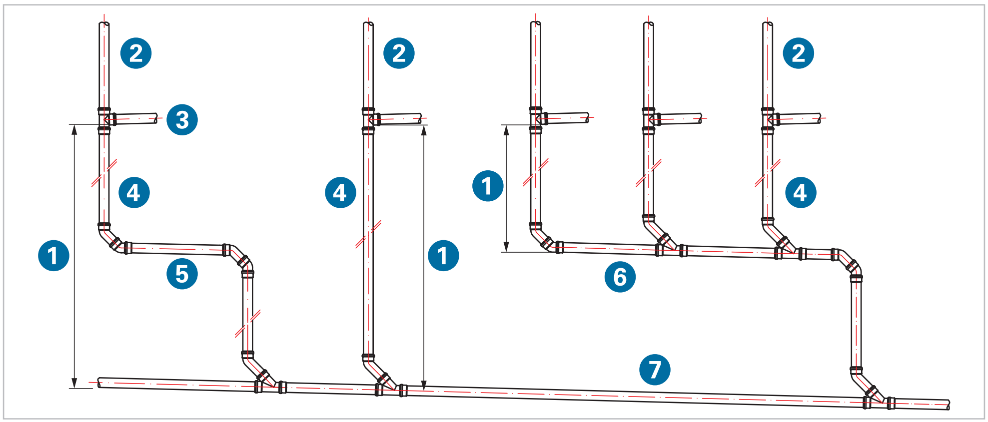


GIV.18
Connection of a single kitchen connection DN50 to a downpipe DN70

1. DN70
2. DN50
3. Excentric reduction DN70 / DN50

If the nominal diameter of the downpipe and the connecting line are the same, 45° branches or 88.5° branches with inner radius should be preferred. This ensures that the pressure fluctuations in the downpipes are reduced to a minimum.

If a downpipe flow is diverted into a header, an underground pipeline or in the area of a downpipe offset, special, design measures must be taken into account, depending on the length of the downpipe. The definate length of the downpipe must be determined using the rules illustrated in Fig. [GIV.19].

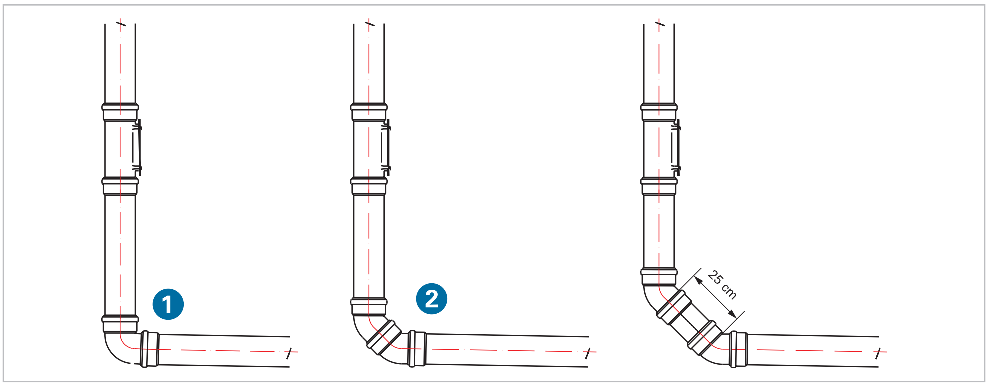


GIV.19
Determining the length of the downpipe

1. Length of the downpipe
2. Main ventilation pipe
3. Collecting pipe
4. Downpipe
5. Downpipe off-set
6. Header pipes vented by adding more downpipes
7. Underground pipeline

Downpipes up to 10 m long

Downpipes up to 10 m long may be connected to horizontal pipelines using 88° elbows. The variants using 2x 45° elbows or 2x 45° elbows with a 25 cm long intermediate piece are hydraulically more favorable, reduce the impact noise and thus improve the sound insulation (➨ [GIV.20]).



GIV.20
Design types of deflections of horizontal downpipes

1. 87° elbow
2. 2x 45° elbows

Downpipes longer than 10 m to 22 m long

When using downpipes longer than 10 m and up to 22 m long, the installation of an 87° elbow for the deflection is no longer permitted. The variants with 2x 45° elbows or 2x 45° elbows with 25 cm long intermediate piece must be used (➨ [GIV.20]).

If the downpipe offset requires directional changes that exceed 45° and which are located in an area subject to critical excessive pressure, connections to the downpipe up to a height of at least 2.00 m are not permitted any more(➨ [GIV.21] and ➨ [GIV.22]).

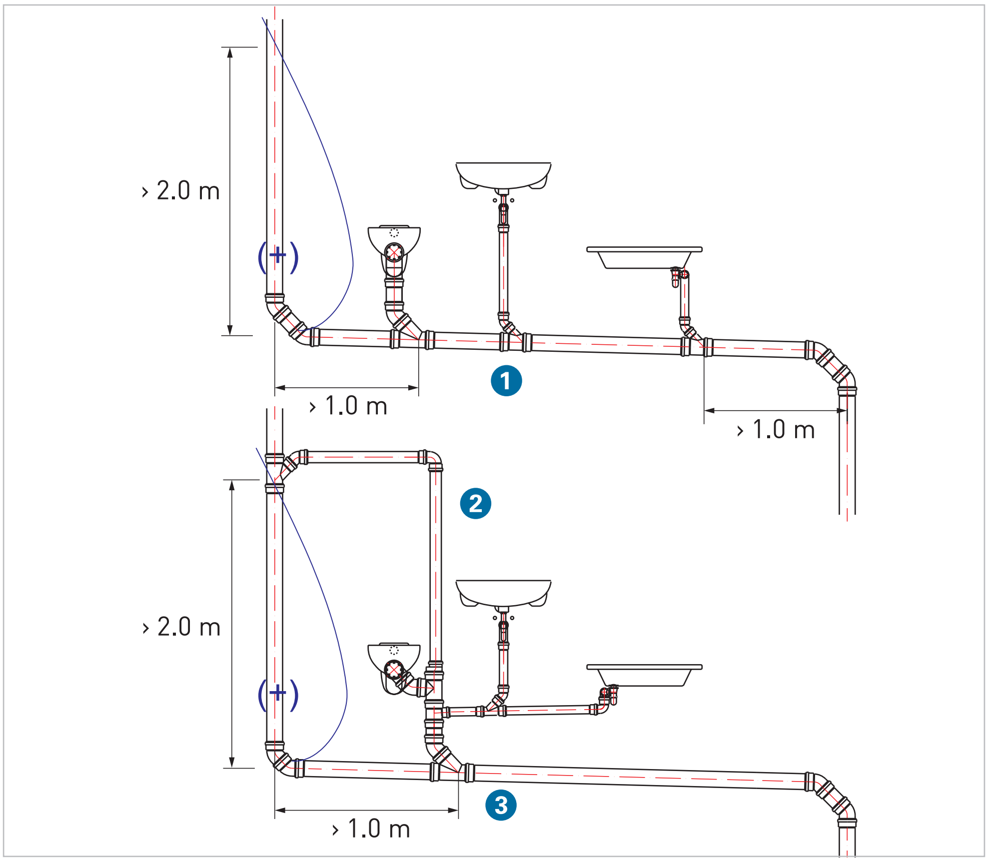
Single and collecting pipes must be connected to the horizontal line in the off-set, taking into account a minimum distance of 1.0 m downstrean of the inflow side elbow and 1 m upstream of the drain side elbow (➨ [GIV.21]).

In a downpipe off-set, the elbows on the inlet and outlet side must be equipped with an additional adaptor measuring 25 cm long between the 45° elbows. When using bypass lines, this additional adaptor can be omitted (➨ [GIV.21] und ➨ [GIV.22]).

However, if the downpipe off-set is shorter than 2.0 m, a bypass must be provided. Single and collecting pipes must be connected to the bypass pipeline. The bypass must be connected at least 2.0 m above the inlet side and 1.0 m below the elbow of the outlet side (➨ [GIV.22]).

Downpipes exceeding a length of 22 m

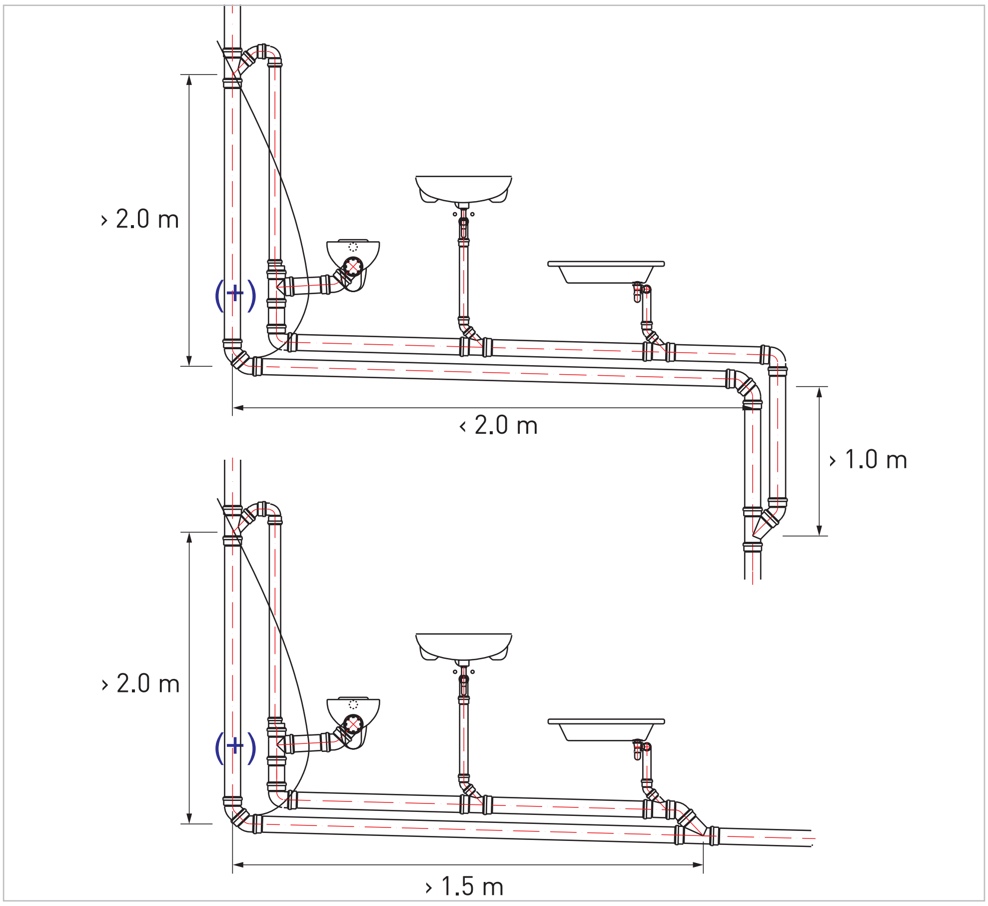
If the length of a downpipe exceeds 22 m, connections in an area subject to critical excessive pressure are only permitted on bypass lines (➨ [GIV.22]).



GIV.21
Connections in an area subject to critical excessive pressure

... taking into account distances or using a ventilation pipe

1. Downpipe off-set
2. Ventilation pipe
3. Downpipe off-set



GIV.22
Connections in an area subject to critical excessive pressure or off-sets with bypass lines

3.8 Rainwater downpipes

Although, inside rainwater downpipes may be connected with 88° elbows to horizontal lines, however, the variants with 2x 45° elbows or 2x 45° elbows with 25 cm long intermediate piece are hydraulically and acoustically significantly better.

In the redirectional area of rainwater downpipes into headers, static pressures can arise in higher buildings, which leads the pipes from slipping apart. Therefore, it may be necessary to protect these connections with circlips, brackets or additional fasteners.

Balcony and patio drainage

In order for water to drain unobstructed in the event of flooding and not to permeate into flats, the principle applies that rainwater drainage pipes from roof drainage systems must not be connected into drains below which may lead to balconies, loggias and patios with closed parapet walls. This also applies if emergency drainage is available in the parapet walls.

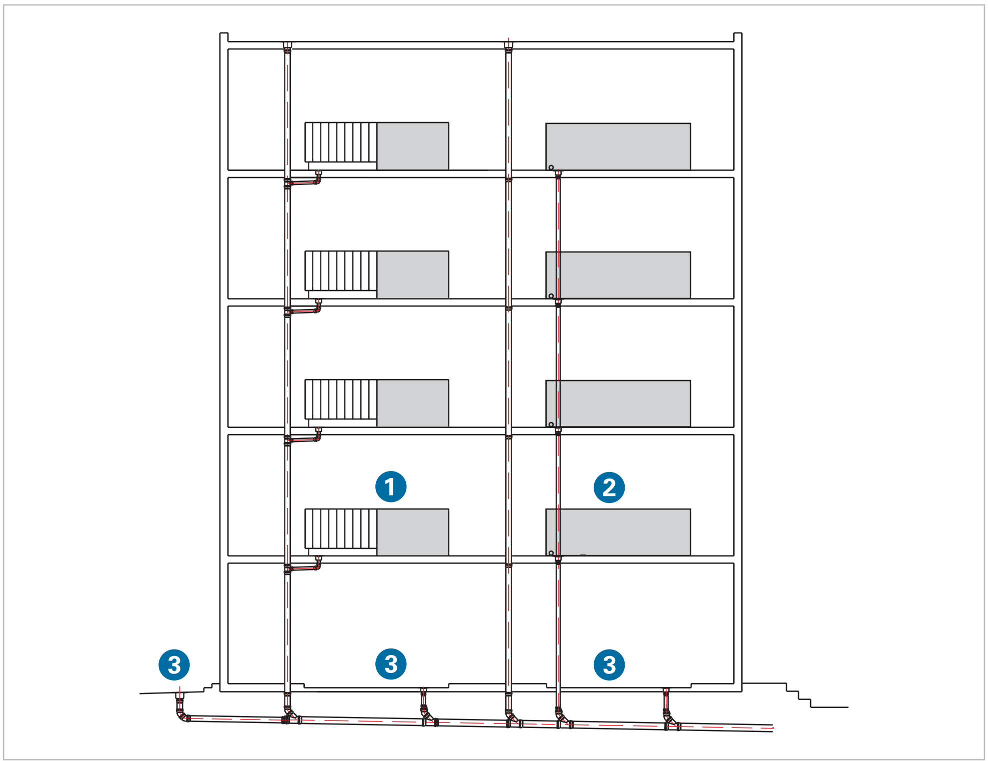
Compliance with this principle may not be required, if:

- balconies or loggias have no parapet
- at least 50% of the parapet allows unobstructed drainage

In principle, flats located on the ground floor should not be connected to downpipes, but to underground lines.

Terrace drains of ground floor flats should only be connected to the rainwater underground pipeline downstream of the point, “where the property eases off”.

Furthermore, terraces should be built with a slight slope. This will ensure that the water can drain into the terrain without causing any damage.



GIV.23
Connections of balcony drains to rainwater downpipes

1 Balconies with parapet closed <50%
2 Balconies with closed parapet
3 Patio

3.9 Pipelines leading to grease separators

The essential requirements for pipes which carry greasy wastewater and lead to grease separators are specified in DIN EN 1825-2 (➨ Chapter [2.7] 'Safety and strength'), namely:

- Wastewater must be supplied to the grease separator in free fall
- If the static water level of the grease separator system is below the backwater level, sewage lifting units must be connected downstream
- Inlet pipes must have a minimum slope of 2.0 cm/m
- If this is not possible due to structural or operational reasons, measures must be taken in accordance with DIN EN 1825-2, Annex D in order to prevent grease formation and deposits. These measures include the thermal insulation of the relevant pipes. If the supply lines are long, or in areas subject to frost, a pipe heating system with thermal insulation must be incorporated
- If downpipes change directions into collecting or underground piping, 2x 45° elbows and an additional adaptor, 25 cm long, must be installed
- In the direction of flow, a water calming section must be incorporated. Its length must be at least 10 times the nominal diameter of the inlet line of the grease separator
- The drainage pipelines should have a sufficient number openings for cleaning purposes
- Odour traps must be installed at all drain points
- Floor drains must be provided with pails, which can be taken out for cleaning purposes
- The temperature of the wastewater at the point of discharge into the public sewerage system can be limited by the appropriate authority

4 Ventilation

4.1 Ventilation of the drainage system

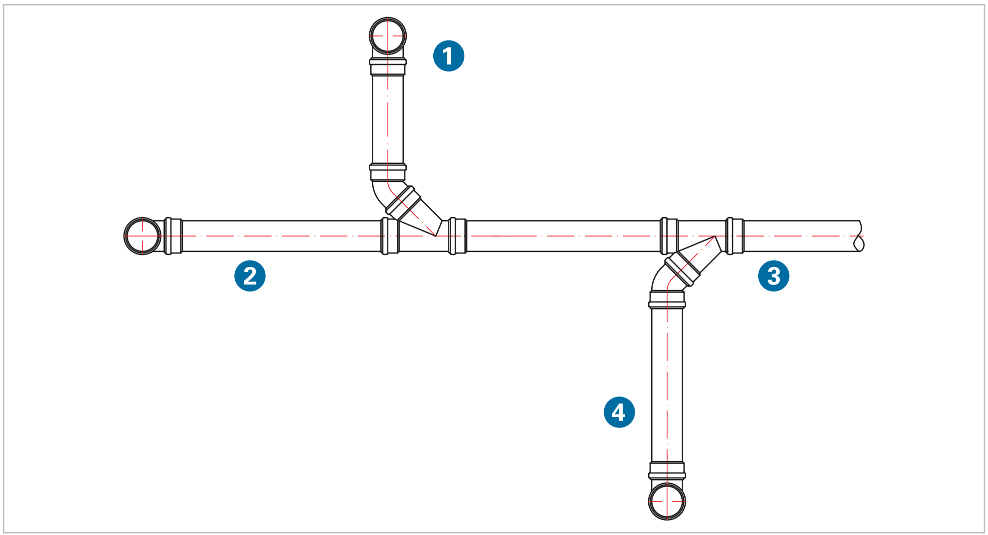
The interaction of the building and property drainage system with the public sewer system, requires compliance with the intended use of the roof ventilation for the safe and proper operation. Reasons for this are:

- The ventilation openings in the manhole covers are not sufficient to dissipate the sewer and digester gases of the public sewer system and thus to ensure safe operation
- Pressure fluctuations resulting from acceleration or deceleration processes of the wastewater flow can only be kept within acceptable limits by providing adequate ventilation of the entire drainage system

In order for this ventilation to function safely, sharing the use of the drainage pipes for room ventilation is not permitted.

Ventilation through the roof must not be interrupted by other installations, for example, odor traps.

In drainage systems without downpipes, at least one ventilation pipe with a nominal diameter of DN70 must be routed through the roof for ventilation. In this case, compliance with the requirements for the design principles of single and multiple collecting pipes (➨ Chapter [5] 'Dimensioning') is mandatory.



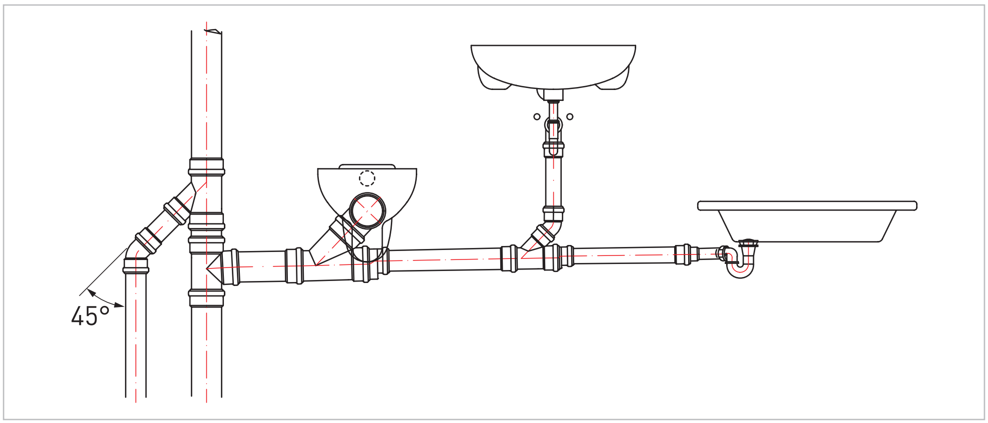
GIV.24
Ventilation methods for drainage systems without downpipes

1. Ventilation through the roof must be at least DN70
2. Collecting pipe
3. Headers
4. Collecting pipe

IV

4.2 Merging ventilation pipes

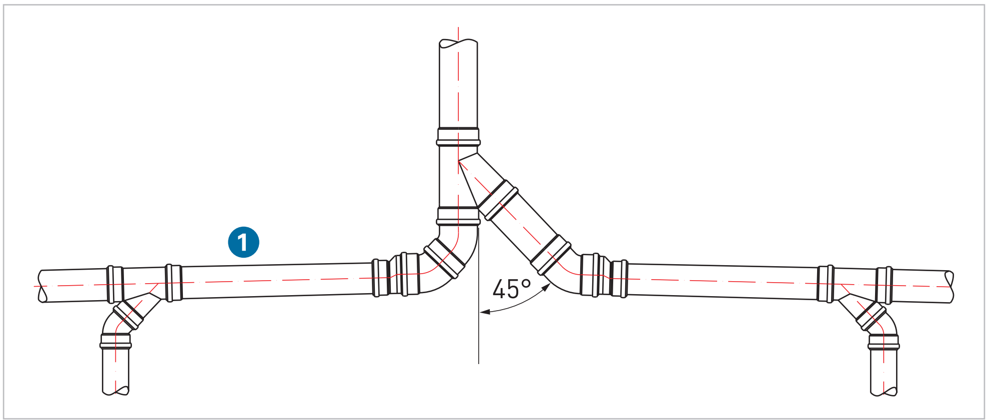
Merging ventilation pipes must only be installed above the highest connecting pipeline at an angle of 45°. The cross-sections of the common nominal diameter must be made in accordance with the design principles (➨ Chapter [5.3] 'Nominal diameters of ventilation pipes').



GIV.25
Merging ventilation pipes

For architectural or structural reasons, the merging of ventilation pipes may be required. Collecting ventilation pipes must be dimensioned according to the nominal widths (➨ Chapter [5.3] 'Nominal diameters of ventilation pipes').

In order for the natural buoyancy – caused by the density differences in the horizontally installed ventilation pipes – to flow effectively over the roof, the horizontal off-sets of the ventilation pipes must have a slope of about 2.0 cm/m and the deflections in the elbows and branches must be at an angle of 45° (➨ [GIV.26]).



GIV.26
Merging main ventilation pipes into collecting ventilation pipes

1. Slope J > 2 cm/m

4.3 Ventilation valves

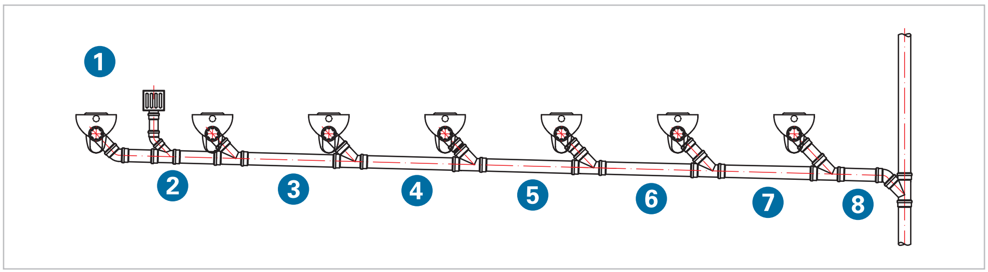
Ventilation valves must comply with DIN EN 12380. They may only be installed in special situations in a drainage system that is otherwise ventilated with at least one main ventilation pipe above the roof.

Ventilation valves can only counteract the formation of vacuum in a drainage system. The installation of ventilation valves in an area subject to critical excessive pressure, for example in the redirectional area of downpipes, is not permitted. Therefore, the use of these valves is limited to the following applications:

- For the ventilation of single or collecting pipes, if the maximum permissible lengths from Table [TIV.2] and Table [TIV.3] are exceeded
- For semi-detached dwelling and duplexes or comparable units these valves can be used as a replacement for additional main ventilation ducts, if at least one downpipe is equipped with a main ventilation pipe
- In existing systems for the subsequent ventilation of single and collecting pipes, for example, as a measure to prevent the odour traps from being sucked empty or to avoid gurgling noises in the pipe
- Replacement for indirect secondary ventilation and ventilation lines, which are intended to counteract the formation of a vacuum (➨ [GIV.27] und ➨ [GIV.28]).

Ventilation valves must be installed so that sufficient air can be supplied and maintenance or replacement is possible.

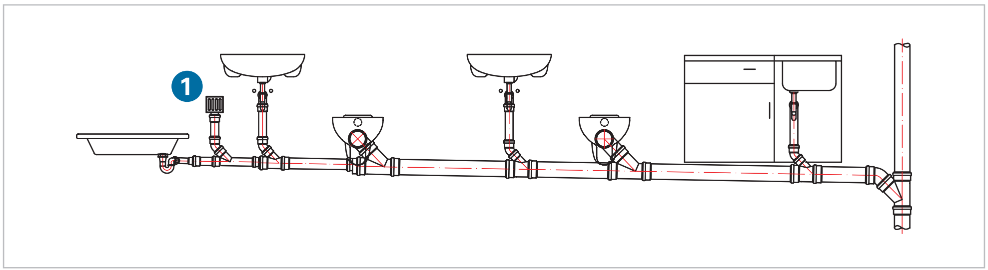
Because of the risk of wastewater discharge, ventilation valves must not be installed below the backwater level.



GIV.27
Ventilation valve as a replacement for an indirect secondary line or ventilation line

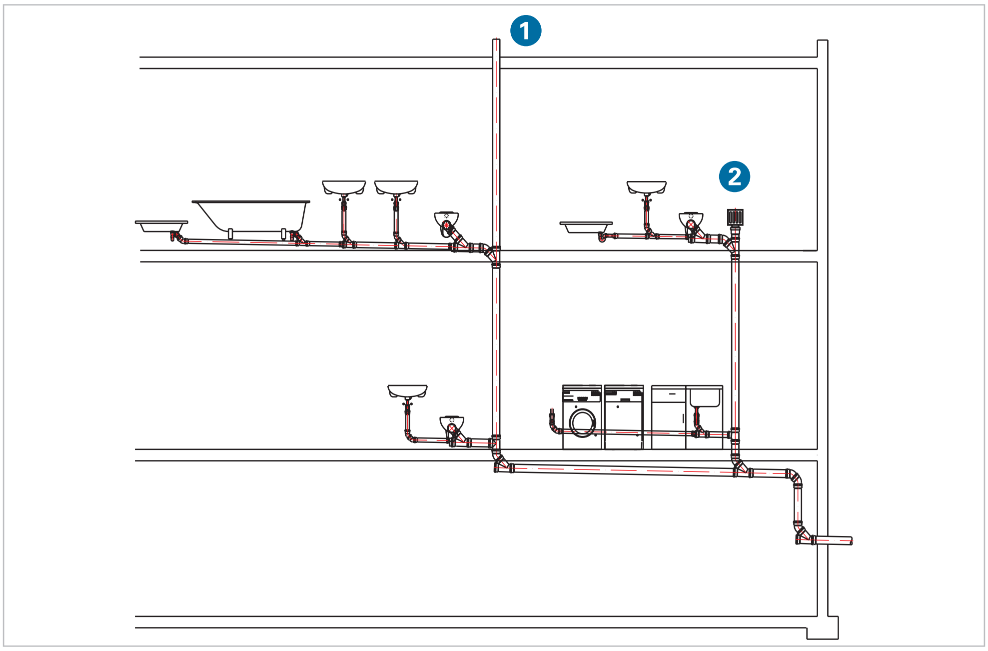
... in a heavily loaded collecting pipe (in-line toilet system)

1. Ventilation valve
2. TS 1
3. TS 2
4. TS 3
5. TS 4
6. TS 5
7. TS 6
8. TS 7



GIV.28
Ventilation valve for longer single or multiple collecting pipes

1. Ventilation valve

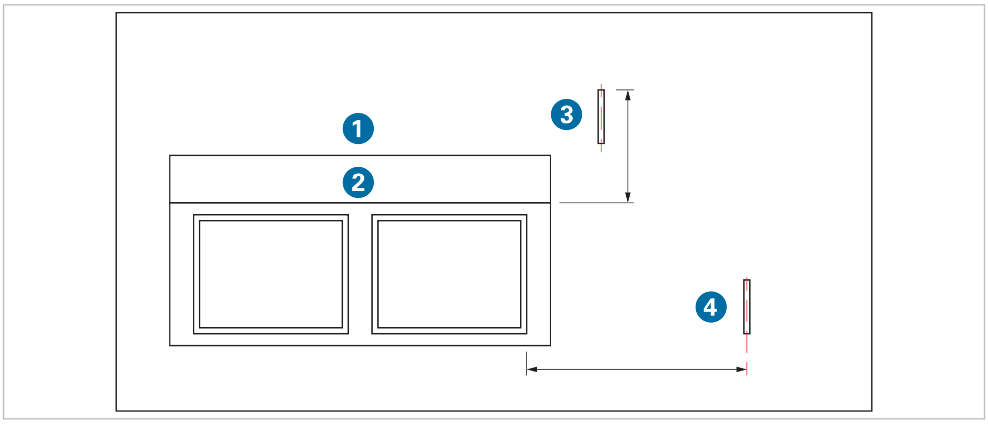


GIV.29
Use of ventilation valves in semi-detached dwelling and duplexes

1. At least one main ventilation pipe above the roof
2. Ventilation valve

At the top end of the ventilation pipe, a stack vent protrudes above the roof. This vent opening must meet the following requirements:

- The stack vent must leave the roof at a perpendicular angle.
- Preferably, the stack vent is open on top. Covers or hoods on the stack vent should be omitted for aerodynamic reasons.
- If covers are used, the air flow must not be deviated by more than 90°.
- The outlet cross-section must be at least 1.5 times the cross-section of the ventilation pipe.
- The vertical distance from the upper edge of the vent opening to the roof surface must be at least 15 cm.
- If the opening of a ventilation pipe is near common rooms, the minimum height of 1.0 m above the window lintel and a minimum lateral distance of 2.0 m from the window opening must be maintained.
- Compliance with these minimum distances is also mandatory in the suction area of ventilation intake points, refrigeration and air conditioning systems and must be coordinated with the manufacturer.
- Roof penetrations must be connected watertight and must comply with the heat protection and airtightness of the functional layers.



GIV.30
Minimum clearances of the endpipes from ventilation pipes to windows of common rooms

1. Gable roof
2. Window lintel
3. End of ventilation pipe (h ≥ 1,0 m)
4. End of ventilation pipe (l ≥ 2,0 m)

4.4 Ventilation of sewage lifting units

Sewage lifting units pursuant to DIN EN 12050-1 must always be ventilated with a separate ventilation pipe above the roof. The connection of a container ventilation line to a collective ventilation line is permitted and must be installed at an angle of 45°. The collective ventilation line must be dimensioned according to the regulations (➨ Chapter [5.3] 'Nominal diameters of ventilation pipes').

If the pump shaft of a sewage lifting unit for faecal-free wastewater is closed odour-tight, the same requirements for the container ventilation apply.

Connecting a container ventilation line to a downpipe is not permitted. Do not use a vent valve to replace the container ventilation pipe above the roof.

Single, collecting and headers that lead to a sewage lifting unit, as described in Chapter [4.1] 'Ventilation of the drainage system') and Chapter [4.2] 'Merging ventilation pipes') are aerated and vented.

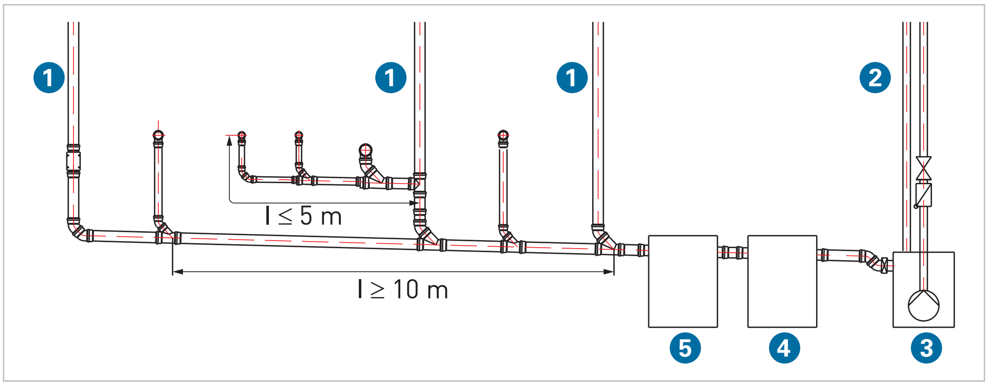
4.5 Ventilation of the pipelines to the grease separator

The inlet line to the grease separator must be ventilated, using a ventilation pipe above the roof pursuant to DIN EN 1825-2. If the inlet pipe is longer than 10 m, an additional ventilation pipe must be connected directly in front of the grease separator (➨ [GIV.31]).

Single and collecting pipes, longer than 5.0 m must be ventilated separately.

The ventilation pipes of the drainage system in front of the grease separator (intake lines) and, if necessary, the grease separator can be combined into a collective ventilation line.

Ventilation pipes of wastewater pipes and of sewage lifting unit must not be connected to the ventilation pipe of the grease separator.



GIV.31
Requirements for the ventilation of grease separator systems

1. Ventilation pipe
2. Ventilation pipe must penetrate the roof separately
3. Sewage lifting unit
4. Grease separator
5. Sludge trap

5 Dimensioning

5.1 Wastewater pipelines

Self-cleaning during operation and adequate pressure equalisation through ventilation are among the most important objectives in the design and dimensioning of a wastewater drainage system.

In a drainage pipeline, wastewater and air for pressure equalisation must be able to flow together but independently of each other. Therefore, the lines for the wastewater transport are only partially utilised (partial filling). The cross-section not used by the wastewater is available to the air flow. The pipes must not be allowed to seep with sewage during normal operation of the drainage system at any time. Even a brief interruption of the air flow caused by the full filling of the pipe, results in pressure fluctuations that jeopardise the trap inserts in the odour traps. During such operating conditions, water seal head can be completely sucked off or pushed back into the drainage pipes. Such operations are accompanied by unpleasant gurgling noises.

In a partially filled pipeline, the wastewater is transported only by the effects of gravity and due to the difference in the water level. The water level difference is generated by installing the pipe invert at a slope.

Conveying the wastewater using external energy is limited to a few exceptional cases.

A hydraulically perfect function in partially filled drainage pipelines can be expected if – with the occurrence of the total water discharge (Q_{tot}) – a flow with a suitable degree of filling (h/d_i) and suitable flow velocity (v_{min}) is set in such a way that suspended matter and sediment can be transported and washed out (self-cleaning ability).

An optimal flow condition is characterised by a parallel course of the waterline with the invert of the pipe, which is installed along the gradient line.

By adapting the normative specifications for a maximum permissible degree of filling (h/d_i), a minimum required pipe invert (J_{min}) and minimum required or maximum permissible flow velocities (v), this optimum flow state becomes the basis of the design.

Drainage systems are designed along the flow path. The design usually starts with the longest flow path. All flow paths must be divided into pipe segments. Within the pipe segments, the total discharge of water (Q_{tot}), the pipe invert (J) and the permissible degree of filling (h/d_i) must not change. The designations of the pipe segments must be chosen without umbiguity and used both in the engineering drawings of the drainage system and in the documentation containing the results of the calculation.

The results of the design must be documented in what is referred to as hydraulic lists.

5.1.1 Total wastewater discharge

The total wastewater that drains into a pipe segment of the drainage system (Q_{tot}) consists of the expected runoff at peak times from the connected sanitary drainage objects (Q_{WW}) and, if applicable, the drainage objects with continuous runoff (Q_C) and the pump flow rates of sewage lifting units (Q_P). Permanent drainages and pump delivery flows must be added to the wastewater drain without deduction.

FIV.1 **Formula 1**

$$Q_{tot} = Q_{ww} + Q_c + Q_p$$

Q_{tot} Total wastewater discharge in L/s
Q_{ww} Wastewater discharge, in L/s
Q_c Continuous discharge in L/s
Q_p Pump delivery rate in L/s
Q_{ww} Wastewater discharge into a pipe segment in L/s

FIV.2 **Formula 2**

$$Q_{ww} = K \cdot \sqrt{\sum(DU)}$$

Q_{ww} Wastewater discharge in L/s
K Discharge indicator
$\sum(DU)$ Sum of the connection values

TIV.1
Discharge indicator K
... depending on the type of building and usage

Building type and usage	K
Irregular use, for example in a block of flats, nursing homes, bed & breakfasts, offices	0.5
Regular use, in hospitals, schools, restaurants, hotels	0.7
Frequent use, for example in public toilet facilities and/or showers	1.0

If drainages from areas with different uses overlap in one pipe segment, Q_{WW} should be calculated with approximately the same amount of wastewater drainage with the respective larger discharge code (K).

IV

5.2 Nominal diameters of drainage pipes

5.2.1 Single collection lines, not vented and vented

Single connection pipes that are not vented, must be dimensioned according to the table, depending on the type of drainage object and the assigned connection value (DU).

TIV.2
Connection values (DU) and nominal diameter of the single connection line of drainage objects

Drainage object	Connection value DU [l/s]	Nominal diameter of single connection pipelines DN
Washbasin, bidet	0.5	40
Shower without plug	0.6	50
Shower with plug	0.8	50
Single urinal with cistern	0.8	50
Single urinal with flush valve	0.5	50
Free standing urinal	0.2	50
Urinal without flushing unit	0.1	50
Bathtub	0.8	50
Kitchen sink and dishwasher	0.8	50
Kitchen sink	0.8	50
Dishwasher	0.8	50
Washing machine up to 6 kg	0.8	50
Washing machine up to 12 kg	1.5	56/60
WC with 4.0/4.5 litre cistern	1.8	80/90
WC with 6.0 litre cistern/flush valve	2.0	80 ... 100
WC with 9.0 litre cistern/flush valve	2.5	100
Floor drain DN50	0.8	50
Floor drain DN70	1.5	70
Floor drain DN100	2.0	100
Note: For lavatory systems with flush valves, the same connection values can be used as for systems with cisterns.		

In addition, compliance with the following requirements is mandatory:

- Minimum slope J_{min} = 1 cm/m
- Maximum length l_{max} = 4 m
- a maximum of three 90° elbows (without connecting elbow) in the flow path
- maximum permissible height difference between a connection to a drainage object and the pipe invert in the connection branch to the downpipe $\Delta h_{max} \leq 1$ m

If one of the above conditions cannot be met, the single connection pipeline must be ventilated.

Ventilated single connection lines must be dimensioned depending on the type of drainage object and the assigned connection value (DU) (➨ [TIV.2]).

Compliance with the following requirements is mandatory:

- Minimum slope J_{min} = 0.5 cm/m
- Maximum length l_{max} = 10 m
- Maximum permissible height difference between a connection to a drainage object and the pipe invert in the connection branch to the downpipe $\Delta h_{max} \leq 3$ m

5.2.2 Collecting pipes

Collecting pipes that are not ventilated. must be dimensioned depending on the discharge code. the sum of the connected values ∑(DU) and the length.

Compliance with the following requirements is mandatory (➨ [TIV.3])::

- Minimum slope J_{min} = 1 cm/m
- Maximum permissible length (l_{max}) according to the table
- A collecting pipe that is not ventilated. must comply with the specifications applicable to single connection pipelines

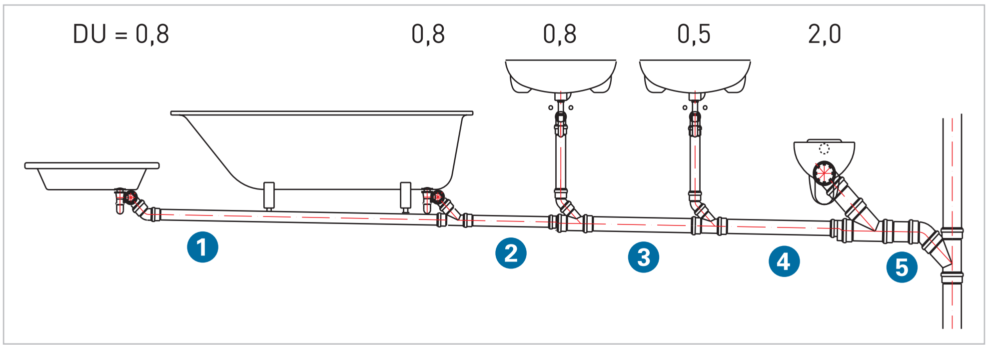
If one of the application limits cannot be met. it is considered a header which must be ventilated and dimensioned accordingly (➨ Chapter [5.2.4] 'Header and underground pipelines inside the building').

TIV.3
Permissible load and maximum permissible length of collecting pipes that are not ventilated

DN	$d_{i.\,min}$ [mm]	Discharge indicator K			Maximum permissible length l_{max} [m]
		K = 0.5 ∑(DU) [l/s]	K = 0.7 ∑(DU) [l/s]	K = 1.0 ∑(DU) [l/s]	
50	44	1.0	1.0	0.8	4.0
56/60	49/56	2.0	2.0	1.0	4.0
70 [a]	68	9.0	4.6	2.2	4.0
80	75	13.0 [b]	8.0 [b]	4.0	10.0
90	79	13.0 [b]	10.0 [b]	5.0	10.0
100	96	16.0	12.0	6.4	10.0

a) No toilets
b) Maximum number of toilets

Dimensioning example of a semi-detached dwelling



GIV.32
Drainage capacity of downpipes

... depending on the diameter and the inlet geometry of the branch
1 TS 1
2 TS 2
3 TS 3
4 TS 4
5 TS 5

TIV.4 **Collecting pipes**

TS	Length [m]	∑(DU) [l/s]	K	Q_{ww} [l/s]	Q_P [l/s]	Q_c [l/s]	Q_{tot} [l/s]	d_i [mm]	J [cm/m]	h/d_i	Q_{zul} [l/s]	v [m/s]
1	1.5	0.8						49.6	1.0			
2	1.0	1.6						49.6	1.0			
3	1.0	2.1						68.8	1.0			
4	1.0	2.6						68.8	1.0			
5	1.0	4.6						68.8	1.0			
Sum:	5.5											

The design of the colleting pipeline illustrated above takes into account the specifications listed in Table [TIV.4].

In the first step. the longest flow path in the collecting pipe must be determined and subdivided into pipe segments. The length of the respective pipe segment and the sum of the connection values are also required for design purposes. With this output data. the required diameters can be determined with Table [TIV.3]. Subsequently. the maximum permissible length of the collecting pipe must be checked. Here. knowing the connection diameter to the downpipe is critical. When using a nominal diameter DN90 (d_i = 80.6 mm). the maximum permissible length of the pipe is 10.0 m. Since in this specific example the collecting pipe is only 5.5 m long. the design can be completed successfully.

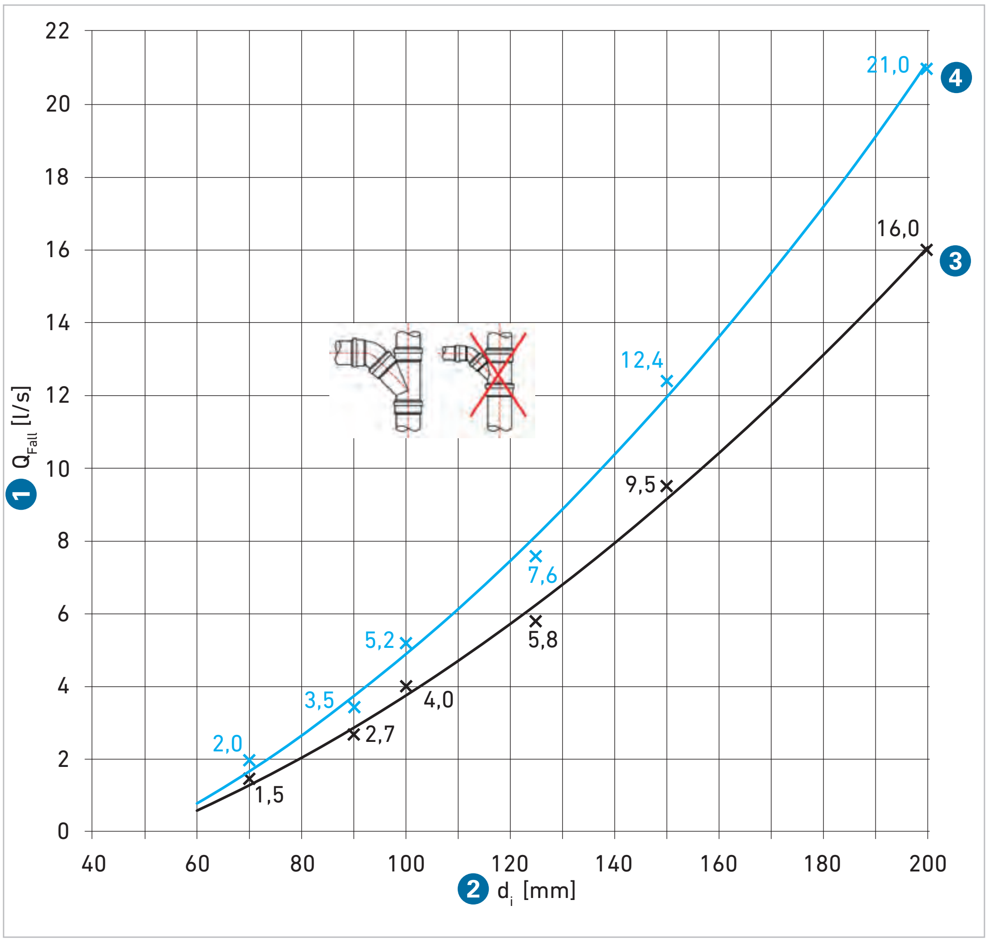
5.2.3 Downpipes with main ventilation

Downpipes with main ventilation must be dimensioned depending on the total wastewater drainage and the geometry of the branch linking the downpipe with the connection or collecting pipeline (➨ [TIV.5]).

The geometry of the branch affects the drainage capacity of the downpipe. If the wastewater is discharged at an angle below 45° or through an 87° branch with inner radius, the downpipe can be stressed higher than a sharp-angled inlet at approx. 90° into a branch without inner radius.

TIV.5
Drainage capacity of a downpipe with main ventilation

DN	Branches without inner radius Q_{max} [L/s]	Branches with inner radius Q_{max} [L/s]
70	1.5	2.0
90	2.7	3.5
100	4.0	5.2
125	5.8	7.6
150	9.5	12.4
200	16.0	21.0
When using lavatory systems with a volume of 4.0 L to 6.0 L flushing water, the nominal diameter for downpipes in system I must be at least DN80.		

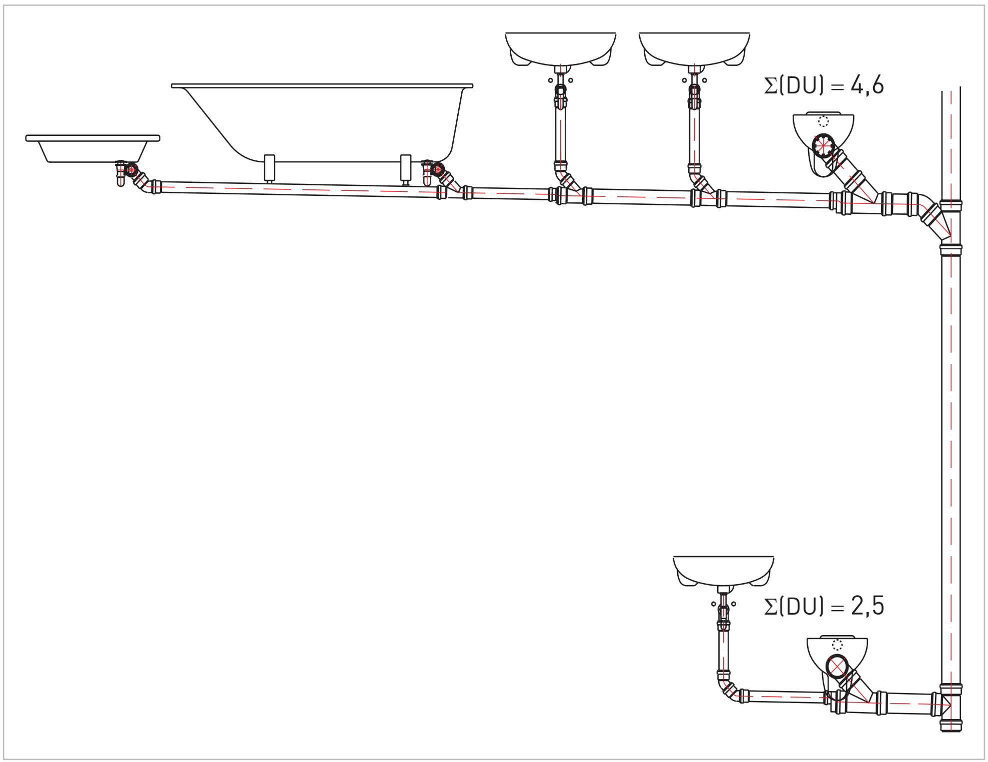


GIV.33
Drainage capacity of downpipes

...depending on the diameter and the inlet geometry of the branch

1. Drainage capacity of a downpipe
2. Internal diameter of the downpipe
3. Branches without inner radius
4. Branches with inner radius

Dimensioning example of a semi-detached dwelling



GIV.34
Design of a downpipe in a semi-detached dwelling

TIV.6
Downpipe

TS	Length [m]	∑(DU) [l/s]	K	Q_{ww} [l/s]	Q_P [l/s]	Q_C [l/s]	Q_{tot} [l/s]	d_i [mm]	J [cm/m]	h/d_i	Q_{zul} [l/s]	v [m/s]
6	2.8	7.1	0.5	1.3			2.0	80.6			3.5	

The following information must be available for the dimensioning of a downpipe:

- Principle of downpipe ventilation (main ventilation, auxilliary ventilation, secondary ventilation)
- Geometry of the connection branch to the downpipe (with or without inner radius)
- The sum of the load values ∑(DU) for the pipe segment at the end of the downpipe and the resulting total discharge Q_{tot}
- The connected value DU of the largest connected drainage object

In this dimensioning example, the connection value DU of the toilet is 2.0 L/s larger than the calculated peak discharge Q_{WW} mit 1.4 L/s. The downpipe must be dimensioned for the larger value (Q_{tot} = 2.0 L/s). The downpipe with main ventilation and connection branches with inner radius (45° branch) can be designed with a nominal diameter of DN90 (d_i = 80.6 mm). The maximum permissible drainage in a downpipe of this nominal diameter is 3.5 L/s (➨ [TIV.5] and [GIV.34]).

5.2.4 Header and underground pipelines inside the building

Headers and underground pipes within the building must be dimensioned for the total wastewater discharge (Q_{tot}) in the respective pipe segments (➨ [TIV.8] and ➨ [TIV.9]).

Compliance with the following requirements is mandatory:

- Maximum permissible degree of filling h/d_i = 0.5
- Maximum permissible degree of filling h/d_i = 0.7 (only for pipe segments downstream of a pump flow from a sewage lifting units)
- Minimum slope J_{min} = 0.5 cm/m
- Minimum flow rate v_{min} = 0.5 m/s

In order to ensure self-cleaning capability, header pipes and underground pipelines must not be designed larger than the calculation procedure specifies.

Header pipes and underground pipelines must always be dimensioned for an even gradient of the pipe invert throughout the entire flow path.

Example applicable to Table [TIV.8]:

The total wastewater flow of Q_{tot} = 4.0 L/s across a pipe segment of a drainage systemis musy be drained. The pipe invert J = 1.0 cm/m and a maximum permissible degree of filling is h / d_i = 0.5.

The required nominal diameter is determined using DN125 (d_i = 124.6 mm) from Table [TIV.5]. The maximum drainage capacity of this nominal diameter for a given gradient and degree of filling is Q = 5.0 L/s at a flow velocity of v = 0.8 m/s and is therefore greater than the required 4.0 L/s. Corresponding results are usually recorded in hydraulic lists (➨ [TIV.9]).

TIV.7 **Hydraulic list with results for the design of a collecting or underground pipeline**

Calculation of peak discharge								Drainage capacity of the selected pipeline				
TS	Length [m]	∑(DU) [l/s]	K	Q_{ww} [l/s]	Q_P [l/s]	Q_C [l/s]	Q_{tot} [l/s]	d_i [mm]	J [cm/m]	h/d_i	Q_{zul} [l/s]	v [m/s]
							4.0	124.6	1.0	0.50	5.0	0.82

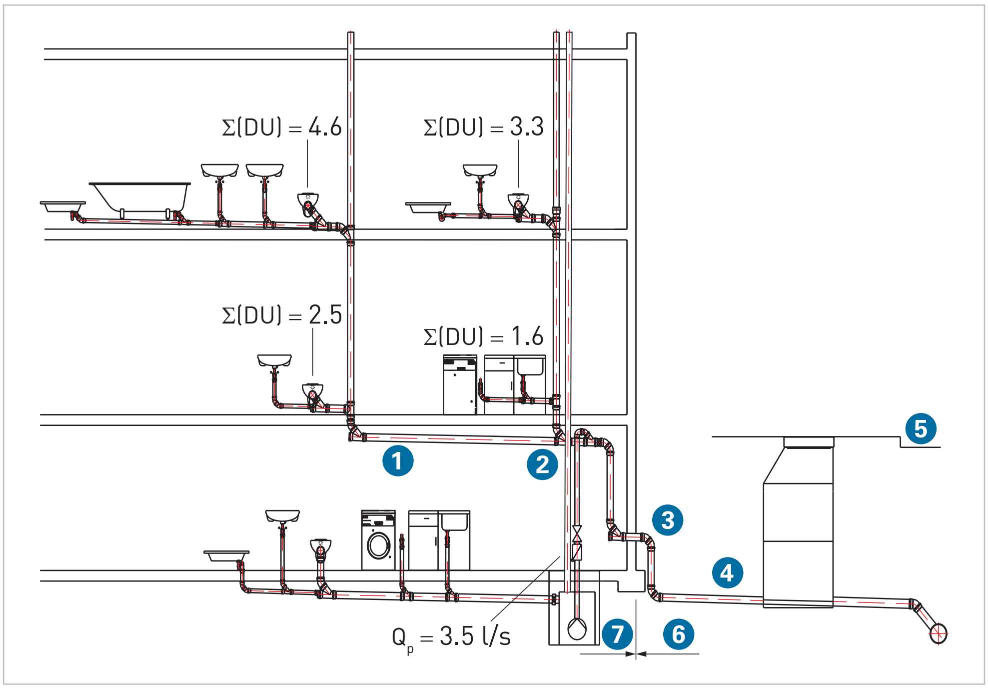
TIV.8 **Drainage capacity of partially filled Silenta Premium pipelines (h/d_i = 0.5)**

J [cm/m]	DN56 d_i = 49,6		DN70 d_i = 68,8		DN90 d_i = 80,6		DN100 d_i = 99		DN125 d_i = 124,6		DN150 d_i = 149,6		DN200 d_i = 189,6	
	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	V [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]
0.5							1.9	0.5	3.5	0.6	5.8	0.7	10.8	0.8
0.6					1.2	0.5	2.1	0.5	3.9	0.6	6.3	0.7	11.9	0.8
0.7			0.9	0.5	1.3	0.5	2.3	0.6	4.2	0.7	6.8	0.8	12.8	0.9
0.8			0.9	0.5	1.4	0.5	2.4	0.6	4.5	0.7	7.3	0.8	13.7	1.0
1.0			1.0	0.5	1.6	0.6	2.7	0.7	5.0	0.8	8.2	0.9	15.4	1.1
1.2	0.5	0.5	1.1	0.6	1.7	0.7	3.0	0.8	5.5	0.9	9.0	1.0	16.8	1.2
1.4	0.5	0.5	1.2	0.7	1.9	0.7	3.2	0.8	5.9	1.0	9.7	1.1	18.2	1.3
1.6	0.5	0.6	1.3	0.7	2.0	0.8	3.4	0.9	6.4	1.0	10.4	1.2	19.5	1.4
1.8	0.6	0.6	1.4	0.7	2.1	0.8	3.7	0.9	6.8	1.1	11.0	1.3	20.7	1.5
2.0	0.6	0.6	1.5	0.8	2.2	0.9	3.9	1.0	7.1	1.2	11.6	1.3	21.8	1.5
2.5	0.7	0.7	1.6	0.9	2.5	1.0	4.3	1.1	8.0	1.3	13.0	1.5	24.4	1.7
3.0	0.7	0.8	1.8	1.0	2.7	1.1	4.7	1.2	8.7	1.4	14.2	1.6	26.7	1.9
3.5	0.8	0.8	1.9	1.0	2.9	1.2	5.1	1.3	9.4	1.5	15.4	1.7	28.9	2.0
4.0	0.9	0.9	2.1	1.1	3.2	1.2	5.5	1.4	10.1	1.7	16.4	1.9	30.9	2.2
4.5	0.9	0.9	2.2	1.2	3.3	1.3	5.8	1.5	10.7	1.8	17.4	2.0	32.7	2.3
5.0	1.0	1.0	2.3	1.2	3.5	1.4	6.1	1.6	11.3	1.9	18.4	2.1	34.5	2.4

TIV.9 **Drainage capacity of partially filled Silenta Premium pipelines (h/d_i = 0.7)**

J [cm/m]	DN56 d_i = 49,6		DN70 d_i = 68,8		DN90 d_i = 80,6		DN100 d_i = 99		DN125 d_i = 124,6		DN150 d_i = 149,6		DN200 d_i = 189,6	
	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]	Q [l/s]	V [m/s]	Q [l/s]	v [m/s]	Q [l/s]	v [m/s]
0.5					1.8	0.5	3.2	0.6	5.9	0.6	9.6	0.7	18.1	0.9
0.6			1.3	0.5	2.0	0.5	3.5	0.6	6.5	0.7	10.6	0.8	19.8	0.9
0.7			1.4	0.5	2.2	0.6	3.8	0.7	7.0	0.8	11.4	0.9	21.4	1.0
0.8			1.5	0.6	2.3	0.6	4.1	0.7	7.5	0.8	12.2	0.9	22.9	1.1
1.0	0.7	0.5	1.7	0.6	2.6	0.7	4.5	0.8	8.4	0.9	13.7	1.0	25.7	1.2
1.2	0.8	0.5	1.9	0.7	2.9	0.8	5.0	0.9	9.2	1.0	15.0	1.1	28.1	1.3
1.4	0.8	0.6	2.0	0.7	3.1	0.8	5.4	0.9	10.0	1.1	16.2	1.2	30.4	1.4
1.6	0.9	0.6	2.2	0.8	3.3	0.9	5.8	1.0	10.7	1.2	17.3	1.3	32.5	1.5
1.8	1.0	0.7	2.3	0.8	3.5	0.9	6.1	1.1	11.3	1.2	18.4	1.4	34.5	1.6
2.0	1.0	0.7	2.4	0.9	3.7	1.0	6.5	1.1	11.9	1.3	19.4	1.5	36.4	1.7
2.5	1.1	0.8	2.7	1.0	4.2	1.1	7.2	1.3	13.3	1.5	21.7	1.7	40.7	1.9
3.0	1.2	0.9	3.0	1.1	4.6	1.2	7.9	1.4	14.6	1.6	23.8	1.8	44.6	2.1
3.5	1.3	0.9	3.2	1.2	4.9	1.3	8.6	1.5	15.8	1.7	25.7	2.0	48.2	2.3
4.0	1.4	1.0	3.5	1.2	5.3	1.4	9.2	1.6	16.9	1.9	27.5	2.1	51.6	2.4
4.5	1.5	1.1	3.7	1.3	5.6	1.5	9.7	1.7	17.9	2.0	29.2	2.2	54.7	2.6
5.0	1.6	1.1	3.9	1.4	5.9	1.6	10.2	1.8	18.9	2.1	30.8	2.3	57.7	2.7

Dimensioning example of a heade (semi-detached dwelling)



GIV.35
Design of a header in a semi-detached dwelling

1. TS 7
2. TS 8 / TS 9
3. TS 10
4. TS 11
5. Street
6. Outside the building
7. Inside the building

TIV.10 **Calculation for gradient J = 1.0 cm/m**

TS	Length [m]	∑(DU) [l/s]	K	Q_{ww} [l/s]	Q_P [l/s]	Q_C [l/s]	Q_{tot} [l/s]	d_i [mm]	J [cm/m]	h/d_i	Q_{zul} [l/s]	v [m/s]
	Calculation of peak discharge							Drainage capacity of the selected pipeline				
7		7.1	0.5	1.3	0.0	0.0	2.0	99.0	1.0	0.50	2.7	0.7
8		11.9	0.5	1.7	0.0	0.0	2.0	124.6	1.0	0.50	5.0	0.82
9		11.9	0.5	1.7	3.5	0.0	5.5	124.6	1.0	0.70	8.4	0.92
10		11.9	0.5	1.7	3.5	0.0	5.5	124.6	1.0	0.70	8.4	0.92
11		11.9	1.5	5.2	3.5	0.0	5.5	124.6	1.0	0.70	8.4	0.92

TIV.11 **Calculation for gradient J = 1.5 cm/m**

Calculation of peak discharge								Drainage capacity of the selected pipeline				
TS	Length [m]	∑(DU) [l/s]	K	Q_{ww} [l/s]	Q_P [l/s]	Q_c [l/s]	Q_{tot} [l/s]	d_i [mm]	J [cm/m]	h/d_i	Q_{zul} [l/s]	v [m/s]
7		7.1	0.5	1.3	0.0	0.0	2.0	99.0	1.5	0.50	3.3	0.87
8		11.9	0.5	1.7	0.0	0.0	2.0	99.0	1.5	0.50	3.3	0.87
9		11.9	0.5	1.7	3.5	0.0	5.5	99.0	1.5	0.70	5.6	0.97
10		11.9	0.5	1.7	3.5	0.0	5.5	99.0	1.5	0.70	5.6	0.97
11		11.9	1.5	5.2	3.5	0.0	5.5	99.0	1.5	0.70	5.6	0.97

The following information must be available when dimensioning a pipe segment in a header or underground pipeline:

- Discharge code (K) for the building type and usage
- The sum of the load values (∑(DU)) for the pipe segment that must be dimensioned
- Flow rate of a sewage lifting unit (Q_P) in the pipe segment
- Connection value (DU) of the largest connected drainage object
- Total wastewater discharge (Q_{tot})
- uniform pipe slope (J)
- maximum permissible degree of filling in the ppe segment (h/d_i)

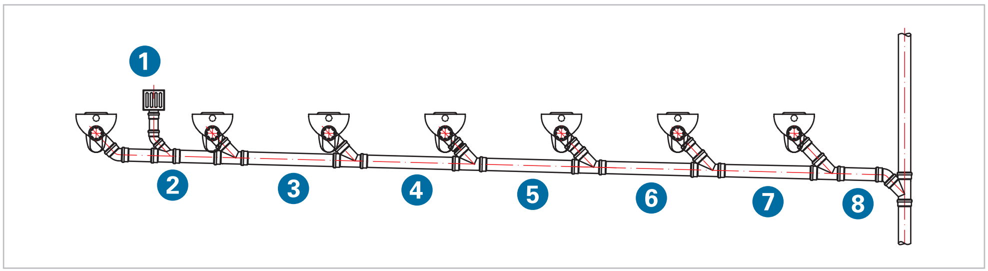
In the pipe segment TS 7, the connection value DU of a lavatory is 2.0 L/s is greater than the calculated peak drainage Q_{WW} of 1.3 L/s. The calculation must continue, using the larger value (DU = 2.0 L/s). The pipe segment TS 7 must be dimensioned taking into account the maximum permissible degree of filling $h/d_i = 0.5$ (➨ [TIV.8]). The pipe invert is initially specified as J = 1.0 cm/m and is applicable to all pipe segment.

In pipe segment TS 9, the pump delivery flow from a sewage lifting unit with $Q_P = 3.5$ L/s is fed into the pipeline. Starting with this pipe segment, the maximum permissible degree of filling can be increased to
$h/d_i = 0.7$ (➨ [TIV.9]).

Due to the flow rate of the sewage lifting unit, a nominal pipe diameter DN125 ($d_i = 124.4$ mm) must be installed when using a pipe invert of J = 1 cm/m in the pipe segments TS 9 – TS 11.

The continuous use of the nominal diameter DN100 ($d_i = 99$ mm) is only possible when installing the header at a point where the pipe invert gradient is equal to J = 1.5 cm/m (➨ [TIV.10] and [TIV.11]).

Dimensioning example for a heavily loaded collecting/header (series toilet system)



GIV.36
Collecting pipelines/header pipes subject to excessive loads (in-line lavatory) used in public facilities

1. Ventilation valve
2. TS 1
3. TS 2
4. TS 3
5. TS 4
6. TS 5
7. TS 6
8. TS 7

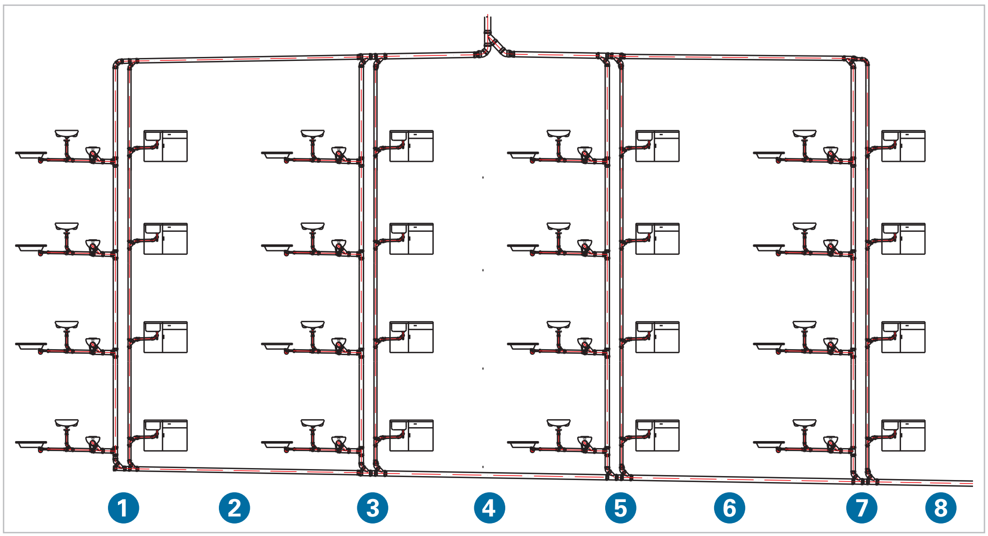
In this case, the design does not succeed as a collecting pipeline (➨ [TIV.4]). When considering the public use of a series toilet system (K = 1.0), the admissible sum of the connected values (∑(DU) = 6.4) – which is used as a prerequisite for the use of the design table – is significantly exceeded when using ∑(DU) = 14.0 in the example.

If one of the application limits in Table [TIV.4] cannot be met, it must be considered a header from a calculation point of view. This implies that the header must be ventilated at the end. In this scenario, a vent valve is used for the ventilation; however, this could also be ensured by recirculating the air or using an indirect secondary ventilation pipe. This header must be dimensioned using Table [TIV.8] (results: ➨ [TIV.12]). Verification of the hydraulic capacity for the continuous use of the nominal diameter DN100 (d_i = 99.0 mm) is only possible, if the header is installed on a pipe invert slope of J = 2.0 cm/m.

TIV.12 **Design of headers for a series toilet system for public use**

Calculation of peak discharge								Drainage capacity of the selected pipeline				
TS	Length [m]	∑(DU) [l/s]	K	Q_{ww} [l/s]	Q_P [l/s]	Q_C [l/s]	Q_{tot} [l/s]	d_i [mm]	J [cm/m]	h/d_i	Q_{zul} [l/s]	v [m/s]
1	1.2	2.0	1.0	1.4	0.0	0.0	2.0	99.0	2.0	0.50	3.9	1.00
2	1.2	4.0	1.0	2.0	0.0	0.0	2.0	99.0	2.0	0.50	3.9	1.00
3	1.2	6.0	1.0	2.4	0.0	0.0	2.4	99.0	2.0	0.50	3.9	1.00
4	1.2	8.0	1.0	2.8	0.0	0.0	2.8	99.0	2.0	0.50	3.9	1.00
5	1.2	10.0	1.0	3.2	0.0	0.0	3.2	99.0	2.0	0.50	3.9	1.00
6	1.2	12.0	1.0	3.5	0.0	0.0	3.5	99.0	2.0	0.50	3.9	1.00
7	1.2	14.0	1.0	3.7	0.0	0.0	3.7	99.0	2.0	0.50	3.9	1.00
Sum:	8.4											

Dimensioning example for headers in a block of flats



GIV.37
Headers in a block of flats
1 to 8: TS1 to TS8

TIV.13 **Design of headers in a block of flats**

		Calculation of peak discharge						Drainage capacity of the selected pipeline				
TS	Length [m]	∑(DU) [l/s]	K	Q_{ww} [l/s]	Q_P [l/s]	Q_C [l/s]	Q_{tot} [l/s]	d_i [mm]	J [cm/m]	h/d_i	Q_{zul} [l/s]	v [m/s]
1		13.2	0.5	1.8	0.0	0.0	2.0	99.0	1.0	0.50	2.7	0.70
2		16.4	0.5	2.0	0.0	0.0	2.0	99.0	1.0	0.50	2.7	0.70
3		29.6	0.5	2.7	0.0	0.0	2.7	99.0	1.0	0.50	2.7	0.70
4		32.8	0.5	2.9	0.0	0.0	2.9	124.6	1.0	0.50	5.0	0.82
5		46.0	0.5	3.4	0.0	0.0	3.4	124.6	1.0	0.50	5.0	0.82
6		49.2	0.5	3.5	0.0	0.0	3.5	124.6	1.0	0.50	5.0	0.82
7		62.4	0.5	3.9	0.0	0.0	3.9	124.6	1.0	0.50	5.0	0.82
8		65.6	0.5	4.0	0.0	0.0	4.0	124.6	1.0	0.50	5.0	0.82

The downpipe with main ventilation and connection branches without inner radius (87° branch) can be designed with a nominal diameter of DN90 (d_i = 80.6 mm). The maximum permissible discharge under the given conditions is 2.7 L/s(➨ [TIV.5] and ➨ [GIV.34]). By contrast, the associated header (TS 1) must already be designed using DN100 (d_i = 99.0 mm) with a specified pipe invert slope of J = 1.0 cm/m.

5.2.5 Pump pressure lines

Pump pressure lines must be dimensioned for the flow rate of the sewage lifting unit Q_P.
Compliance with the following requirements is mandatory:

- The flow rate of a sewage lifting unit Q_P must be greater than or equal to the inflow, for example, the total wastewater Q_{tot} and calculated, using the following formula [FIV.1].
- The nominal diameter of the pump pressure line must not be smaller than the diameter of the pump discharge nozzle of the sewage lifting unit.
- When dimensioning the pressure line, the flow rate must not drop below v_{min} = 0.7 m/s and not exceed v_{max} = 2.3 m/s.

When calculating the pump differential pressure Δp_P formula [FIV.3] must be used.

FIV.3 **Formula 3**

$$\Delta p_P = \Delta p_{geo} + \sum(l \cdot R + Z)$$

Δp_P Pump differential pressure [hPa]
Δp_{geo} Geodetic pressure difference [hPa], resulting from the height difference (h_{geo}) between the water level in the tank and the pipe axis of the pressure line in the backflow loop

FIV.4 **Formula 4**

$$\Delta p_{geo} = h_{geo} \cdot \rho \cdot g$$

ρ Density of water at 10°C [kg/m³]
g Gravitational acceleration [m/s²]
l Length of the pipe segment [m]
R Pipe friction pressure drop [hPa / m]
Z Individual resistance pressure drop

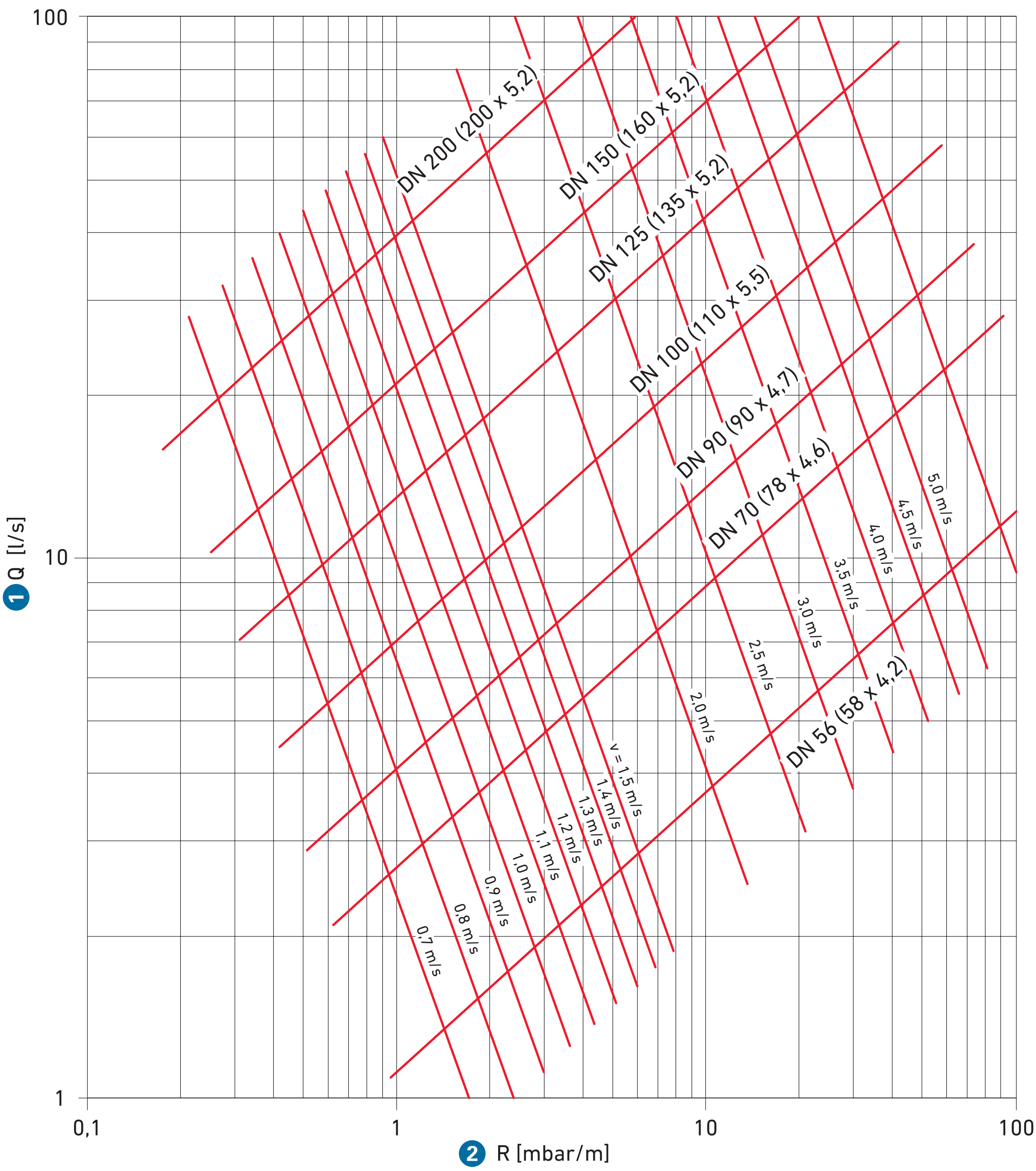
FIV.5 **Formula 5**

$$Z = \sum\zeta \cdot \frac{v^2 \cdot \rho}{2}$$

ζ Coefficient of drag
v Mean flow velocity in the pipe segment[m/s]

TIV.14
Resistance coefficients of fittings and moulded part

Type of individual resistance	ζ
Shut-off valve	0.5
Non-return valve	2.2
90° elbow	0.5
45° elbow	0.3
Unobstructed discharge	1.0
Enlargement of cross-section	0.3



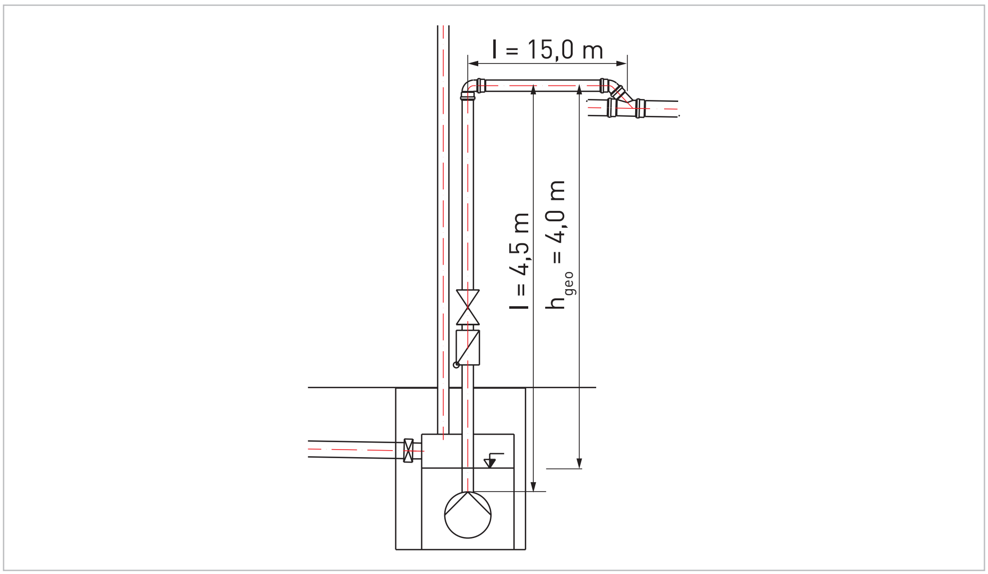
GIV.38
Pressure loss diagram for Silenta Premium pipelines

k = 0,1 mm

1 Volume flow
2 Pipe friction pressure drop

Pipe Dimension DN	D1 (d_a) [mm]	e	d_i [mm]
56	58	4.2	49.6
70	78	4.6	68.8
90	90	4.7	80.6
100	110	5.5	99.0
125	135	5.2	124.6
150	160	5.2	149.6
200	200	5.2	189.6

Dimensioning example of a pump pressure line



GIV.39
Dimensioning example of a pump pressure line (sewage lifting unit in a public area)

When using a sewage lifting unit that drains a public toilet system below the backwater level, the pump flow rate and the pump differential pressure must be determined.

An underground pipeline supplies the sewage lifting unit with wastewater from 12 toilets with a capacity of 6.0-litre each, 6 urinals and 8 washbasins.

By applying the sum of the connected values and a building code of K = 1.0 for public use, the total wastewater drainage is Q_{tot} = 5.2 L/s (➨ [TIV.15] and ➨ [TIV.16]).

TIV.15
Detrmining the total wastewater discharge Q_{tot}

Quantity [Piece]	Drainage object	DU [l/s]	∑(DU) [l/s]
12	WC with 6.0 litre cistern	2.0	24.0
6	Single urinal with flush valve	0.5	3.0
8	Washbasin	0.5	4.0
			31.0

TIV.16
Calculation of peak discharge

TS	∑(DU) [l/s]	K	Q_{ww} [l/s]	Q_c [l/s]	Q_{tot} [l/s]
1	27	1	5.2	0	5.2

IV

The pump flow rate of the sewage lifting unit must be equal to or greater than the calculated total wastewater drainage. The pump flow rate is initially set to Q_P = 6.0 L/s.

The pump discharge nozzle of a suitable sewage lifting unit – in this example DN100 – usually specifies the nominal diameter of the pump pressure line. First, the average flow rate must be verified. When using a nominal diameter of DN100 (d_i = 99.0 mm) and a pump delivery rate of Q_P = 6.0 L/s, the average flow rate is v = 0.78 m/s. This is higher than the required minimum flow velocity v_{min} = 0.7 m/s (➨ [TIV.17]).

The choice of the pump flow rate Q_P = 6.0 L/s in conjuntion with the nominal diameter DN100, leads to suitable operating conditions.

In order to determine the pump differential pressure Δp_P, the total pressure loss (= l · R + Z) in the pump pressure line must subsequently be calculated using Fig. [GIV.38] and Table [TIV.14]. At 27.7 hPa, the pressure difference is relatively low compared to the geodetic pressure difference of 392.2 hPa.

In order to alculate the pump differential pressure, formula [FIV.3] is used, which results in Δp_P = 420 hPa (➨ [TIV.17]).

TIV.17
Pressure loss calculation for the pump pressure line

Pressure loss calculation Pump pressure line										
TS	Length [m]	Q_P [l/s]	DN	d_i [mm]	v [m/s]	R [hPa/m]	I·R [hPa]	∑ζ	Z [hPa]	I·R+Z [hPa]
1	19.5	6.0	100	99.0	0.78	0.7	14.1	4.5	13.7	27.7

TIV.18
Individual resistances and sums

Quantity (Piece)	Individual resistance	ζ	∑(ζ)
1	Non-return valve	2.2	2.2
1	Shut-off valve	0.5	0.5
1	90° elbow	0.5	0.5
1	45° elbow	0.3	0.3
1	Transfer to partial filling	1.0	1.0
			4.5

TIV.19
Determining the pump differential pressure

Designation	Symbol	Value	Unit of measure
geodetic height difference	h_{geo}	4.0	m
geodetic pressure difference	Δp_{geo}	392.2	hPa
Pipeline pressure drop	∑(I*R+Z)	27.7	hPa
Pump differential pressure	Δp_P	**420.0**	hPa

5.3 Nominal diameters of ventilation pipes

5.3.1 Main ventilation pipes

Main ventilation pipes must have the same cross-sectional areas as the applicable downpipes.

TIV.20 **Cross-sections of ventilation pipes (Silenta Premium)**

DN	d_i [mm]	A_{HL} [cm²]
56	49.6	19.3
70	68.8	37.2
90	80.6	51.0
100	99.0	77.0
125	124.6	121.9
150	149.6	175.8
200	189.6	282.3

5.3.2 Collecting main ventilation pipes

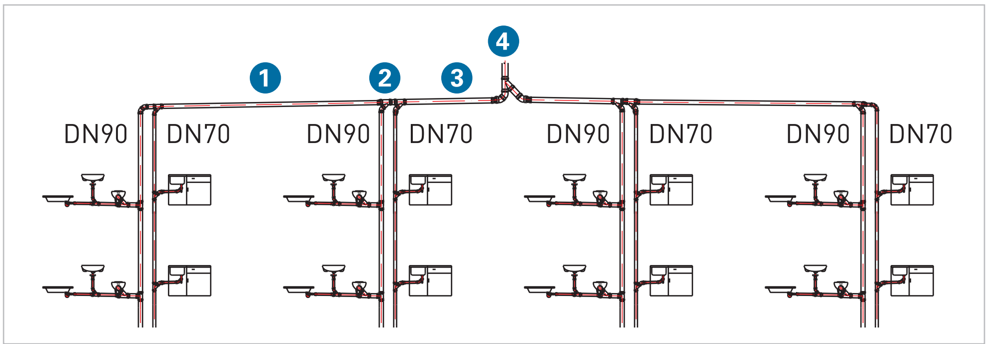
The cross-section of a collecting main ventilation pipe (A_{SHL}) must be at least as large as half the sum of the cross-sectional areas of the individual main ventilation pipes (A_{HL}).

FIV.6 **Formula 6**

$$A_{SHL} \geq \frac{\sum(A_{HL})}{2}$$

The nominal diameter of the collecting main ventilation pipe must be at least one nominal size larger than the largest nominal diameter of the applicable main ventilation pipe.

Dimensioning example: Collecting main ventilatin pipes for block of flats



GIV.40 **Dimensioning example**
1 to 4: TS1 to TS4

TIV.21 **Dimensioning collecting main ventilation pipes for block of flats**

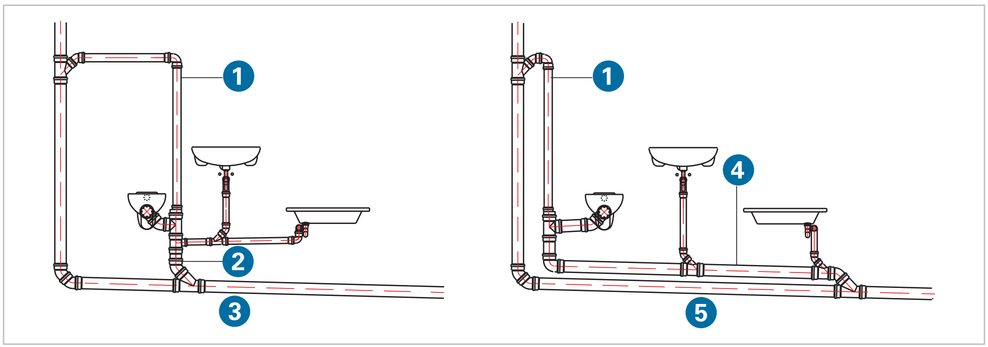
TS	$\sum(A_{HL})$ [cm²]	A_{SHL} [cm²]	$d_{i,min}$ [mm]	d_i [mm]	DN
1	88.2	44.1	74.9	99.0	**100**
2	139.2	69.6	94.1	99.0	**100**
3	176.4	88.2	106.0	124.6	**125**
4	352.8	176.4	149.9	149.9	**150**

For segment TS 1, formula [FIV.6] results in a minimum internal diameter of $d_{i,\,min}$ = 74.9 mm (➨ [TIV.21]). However, since the nominal diameter of the collective main ventilation must be at least one nominal size larger than the largest nominal diameter of the associated main ventilation (DN90), this pipe segment of the collective main ventilation must be dimensioned as DN100. The collecting main ventilation must be routed vertically above the roof, using an end pipe of nominal diameter DN150 (TS 4).

5.3.3 Bypass and ventilation pipes

The nominal diameter of a bypass shall be the same as the downpipe, however, it must not exceed DN100.

Where a ventilation pipe merges into a downpipe, downpipe off-set or header pipe, the ventilation pipe shall be designed having the same nominal diameter as the header it is intended to ventilate, however, a DN70 is sufficient.



GIV.41
Dimensioning bypass and ventilation pipes

1. Ventilation pipe ≥DN70
2. Collecting pipe
3. Downpipe off-set
4. Bypass ≤DN100
5. Header

5.4 Nominal diameters of rainwater pipes

Rainwater drainage systems inside buildings are designed and dimensioned for a medium rainfall event. These pipes are non-pressurised gravity drain pipes and are planned and designed using the rain intensity calculation method ($r_{(D,T)}$). When heavy rainfall events are expected, the rainwater pipes will be overloaded according to their design. This excess load causes operating conditions with strongly fluctuating high and low pressures.

5.4.1 Rainwater dranage

The basics on how to determine the number of drains required and how to dimension the pipes, the rainwater runoff from a precipitation surface shall be determined using the following formula (➨ [FIV.7]).

FIV.7 **Formula 7**

$$Q_R = r_{(D,T)} \cdot C_S \cdot A \cdot \frac{1}{10\,000}$$

$r_{(D,T)}$ Rain intensity calculation [L/(s·ha)]
C_S Peak discharge coefficient (➨ [TIV.22])
A Effluent rainfall area [m²] (roof area projected in the floor plan)
Q_R Rainwater drainage from the roof surface [L/s]

In order to design rainwater pipes that drain surfaces from "inside the building", such as roofs, balconies, loggias, terraces, etc., the rain intensity calculation for the building site is a block with a rain duration of D = 5 minutes and a yearly minimum of 5 years (T = 5).

The authoritative rain intensity calculation method must be determined on the basis of KOSTRA-DWD (Germany's National Meteorological Service).

TIV.22
Peak drainage coefficients of roof areas

Type of rainwater catchment area	C_S
Roof surfaces (sloping or pitched roofs)	1.0
Roofs covered with gravel	0.8
Green roofs	
• Extensive green roofs (> 5 °)	0.7
• Extensive green roofs with less than 10 cm growing medium (≤5°)	0.5
• Extensive green roofs with more than 10 cm growing medium (≤5°)	0.4
• Extensive green roofs with more than 30 cm growing medium (≤5°)	0.2

5.4.2 Number of and design of roof drains

The minimum required number of roof drains (n_{DA}) for the drainage of a roof surface (A) must be determined using the formula (➨ [FIV.8]).

FIV.8 **Formula 8**

$$n_{DA} = \frac{Q_R}{Q_{DA}}$$

n_{DA}	Number of roof drains
Q_R	Rainwater drainage from the roof area [L/s] (Formula [FIV.7]
Q_{DA}	Drainage capacity of the roof drain [L/s]

The drainage capacity of the roof drain (Q_{DA}) must be verified by the manufacturer, applying a test pursuant to DIN EN 1253-2.

TIV.23
Minimum drainage of a roof drain pursuant to DIN EN 1253-1

DN	Minimum drainage Q_{DA} [l/s]	Pressure height h [mm]
70	1.7	35
100	4.5	35
125	7.0	45

When arranging and selecting roof drains, the following additional criteria must be taken into account:

- Every low point on the roof must have at least one roof drain.
- The distance between the roof drains must not exceed 20 m.

5.4.3 Emergency drainage

Roof areas must be protected against undue flooding, which must include the century rain event. This usually requires emergency drainage via drains and/or overflows.

Together, the drainage and emergency drainage systems must be able to drain an amount of rain that is equal to the century rainfall event ($r_{(5,100)}$) and can be expected at the building site over a period of 5 minutes.

The dimensioning of emergency drainage is not part of this publication.

5.4.4 Downpipes

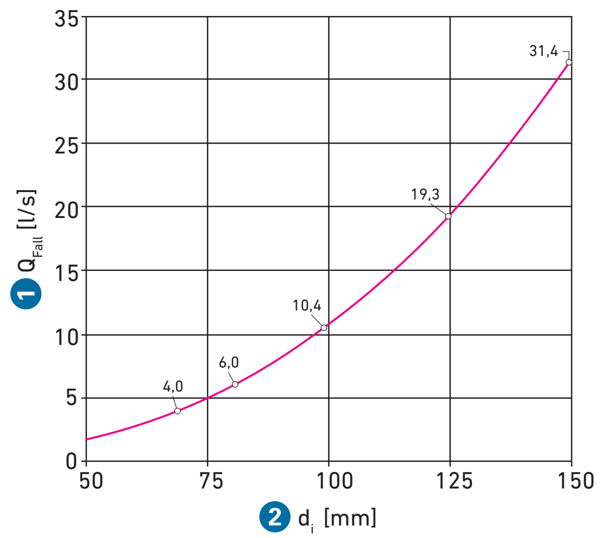
Downpipes must be dimensioned based on the calculated rainwater discharges (Q_R) (➨ [TIV.24].

Compliance with the following requirements is mandatory:

- Diameter of the downpipe ≥ nominal diameter of the applicable roof drain or the collecting pipe
- Downpipe off-sets <10° (J <18 cm/m) must be calculated considering the slope of the off-set at a degree of filling $h/d_i = 0.7$ (➨ [TIV.9]).

TIV.24
Drainage capacity of rainwater downpipes (Silenta Premium)

DN	d_i [mm]	Q_{drop} [L/s]
56	49.6	1.7
70	68.8	4.0
90	80.6	6.0
100	99.0	10.4
125	124.6	19.3
150	149.6	31.4
200	189.6	59.0



GIV.42
Drainage capacity of rainwater downpipes (Silenta Premium)

1. Rainwater dranage
2. Internal diameter of the downpipe

5.4.5 Single, collecting, header and underground pipes

Rain drainage pipes that are installed horizontally, must be dimensioned for the calculated rainwater discharge (Q) in the respective sections (➨ [TIV.9]).

Compliance with the following requirements is mandatory:

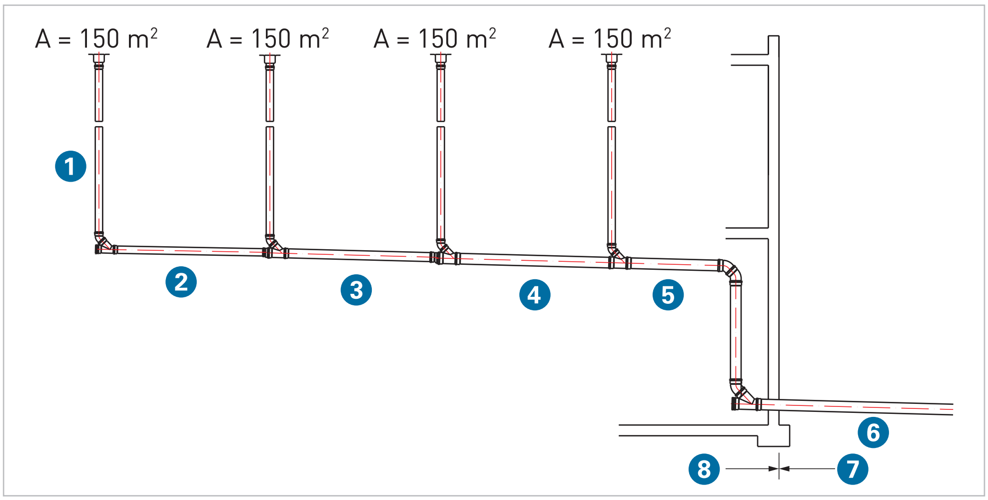
Pipelines inside the building

- Minimum nominal diameter for underground pipes DN100
- Maximum permissible degree of filling $h/d_i = 0.7$ (➨ [TIV.9])
- Minimum slope $J_{min} = 0.5$ cm/m

Underground pipes outside the building

- Minimum nominal diameter DN100
- Maximum permissible degree of filling $h/d_i = 0.7$ (➨ [TIV.9])
- Pipelines behind an open-flow shaft can be dimensioned for full fill
- Minimum slope J_{min} = 1: DN
- Minimum flow rate $v_{min} = 0.7$ m/s
- Maximum flow rate $v_{min} = 2.5$ m/s

Dimensioning example



GIV.43
Design of the rainwater header in a block of flats and a commercial building

1. TS 1
2. TS 2
3. TS 3
4. TS 4
5. TS 5
6. TS 6
7. Outside the building
8. Inside

TIV.25 **Design of the rainwater header in a block of flats and a commercial building**

Calculation of the rainwater discharge								Drainage capacity of the selected pipeline				
TS	Length [m]	Area [m²]	$r_{(D,T)}$ [l/(s·ha)]	C	Q_R [l/s]	Q_P [l/s]	Q_{tot} [l/s]	d_i [mm]	J [cm/m]	h/d_i	Q_{zul} [l/s]	v [m/s]
1		150	300	1.0	4.5		4.5	**99.0**			10.4	
2		150	300	1.0	4.5		4.5	**99.0**	2.0	0.70	6.5	1.12
3		300	300	1.0	9.0		9.0	**124.6**	2.0	0.70	11.9	1.31
4		450	300	1.0	13.5		13.5	**149.6**	2.0	0.70	19.4	1.48
5		600	300	1.0	18.0		18.0	**149.6**	2.0	0.70	19.4	1.48
6		600	300	1.0	18.0		18.0	**149.6**	2.0	0.70	19.4	1.48

In order to drain a roof area measuring 600 m², the rainwater headers should be dimensioned according to the rain intensity calculation method $r_{(D, T)}$ = 300 l/(s·ha). The required number of roof drains (n_{DA}) can be determined with 4 pieces using a standard DN100 drain with a drainage capacity of Q_{DA} = 4.5 L/s (➨ [TIV.23]).

FIV.9 **Formula 9**

$$n_{DA} = \frac{600 \cdot 300 \cdot 1{,}0}{10\,000 \cdot 4{,}5} = 4$$

The pipe invert slope is speicified as J = 2.0 cm/m. When using Table [TIV.9], the required cable diameters can be determined.

Important: In the diversion area of rainwater downpipes in headers, push-in joints must be secured with safety clips, additional brackets and fasteners must be incorporated in order to prevent the pipes from slipping apart and/or causing the misalignment of their mutual axes.

6 Cleaning

6.1 Cleaning openings

In order to proceed with inspection and cleaning tasks on drainage pipes, cleaning openings must be provided.

Internal drainage pipes can be fitted with cleaning pipes having rectangular, round or oval openings as well as pipe end closures.

In underground pipelines inside buildings, only shafts with closed off flow and rectangular cleaning pipes may be used.

In underground pipelines outside the building, the use of open-flow shafts is preferred.

In underground pipelines and header, cleaning openings must be installed at least every 20 m.

Other rules and clearance dimensions of shafts or inspection openings apply to drainage pipes installed outside buildings (DIN 1986-100, 6.6).

In headers, cleaning and pipe end closures must be used.

Downpipes must be provided with a cleaning pipe immediately upstream of the transition to a collecting or underground pipeline. The cleaning opening may also be installed in the header instead of in the downpipe. However, in this case the cleaning opening must be located inside the flat.

7 Operation, maintenance and repair

Part 3 of DIN 1986 regulates the operation and maintenance of drainage systems.

In addition to the system's intended operation, regular inspections of the drainage systems to verify their proper function and safe condition is mandatory. If necessary, maintenance measures (inspection, maintenance, repair) must be carried out in order to keep the system fail-safe.

The owner or authorised user (operator) shall be responsible for the appropriate operation and regular maintenance.

Pursuant to DIN 1986-3, maintenance, repairs and changes to drainage systems may only be carried out by expert personnel.

According to VOB DIN 18381 "Section 3.5 Applicable Documents", the contractor must hand over all operating and maintenance instructions required for the safe and cost-effective operation no later than at the time of acceptance. The trained operating and maintenance personnel for the systems must be instructed by the contractor.

For this purpose, the Central Association of Plumbing, Heating and Air, St Augustin, has the "Drainage system" instruction manual and the Model Maintenance Contracts.

Plan

Insulation, Fire protection

IV

Insulation, Fire protection

1 Insulation

> **Insulation**
> For information on implementing insulation with GF Systems, refer to the relevant system chapters in the 'Build' part of this manual:
> ➨ Part V 'Build'

1.1 Temperature, humidity and formation of condensation

+ Installations must be protected in order to prevent the inadmissible heating and formation of condensation.

In the text that follows, the term **condensate** is used. Often the terms **condensation** and **condensated water** are also used.
When the air on a surface that is colder than the ambient temperature cools down to the point where this temperature drops below the dew point temperature of the air, condensate is formed. This is prevented if the pipeline or fitting is insulated accordingly.

TIV.1 **Dew point temperature, depending on air temperature and relative humidity**

Room condition	too dry	dry		normal moist			moist			too moist		too wet			
Air temperature	Relative humidity [%]														
[°C]	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10	-6.0	-4.2	-2.6	-1.2	0.1	1.4	2.6	3.7	4.8	5.8	6.7	7.6	8.4	9.2	10.0
11	-5.2	-3.4	-1.8	-0.4	1.0	2.3	3.5	4.7	5.8	6.7	7.7	8.6	9.4	10.2	11.0
12	-4.5	-2.6	-1.0	0.4	1.9	3.2	4.5	5.7	6.7	7.7	8.7	9.6	10.4	11.2	12.0
13	-3.7	-1.9	-0.1	1.3	2.8	4.2	5.5	6.6	7.7	8.7	9.6	10.5	11.4	12.2	13.0
14	-2.9	-1.0	0.6	2.3	3.7	5.1	6.4	7.5	8.6	9.6	10.6	11.5	12.4	13.2	14.0
15	-2.2	-0.3	1.5	3.2	4.7	6.1	7.3	8.5	9.6	10.6	11.6	12.5	13.4	14.2	15.0
16	-1.4	0.5	2.4	4.1	5.6	7.0	8.2	9.4	10.5	11.6	12.6	13.5	14.4	15.2	16.0
17	-0.6	1.4	3.3	5.0	6.5	7.9	9.2	10.4	11.5	12.5	13.5	14.5	15.3	16.2	17.0
18	0.2	2.3	4.2	5.9	7.4	8.8	10.1	11.3	12.5	13.5	14.5	15.4	16.3	17.2	18.0
19	1.0	3.2	5.1	6.8	8.3	9.8	11.1	12.3	13.4	14.5	15.5	16.4	17.3	18.2	19.0
20	1.9	4.1	6.0	7.7	9.3	10.7	12.0	13.2	14.4	15.4	16.4	17.4	18.3	19.2	20.0
21	2.8	5.0	6.9	8.6	10.2	11.6	12.9	14.2	15.3	16.4	17.4	18.4	19.3	20.2	21.0
22	3.6	5.9	7.8	9.5	11.1	12.5	13.9	15.1	16.3	17.4	18.4	19.4	20.3	21.2	22.0
23	4.5	6.7	8.7	10.4	12.0	13.5	14.8	16.1	17.2	18.3	19.4	20.3	21.3	22.2	23.0
24	5.4	7.6	9.6	11.3	12.9	14.4	15.8	17.0	18.2	19.3	20.3	21.3	22.3	23.1	24.0
25	6.2	8.5	10.5	12.2	13.9	15.3	16.7	18.0	19.1	20.3	21.3	22.3	23.3	24.1	25.0
26	7.1	9.4	11.4	13.2	14.8	16.3	17.6	18.9	20.1	21.2	22.3	23.3	24.2	25.1	26.0
27	8.0	10.2	12.2	14.1	15.7	17.2	18.6	19.9	21.1	22.2	23.3	24.3	25.2	26.1	27.0
28	8.8	11.1	13.1	15.0	16.6	18.1	19.5	20.8	22.0	23.2	24.2	25.2	26.2	27.1	28.0
29	9.7	12.0	14.0	15.9	17.5	19.0	20.4	21.7	23.0	24.1	25.2	26.2	27.2	28.1	29.0
30	10.5	12.9	14.9	16.8	18.4	20.0	21.4	22.7	23.9	25.1	26.2	27.2	28.2	29.1	30.0

The formation of condensate depends on the following factors:

- Temperature of the air in the room (ambient temperature)
- Temperature of the surface (pipeline, fitting, etc.)
- Relative humidity in the room

In general terms, the relationships between these factors can be formulated as stated below: The higher the temperature of the room air, the greater the relative humidity of this air, and the greater the difference in temperature between the room air and a surface, the higher the amount of condensate precipitated after the dew point has been reached.

1.2 Insulation and coating of pipes

Insulation is used to reduce thermal losses (in warm drinking water) and to prevent warming (in cold drinking water) of the respective medium.

Coating of pipes, on the other hand, has mainly protective functions such as corrosion protection, sound protection, avoiding contacts between piping and structure or are used to accommodate changes in length.

1.2.1 Requirements for the insulation and coating materials

In principle, all pipelines, fittings and devices used in drinking water installations must be provided with insulating or coating materials in accordance with the technical requirements, the physical challenges and the conditions at the installation site.

Among other things, the following factors must be taken into account:

- Operating temperatures
- Operating mode of the system
- Static and dynamic loads
- Thermal losses, hot or cold
- Condensation prevention
- Sound emission
- Fire behaviour
- Chemical behaviour of the insulating materials
- Environmental conditions at the site (ambient temperatures, relative humidity)
- Available space
- Aggressiveness of the atmosphere
- Ecological behaviour (e.g. when recycling)

Nevertheless, it must be ensured that the materials used do not damage the pipes, valves, components and fittings when insulating and coating caused by contact or chemical corrosion.

Insulation and coating materials must at least meet the fire protection requirements that apply to standard flammable building materials. The use of highly flammable building materials is prohibited.

1.3 Insulating drinking water pipes (cold)

Drinking water pipes (cold) must be insulated in order to prevent warming of the water at elevated ambient temperatures and must prevent the formation of condensation at an assumed drinking water temperature of 10°C.

However, the insulation of drinking water pipes (cold) can be omitted if warming caused by ambient temperatures is not expected, condensation does not occurs and as a result, this has no effect on the structure, its facilities or the piping system construction's components.

During longer periods of stagnation, even 100% insulation cannot provide lasting protection against warming of the drinking water (cold) above the permitted maximum value of 25°C.

In these cases, the operator must ensure to change to the water regularly in accordance with the intended use of the water. As an option, technical equipment must be installed (time or temperature controlled), which ensures that the temperature specification is maintained by using a controlled drainage method.

TIV.2 **Thicknesses of the insulating layer of drinking water pipes, cold (Recommendation based on DIN 1988-200)**

Type of pipes	Installation situation	Ambient temperature [°C]	Thicknesses of the insulating layer* [mm]	Remark
Pipelines	• open installation in unheated rooms	≤20	9	–
	• installed in pipe shafts, floor ductsand on suspended ceilings	≤25	13	–
	• installed in technical centres, media ducts, shafts with thermal loads	≥25	–	Insulation for hot water pipes, see [TIV.3]: Installation situation 1 to 6
Single supply lines and pipelines on individual floor levels	• in the in-wall installation	–	4	or: Pipe-in-pipe
	• in the floor superstructure (also next to non-circulating warm drinking water pipes)**	–	4	or: Pipe-in-pipe
	• in the floor structure next to warming, circulating pipes**	–	13	–

Reference: DIN 1988-200

* The specified insulation thicknesses are based on a thermal conductivity value of 0.040 W / (m·K).
  - Reference temperature for the specified thermal conductivity: 10 °C
  - For other thermal conductivities: Convert insulation thicknesses accordingly.

** In conjunction with underfloor heating systems, the pipelines for drinking water (cold) must be installed in such a way that the cold water temperature does not exceed 25 °C for a maximum of 30 s after the tapping point is fully opened.

1.4 Insulating drinking water pipes (warm)

Drinking water pipes (warm), which are integrated into the circulation system must be insulated for energy saving reasons and in order to limit heat dissipation. The applicable insulation thicknesses can be found in the following table. These include the distribution, riser and circulation pipes as well as main branch pipes, if these are included in the circulation circuit.

Exempted from this principle are main branch pipes and individual supply lines, that have a pipe volume of less than 3 litres and are not included in the circulation cycle. These pipes must **not** be insulated against thermal loss. However, when a concealed installation is used, a coating as mechanical protection and corrosion protection is necessary,

TIV.3 **Thicknesses of the insulating layer of drinking water pipes, warm (Recommendation based on DIN 1988-200)**

Installation situation, type of pipes	Pipe, inside diameter [mm]	Thicknesses of the insulating layer* [mm]	Remark
1	22	20	–
2	22 – 35	30	–
3	>35 – 100	= inside diameter of pipe	–
4	>100	100	–
5 Pipes/fittings, according to installation situations 1 - 4 • in wall and ceiling openings • in areas where pipes are crossing • at pipe connection points • where main pipe distributors are located	–	50% of the values specified for 1 - 4	–
6 Drinking water pipes (warm) • not included in the circulation circuit • not equipped with a temperature maintenance strap	–	no insulation requirements against heat emission**	for example, storey or individual supply lines with a water volume of ≤3 l

Reference: DIN 1988-200

* The specified insulation thicknesses are based on a thermal conductivity value of 0.035 W / (m·K).
- Reference temperature for the specified thermal conductivity: 40 °C
- For other thermal conductivities: Convert insulation thicknesses accordingly.

** For flush-mounted installation, insulation is required; for example, pipe-in-pipe or 4 mm as mechanical protection or corrosion protection

1.5 Insulating shut-off valves

>In order to avoid unacceptable heat loss in drinking water pipes (warm) or preventing the heat transfer in drinking water pipes (cold), shut-off valves must also be insulated.

1.6 Thermal conductivity of insulating materials

The tables contain the calculated values for the insulation materials: λ = W / (m · K)

TIV.4 **Thermal conductivity – natural organic insulating materials**

Average temperature	Natural organic insulating materials	Inorganic, fibrous insulating materials		Inorganic, cellular insulation materials
	expanded cork	Mineral fibre products	Mineral fibre laminated plate	Cellular glass
–20	0.031 – 0.043	–	–	0.041
0	0.033 – 0.045	–	–	0.044
20	0.035 – 0.047	0.033 – 0.038	0.042 – 0.044	0.047
40	0.037 – 0.049	0.035 – 0.042	0.046 – 0.049	0.050
60	0.039 – 0.051	0.037 – 0.046	0.050 – 0.054	0.053
80	0.041 – 0.053	0.039 – 0.050	0.055 – 0.060	0.055
100	0.043 – 0.055	0.041 – 0.054	0.060 – 0.066	0.060

TIV.5 **Thermal conductivity – artificial organic insulating materials (plastic foams)**

Average temperature	Polystyrene particle foam	Extruded polystyrene foam	Rigid polyurethane-polyisocyanurate foam	Phenolic resin foam	Polyethylene foam	Synthetic foam rubber	Polyvinyl chloride foam
–20	0.028 – 0.031	0.023 – 0.025	0.025 – 0.032	0.026 – 0.035	0.036 – 0.044	0.036	0,030 – 0,039
0	0.031 – 0.034	0.025 – 0.028	0.023 – 0.032	0.029 – 0.038	0.038 – 0.046	0.038	0,032 – 0,043
20	0.033 – 0.037	0.028 – 0.031	0.023 – 0.033	0.032 – 0.041	0.040 – 0.048	0.040	0,035 – 0,047
40	0.037 – 0.041	0.030 – 0.033	0.026 – 0.035	0.035 – 0.044	0.042 – 0.050	0.042	0,038 – 0,052

Calculated values for the thermal conductivity

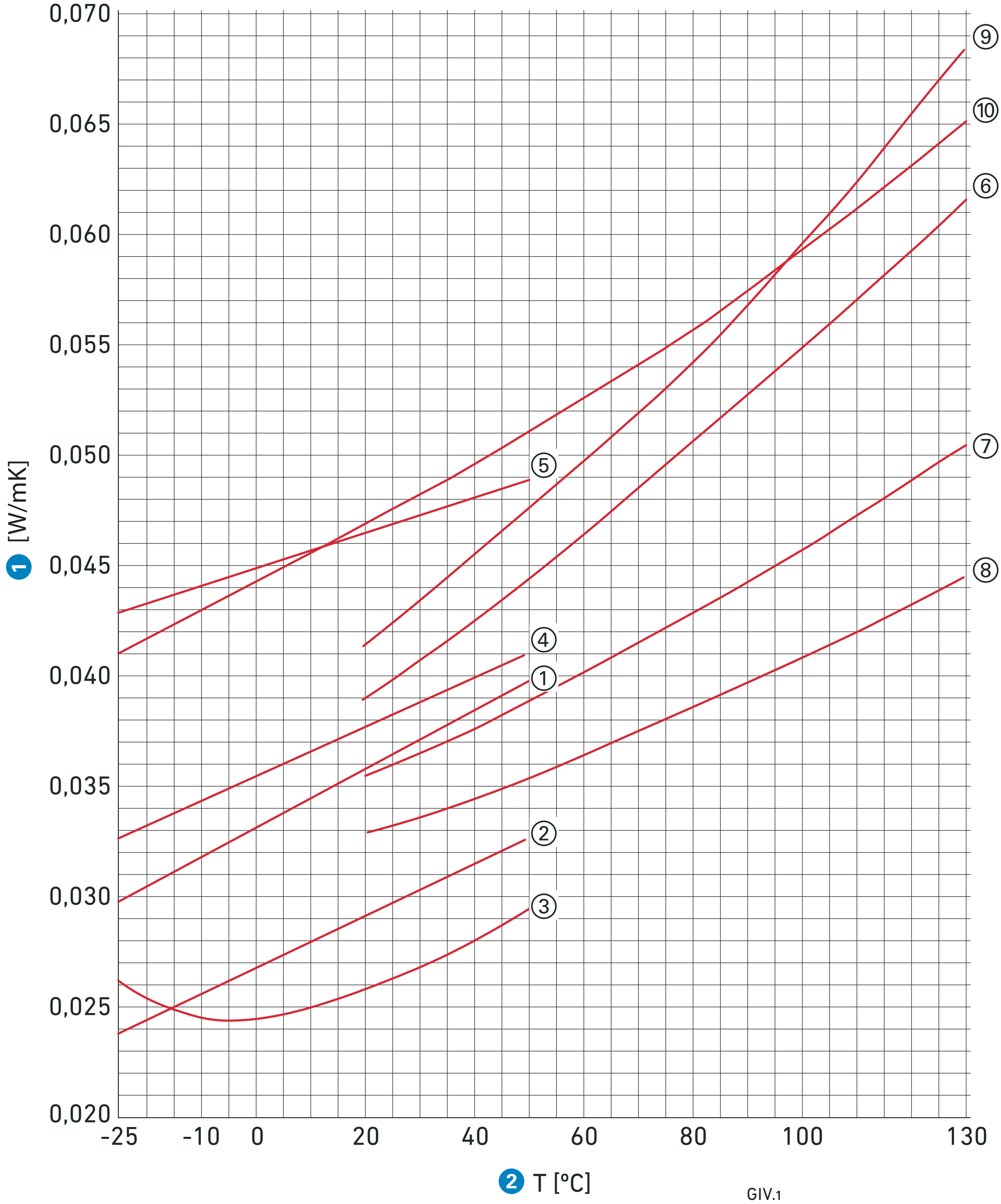
The lower the thermal conductivity, the better the insulating capability of the insulating material. Before the thermal conductivity can be determined, the test specimens must be stored for 2 months in a climatic room at 20°C and an average humidity of 60%.

As a rule, the measured values should be used forthwith. An exception is the thermal conductivity of PIR products. For these products the thermal conductivity measurement should be done at the age of 2 months. In this case, the calculated value must be the measured value with a surcharge of 30%.

§ **As of 1.1.1995, only CFC-free PIR shells must be used.**

CFC = Chlorofluorocarbons

1.7 Thermal conductivity of insulation materials as a function of the mean temperature



GIV.1
Thermal conductivity

1. Thermal conductivity [W/(m·K)]
2. Average temperature

The thermal conductivity of a specific product must be demonstrated by a neutral test report submitted by a recognised test institute.

1. EPS Expanded polystyrene particle foam
2. XPS Extruded polystyrene foam
3. PUR Polyurethane hard foam
4. PVC Polyvinyl chloride foam
5. PE Polyethylene foam
6. MW Mineral wool with low density
7. MW Mineral wool with medium density
8. MW Mineral wool with high density
9. MW Mineral wool lamella mats
10. Cellular glass
11. PIR Polyisocyanurate (analogue ③)

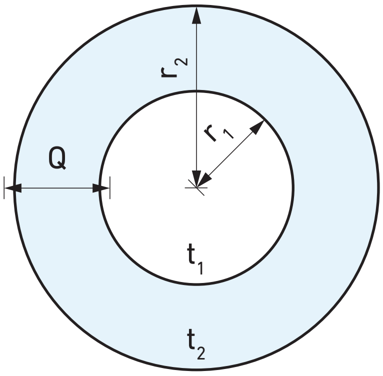
1.8 Calculation of the surface temperature of the pipe

1.8.1 Calculation of the surface temperature of the pipe

$$Q = \frac{2 \cdot \pi \cdot l \cdot (t_1 - t_L)}{\frac{\ln \frac{r_2}{r_1}}{\lambda} + \frac{l}{\alpha_K \cdot r_2}}$$

$$t_2 = -\frac{Q \cdot \ln \frac{r_2}{r_1}}{2 \cdot \pi \cdot l \cdot \lambda} + t_1$$

Q Amount of heat
s Pipe length
l Water temperature
t_1 Surface temperature of the pipe, outside
t_2 Air temperature
α_K Heat transfer coefficient, determined from measurements
λ Thermal conductivity of the material
r_1 Pipe radius, inside
r_2 Pipe radius, outside



1.8.2 Heat dissipation from pipes, not insulated

Calculation of heat dissipation

Heat transfer coefficient

$$k_{Rohr} = \frac{\pi}{\frac{1}{\alpha_i \cdot d_i} + \frac{1}{\alpha_a \cdot d_a} + \left(\frac{1}{2 \cdot \lambda} \cdot \ln \frac{d_a}{d_i}\right)}$$

Thermal loss

$$\Phi = k_{Rohr} \cdot (v_a - v_i)$$

k_{Pipe} Heat transfer coefficient [W/(m² · K)]
α_i Heat transfer [W/(m² · K)]
α_a Heat transfer [W/(m² · K)]
d_a Outside diameter of pipe [m]
d_i Inside diameter of pipe [m] [m]
λ Thermal conductivity of the material [W/(m² · K)]
Φ Thermal loss [W/m²]
ν_a Ambient temperature [K]
ν_i Medium temperature [K]

1.9 Material properties of layers and coatings

TIV.6 **Material properties**

Materials	Thickness [mm]	BKZ** (German Fire Code)	RF**	Temperature resistance [°C]	Brief description	Coating
Cold bitumen coating	1	3	4	up to approx. 60	Single coat, protection against moisture, low mechanical strength	Non-metallic
White cement or gypsum/ kieselguhr coating	1 – 3	6	1	up to approx. 150	Single coat, low mechanical strength	
Wire mesh tapes with coat of white cement or gypsum/kieselguhr mixture	3	6	1	up to approx. 200	Single coat, low mechanical strength	
Bituminous roofing felt	2	3	4	up to approx. 80	Simple coating, protection against moisture or dripping water, small mechanical strength	
Rigid PVC film	0.3 – 0.4	5.2	2	up to approx. 70 – 75	Low strength, not UV resistant, high chemical resistance, suitable inside of buildings	
Rabitz wire mesh made of stainless steel Mesh size 20 × 25	0.7	6	1	up to approx. 600	Simple mechanical protection, low strength	
Aluminium foil	0.1	6	1	up to approx. 300	Very low strength, not resilient to mechanical stress	Metallic
Coarse grid aluminium foil	0.2 – 0.3	6	1	up to approx. 300	Very low strength, cannot be mechanically stressed, longitudinal and transverse joints glued with aluminium adhesive tapes, application inside	
ALUMAN-100, semi-hard	0.6 – 1.0	6	1	up to approx. 300	Medium strength, atmospheric and chemical resistance, very good ductility	
PERALUMAN-150	0.6 – 1.0	6	1	up to approx. 300	Medium strength, good corrosion resistance, good ductility	
PERALUMAN-300	0.6 – 1.0	6	1	up to approx. 300	Good strength, high corrosion resistance (especially against seawater), good ductility	
Steel sheet, galvanized	0.6 – 1.0	6	1	up to approx. 350	Good strength, mechanically strong, risk of corrosion at interfaces	
Steel sheet, corrosion-resistant, V2A, Material no. 1.4301 *	0.4 – 0.9	6	1	up to approx. 400	High strength and high chemical resistance, moderate ductility	
Steel sheet, corrosion-resistant, V4A, Material no. 1.4435	0.4 – 0.9	6	1	up to approx. 400	High strength and high chemical resistance, difficult to deform	

* Easy when processing in the cold state. After heat treatment or welding >600°C (intergranular corrosion). The fire incident code of a specific product must be demonstrated by a recognised test institute and a neutral test report must be submitted.
** The Fire Codes (German: BKZ) have been replaced by the RF (Réaction feu) numbers according to the fire safety guidelines of 2015.

1.10 Material properties of vapour barriers and vapour retarders

TIV.7 **Material properties**

Barrier material	Material thickness s (min.) [mm]	German Fire Code	RF	Ranges of barrier values; diffusion equivalent air layer thickness SD = μ · s [m; Caution: does not refer to linear metres!]				
				10 m	50 m	100 m	200 m	1000 m
Preparation quantity, does not contain bituminous solvent	*	4	3					
Coating, using liquid preparation quantity	0.3 – 0.5	4	3		x			
Liquid plastic, double layer **	0.8 – 1.0	5.3	2			x		
Liquid plastic, multiple layers **	1.2 – 1.5	5.3	2				x	
Bitumen coating								
Overpainting, dry film thickness	1.0	4	3	x				
Coating, single layer, dry layer thickness	2.0	4	3		x			
Coating, multiple layers, dry layer thickness	3.0	4	3			x		
Adhesive tapes								
Polyethylene (PE)	0.4	5	2		x			
Polyethylene (ALU)	0.05	6	1				x	
Foils								
Aluminium (ALU foil)***	0.1	6	1					x
Aluminium coarse grain (ALU coarse grain foil)***	0.2 – 0.3	6	1					x
Sheet metal sheathings								
Crimps and longitudinal seams, not sealed		6	1	x	x			
Crimps and longitudinal seams, sealed		6q.	1		x	x		

* Cavity and gap filling
** Dry film thickness liquid plastic = 1/2 wet thickness
*** Longitudinal and transverse joints glued

1.11 Mollier diagram

h-x diagram (for P = 950 mbar, H = 540 m above sea level) for determining the water vapour content and heat content of the air as a function of the temperature and the relative humidity

Example on how to read the diagram (on next page)

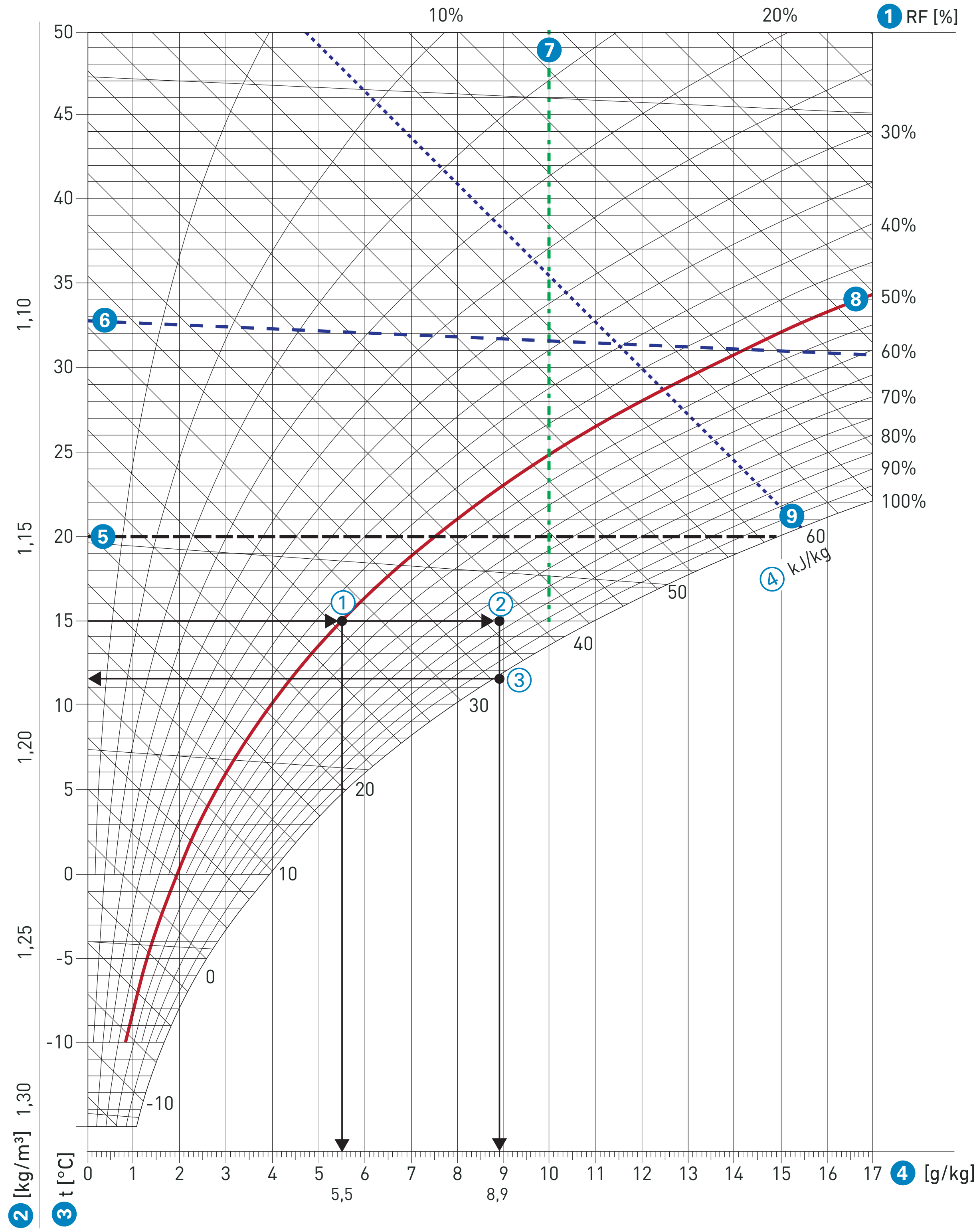
Starting position

Building location 540 m above sea level.
Room temperature t (basement) 15°C
Relative humidity RF 50%
Cold water pipeline 8°C
Surface moisture 80%

Readout

Result: Steam content 8.9 g/kg
Result: Saturation limit of 100% is reached at a room temperature of 11.5°C. Below 11.5°C, condensation forms on the cold water pipe.

Mollier diagram



1. relative humidity
2. Density
3. Air temperature
4. Steam content
5. Constant temperature [°C]
6. Constant density [kg/m³]
7. Constant steam content [g/kg]
8. Constant relative humidity [%]
9. Constant enthalpy [kJ/kg]

① Read-out point
② Read-out point
③ Dew point
④ Specific enthalpy

GIV.2
Mollier diagram

2 Fire protection

Country-specific regulations
Fire protection may be regulated differently in each countries by laws, directives, ordinances, standards, regulations and bulletins.
→ Compliance with the local fire protection regulations is mandatory.

The classification of the building materials is based on the relevant European standards. Building materials may only be used for the intended purpose of the test.

Fire protection
Information on implementing fire protection with GF systems can be found in the relevant system chapters in the 'Building' part of this manual:
➨ Part V 'Build'

Fire behaviour groups

Acronym	Explanation
	areas highlighted in grey: Application restriction due to critical behaviour in case of fire or due to the inadmissible contribution to fire.
RF1	no contribution to fire
RF2	no significant contribution to fire
RF3	permissible contribution to fire
RF4	non-permissible contribution to fire
Classes A1 -> E	increasing contribution to fire
F	Materials that no longer meet the requirements of Class E and are not approved as building materials
Class a1 -> a3	increasing corrosivity of combustion gases
Class s1 -> s3	increasing formation of smoke
Class d0 -> d2	increasing intensity of burning droplets/debris

2.1 Allocation tables*

*Source: VKF, AEAI: "Brandschutzrichtlinie", VKF, Bern 2015

TIV.8 **Allocation acc. to SN EN 13501-1:2009**

Group	Critical behaviour	Classification		
		Construction products	Linear pipe insulation	Floor coverings
RF1		A1 A2-s1,d0	$A1_L$ $A2_L$-s1,d0	$A1_{fl}$ $A2_{fl}$-s1
RF2		A2-s1,d1 A2-s2,d0 A2-s2,d1	$A2_L$-s1,d1 $A2_L$-s2,d0 $A2_L$-s2,d1	
		B-s1,d0 B-s1,d1 B-s2,d0 B-s2,d1	B_L-s1,d0 B_L-s1,d1 B_L-s2,d0 B_L-s2,d1	B_{fl} -s1
		C-s1,d0 C-s1,d1 C-s2,d0 C-s2,d1	C_L-s1,d0 C_L-s1,d1 C_L-s2,d0 C_L-s2,d1	C_{fl} -s1
	cr	A2-s1,d2 A2-s2,d2 A2-s3,d0 A2-s3,d1 A2-s3,d2	$A2_L$-s1,d2 $A2_L$-s2,d2 $A2_L$-s3,d0 $A2_L$-s3,d1 $A2_L$-s3,d2	
	cr	B-s1,d2 B-s2,d2 B-s3,d0 B-s3,d1 B-s3,d2	B_L-s1,d2 B_L-s2,d2 B_L-s3,d0 B_L-s3,d1 B_L-s3,d2	B_{fl} -s2
	cr	C-s1,d2 C-s2,d2 C-s3,d0 C-s3,d1 C-s3,d2	C_L-s1,d2 C_L-s2,d2 C_L-s3,d0 C_L-s3,d1 C_L-s3,d2	C_{fl} -s2
RF3		D-s1,d0 D-s1,d1 D-s2,d0 D-s2,d1	D_L-s1,d0 D_L-s1,d1 D_L-s2,d0 D_L-s2,d1	D_{fl} -s1
	cr	D-s1,d2 D-s2,d2 D-s3,d0 D-s3,d1 D-s3,d2	D_L-s1,d2 D_L-s2,d2 D_L-s3,d1 D_L-s3,d2 D_L-s3,d0	D_{fl} -s2
	cr	E E-d2	E_L E_L-d2	E_{fl}
RF4		–	–	
no construction material		F	F_L	F_{fl}

TIV.9 **Allocation acc. to SN EN 13501-1:2009**

Group	Critical behaviour	Classification Results derived from tests of roofs when exposed to external fire
RF1		–
RF2		–
	cr	B_{ROOF} (t1) B_{ROOF} (t2) B_{ROOF} (t3) B_{ROOF} (t4)
RF3		–
	cr	C_{ROOF} (t3) C_{ROOF} (t4) D_{ROOF} (t3) D_{ROOF} (t4)
RF4	cr	E_{ROOF} (t4)
no construction material		F_{ROOF} (t1) F_{ROOF} (t2) F_{ROOF} (t3) F_{ROOF} (t4)

TIV.10 **Allocation acc. to VKF (BKZ)**

Group	Critical behaviour	Classification acc. to VKF (BKZ)
RF1		6.3 6q.3
RF2		5 (200°C).3 5.3 5 (200°C).2 5.2
	cr	5 (200°C).1 5.1
RF3		4.3 4.2
	cr	4.1
RF4	cr	3.3 3.2 3.1
no construction material		2.3 2.2 2.1 1.3 1.2 1.1

(grey box)	highlighted area: Application restriction due to critical behaviour in case of fire or due to the inadmissible contribution to fire.
6 – 1	Flammability levels (increasing from 6 to 1, Grade 1 and 2 materials are not allowed as building materials)
.3 – .1	from 3 to 1 increasing degrees of smoke

TIV.11 Allocation acc. to SN EN 13501-1:2009

Group	Critical behaviour	Classification		
		Classification with results from the fire behaviour tests of electrical cables		
RF1			A_{ca}	
RF2		$B1_{ca}$-s1,a1,d0	$B2_{ca}$-s1,a1,d0	C_{ca}-s1,a1,d0
		$B1_{ca}$-s1,a2,d0	$B2_{ca}$-s1,a2,d0	C_{ca}-s1,a2,d0
		$B1_{ca}$-s1a,a1,d0	$B2_{ca}$-s1,a1,d1	C_{ca}-s1,a1,d1
		$B1_{ca}$-s1a,a2,d0	$B2_{ca}$-s1,a2,d1	C_{ca}-s1,a2,d1
		$B1_{ca}$-s1b,a1,d0	$B2_{ca}$-s1a,a1,d0	C_{ca}-s1a,a1,d0
		$B1_{ca}$-s1b,a2,d0	$B2_{ca}$-s1a,a2,d0	C_{ca}-s1a,a2,d0
		$B1_{ca}$-s1,a1,d1	$B2_{ca}$-s1a,a1,d1	C_{ca}-s1a,a1,d1
		$B1_{ca}$-s1,a2,d1	$B2_{ca}$-s1a,a2,d1	C_{ca}-s1a,a2,d1
		$B1_{ca}$-s1a,a1,d1	$B2_{ca}$-s1b,a1,d0	C_{ca}-s1b,a1,d0
		$B1_{ca}$-s1a,a2,d1	$B2_{ca}$-s1b,a2,d0	C_{ca}-s1b,a2,d0
		$B1_{ca}$-s1b,a1,d1	$B2_{ca}$-s1b,a1,d1	C_{ca}-s1b,a1,d1
		$B1_{ca}$-s1b,a2,d1	$B2_{ca}$-s1b,a2,d1	C_{ca}-s1b,a2,d1
		$B1_{ca}$-s2,a1,d0	$B2_{ca}$-s2,a1,d0	C_{ca}-s2,a1,d0
		$B1_{ca}$-s2,a2,d0	$B2_{ca}$-s2,a2,d0	C_{ca}-s2,a2,d0
		$B1_{ca}$-s2,a1,d1	$B2_{ca}$-s2,a1,d1	C_{ca}-s2,a1,d1
		$B1_{ca}$-s2,a2,d1	$B2_{ca}$-s2,a2,d1	C_{ca}-s2,a2,d1
	cr	$B1_{ca}$-s1,a3,d0	$B1_{ca}$-s3,a3,d2	C_{ca}-s1,a3,d0
		$B1_{ca}$-s1a,a3,d0	$B2_{ca}$-s1,a3,d0	C_{ca}-s1,a3,d1
		$B1_{ca}$-s1b,a3,d0	$B2_{ca}$-s1,a3,d1	C_{ca}-s1,a1,d2
		$B1_{ca}$-s1,a3,d1	$B2_{ca}$-s1a,a3,d0	C_{ca}-s1,a2,d2
		$B1_{ca}$-s1,a1,d2	$B2_{ca}$-s1a,a3,d1	C_{ca}-s1,a3,d2
		$B1_{ca}$-s1,a2,d2	$B2_{ca}$-s1,a1,d2	C_{ca}-s1a,a3,d0
		$B1_{ca}$-s1,a3,d2	$B2_{ca}$-s1,a2,d2	C_{ca}-s1a,a3,d1
		$B1_{ca}$-s1a,a3,d1	$B2_{ca}$-s1,a3,d2	C_{ca}-s1a,a1,d2
		$B1_{ca}$-s1a,a1,d2	$B2_{ca}$-s1a,a1,d2	C_{ca}-s1a,a2,d2
		$B1_{ca}$-s1a,a2,d2	$B2_{ca}$-s1a,a2,d2	C_{ca}-s1a,a3,d2
		$B1_{ca}$-s1a,a3,d2	$B2_{ca}$-s1a,a3,d2	C_{ca}-s1b,a3,d0
		$B1_{ca}$-s1b,a3,d1	$B2_{ca}$-s1b,a3,d0	C_{ca}-s1b,a3,d1
		$B1_{ca}$-s1b,a1,d2	$B2_{ca}$-s1b,a3,d1	C_{ca}-s1b,a1,d2
		$B1_{ca}$-s1b,a2,d2	$B2_{ca}$-s1b,a1,d2	C_{ca}-s1b,a2,d2
		$B1_{ca}$-s1b,a3,d2	$B2_{ca}$-s1b,a2,d2	C_{ca}-s1b,a3,d2
		$B1_{ca}$-s2,a3,d0	$B2_{ca}$-s1b,a3,d2	C_{ca}-s2,a3,d0
		$B1_{ca}$-s2,a3,d1	$B2_{ca}$-s2,a3,d0	C_{ca}-s2,a3,d1
		$B1_{ca}$-s2,a1,d2	$B2_{ca}$-s2,a3,d1	C_{ca}-s2,a1,d2
		$B1_{ca}$-s2,a2,d2	$B2_{ca}$-s2,a1,d2	C_{ca}-s2,a2,d2
		$B1_{ca}$-s2,a3,d2	$B2_{ca}$-s2,a2,d2	C_{ca}-s2,a3,d2
		$B1_{ca}$-s3,a1,d0	$B2_{ca}$-s2,a3,d2	C_{ca}-s3,a1,d0
		$B1_{ca}$-s3,a1,d1	$B2_{ca}$-s3,a1,d0	C_{ca}-s3,a1,d1
		$B1_{ca}$-s3,a2,d0	$B2_{ca}$-s3,a1,d1	C_{ca}-s3,a1,d2
		$B1_{ca}$-s3,a2,d1	$B2_{ca}$-s3,a2,d0	C_{ca}-s3,a2,d0
		$B1_{ca}$-s3,a3,d0	$B2_{ca}$-s3,a2,d1	C_{ca}-s3,a2,d1
		$B1_{ca}$-s3,a3,d1	$B2_{ca}$-s3,a3,d1	C_{ca}-s3,a2,d2
		$B2_{ca}$-s3,a3,d0	$B2_{ca}$-s3,a1,d2	C_{ca}-s3,a3,d0
		$B1_{ca}$-s3,a1,d2	$B2_{ca}$-s3,a2,d2	C_{ca}-s3,a3,d1
		$B1_{ca}$-s3,a2,d2	$B2_{ca}$-s3,a3,d2	C_{ca}-s3,a3,d2

Group	Critical behaviour	Classification		
		Classification with results from the fire behaviour tests of electrical cables		
RF3		D_{ca}-s1,a1,d0	D_{ca}-s1a,a1,d1	D_{ca}-s2,a1,d0
		D_{ca}-s1,a2,d0	D_{ca}-s1a,a2,d1	D_{ca}-s2,a2,d0
		D_{ca}-s1,a1,d1	D_{ca}-s1b,a1,d0	D_{ca}-s2,a1,d1
		D_{ca}-s1,a2,d1	D_{ca}-s1b,a2,d0	D_{ca}-s2,a2,d1
		D_{ca}-s1a,a1,d0	D_{ca}-s1b,a1,d1	
		D_{ca}-s1a,a2,d0	D_{ca}-s1b,a2,d1	
	cr	D_{ca}-s1,a3,d0	D_{ca}-s1b,a3,d0	D_{ca}-s3,a1,d0
		D_{ca}-s1,a3,d1	D_{ca}-s1b,a3,d1	D_{ca}-s3,a2,d0
		D_{ca}-s1,a1,d2	D_{ca}-s1b,a1,d2	D_{ca}-s3,a3,d0
		D_{ca}-s1,a2,d2	D_{ca}-s1b,a2,d2	D_{ca}-s3,a1,d1
		D_{ca}-s1,a3,d2	D_{ca}-s1b,a3,d2	D_{ca}-s3,a2,d1
		D_{ca}-s1a,a3,d0	D_{ca}-s2,a1,d2	D_{ca}-s3,a3,d1
		D_{ca}-s1a,a3,d1	D_{ca}-s2,a2,d2	D_{ca}-s3,a1,d2
		D_{ca}-s1a,a1,d2	D_{ca}-s2,a3,d0	D_{ca}-s3,a2,d2
		D_{ca}-s1a,a2,d2	D_{ca}-s2,a3,d1	D_{ca}-s3,a3,d2
		D_{ca}-s1a,a3,d2	D_{ca}-s2,a3,d2	E_{ca}
RF4	cr		–	
no construction material			F_{ca}	

3 Fire extinguishing and fire protection systems

When planning and designing fire extinguishing and fire protection systems, compliance with both the fire safety concerns of the design documents and the demands for a hygienic drinking water supply is mandatory.

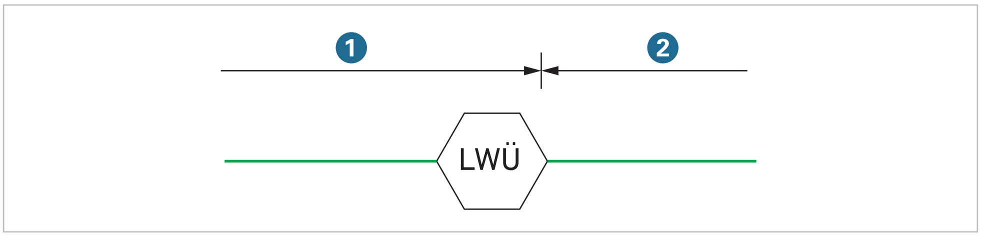
Fire extinguishing and fire protection systems are not used at all or only rarely (in case of fire) over the years. If the fire extinguisher pipes are filled with water and there is no regular water exchange, long periods of stagnation can create dangers to the drinking water supply.

Basic requirements:

→ When planning, designing, maintaining and modifying fire fighting and fire protection systems after the installation of drinking water pipelines, compliance with the following scenarios is mandatory:
- The firefighting water is separated from the drinking water installation line at the firefighting water hand-over point (HOP).
- The connecting line up to the HOP is filled sufficiently with drinking water.

Firefighting water hand-over point

The drinking water installation ends at the firefighting water hand-over point and the latter system begins here. The HOP ensures the protection of the drinking water and negative repercussions from the firefighting water system to the drinking water installation are eliminated.



GIV.3
Firefighting water hand-over point

1 Drinking water installation
2 Firefighting water system
LWÜ Firefighting water hand-over point (HOP)

The safety devices of a HOP include, for example:
- free discharges type AA and AB
- Filling and discharging stations
- Direct connection stations
- Hose connection valve 1" with built-in non-return valve and aerator
- Above ground and below ground fire hydrants

These safety devices must be used depending on the type of extinguishing water system.

3.1 Fire extinguishing and fire protection systems in stock

If drinking water pipes exhibit inadequate flow in the area of fire extinguishing and fire protection systems this will lead to acute health hazards, and renovation of existing systems becomes indispensable.

☑ During renovation work, not only compliance with the drinking water hygiene requirements is mandatory but also conformity with the demands of fire protection (fire protection concept) is mandated.

IV

3.2 Planning fundamentals

For the distribution of drinking water and fire extinguishing water from the public and the building supply lines, the following **basic rule** applies:

Drinking water requirement ≥ fire extinguishing water requirement

Fire-extinguishing and fire protection systems are connected via a firefighting water hand-over point in compliance with the prescribed principle.

The pipe diameter for the common supply of drinking water and firefighting water is determined exclusively for the peak volume flow of the drinking water installation. This principle may mean that the necessary quantities of water have to be stored in order to ensure the supply of firefighting water.

Only **wall hydrants of type S** (self-service equipment) may be connected directly to the drinking water installation – but not at the end! Here, the above-mentioned **basic rule** applies as well: The drinking water requirement must be equal to or greater than the demand for fire extinguishing water in each direction of flow.

3.3 Fire protection concept

The fire protection concept takes into account the requirements for the fire fighting and fire protection systems as well as the preventive and defensive fire protection. These demands are set by a fire protection expert or a fire protection authority taking into account.

The **fire defence** is the task of the fire brigade. This task includes:
- the primary fire protection for residential, commercial and industrial areas.
- the property protection – which covers object and use-specific concerns of the fire protection – such as spatial dimensions of the building, increased personal risk, magnified fire loads, tight construction methods for building interiors or high machine density.

Preventive fire protection defines all measures that preclude or limit the formation, spread and impact of fires in advance and facilitate firefighting operations. Preventive fire protection includes the structural, technical and organisational fire protection.

Fire extinguishing systems of preventive fire protection are:
- Firefighting systems using dry chemicals
- Below ground and above ground fire hydrants
- Wall hydrants, type F and type S
- Sprinkler systems
- Systems with open nozzles

3.4 Materials

The materials of the pipelines for fire extinguishing and fire protection systems must be made of non-combustible materials, namely metallic materials.

Buried pipelines and those in machinery rooms that are protected against the effects of fire are an **exceptions**.

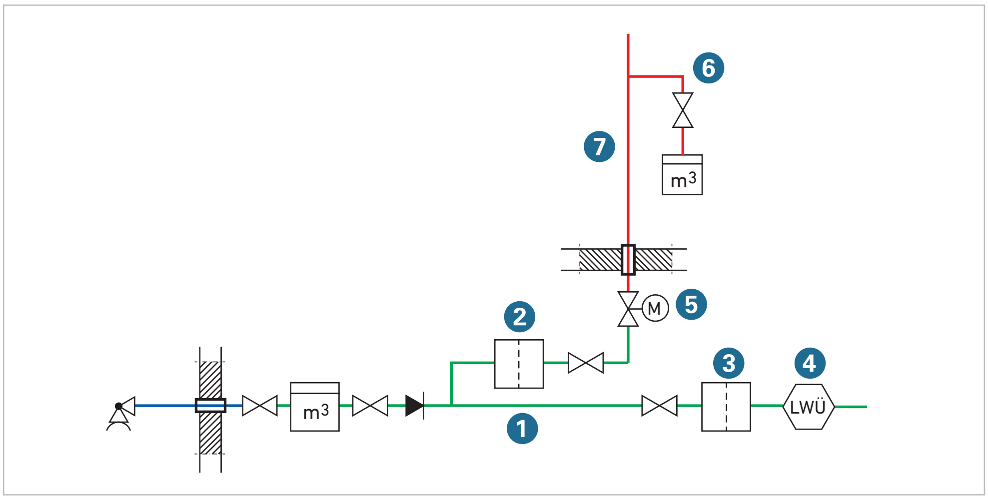
Another **exception** are distribution and riser pipes made of plastic. In this case, an automatically shut-off valve must be integrated, which closes the direction of flow for drinking water and firefighting water extraction in the event of a fire. Up to this valve, the material of the pipes must be metal (non-flammable).

Plastic pipes for the connection of wall hydrants with self-service devices type S are permitted if they are installed under plaster with a coverage of at least 15 mm plaster or mineral building materials.

If another fire extinguishing and fire protection system is connected to the drinking water installation, distribution and riser pipes with type S wall hydrants must be made of metallic materials.

Single-storey and individual supply lines made of plastic are permitted if they are installed under plaster with a coverage of at least 15 mm of plaster or mineral building materials.

Automatic shut-off valve made of plastic in drinking water pipes

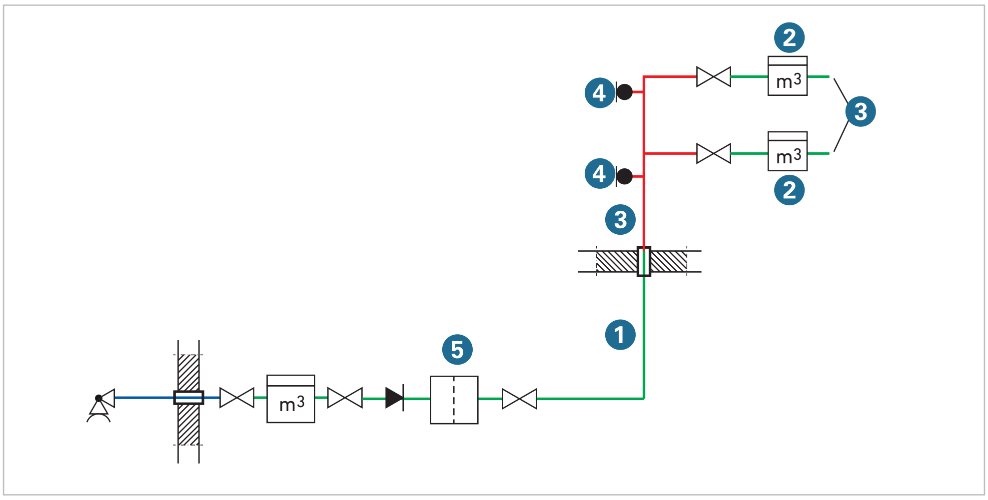


GIV.4
Automatic shut-off valve

1. Material: Metal (green)
2. Filter
3. Stone trap
4. Firefighting water
5. automatic shut-off valve, closed in the event of a fire
6. Drinking water installation
7. Material: Plastic (red)

LWÜ Firefighting water hand-over point (HOP)

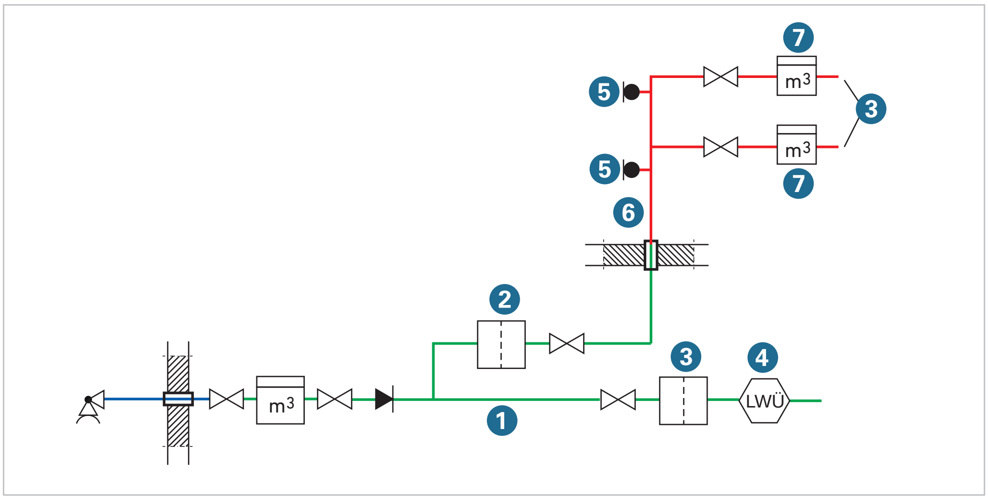
Plastic drinking water pipes with wall hydrants type S



GIV.5
Wall hydrant type S

1. Material: Metal (green)
2. for fire protection reasons: all plastic pipes must be installed behind plaster or mineral building material (at least 15 mm thick)
3. Material: Plastic (red)
4. Wall hydrant type S
5. Filter

Drinking water installation with wall hydrant type S and an additional fire extinguishing and fire protection system



GIV.6
Wall hydrant type S and fire extinguishing/fire protection system

1. Material: Metal
2. Filter
3. Stone trap
4. Firefighting water
5. Wall hydrant type S
6. Material: Plastic
7. for fire protection reasons: all plastic pipes must be installed behind plaster or mineral building material (at least 15 mm thick)

LWÜ Firefighting water hand-over point (HOP)

Build

V

Build

INSTAFLEX

V

INSTAFLEX

Overview

This chapter contains basic information about the INSTAFLEX system.

Additional technical and sales information

- For more information on the use and connection of other system components, piping and controls and instruments, see the chapters applicable to the appropriate systems.
- More technical information about this system and ordering information can be found on the GF website and in the sales catalogue.

1 System overview

1.1 System description

INSTAFLEX is a modern plastic piping system made of polybutene used in the building technology, for industrial applications and in the ship building industry. Thanks to its elasticity, the sound-absorbing system traces the contour of the building and is particularly cost-effective when prefabrication of components is required. The clearance of the flow area enables a system to be designed from the entry into the house to the tap.

INSTAFLEX offers complete solutions for single-family dwellings, large residential complexes, public or commercial buildings.

INSTAFLEX	Description
Pipe dimension	d16 – d315
Application area	Cold and hot water, compressed air, cooling systems
Installation	Surface and flush-mounted pipelines
Pipes	100% plastic made of polybutene (PB)
Fittings and system parts	Plastic (predominantly), brass (partially)
Method	Socket fusion welding, electrofusion, butt fusion, clamp connections

1.2 Approvals and quality assurance

The system is subject to constant inspection by internal and external bodies. These inspections range from quality assurance during production to ISO certification for environmental and process safety. The INSTAFLEX system meets all the essential requirements for building technology applications and is subject to constant monitoring by the licensing offices for drinking water, heating and compressed air installations on land and sea.

System approvals
General information:
➨ Annex A , Section 'Approvals'
Up-to-date information on system approvals is available from Technical Support.

Sustainability/EPD

An EPD was prepared according to EN 15408 especially for the INSTAFLEX (PB) system and verified according to Third Party Verification compliant with EN ISO 14025:2010.

The EPD, including results for all parameters, is available at www.gfps.com

1.3 Scope and application areas

The installation system INSTAFLEX is intended for the following applications:

- Drinking water installations in the cold and hot water area
- Grey water installations (rainwater and the like)
- Compressed air installations
- Air conditioning
- Distribution with demineralised water
- Refrigeration Installation

Potential equalisation

The installation of the system is not a conductive metallic pipework. The installation cannot be used as a grounding conductor for electrical installations.

☑ The installation must **not** be used for equipotential bonding purposes and must **not** be used as an earth connection.

Responsibility for equipotential bonding
The installer of the electrical system is responsible for the correct implementation of the equipotential bonding.

DHW heaters

It is feasible to connect the system to **water heaters** without a metallic connection. In this case, restrictions do not apply if the water temperatures never exceed 70°C.

The use in conjunction with **flow DHW heaters** is permitted. However, only the manufacturer of the device is authorised to approve the use of the tankless water heaters.

☑ Compliance with the manufacturer's instructions for the devices is mandatory.

Protection of piping materials and connections

☑ If using flow DHW heater: Only use **thermostats** or **safety temperature limiter**, which ensure that the water temperature of 95°C is not exceeded at any point or at any time – not even when reheating.

☑ When using hydraulically controlled devices: Ensure that the **automatic switch-off** does not permit any pressures above 10 bar, even in case of the reheat effect.

Recommendation
If the temperature cannot be kept below 95°C or in older hydraulically controlled, electrically or gas-fired instantaneous water heaters, where the temperatures cannot be reliably maintained below 95°C, the following shall apply:

☑ A metallic connection with a length of 1.0 m shall be provided.

Fire extinguishing systems

When installing fire extinguishing pipes and sprinkler systems using INSTAFLEX system components:

☑ Compliance with local regulations and fire protection requirements is mandatory.

> **Detailed information on sprinkler systems with INSTAFLEX**
>
> ➨ Chapter [13.7] 'Sprinkler systems'

1.4 Properties and requirements

> **Service life limitation applicable to the installation**
>
> The quality of the water (pH value), the constituents of the water as well as the operating conditions can have a direct influence on the lifetime of the installation, especially in strongly chlorinated waters and hot water.

1.4.1 Materials

> **Materials polybutene (PB) and brass**
>
> Detail information:
>
> ➨ Part III 'The basics', Section 'Materials and jointing technology'

1.4.2 Hygienic properties

Verification of the system's hygienic safety is provided. The test certificate issued by the DVGW-Technologiezentrums Wasser – TZW (the German Water Centre – as part of DVGW e.V., the German Gas and Waterworks Association) proves that the plastic components comply with the KTW (official German recommendation concerning the levels of polymers in drinking water) recommendations by the German Federal Health Agency, the specifications of the Umweltbundesamtes (UBA) (Federal Environmental Agency) in Germany and the basic requirements of the Federal Food Control Institute according to ÖNORM B 5014, Part 1.
This also applies to other institutions in the field of building technology and maritime industry, for example, ACS, SINTEF, BS 6920 and KIWA/ATA.

All plastic and metal components are continuously inspected in accordance with the recommendations mentioned above in order to ensure they meet all national and international requirements, such as the DVGW worksheet W270.

1.4.3 Chemical resistance

The system exhibits a high chemical resistance to all natural drinking water substances (acc. to DIN 2000 and TrinkwV 2001), against disinfectants and cleaning agents

(acc. to DVGW-Arbeitsblatt W291) and against corrosion inhibitors (acc. to DIN 1988, Part 4).

In addition to the utilisation for drinking water, the system can also be used for the liquid and gaseous media mentioned in [TV.1].

> **Suitability of the system**
>
> However, the suitability of the system is not limited to the defined chemical resistance mentioned above, but also depends on the use of the appropriate medium. The characteristics of the medium may be changed by the pipes and fittings.

TV.1 **Media**

Medium	Classification	Max. operating temperature [°C]	Max. operating pressure [bar]
Drinking water	Cold water	0 – 20	10
	Hot water	20 – 70*	
	Heating water	0 – 70*,**	
Softened water	pH neutral (0°fH)	0 – 70	
Rain water	pH value >6.0	0 – 40	
Osmosis treatment***	–	0 – 70	
VE water***	desalinated	70	
Cooling water****	40 Vol.% ethylene glycol, Antifrogen®, ethyl alcohol	–25 – 40**	
	25 Vol.% propylene glycol	–10 – 40**	
	Saline solutions	–20 – 40**	
Disinfectant solution*****	ready for use	40	
Compressed air	Class 1 acc. to DIN ISO 8573-1 • Residual oil content: 0.01 mg/m³ • oil and fat free	0 – 40	
	Class 2 and 3 acc. to DIN ISO 8573-1 • Residual oil content: 1.0 mg/m³ • Residual water content: 0.88 mg/m³ • Dew point: –20°C • low in oil and fat	0 – 40******	
Nitrogen	–	0 – 40******	
Vacuum	–	40	-0.8 p_a ≈0.2

* Short term peak temperature of 95°C during max. 150 h/a
** Only permissible with oxygen diffusion-tight pipes
*** Brass and red bronze fittings release small amounts of metal ions into osmosis-treated water. If ion-free water is desired, additional treatment at the tap is required or RG fittings with epoxy coating inside (JRG Sanipex MT up to 30°C) should be used.
**** Higher concentrations must be requested.
***** Concentrations must be requested.
****** Not suitable for PB pipes

Requests concerning resistance in special cases

If the system must be used for applications or concentrations exceeding the values in the table, the resistance of the materials etc. must be checked and approved by GF. The following information is required in advance for testing and approval:

- Product and safety data sheet of the medium
- Operating temperature and pressure
- Concentration, exposure time, frequency and flow rate of the medium (even a sample, if required)

The use of the system for **medical gases** is **not** recommended.

Medical gases include gases that meet the requirements of the European Pharmacopoeia or which are anaesthetic gases, medical oxygen or medical carbonic acids. All of the above are approved according to the drug regulations as finished medicinal products.

1.4.4 Fire protection

§ **Country-specific regulations**
Fire protection may be regulated differently in each countries by laws, directives, ordinances, standards, regulations and bulletins.
→ Compliance with the local fire protection regulations is mandatory.

1.4.5 Soundproofing

The basics

Water pipes do not generate any noise if the nominal pipe dimension, design, fastening method and operation are correct. There are no test regulations specified in standards or other directives to determine or assess the noise behaviour in drinking water systems.

+ Basically, plastic systems show greater benefits than metal pipe systems.

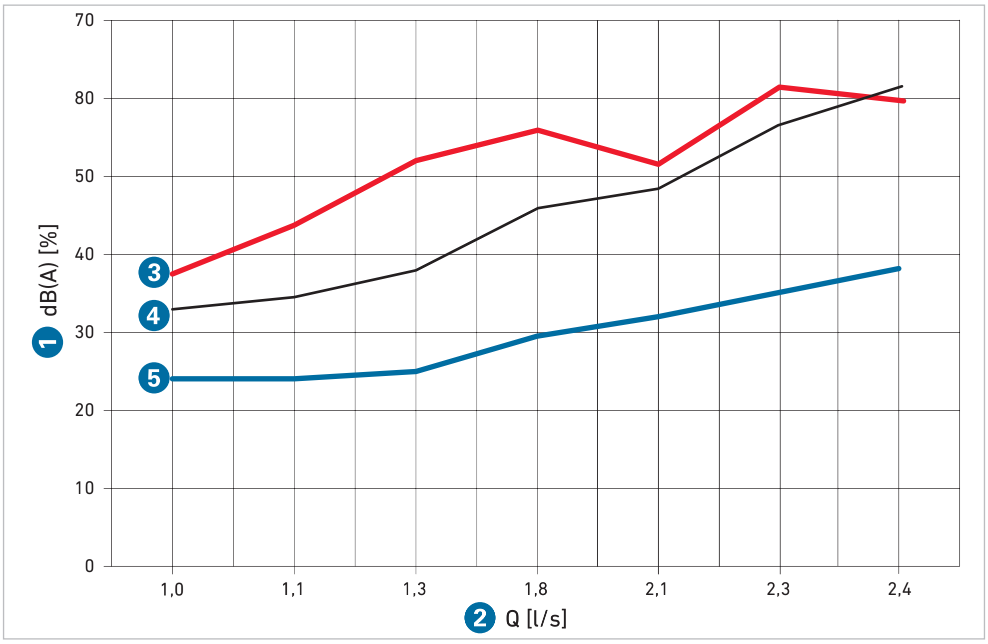
By default, drinking water systems are designed so that the volumetric flow is 2 m/s for distribution lines (standard value, which is and may only be exceeded for certain line sections) and max. 4 m/s for discharge lines is maintained. These are flow velocities at which the inherent noise of the pipelines comparted to the noise generated by the fittings or other ambient noise is not noticeable. However, the noises resonating from sanitary equipment and fittings are being transmitted. Therefore, sound insulation – which absorbs the structure-borne noise reverberating from the building – must be added to the system components.

INSTAFLEX

The INSTAFLEX installation system is compliant with the requirement of DIN 4109 and SIA I81 (6.2006). However, this implies that the installation must be carried out according to the recognised rules of technology and the assembly instructions.

+ INSTAFLEX ensures maximum sound insulation in the overall installation.

In the diagram [GV.1], sound velocity and sound propagation are compared with metal systems.



GV.1
Noise check
SVGW No.. 0711-5292
1. Sound pressure (percentage)
2. Flow rate
3. Difference [%]
4. Metal
5. PB, d32

+ How to read the table: At 1.5 l/s the difference between PB and metal is approx. 18 dB (about 55%)!

1.4.6 Insulation

Insulation
General information on insulation:
➨ Part IV 'Plan', Section 'Insulation, Fire protection'

Country-specific regulations
The insulation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.
→ When it comes to insulation methods, compliance with the applicable rules and regulations is mandatory.

The basics

Information on the insulation value of polybutene
The plastic PB naturally offers a high thermal insulation value. As a result, the thickness of additional insulation can often be omitted or reduced. However, condensate formation must always be taken into account.

☑ Piping systems must always be insulated in order to prevent heat loss and/or heat absorption.
- Cold water pipes, in order to prevent condensation, heating of drinking water and sound transmission
- Hot water, circulation and heating pipes, to reduce heat loss, absorb expansion and prevent sound transmission

☑ Select the insulation/sheathing according to the respective field of application.
☑ Ensure that the insulation does not cause corrosion to the piping materials.

Soundproofing
☑ The soundproofing may be subject to special requirements. Ensure that these potential prerequisites are considered in the design of the insulation.

Hygiene
Applying insulation to cold water pipes, for example, in order to prevent them from heating can improve the hygiene and help reduce the risk of legionella.

Planning fundamentals
The EnEV (German Energy Saving Ordinance) or DIN 1988 in Germany or the model regulations of the cantons in the energy sector (MuKEn) in Switzerland are available in the current version with comprehensive, detailed and practice-oriented documents. They are equally valid for new constructions, renovations and modernisations.

1.4.7 Protecting the installation

The system is absolutely stable in normal and dry environments.

System components installed flush with the wall or walled in

Concealed pipelines are pipes installed inside (self-levelling) sub-floors such a concrete.

☑ Fittings and pipes must be insulated with a suitable material in order to absorb thermally induced changes in length, to prevent the transmission of sound, to preclude the formation of condensation, heat emission, heat loss or heating of the medium and other influences caused by building materials.

☑ Separating the piping system from the building structure is mandatory, in particular when installing the pipes inside concrete ceilings or wall panels, protective conduits made of PE, wrappings, insulating hoses or half shells with and without sheathing or a combination thereof shall be used.

☑ All system components must be protected from direct contact with oils, greases, solvents, solvent-based adhesives (adhesive tapes), foams, bitumen (also bituminous membranes). Furthermore, the components must not contact building materials such as screed, concrete, mortar or plaster.

Protection against environmental influences and building materials

Special measures apply to the following rooms:

- permanently or periodically wet rooms
  - Slaughterhouses, butcher shops (pressure washer)
  - Carwash
  - Tiled shower stalls, spa areas
  - Commercial kitchens
  - Rooms with risk of external water ingress
  - Swimming pools, sauna
- Areas subject to offensive gases or aggressive environments
  - Stables (ammonia)
  - Dairy factories/cheese dairies (nitric acid)
  - Swimming pools/swimming pool centres (chlorine, hydrochloric acid)
- Areas subject to uncontrollable environmental influences

Due to the moisture permeating the building materials and the resulting permanent wetness (e.g. in public showers and baths or commercial wet rooms), it is possible for an aggressive environment to form around the pipe.

☑ Appropriate precautions must be taken to protect the installation, e.g. by using the following measures:
  - Use of suitable anti-corrosion tapes (e.g. supplied by KEBU, Gyso or DENSO)
  - Wrapping the pipe with heat-shrinkable materials.

☑ Ensure that pipes and fittings are dry when mounting.

Protection from UV radiation

☑ Appropriate precautions must be taken in order to prevent the installation from permanent exposure to UV rays.

When using the pipe-in-pipe system with protective conduit, this will ensure sufficient UV protection during the installation phase. Sheathing with insulating material can assume the function of UV protection.

☑ Pipes and fittings must be shielded from direct sunlight and UV radiation.

☑ Keep the INSTAFLEX PB pipes and INSTAFLEX fittings in their packaging (sachets or boxes) until they are ready to use.

Protection against aggressive waters

Recommendation

In areas with particularly aggressive waters, ensure the installations are easy to access.

☑ Distribution lines in the single tap system (pipe-in-pipe) must be designed and installed such in order to ensure system components can be replaced at any time without damaging the building's structure.

1.4.8 Disinfection procedure

Disinfection

General information on common disinfection procedures:

➨ Part VI 'Operate', Chapter [3] 'Custodian's responsibility, Maintenance'

Information on the hygiene concept used at GF:

➨ Part II 'Plan – Build – Operate', Chapter [1] 'Introduction'

Chlorine dioxide

The use of chlorine dioxide for chemical disinfection can severely limit the lifetime of the entire drinking water installation. Before implementation, the conditions must be recorded on site.

The water quality (pH value), the water constituents, as well as the operating conditions can have a direct influence on the service life of the installation, especially if chlorinated waters are being used.

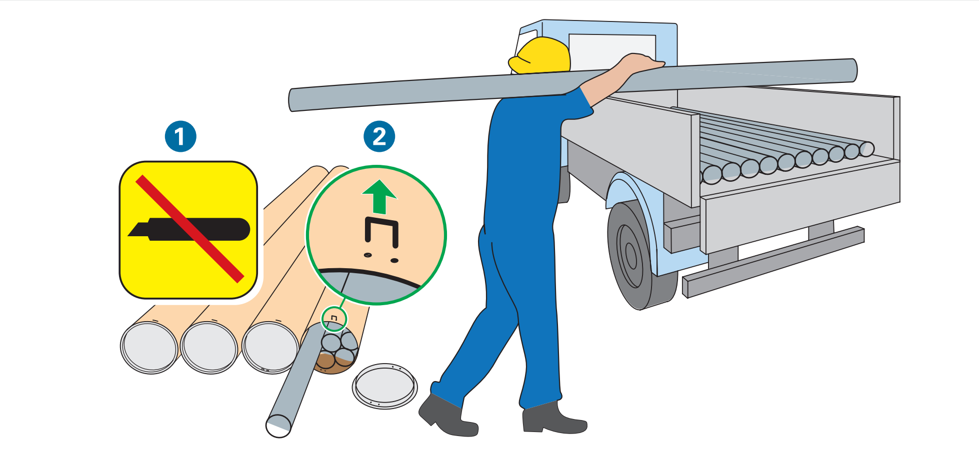
1.5 Safe application and processing

- ☑ Only use the product as intended in accordance with the defined areas of application and operating ranges.
- ☑ Check compatibility of medium and material.
- ☑ Do not use the product if it is damaged or defective. Damaged product must be removed immediately.
- ☑ Use only approved accessories.
- ☑ Only properly trained personnel shall be permitted to assemble the product and accessories.
- ☑ All personnel shall be instructed on all applicable issues of local occupational safety and environmental regulations, in particular for pressurised piping. These instructions must be held on a regular basis.
- ☑ Compliance with the valid standards for drinking water and grey water installations as well as compliance with the regulations of the system manufacturer is mandatory.
- ☑ Compliance with the local water supply regulation is mandatory.
- ☑ Make sure that the piping system is installed correctly and inspected regularly.
- ☑ All installations must comply with the instructions specified in the technical documentation of the product.
- ☑ Compliance with the operating, maintenance and assembly instructions of the tools is mandatory.
- ☑ Tools must be used as intended and must not be applied for other purposes.
- ☑ When assembling the INSTAFLEX installation system, use only INSTAFLEX assembly tools and fusion devices.

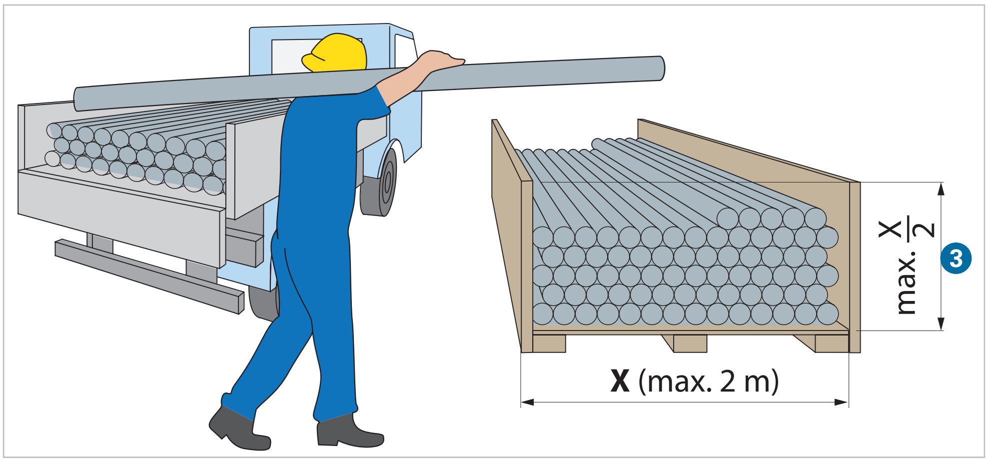
1.5.1 Transport and storage

For hygienic reasons, all openings in pipes, fittings, controls and instruments must be closed until final assembly.

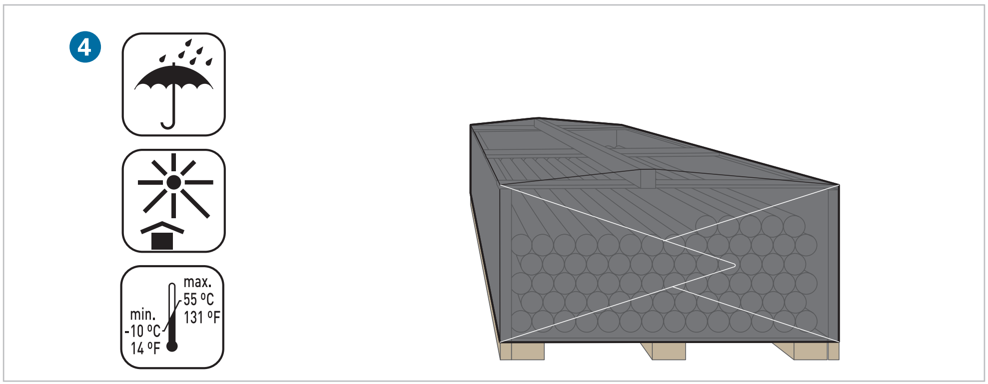
☑ Keep the INSTAFLEX PB pipes and INSTAFLEX fittings in their packaging (sachets or boxes) until they are ready to use.
☑ Ensure to protect the products against external force (shock, impact, vibration, etc.) during transport.
☑ Transport and/or store the products in unopened original packing.



☑ Do not use a knife 1 when opening the tube sleeves.
☑ Ensure to remove all staples 2.



☑ When storing, observe the maximum stacking dimensions 3



☑ Protect products from dust, dirt, moisture, humidity, rain, rain, sunlight, heat and UV radiation 4 .
- Store only at a temperature range of -10 to 55°C.

☑ Ensure that the products are not damaged by mechanical or thermal influences.
☑ Before proceeding with the assembly, inspect the products for damage that may have occurred during the transport.

1.5.2 Installation and assembly

The INSTAFLEX System is suitable for the following types of installation:
- Flush-mounted or concealed installations
- Installation in shafts and channels, on ceilings and on floors
- Installation inside of in-wall, element, wood and lightweight constructions

☑ Keep PB pipes and fittings in packaging (bags or boxes) until use. Remove them from their packaging just before use (installation, assembly).

1.5.3 Acceptance and putting into operation

§ **Country-specific regulations**
Acceptance and putting into operation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.
→ When it comes to acceptance and putting into operation, compliance with the applicable rules and regulations is mandatory.

Acceptance, pressure test, flushing and putting into operation
General information and master copies of the reports:
➨ Part V 'Build', Section 'Putting into operation'

1.5.4 Operation, maintenance, servicing, repair and decommissioning

☑ To ensure trouble-free operation: Check installation and all control and safety fittings regularly.

Risk of injury due to pressure or explosion!
If the system is not completely depressurised, media may escape uncontrollably from the installation.
☑ Before removal/maintenance/disassembly: Pipeline must be completely depressurised.
☑ If harmful, combustible or explosive media is used: Completely empty and flush the pipeline before disassembling it. Look for potential residues.
☑ Use appropriate measures to ensure the medium is collected properly.

Risk of injury due to media harmful to health and the environment!
Risk of personal injury or environmental damage due to uncontrolled escape of hazardous media.
☑ During maintenance, servicing, repair and decommissioning, prescribed protective clothing must be worn.
☑ Compliance with the media safety data sheets is mandatory.
☑ Collect leaking media and dispose of according to local regulations.

Risk of injury due to the use of unsuitable spare parts!
Damage to the installation and risk of injury.
☑ Only use replacement parts from the current product range during the installation and repairs.

1.5.5 Disposal

The entire INSTAFLEX product range is made from environmentally friendly and recyclable materials.

§ **Country-specific regulations**
Disposal and recycling may be regulated differently in each country by laws, ordinances, standards, regulations, and bulletins.
→ When disposing of or recycling the product, the individual components and the packaging, compliance with the local regulations is mandatory.

→ Before disposing of individual materials, they must be separated according to their recyclability, and whether these materials are considered normal waste or special waste.

2 System components

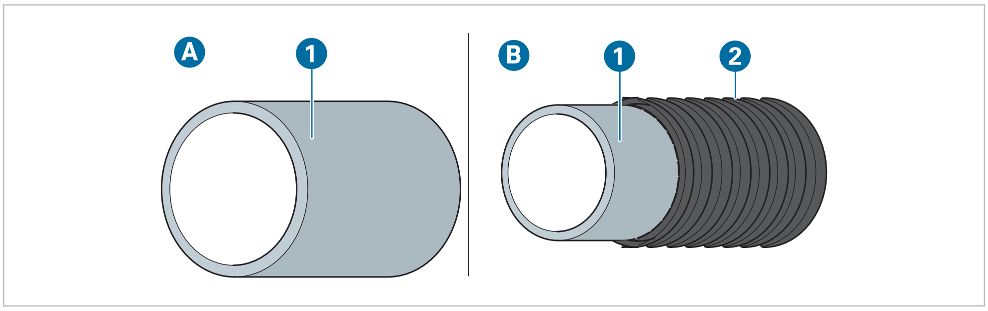
2.1 INSTAFLEX pipes

INSTAFLEX is a state-of-the-art plastic piping system made of polybutene for applications in the building technology sector as well as in the maritime industry.

Main applications are hot and cold water systems, cooling systems and compressed air lines. INSTAFLEX offers complete solutions for single-family dwellings, large residential complexes and public or commercial buildings. The pipes come in the dimension range from d16 to d110 (16 bar) and from d125 to d315 (10 bar), whereby different connection technologies can be used.

2.1.1 Pipe marking

The pipes for the INSTAFLEX system are designed as follows.

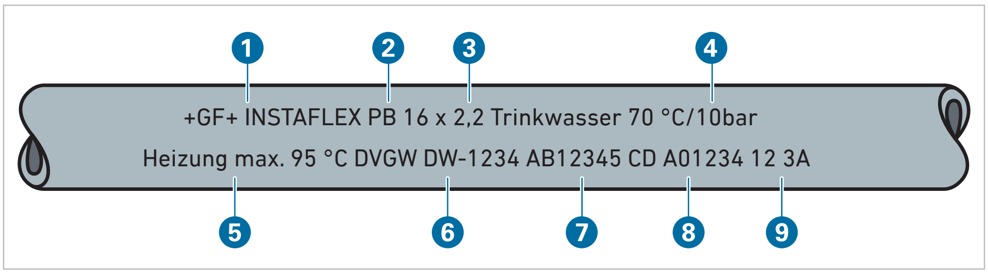


GV.2
Pipe design
A PB pipe
1 Polybutene pipe

B PB pipe d16 – d25, with protective conduit
1 Polybutene pipe
2 Protective conduit (PE)

Pipe marking

The pipes are marked as follows.



GV.3
Pipe marking

	Labelling (example)	Meaning
1	INSTAFLEX	Product name: Company name and system name
2	PB	Material code: PB pipe
3	16 × 2.2	Dimension: Outside diameter x wall thickness
4	70°C / 10 bar	Medium: Operating temperature/max. operating pressure
5	max. 95°C	Heater: max. temperature
6	SVGW-... / DVGW XX-1234... / ÖVGW X1.123	Approval(s) and number(s)
7	AB 12345	Production location and production date
8	CD A01234	Order number
9	12 3A	Internal factory code

§ **The labelling of the pipes may change; the information provided here is without guarantee.**

2.1.2 Operating conditions

When sizing plastic pipes for domestic drinking water installations (cold and hot pipes), the 50-year value of the reference tension caused by the respective creep curve shall be reduced by a safety factor ≥1.5 included in the basic form.

TV.2
Operating conditions

Medium	Operating pressure [bar]	Temperature [°C]	Duration [h/a]
Cold water[1]	0 to 10 (fluctuating)	up to 25	8760
Hot water[2]	0 to 10 (fluctuating)	up to 60 up to 85	8710 50

According to DVGW (DIN 1988/Part 2)
[1] Reference temperature for the long-term creep strength: 20°C
[2] Reference temperature for the long-term creep strength: 70°C

2.1.3 Technical Data

INSTAFLEX

Feature	Pipe	Polybutene pipe (PB)
Conditions in continuous operation (SF 1.5)		70°C, 10 bar (50 years)
Max. operating temperature [°C]		95 (briefly)
Max. operating pressure [bar]		16
Processing temperature [°C]		up to –10
Material constant C		10
Physical properties		
Melt flow rate 190°C / 2.16 kg [dg/min]		0.4
Density [g/cm³]		0.925
Hardness (acc. to shore-D)		60
Thermal properties		
Melting temperature range [°C]		127–129
Vicat softening temperature [°C]		120
Coefficient of thermal expansion α (linear) [mm/(m·K)]		0.13
Thermal conductivity (30–70°C) [W/(m·K)]		0.19
Glass transition temperature [°C]		–16
Mechanical properties		
Surface roughness k [mm]		0.007
Tensile stress at yield [MPa]		20
Tensile strength [MPa]		35
Elongation at break [%]		300
Flexural modulus [MPa]		450
Modulus of elasticity E		450
Impact strength at 20°C [kJ/m²]		20
Impact strength at 70°C [kJ/m²]		7
Specific features		
Wet abrasion (sand slurry test, 23°C, 100 h) [%]		2.5
Fire code		RF3
Fire load [MJ/kg]		45.2

Pipe	Polybutene pipe (PB)													
Feature	d16	d20	d25	d32	d40	d50	d63	d75	d90	d110	d125	d160	d225	d315
Nominal width DN [mm]	12	15	20	25	32	40	50	65	80	100	100	150	200	300
Outside diameter d_a [mm]	16	20	25	32	40	50	63	75	90	110	125	160	225	315
Wall thickness s [mm]	2.2	2.8	2.3	2.9	3.7	4.6	5.8	6.8	8.2	10.0	11.4	14.6	20.5	28.6
Internal diameter d_i [mm]	11.6	14.4	20.4	26.2	32.6	40.8	51.4	61.4	73.6	90.0	102.2	130.8	184.0	257.8
Weight [g/m]	88	141	152	254	392	610	969	1354	1960	2920	3950	6460	12700	24800
Cross section inside A [cm^2]	1.06	1.63	3.27	5.39	8.35	13.07	20.75	29.61	42.54	63.62	82.03	134.37	265.90	521.98
Volume [l/m]	0.10	0.16	0.33	0.53	0.83	1.31	2.07	2.96	4.25	6.36	8.20	13.40	26.60	52.20

Protective conduits

Feature	**Pipe**	PE pipe
Density [kg/dm^3]		~0.95
Tensile strength [N/mm^2]		~25
Temperature resistance [°C]		100
Melt flow index		MFI 190/5: 0.4 g/10 min
Elongation at break [%]		600
Thermal conductivity [W/(m·K)]		0.45

Feature	**Dimension**	d16	d20	d25
Outside diameter d_a [mm]		25	28.5	34
Internal diameter d_i [mm]		20.9	24.1	29.2

2.2 Controls and instruments

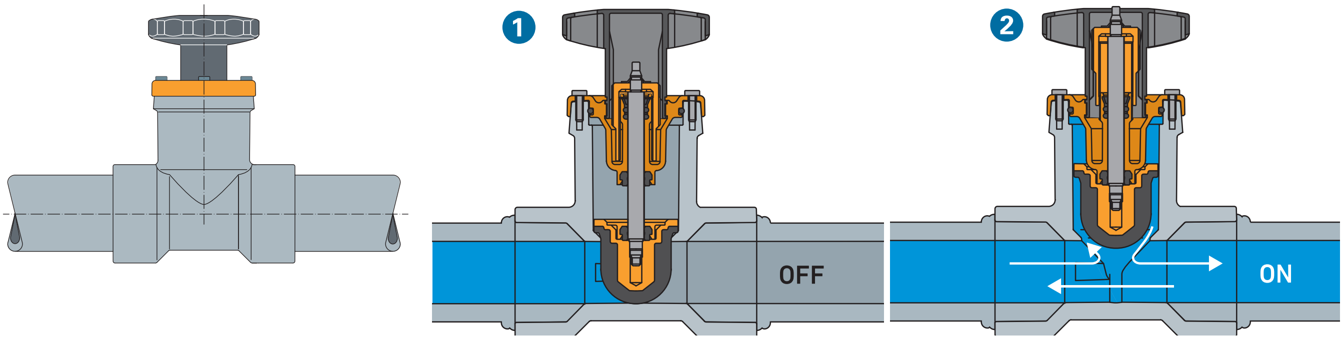
2.2.1 PB valve

Design and function

The structure of the valve corresponds in shape and design to a “straight seat valve”, but has a clear passage, similar to a “Y-type valve”. Due to the appropriate design of the valve’s upper part, an operation with handwheel or the use of a typical commercial UP operation method is possible. UP actuation units from other manufacturers (Grohe, Hansa and others) can be used.

TV.3 **PB valve with handwheel operation (d20 – d32)**

PB valve



Certificate number: DIBT-Berlin PA-IX 7010/I	1 closed 2 open

The design of the valve is based on the concept of a slide valve with direct sealing of the poppet inside the valve’s body. As a result, any medium flow direction is feasible.
Full opening of the flow cross-section, without the valve stem lifting, guarantees the character of a free-flow valve. Flow rates up to a maximum of 5 m/s (according to DVGW DIN 1988) are therefore permissible.
The valve actuation, which moves 90° to the direction of flow, makes it possible to use it as a balancing shut-off valve or as an UP (concealed) valve. In both cases, the upper part is interchangeable.
Fittings with drains are designed with ¼“ threads on both sides so that standard drain valves can be used. The discharge spout of the drain valve can always be rotated in the desired direction, regardless of the installation situation.

Gaskets

The gaskets are made of ethylene-propylene-diene rubber (EPDM) and comply with the KTW recommendations (plastics in drinking water) and can be used at a constant operating temperature of 90°C. A short-term overlap of up to 110°C is possible.

Noise behaviour

The INSTAFLEX valve is compliant with DIN 52218. It therefore is categorised as a low-noise fitting and is assigned to the **Fitting noise group I**.

L_{AG} < 20 dB (A)

TV.4 **Values K_v 100**

Dimension d	20	25	32	40	50	63
K_v 100 [m^3/h]	25.3	25.3	25.3	77.5	77.5	77.5

TV.5 **Zeta values**

Dimension d	20	25	32	40	50	63
ζ value	0.4	0.4	0.4	0.3	0.3	0.3

Installation

- no restriction of the installation method, either concealed or flush-mounted
  - Installation vertical and horizontal possible, upper parts can be installed hanging or standing
- The direction of flow can be arbitrary
- Pipes, distributors and fittings can be directly welded in

Assembly and replacement of PB valves
Instructions for the assembly and replacement:
➨ Chapter [9.6] 'Assembly of PB valves (d20 – d63)'

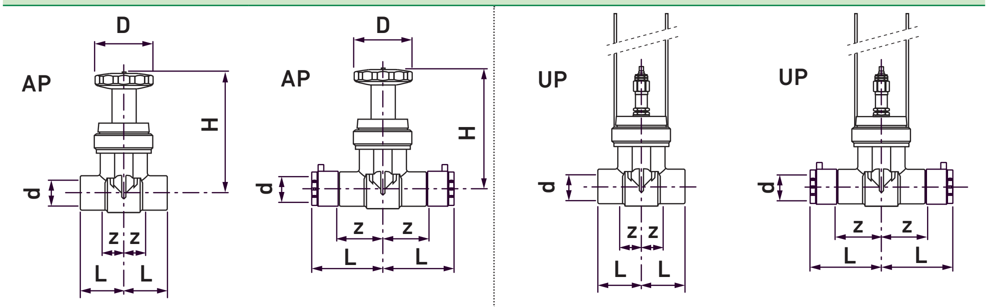
AP	UP	d [mm]	H [mm]	L [mm]	z [mm]	D [mm]
x	x	20	112	40	25	55
x	x	25	112	40	22	55
x	x	32	112	43	23	55
x	–	40	165	55	33	90
x	–	50	165	60	35	90
x	–	63	165	75	47	90

TV.6
Assembly dimensions
AP flush-mounted
UP concealed

AP	UP	d [mm]	H [mm]	L [mm]	z [mm]	D [mm]
x	x	20	112	86	47	55
x	x	25	112	89	47	55
x	x	32	112	94	52	55
x	–	40	165	112	65	90
x	–	50	165	120	71	90
x	–	63	165	141	90	90

TV.7
Assembly dimensions
AP flush-mounted
UP concealed

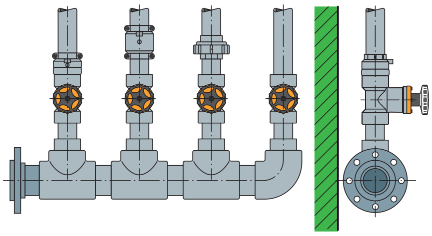
AP	UP



2.2.2 Shut-off valves – Application examples

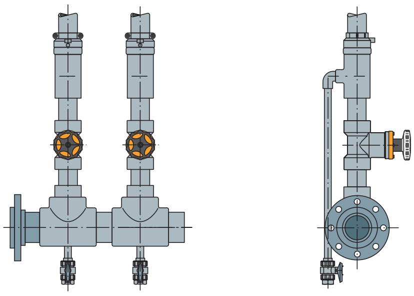
PB valves for basement distributors

Basement distribution group up to d63



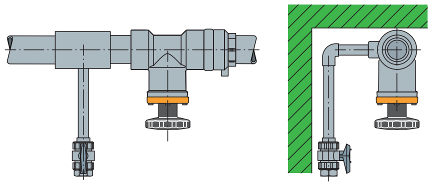
- with drain and different pipe connections

Basement distribution group without drain



- Drainage is designed as separate outlet.

Balancing shut-off valve without drain



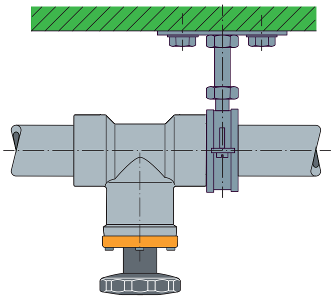
- Drainage is designed as separate outlet.
- Application with continuous thermal insulation

PB valves used as balancing shut-off valves

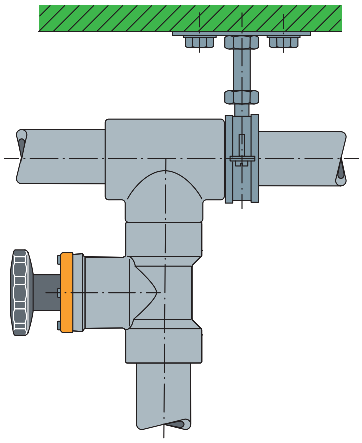
When attaching the valve, it must be ensured that the forces occurring when the valve is activated are not be transmitted into the pipeline. The forces must be absorbed by the attachment. Therefore, it is recommended to use a **double-sided attachment with two pipe clips**. This way, the valve can also be used as a **fixed point**.

☑ Attachment using commercially available pipe clips.

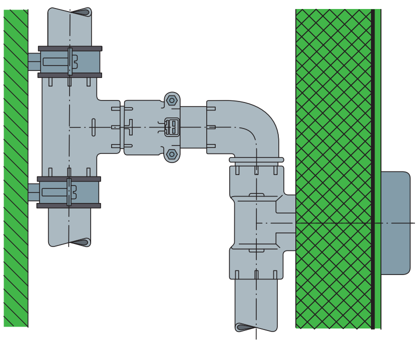
Balancing valve, horizontal installation



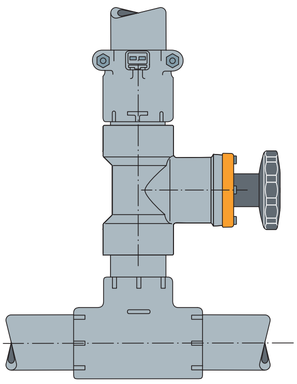
Balancing valve, vertical installation



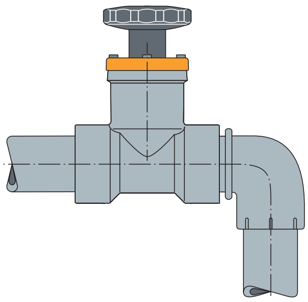
Balancing valve installed in riser pipe discharge (UP assembly incl. attachment)



Balancing valve with HWS transition (e.g. when using riser pipes)



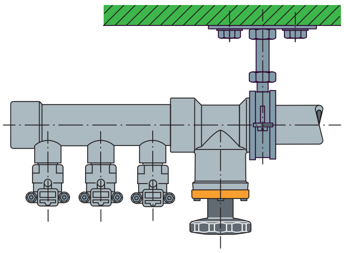
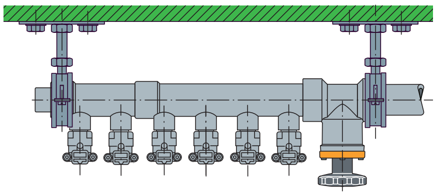
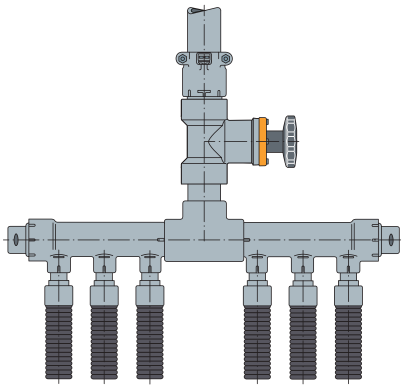
Balancing valve with welded in fitting



V

PB valves arranged with PB distributor (d25/d32)

When used with a distributor, the placement of the attachment depends on the number of distributor outlets. When using a short distributor pipe with up to 3 distributor outlets, an attachment to the valve is sufficient. However, if several outlets are part of the distributor pipe, a separate attachment of the distributor becomes necessary.

PB valve with distributor in the duct pipe shaft	PB valve with multiple distributors	PB valve with handwheel HWS transition, double distributor
		

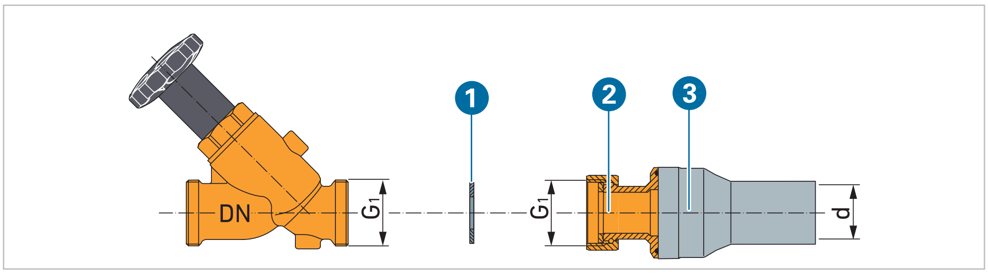
2.3 Adaptor unions

2.3.1 Adaptor union for valves

Distribution valves, shut-off valves, return flow inhibitors, safety groups made of metal with male thread for pipe fittings (G) can be permanently sealed with the **INSTAFLEX adaptor union**. However, the external threads for metal pipe fittings deviate from the male threads for plastic pipe fittings by **one** thread dimension.

Example
Threaded connection: DN25
Transition: Metal 1" onto G1½" thread
Transition: Plastic (PB) d32 onto G 2" thread

The dimensional jump occurring in the screw thread (G) depends on the different mechanical strength of the materials (metal/plastic). The INSTAFLEX valve adaptor union consist of a **PB flange adaptor** with groove and O-ring, a **brass coupling nut** and a **brass intermediate ring** (nickel-plated). Thus, the design essentially corresponds to an INSTAFLEX adaptor union. The intermediate ring serves to bridge the diameter of the different screw threads (G_1–G). The other two parts are needed for the socket welding with gasket. The dimensions are adapted to the standard Y-type valves and distribution valves as well as safety fittings. If the thread combinations do not match (**G_1**) pipe (**d**), this may be compensated for by welding in reductions.



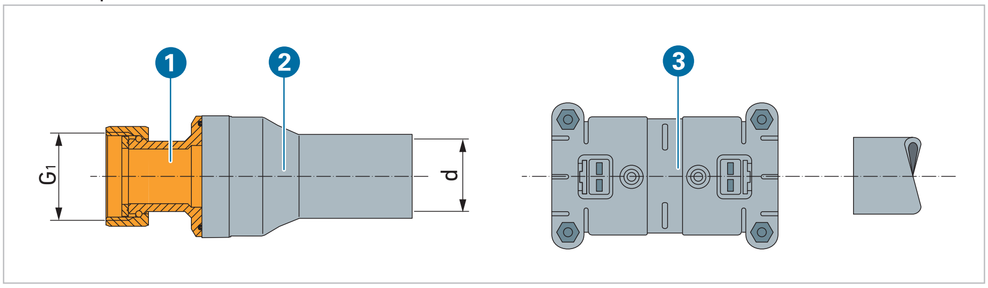
GV.4
Adaptor union
1. Intermediate ring
2. Coupling nut
3. PB flange adaptor (system adaptor)

TV.8 **The technical data of the valve adaptor union**

DN	12	15	15	20	20	20	25	25	25	32	32	32	40	40	50	50
D	16	20	20	25	25	25	32	32	32	40	40	40	50	50	63	63
G_1	¾″	¾″	1″	¾″	1″	1¼″	1″	1¼″	1½″	1¼″	1½″	2″	1¾″	2¼″	2⅜″	2¾″

Adaptor union for electrofusion welding

The adaptor union for electrofusion welding (HWS) allows easy assembly with little effort and without special tools.



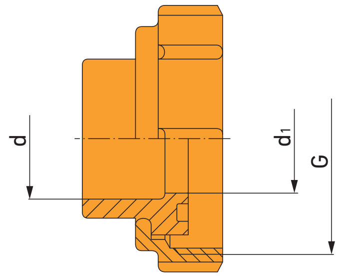
GV.5
Adaptor union for electrofusion welding (HWS)
1. Coupling nut
2. System adaptor
3. HWS socket

Special applications

If special applications are required (see also the applications below), the brass coupling nut with the PB flange adaptor can also be used as a direct connection.

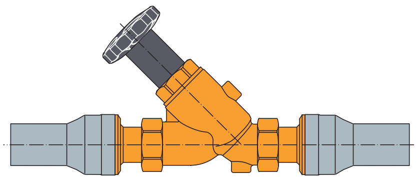
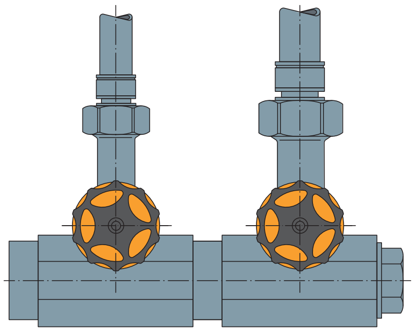
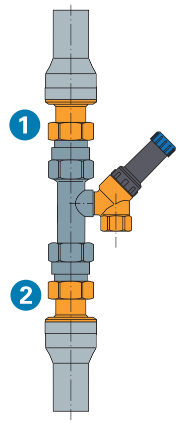
TV.9
Technical data
Brass coupling nut

d	16	20	25	32	40	50	63
D	1″	1¼″	1½″	2″	2½"	2¾″	3¼"
d_1	13	16	21	28	36	45	57

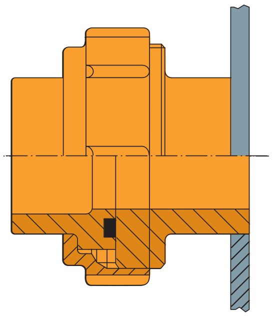
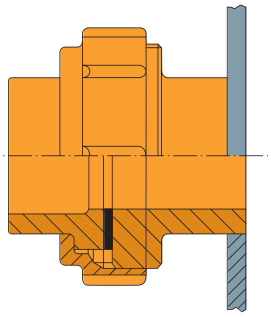


Applications

There are various connection options.

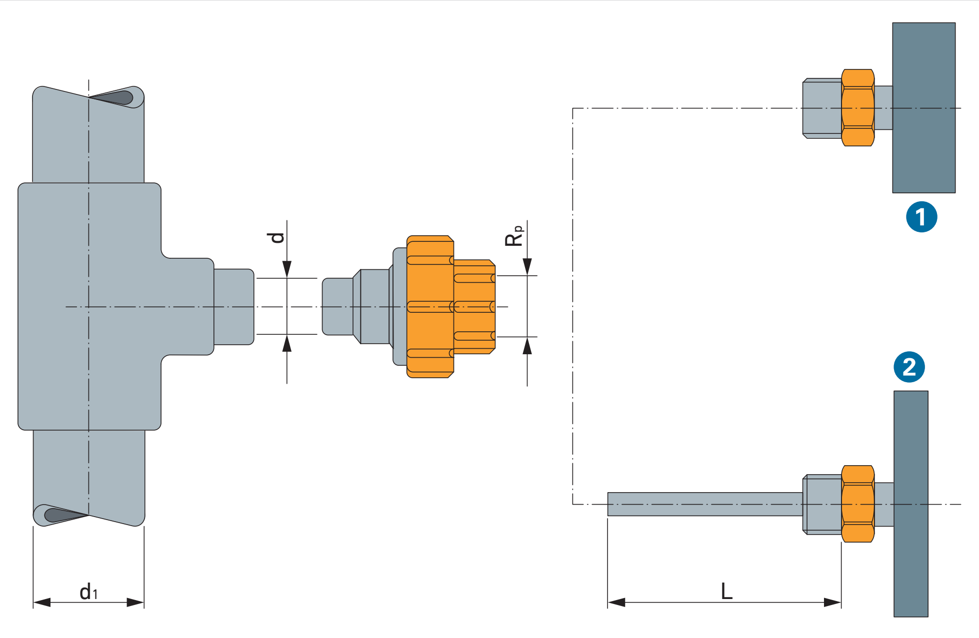
How to connect a Y-type valve	How to connect distribution valves	How to connect a safety group
• with two valve adaptor unions	• with valve adaptor union	• with valve adaptor union and adaptor union with $R_p$thread
		
	Changes in diameter can be achieved by adding welded reductions.	Example: 1 d25 – G 11/4" 2 d25 – R_p 3/4"

Direct connections

with coupling nut and flange adaptor with groove and O-ring	with coupling nut and flange adaptor without groove and with flat gasket
	
• for container connections etc. ☑ Ensure the O-ring seal of the flange adaptor seals the entire area.	• for connections to containers and fittings (filter, DRV etc.). ☑ Use only for cold water installations ☑ Use a soft rubber seal ☑ This connection is **not** subject to compliance with the INSTAFLEX system. Therefore, the connection is **not** tested and is **not** permitted.

2.3.2 Adaptor union for pressure gauge and thermometer

The adaptor union allows for the safe installation of thermometer and pressure gauges into the piping system.



GV.6
Adaptor union
1 Pressure gauge
2 Thermometer

The length of the immersion sleeve **L** depends on the dimension of the pipeline. The diameter of the immersion sleeve **d** must not exceed max. 12 mm.

TV.10
Length of the immersion sleeve, connection of the screw connection

Pipe, Dimension d_1	Immersion sleeve L [mm]	Connection R_p
25	≈70	½"
32	≈70 – 80	¾"
40	≈90 – 110	1"
50	≈100 – 120	–
63	≈110 – 140	–
75	≈150 – 190	–
90	≈170 – 210	–
110	≈180 – 240	–

V

2.3.3 Adaptor union for water meters

When determining the proportionate consumption of water, there is a duty to record this for each consumer individually. Water meters are therefore indispensable instruments for consumer-friendly cost accounting.

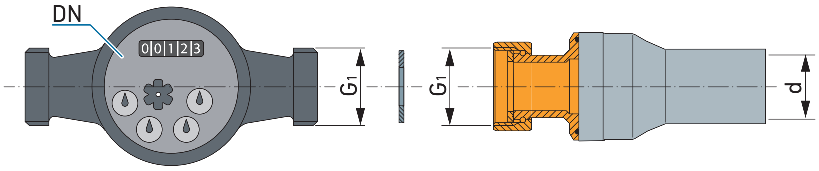
The INSTAFLEX water meter fitting is the ideal link between commercial water meters and the INSTAFLEX shut-off valve or distributor.

Adaptor union for electrofusion welding (HWS)

TV.11
Technical data on adaptor unions for electrofusion welding

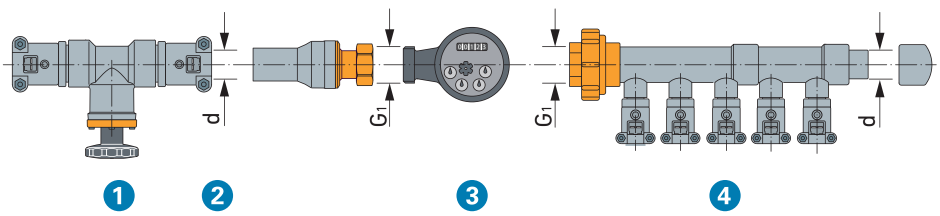
DN	G_1
15	¾
20	1
20	1

G_1	d
¾	25
1	25
1	32



Application

The adaptor union has a flat sealing thread on one side and a PB flange adaptor (socket) on the other side. The existing threaded connections with different dimensions allow for a variety of combinations.



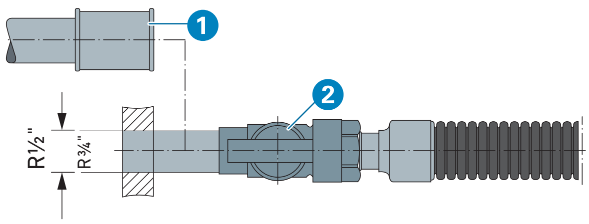
GV.7
Preassembled unit

1. PB valve
2. HWS transitions
3. Water meter
4. PB distributor

2.3.4 Transition with shut-off for metal valves

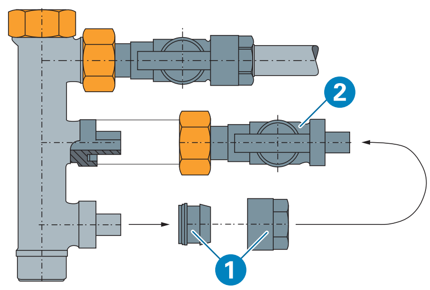
The core of the transitions with older type of shut-offs is the integrated ball valve.
Due to the different design of the transition ends, the parts are versatile.

Transition with male thread
- for connections to pipelines and fittings with internal threads.



1. Transition
2. Ball valve

Transition to the clamp connection
- for attachments to INSTAFLEX clamp connections (e.g. distributor).



1. existing clamp connection
2. Ball valve

→ Release the transition nut and clamping ring from the clamp connection and place both onto the transition.
→ Screw the transition with gasket onto the applicable clamp connection.

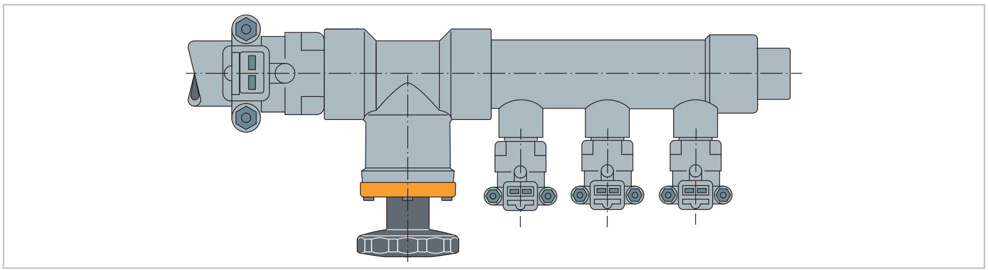
2.4 Drain pipes

☑ Attach the drain valve so, when activated, it cannot damage the associated polybutene line.
☑ Always use a pipe clip to attach the drain valves.

2.5 Prefabrication of distribution valve groups

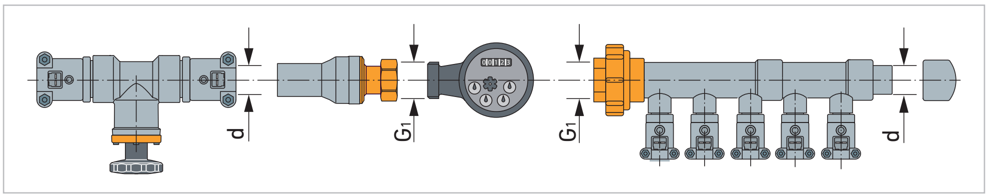
Distributor inside a flat

Variant 1
A distributor inside a flat consists of an INSTAFLEX valve with a HWS transition and a multiple distributor with HWS transitions.



GV.8
PB valve with HWS transition and multiple distributors with HWS transitions

Variant 2
A second variant consists of an INSTAFLEX valve with water meter installed flush to the wall and a multiple distributor. The transitions are made with water meter screw connections.



GV.9
Distribution with decentralised hot water supply
e.g. in a flat with an instantaneous water heaters

2.6 DHW heater

2.6.1 How to connect a DHW heater

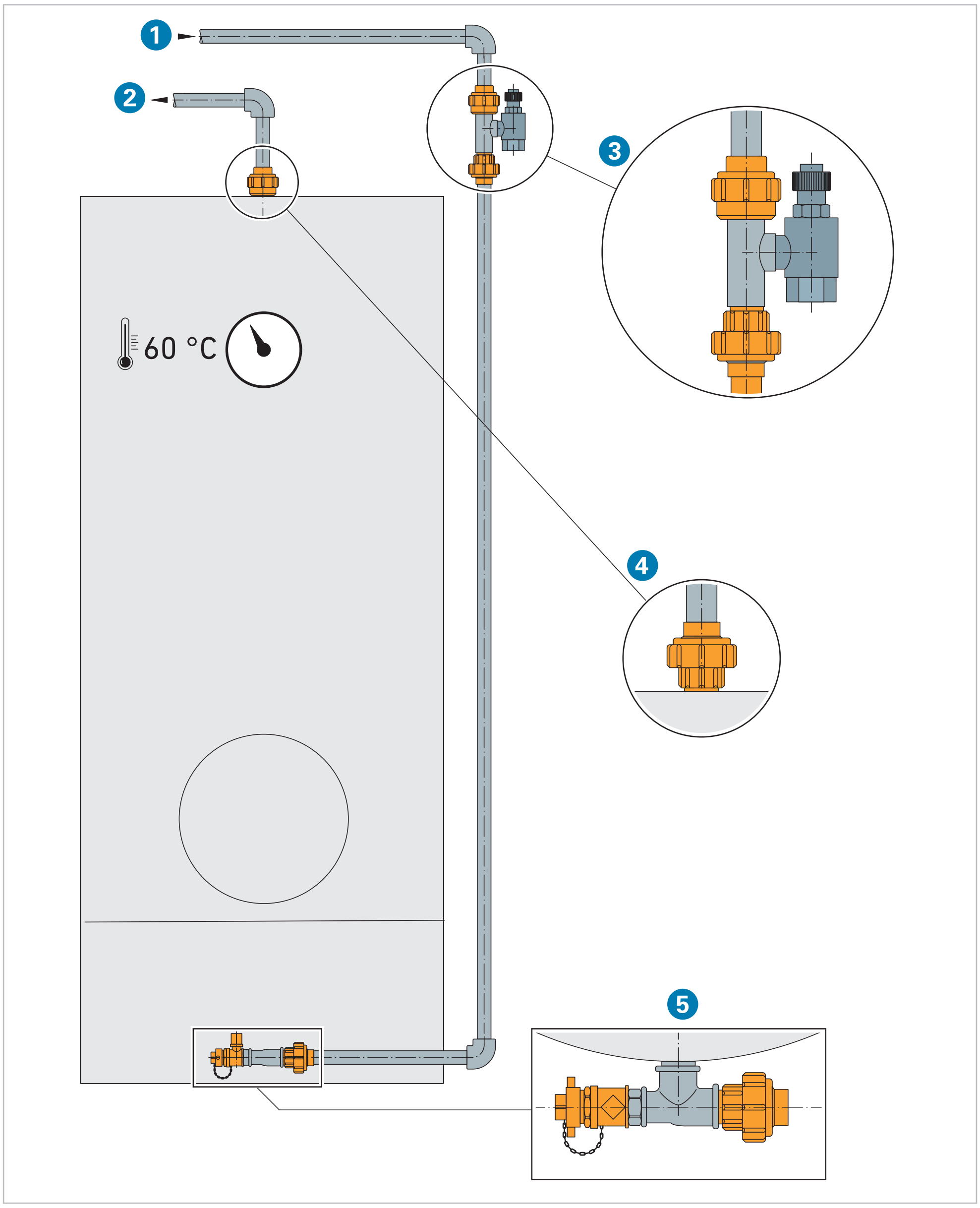
Functionally designed and user-friendly connection elements facilitate the connection to DHW heaters.

Depending on the design, the **safety group** is connected with a valve or a PB adaptor union.

Preferably, a non-ferrous metal tee is installed at the **cold water inlet** of the DHW heater. Thus, the drain cock can be screwed directly. The PB supply line is connected via a PB adaptor union with male thread.

A PB adaptor union with female thread is used to connect the **hot water outlet** of the DHW heaters and the **circulation pipe** to the DHW heater.

The adaptor unions provide quick, easy and safe connection to DHW heaters and appliances.



GV.10
How to connect a DHW heater

1. Cold water supply
2. Hot water discharge
3. Safety group
4. DHW heater outlet/ circulation connection
5. DHW heater inlet

2.7 Fittings for welded connections

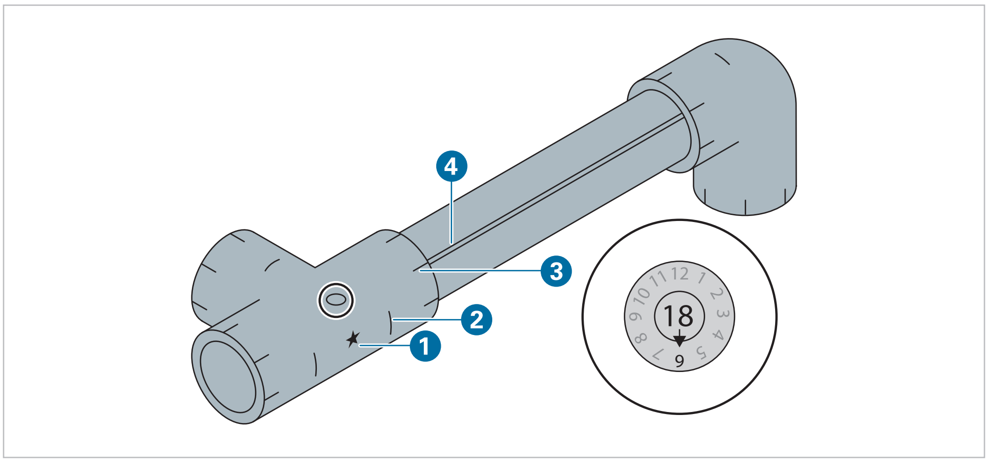
2.7.1 Fittings for socket fusion welding (HMS)

The design of the fitting makes working with the INSTAFLEX installation system fast and economical.

- Graduation
- Marking of the insertion depth
- Product identification
- Longitudinal marking of the pipe

Degree graduation and **longitudinal marking of the pipe** facilitate the addition of component combinations. A time-consuming marking of fitting and pipe is eliminated, the markings allow a more precise work.

The **marking of the insertion depth** on the pipe prevents the formation of an internal bead in the fusion zone when using the proper fusion process. The marking can be applied to the **z dimension** MBT 140 DE during installation.



GV.11
Markings on the pipe

1. Indication of dimension, material, production code
2. Insertion depth marking (welding length)
3. Degree marking (every 45°) for component combinations
4. Longitudinal marking of the pipe

2.7.2 Fittings for electrofusion welding (HWS)

The fittings used for electrofusion consists of a complete assortment of fitting dimensions from d16 to d110 (equal tees, reduced tees, 90° elbows, 45° elbows, reducers, sockets and flange adaptors) and valves from d20 to d63 and distributors.

The HWS fittings are designed so that each pipe connection must be welded separately. An integrated locking device, a coded plug connection, a degree marking as well as visual fusion indication and insertion depth marking allow for individual work depending on construction progress or prefabrication phase.

During the development of the HWS socket for INSTAFLEX, the specific conditions of piping system construction in building technology were considered:

- no separate holding devices
- preferably, processing the ends of the pipes should be avoided
- no axial displacement of the pipes during assembly
- simple, functionally reliable and secure connection of the welding cables
- clearly visible marking and fusion indication
- easy transition from electrofusion to socket fusion welding and threads

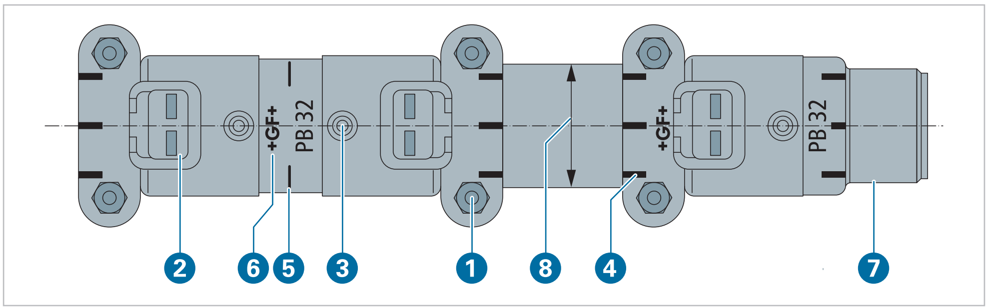
The welding pressure required for welding is achieved by the co-ordinated INSTAFLEX pipes and the special INSTAFLEX fittings for electrofusion welding.

NOTE! Damage to the installation due to incorrect use.

→ Do **not** use the HWS socket to compensate for the length

→ Insert both pipe ends into the socket as far as they will go.

Features



GV.12
INSTAFLEX fittings for electro-fusion welding

1. Integrated pipe attachment
2. Coded plug connection for the welding cable
3. Visual fusion indication
4. Degree marking (every 45°) for component combinations
5. Marking of the insertion depth
6. Indication of dimension, material, production code
7. Spigot for heating element socket fusion welding
8. Inner diameter of the fitting, designed as a sliding sleeve

Integrated pipe attachment

Due to the pipe attachment integrated into the fitting, additional holding devices can be omitted during the welding process.
Primarily in poorly accessible places of the pipeline (obstructing heating pipes, ventilation ducts), and especially in the restauration area, omitting holding devices due to the integrated pipe attachment is a decisive advantage.

3 Tools

When processing INSTAFLEX components, special tools are used depending on the pipe dimension and connection technology.

☑ Compliance with the tool's operating instruction is mandatory.

⚠ **Material damage and risk of injury when using unsuitable tools or non-original spare parts.**

→ Only use tools available from the current product range.
→ Tools must be used compliant with the operating instructions.
→ Only use replacement parts from the current product range.

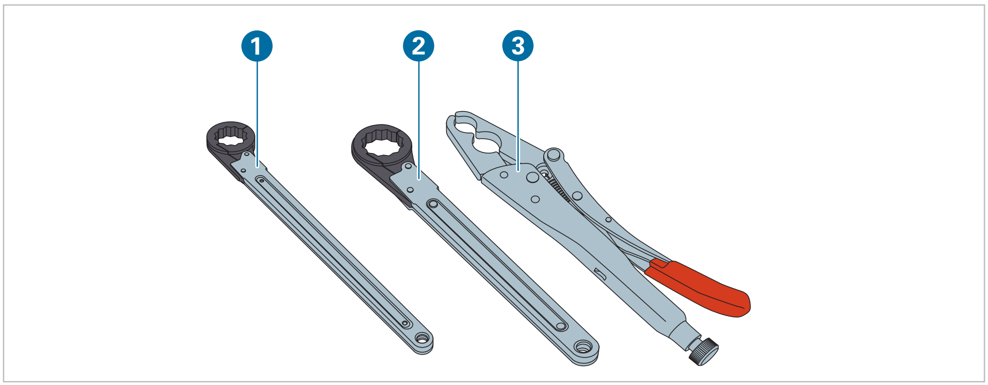
Care, testing and maintenance of tools

A flawlessly functioning tool is a basic prerequisite for a permanently sealed connection.

⚠ **Risk of injury and material damage due to poor care, incorrect testing and faulty maintenance!**

→ Tools must be maintained as specified in the operating instructions and their operation must be inspected regularly (at least once a year).

3.1 Clamp connections (d16 – d110)



GV.13
Tools

1. Ratchet key d16
2. Ratchet key d20
3. Circlip pliers (d16 – d25)

3.2 Welded connections

INSTAFLEX welding tools are designed specifically for the INSTAFLEX pipeline system. This specification of the tools offers decisive advantages in the areas of pipe support, heating element and stop system, which are important for a plastic-compatible, functionally reliable and economical welding connection.

Renting equipment
Fusion jointing machines can also be rented from GF.
Contact the sales representative working with your sales company.

3.2.1 Socket fusion welding (HMS) (d16 – d110)

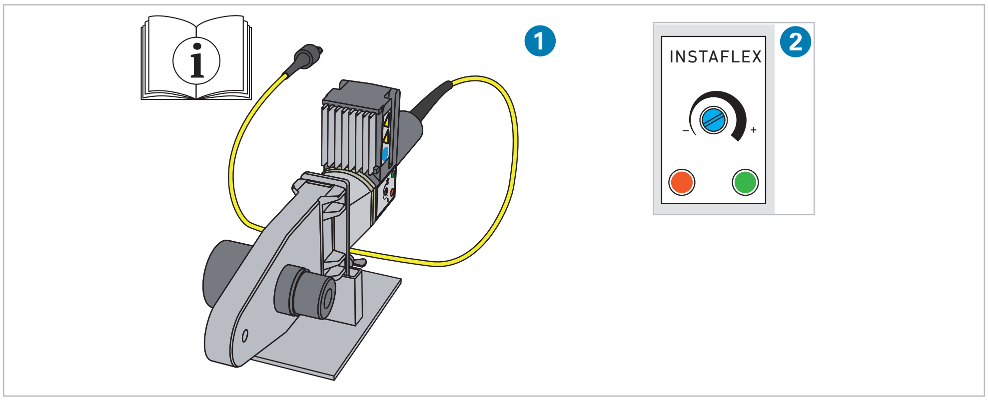
Socket fusion welding is a process for producing secure, firmly bonded pipe connections in the dimensions d16 to d110. For information on the safe handling of the tools, refer to the INSTAFLEX socket fusion welding instructions for polybutylene (PB) fittings and pipes, available upon request.

Material damage and risk of injury when using unsuitable tools and if handling the tools incorrectly.
→ Only use tools available from the current product range.
→ Tools must be used compliant with the operating instructions.

Fusion parameters
Information about the fusion parameters and the sequence of welding:
➨ Chapter [9.3] 'Socket fusion welding (HMS)'

Heating element (HSG)

The rated power of the heating element is 800 W and is electrically heated (220 V / 50 Hz). The electronic temperature control ensures constant temperatures at the heating tools. The temperature can be readjusted via a control screw. The red and the green indicator lights signal the operation of the unit.

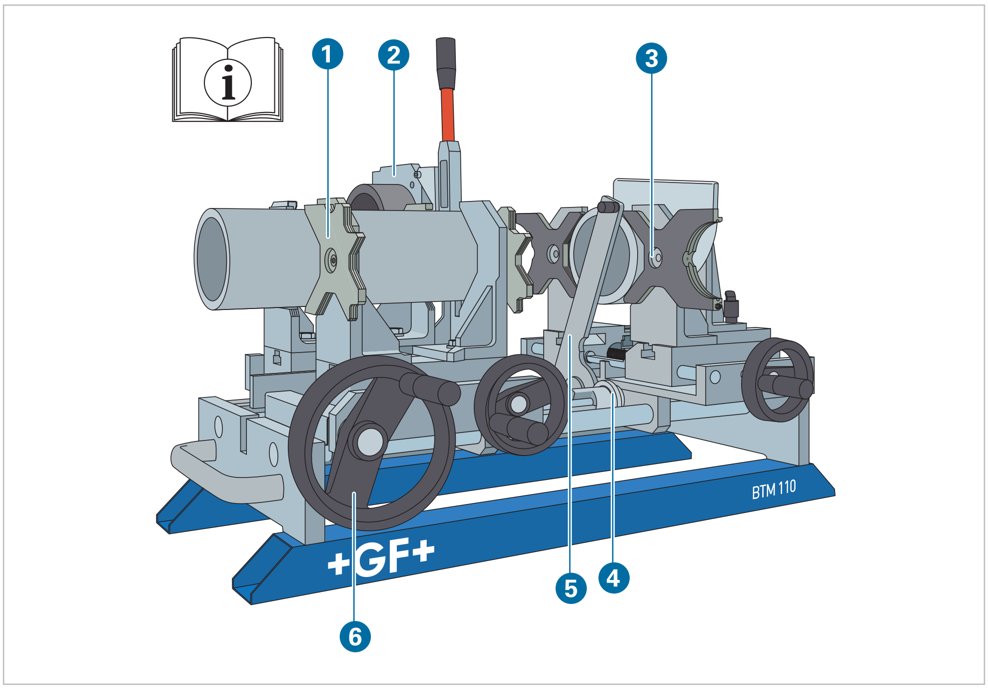


GV.14
Heating element (HSG)
1 Heating element
2 Control panel with temperature control screw and indicator lights

Socket fusion machine (BTM 110)

The use of the socket fusion machine proves to be particularly advantageous during the INSTAFLEX prefabrication process and when using larger diameters.

The electrical functions and values are identical to those of the heating element and the rated power is also 800 W. Easy handling and a special fitting support for low-voltage welding make the machine a valuable tool during the processing.



GV.15
Socket fusion machine BTM 110 (d16 – d110)

1. Clamping fixture for pipes and fittings d16 – d110
2. Support for handheld heating element
3. Circular clamping device for fittings up to d110
4. Stop button for basic setting
5. Rotary knob for stop system
6. Handwheel for moving the carriages

3.2.2 Electrofusion (HWS) (d16 – d110, d125 – d225)

Electrofusion is one of the two methods for producing secure, firmly bonded pipe connections in sanitary installations. GF offers two specially suitable welding devices for this purpose.

Material damage and risk of injury when using unsuitable tools and if handling the tools incorrectly.

→ Only use tools available from the current product range.

→ Tools must be used compliant with the operating instructions.

How to operate the units

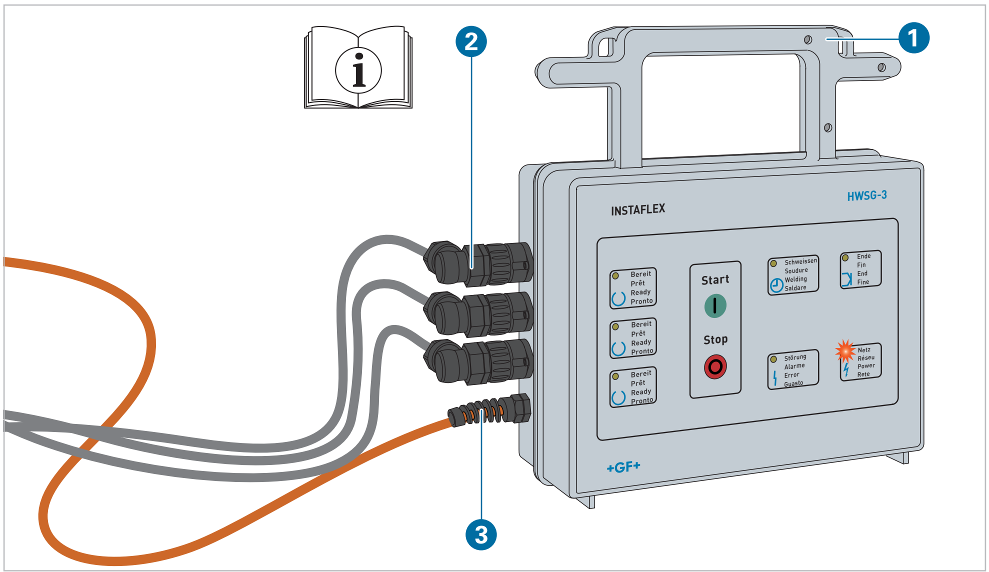
Information on the safe handling and technical data can be found in the operating instructions for the devices.

Fusion parameters

Information about the fusion parameters and the sequence of welding:

➨ Chapter [9.4] 'Electrofusion welding (HWS)'

Fusion device HWSG-3 (d16 – d110)



GV.16
Fusion device HWSG-3

Pipe dimensions d16 – d110

1. Device handle
2. Power cable
3. Welding cable

The HWSG-3 is specially designed for welding the INSTAFLEX HWS fittings with the PB pipe of dimensions d16 to d110. The HSWG-3 permanently checks the parameters during the fusion process. In case of deviations, the welding process is interrupted and the indicator light flashes.

Features and functions

- Recognition of the connected fitting type and dimension through integrated coding
- Fully automatic fusion steps. Errors due to incorrect setting of parameters are thus excluded.
- Acoustic and visual signalling of the beginning and end of the fusion steps
- Display of faults in the fusion steps
- Simultaneous welding of 3 different dimensions

Welding channels

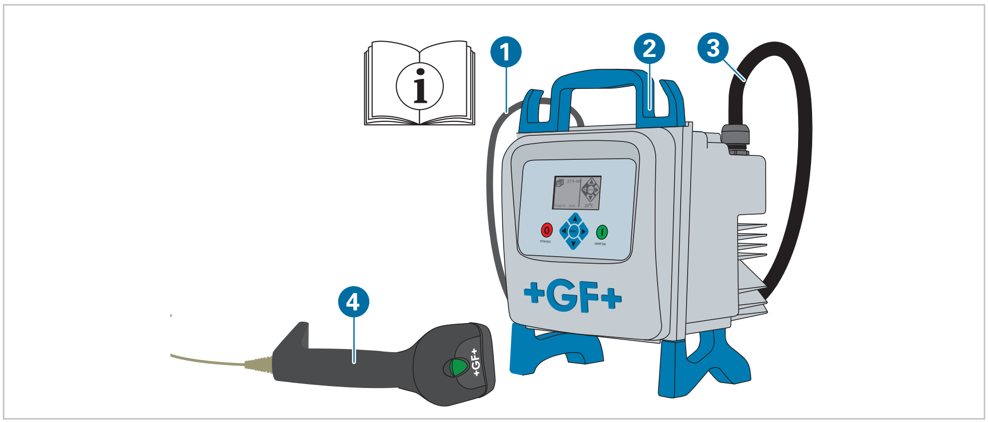
Each connected welding channel independently recognises the connected part and its dimension. Up to three welds in different dimensions can be executed simultaneously. Welding channels that are not connected are blocked during the welding process (de-energized).

Connection of the fitting

The coding in the plug section of each HWS fitting indicates the connected part and its dimension to the fusion device.

Fusiondevice MSA 2 MULTI (d125 – d225)

The fusion device MSA 2 MULTI is suitable for pipe dimensions from d125 upwards.



GV.17
HWS fusion device MSA 2 MULTI

Pipe dimensions d125 – d225
1 Device handle
2 Welding cable
3 Power cable
4 Bar code scanner

Features and functions

The MSA 2 MULTI combines light weight with maximum performance. The MSA 2 MULTI allows processing pipe materials such as PE, PP, INSTAFLEX PB among other things.
The bar code scanner makes working easier, as does the intuitive display, which guides the user safely through all work steps. Up to 500 welding processes can be stored in the device and transferred to a USB stick in PDF format.
The device can be used at ambient temperatures of -20 to 50°C, it is dust-proof and protected against water jets (IP 65).

3.2.3 Butt fusion (d125 – d315)

Butt fusion welding is one of the processes for making secure, firmly bonded pipe connections in sanitary installations for PB pipes of dimension d125 to d315. Depending on the butt fusion machine used, the fusion parameters must be adapted to the respective machine.

Material damage and risk of injury when using unsuitable tools and if handling the tools incorrectly.
→ Only use tools available from the current product range.
→ Tools must be used compliant with the operating instructions.

How to operate the units
Information on the safe handling can be found in the operating instructions for the devices.

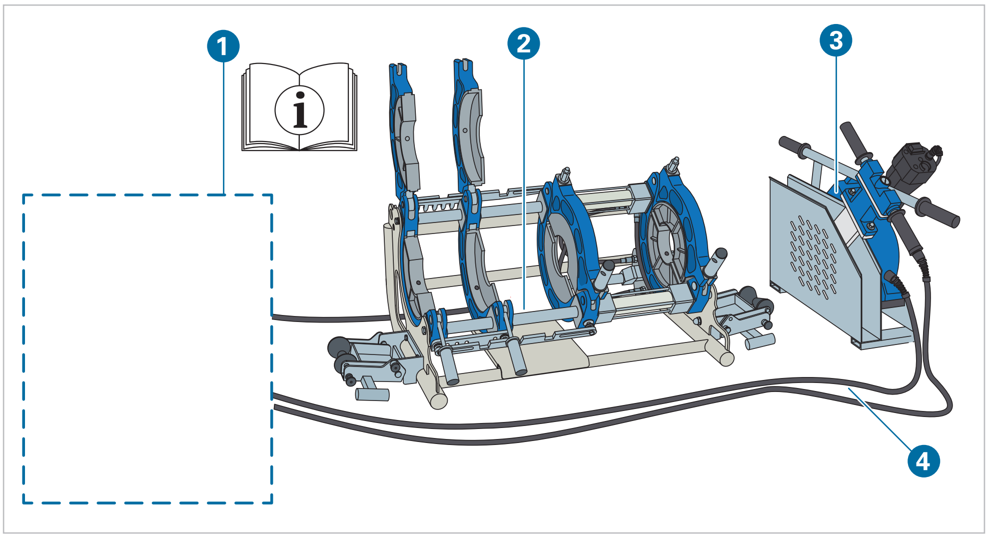
Fusion parameters
Information about the fusion parameters and the sequence of welding:
➨ Chapter [9.5] 'Butt fusion welding'

Butt fusion machines TOP 250 and TOP 400

The socket fusion machines TOP 250 and TOP 400 are suitable for welding plastic pipes, fittings and other equipment. For the dimension d315 we recommend the TOP 400 with special clamping jaws.

- TOP 250: Dimensions d125 to d225
- TOP 400: Dimension d315

Butt fusion machines
Other commercially available butt fusion machines are also approved and if they comply with the fusion parameters, (➨ Chap. [9.5] 'Butt fusion welding') they can be used.



GV.18
Butt fusion machine

1. manual control; depending on the type, if necessary also hydraulic unit
2. Clamping and sliding unit
3. Box with heating element and planer
4. Hydraulic hoses

4 Dimensioning

Simplified calculation method
Basic information, examples and sample tables for simplified calculation:
➨ Part IV 'Plan', Section 'Drinking water installation'

The product-specific data for the simplified calculation and the calculation method are available in this chapter.

4.1 Loading units

➕ **The loading unit (LU – previously abbreviated BW) designates the flow rate provided at the connection point upstream of the tap as a function of the intended use and the duration of use. The loading unit does not correspond to the withdrawal flow from the respective product specification.**

A loading unit LU is equal to a flow of 0.1 l/s.

4.1.1 Controls and instruments and equipment

GV.19
Loading units according to intended purpose

Usage Connections DN15 (½")	Volumetric flow rate Q_A per connection		LU per connection
	[l/s]	[l/min]	
Wash-hand basin, washing trough, vanity unit, bidet, cistern, vending machine, hairdresser, household dishwasher	0.1	6	1
Sink, utility sink, taps for balcony and terrace, washing trough, shower, standing and wall spout, household washing machine	0.2	12	2
Urinal flushing (automatic), Bathtub	0.3	18	3
Tap for the garden or garage	0.5	30	5

Source: SVGW Guidelines W3, Edition 2013

4.1.2 Pipes

GV.20
Load values for INSTAFLEX pipes

Designation	Dimension						
Total loading units LU	3	4	5	8	25	55	180
Largest single value LU	–	–	4	5	–	–	–
d_a × s [mm]		16 × 2.2		20 × 2.8	25 × 2.3	32 × 2.9	40 × 3.7
d_i [mm]		11.6		14.4	20.4	26.2	32.6
Length of pipeline, recommended [m]	9	5	4	–	–	–	–
Controls and instruments		½"		½"	¾"	1"	1¼"

Pressure losses and discharge times

If using tee installations:
→ Calculate the discharge times and pressure losses.

For systems with individual tap locations:
→ Never exceed a maximum cable length of 12 m.

V

4.2 Pressure losses for pipes

4.2.1 The basics

GV.21
Flow velocities

Designation	Value
Discharge pipeline	max. 4.0 m/s
Groups of equipment	max. 3.0 m/s
Pipelines on individual floor levels	max. 3.0 m/s
Distribution pipelines	max. 2.0 m/s

* recommended (acc. to SVGW Guideline W3/2013)

4.2.2 Pressure losses for pipes

A loading unit LU is equal to a flow of 0.1 l/s.

TV.12 **Pressure loss in INSTAFLEX pipes**

LU 1 up to LU 5

Pipe, Dimension		Pressure loss [hPa/m pipe (= mbar/m)]				
	LU	1	2	3	4	5
	[l/s]	0.1	0.2	0.3	0.4	0.5
d16		12,8	43,5	89,9	151,3	–
d20		4,6	15,4	31,6	52,9	79,1
d25		–	–	–	9,9	14,7
d32		–	–	–	–	4,5
d40		–	–	–	–	–

4.2.3 Pressure loss at 10°C

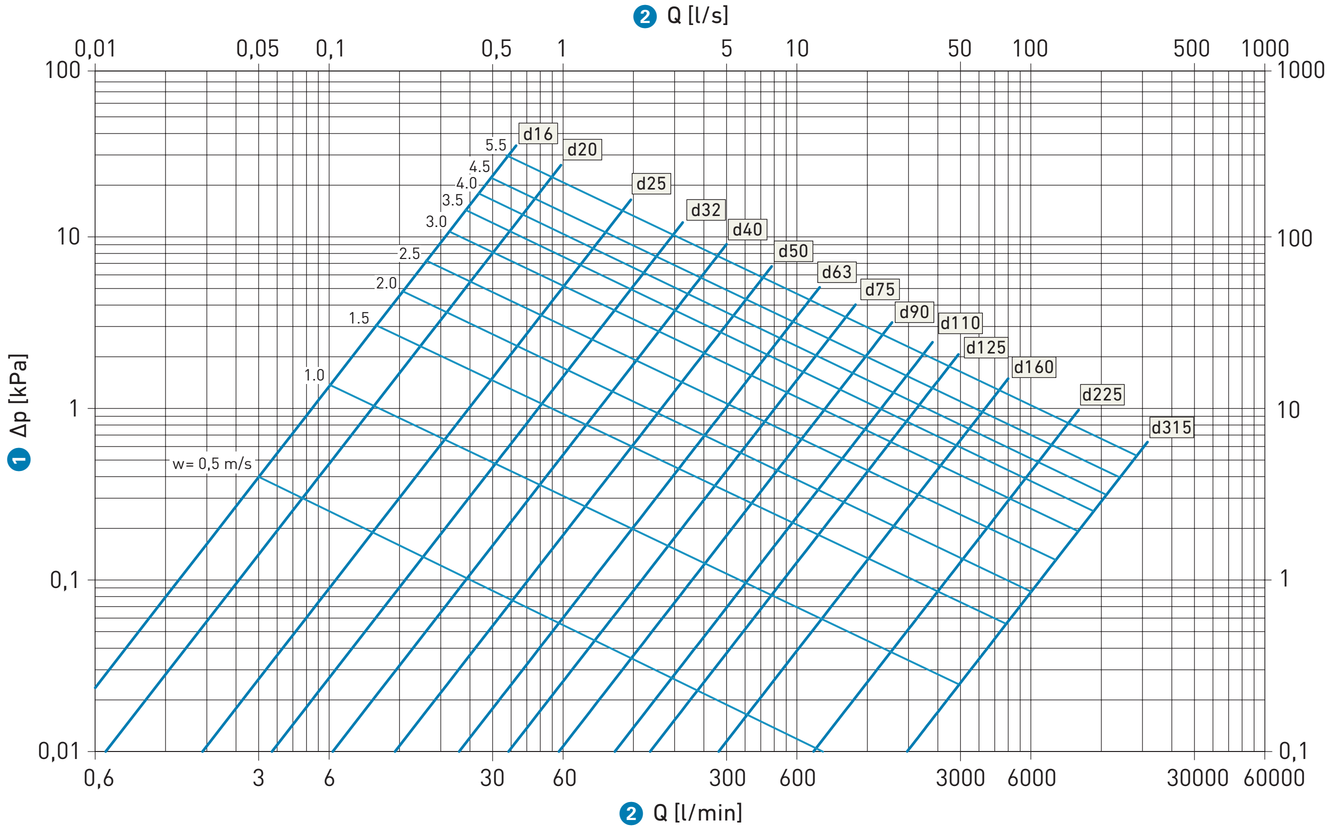
The basics

Designation	Value
Dimension	d16 – d315
Density ρ (water)	999.70 kg/m³
Water temperature	10°C
Surface roughness k (inner pipe)	0.007 mm
Viscosity	0.00131 Pa · s

GV.22
Design fundamentals

Pipe friction pressure drop as a function of the volumetric flow

The diagram and the tables show the pipe friction pressure drop R and the calculated flow velocity v as a function of the volumetric flow Q.



1 Pressure loss
2 Volumetric flow rate

V

Pressure loses at 10°C/Part 1: d16 – d63

TV.13 **Pipe friction pressure loses, flow velocity, peak flow (Part 1: d16 – d63)**

d_1 × s	16 × 2.2		20 × 2.8		25 × 2.3		32 × 2.9		40 × 3.7		50 × 4.6		63 × 5.8	
d_2	11.6		14.4		20.4		26.2		32.6		40.8		51.4	
Q [l/s]	v [m/s]	R [hPa/m]	v m/s	R hPa/m	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
0.01	0.1	0.2	–	–	–	–	–	–	–	–	–	–	–	–
0.02	0.2	0.8	–	–	–	–	–	–	–	–	–	–	–	–
0.03	0.3	1.6	0.2	0.6	–	–	–	–	–	–	–	–	–	–
0.04	0.4	2.7	0.2	1.0	–	–	–	–	–	–	–	–	–	–
0.05	0.5	4.0	0.3	1.4	–	–	–	–	–	–	–	–	–	–
0.06	0.6	5.5	0.4	1.9	–	–	–	–	–	–	–	–	–	–
0.07	0.7	7.2	0.4	2.5	0.2	0.5	–	–	–	–	–	–	–	–
0.08	0.8	9.1	0.5	3.2	0.2	0.6	–	–	–	–	–	–	–	–
0.09	0.9	11.2	0.6	4.0	0.3	0.7	–	–	–	–	–	–	–	–
0.10	1.0	13.7	0.6	4.8	0.3	0.9	–	–	–	–	–	–	–	–
0.15	1.4	27.4	0.9	9.7	0.5	1.8	–	–	–	–	–	–	–	–
0.20	1.9	45.3	1.2	16.1	0.6	3.0	0.4	0.9	–	–	–	–	–	–
0.25	2.4	67.1	1.5	23.8	0.8	4.5	0.5	1.3	–	–	–	–	–	–
0.30	2.8	92.4	1.8	32.7	0.9	6.1	0.6	1.8	–	–	–	–	–	–
0.35	3.3	121.1	2.1	42.9	1.1	8.1	0.6	2.4	–	–	–	–	–	–
0.40	3.8	153.1	2.5	54.2	1.2	10.2	0.7	3.1	0.5	1.1	–	–	–	–
0.45	4.3	188.3	2.8	66.7	1.4	12.5	0.8	3.8	0.5	1.3	–	–	–	–
0.50	4.7	226.6	3.1	80.2	1.5	15.1	0.9	4.5	0.6	1.6	–	–	–	–
0.58	5.2	267.9	3.4	94.9	1.7	17.8	1.0	5.4	0.7	1.9	–	–	–	–
0.60	5.5	294.1	3.6	104.1	1.8	19.6	1.1	5.9	0.7	2.1	–	–	–	–
0.65	–	–	4.0	127.2	2.0	23.9	1.2	7.2	0.8	2.5	–	–	–	–
0.70	–	–	4.3	144.9	2.1	27.2	1.3	8.2	0.8	2.9	0.5	1.0	–	–
0.75	–	–	4.6	163.5	2.3	30.7	1.4	9.2	0.9	3.2	0.6	1.1	–	–
0.80	–	–	4.9	183.1	2.4	34.4	1.5	10.3	1.0	3.6	0.6	1.2	–	–
0.85	–	–	5.2	203.7	2.6	38.3	1.6	11.5	1.0	4.0	0.7	1.4	–	–
0.90	–	–	5.5	225.2	2.8	42.3	1.7	12.7	1.1	4.5	0.7	1.5	–	–
0.95	–	–	–	–	2.9	46.5	1.8	14.0	1.1	4.9	0.7	1.7	–	–
1.00	–	–	–	–	3.1	50.9	1.9	15.3	1.2	5.4	0.8	1.8	–	–
1.10	–	–	–	–	3.4	60.2	2.0	18.1	1.3	6.3	0.8	2.2	0.5	0.7
1.20	–	–	–	–	3.7	70.1	2.2	21.1	1.4	7.4	0.9	2.5	0.6	0.8
1.30	–	–	–	–	4.0	80.7	2.4	24.3	1.6	8.5	1.0	2.9	0.6	1.0
1.40	–	–	–	–	4.3	91.9	2.6	27.6	1.7	9.7	1.1	3.3	0.7	1.1
1.50	–	–	–	–	4.6	103.7	2.8	31.2	1.8	10.9	1.1	3.7	0.7	1.2
1.60	–	–	–	–	4.9	116.2	3.0	34.9	1.9	12.2	1.2	4.2	0.8	1.4
1.70	–	–	–	–	5.2	129.2	3.2	38.9	2.0	13.6	1.3	4.6	0.8	1.5
1.80	–	–	–	–	5.5	142.9	3.3	43.0	2.2	15.0	1.4	5.1	0.9	1.7
1.90	–	–	–	–	–	–	3.5	47.2	2.3	16.5	1.5	5.6	0.9	1.9
2.00	–	–	–	–	–	–	3.7	51.7	2.4	18.1	1.5	6.2	1.0	2.0
2.10	–	–	–	–	–	–	3.9	56.3	2.5	19.7	1.6	6.7	1.0	2.2
2.20	–	–	–	–	–	–	4.1	61.1	2.6	21.4	1.7	7.3	1.1	2.4
2.30	–	–	–	–	–	–	4.3	66.1	2.8	23.1	1.8	7.9	1.1	2.6
2.40	–	–	–	–	–	–	4.5	71.2	2.9	24.9	1.8	8.5	1.2	2.8
2.50	–	–	–	–	–	–	4.6	76.5	3.0	26.8	1.9	9.1	1.2	3.0
2.60	–	–	–	–	–	–	4.8	82.0	3.1	28.7	2.0	9.8	1.3	3.2
2.70	–	–	–	–	–	–	5.0	87.6	3.2	30.7	2.1	10.4	1.3	3.4
2.80	–	–	–	–	–	–	5.2	93.3	3.4	32.7	2.1	11.1	1.3	3.7
2.95	–	–	–	–	–	–	5.5	102.3	3.5	35.8	2.3	12.2	1.4	4.0
3.00	–	–	–	–	–	–	–	–	3.6	36.9	2.3	12.6	1.4	4.1
3.10	–	–	–	–	–	–	–	–	3.7	39.1	2.4	13.3	1.5	4.4
3.20	–	–	–	–	–	–	–	–	3.8	41.3	2.4	14.1	1.5	4.6
3.30	–	–	–	–	–	–	–	–	4.0	43.6	2.5	14.9	1.6	4.9

$d_1 \times s$	16 × 2.2		20 × 2.8		25 × 2.3		32 × 2.9		40 × 3.7		50 × 4.6		63 × 5.8	
d_2	11.6		14.4		20.4		26.2		32.6		40.8		51.4	
Q [l/s]	v [m/s]	R [hPa/m]	v m/s	R hPa/m	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
3.40	–	–	–	–	–	–	–	–	4.1	46.0	2.6	15.7	1.6	5.2
3.50	–	–	–	–	–	–	–	–	4.2	48.4	2.7	16.5	1.7	5.4
3.60	–	–	–	–	–	–	–	–	4.3	50.8	2.8	17.3	1.7	5.7
3.70	–	–	–	–	–	–	–	–	4.4	53.3	2.8	18.2	1.8	6.0
3.80	–	–	–	–	–	–	–	–	4.6	55.9	2.9	19.0	1.8	6.3
3.90	–	–	–	–	–	–	–	–	4.7	58.5	3.0	19.9	1.9	6.6
4.00	–	–	–	–	–	–	–	–	4.8	61.1	3.1	20.8	1.9	6.9
4.25	–	–	–	–	–	–	–	–	5.1	68.0	3.3	23.2	2.0	7.6
4.60	–	–	–	–	–	–	–	–	5.5	78.1	3.5	26.6	2.2	8.8
4.75	–	–	–	–	–	–	–	–	–	–	3.6	28.2	2.3	9.3
5.00	–	–	–	–	–	–	–	–	–	–	3.8	30.8	2.4	10.2
5.25	–	–	–	–	–	–	–	–	–	–	4.0	33.6	2.5	11.1
5.50	–	–	–	–	–	–	–	–	–	–	4.2	36.4	2.7	12.0
5.75	–	–	–	–	–	–	–	–	–	–	4.4	39.4	2.8	13.0
6.00	–	–	–	–	–	–	–	–	–	–	4.6	42.4	2.9	14.0
6.25	–	–	–	–	–	–	–	–	–	–	4.8	45.6	3.0	15.0
6.50	–	–	–	–	–	–	–	–	–	–	5.0	48.8	3.1	16.1
6.75	–	–	–	–	–	–	–	–	–	–	5.2	52.2	3.3	17.2
7.00	–	–	–	–	–	–	–	–	–	–	5.4	55.6	3.4	18.4
7.25	–	–	–	–	–	–	–	–	–	–	5.5	59.2	3.5	19.5
7.50	–	–	–	–	–	–	–	–	–	–	–	–	3.6	20.7
7.75	–	–	–	–	–	–	–	–	–	–	–	–	3.7	21.9
8.00	–	–	–	–	–	–	–	–	–	–	–	–	3.9	23.2
8.25	–	–	–	–	–	–	–	–	–	–	–	–	4.0	24.5
8.50	–	–	–	–	–	–	–	–	–	–	–	–	4.1	25.8
8.75	–	–	–	–	–	–	–	–	–	–	–	–	4.2	27.2
9.00	–	–	–	–	–	–	–	–	–	–	–	–	4.3	28.5
9.25	–	–	–	–	–	–	–	–	–	–	–	–	4.5	29.9
9.50	–	–	–	–	–	–	–	–	–	–	–	–	4.6	31.4
9.75	–	–	–	–	–	–	–	–	–	–	–	–	4.7	32.8
10.00	–	–	–	–	–	–	–	–	–	–	–	–	4.8	34.3
10.25	–	–	–	–	–	–	–	–	–	–	–	–	4.9	35.8
10.50	–	–	–	–	–	–	–	–	–	–	–	–	5.1	37.4
10.75	–	–	–	–	–	–	–	–	–	–	–	–	5.2	39.0
11.00	–	–	–	–	–	–	–	–	–	–	–	–	5.3	40.6
11.50	–	–	–	–	–	–	–	–	–	–	–	–	5.5	43.9

Pressure loses at 10°C/Part 2: d75 – d225

TV.14 **Pipe friction pressure loses, flow velocity, peak flow (Part 2: d75 – d225**

$d_1 \times s$	75 × 6.8		90 × 8.2		110 × 10		125 × 11.4		160 × 14.6		225 × 20.5		315 × 28.6	
d_2	61.4		73.6		90.0		102.2		130.8		184.0		257.8	
Q [l/s]	v [m/s]	R [hPa/m]	v m/s	R hPa/m	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
1.60	0.5	0.6	–	–	–	–	–	–	–	–	–	–	–	–
1.70	0.6	0.7	–	–	–	–	–	–	–	–	–	–	–	–
1.80	0.6	0.7	–	–	–	–	–	–	–	–	–	–	–	–
1.90	0.6	0.8	–	–	–	–	–	–	–	–	–	–	–	–
2.00	0.7	0.9	–	–	–	–	–	–	–	–	–	–	–	–
2.20	0.7	1.0	0.5	0.4	–	–	–	–	–	–	–	–	–	–
2.40	0.8	1.2	0.6	0.5	–	–	–	–	–	–	–	–	–	–
2.60	0.9	1.4	0.6	0.6	–	–	–	–	–	–	–	–	–	–
2.80	0.9	1.6	0.7	0.7	–	–	–	–	–	–	–	–	–	–
3.00	1.0	1.8	0.7	0.7	–	–	–	–	–	–	–	–	–	–
3.20	1.1	2.0	0.8	0.8	–	–	–	–	–	–	–	–	–	–
3.40	1.1	2.2	0.8	0.9	0.5	0.4	–	–	–	–	–	–	–	–
3.60	1.2	2.4	0.8	1.0	0.6	0.4	–	–	–	–	–	–	–	–
3.80	1.3	2.7	0.9	1.1	0.6	0.4	–	–	–	–	–	–	–	–
4.00	1.4	2.9	0.9	1.2	0.6	0.5	–	–	–	–	–	–	–	–
4.50	1.5	3.6	1.1	1.5	0.7	0.6	0.5	0.3	–	–	–	–	–	–
5.00	1.7	4.3	1.2	1.8	0.8	0.7	0.6	0.4	–	–	–	–	–	–
5.50	1.9	5.1	1.3	2.1	0.9	0.8	0.7	0.4	–	–	–	–	–	–
6.00	2.0	6.0	1.4	2.5	0.9	1.0	0.7	0.5	–	–	–	–	–	–
6.50	2.2	6.9	1.5	2.9	1.0	1.1	0.8	0.6	–	–	–	–	–	–
7.00	2.4	7.8	1.6	3.3	1.1	1.2	0.9	0.7	0.5	0.2	–	–	–	–
7.50	2.5	8.8	1.8	3.7	1.2	1.4	0.9	0.8	0.6	0.2	–	–	–	–
8.00	2.7	9.9	1.9	4.1	1.3	1.6	1.0	0.9	0.6	0.3	–	–	–	–
8.50	2.9	11.0	2.0	4.6	1.3	1.8	1.0	1.0	0.6	0.3	–	–	–	–
9.00	3.0	12.2	2.1	5.1	1.4	1.9	1.1	1.1	0.7	0.3	–	–	–	–
9.50	3.2	13.4	2.2	5.6	1.5	2.1	1.2	1.2	0.7	0.4	–	–	–	–
10.0	3.4	14.6	2.4	6.1	1.6	2.3	1.2	1.3	0.7	0.4	–	–	–	–
11.0	3.7	17.3	2.6	7.2	1.7	2.8	1.3	1.5	0.8	0.5	–	–	–	–
12.0	4.1	20.1	2.8	8.4	1.9	3.2	1.5	1.7	0.9	0.5	–	–	–	–
13.0	4.4	23.2	3.1	9.7	2.0	3.7	1.6	2.0	1.0	0.6	–	–	–	–
14.0	4.7	26.4	3.3	11.1	2.2	4.2	1.7	2.3	1.0	0.7	0.5	0.1	–	–
15.0	5.1	29.8	3.5	12.5	2.4	4.8	1.8	2.6	1.1	0.8	0.6	0.2	–	–
16.4	5.5	34.8	3.9	14.6	2.6	5.6	2.0	3.0	1.2	0.9	0.6	0.2	–	–
17.0	–	–	4.0	15.5	2.7	5.9	2.1	3.2	1.3	1.0	0.6	0.2	–	–
18.0	–	–	4.2	17.2	2.8	6.5	2.2	3.6	1.3	1.1	0.7	0.2	–	–
19.0	–	–	4.5	18.9	3.0	7.2	2.3	3.9	1.4	1.2	0.7	0.2	–	–
20.0	–	–	4.7	20.7	3.1	7.9	2.4	4.3	1.5	1.3	0.8	0.3	–	–
21.0	–	–	4.9	22.5	3.3	8.6	2.6	4.7	1.6	1.4	0.8	0.3	–	–
22.0	–	–	5.2	24.5	3.5	9.3	2.7	5.1	1.6	1.5	0.8	0.3	–	–
23.5	–	–	5.5	27.5	3.7	10.5	2.9	5.7	1.7	1.7	0.9	0.3	–	–
24.0	–	–	–	–	3.8	10.8	2.9	5.9	1.8	1.8	0.9	0.4	–	–
25.0	–	–	–	–	3.9	11.7	3.0	6.3	1.9	1.9	0.9	0.4	–	–
26.0	–	–	–	–	4.1	12.5	3.2	6.8	1.9	2.1	1.0	0.4	–	–
27.0	–	–	–	–	4.2	13.3	3.3	7.2	2.0	2.2	1.0	0.4	–	–
28.0	–	–	–	–	4.4	14.2	3.4	7.7	2.1	2.4	1.1	0.5	0.5	0.5
29.0	–	–	–	–	4.6	15.1	3.5	8.2	2.2	2.5	1.1	0.5	0.6	0.5
30.0	–	–	–	–	4.7	16.0	3.7	8.7	2.2	2.7	1.1	0.5	0.6	0.5
31.0	–	–	–	–	4.9	17.0	3.8	9.2	2.3	2.8	1.2	0.5	0.6	0.5
32.0	–	–	–	–	5.0	18.0	3.9	9.8	2.4	3.0	1.2	0.6	0.6	0.6
33.0	–	–	–	–	5.2	19.0	4.0	10.3	2.5	3.2	1.2	0.6	0.6	0.6
34.0	–	–	–	–	5.3	20.0	4.1	10.9	2.5	3.3	1.3	0.6	0.7	0.6

$d_1 \times s$	75 × 6.8		90 × 8.2		110 × 10		125 × 11.4		160 × 14.6		225 × 20.5		315 × 28.6	
d_2	61.4		73.6		90.0		102.2		130.8		184.0		257.8	
Q [l/s]	v [m/s]	R [hPa/m]	v m/s	R hPa/m	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
35.0	–	–	–	–	5.5	21.0	4.3	11.4	2.6	3.5	1.3	0.7	0.7	0.7
36.0	–	–	–	–	–	–	4.4	12.0	2.7	3.7	1.4	0.7	0.7	0.7
37.0	–	–	–	–	–	–	4.5	12.6	2.8	3.9	1.4	0.7	0.7	0.7
38.0	–	–	–	–	–	–	4.6	13.2	2.8	4.0	1.4	0.8	0.7	0.8
39.0	–	–	–	–	–	–	4.8	13.8	2.9	4.2	1.5	0.8	0.7	0.8
40.0	–	–	–	–	–	–	4.9	14.4	3.0	4.4	1.5	0.9	0.8	0.9
42.0	–	–	–	–	–	–	5.1	15.7	3.1	4.8	1.6	0.9	0.8	0.9
44.8	–	–	–	–	–	–	5.5	17.6	3.3	5.4	1.7	1.0	0.9	1.0
46.0	–	–	–	–	–	–	–	–	3.4	5.6	1.7	1.1	0.9	1.1
48.0	–	–	–	–	–	–	–	–	3.6	6.1	1.8	1.2	0.9	1.2
50.0	–	–	–	–	–	–	–	–	3.7	6.5	1.9	1.3	1.0	1.3
52.0	–	–	–	–	–	–	–	–	3.9	7.0	2.0	1.4	1.0	1.4
54.0	–	–	–	–	–	–	–	–	4.0	7.5	2.0	1.5	1.0	1.5
56.0	–	–	–	–	–	–	–	–	4.2	8.0	2.1	1.5	1.1	1.5
58.0	–	–	–	–	–	–	–	–	4.3	8.5	2.2	1.6	1.1	1.6
60.0	–	–	–	–	–	–	–	–	4.5	9.0	2.3	1.7	1.1	1.7
65.0	–	–	–	–	–	–	–	–	4.8	10.4	2.4	2.0	1.2	2.0
74.0	–	–	–	–	–	–	–	–	5.5	13.0	2.8	2.5	1.4	2.5
75.0	–	–	–	–	–	–	–	–	–	–	2.8	2.6	1.4	2.6
80.0	–	–	–	–	–	–	–	–	–	–	3.0	2.9	1.5	2.9
85.0	–	–	–	–	–	–	–	–	–	–	3.2	3.2	1.6	3.2
90.0	–	–	–	–	–	–	–	–	–	–	3.4	3.6	1.7	3.6
95.0	–	–	–	–	–	–	–	–	–	–	3.6	3.9	1.8	3.9
100.0	–	–	–	–	–	–	–	–	–	–	3.8	4.3	1.9	4.3
110.0	–	–	–	–	–	–	–	–	–	–	4.1	5.1	2.1	5.1
120.0	–	–	–	–	–	–	–	–	–	–	4.5	5.9	2.3	5.9
130.0	–	–	–	–	–	–	–	–	–	–	4.9	6.8	2.5	6.8
145.0	–	–	–	–	–	–	–	–	–	–	5.5	8.2	2.8	8.2
150.0	–	–	–	–	–	–	–	–	–	–	–	–	2.9	8.7
160.0	–	–	–	–	–	–	–	–	–	–	–	–	3.1	9.8
170.0	–	–	–	–	–	–	–	–	–	–	–	–	3.3	10.9
180.0	–	–	–	–	–	–	–	–	–	–	–	–	3.4	12.0
190.0	–	–	–	–	–	–	–	–	–	–	–	–	3.6	13.2
200.0	–	–	–	–	–	–	–	–	–	–	–	–	3.8	14.5
220.0	–	–	–	–	–	–	–	–	–	–	–	–	4.2	17.1
240.0	–	–	–	–	–	–	–	–	–	–	–	–	4.6	19.9
260.0	–	–	–	–	–	–	–	–	–	–	–	–	5.0	23.0
280.0	–	–	–	–	–	–	–	–	–	–	–	–	5.4	26.1
285.0	–	–	–	–	–	–	–	–	–	–	–	–	5.5	27.0

4.2.4 Pressure losses at 60°C

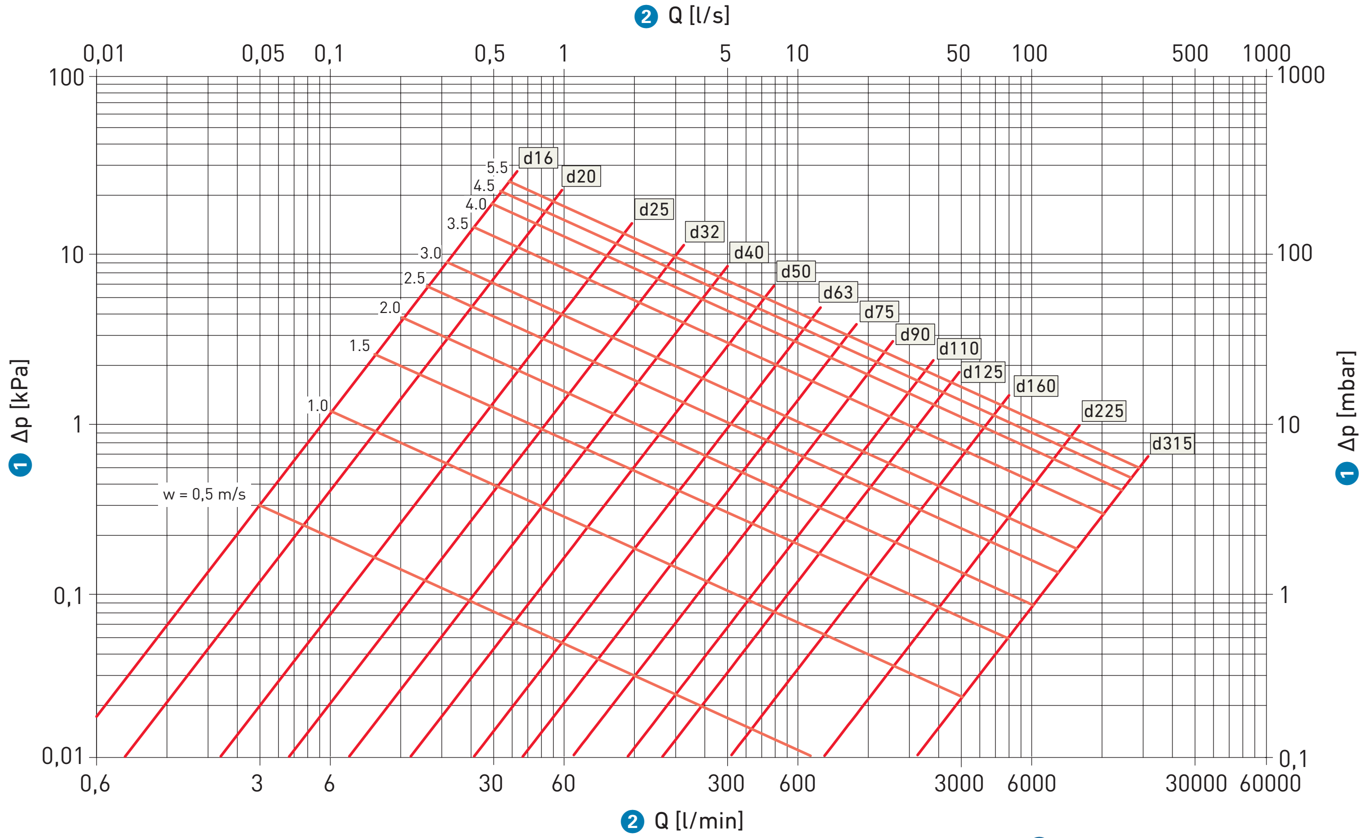
TV.15
Design fundamentals

The basics

Designation	Value
Dimension	d16 – d315
Density ρ (water)	983.19 kg/m³
Water temperature	60°C
Surface roughness k (inner pipe)	0.007 mm
Viscosity	0.00476 Pa · s

Pipe friction pressure drop as a function of the volumetric flow

The diagram and the tables show the pipe friction pressure drop R and the calculated flow velocity v as a function of the volumetric flow Q.



1 Pressure loss
2 Volumetric flow rate

Pressure loses at 60°C/Part 1: d16 – d63

TV.16 **Pipe friction pressure loses, flow velocity, peak flow (Part 1: d16 – d63)**

d_1 × s	16 × 2.2		20 × 2.8		25 × 2.3		32 × 2.9		40 × 3.7		50 × 4.6		63 × 5.8	
d_2	11.6		14.4		20.4		26.2		32.6		40.8		51.4	
Q [l/s]	v [m/s]	R [hPa/m]	v m/s	R hPa/m	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
0.01	0.1	0.2	0.1	0.1	–	–	–	–	–	–	–	–	–	–
0.02	0.2	0.6	0.1	0.2	–	–	–	–	–	–	–	–	–	–
0.03	0.3	1.5	0.2	0.5	–	–	–	–	–	–	–	–	–	–
0.04	0.4	2.0	0.2	0.7	0.1	0.1	–	–	–	–	–	–	–	–
0.05	0.5	3.0	0.3	1.1	0.2	0.2	–	–	–	–	–	–	–	–
0.06	0.6	4.2	0.4	1.5	0.2	0.3	–	–	–	–	–	–	–	–
0.07	0.7	5.5	0.4	1.9	0.2	0.4	–	–	–	–	–	–	–	–
0.08	0.8	7.0	0.5	2.5	0.2	0.5	0.1	0.1	–	–	–	–	–	–
0.09	0.9	8.6	0.6	3.0	0.3	0.6	0.2	0.2	–	–	–	–	–	–
0.10	1.0	10.6	0.6	3.7	0.3	0.7	0.2	0.2	0.1	0.1	–	–	–	–
0.16	1.5	24.0	1.0	8.5	0.5	1.6	0.3	0.5	0.2	0.2	0.1	0.1	–	–
0.20	1.9	35.8	1.2	12.6	0.6	2.4	0.4	0.7	0.2	0.2	0.2	0.1	–	–
0.25	2.4	53.2	1.5	18.8	0.8	3.5	0.5	1.1	0.3	0.4	0.2	0.1	–	–
0.30	2.8	73.7	1.8	26.0	0.9	4.9	0.6	1.5	0.4	0.5	0.2	0.2	0.1	0.1
0.35	3.3	97.0	2.1	34.2	1.1	6.4	0.6	1.9	0.4	0.7	0.3	0.2	0.2	0.1
0.40	3.8	123.0	2.5	43.4	1.2	8.1	0.7	2.4	0.5	0.8	0.3	0.3	0.2	0.1
0.45	4.3	151.8	2.8	53.6	1.4	10.0	0.8	3.0	0.5	1.0	0.3	0.4	0.2	0.1
0.50	4.7	183.1	3.1	64.6	1.5	12.1	0.9	3.6	0.6	1.3	0.4	0.4	0.2	0.1
0.55	5.2	217.0	3.4	76.6	1.7	14.3	1.0	4.3	0.7	1.5	0.4	0.5	0.3	0.2
0.58	5.5	238.5	3.6	84.2	1.8	15.7	1.1	4.7	0.7	1.6	0.4	0.6	0.3	0.2
0.65	–	–	4.0	103.2	2.0	19.3	1.2	5.8	0.8	2.0	0.5	0.7	0.3	0.2
0.70	–	–	4.3	117.7	2.1	22.0	1.3	6.6	0.8	2.3	0.5	0.8	0.3	0.3
0.75	–	–	4.6	133.2	2.3	24.9	1.4	7.5	0.9	2.6	0.6	0.9	0.4	0.3
0.80	–	–	4.9	149.4	2.4	27.9	1.5	8.4	1.0	2.9	0.6	1.0	0.4	0.3
0.85	–	–	5.2	166.4	2.6	31.1	1.6	9.3	1.0	3.3	0.7	1.1	0.4	0.4
0.90	–	–	5.5	184.3	2.8	34.4	1.7	10.3	1.1	3.6	0.7	1.2	0.4	0.4
0.95	–	–	–	–	2.9	37.9	1.8	11.4	1.1	4.0	0.7	1.3	0.5	0.4
1.00	–	–	–	–	3.1	41.6	1.9	12.5	1.2	4.3	0.8	1.5	0.5	0.5
1.10	–	–	–	–	3.4	49.2	2.0	14.8	1.3	5.2	0.8	1.7	0.5	0.6
1.20	–	–	–	–	3.7	57.5	2.2	17.2	1.4	6.0	0.9	2.0	0.6	0.7
1.30	–	–	–	–	4.0	66.3	2.4	19.9	1.6	6.9	1.0	2.4	0.6	0.8
1.40	–	–	–	–	4.3	75.7	2.6	22.7	1.7	7.9	1.1	2.7	0.7	0.9
1.50	–	–	–	–	4.6	85.6	2.8	25.7	1.8	9.0	1.1	3.0	0.7	1.0
1.60	–	–	–	–	4.9	96.0	3.0	28.8	1.9	10.0	1.2	3.4	0.8	1.1
1.70	–	–	–	–	5.2	107.0	3.2	32.1	2.0	11.2	1.3	3.8	0.8	1.2
1.80	–	–	–	–	5.5	118.4	3.3	35.5	2.2	12.4	1.4	4.2	0.9	1.4
1.90	–	–	–	–	–	–	3.5	39.1	2.3	13.6	1.5	4.6	0.9	1.5
2.00	–	–	–	–	–	–	3.7	42.8	2.4	15.0	1.5	5.1	1.0	1.7
2.10	–	–	–	–	–	–	3.9	46.7	2.5	16.3	1.6	5.5	1.0	1.8
2.20	–	–	–	–	–	–	4.1	50.8	2.6	17.7	1.7	6.0	1.1	2.0
2.30	–	–	–	–	–	–	4.3	54.9	2.8	19.2	1.8	6.5	1.1	2.1
2.40	–	–	–	–	–	–	4.5	59.3	2.9	20.7	1.8	7.0	1.2	2.3
2.50	–	–	–	–	–	–	4.6	63.8	3.0	22.3	1.9	7.6	1.2	2.5
2.60	–	–	–	–	–	–	4.8	68.4	3.1	23.9	2.0	8.1	1.3	2.7
2.70	–	–	–	–	–	–	5.0	73.1	3.2	25.5	2.1	8.7	1.3	2.9
2.80	–	–	–	–	–	–	5.2	78.0	3.4	27.2	2.1	9.2	1.3	3.0
2.90	–	–	–	–	–	–	5.4	83.1	3.5	29.0	2.2	9.8	1.4	3.2
2.95	–	–	–	–	–	–	5.5	85.6	3.5	29.9	2.3	10.1	1.4	3.3
3.10	–	–	–	–	–	–	–	–	3.7	32.7	2.4	11.1	1.5	3.6
3.20	–	–	–	–	–	–	–	–	3.8	34.6	2.4	11.7	1.5	3.9
3.30	–	–	–	–	–	–	–	–	4.0	36.5	2.5	12.4	1.6	4.1

$d_1 \times s$	16 × 2.2		20 × 2.8		25 × 2.3		32 × 2.9		40 × 3.7		50 × 4.6		63 × 5.8	
d_2	11.6		14.4		20.4		26.2		32.6		40.8		51.4	
Q [l/s]	v [m/s]	R [hPa/m]	v m/s	R hPa/m	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
3.40	–	–	–	–	–	–	–	–	4.1	38.5	2.6	13.1	1.6	4.3
3.50	–	–	–	–	–	–	–	–	4.2	40.5	2.7	13.8	1.7	4.5
3.60	–	–	–	–	–	–	–	–	4.3	42.6	2.8	14.5	1.7	4.8
3.70	–	–	–	–	–	–	–	–	4.4	44.8	2.8	15.2	1.8	5.0
3.80	–	–	–	–	–	–	–	–	4.6	46.9	2.9	15.9	1.8	5.2
3.90	–	–	–	–	–	–	–	–	4.7	49.2	3.0	16.7	1.9	5.5
4.00	–	–	–	–	–	–	–	–	4.8	51.4	3.1	17.5	1.9	5.7
4.20	–	–	–	–	–	–	–	–	5.0	56.1	3.2	19.0	2.0	6.3
4.40	–	–	–	–	–	–	–	–	5.3	60.9	3.4	20.7	2.1	6.8
4.60	–	–	–	–	–	–	–	–	5.5	66.0	3.5	22.4	2.2	7.4
4.80	–	–	–	–	–	–	–	–	–	–	3.7	24.2	2.3	7.9
5.00	–	–	–	–	–	–	–	–	–	–	3.8	26.0	2.4	8.5
5.20	–	–	–	–	–	–	–	–	–	–	4.0	27.9	2.5	9.2
5.40	–	–	–	–	–	–	–	–	–	–	4.1	29.8	2.6	9.8
5.60	–	–	–	–	–	–	–	–	–	–	4.3	31.8	2.7	10.5
5.80	–	–	–	–	–	–	–	–	–	–	4.4	33.8	2.8	11.1
6.00	–	–	–	–	–	–	–	–	–	–	4.6	36.0	2.9	11.8
6.25	–	–	–	–	–	–	–	–	–	–	4.8	38.7	3.0	12.7
6.50	–	–	–	–	–	–	–	–	–	–	5.0	41.5	3.1	13.6
6.75	–	–	–	–	–	–	–	–	–	–	5.2	44.4	3.3	14.6
7.00	–	–	–	–	–	–	–	–	–	–	5.4	47.3	3.4	15.6
7.25	–	–	–	–	–	–	–	–	–	–	5.5	50.4	3.5	16.6
7.50	–	–	–	–	–	–	–	–	–	–	–	–	3.6	17.6
7.75	–	–	–	–	–	–	–	–	–	–	–	–	3.7	18.7
8.00	–	–	–	–	–	–	–	–	–	–	–	–	3.9	19.7
8.25	–	–	–	–	–	–	–	–	–	–	–	–	4.0	20.9
8.50	–	–	–	–	–	–	–	–	–	–	–	–	4.1	22.0
8.75	–	–	–	–	–	–	–	–	–	–	–	–	4.2	23.2
9.00	–	–	–	–	–	–	–	–	–	–	–	–	4.3	24.4
9.25	–	–	–	–	–	–	–	–	–	–	–	–	4.5	25.6
9.50	–	–	–	–	–	–	–	–	–	–	–	–	4.6	26.8
9.75	–	–	–	–	–	–	–	–	–	–	–	–	4.7	28.1
10.0	–	–	–	–	–	–	–	–	–	–	–	–	4.8	29.4
10.5	–	–	–	–	–	–	–	–	–	–	–	–	5.1	32.1
11.0	–	–	–	–	–	–	–	–	–	–	–	–	5.3	34.8
11.5	–	–	–	–	–	–	–	–	–	–	–	–	5.5	37.7

Pressure losses at 60°C / Part 2: 75 – d225

TV.17 **Pipe friction pressure loses, flow velocity, peak flow (Part 2: d75 – d225)**

$d_1 \times s$	75 × 6.8		90 × 8.2		110 × 10		125 × 11.4		160 × 14.6		225 × 20.5		315 × 28.6	
d_2	61.4		73.6		90.0		102.2		130.8		184.0		257.8	
Q [l/s]	v [m/s]	R [hPa/m]	v m/s	R hPa/m	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
0.50	0.2	0.1	–	–	–	–	–	–	–	–	–	–	–	–
0.55	0.2	0.1	–	–	–	–	–	–	–	–	–	–	–	–
0.60	0.2	0.1	–	–	–	–	–	–	–	–	–	–	–	–
0.65	0.2	0.1	–	–	–	–	–	–	–	–	–	–	–	–
0.70	0.2	0.1	–	–	–	–	–	–	–	–	–	–	–	–
0.75	0.3	0.1	0.2	0.1	–	–	–	–	–	–	–	–	–	–
0.80	0.3	0.1	0.2	0.1	–	–	–	–	–	–	–	–	–	–
0.85	0.3	0.2	0.2	0.1	–	–	–	–	–	–	–	–	–	–
0.90	0.3	0.2	0.2	0.1	–	–	–	–	–	–	–	–	–	–
0.95	0.3	0.2	0.2	0.1	–	–	–	–	–	–	–	–	–	–
1.00	0.3	0.2	0.2	0.1	–	–	–	–	–	–	–	–	–	–
1.05	0.4	0.2	0.2	0.1	–	–	–	–	–	–	–	–	–	–
1.10	0.4	0.2	0.3	0.1	–	–	–	–	–	–	–	–	–	–
1.15	0.4	0.3	0.3	0.1	–	–	–	–	–	–	–	–	–	–
1.20	0.4	0.3	0.3	0.1	–	–	–	–	–	–	–	–	–	–
1.25	0.4	0.3	0.3	0.1	–	–	–	–	–	–	–	–	–	–
1.30	0.4	0.3	0.3	0.1	0.2	0.1	–	–	–	–	–	–	–	–
1.35	0.5	0.4	0.3	0.1	0.2	0.1	–	–	–	–	–	–	–	–
1.40	0.5	0.4	0.3	0.2	0.2	0.1	–	–	–	–	–	–	–	–
1.45	0.5	0.4	0.3	0.2	0.2	0.1	–	–	–	–	–	–	–	–
1.50	0.5	0.4	0.4	0.2	0.2	0.1	–	–	–	–	–	–	–	–
1.55	0.5	0.5	0.4	0.2	0.2	0.1	–	–	–	–	–	–	–	–
1.60	0.5	0.5	0.4	0.2	0.3	0.1	–	–	–	–	–	–	–	–
1.65	0.6	0.5	0.4	0.2	0.3	0.1	–	–	–	–	–	–	–	–
1.70	0.6	0.5	0.4	0.2	0.3	0.1	–	–	–	–	–	–	–	–
1.80	0.6	0.6	0.4	0.2	0.3	0.1	0.2	0.1	–	–	–	–	–	–
1.90	0.6	0.6	0.4	0.3	0.3	0.1	0.2	0.1	–	–	–	–	–	–
2.00	0.7	0.7	0.5	0.3	0.3	0.1	0.2	0.1	–	–	–	–	–	–
2.20	0.7	0.8	0.5	0.4	0.3	0.1	0.3	0.1	–	–	–	–	–	–
2.40	0.8	1.0	0.6	0.4	0.4	0.2	0.3	0.1	–	–	–	–	–	–
2.60	0.9	1.1	0.6	0.5	0.4	0.2	0.3	0.1	–	–	–	–	–	–
2.80	0.9	1.3	0.7	0.5	0.4	0.2	0.3	0.1	–	–	–	–	–	–
3.00	1.0	1.5	0.7	0.6	0.5	0.2	0.4	0.1	–	–	–	–	–	–
3.20	1.1	1.6	0.8	0.7	0.5	0.3	0.4	0.1	–	–	–	–	–	–
3.40	1.1	1.8	0.8	0.8	0.5	0.3	0.4	0.2	–	–	–	–	–	–
3.60	1.2	2.0	0.8	0.8	0.6	0.3	0.4	0.2	0.3	0.1	–	–	–	–
3.80	1.3	2.2	0.9	0.9	0.6	0.4	0.5	0.2	0.3	0.1	–	–	–	–
4.00	1.4	2.4	0.9	1.0	0.6	0.4	0.5	0.2	0.3	0.1	–	–	–	–
4.40	1.5	2.9	1.0	1.2	0.7	0.5	0.5	0.2	0.3	0.1	–	–	–	–
4.80	1.6	3.4	1.1	1.4	0.8	0.5	0.6	0.3	0.4	0.1	–	–	–	–
5.20	1.8	3.9	1.2	1.6	0.8	0.6	0.6	0.3	0.4	0.1	–	–	–	–
5.60	1.9	4.4	1.3	1.9	0.9	0.7	0.7	0.4	0.4	0.1	–	–	–	–
6.00	2.0	5.0	1.4	2.1	0.9	0.8	0.7	0.4	0.4	0.1	–	–	–	–
6.40	2.2	5.6	1.5	2.4	1.0	0.9	0.8	0.5	0.5	0.1	–	–	–	–
6.80	2.3	6.3	1.6	2.6	1.1	1.0	0.8	0.5	0.5	0.2	–	–	–	–
7.20	2.4	7.0	1.7	2.9	1.1	1.1	0.9	0.6	0.5	0.2	–	–	–	–
7.60	2.6	7.7	1.8	3.2	1.2	1.2	0.9	0.7	0.6	0.2	–	–	–	–
8.00	2.7	8.4	1.9	3.5	1.3	1.3	1.0	0.7	0.6	0.2	–	–	–	–
8.40	2.8	9.2	2.0	3.8	1.3	1.5	1.0	0.8	0.6	0.2	–	–	–	–
8.80	3.0	9.9	2.1	4.2	1.4	1.6	1.1	0.9	0.7	0.3	0.3	0.1	–	–
9.20	3.1	10.8	2.2	4.5	1.4	1.7	1.1	0.9	0.7	0.3	0.3	0.1	–	–

$d_1 \times s$	75 × 6.8		90 × 8.2		110 × 10		125 × 11.4		160 × 14.6		225 × 20.5		315 × 28.6	
d_2	61.4		73.6		90.0		102.2		130.8		184.0		257.8	
Q [l/s]	v [m/s]	R [hPa/m]	v m/s	R hPa/m	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
9.60	3.2	11.6	2.3	4.9	1.5	1.8	1.2	1.0	0.7	0.3	0.4	0.1	–	–
10.0	3.4	12.5	2.4	5.2	1.6	2.0	1.2	1.1	0.7	0.3	0.4	0.1	–	–
11.0	3.7	14.8	2.6	6.2	1.7	2.3	1.3	1.3	0.8	0.4	0.4	0.1	–	–
12.0	4.1	17.3	2.8	7.2	1.9	2.7	1.5	1.5	0.9	0.5	0.5	0.1	–	–
13.0	4.4	19.9	3.1	8.3	2.0	3.2	1.6	1.7	1.0	0.5	0.5	0.1	–	–
14.0	4.7	22.7	3.3	9.5	2.2	3.6	1.7	2.0	1.0	0.6	0.5	0.1	–	–
15.0	5.1	25.7	3.5	10.7	2.4	4.1	1.8	2.2	1.1	0.7	0.6	0.1	–	–
16.4	5.5	30.1	3.9	12.6	2.6	4.8	2.0	2.6	1.2	0.8	0.6	0.2	–	–
17.0	–	–	4.0	13.4	2.7	5.1	2.1	2.8	1.3	0.8	0.6	0.2	–	–
18.0	–	–	4.2	14.9	2.8	5.6	2.2	3.1	1.3	0.9	0.7	0.2	–	–
19.0	–	–	4.5	16.4	3.0	6.2	2.3	3.4	1.4	1.0	0.7	0.2	–	–
20.0	–	–	4.7	17.9	3.1	6.8	2.4	3.7	1.5	1.1	0.8	0.2	–	–
22.0	–	–	5.2	21.3	3.5	8.1	2.7	4.4	1.6	1.3	0.8	0.3	0.4	0.1
23.5	-	-	5.5	23.9	3.7	9.1	2.9	4.9	1.7	1.5	0.9	0.3	0.5	0.1
26.0	–	–	–	–	4.1	10.9	3.2	5.9	1.9	1.8	1.0	0.3	0.5	0.1
28.0	–	–	–	–	4.4	12.4	3.4	6.7	2.1	2.1	1.1	0.4	0.5	0.1
30.0	–	–	–	–	4.7	14.0	3.7	7.6	2.2	2.3	1.1	0.4	0.6	0.1
34.8	–	–	–	–	5.5	18.3	4.2	9.9	2.6	3.0	1.3	0.6	0.7	0.1
38.0	–	–	–	–	–	–	4.6	11.6	2.8	3.5	1.4	0.7	0.7	0.1
42.0	–	–	–	–	–	–	5.1	13.9	3.1	4.2	1.6	0.8	0.8	0.2
45.5	–	–	–	–	–	–	5.5	16.0	3.4	4.9	1.7	0.9	0.9	0.2
50.0	–	–	–	–	–	–	–	–	3.7	5.8	1.9	1.1	1.0	0.2
55.0	–	–	–	–	–	–	–	–	4.1	6.8	2.1	1.3	1.1	0.3
60.0	–	–	–	–	–	–	–	–	4.5	8.0	2.3	1.5	1.1	0.3
65.0	–	–	–	–	–	–	–	–	4.8	9.2	2.4	1.8	1.2	0.4
70.0	–	–	–	–	–	–	–	–	5.2	10.5	2.6	2.0	1.3	0.4
74.5	–	–	–	–	–	–	–	–	5.5	11.7	2.8	2.3	1.4	0.4
80.0	–	–	–	–	–	–	–	–	–	–	3.0	2.6	1.5	0.5
90.0	–	–	–	–	–	–	–	–	–	–	3.4	3.2	1.7	0.6
100	–	–	–	–	–	–	–	–	–	–	3.8	3.8	1.9	0.8
110	–	–	–	–	–	–	–	–	–	–	4.1	4.5	2.1	0.9
120	–	–	–	–	–	–	–	–	–	–	4.5	5.3	2.3	1.0
130	–	–	–	–	–	–	–	–	–	–	4.9	6.1	2.5	1.2
140	–	–	–	–	–	–	–	–	–	–	5.3	7.0	2.7	1.4
145	–	–	–	–	–	–	–	–	–	–	5.5	7.4	2.8	1.5
160	–	–	–	–	–	–	–	–	–	–	–	–	3.1	1.7
170	–	–	–	–	–	–	–	–	–	–	–	–	3.3	1.9
180	–	–	–	–	–	–	–	–	–	–	–	–	3.4	2.2
190	–	–	–	–	–	–	–	–	–	–	–	–	3.6	2.4
200	–	–	–	–	–	–	–	–	–	–	–	–	3.8	2.6
225	–	–	–	–	–	–	–	–	–	–	–	–	4.3	3.2
250	–	–	–	–	–	–	–	–	–	–	–	–	4.8	3.9
275	–	–	–	–	–	–	–	–	–	–	–	–	5.3	4.6
285	–	–	–	–	–	–	–	–	–	–	–	–	5.5	4.9

4.3 Pressure losses for system parts and pipe

The zeta values and equivalent pipe lengths were determined in accordance with the specifications of the SVGW (SV EN 1267).

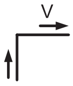
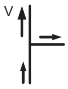
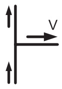
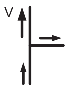
Loading unit and ζ value
A loading unit **LU** is equal to a flow of 0.1 l/s.
The ζvalue for w = 2 m/s, as shown in the table.

4.3.1 Simplified representation for 1 loading unit (LU)

TV.18 **Pressure loses in INSTAFLEX system parts, clamp connection**

Code	Designation		Symbol	Dimensions	ζ value	Equivalent length of pipeline [m]
3000	Box, single, 90°			1/2" – d16	12.6	5.33
				1/2" – d20	3.1	1.31
				3/4" – d20	11.2	6.02
3002	Box, double, 90°	Discharge		1/2" – d16 – d16	10.9	4.61
				1/2" – d16 – d20	7.3	3.09
				1/2" – d20 – d20	8.6	3.63
		Flow rate		1/2" – d16 – d16	3.3	1.16
				1/2" – d16 – d20	2.6	0.91
				1/2" – d20 – d16	4.2	1.73
3032	Connections to controls and instruments, single			1/2" – d16	9.5	4.02
				1/2" – d20	3.8	1.61
				3/4" – d20	11.4	6.13
3030	Connections to controls and instruments, double	Discharge		1/2" – d16 – d16	9.4	3.98
3043				1/2" – d16 – d16	10.2	4.32
3043				1/2" – d20 – d20	8.5	3.60
3030		Flow rate		1/2" – d16 – d16	2.6	0.91
3043				1/2" – d16 – d16	4.8	1.68
3043				1/2" – d20 – d20	5.0	2.06
3270	Distributor 3/4"	Discharge		3/4" – d16	2.1	0.74
				3/4" – d20	1.9	0.78
		Flow rate		3/4"	1.4	–
3250	Distributor 1"	Discharge		1" – d16	2.0	0.70
				1" – d20	2.0	0.82
		Flow rate		1" – d16	1.4	–
				1" – d20	1.2	–
3363	90° angle			d16	5.4	1.89
				d20	4.0	1.65
3350	Tees, equal	Flow rate		d16	1.7	0.60
				d20	1.1	0.45
		Pipe branch		d16	5.6	1.96
				d20	4.4	1.81
3355	Tee, reduced	Flow rate		d16 – d20 – d16	1.5	0.53
				d20 – d20 – d16	1.1	0.45
		Pipe branch		d20 – d16 – d16	3.9	1.37
				d20 – d20 – d16	3.5	1.23
3330	Coupling			d16	1.5	0.53
				d20	1.2	0.49

TV.19 **Pressure loses in INSTAFLEX system parts, HWS and HMS fittings**

Code HWS	Code HMS	Designation		Symbol	Dimension d	ζ value	Equivalent length of pipeline [m]
6200	5040	Socket			16	0.1	0.04
					20	0.1	0.04
					25	0.1	–
6202	5005	90° angle			16	1.2	0.42
					20	1.2	0.49
					25	1.2	–
					32	1.2	–
					40	1.1	–
					50	1.1	–
					63	1.1	–
					75	1.1	–
					90	1.1	–
					110	1.1	–
6203	5010	45° angle			16	0.3	0.11
					20	0.3	0.12
					25	0.3	–
					32	0.3	–
					40	0.3	–
					50	0.3	–
					63	0.3	–
					75	0.3	–
					90	0.3	–
					110	0.3	–
6204	5015	Tee 90° equal	Flow-through		16	0.1	0.04
					20	0.1	0.04
					25	0.1	–
					32	0.1	–
6204	5015	Tee 90° equal	Pipe branch		16	1.4	0.49
					20	1.4	0.58
					25	1.3	–
					32	1.2	–
					40	1.2	–
					50	1.2	–
					63	1.1	–
					75	1.1	–
					90	1.1	–
					110	1.1	–
6205	5020	Tee 90° reduced	Flow-through		d20-16-16	0.1	0.04
					d20-16-20	0.1	0.04
					d25-20-20	0.3	–
					d25-20-25	0.1	–
					d25-25-20	0.2	–
					d32-25-25	0.2	–
					d32-25-32	0.1	–

Code HWS	Code HMS	Designation		Symbol	Dimension d	ζ value	Equivalent length of pipeline [m]
6205	5020	Tee 90° reduced	Pipe branch		d20-16-16	1.5	0.53
					d20-16-20	1	0.41
					d25-20-20	1.4	–
					d25-20-25	0.8	–
					d25-25-20	1.2	–
					d32-25-25	0.8	–
					d32-25-32	0.8	–
					d40-25-40	0.6	–
					d40-32-40	0.9	–
					d50-25-50	0.7	–
					d50-32-50	0.8	–
					d63-25-63	0.6	–
					d63-40-63	0.6	–
6207	5045	Reduction			d20-16	0.1	0.04
					d25-20	0.2	0.08
					d32-25	0.1	–
					d40-32	0.1	–
					d50-40	0.1	–
					d63-50	0.1	–
					d75-63	0.1	–
					d90-75	0.1	–
					d110-90	0.1	–
6214	–	Transition			d16-1/2"	2.6	0.91
					d20-3/4"	2	0.82
					d25-1"	1.3	–
					d32-1"	0.5	–
					d40-1 1/4" 145	0.7	–
					d50-1 1/2" 158	0.4	–
					d63-2"	0.3	–
6210	–	Flange adaptor			d75	0	–
					d90	0	–
					d110	0	–

Dimension d	20	25	32	40	50	63
ζ value	0.4	0.4	0.4	0.3	0.3	0.3

TV.20
Pressure losses for INSTAFLEX PB valve

4.4 Discharge times

The discharge times indicate the time elapsed until a temperature of 40°C is reached at the tap (in accordance with SIA 385/2, 2015 edition) and signal the beginning of usability. These discharge times apply to fully opened taps set to maximum “hot”. In the interests of economical water and energy consumption, these discharge times should not be set too high.

In order to keep the discharge losses within economically justifiable limits and at the same time to meet the comfort requirements of the hot water user, the requirements defined in [TV.21] for discharge periods apply.* The measurement itself is carried out with the fitting installed at the installation site.

If it is not possible to choose a distribution system that conveys the hot water from the hot water storage tank to the tap within a reasonable time (discharge time), a circulation pipeline or auxiliary heating system must be planned and installed, or the arrangement of the sanitary equipment and riser zones must be optimised.

TV.21 **Discharge times – Requirements**

* Excerpt from SIA 385/1

Sanitary fixtures	Discharge time t [s]	
	without keeping warm (e.g. without circulation)	with keeping warm (e.g. with circulation)
Vanity unit, wash-hand basin, bidet, showers, bathtubs, sink (kitchen), utility sink	15	10

According to EN 806-2 also applies to the intended operation:

- Drinking water, cold: Max. 30 s after full opening of a tapping point:
  - Temperature must not exceed 25 °C.
- Drinking water, hot: Max. 30 s after full opening of a tapping point:
  - Temperature must be min. 55 °C.

According to VDI 6003 the following values result for different sanitary objects:

TV.22 **Discharge times – Requirements**

* Excerpt from VDI 6003 (requirement levels = comfort criteria)

Sanitary fixtures	Useful temperature [°C]	Discharge time t [s]* Requirement level I	II	III
Vanity unit	40	60	18	10
Shower	42	~26	10	7
Bathtub	45	~26	12	9
Flushing	50	60	18	10
Bidet	40	–	15	15
Whirlpool / Large tub	50	–	10	10

Factors influencing the output times include the following

TV.23 **Factors for output times**

Desired comfort	(criteria)
Floor plan	Distance to sanitary objects, grouping
Number of strings supplying the apartment	
Planning, construction and operation • Compliant with regulations (according to TRWI) or not	• with or without circulation system • Running time of the circulation pump. If the circulation pump is switched off, the distribution lines for domestic hot water will inevitably cool down. Fixed discharge times are then no longer to be observed. • Correct sizing of the circulation system, based on the product-specific resistance coefficients of the piping system.
Floor installation type	• Distribution with single supply line • Tee installation • Pipeline in series • Ring pipeline
Supply type hot water	• Individual supply line • Group supply: decentralized or centralized in apartments • Central supply: Storage system or storage charging system

Calculation

Calculating the discharge time
➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [12] 'Dimensioning'

The discharge times must be matched to the pipe dimension, length of the pipeline and the volume flows. Especially when using energy-saving mixers (flow restrictors), the effective volumetric flow must always be determined and converted (acc. to SIA 385/2, Issue 2015, Annex G), because the reduced volumetric flow results in a longer discharge time.

The calculation is based on the standard SIA 385/1, which contains the fundamental principles and requirements for domestic hot water systems. The calculation is also based on the standard SIA 385/2, which describes the hot water demand, the overall requirements and the design, such as the calculation of the discharge times.

Discharge times for INSTAFLEX pipe

The following table does not consider fittings but only pipes.

- Input variables: Outside diameter d, wall thickness s_w
- Calculated quantities: [l/m], max. length of pipeline [m], discharge times [s/m]

TV.24 **Discharge times and lengths – INSTAFLEX pipe (PB)**

Pipe, Dimension				max. feasible duration of the discharge times [s] of						Discharge time [s] per 1 m pipe length		
			[s]	15			10			Cold phase + warm-up phase		
			[l/s_w]	0.1	0.2	0.3	0.1	0.2	0.3	0.1	0.2	0.3
DN	**d**	s_w	[l/m]	max. pipe length [m]						[s]		
12	16	2.2	0.106	7.1	14.1	21.2	4.7	9.4	14.1	2.1	1.1	0.7
15	20	2.8	0.163	4.6	9.2	13.8	3.0	6.1	9.2	3.3	1.6	1.1

4.5 Change of length and compensation for expansion

Due to heat and depending on the material, pipelines expand to varying degrees. Even if the temperatures of the medium (e.g. drinking water) exceeds room temperature, this causes a thermal expansion and must be taken into account in the design of the installation.

How to calculate the change in length
In order to calculate the change in length, product and material-specific values are required:
➨ Technical data for system, Chapter [2.1] 'INSTAFLEX pipes'

This thermally induced change in length can be compensated during the installation and mounting of the pipe. Suitable measures are:
- Directional changes of the pipeline
- Providing expansion space
- Installation of expansion joints
- Setting the fixed points and floating points

The bending and torsional forces occurring during the operation of a pipeline are safely absorbed, taking into account the above-mentioned measures. The following parameters have a significant influence on the expansion compensation:
- Material
- structural conditions
- Operating conditions

Minor changes of lengths of the pipelines, especially when using smaller dimensions, can be compensated for by the elasticity of the piping system or with a corresponding insulation.

For larger piping systems, the changes in length must be absorbed by the **expansion joints**: Insulations, flexible pipe legs and U-shaped expansion loops compensate for the thermally induced change in length. The required measures for GF's plastic piping systems are – depending on the type of installation:

TV.25
Measures for the expansion compensation for plastic pipelines made by GF

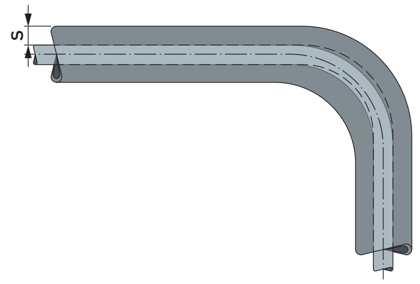
Medium	Cold water	Hot water/circulation/heater	
Dimension	d16 – d110	d16 – d26	d32 – d110
Length of pipeline L ≤12 m	If using insulated pipelines, compensation for the change in length does **not** require floating points and fixed points		
Length of pipeline L ≥12 m	If using insulated pipelines, compensation for the change in length does **not** require floating points and fixed points		Compensation for the change in length requires floating points and fixed points

4.5.1 Compensation for the change in length by using insulation

When using insulation in order to compensate for the change in length, the minimum insulation thickness **s** must be at least 1.5 times the length change.

$$s = 1.5 \cdot \Delta l$$

s Insulation thickness, min.
Δl Change in length



For installations with temperatures up to 60°C (ΔT = 50 K), a length change Δl of 1.3 mm must be taken into account per meter of straight pipeline length. This corresponds to an insulation thickness of 2.0 mm per meter of straight pipeline length.

Insulation
Information on insulation:
➨ Part IV 'Plan', Section 'Insulation, Fire protection'
Information about insulation when installing riser pipes:
➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [13] 'Installation and attachment'

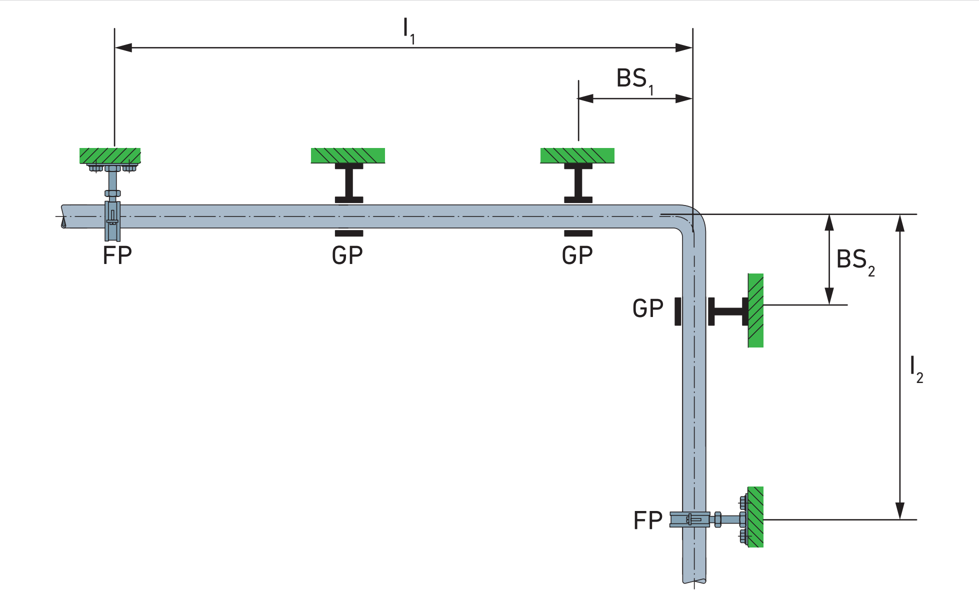
4.5.2 Compensation for the change in length by using expansion joints

Flexible pipe legs and **U-shaped expansion loops** are used as **expansion joints**.
In order to ensure the function of the 2D expansion loop, **fixed points** and **floating points** (with sliding pipe clips) are installed.

Fixed points can be created at a suitable location along the pipeline, using a commercially available, custom-fit fixed point clips or a system-specific solution (e.g. fixed point clip in combination with a fixed-point pipe clip of the system used).

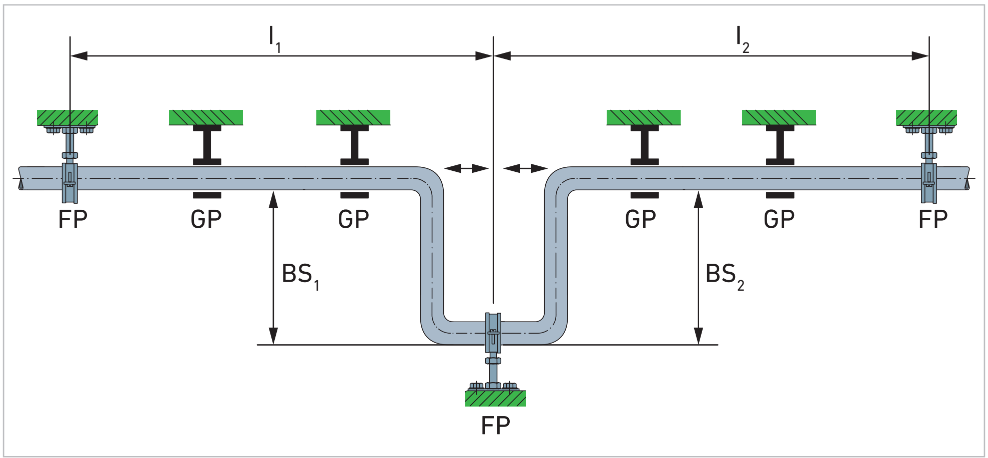
The **pipe clip** must assume the shape of the pipe and, when tightening the clip, the actual pipe diameter must not be constrict by more than 0.5 mm.

Examples – Basic design of a flexible pipe leg and U-shaped expansion loop



GV.23
Flexible pipe leg

FP Fixed point
GP Floating point (with sliding pipe clip)
BS Flexible pipe leg
l Pipe length between fixed point and deflection



GV.24
U-shaped expansion loop

FP Fixed point
GP Floating point (with sliding pipe clip)
BS Flexible pipe leg
l Pipe length between fixed point and deflection

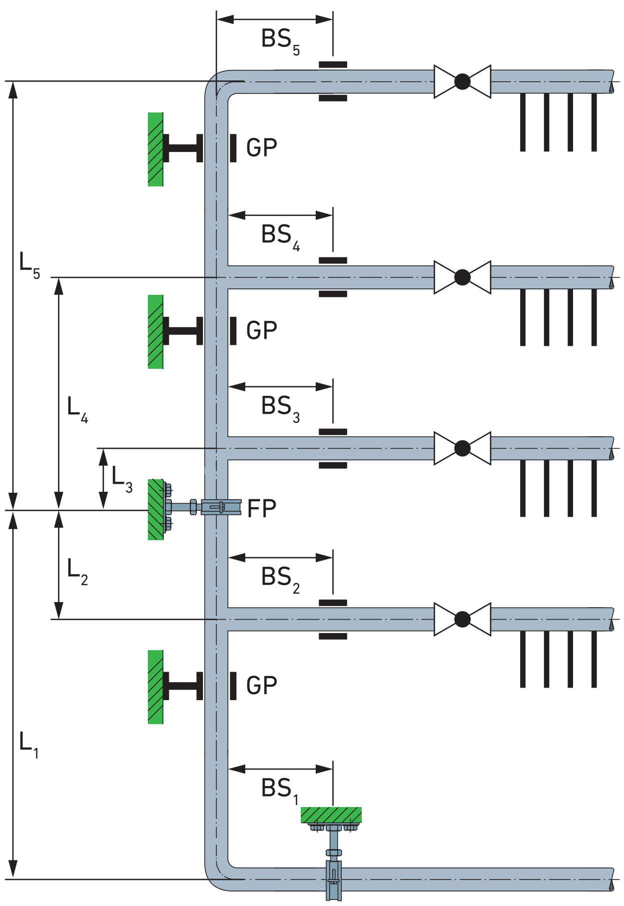
4.5.3 Fixed points and floating points when using riser pipes

If riser pipes are leading up to several storeys and accordingly have multiple fixed points (FP), the change in length between the individual fixed points must be absorbed by the flexible pipe leg (BS). The sliding pipe clamp mounted to the horizontal pipe affects the **vertical** expansion of the pipe similar to a fixed point (FP).

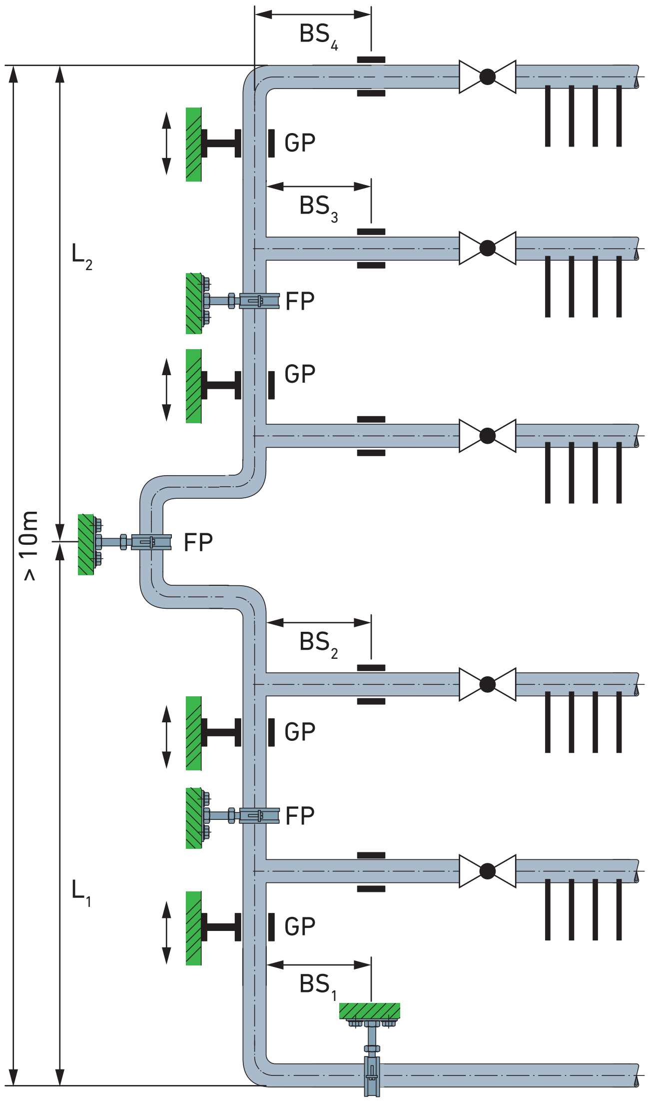
Examples – Basic design of fixed points and floating points

TV.26 **Spacing of fixed points and floating points in a riser pipe**

Riser pipe up to a height of 10 m



Riser pipe starting at a height of 10 m



Riser pipe up to a height of 10 m	Riser pipe starting at a height of 10 m
Up to a **riser pipe height of 5 m,** neither a U-shaped expansion loop nor a fixed point shall be installed along the riser pipe. Up to a **riser pipe height of 10 m,** a U-shaped expansion loop can be omitted. In the middle of the riser pipe, however, a fixed point (FP) must be installed.	Starting at a **riser pipe height of 10 m,** a U-shaped expansion loop with fixed points (FP) must be installed at intervals of 10 m.

L_{1-5} Pipe length between fixed point and deflection
FP Fixed point
BS_{1-5} Flexible pipe leg
GP Floating point (with sliding pipe clip)

4.5.4 How to calculate the change in length

The **change in length of a pipeline** and the corresponding design of the flexible pipe leg and U-shaped expansion loop also depend on the material used. When calculating the change in length, this must be taken into account by using corresponding material-dependent parameters.

The **calculation of the length of the flexible pipe leg** depends on the design of the flexible pipe leg:

- If using a **flexible pipe leg** in order to compensate for an extension, or if a branch line is used, the length of the flexible pipe leg must be calculated.
- In the case of expansion compensation by means of a **U-shaped expansion loop,** the length of the flexible pipe leg in the U-shaped expansion loop is calculated.

Material constant and coefficient of thermal expansion
In order to calculate the change in length, product and material-specific values are required:
➨ Technical data for system, Chapter [2.1] 'INSTAFLEX pipes'

How to calculate the change in length

The thermally induced **length of change** Δl of the pipes is calculated (in non-resisting installations) from the **temperature difference** ΔT and the **pipe length** L, using the following formula:

$$\Delta l = \alpha \cdot L \cdot \Delta T$$

Symbol	Meaning	Unit	Remark
L	Length of pipeline	[m]	–
α	Linear coefficient of thermal expansion	[mm/(m·K)]	product-/material-specific
Δl	Change in length	[mm]	–
ΔT	Temperature difference	[K]	–

Sample calculation using a plastic pipe (PB)
The length of the pipeline is 5 m. The thermally induced change of length of this pipe section must be absorbed by a flexible pipe leg. The difference between the installation temperature and the maximum operating temperature is 50 K.

Plastic pipe, PB	d40
Length of pipeline L	5.0 m
Linear coefficient of thermal expansion α	0.13 mm/(m·K)
Temperature difference	50 K

How to calculate the change in length

$$\Delta l = \alpha \cdot L \cdot \Delta T$$

$$\Delta l = 0.13\ [mm/(m \cdot K)] \cdot 5\ [m] \cdot 50\ [K]$$

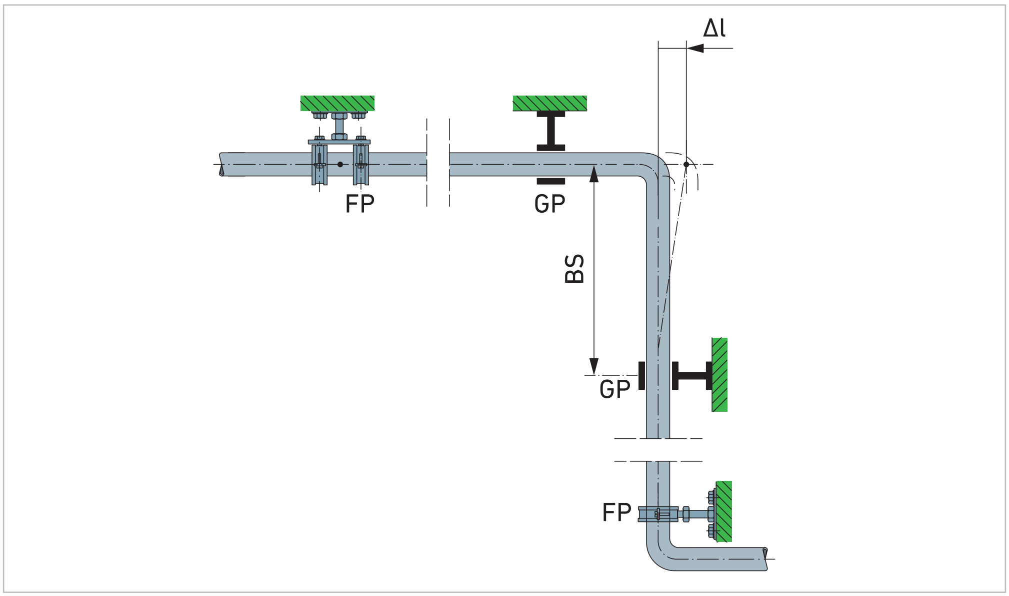
$$\Delta l = \sim 32.5\ mm$$

4.5.5 Calculating the length of the flexible pipe leg

Calculation of the length of the flexible pipe leg

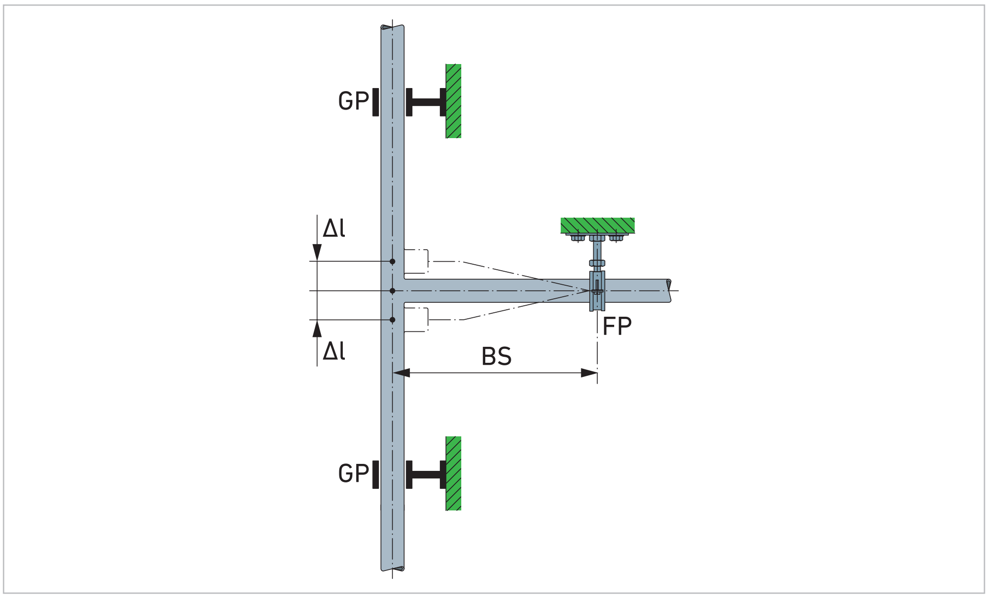
Due to the thermally induced change in length **Δl** , a pipeline shifts a pipe bend by a value **Δl**.
This change must be absorbed by a flexible pipe leg with a length equal to **BS**.

Length of flexible pipe leg



GV.25
Length of flexible pipe leg
GP Floating point
FP Fixed point
BS Length of flexible pipe leg

Length of flexible pipe leg intended to use for the branch line



GV.26
Length of flexible pipe leg
GP Floating point
FP Fixed point
BS Length of flexible pipe leg

The **length of the flexible pipe leg** BS is calculated from the **change in length** Δl and the **outside diameter** d of the pipe, using the following formula:

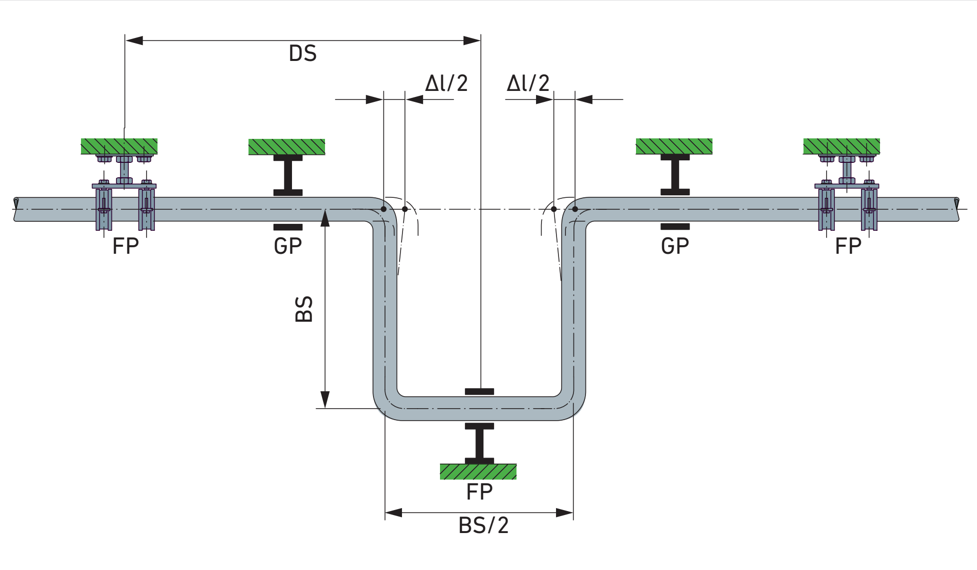
$$BS = C \cdot \sqrt{d \cdot \Delta l}$$

Symbol	Meaning	Unit	Remark
BS	Length of flexible pipe leg	[mm]	–
d	Outside diameter of pipe	[mm]	–
Δl	Change in length	[mm]	–
C	Material constant	–	product-/material-specific

Calculation of the length of the flexible pipe leg in a U-shaped expansion loop

Due to the thermally induced change in length **Δl** a pipe displaces a U-shaped loop at both bends by half the value **Δl**. This change must be absorbed by the two flexible pipe legs **BS**.

Length of the U-shaped expansion loop



GV.27
Length of the U-shaped expansion loop

GP Floating point
FP Fixed point
BS Length of flexible pipe leg
DS Length of the 2D expansion loop

Sample calculation using a plastic pipe (PB)
The length of the pipeline is 5 m. The thermally induced change of length of this pipe section must be absorbed by a flexible pipe leg. The difference between the installation temperature and the maximum operating temperature is 50 K.

Plastic pipe, PB, dimension	d40
Material constant C	10
Change in length Δl	32.5 mm

Calculation of the length of the flexible pipe leg

$$BS = C \cdot \sqrt{d \cdot \Delta l}$$

$$BS = 10 \cdot \sqrt{}(40\ \text{mm} \cdot 32.5\ \text{mm})$$

$$BS = \sim 360\ \text{mm}$$

In order to simplify the determination of the required length of the flexible pipe leg, a material-specific diagram can also be used to determine the length of the flexible pipe leg.

When comparing this result with the result of a metal pipe – which has the same dimension – the size of a flexible pipe leg made of metal will be significantly larger. The explanation for this is the much higher material constant C for metal pipes than the material constant C for a plastic pipe.

4.6 Diagrams – Change in length and length of flexible pipe leg

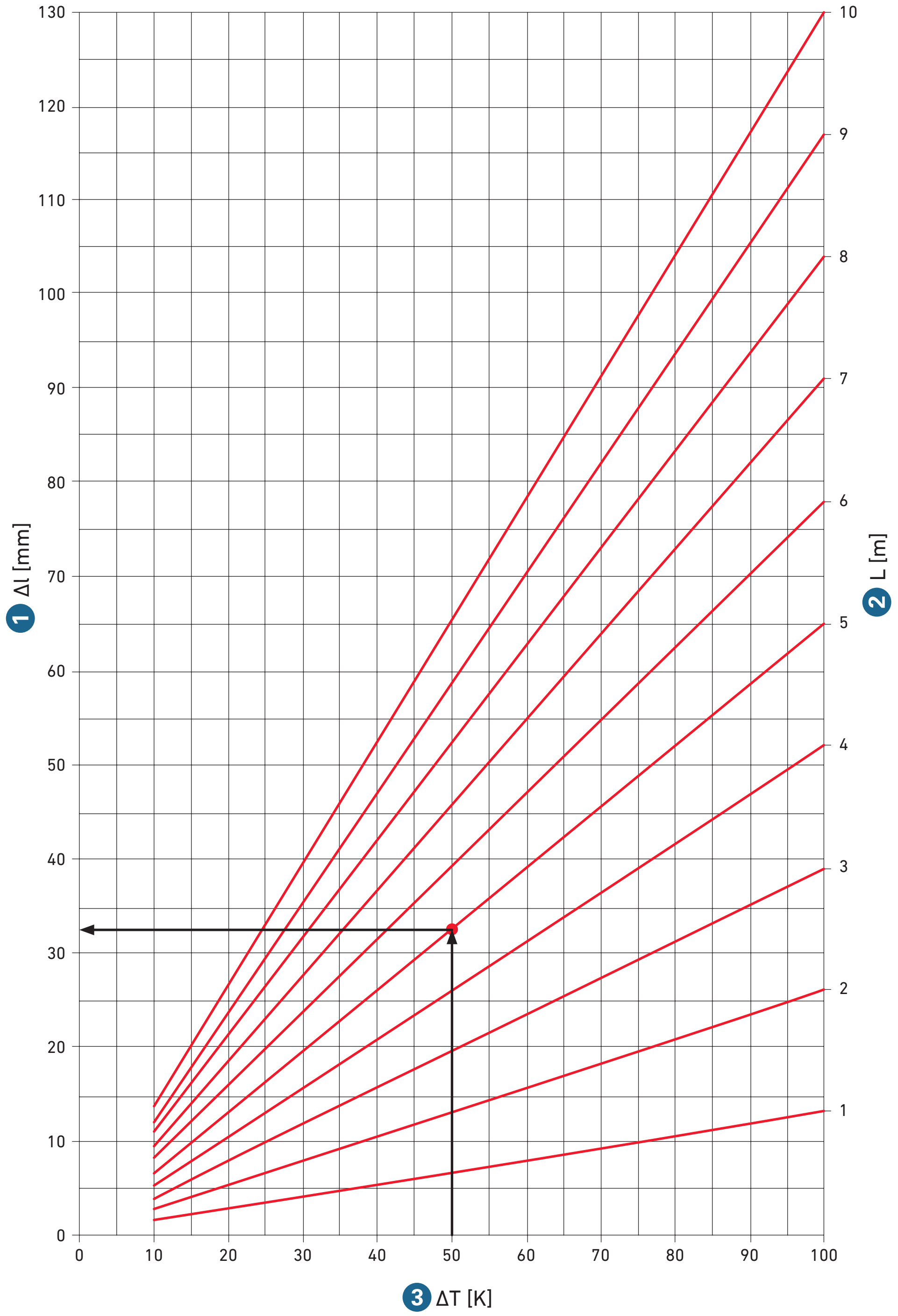
4.6.1 Change in length

The diagram shows the length expansion of INSTAFLEX pipes as a function of the temperature and length of the pipe, if installed without resistance.

How to read the table

Plastic pipe, PB, dimension	d40
Length of pipeline l	5.0 m
Linear coefficient of thermal expansion α	0.13 mm/(m·K)
Temperature difference ΔT	~50 K

Δl = ~32.5 mm



GV.28
Change in length – INSTAFLEX pipes (PB)

1. Change in length
2. Length of pipeline
3. Temperature difference

V

TV.27 **Thermally induced change of length – INSTAFLEX pipes**

Length of pipeline [m]	Temperature difference ΔT [K] 10	20	30	40	50 ▼	60	70	80	90	100
	Change in length [cm]									
0.1	0.01	0.03	0.04	0.05	0.07	0.08	0.09	0.10	0.12	0.13
0.2	0.03	0.05	0.08	0.10	0.13	0.16	0.18	0.20	0.23	0.26
0.3	0.04	0.08	0.12	0.16	0.20	0.23	0.27	0.31	0.35	0.39
0.4	0.05	0.10	0.16	0.21	0.26	0.31	0.36	0.42	0.47	0.52
0.5	0.06	0.13	0.20	0.26	0.33	0.39	0.46	0.52	0.59	0.65
0.6	0.08	0.16	0.23	0.31	0.39	0.47	0.55	0.62	0.70	0.78
0.7	0.09	0.18	0.27	0.36	0.46	0.55	0.64	0.73	0.82	0.91
0.8	0.10	0.21	0.31	0.42	0.52	0.62	0.73	0.83	0.94	1.04
0.9	0.12	0.23	0.35	0.47	0.59	0.70	0.82	0.94	1.05	1.17
1.0	0.13	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.17	1.30
2.0	0.26	0.52	0.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60
3.0	0.39	0.78	1.17	1.56	1.95	2.34	2.73	3.12	3.51	3.90
4.0	0.52	1.04	1.56	2.08	2.60	3.12	3.64	4.16	4.68	5.20
5.0 ►	0.65	1.30	1.95	2.60	**3.25**	3.90	4.55	5.20	5.85	6.50
6.0	0.78	1.56	2.34	3.12	3.90	4.68	5.46	6.24	7.02	7.80
7.0	0.91	1.82	2.73	3.64	4.55	5.46	6.37	7.28	8.19	9.10
8.0	1.04	2.08	3.12	4.16	5.20	6.24	7.28	8.32	9.36	10.40
9.0	1.17	2.34	3.51	4.68	5.85	7.02	8.19	9.36	10.53	11.70
10.0	1.30	2.60	3.90	5.20	6.50	7.80	9.10	10.40	11.70	13.00

► Example for L = 5 m: ΔT = 50 K

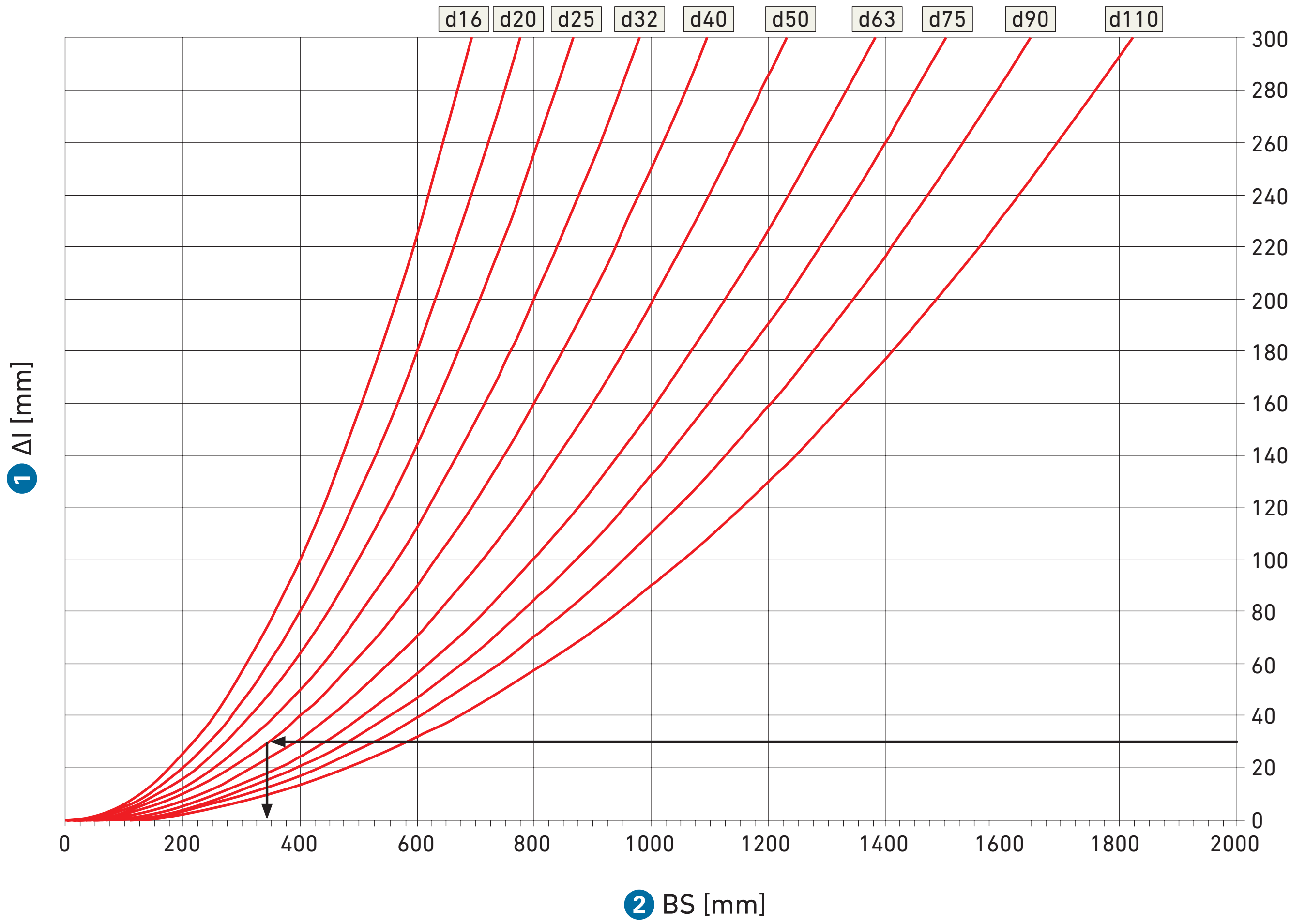
4.6.2 Length of flexible pipe leg

The length of the flexible pipe leg is derived from the pipe's change in length.

How to read the table

Plastic pipe, PB, dimension	d40
Material constant C	10
Change in length Δl	32.5 mm

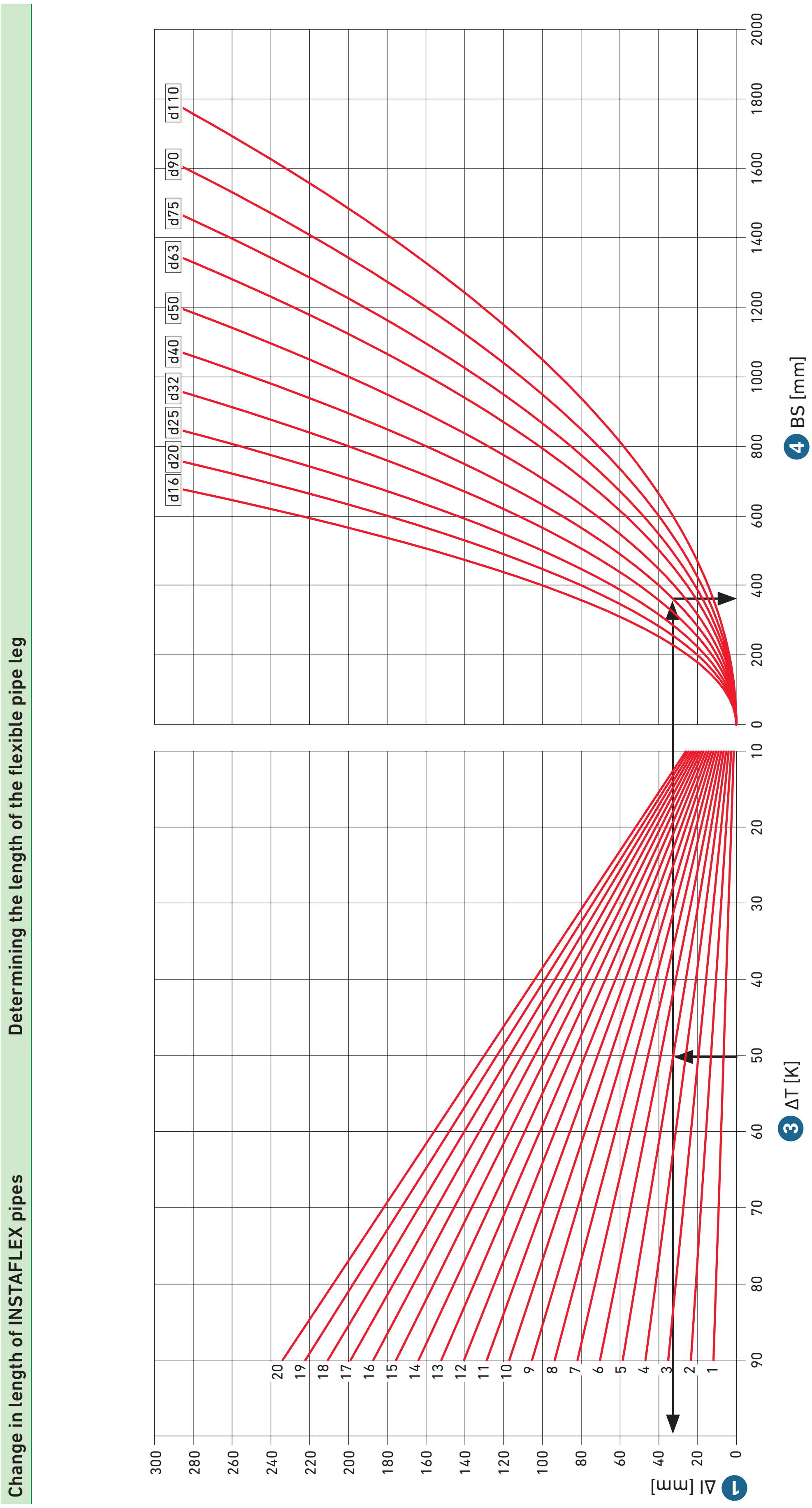
BS = ~360 mm



GV.29
Length of flexible pipe leg
1 Change in length of the pipe
2 Length of flexible pipe leg

Graphic determination of the length of flexible pipe leg

The length of the flexible pipe leg can be determined with the two combined diagrams.



How to use the diagram

1. Read off temperature difference ❸.
2. Select the length of pipeline ❷.
3. Read change of length ❶.
4. Read off the pipe dimension.
5. Read length of the flexible pipe leg ❹.

❶ Change in length
❷ Length of the pipeline
❸ Temperature difference
❹ Length of flexible pipe leg

4.7 Heat emission and insulation

4.7.1 INSTAFLEX pipes

TV.28 **Heat emission of INSTAFLEX pipes (PB)**

Dimension DN	12	15	20	25	32	40	50	65	80	90	100	150	200	300
d_a	16	20	25	32	40	50	63	75	90	110	125	160	225	315
d_i	11.6	14.4	20.4	26.2	32.6	40.8	51.4	61.4	73.6	90.0	102.2	130.8	184.0	257.8
ΔT [K]								[W/m_{Rohr}]						
20	8.8	10.7	13.8	17.2	20.6	24.7	29.6	33.7	38.2	43.7	47.2	54.3	64.5	74.3
30	13.3	16.0	20.7	25.8	31.0	37.1	44.3	50.6	57.4	65.5	70.8	81.5	96.7	111.5
40	17.7	21.4	27.7	34.4	41.3	49.5	59.1	67.5	76.5	87.3	94.4	108.7	128.9	148.6
50	22.1	26.7	34.6	42.9	51.6	61.9	73.9	84.3	95.6	109.2	118.0	135.8	161.2	185.8
60	26.5	32.1	41.5	51.5	61.9	74.2	88.7	101.2	114.7	131.0	141.6	163.0	193.4	223.0
70	30.9	37.4	48.4	60.1	72.3	86.6	103.4	118.1	133.9	152.8	165.2	190.1	225.6	260.1
k_{Rohr} [W/(m^2·K)]	0.44	0.53	0.69	0.86	1.03	1.24	1.48	1.69	1.91	2.18	2.36	2.72	3.22	3.72

4.7.2 Insulated INSTAFLEX pipes

When INSTAFLEX pipes warm up, they bend easily without large axial thrust forces due to their flexibility. This ease of movement is ensured by using insulation that is as flexible as possible. The insulation also provides protection against possible mechanical damage.

TV.29
Insulation thicknesses

Dimension d	**Room temperature [°C]**					
	15	20	25	30	35	40
d16	10	10	30	30	20	20
d20	10	10	30	30	20	20
d25	10	10	30	30	20	20
d32	10	10	30	30	20	20
d40	10	10	30	30	20	20
d50	10	10	30	30	20	20
d63	10	30	30	20	20	20
d75	10	30	30	20	20	20
d90	10	30	30	20	20	20
d110	10	30	30	20	20	20
d125	10	30	30	20	20	20
d160	10	30	30	20	20	20
d225	10	30	30	20	20	20
d315	10	30	30	20	20	20

Colour	Insulation [mm]
(light grey)	10
(medium grey)	20
(dark grey)	30

Heat emission – Sample calculation

Heat emission of a pipe

Calculation formula:

➡ Part IV 'Plan', Section 'Insulation, Fire protection', Chapter for calculating the surface temperature of the pipe

Calculation example for the heat emission of an PB pipe not insulated

$$k_{Rohr} = \frac{\pi}{\frac{1}{\alpha_i \cdot d_i} + \frac{1}{\alpha_a \cdot d_a} + \left(\frac{1}{2 \cdot \lambda} \cdot \ln\frac{d_a}{d_i}\right)}$$

k_{Pipe} Heat transfer coefficient [W/(m²·K)]
α_i Heat transfer [W/(m²·K)]
α_a Heat transfer [W/(m²·K)]
d_a Outside diameter of pipe [m]
d_i Inside diameter of pipe [m] [m]
λ Thermal conductivity of the material [W/(m·K)]

PB pipe, not insulated, d40 x 3.7

$$k_{40} = \frac{\pi}{\frac{1}{6000 \cdot 0{,}0326} + \frac{1}{10 \cdot 0{,}04} + \frac{1}{2 \cdot 0{,}19} \cdot \ln\frac{0{,}04}{0{,}0326}} = 1{,}03\ W/(m^2{\cdot}K)$$

Thermal loss

Calculating the following parameters

- Temperature difference 40°K
- Medium temperature 60°C
- Ambient temperature 20°C

$$\Phi = k_{Rohr} \cdot (v_a - v_i)$$

$$\Phi = 1{,}03 \cdot (60 - 20) = 41{,}2\ W/m^2$$

Φ Thermal losses [W/m²]
v_a Ambient temperature [K]
v_i Medium temperature [K]

Symbol	Meaning	Value
α_i	Heat transfer on the inside of the pipe	6000 W/(m²·K)
α_a	Heat transfer on the outside of the pipe	10 W/(m²·K)
λ	Thermal conductivity of a PB pipe	0.19 W/(m·K)

5 Fire protection

> **Fire protection**
> See the legal requirements as they apply to fire protection (prevention of the transmission of fire and smoke to other fire compartments) in the amended state building codes and the introductory decrees of technical building regulations (ETB).
> General information on fire protection:
> ➨ Part IV 'Plan', Section 'Insulation, Fire protection'

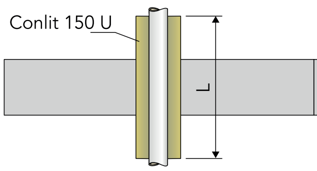
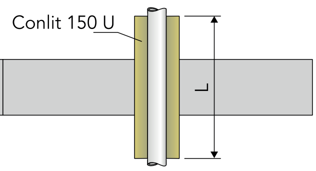
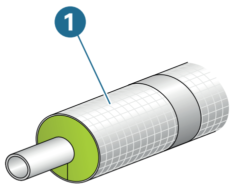
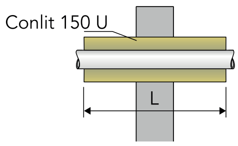
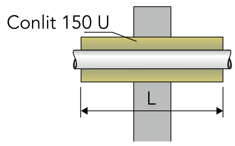
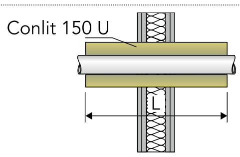
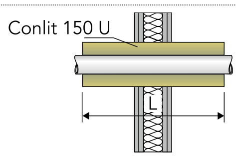
> **§ Country-specific regulations**
> The insulation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.
> ☑ When it comes to insulation methods, compliance with the applicable rules and regulations is mandatory.

5.1 Implementation with Rockwool

R30 to R90 pipe penetrations for installation systems with non-combustible media, e.g. drinking water, heating

> **Fire protection with Rockwool**
> For more information, see the Rockwool Planning Guide and the Rockwool website.

TV.30 **Components and implementation**

Component F 30 to F 90 Thickness [mm]	F 30	F 60 F 90	
Solid ceiling min. 150			 1 ROCKWOOL 800 / Teclit PS Cold Minimum thickness: 30 mm
	L ≥ 1000 mm; WD [2)]		
Solid wall min. 100			
	L ≥ 1000 mm; WD [2)]		
Lightweight partition min. 100			
	L ≥ 1000 mm; WD [2)]		

Design variant according to ROCKWOOL abP P-3276/4140-MPA BS.

TV.31 **System and components**

System	Pipe dimension	Conlit 150 U		ROCKWOOL 800 [1), 2), 3)] Teclit PS Cold [1), 2), 3)]			
	Diameter, outside Da [mm]	Type [3)]	Insulation thickness [4)] s [mm]	Core drilling THK [mm]	EnEV 100%, warm, type	EnEV 50%, warm, type	DIN 1988-200, cold, type [3)]
INSTAFLEX Polybuten [5)]	16	16/22	22	60	18/20	18/20	18/20
	20	20/20	20	60	22/20	22/20	22/20
	25	25/17,5	17,5	60	28/20	28/20	28/20
	32	32/24	24	80	35/30	35/20	35/30
	40	40/20	20	80	42/40	42/20	42/40
	50	50/25	25	100	54/40	54/30	54/40
	63	63/33,5	33,5	130	64/60	64/30	64/50
	75	75/52,5	52,5	180	76/70	76/40	76/70
	90	90/65	65	220	102/80	102/40	102/80
	110	110/70	70	250	114/100	114/50	114/100

Notes and special installation conditions

1) In individual cases, the minimum insulation thickness that can be supplied is specified.

2) The insulation shell ROCKWOOL 800 or Teclit PS Cold can be used as further insulation.

3) For cold pipes, a vapor barrier must be installed according to DIN 1988-200. Therefore, only use fire protection pipe shell Conlit 150 U, insulation shell ROCKWOOL 800 or Teclit PS Cold.

4) Insulation thickness after EnEV 50% as well as according to DIN 1988-200 suitable for core drill diameter DK

5) Sheathing (such as protective pipes or factory insulation) must be removed in the lead-through area.

All boundary conditions of the specified general building inspection test certificates (abP) must be taken into account.

6 Installation

Installation of pipelines
General technical information on installation types:
➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [13] 'Installation and attachment'
➨ Part V 'Build', Section 'Installation'

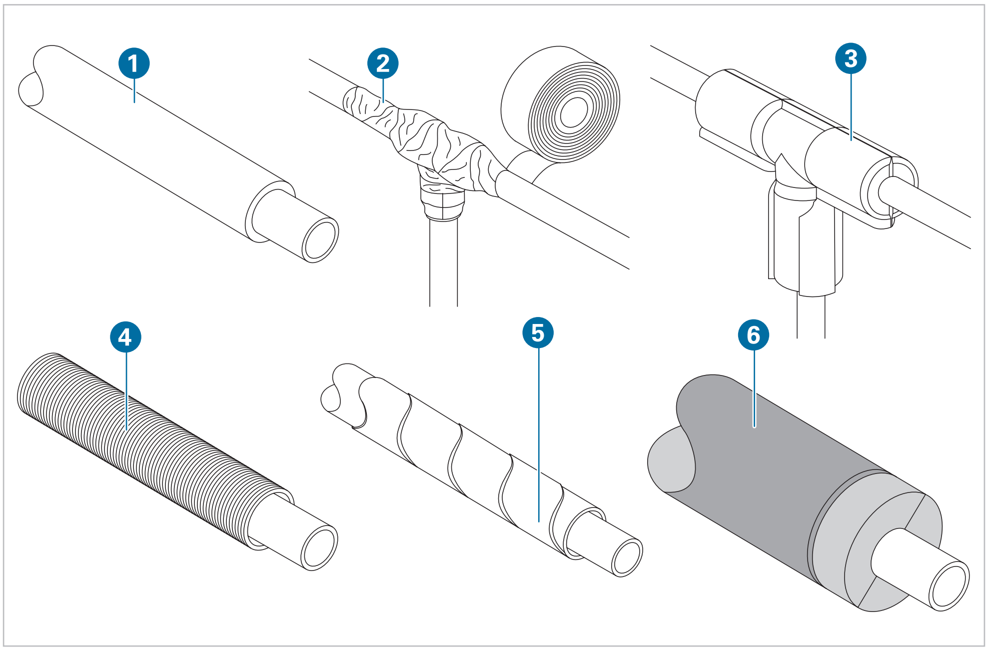
The INSTAFLEX System is suitable for the following types of installation:
- Surface or flush-mounted installations
- Installation in shafts and channels, on ceilings and on floors
- Installation in-wall, element, wood and lightweight constructions
- Installing in concrete

6.1 Protection against environmental influences and building materials

The INSTAFLEX pipes do not require any special protection. Only the brass system components need to be protected.
System components flush-mounted or concealed behind a wall:
☑ In order to absorb thermally induced changes in length, to prevent the transmission of sound, to avoid the formation of condensation, to preclude heat dissipation, heat loss or to heat the medium and to protect from other building material influences, fittings or pipes must be covered with a suitable materials or they must be separated entirely from the structure of the building.

In permanently or periodically damp rooms, in areas subject to aggressive gases or other offensive environment and under uncontrollable environmental influences:
☑ Appropriate precautions must be taken to protect the installation, e.g. by using the following measures:
  - Use of suitable anti-corrosion tapes (e.g. supplied by KEBU, Gyso or DENSO)
  - Wrapping the pipe with heat-shrinkable materials.

☑ Ensure that pipes and fittings are dry when mounting.
☑ All system components must be protected **from direct contact** with oils, greases, solvents, solvent-based adhesives (adhesive tapes), foams, bitumen (also bituminous membranes). Furthermore, the components must not **contact** building materials such as screed, concrete, mortar or plaster.
☑ Separating the piping system from the building structure is mandatory. In this case, protective conduits made of PE, wrappings, insulating hoses or pipe saddles with and without sheathing or a combination thereof shall be used.



GV.30
Safety measures
1 Pe-insulated pipe
2 Pipe with wrapping
3 Half shells
4 Protective conduit
5 Wrapping
6 Sheathing

6.2 Concealed installation flush with wall

☑ Compliance with the general requirements for the concealed installation of the pipes flush with the wall.
☑ If threaded connections are concealed behind a wall, they must be protected from moisture and contamination.

6.3 Installation in concrete ceiling

INSTAFLEX pipes inside a protective conduit may be cast in solid structures.
☑ Compliance with the general requirements for installing pipes in concrete ceilings is mandatory.
☑ Do not install threaded connections or fittings into the pipe section that will be covered in concrete.
If the GF installation accessories are used during the installation, the conditions can be met.
☑ Do not exceed 6 directional change for one 90° turn.
☑ Bending radius $R \geq 8 \times d$ must be maintained.
☑ The protective conduits must cover the entire length of the pipe.
☑ If installing in a cavity: Pipes must be secured properly, especially in the areas where directional changes take place.
☑ Make sure to prevent dirt from settling between the protective tube and the inner pipe.

6.4 Installation in a pipe shaft, basement distributor and riser pipes

☑ Compliance with the general requirements for installing pipes is mandatory.

Change in length, flexible pipe leg and 2D expansion loop, fixed and floating points
☑ When installing, observe the change in length of the pipes, the resulting 2D expansion loops and the required fixed points.

Where the pipes are in clear view, pipe saddles are used. If the pipes are concealed (in shafts, suspended ceilings, etc.) the pipe saddles can be omitted

6.5 Installation on top of a concrete ceiling

☑ Compliance with the general requirements for installing pipes on concrete ceilings is mandatory.

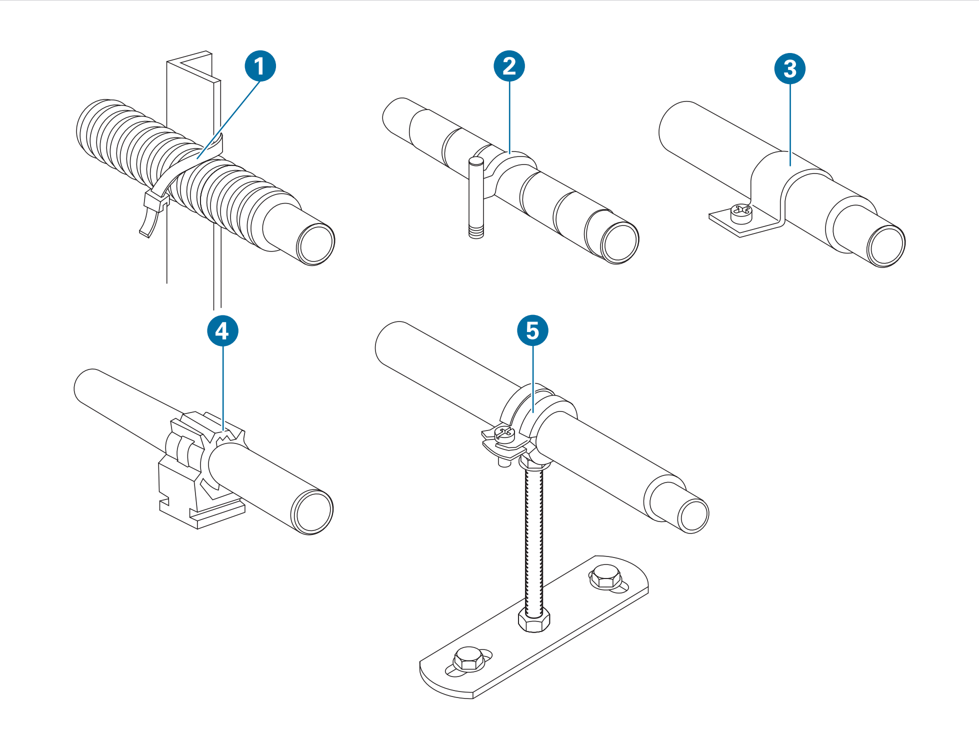
7 Attachment

Pipeline attachment
General information:
➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [13] 'Installation and attachment'

7.1 Attachment components

INSTAFLEX installations can be installed using attachment components from INSTAFLEX systems or with commercially available fasteners. The INSTAFLEX pipes d16 to d20 can be mounted using **pipe binders**, **pipe clamps**, **dowel hooks** or **pipe clips**.

☑ When using pipe clips on fixed points and floating points, which rest against the pipe, a protective tape must be inserted.



GV.31
Pipe attachments
1 Pipe binders
2 Dowel hooks
3 Pipe clip
4 Pipe clips
5 Pipe clips

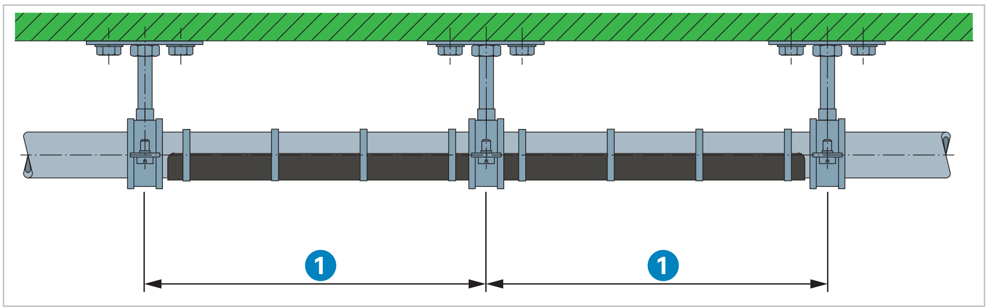
INSTAFLEX pipelines installed above ground **do not** require pipe saddles, protective conduits.

7.2 Attachment using pipe clips

NOTE! Damaged pipes due to excessive mounting distances.

→ Excessive spacing between the attachments can lead to deformation and weakening of the material as well as vibrations (formation of noise).

☑ Mounting distances BA and pipe lengths according to tables [TV.32] and [TV.33] must be observed.
☑ Observe the change in length and allow for appropriate expansion compensation.
☑ Expansion forces must be taken into account: ➨ Chapter [7.3.1] 'Elongation forces acting on the fixed point'
☑ When pipes pass through wall and ceiling openings, allowance for the fluctuations of the pipes must be taken into account.



GV.32
Mounting distances
1 Mounting distance

If using a concealed installation, an in-wall installation or on a concrete ceiling (d16 – d20)

☑ A mounting distance of 80 cm must be maintained.

Attachment when installing "pipe-in-pipe"

NOTE! Noise emissions due to pressure surges.

Pressure surges on quick-action fittings can cause noise emissions.

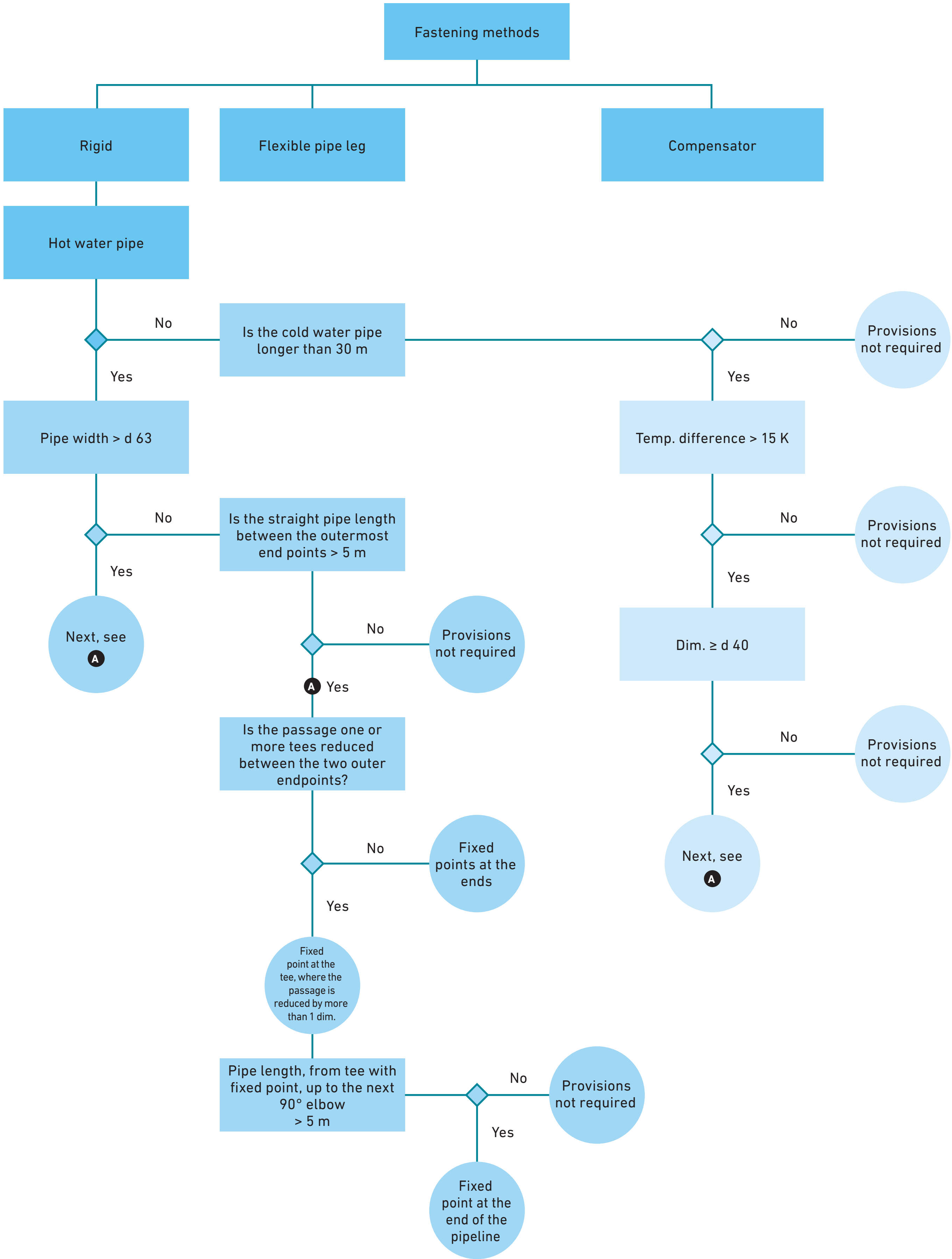
→ When using a **"pipe-to-pipe" installation** made of INSTAFLEX pipelines, appropriate precautions must be taken.

Recommendation for mounting distance

Moreover, we recommend a maximum mounting distance of 60 cm when installing with a protective conduit ("pipe-in-pipe" installation).

☑ Ensure the pipes do not kink.

7.2.1 Procedure on how to determine the fastening type and the fixed point



7.2.2 Rigid assembly

Use of pipe saddles for rigid assembly

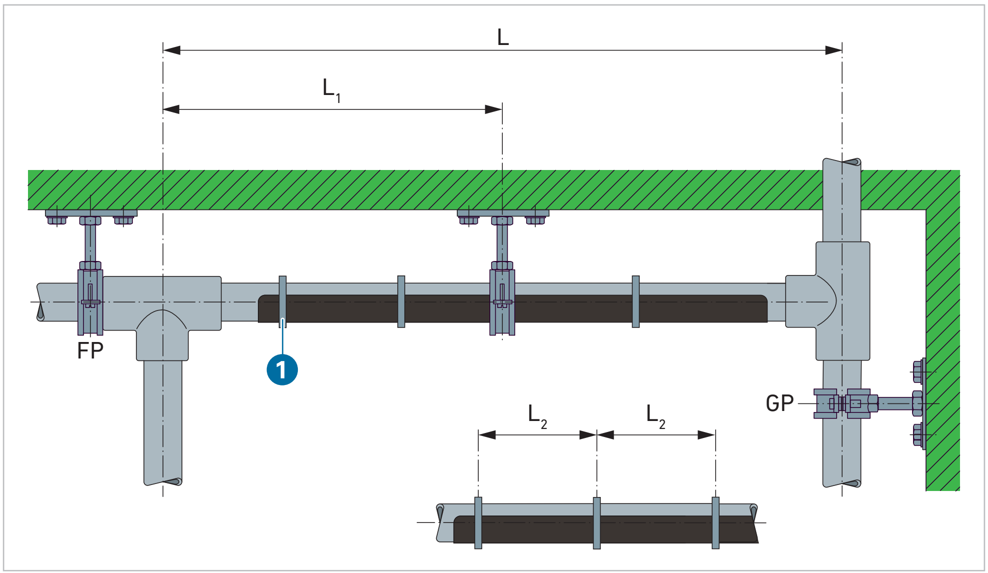
When using INSTAFLEX pipes, a rigid assembly is **only** possible in conjunction **with pipe saddles**

☑ Ensure the burrs of the pipe saddles do not damage the pipe.

TV.32 **INSTAFLEX, PB pipe mounting distances**

Pipe, Dimension d	**Mounting distances**				
		Cold water		Hot water	
	Fixed points L Spacing	Mountings$_1$ [m]	Pipe binder L_2 [m]	Mountings$_1$ [m]	Pipe binder L_2 [m]
d16 – d25	individual, depending on the construction site	1.5 – 2.0	0.5	1.5 – 2.0	0.25
d32 – d110		1.5 – 2.0	0.75	1.5 – 2.0	0.5
d125, d160		1.8 – 2.0	0.75	1.8 – 2.0	0.5
d225, d315		1.8 – 2.0	0.75	1.8 – 2.0	0.5

If a lateral deflection (bending outward) of the INSTAFLEX pipes is not desirable, the INSTAFLEX pipes can be installed using clip-on pipe saddles. The pipe saddle encloses the pipe about 60% and prevents the tube from bending outward. The thermally induced change in length is reduced as well. If the INSTAFLEX pipe with clip-on pipe saddle is installed, the latter must overlap by 25 cm, so that the thermally induced change in length is possible.



GV.33
Rigid assembly, with pipe saddles

FP Fixed point
GP Floating point
① Pipe binders
L Spacing of the fixed points
L1 Spacing of the attachments
L2 Spacing of the pipe binders

Information about plastic-compatible assembly using pipe saddles

On the one hand, the use of **pipe saddles** serves the aesthetics of the installation; on the other hand, the trays must specifically transfer the expansion force into the fixed points. If the overlap of the pipe saddles is too low, especially in the rigid assembly, it can happen that the force breaks out right there, namely at the weakest point and thus the pipe becomes crooked.

For the assembly with pipe saddles

☑ All piping installed in clear view and horizontal pipes must be mounted with pipe saddles.

☑ Always overlap the pipe saddles by at least 25 cm and pipe ties (cable ties) to fasten them. This ensures stability and a straight run of the pipeline.

☑ Clip-on type support saddles must be attached flush with each other.

7.2.3 Assembly of flexible pipe legs

☑ Do not install pipe saddles with the flexible pipe leg
☑ Flexible pipe legs in a concealed installation must be wrapped with elastic material (mineral wool, foam material, etc.); this will not prevent expansion of the pipe's length.

The flexible INSTAFLEX pipes allow the absorption of thermally induced changes in length due to short flexible pipe legs.

TV.33 **INSTAFLEX, PB pipe, pipe lengths**

Pipe, Dimension d	Cold water pipelines up to 20°C			Hot water >20°C		
	without pipe saddles	**with** pipe saddles	Pipe binders	**without** pipe saddles	**with** pipe saddles	Pipe binders
	L_1 [cm]	L_2 [m]	[m]	L_1 [cm]	L_2 [m]	[m]
d16	50	approx. 1.5 – 2	0.5	35	approx. 1.5 – 2	0.25
d20	60			40		
d25	70			45		
d32	80	approx. 1.5 – 2	0.75	50	approx. 1.5 – 2	0.5
d40	100			50		
d50	120			60		
d63	140			75		
d75	160	approx. 1.5 – 2	0.75	90	approx. 1.5 – 2	0.5
d90	180			110		
d110	200			130		
d125	200	2.0	0.75	150	approx. 2.0	approx. 0.5
d160	200			190		
d225	200			190		
d315	200			190		

V

7.3 Fixed points design

➕ **Fixed points should always be installed next to a fitting and the fitting should be supported on both sides.**

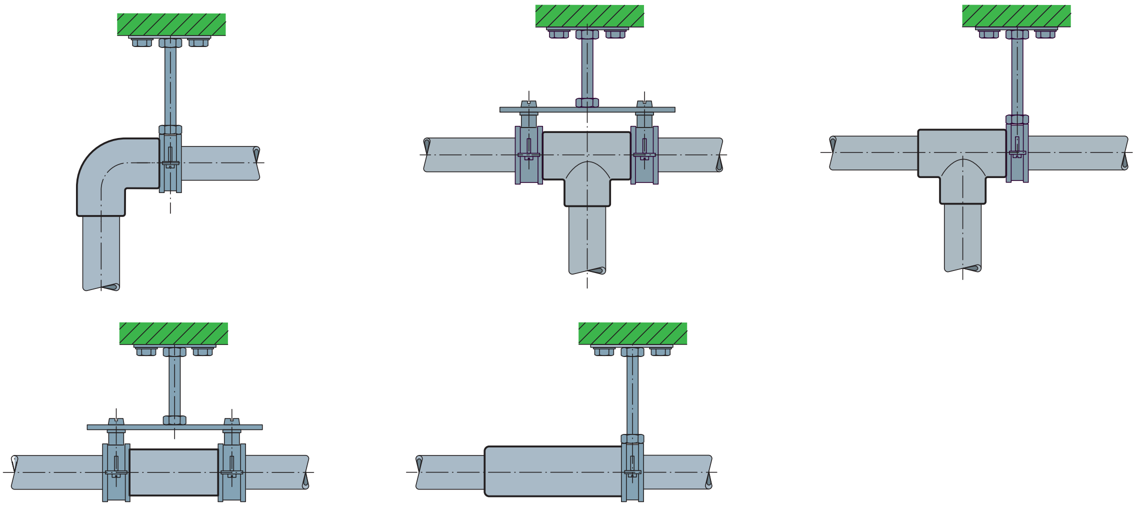
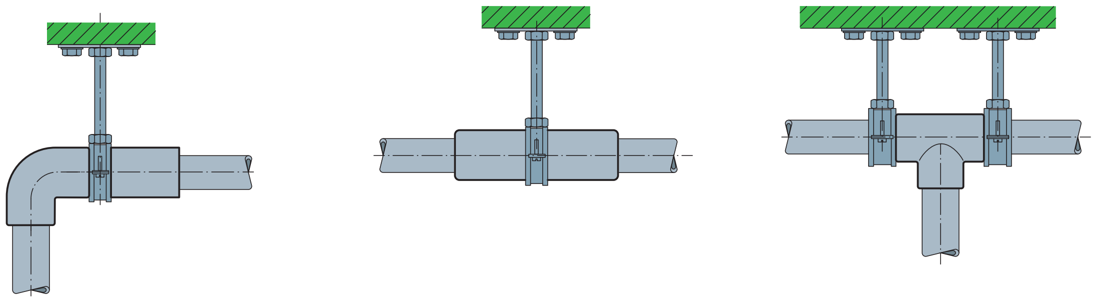
☑ When using metal valves **up to d63**: Considering 2 clips for attachment purposes.

☑ When using metal valves **starting at d75**: Attachment connected directly to the valve.

Fixed point attachment for pipes up to d63 and from d75

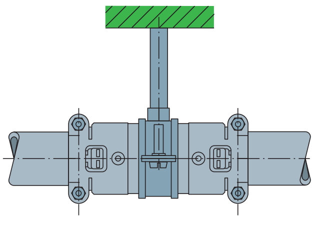
Polybutene (PB): Due to the low expansion forces, commercially available pipe clips with PVC insert tapes are sufficient for this plastic pipe **up to d63**.

TV.34 **Fixed points design**

Pipe, Dimension d	Fixed points design
≤d63	
≥d75	

Fixed points design with half HWS sockets

This is a special fitting for simple and inexpensive attachment of a fixed point clamp with the help of a factory separate electric socket.



Fixed point design with half HWS sockets
→ For questions about this application, contact your sales company.

7.3.1 Elongation forces acting on the fixed point

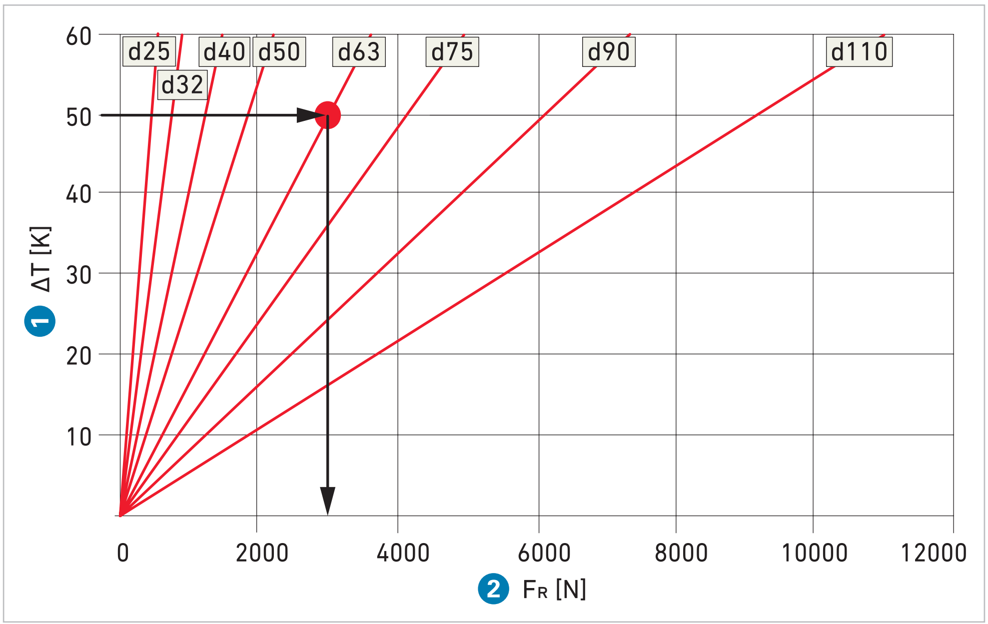
Elongation forces acting at different temperatures

- **During the planning and installation of pipelines, in addition to the thermally induced change of length, the occurring tensile forces, in particular in the case of a rigid assembly, must also be taken into account. Depending on the pipe dimension, these forces can have a significant impact on the required fixed point attachment.**
- **In a rigid assembly, the forces acting on the fixed points are much higher than in the flexible pipe leg assembly. For larger wall and ceiling spacings, an additional support structure is required.**

In a **rigid assembly,** the occurring expansion forces are transferred from the fixed point attachment to the structure. The initial expansion forces that occur during a **rigid assembly** change over time to tensile forces, depending on the stress caused due to temperature changes. Therefore, when designing the fixed point attachment, it must be ensured that not only **expansion forces** but also **tensile forces** can be absorbed.

Elongation forces at the fixed point
General information on elongation forces at the fixed point and applicable calculations:
➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [13] 'Installation and attachment'

Elongation forces on the INSTAFLEX pipe (PB)

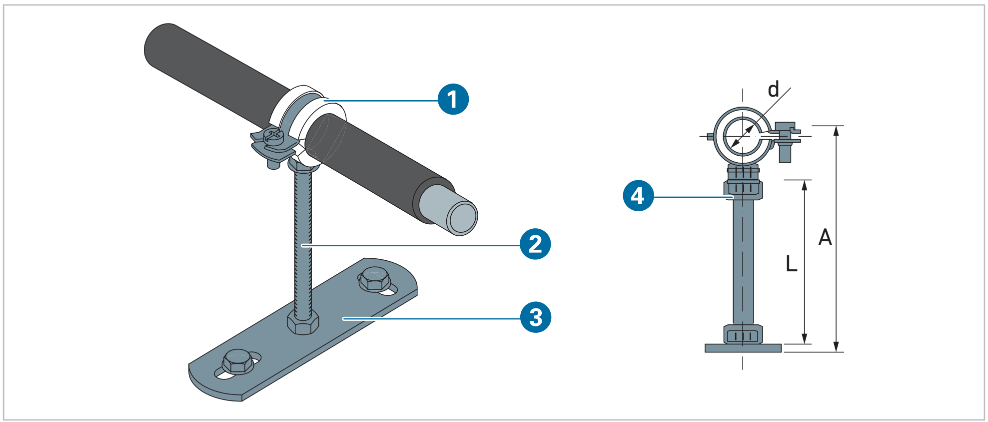


GV.34
Elongation force F_R (INSTAFLEX, PB pipe)
1 Temperature difference
2 Elongation force

Sample calculation
The difference between the installation temperature and the operating temperature is 50 K.
The dimension of the used INSTAFLEX pipe is d63.
The diagram indicates a tensile force of 3047 N.

Design of a fixed point with pipe clip and base plate

The design of a fixed point with pipe clip and base plate is laid out as follows



GV.35
Design of a fixed point with pipe clip

1. Pipe clip
2. Threaded rod
3. Base plate
4. Reducing piece M10 – ½″

d Pipe dimension
L Length of the threaded rod
A Centre distance

Space between ceiling [cm]	d16	d20	d25	d32	d40	d50	d63
10	M10	M10	M10	M10	M10	M10	½″
15	M10	M10	M10	½″	½″	½″	½″
20	M10	½″	½″	½″	½″	½″	½″
25	½″	½″	½″	½″	½″	½″	½″
30	½″	½″	½″	½″	½″	½″	¾″
35	½″	½″	½″	½″	½″	¾″	¾″
40	½″	½″	½″	½″	½″	¾″	¾″

TV.35
Selection of threaded rod

All data refer to a temperature difference of 60 K.

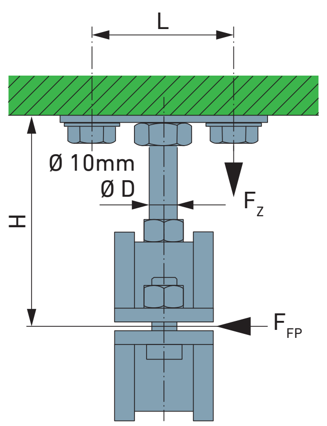
Formula for calculating the length of the threaded rod

$$L = A - x$$

	Pipe clip, dimension d	d16	d20	d25	d32	d40	d50	d63	d75
Value **x** if threaded rod	M10	27	31	33	38	42	46	53	60
	½″	49	53	55	60	64	68	75	82

TV.36
Pipe clips and threaded rod

Calculation of the holding force at fixed points



GV.36
Fixed point attachment

D Diameter of the attachment
H Pipeline spacing between ceiling and wall
L Screw spacing
X Number of tensioned screws
F_{FP} Fixed point force (N)
F_Z Holding force of screws or dowels (N)

Formula for calculating the retention force of screws

$$F_Z = (F_{FP} \times H) / (L \times X)$$

- **X** if using 2 hole base plate: 1
- **X** if using 4 hole base plate: 2

Calculation example for PB pipe and 4-hole base plate

$$F_Z = (3047 \text{ N} \times 20 \text{ cm}) / (12 \text{ cm} \times 2) = \sim 2540 \text{ N}$$

Holding force per screw: ~2540 N

7.4 Floating points design

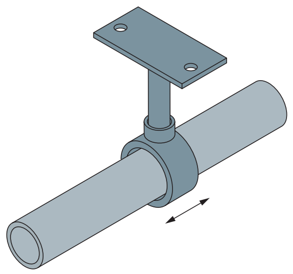
+ The floating points allow the movement of the pipeline in the axial direction.

☑ Ensure that the pipe guide is not canted.

☑ A protective tape must be inserted into the sliding pipe clamps in order to prevent damage to the pipe.

Diameter of pipe and fitting

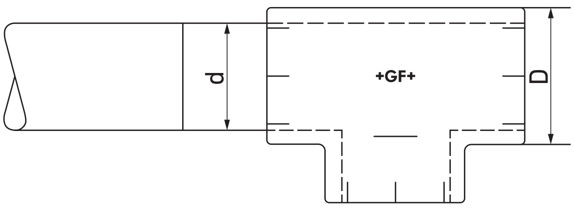
The diameter of the socket corresponds approximately to the respective larger pipe diameter d.



GV.37
Illustration of the pipe's mobility inside the pipe clip (floating point)

TV.37
Fixed points design with pipe clip

Pipe, Dimension d	Fitting, diameter D [mm]
d16	22
d20	26
d25	32
d32	40
d40	51
d50	64
d63	81
d75	93
d90	112
d110	134



7.5 ROM pipe clips

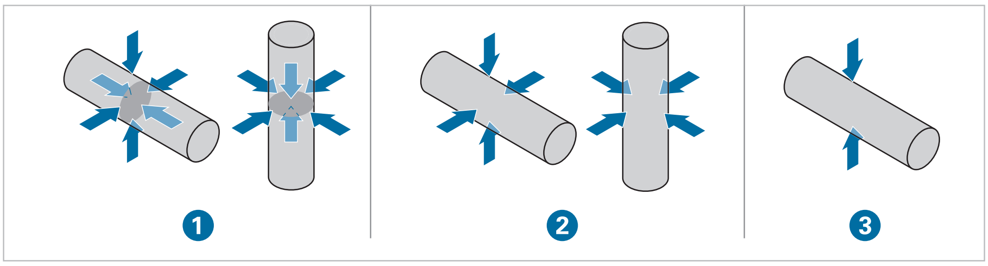
The pipe clip ROM consists of a Ω-shaped pipe clips bridge with a rubber insert, which is screwed onto a stable base plate and supports the PB pipe without changing its shape (no constriction or pinching).

7.5.1 Usage and application areas

TV.38
ROM pipe clips

GF code	Size	Use of pipe, dimension d	maximum forces [N] (if using a fixed point attachment)	Weight [kg]
761 070 337	ROM 125	d125	8.5	0.512
761 070 338	ROM 160	d160	15.0	0.585
761 070 343	ROM 225	d225	35.0	1.260

The ROM pipe clips are approved for the following installation situations:



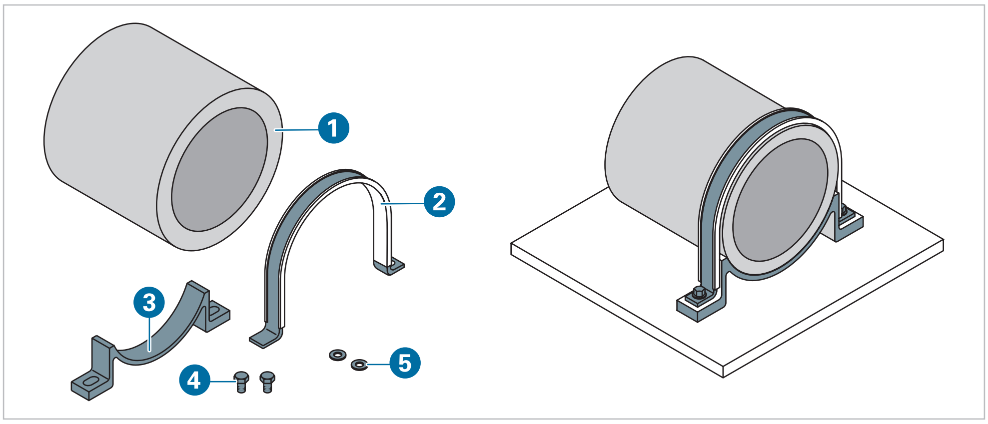
GV.38
Applications

1. Fixed point
2. Floating point
3. Weight point

More information
More information is available from GF Service.

7.5.2 Components

The ROM pipe clips comprise the following components:

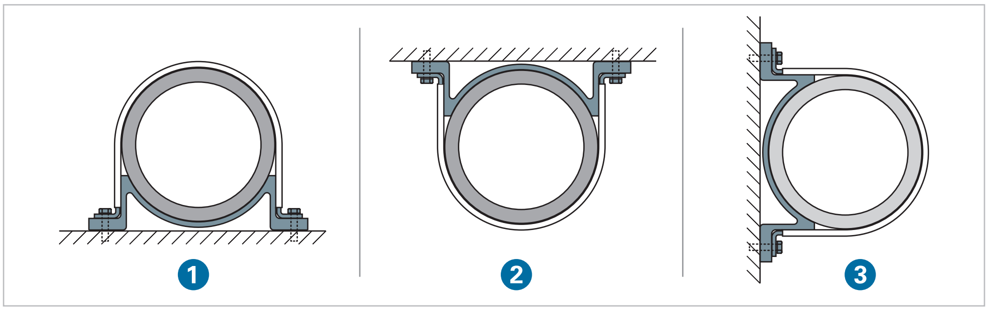


GV.39
ROM, components

1. PB pipe
2. Ω-shaped clips with rubber insert
3. Base plate
4. 2 screws
5. 2 washers

7.5.3 Assembly

The following mounting positions are permitted:



GV.40
Applications

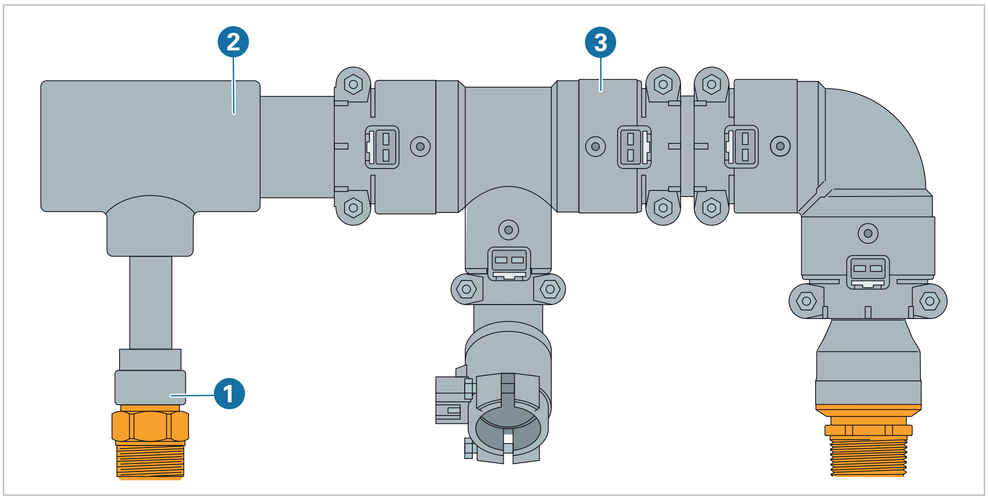
1. upright (standing)
2. suspended
3. laterally

8 Connection

Jointing technology
General information on connection techniques:
➨ Part III 'The basics', Section 'Materials and jointing technology'

8.1 Overview

The INSTAFLEX installation system offers different connection techniques for different applications:

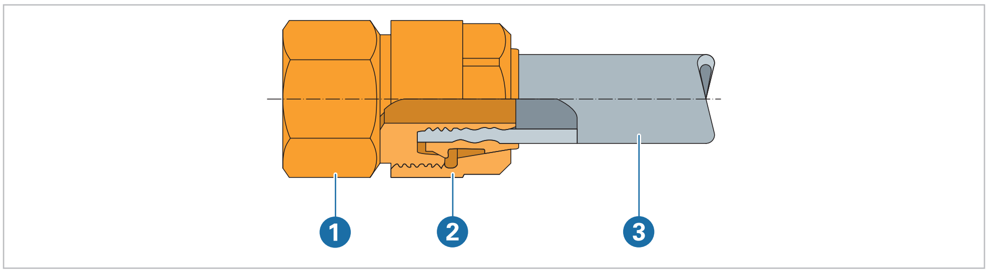


GV.41
Jointing technologies
1. Clamp connection d16 – d110
2. Socket fusion welded connection (HMS) d16 – d110
3. Electrofusion (HWS) (d16 – d225)

- Clamp connection: as connection and transition to other materials
- Welded connections:
  - Socket fusion connection: cost-effective variant in prefabrication
  - Electrofusion connection: for quick and safe assembly on the construction site

8.2 Clamp connection

The INSTAFLEX compression joints are plastic-compatible, reliable and economical.
- The compression joints take into account the creep behaviour through separation of functions in holding and sealing areas, the notch behaviour due to wavy holding profile and tolerances in pipe production due to the internal calibration of the pipe ends.
  - In the holding area there is a rounded wave-shaped profile.
  - In the sealing area there is an angular, saw-like profile.
- Together, they allow a permanently sealed connection without O-rings. This type of connection can be installed and concealed **under the plaster**
- They are suitable for transitions from plastic to metal.
- They ensure a simple, fast and safe assembly without special tools.



GV.42
Clamp connection
1. Thread transition
2. Threaded clamp connection
3. PB pipe

8.3 Welded connections

When using polybutene (PB) material, the welded connection can be used as a secure, firmly bonded pipe connection in sanitary installations.

Procedure

Three welding methods are most common, which are described in more detail below.

- Socket fusion welding; also referred to as “heating element socket fusion welding”, “HMS”
- Electrofusion; also referred to as "heating coil welding", "HWS"
- Butt fusion welding

Welding INSTAFLEX pipes
GF Piping Systems offers a special training program welding INSTAFLEX pipes and INSTAFLEX fittings.

8.4 Flange connections

Detachable fittings or flange connections with a gasket are used to connect plastic pipes and plastic pipes with fittings (valves, pumps) of various dimensions.

When manufacturing flange connections with O-rings, the screw tightening forces that are required are minimum. In order to avoid excessive torque on the screws, it is recommended to use a torque wrench and to follow the manufacturer's instructions for the system.

TV.39
Guide values for fastening flange connections using an O-ring

Feature	Values												
Pipe, Dimension d [mm]	16	20	25	32	40	50	63	75	90	110	125	160	225
Torque [Nm]	10	10	15	15	15	25	35	40	40	50	50	60	75

9 Assembly

9.1 Clamp connection

☑ Compliance with the tool's operating instruction is mandatory.
☑ Make sure, the tool is working properly.

9.1.1 Assembly – Pipes (d16 – d20)

⚠ **Using the wrong tool will damage the pipe!**
→ In order to shorten the protective conduit, use only the pipe cutter for the protective conduit. This will prevent damage to the conduit.

ℹ **The individual steps are illustrated on the next page.**

Clamp connection – Connecting pipes (d16 – d20)

Preparing the pipe, cutting the protective conduit

① → Cut the pipe and protective conduit to length using the pipe cutter.

② → Determine the length of the protective conduit part that must removed using the aid of the protective pipe cutter integrated into the pipe cutter.

③ ⚠ **Damage to the pipe when the protective conduit is cut to length!**
→ Proceed with caution and make sure that the inside pipe is not damaged.

→ Insert the protective conduit into the grooves of the protective conduit cutter, lightly squeeze it and move it back and forth.
→ Completely turn off the separated part from the protective conduit.

Make the clamp connection

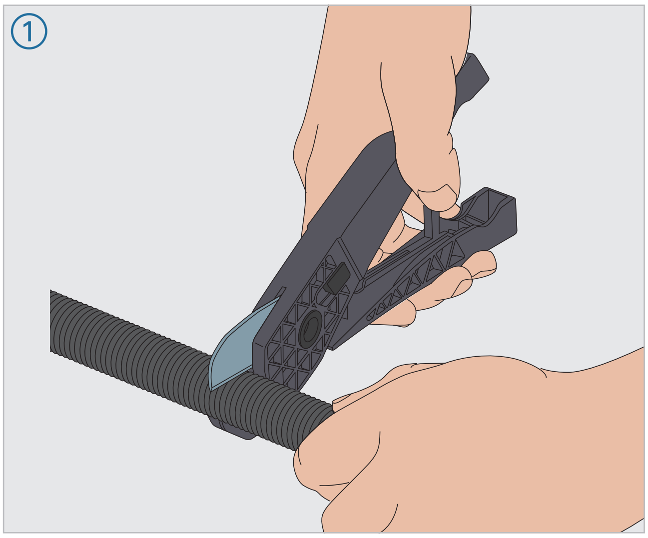
④ → Mark the insertion depth.

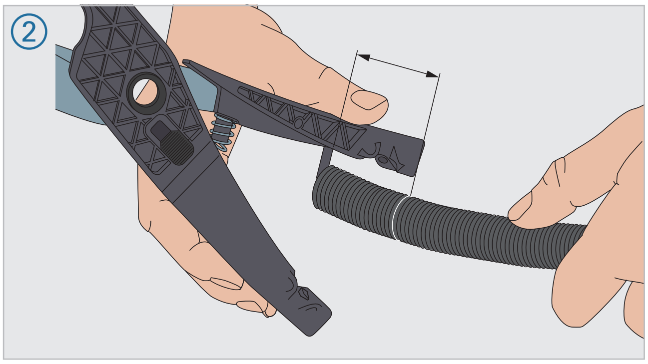
⑤ → Insert the pipe into the fitting up to the marking.

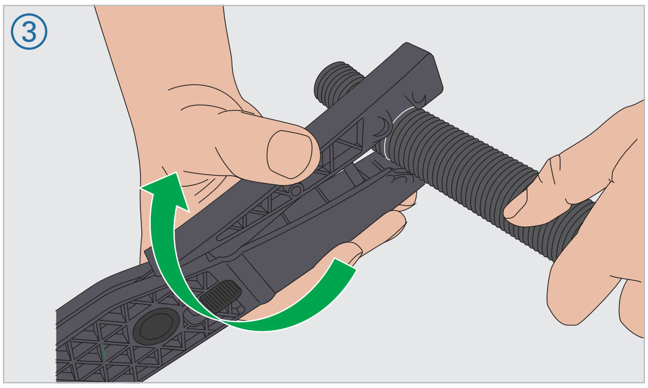
⑥ → Use the ratchet key to tighten the coupling nut.

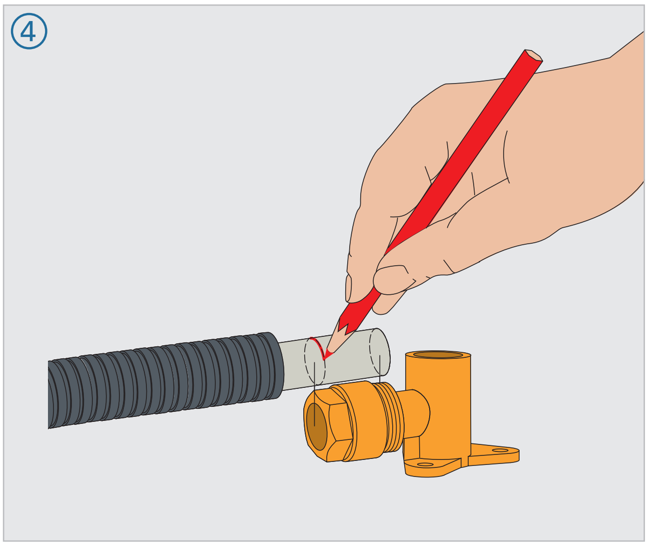
⑦ → Check the clamp connection.
☑ About 1 mm of the clamping ring must be visible.

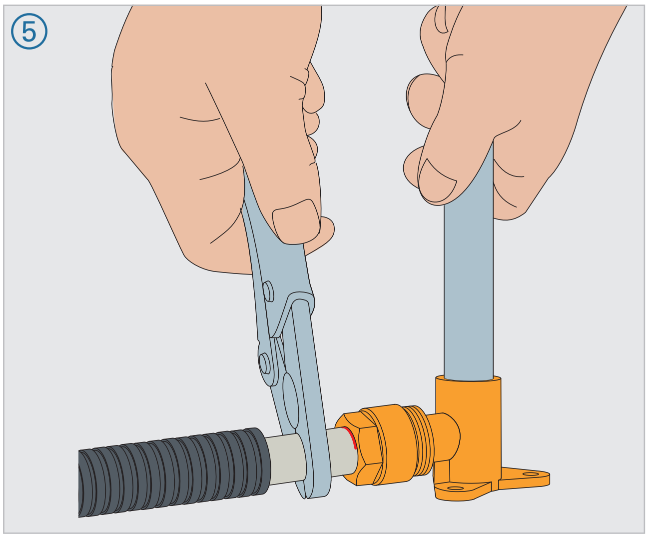
Clamp connection – Assembling the pipes (d16 – d20)

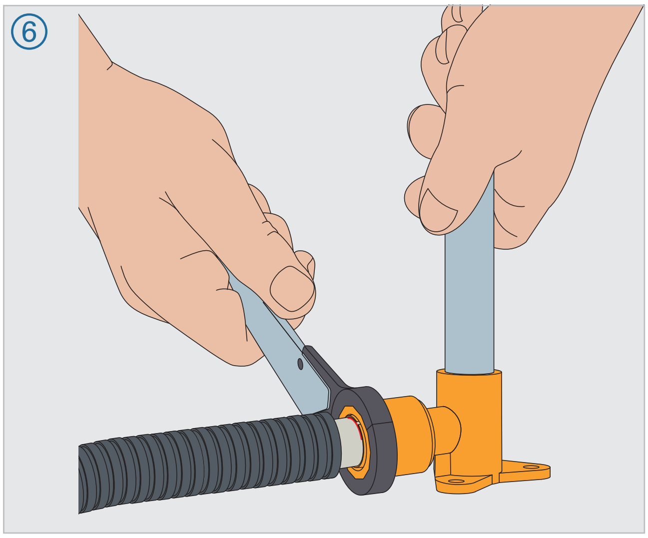


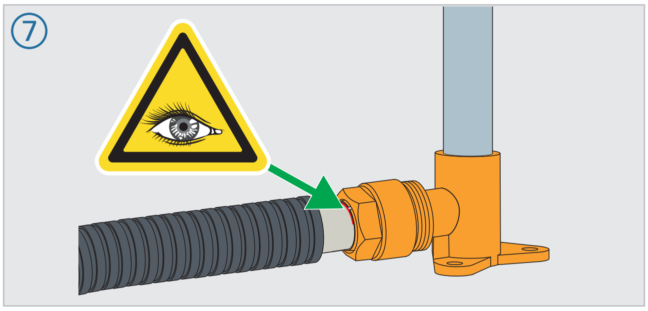












9.1.2 Assembly – Pipes (d25 – d50)

The individual steps are illustrated on the next page.

Clamp connection – Assembling the pipes (d25 – d50)

Preparing the pipe

① → Use the pipe cutter in order to cut the pipe at right angle.

Make the clamp connection

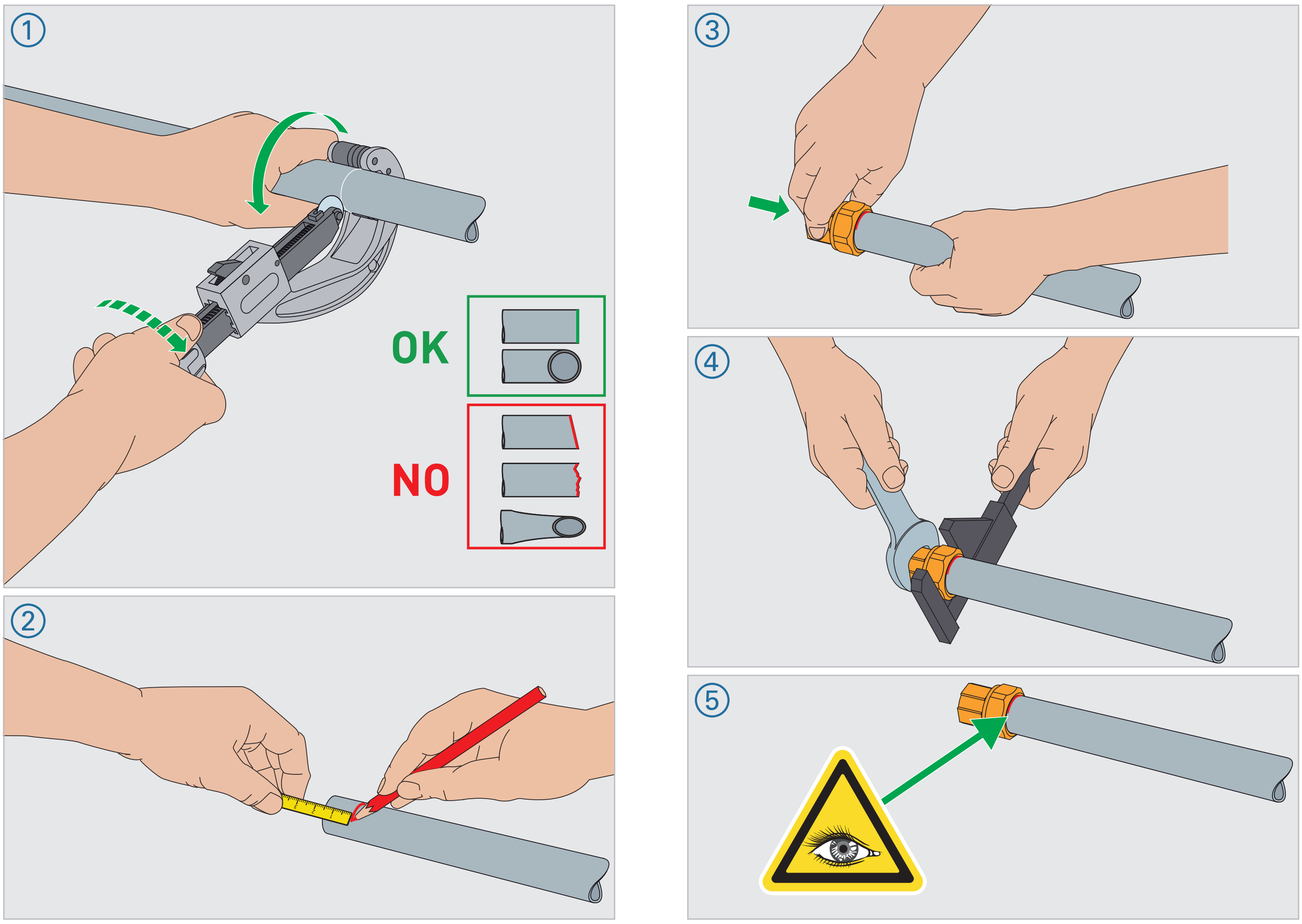
② → Mark the insertion depth.

③ → Insert the pipe into the fitting and up to the marking.

④ → Use a wrench to tighten the screw connection.

⑤ → Check the clamp connection.

Clamp connection – Assembling the pipes (d25 – d50)



9.2 Flange connection

☑ Compliance with the tool's operating instruction is mandatory.
☑ Make sure the tool is working properly.

9.2.1 Assembly – Pipes (d63 – d75)

The individual steps are illustrated on the next page.

Flange connection – Assembling the pipes (d63 – d75)

Preparing the pipe

① → Use the pipe cutter in order to cut the pipe at right angle.

② → Use a chamfering tool to chamfer the pipe.

Proceed with the flange connection

③ → Slide the flange and clamping ring over the pipe.
→ Insert the back-up ring.

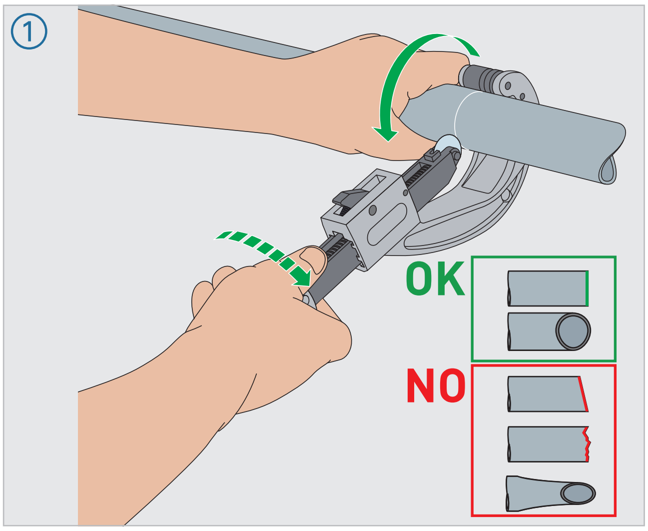
④ → Tap in the back-up ring completely.
→ To do this, use a mallet.

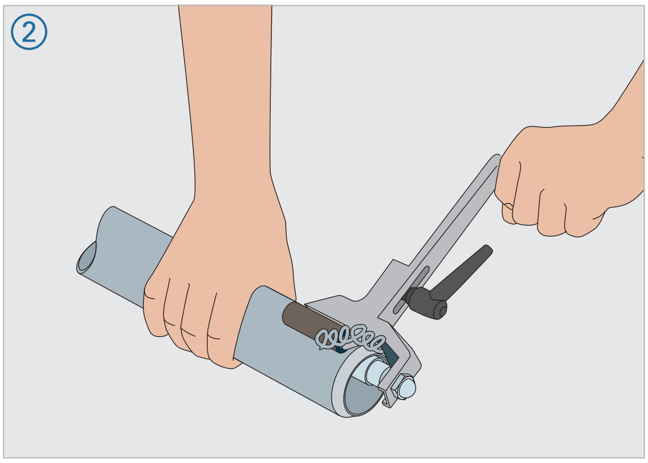
⑤ → Push screw connection flange onto the pipe as far as it will go.

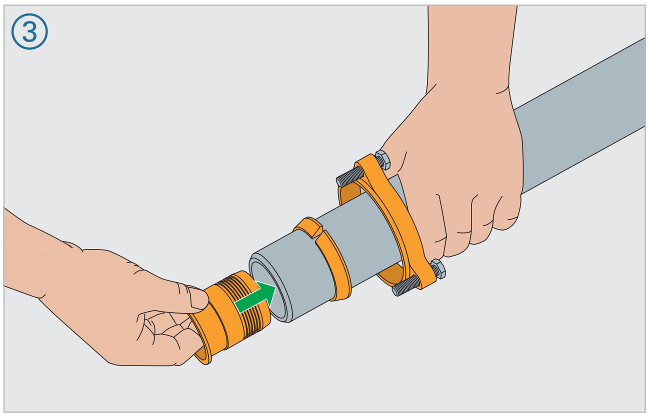
⑥ → Push the flange onto the screw connection flange.
→ Tighten screws evenly until a form-locking fit between the flange and the screw connection flange is ensured.

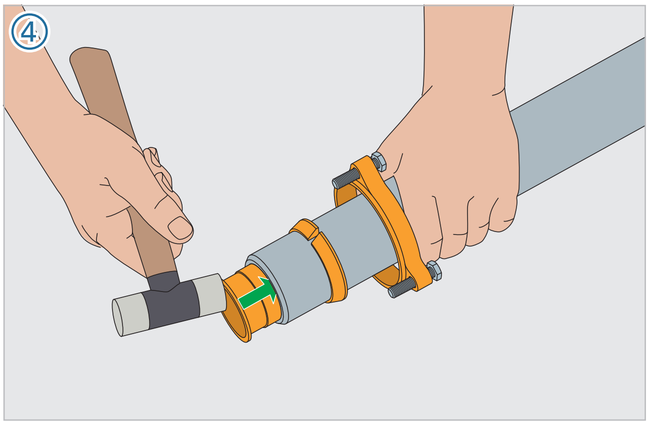
⑦ → Check connection.
☑ A form-locking fit is required.

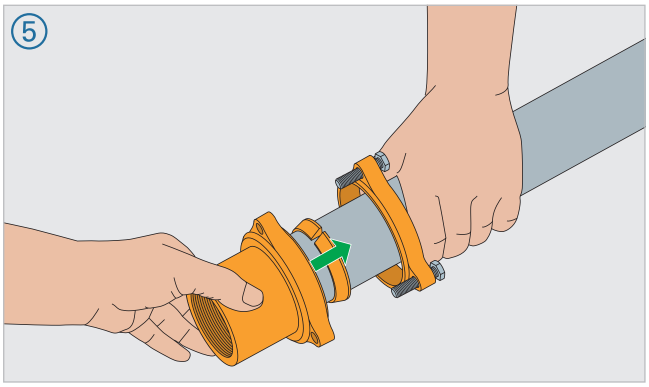
Flange connection – Assembling the pipes (d63 – d75)

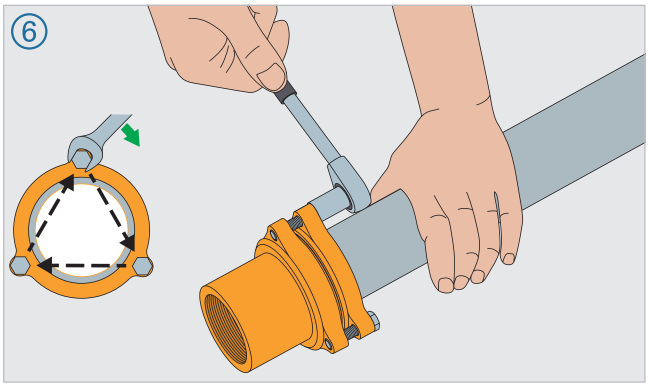


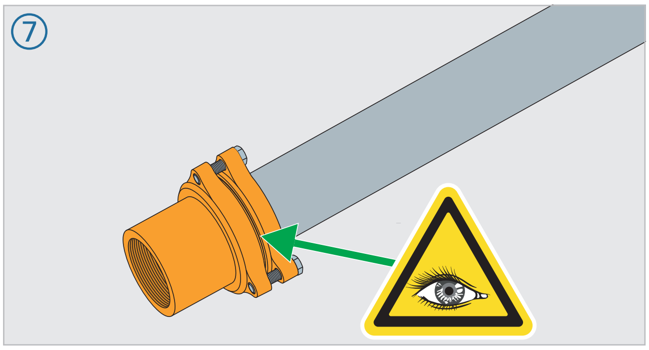












9.2.2 Assembly – Pipes (d90 – d110)

The individual steps are illustrated on the next page.

Flange connection – Assembling the pipes (d90 – d110)

Preparing the pipe

① → Use the pipe cutter in order to cut the pipe at right angle.

② → Use a chamfering tool to chamfer the pipe.

Proceed with the flange connection

③ → Slide the flange, clamping ring, back-up ring and O-ring over the pipe.
→ Insert the back-up ring.

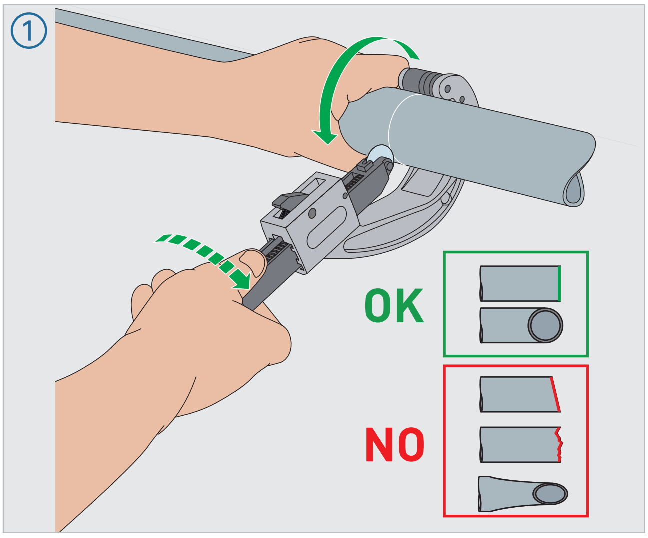
④ → Tap in the back-up ring completely.
→ To do this, use a mallet.

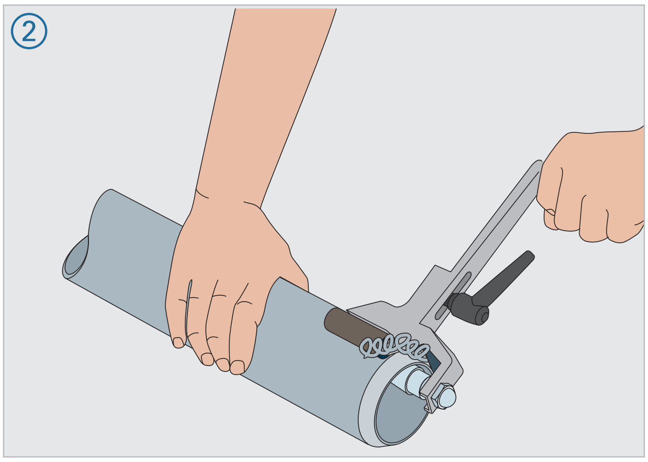
⑤ → Push screw connection flange onto the pipe as far as it will go.

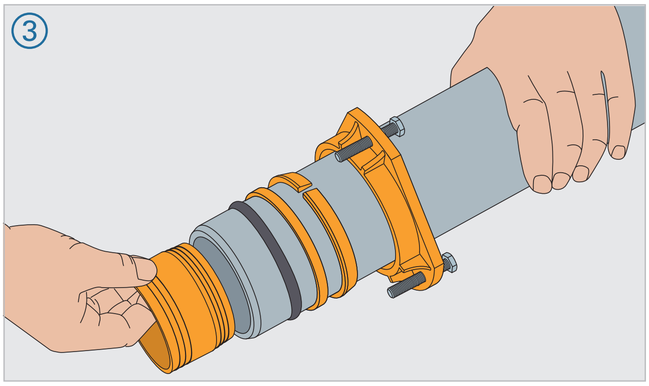
⑥ → Push the flange onto the screw connection flange.
→ Tighten screws evenly until a form-locking fit between the flange and the screw connection flange is ensured.

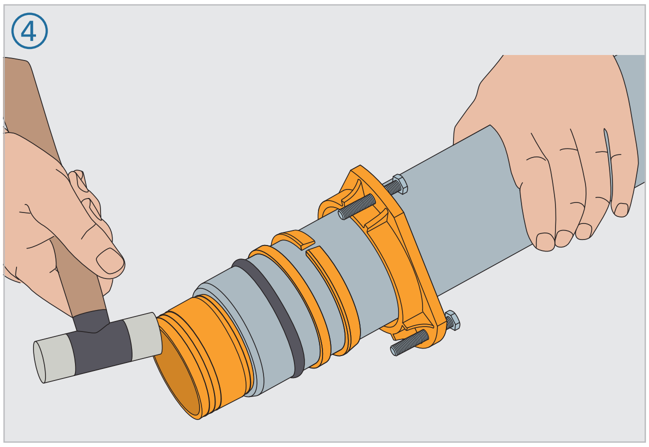
⑦ → Check connection.
☑ A form-locking fit is required.

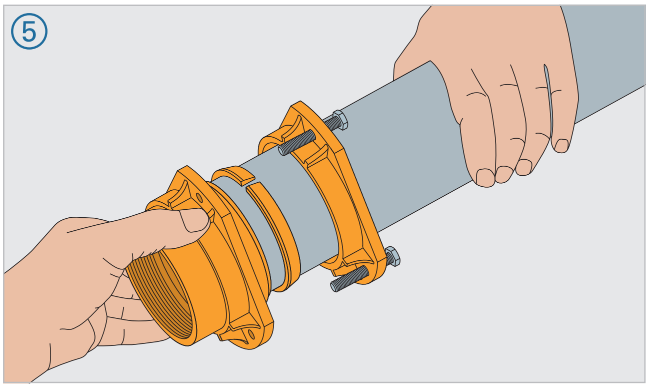
Flange connection – Assembling the pipes (d90 – d110)

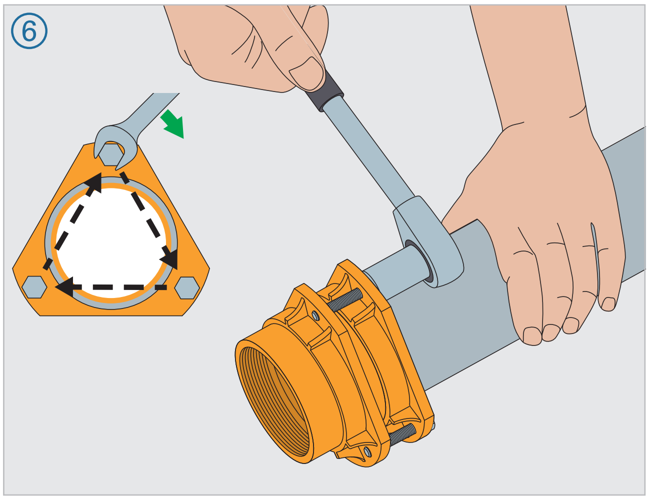


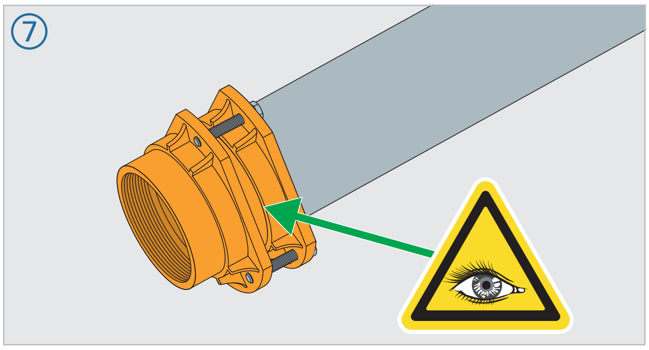












9.3 Socket fusion welding (HMS)

☑ Compliance with the tool's operating instruction is mandatory.
☑ Fusion device and fusion area must be protected against moisture and dirt.

Welding can be carried out up to a temperature of -10°C, if complying with the required fusion parameters.

9.3.1 Preparation – Pipes (d16 – d110)

The individual steps are illustrated on the next page.

Socket fusion welding – Preparing the pipes (d16 – d110)

Before the welding

NOTE! Welding defect due to damaged or worn heating bushes!
→ Replace the heating bushes.
→ Send old heating bushes to GF for recoating.

Preparing the pipe and fitting

It is not necessary to mark INSTAFLEX pipes and fittings as the corresponding markings are applied to the pipes and fittings at the factory.

① → Cut off pipes at a right angle using commercially available tools.
→ Deburr the inside of the pipe, if necessary.

Chamfer the pipe

Only pipes starting at dimension d32 require chamfering.
→ Pipes with dimensions **d16**, **d20** and **d25 do not** require processing.

② Chamfering reduces the force needed to insert the cold pipe into the heating bush. Furthermore, this ensures that the pipe is securely inserted into the socket-shaped heating bush.
→ Pipe ends can be chamfered at an angle of 15° and up to half the wall thickness.

Cleaning the pipe and fitting

③ ☑ Tangit KS wipes
☑ Ethyl alcohol-based cleaning agent: Tangit KS cleaning agent
→ Clean pipe and fitting with absorbent, non-fibrous paper. Moisten paper slightly, if necessary.

Immediately before the beginning of welding:
→ Clean the connecting surfaces of the parts to be welded (fitting and pipe end).
→ Use the cleaning paper to remove the cleaning fluid completely.

Mark the joint depth

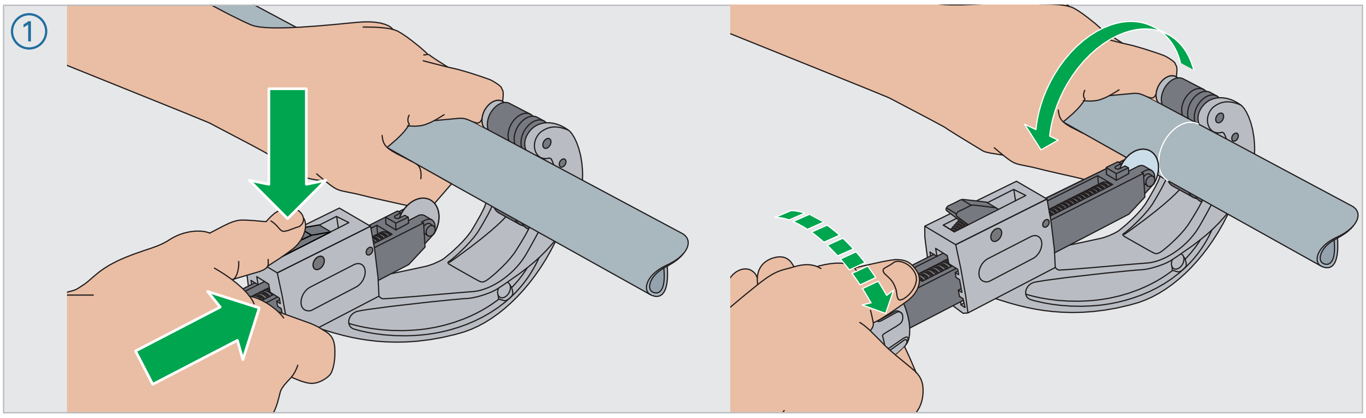
④ → Keep connecting surfaces clean during all processing steps.
→ Mark the joint depth.

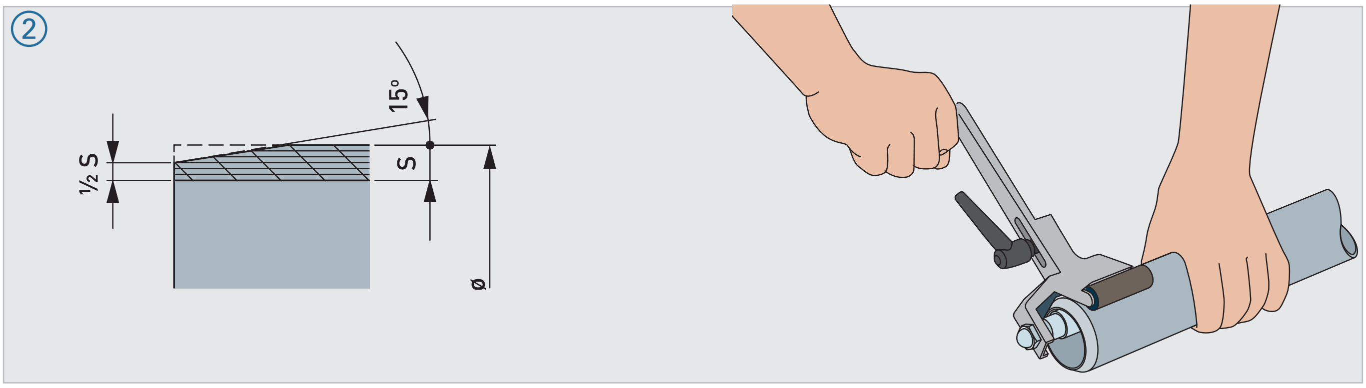
Fusion welding

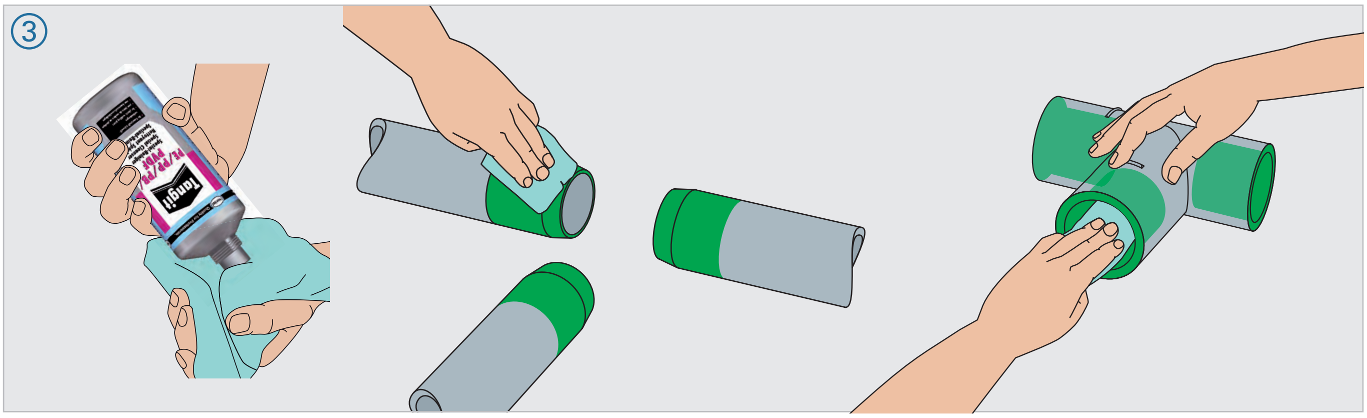
The welding is done using the **heating element** or the **fusion machine**.

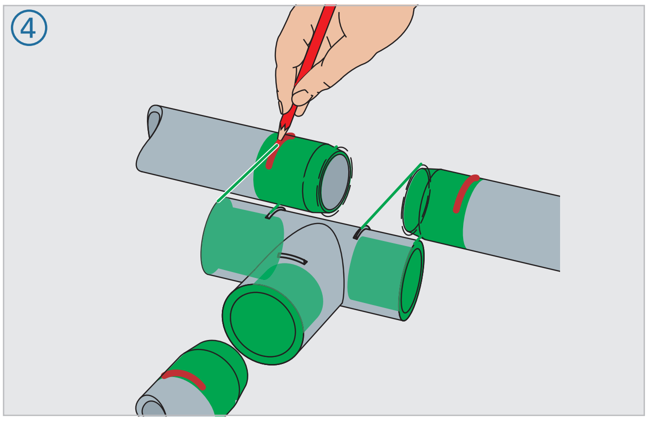
➨ Welding with the heating element: Chap. [9.3.4]
➨ Welding with the fusion jointing machine: Chap. [9.3.3]

Socket fusion welding – Preparing the pipes (d16 – d110)







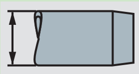
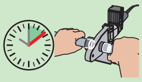
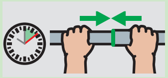
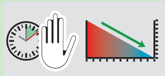


9.3.2 Fusion parameters (d16 – d110)

> **Welding can be carried out up to a temperature of -10°C, if complying with the required fusion parameters.**

> **The individual steps for welding with the heating element are shown on the following pages.**

TV.40
Fusion parameters

Pipe Dimension d 	Weld length [mm]	Warm-up time t [s] 	Holding time t1 [s] 	Cooling time t2 [min] 
16	15	5	15	2
20	15	6	15	2
25	18	6	15	2
32	20	10	20	4
40	22	14	20	4
50	25	18	30	4
63	28	22	30	6
75	31	26	60	6
90	36	30	75	6
110	42	35	90	6

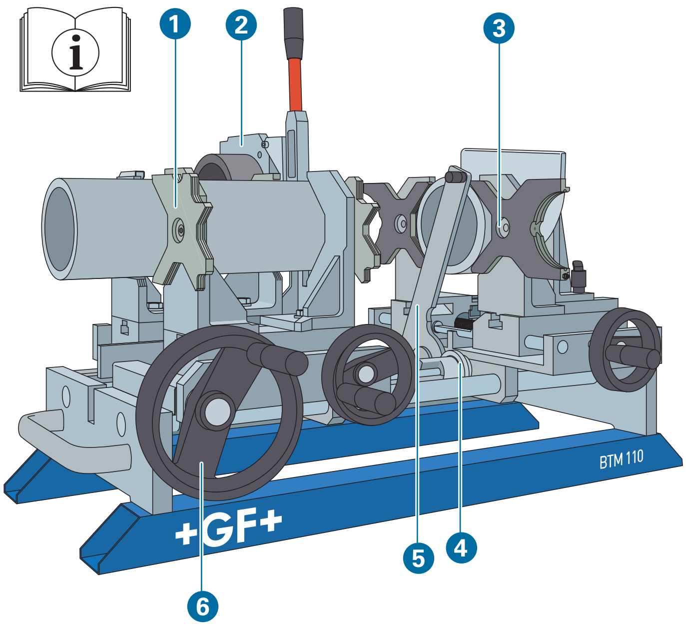
Welding report

The welding process can be recorded in a welding log.

9.3.3 Welding with the fusion machine BTM 110 (d16 – d110)

☑ Compliance with the operating instructions of the applicable fusion device is mandatory.
☑ Fusion parameters must be observed.

Welding with the BTM 110 fusion jointing machine is described in detail in the separate operating instructions.



GV.43
Socket fusion machine BTM 110 (d16 – d110)

1. Clamping fixture for pipes and fittings d16 – d110
2. Support for handheld heating element
3. Circular clamping device for fittings up to d110
4. Stop button for basic setting
5. Rotary knob for stop system
6. Handwheel for moving the carriages

9.3.4 Welding with the heating element (pipes d16 – d63)

☑ Compliance with the operating instructions of the fusion device is mandatory.
☑ Fusion parameters must be observed.

The individual steps are illustrated on the next page.

Socket fusion welding – Welding pipes (d16 – d63) with the heating element

Mark the insertion depth

① On INSTAFLEX fittings, the weld length is also indicated on the fitting.
☑ Keep connecting surfaces clean during all processing steps.

Pipe, dimension d	16	20	25	32	40	50	63
Insertion/joining depths [mm]	15	15	18	20	22	26	28

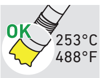
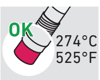
→ Mark the insertion and joining depth of the pipe in the heating socket or fitting socket.
→ Ensure the marking remains visible during the heating and joining process.

Prepare the heating element and heat it up

② → Connect the fusion device to the electrical point.

CAUTION! Danger of burning injuries when contacting the hot parts of the fusion device.
→ Careful when handling the fusion device. Stay clear of hot parts.

③ Socket fusion welding requires a temperature between 255°C and 260°C.
→ Set the welding temperature on the heating element to 260°C.
→ Heat up the device. Ensure to observe the indicator.
→ Check the welding temperature on the outside of the heating bush using thermochromic pins.
☑ The correct temperature of the heating element is reached when the 253°C pen **melts**, and the 274°C pen **does not melt** when coming into contact with the outside of the heating bush.

Pen	Status of the pen (outside)	Condition of the device
	The 253°C pen **does not** melt.	Temperature of the heating element is **too low**.
	The 274°C pen melts.	
	The 253°C pen melts.	Temperature of the heating element is **correct**.
	The 274 pen **does not** melt.	

In the case of adverse weather conditions:
→ Repeat the test regularly during the individual fusion steps.

Heat up pipe end and fitting socket

④ → Push the pipe end and fitting socket without twisting and **slowly** onto the heating spigot or heating nozzle as the material takes some time to melt.
→ Wait for the warm-up time to elapse.
The **warm-up time** starts when the pipe and fitting are pushed completely into the heating spigot or pushed onto the heating adaptor.
→ Slowly pull the pipe end and fitting socket without twisting from the heating tools.

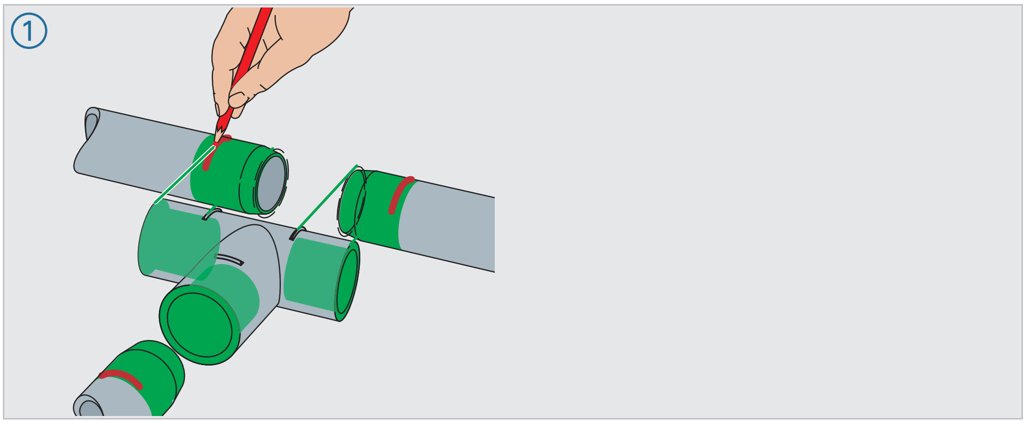
Join the pipe and fitting

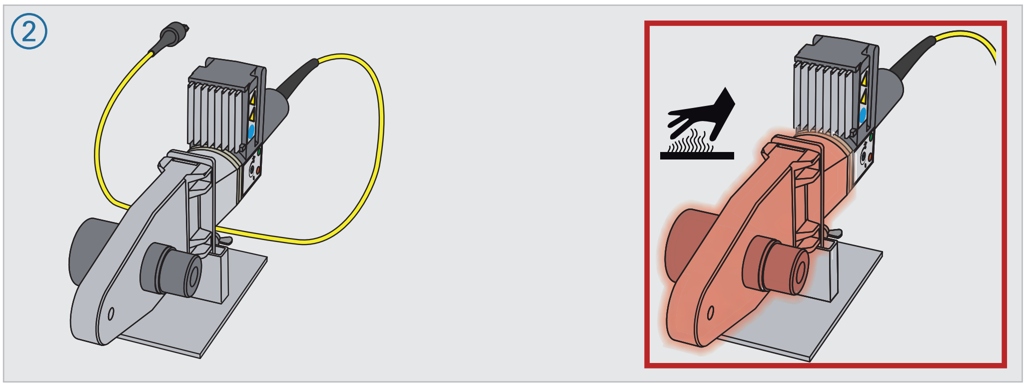
⑤ → After the warm-up: **Immediately** join the fitting and the pipe along their axes without twisting. Compliance with the **holding time** and **cool-off time** is mandatory.

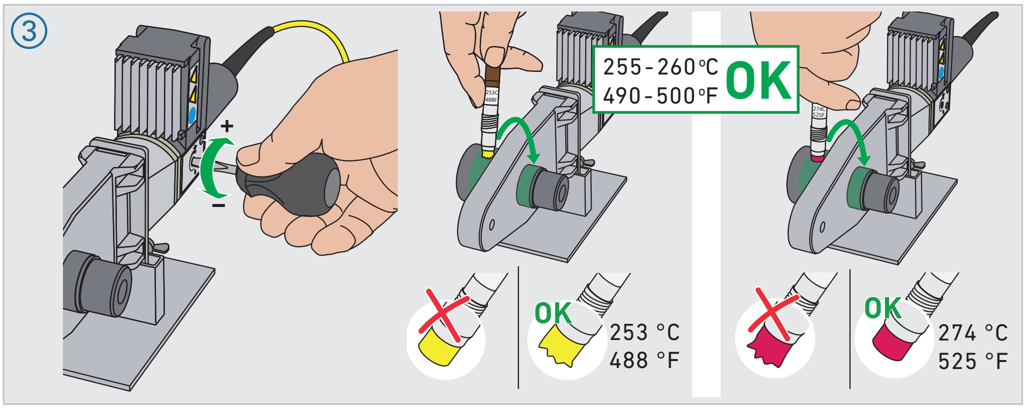
After the welding procedure

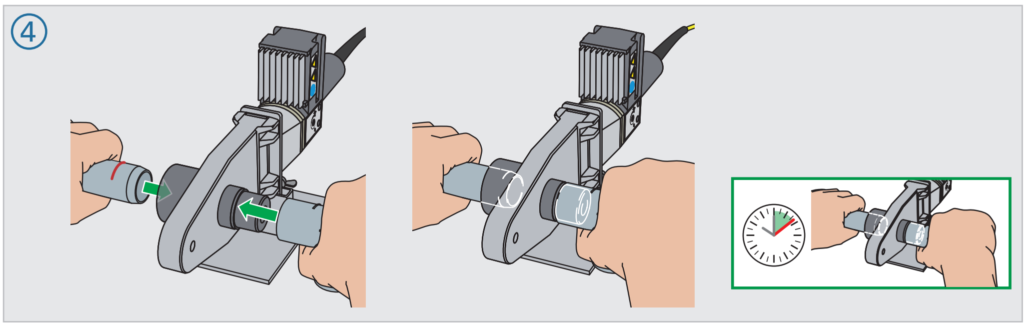
➨ Chapter [9.3.5] 'After the welding procedure'

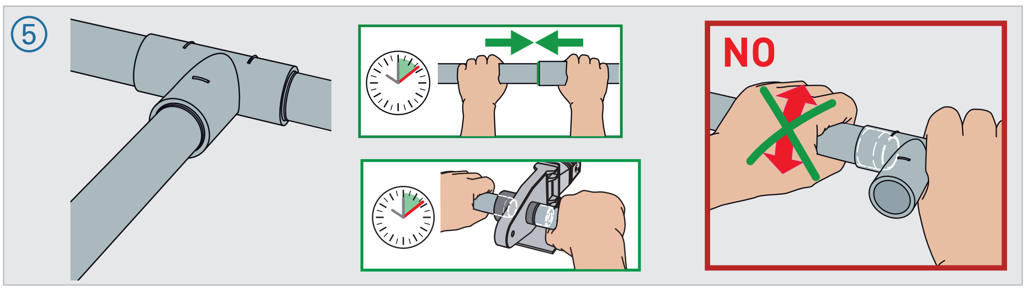
Socket fusion welding – Welding pipes (d16 – d63) with the heating element











9.3.5 After the welding procedure

The procedure is the same for **heating element** or the **fusion jointing machine**.

DANGER! Burning injuries may occur when contacting the hot parts of the fusion device.
Parts of the fusion device are still hot after welding.
→ Careful when handling the fusion device.
→ Stay clear of hot parts.

The individual steps are illustrated on the next page.

Socket fusion welding – After the welding process

Cleaning the heating socket and the heating spigot

① → After welding, clean the heating socket and heating spigot with a clean, non-fibrous, dry paper **without** cleaning agent.

Inspecting the weld

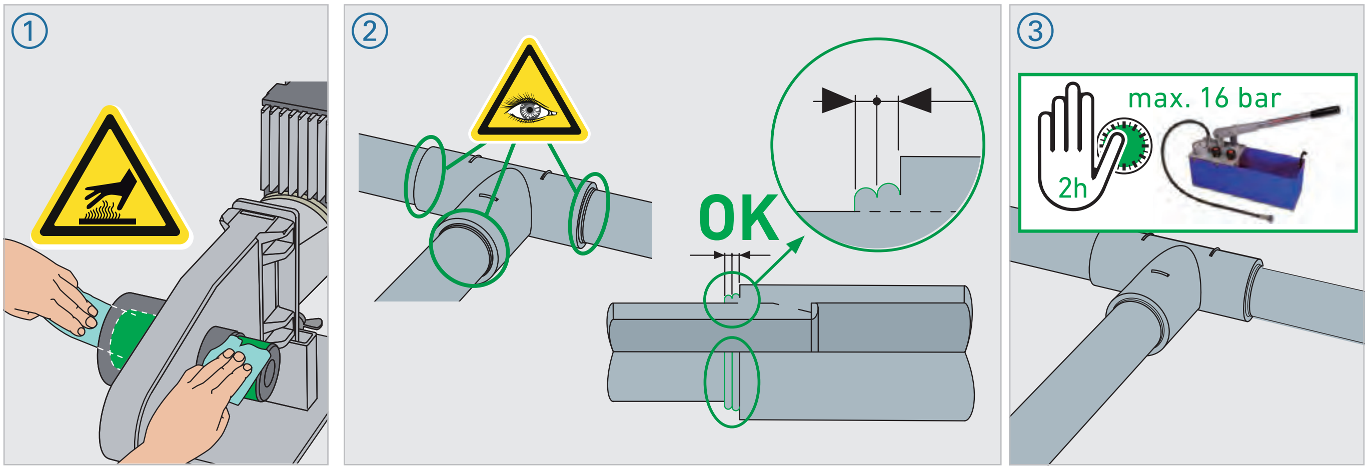
② → Inspecting the weld seam.
☑ A fusion bead a that is as uniform as possible must be present along the entire circumference of the fusion zone.

Proceed with the pressure test

③ Before proceeding with the pressure test:
☑ All welded joints are completely cooled off.
☑ Waiting time: at least 2 hours after the last fusion process has been completed
→ The pressure test must be completed with max. 16 bar.

Information about possible welding defects:
➨ Part III 'The basics', Section 'Materials and jointing technology', Chapter [5] 'Welded connections'

Socket fusion welding – After the welding process



9.3.6 Welding the weld-on saddles

Various connections can be mounted on a weld-on saddle.

Spacing between the weld-on saddles

When positioning the weld-on saddles onto the INSTAFLEX pipe, the following spacings must be taken into account:

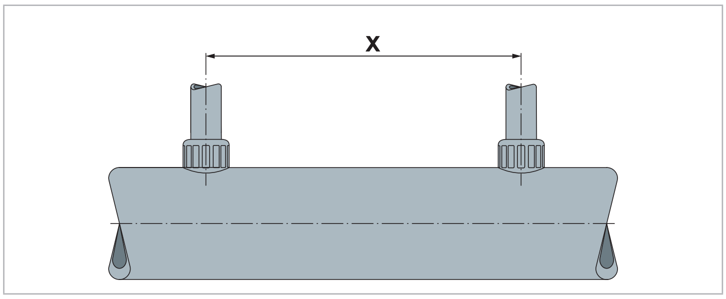
- Spacing between two weld-on saddles
- Spacing of the weld-on saddles over the circumference
- Spacing of the weld-on saddles and fitting

The saddle dimension must match the pipe dimension on the pipe side.

Spacing between two weld-on saddles

The minimum distance **X** between two weld-on saddles must be at least **30 mm**. This information applies to the dimensions d50 to d225 with all outlets.

> **To determine the distance, bursting and pulsation tests were carried out on the welded-on saddles.**

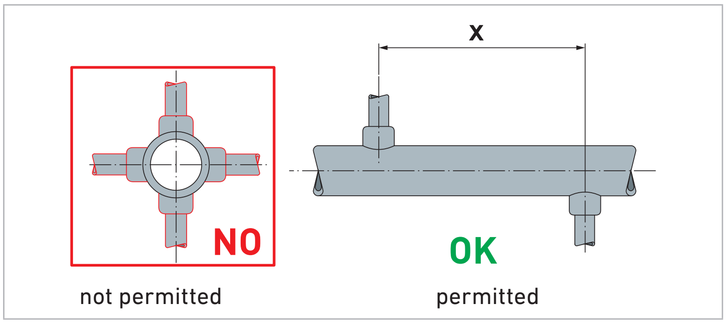


Spacing of the weld-on saddles over the circumference
Dimension d50 – d90

If a weld-on saddle has been welded to the pipe, it is not permissible to weld another one or more weld-on saddles over the circumference at this point.

Alternatively, a saddle can be welded in again with a minimum distance **X** of 30 mm over the circumference.

This information applies to the dimensions d50 to d90 with all outlets d20, d25 und d32.

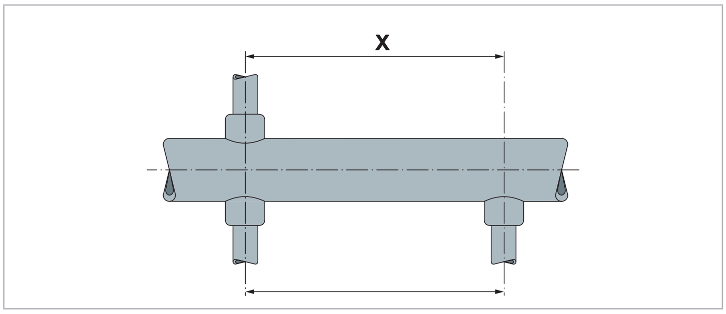


Dimension d110 – d225

If a weld-on saddle was welded to the respective pipe in the dimensions d110 to d225, it is permissible to weld another weld-on saddle offset by 180 ° over the circumference.

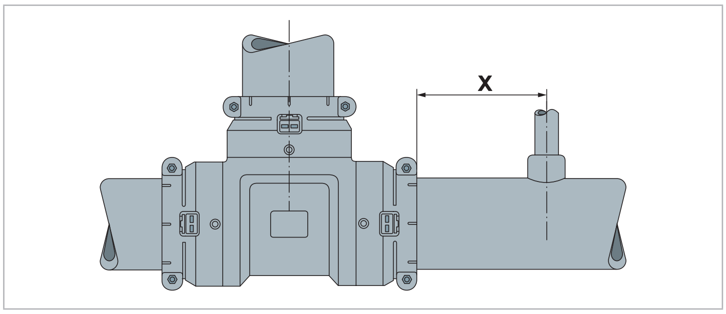
☑ Compliance with the minimum distance of **X** = 30 mm from saddle to saddle is mandatory.

It is **not permitted** to weld more than 2 saddles over the circumference.

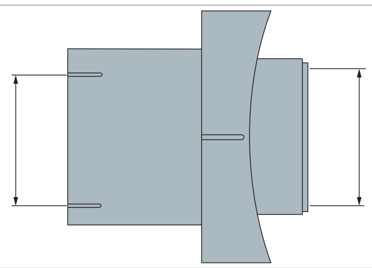


Spacing of the weld-on saddles and fitting

The minimum distance **X** between the weld-on saddle and fitting must be at least 30 mm. This information applies to the dimensions d50 to d225, regardless of the dimension of the outlet.



Welding times



GV.44
Dimensions

TV.41 **Welding times for d50 to d110**

Pipe, Dimension d–d1 [mm]	Temp. [°C]	**Weld-on saddle onto pipe** Welding time			**Pipe inside weld saddle** Welding time		
		Warm-up time [s]	Holding time [s]	Cooling time Min.	Warm-up time [s]	Holding time [s]	Cooling time Min.
50–20	260	22–24	30	4	6	15	2
50–25	260	22–24	30	4	6	15	2
50–32	260	22–24	30	4	10	20	4
63–20	260	22–24	30	4	6	15	2
63–25	260	22–24	30	4	6	15	2
63–32	260	22–24	30	4	10	20	4
75–20	260	24–26	30	4	6	15	2
75–25	260	24–26	30	4	6	15	2
75–32	260	24–26	30	4	10	20	4
90–20	260	26–28	30	4	6	15	2
90–25	260	26–28	30	4	6	15	2
90–32	260	26–28	30	4	10	20	4
110–20	260	28–32	30	4	6	15	2
110–25	260	28–32	30	4	6	15	2
110–32	260	28–32	30	4	10	20	4

TV.42 **Welding times for d125 to d225**

Pipe, Dimension d–d1 [mm]	Temp. [°C]	**Weld-on saddle onto pipe** Welding time			**Pipe inside weld saddle** Welding time		
		Warm-up time [s]	Holding time [s]	Cooling time Min.	Warm-up time [s]	Holding time [s]	Cooling time Min.
125–32	260	29–33	30	4	10	20	4
125–40	260	31–35	30	4	14	20	4
125–50	260	31–35	30	4	18	30	4
160–32	260	28–30	120	4	10	20	4
160–40	260	42–45	120	4	14	20	4
160–50	260	42–45	120	4	18	30	4
225–32	260	25–30	120	4	10	20	4
225–40	260	45–50	120	4	14	20	4
225–50	260	45–50	120	4	18	30	4

Socket fusion welding – Welding the pipe saddle

☑ Compliance with the operating instructions of the fusion device is mandatory.

☑ Fusion parameters must be observed.

The individual steps are illustrated on the next page.

Information about possible welding defects:

➨ Part III 'The basics', Section 'Materials and jointing technology', Chapter [5] 'Welded connections'

Socket fusion welding – Welding the pipe saddle

Preparing the tool

① → Select drill bit dimension.
- Drill bit for outlet: 20, 25, 32
- Drill bit for outlet: 40, 50

→ Select heating bushes for the applicable dimension.

② → Mount the heating bushes onto the welding mirror.

Preparing the pipe

③ → Mark the drilling position.

④ → Place a pipe clip approx. 15 to 20 cm away from the drilling position.

⑤ ☑ Tool: variable speed drill, 300–350 rpm

→ Use a suitable drill in order to drill through the pipe wall **at right angle**.

⑥ → Chamfer the hole.
- This makes it easier to insert the heating bush into the bore during the next work step.

⑦ → Use a Tangit KS cleaning agent to clean the pipe and bore hole.

→ Use the cleaning paper to remove the cleaning fluid completely.

⑧ → Clean weld saddle with Tangit KS cleaner.

→ Use the cleaning paper to remove the cleaning fluid completely.

→ Ensure the dimensions of the saddle and pipe are matching.

Socket fusion welding – Welding the pipe saddle

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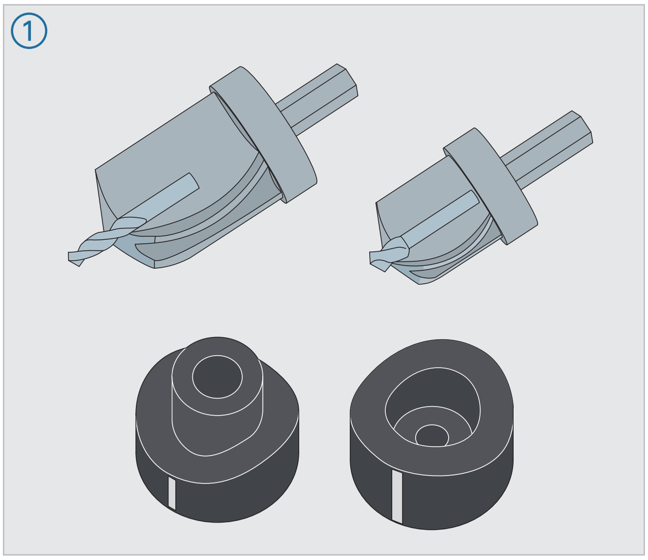

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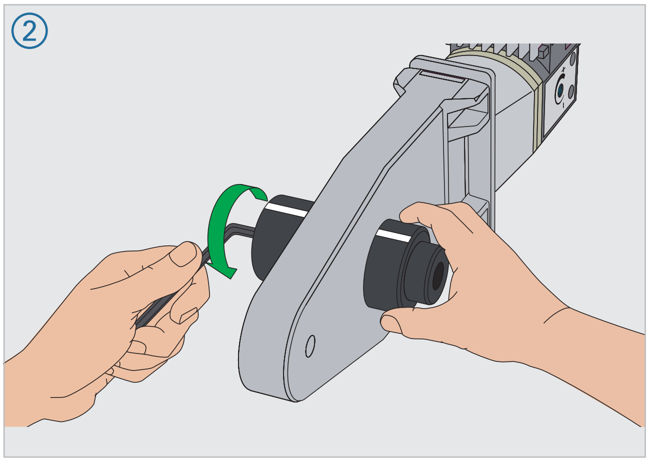

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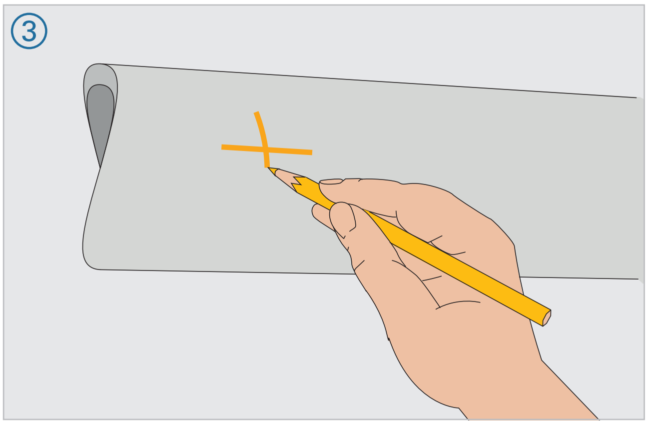

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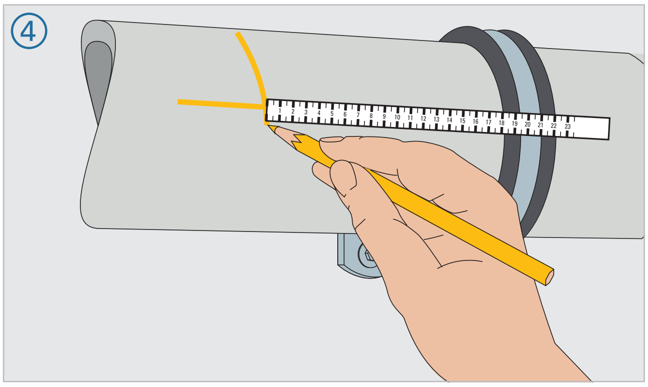

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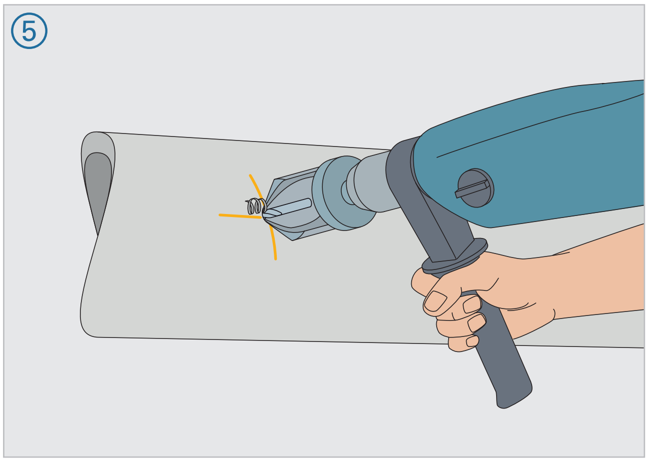

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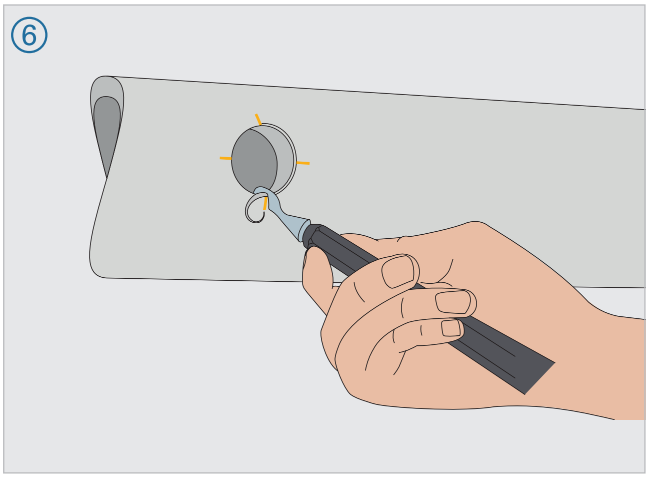

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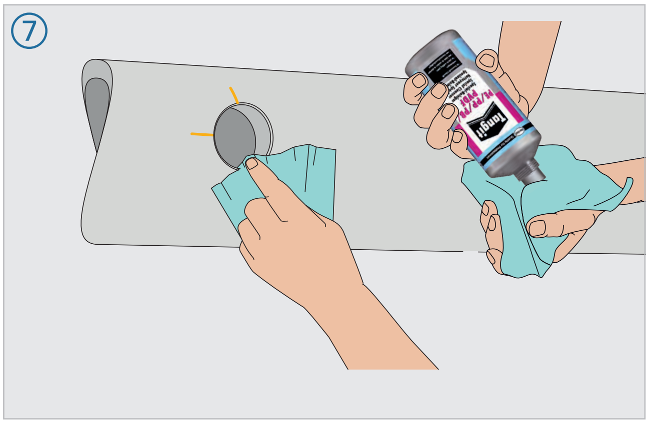

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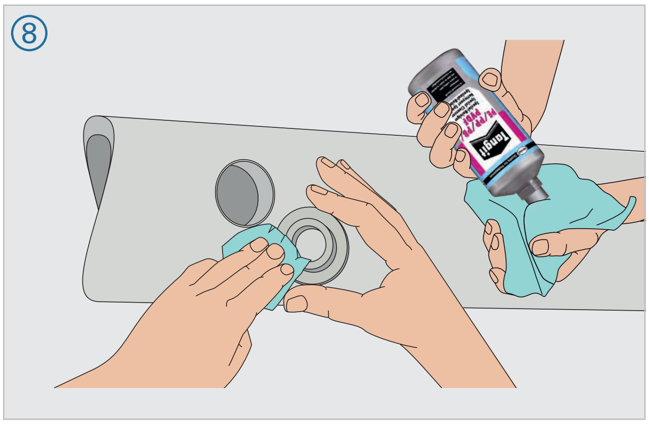


Socket fusion welding – Welding the pipe saddle ▶▶

▶▶ Socket fusion welding – Welding the pipe saddle

Prepare the heating element and heat it up

⑨ → Connect the fusion device to the electrical point.

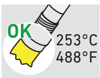
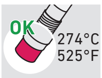
⚠ **CAUTION! Danger of burning injuries when contacting the hot parts of the fusion device.**

→ Careful when handling the fusion device.
→ Stay clear of hot parts.

⑩ When using the INSTAFLEX system for socket fusion welding, a temperature between 255°C and 260°C is required.

→ Set the welding temperature on the heating element to 260°C.
→ Heat up the device. Ensure to observe the indicator.
→ Check the welding temperature on the outside of the heating bush using thermochromic pins.

☑ The correct temperature of the heating element is reached when the 253°C pen **melts**, and the 274°C pen **does not melt** when coming into contact with the outside of the heating bush.

Pen	Status of the pen (outside)	Condition of the device
	The 253°C pen **does not** melt.	Temperature of the heating element is **too low**.
	The 274°C pen melts.	
	The 253°C pen melts.	Temperature of the heating element is **correct**.
	The 274 pen **does not** melt.	

In the case of adverse weather conditions:
→ Repeat the test regularly during the individual fusion steps.

Welding the weld saddle

⑪ → Push the weld saddle and pipe onto the heating bushes at the same time.

Warm-up times

- d50 to d110: Table [TV.41]
- d125 to d225: Table [TV.42]

→ Remove the weld-on saddle and pipe from the heating bushes.

⑫ ↳ After heating the pipe and saddle, a uniform melt bead ❶ has formed on the pipe around the bore hole.

→ Immediately push the weld-on saddle into the pipe. Ensure the saddle is not twisted.
→ Holding time and cooling time must be maintained.

Holding and cooling time

- d50 – d110: Table [TV.41]
- d125 to d225: Table [TV.42]

↳ The saddle is welded onto the pipe.

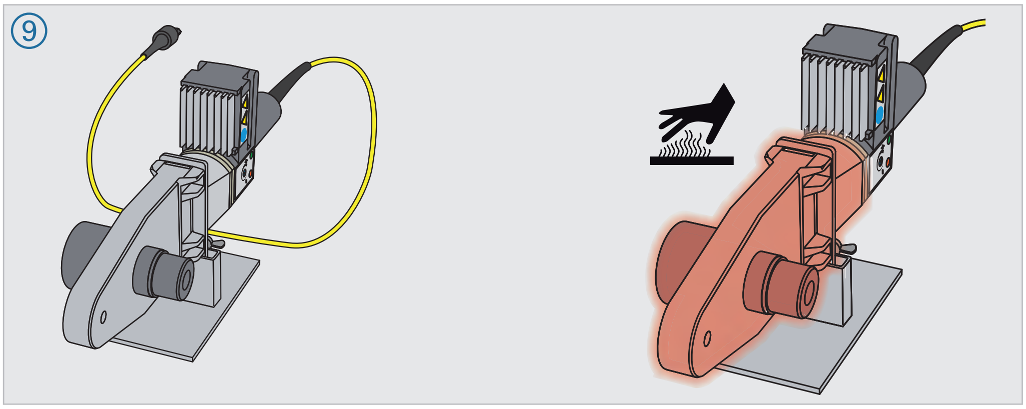
Cleaning the heating bushes

⑬ → Clean the heating bushes after each welding connection.

☑ Ensure all polybutene has been removed from the heating bushes for the next welding connection.

Socket fusion welding – Welding the pipe saddle

9



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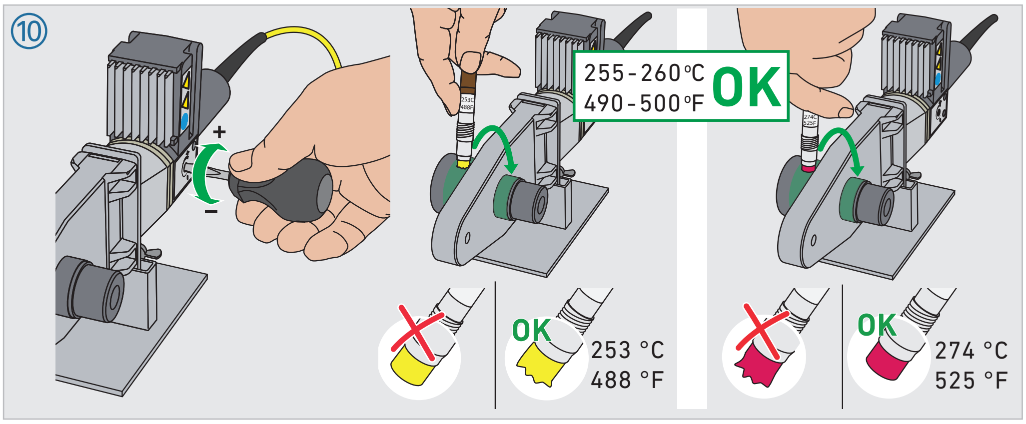

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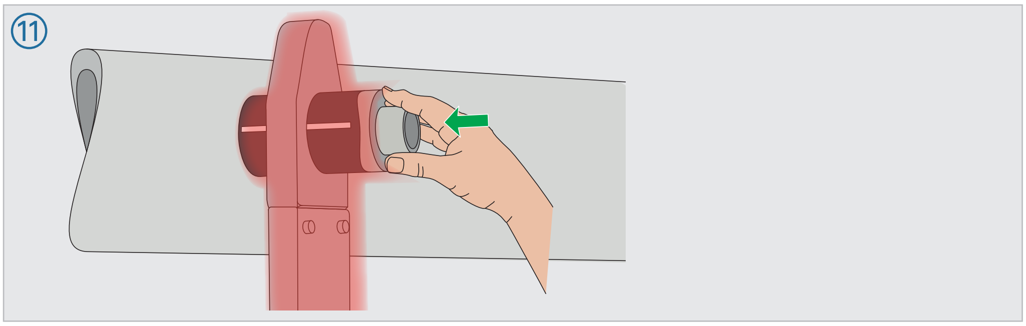

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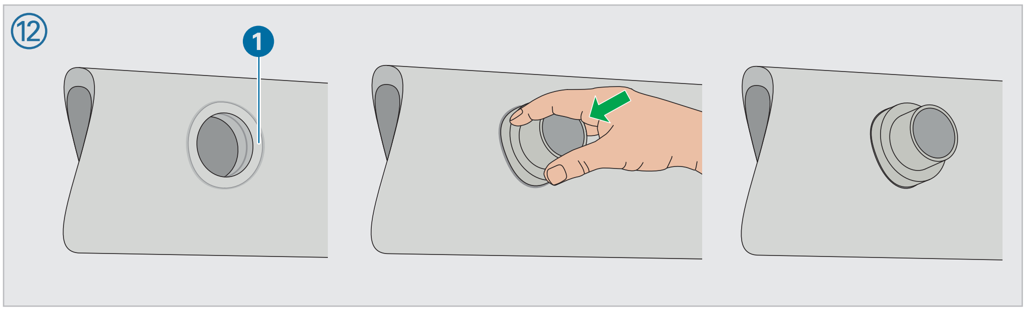

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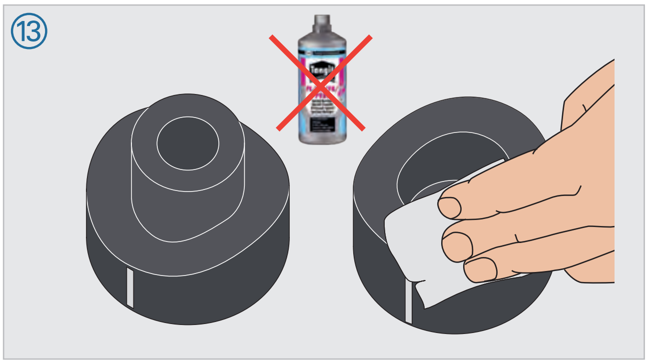


9.4 Electrofusion welding (HWS)

9.4.1 Electrofusion welding – Pipes (d16 – d110)

☑ Compliance with the operating instructions of the fusion device is mandatory.
☑ Fusion parameters must be observed.
☑ Fusion device and fusion area must be protected against moisture and dirt.

The individual steps are illustrated on the next page.

Information about possible welding defects:
➨ Part III 'The basics', Section 'Materials and jointing technology', Chapter [5] 'Welded connections'

Electrofusion welding – Pipes (d16 – d110)

Preparing pipes and fittings

① → Cut pipes at right angle. If necessary, the inside and outside must be deburred.
- Use a pipe cutter for plastic pipes.
- Do not chamfer the ends of the pipe.

② → Clean connecting surfaces of the parts to be welded (fittings and pipe ends) with absorbent, non-fibrous paper (slightly moistened, if necessary) and an ethyl alcohol-based cleaning agents.
→ Use the paper to remove the cleaning fluid completely.

③ → Keep connecting surfaces clean during all processing steps.
→ Mark the insertion and joint depth on both pipes. Make sure that the marking line remains visible when joining the pipes. Do not use a grease pencil.

Fix the pipe inside the fitting

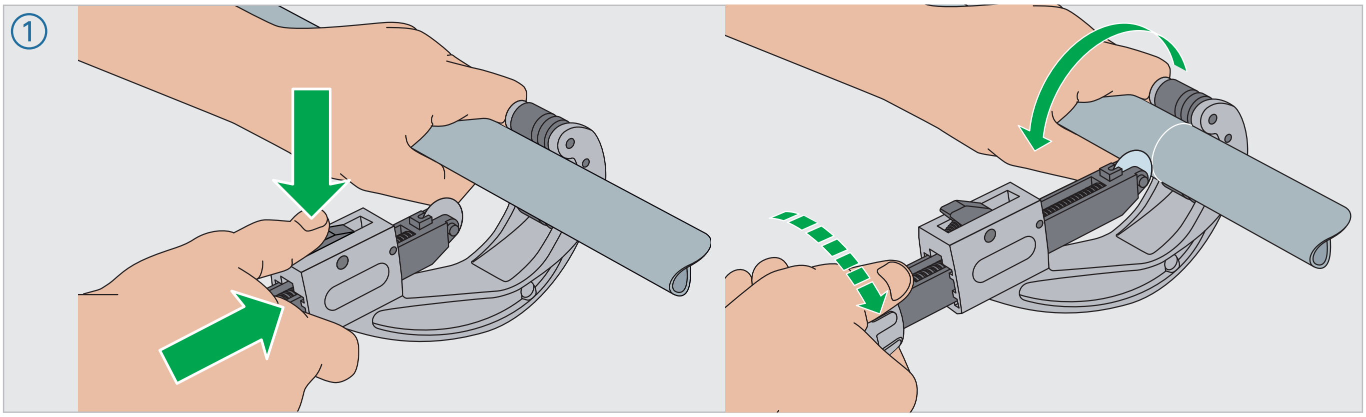
④ At a pipe surface temperature of > 40°C and the associated expansion of the pipe, it can be difficult to push the fitting onto the pipe due to the necessary tight tolerances.
→ Insert the pipes into the fitting and up to the marking.
→ Ensure that at the front-end the pipes make contact in the centre of the socket.

⑤ → The screws of the integrated pipe attachment must be tightened in a crosswise pattern.
→ Ensure some clearance remains when tightening the screws.

▶▶

Electrofusion welding – Pipes (d16 – d110)

1



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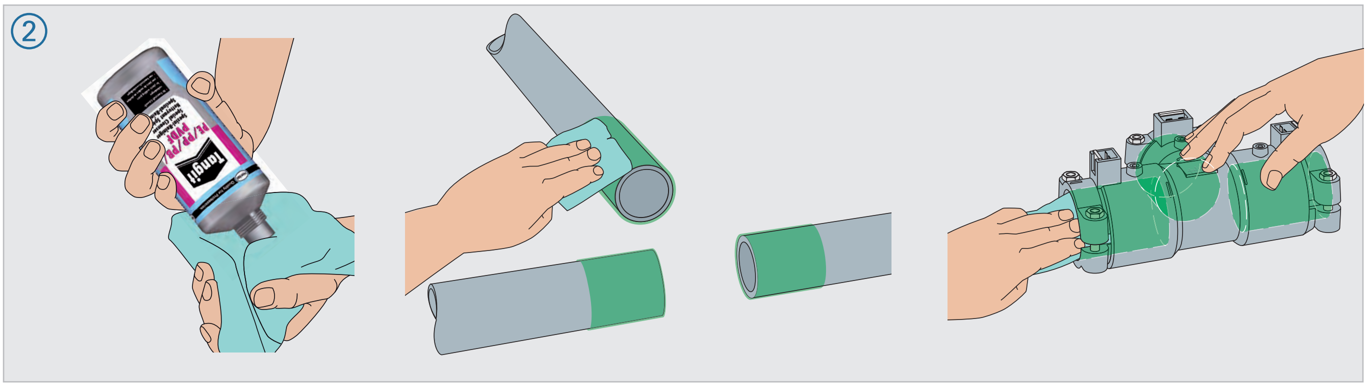

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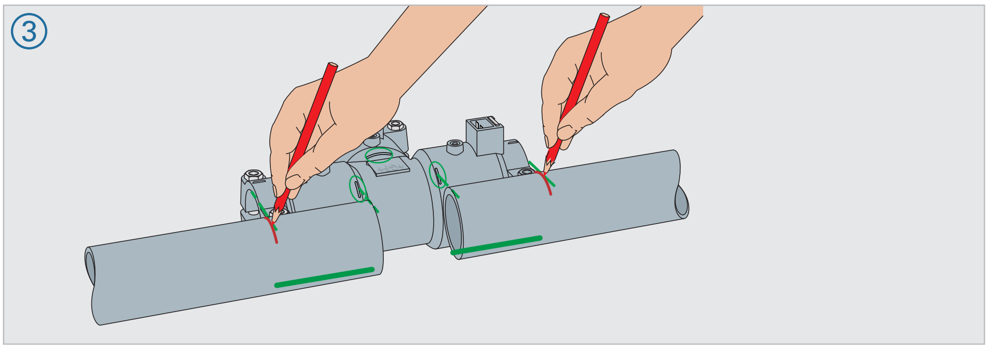

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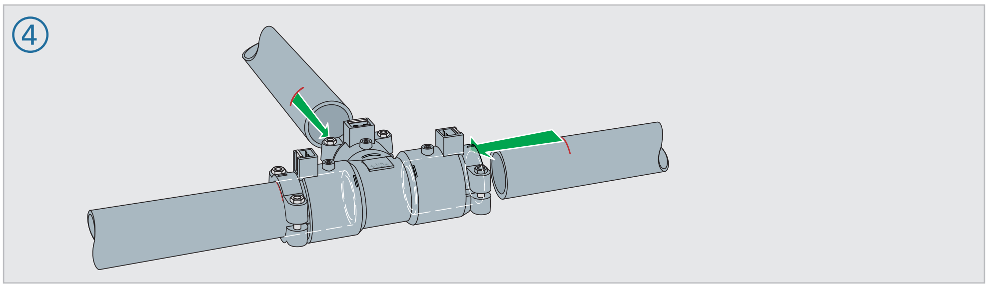

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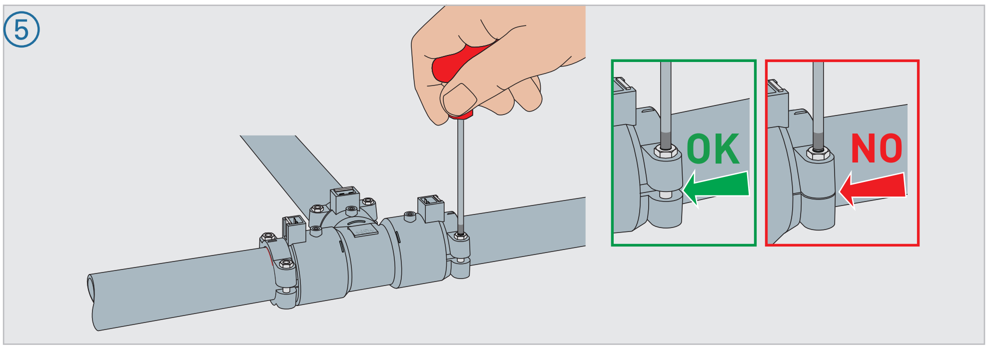


Electrofusion welding – Pipes (d16 – d110) ▶▶

▶▶ Electrofusion welding – Pipes (d16 – d110)

Fusion welding

⑥ → Connecting the fusion device to the power supply.

⚠ **During the fusion process, the parts to be welded (fitting and pipe) may only be subject to loads that are resulting from forces caused by the correct installation (pipeline attachment).**

→ Welded parts (fittings and pipes) must not be stressed by installation work taking place after the welding until **after the cooling time has elapsed**.

⑦ → Insert the welding cable to the pipe (or the fittings).

⑧ → Starting the fusion weld process.

⑨ **If faults occur during the fusion process**

The indicator is lit. The welding process that was interrupted by a fault can be repeated after a minimum waiting time of 2 hours.

→ Interrupting the fusion process.

Repeat the fusion welding process

1. Disconnect the welding cable from the fitting.
2. Disconnect the fusion device from the power supply.
3. Start a new welding process according to the fusion steps.

Inspecting the weld

⑩ → Use the visually fusion indicator to inspect the weld.

☑ The welded HWS socket can be detected by the material pin.

Proceed with the pressure test

⑪ Before proceeding with the pressure test:

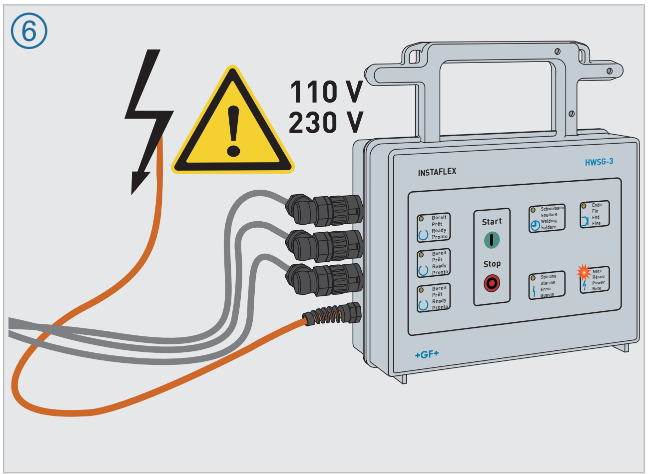
☑ All welded joints are completely cooled off.

☑ Waiting time: at least 2 hours after the last fusion process has been completed

→ The pressure test must be completed with max. 16 bar.

Electrofusion welding – Pipes (d16 – d110)

⑥



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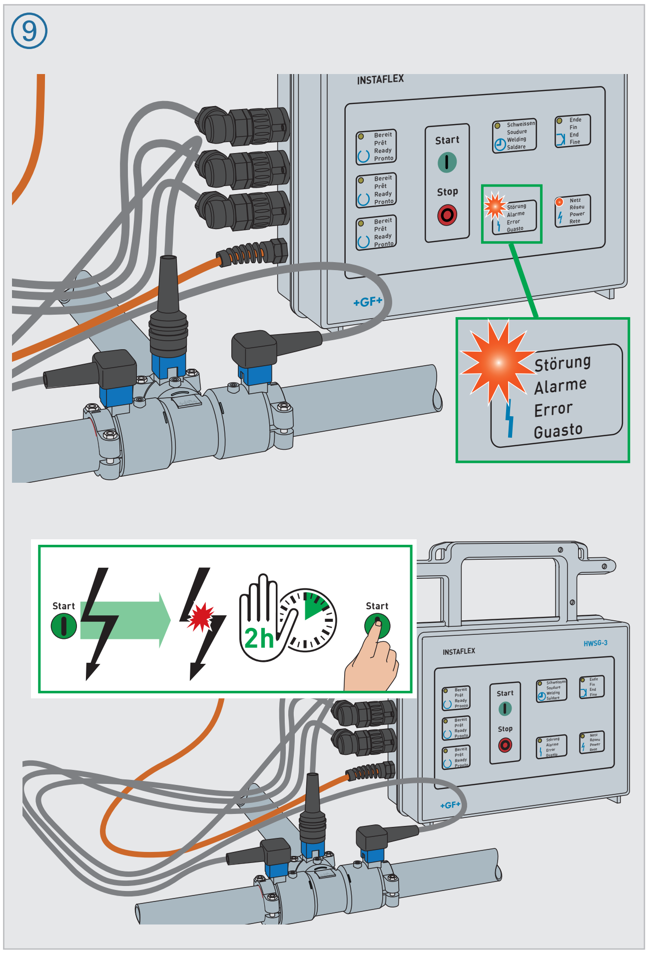

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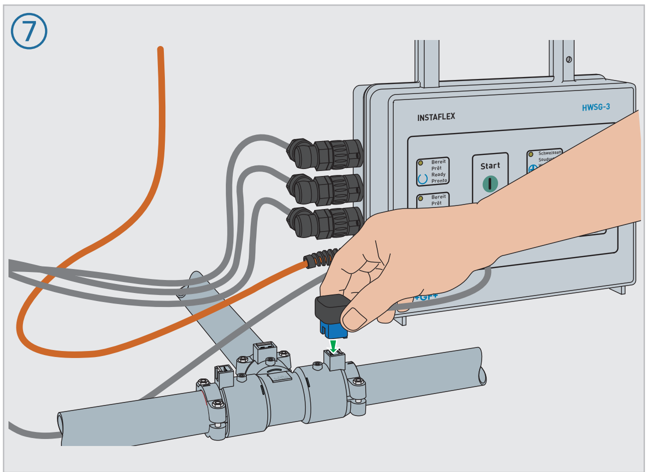

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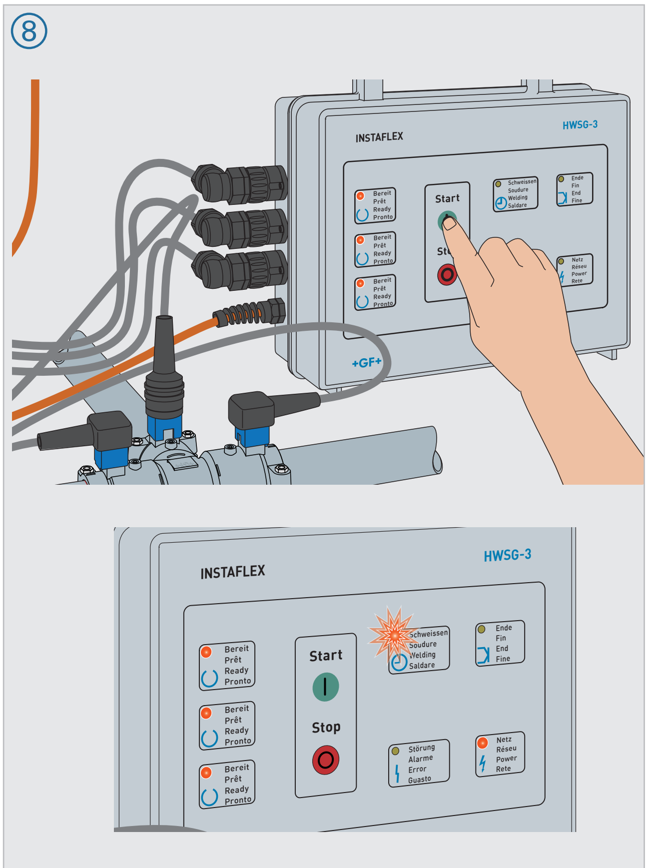

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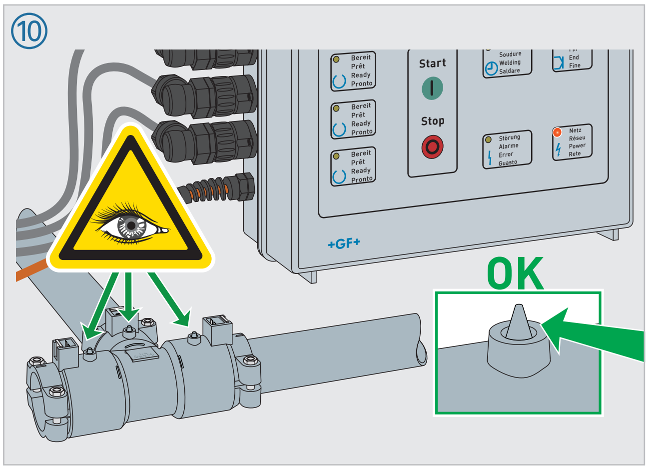

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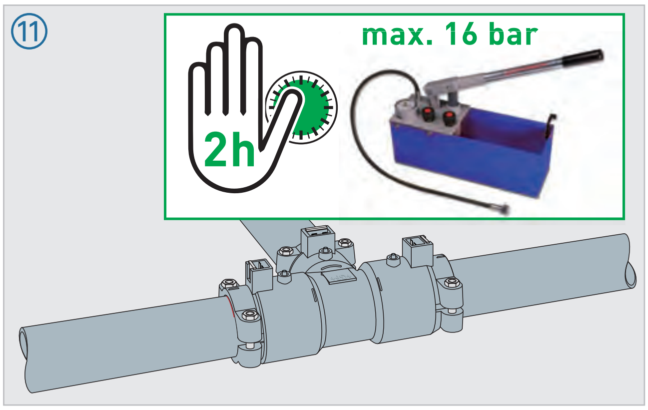


V

9.4.2 Electrofusion welding – Pipes (d125 – d225)

☑ Fusion device and fusion area must be protected against moisture and dirt.

☑ Compliance with the tool's operating instruction is mandatory.

ℹ Welding can be carried out up to a temperature of -10°C, if complying with the required fusion parameters.

TV.43
Peeling length for electrofusion welding

Pipe, dimension d [mm]	Peeling length [mm]	Length requirement with peeler [mm]	Width of the peeler [mm]
d125	60	160	360
d160	95	190	380
d225	110	210	450

ℹ **The individual steps are illustrated on the next page.**

Information about possible welding defects:
➨ Part III 'The basics', Section 'Materials and jointing technology', Chapter [5] 'Welded connections'

Electrofusion welding – Pipes (d125 – d225)

Preparing the pipe

① → Cut pipes at right angle. If necessary, the inside must be deburred.
- Use a pipe cutter for plastic pipes.

② ☑ Rotary peeler
→ Use the peeler to peel off the most upper layer in one pass.
- The peeling length must match the length listed in the table.

Cleaning the pipe and fitting

③ ☑ use an absorbent, non-fibrous paper (moisten paper slightly, if necessary): Tangit KS wipes
☑ Ethyl alcohol-based cleaning agent: Tangit KS cleaning agent
→ Clean connecting surfaces of sleeve and pipe end.
→ Use the paper to remove the cleaning fluid completely.
→ Keep connecting surfaces clean during all processing steps.

Fix the pipe inside the fitting

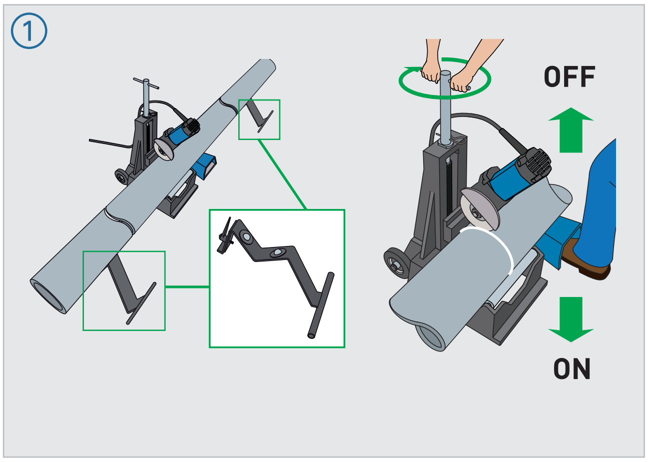
④ → Mark the insertion depth on the pipe. The lengths must match the lengths listed in the table.
- Do not use a grease pencil.

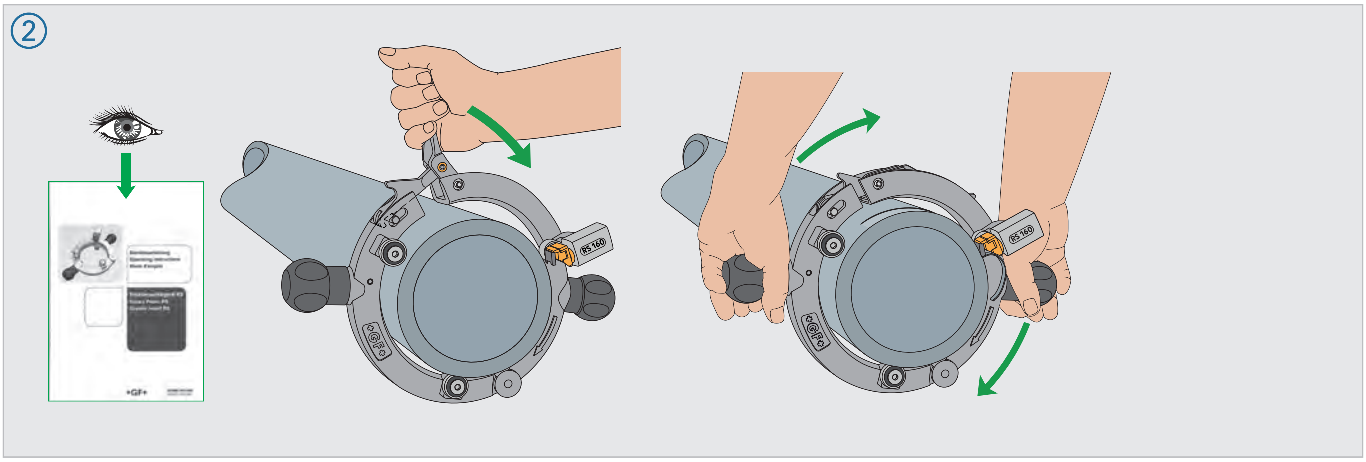
→ Make sure that the marking line remains visible when joining the pipes.

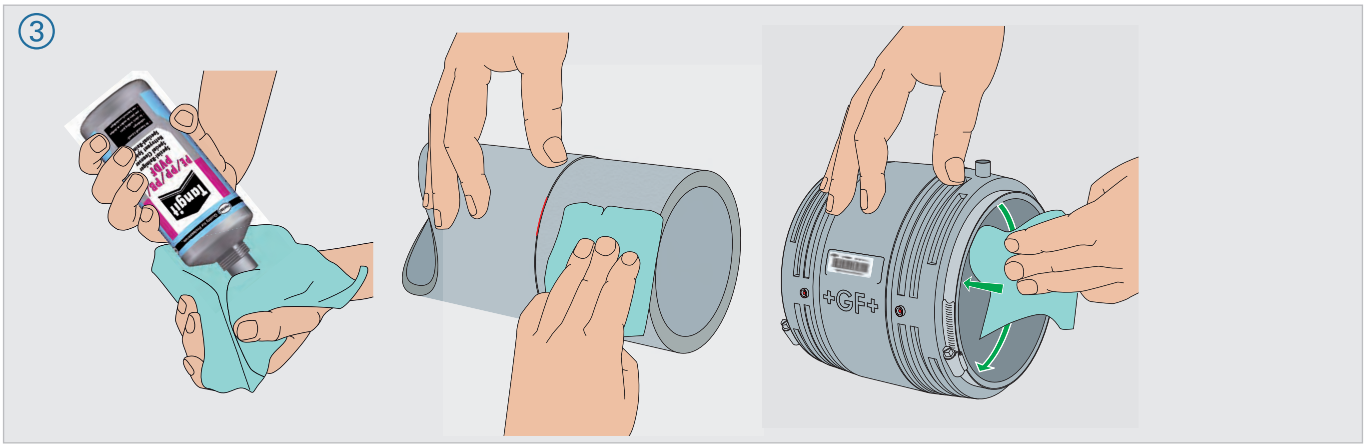
⑤ → Push the socket onto the pipe.
→ Use the tension strap to tighten the socket on the pipe.

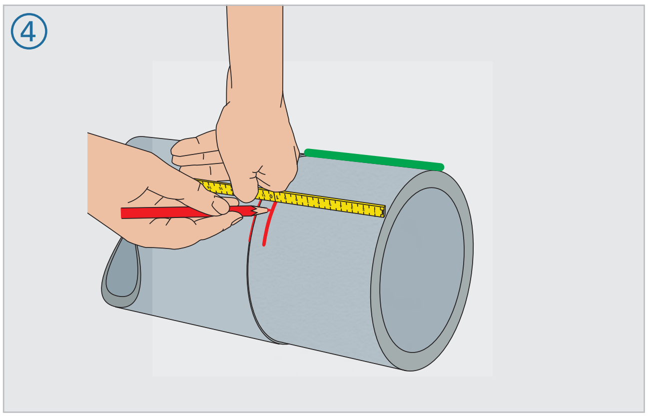
▶▶

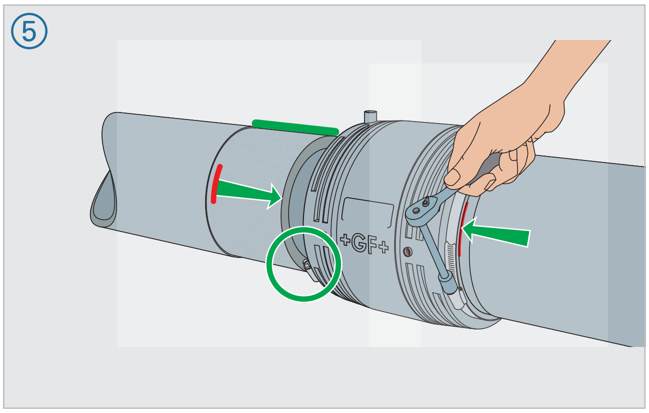
Electrofusion welding – Pipes (d125 – d225)











Electrofusion welding – Pipes (d125 – d225) ▶▶

▶▶ Electrofusion welding – Pipes (d125 – d225)

Fusion welding

⑥ → Connecting the fusion device to the power supply.

⑦ → Connect the welding cable of the fusion device to the electric welding socket.

⑧ → Use the barcode reader to swipe the code.
↳ The welding data are transmitted to the fusion device.

⑨ → Starting the fusion weld process.

⑩ **If faults occur during the fusion process**
→ Interrupting the fusion process.
→ Check the power supply.
→ Check the welding plug on the fittings.
→ Check the plug on the fusion device.

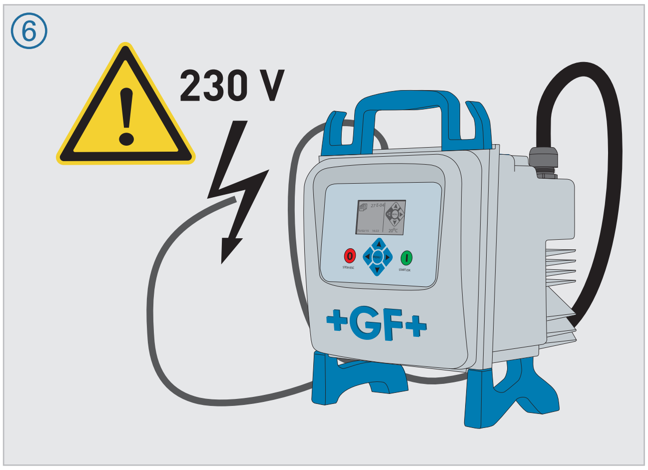
Inspecting the weld

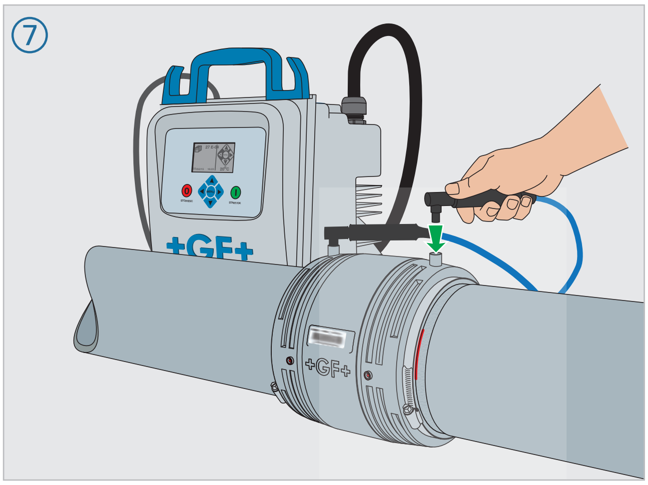
⑪ → Use the visually fusion indicator to inspect the weld.
↳ A welded HWS socket is visible on the material pin.

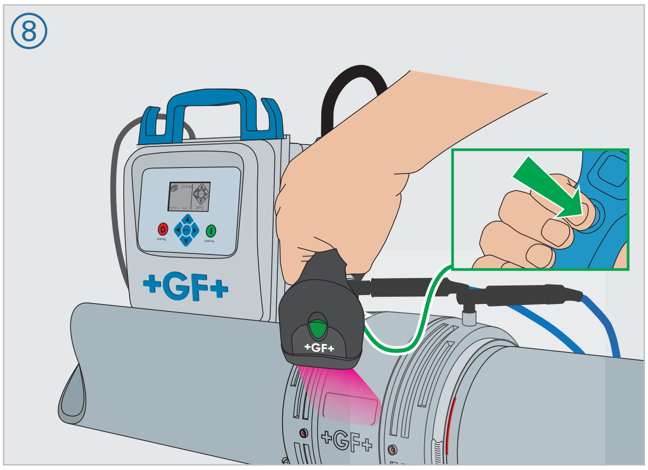
Proceed with the pressure test

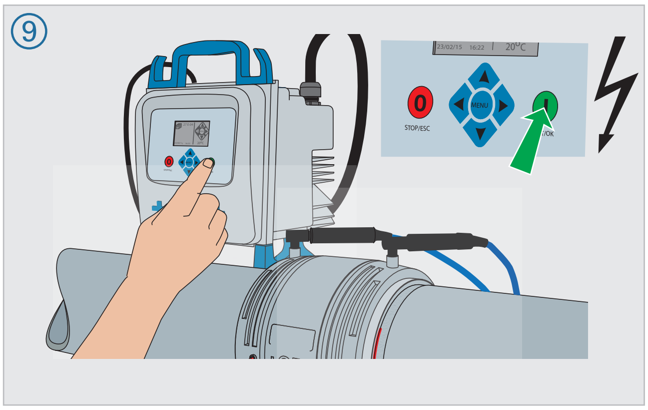
⑫ Before proceeding with the pressure test:
☑ All welded joints are completely cooled off.
☑ Waiting time: at least 1 hour after the last fusion process has been completed
→ The pressure test must be completed with max. 16 bar.

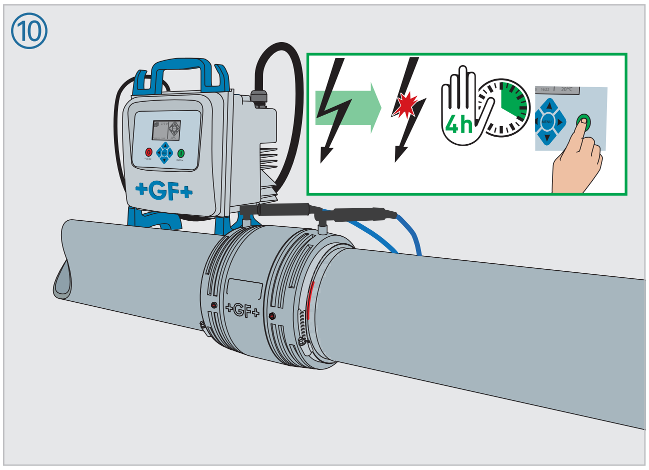
Electrofusion welding – Pipes (d125 – d225)

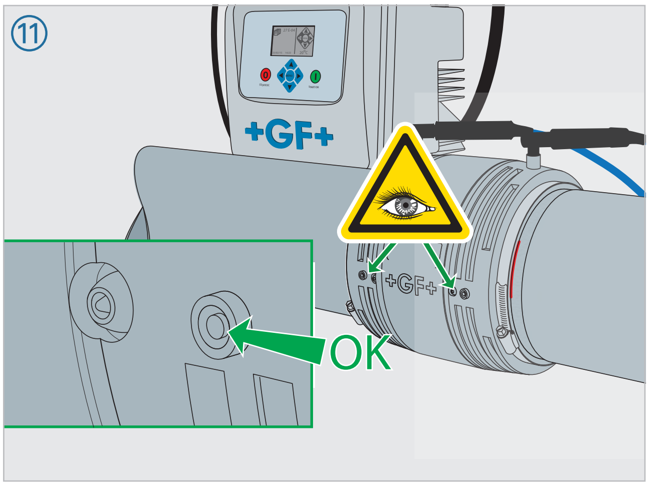


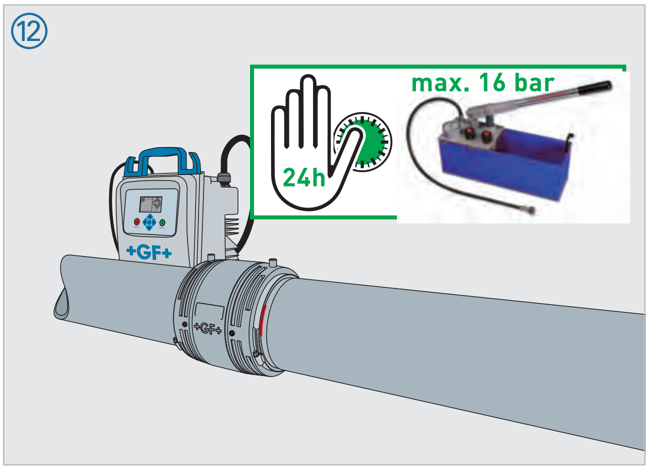












9.5 Butt fusion welding

Butt fusion welding is one of the processes for making secure, firmly bonded pipe connections in sanitary installations.

☑ Fusion device and fusion area must be protected against moisture and dirt.
☑ Compliance with the tool's operating instruction is mandatory.
☑ Make sure the circlip pliers is working properly.

Welding can be carried out up to a temperature of -10°C, if complying with the required fusion parameters.

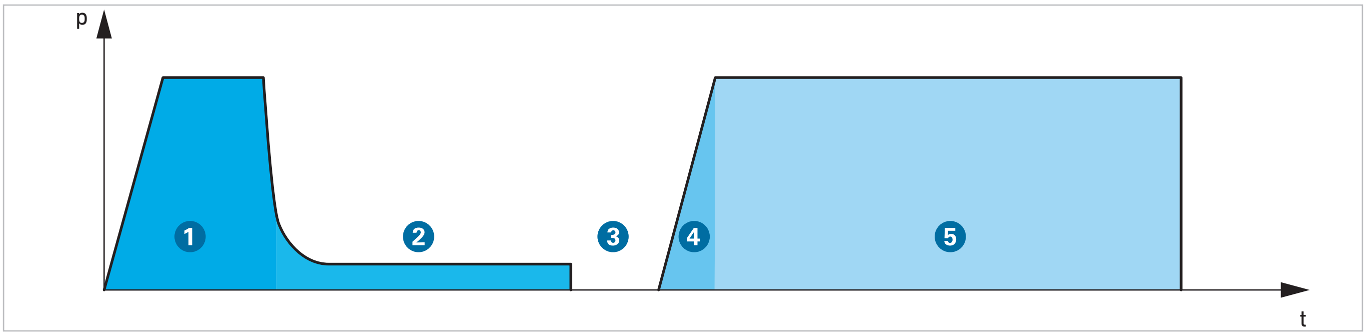
GF recommends to use the TOP 400 machine during fusion welding.
Other machines can be used. However, compliance with the fusion parameters is mandatory.

9.5.1 Fusion parameters

→ Add the joining force to the movement resistance of the carriage.

GV.45 **Fusion steps**

1. Adjustment time
2. Warm-up time
3. Change-over time
4. Build-up time with jointing pressure
5. Cooling time

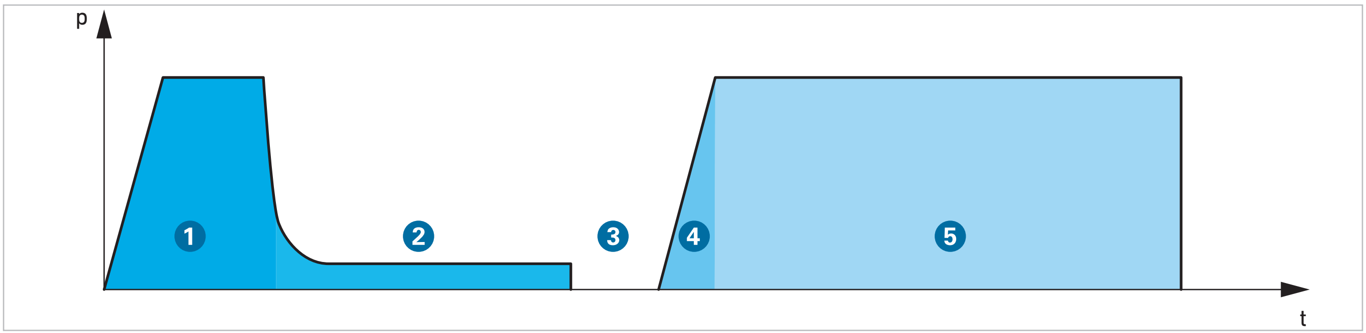


TV.44 **Fusion parameters for butt fusion welding**

Pipe, Dimension d_{xs}	① Fusing pressure p = 0.1 N/mm²		② Heat-up pressure p = 0.01 N/mm²		③ max. change-over time	④ Build-up time Jointing pressure	⑤ Jointing pressure p = 0.1 N/mm²	
[mm]	Fusing pressure [daN]	Bead height [mm]	Heat-up pressure [daN]	Warm-up time [s] = [min]	[s]	[s]	Fusing pressure [daN]	Cooling time [min]
IM 315 (Heating element temperature 255°C ±10°C								
110 × 10.0	31	1	3	95 = 1.35	6	8–12	31	10–16
125 × 11.4	41	1	4	95 = 1.35	6	8–12	41	10–16
160 × 14.6	67	1	7	145 = 2.25	7	10–15	67	17–24
225 × 20.5	132	1.5	13	220 = 3.40	8	10–15	132	20–30
315 × 28,6	257	2	26	290 = 4,85	9	15 –20	257	min. 30

GV.46
Fusion steps

1. Adjustment time
2. Warm-up time
3. Change-over time
4. Build-up time with jointing pressure
5. Cooling time



TV.45 **Fusion parameters for butt fusion welding**

Pipe, Dimension d_{xs}	1 Fusing pressure p = 0.1 N/mm²		2 Heat-up pressure p = 0.01 N/mm²		3 max. change-over time	4 Build-up time Jointing pressure	5 Jointing pressure p = 0.1 N/mm²	
[mm]	Fusing pressure [bar]	Bead height [mm]	Heat-up pressure [bar]	Warm-up time [s] = [min]	[s]	[s]	Fusing pressure [bar]	Cooling time [min]
TOP 160 (Heating element temperature 255°C ±10°C)								
110 × 10,0	9	1	1	95 = 1,35	6	8–12	9	10–16
125 × 11,4	12	1	1	95 = 1,35	6	8–12	12	10–16
160 × 14,6	19	1	2	145 = 2,25	7	10–15	19	17–24
TOP 250, TOP 315 (Heating element temperature 255°C ±10°C)								
110 × 10,0	6	1	1	95 = 1,35	6	8–12	6	10–16
125 × 11,4	8	1	1	95 = 1,35	6	8–12	8	10–16
160 × 14,6	13	1	1	145 = 2,25	7	10–15	13	17–24
225 × 20,5	26	1,5	3	220 = 3,40	8	10–15	26	20–30
315 × 28,6	→ Please process with the TOP 400 welding machine!							
TOP 400								
125 × 11,4	5	1	1	95 = 1,35	6	8–12	5	10–16
160 × 14,5	7	1	1	145 = 2,25	7	10–15	7	17–24
225 × 20,5	15	1,5	1	220 = 3,4	8	10–15	15	20–30
315 × 28,6	28	2	3	290 = 4,8	9	15–20	28	30

9.5.2 Fusion welding

☑ Fusion device and fusion area must be protected against moisture and dirt.
☑ Compliance with the tool's operating instruction is mandatory.

Welding can be carried out up to a temperature of -10°C, if complying with the required fusion parameters.

The individual steps are illustrated on the next page.

Butt fusion welding

Preparing the machine

① → Insert the fixing device, suitable for the pipe diameter, into the clamping device and tighten it.

Locking the pipe into place

② → Insert the pipe
→ Close the clamping lever.

③ → Position the pipe the width of 2 fingers away from the fixation plate.
→ Tighten the clamping lever of the clamping device

Planing the pipe.

④ ↳ The welding machine pulls the pipe ends together and then back, equal to the width of the planer.

⑤ → Insert the planer.

⑥ ↳ Both pipe ends are planed.

⑦ → Check the length of the span of the planer. It must lead at least 3 x around the pipe diameter.
→ Remove the planer.

Cleaning the pipe

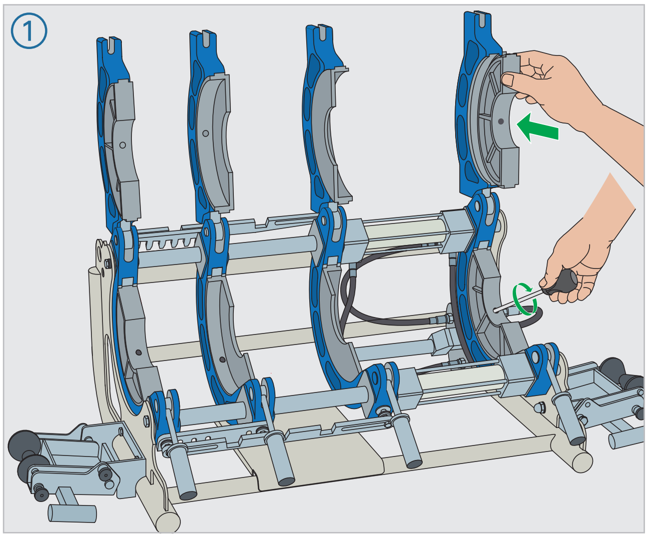
⑧ → Use Tangit cleaning agent to clean the ends of the pipe

Welding the pipe

▶▶

Information about possible welding defects:
➨ Part III 'The basics', Section 'Materials and jointing technology', Chapter [5] 'Welded connections'

Butt fusion welding

①


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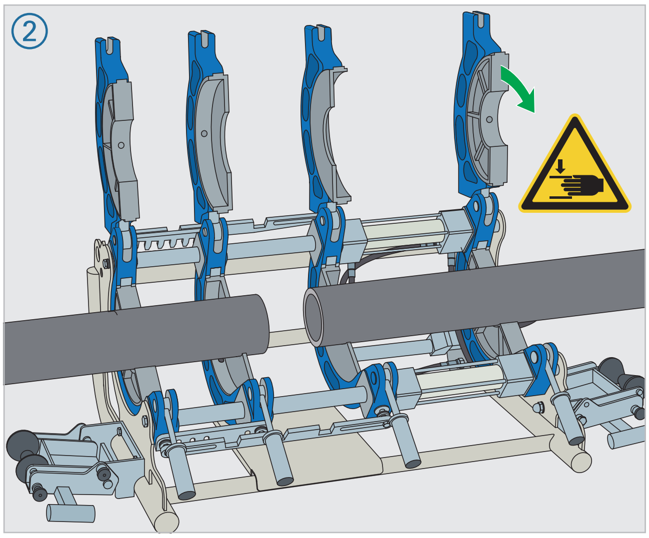

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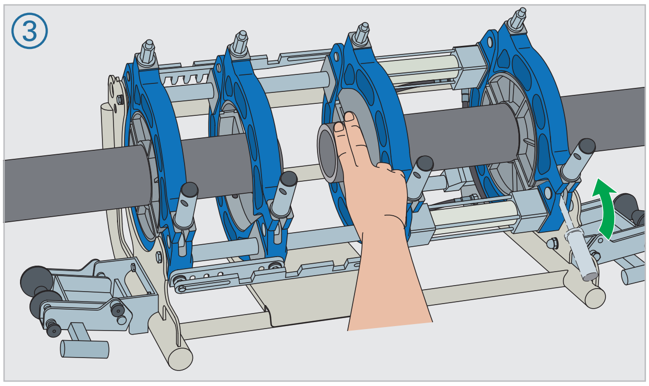

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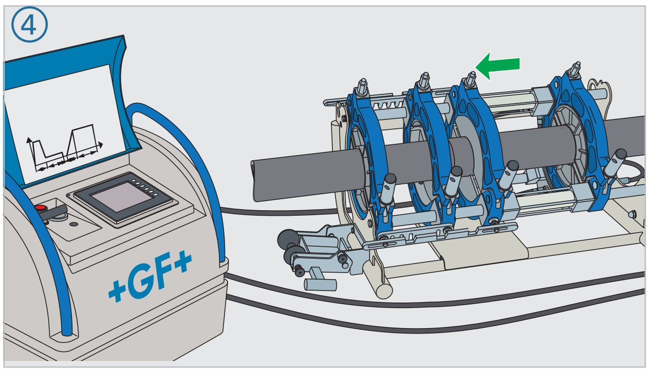

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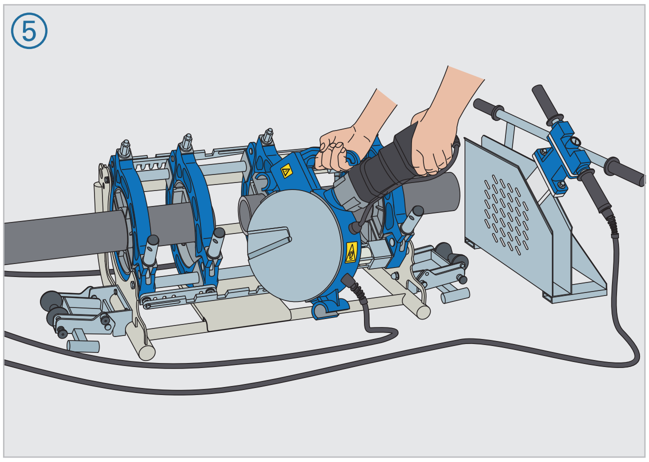

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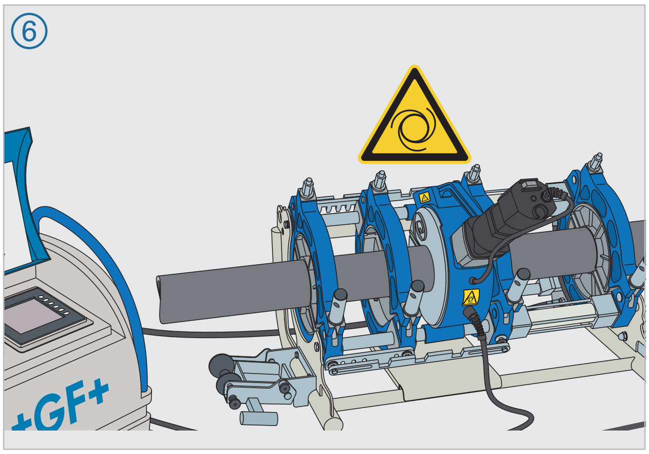

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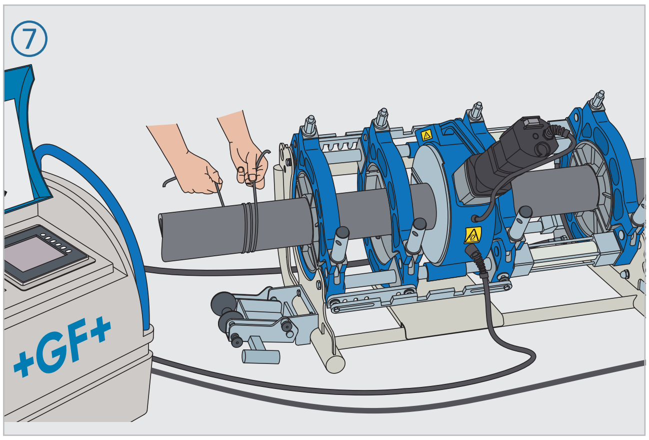

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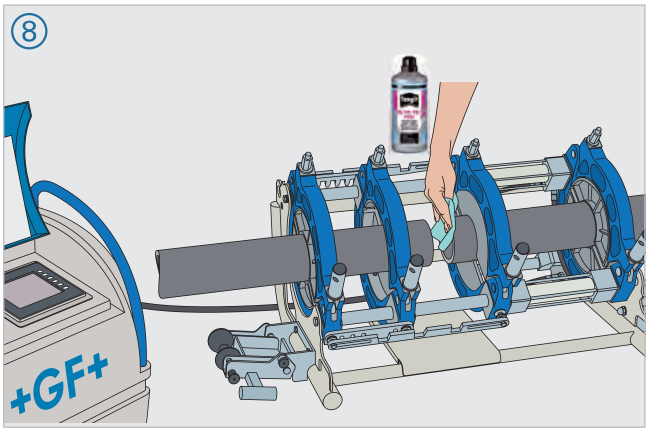


Butt fusion welding ▶▶

The individual steps are illustrated on the next page.

▶▶ Butt fusion welding

Welding the pipe

⑨ → Insert the welding mirror

→ Ensure to maintain a uniform welding temperature.

CAUTION! Danger of burning injuries when contacting the hot parts of the fusion device.

The temperature of the heating element is 250°C.

→ Careful when handling the fusion device.

→ Stay clear of hot parts.

⑩ ↳ The pipes are being heated

→ After the warm-up: Remove the welding mirror.

⑪ ↳ The pipes are pushed together and welded.

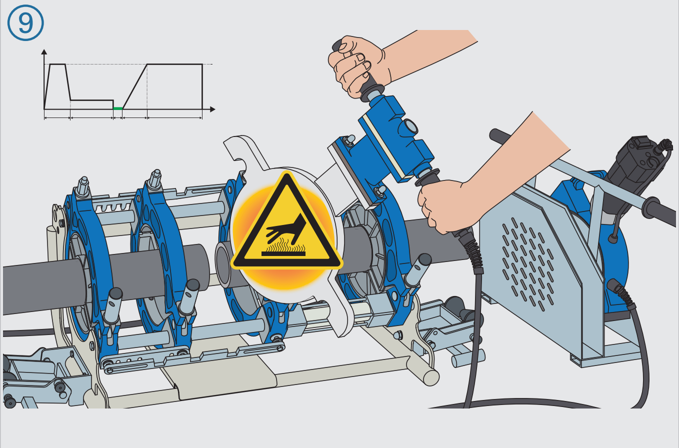
⑫ ↳ Inspecting the weld seam.

☑ Both fusion beads should form evenly around the pipe.

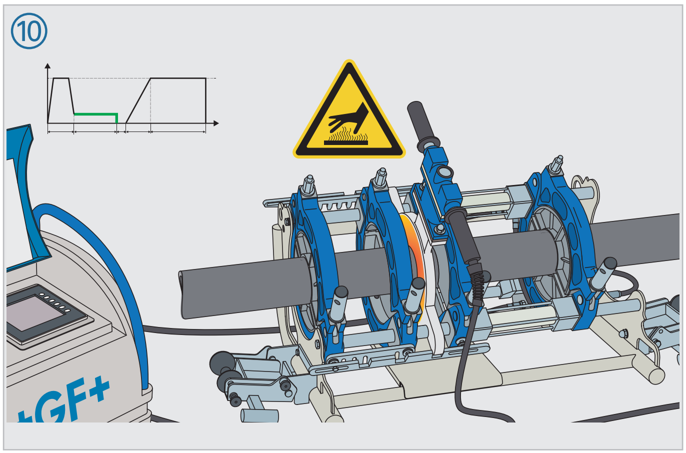
Information about possible welding defects:

Butt fusion welding

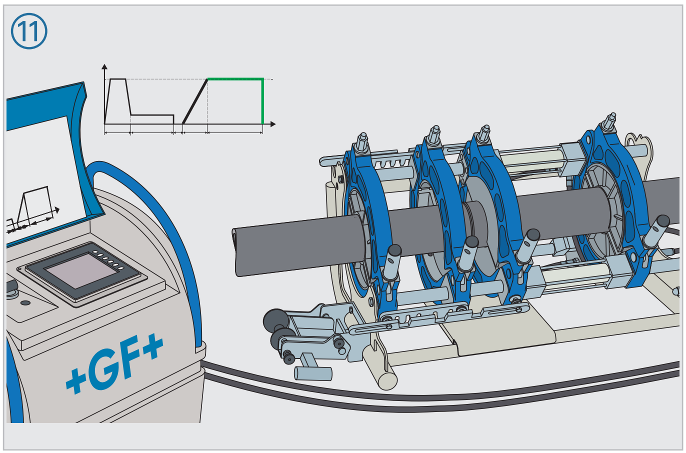
⑨



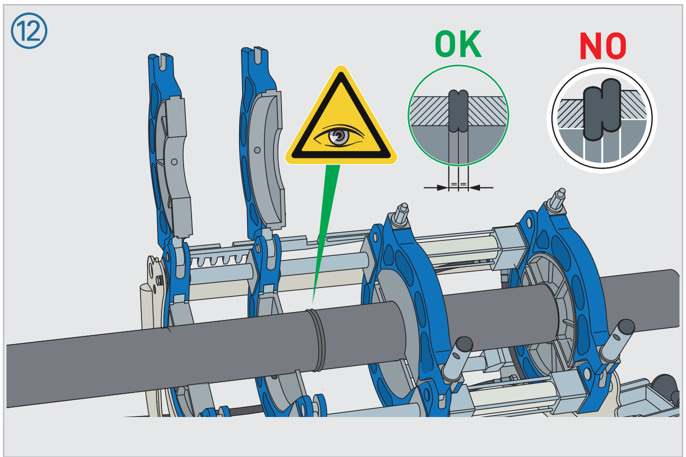
⑩



⑪



⑫



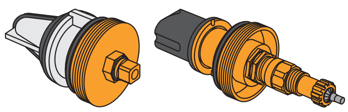
9.6 Assembly of PB valves (d20 – d63)

NOTE! Material damage due to incorrect assembly.
→ Compliance with the assembly instructions is mandatory.

9.6.1 Balancing valve/distribution valve

When using as a **flush-mounted installation** with handwheel activation, the valve can be used as a balancing shut-off or as a distributor shut-off valve. The valves are equipped with an anthracite-coloured handwheel. The enclosed washers (red/green) are used to mark hot or cold water. The valve can be welded to the INSTAFLEX welding machine using a similar process as the one used for the fittings.
→ Weld pipes and/or distributors directly into the distributor body according to the welding instructions.

9.6.2 Assembly – Replacing the PB valve (d20, d25, d32)



The individual steps are illustrated on the next page.

Replacing the PB valve (d20, d25, d32)

① **Material damage due to escaping medium!**
→ Before starting work: Turn off the water at the main tap.
→ Completely empty the pipeline.

→ Open the valve as far as it will go.

Remove the old valve

② → Loosen the screw of the handwheel.
→ Pull off the handwheel.

③ → Loosen the upper part, turning it counter-clockwise (whole thread length).

④ → Remove the upper part.

Install new valve

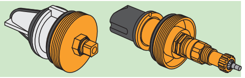
⑤ → Open the valve as far as it will go.

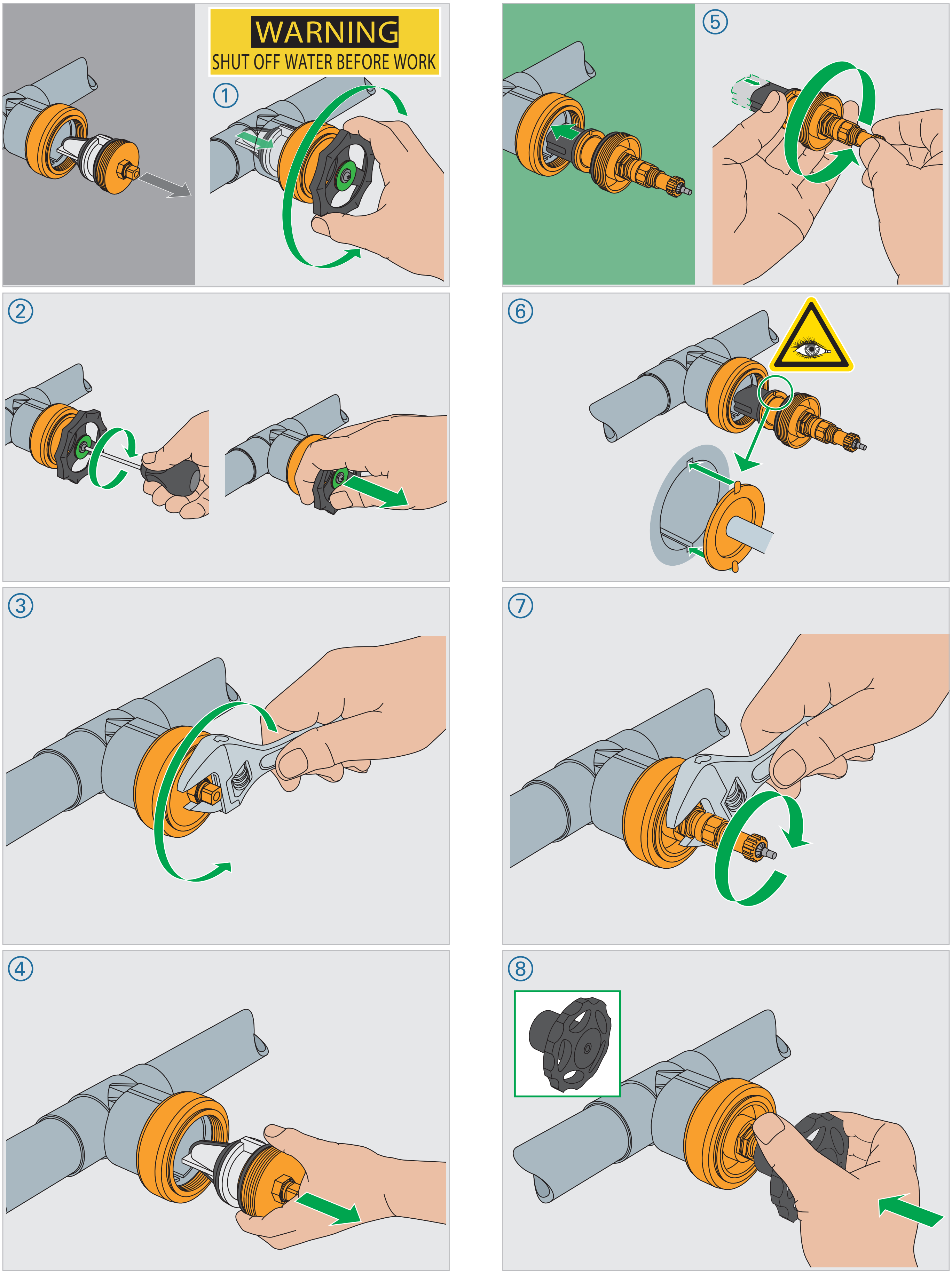
⑥ → Insert new upper part.
- Ensure the pins engage in the opening grooves.

⑦ → Tighten the upper part.

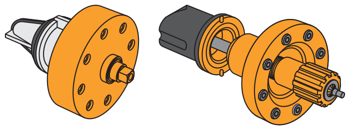
⑧ → Insert the handwheel.

Assembly – Replacing the PB valve (d20, d25, d32)





9.6.3 Assembly – Replacing the PB valve (d40, d50, d63)



The individual steps are illustrated on the next page.

Replacing the PB valve (d40, d50, d63)

① **Material damage due to escaping medium!**
- → Before starting work: Turn off the water at the main tap.
- → Completely empty the pipeline.

→ Open the valve as far as it will go.

Remove the old valve

② → Loosen the screw of the handwheel.
→ Pull off the handwheel.

③ → Use a cordless screwdriver to loosen the screws on upper part and remove them.

④ → Remove the upper part.

Install new valve

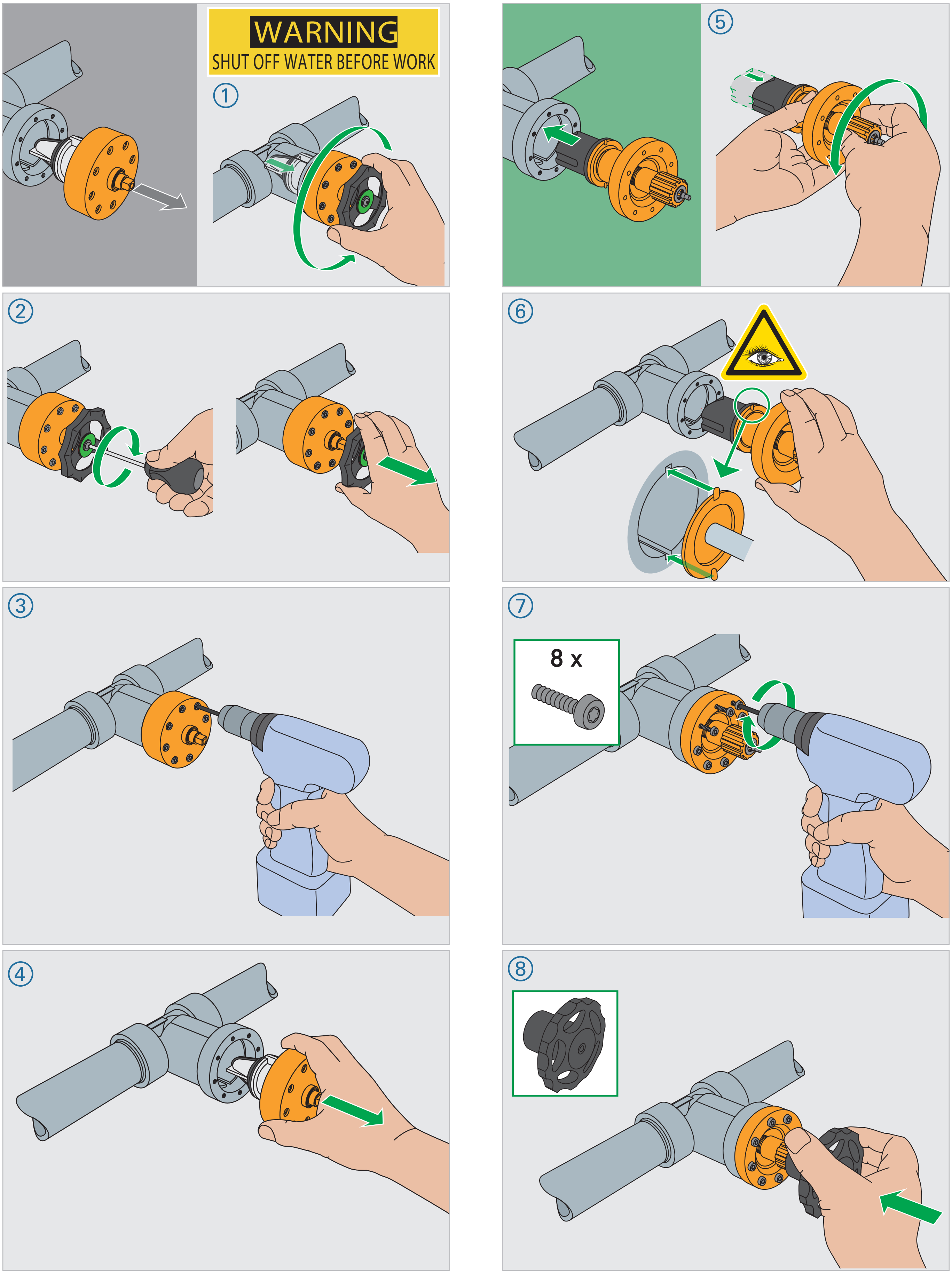
⑤ → Open the valve as far as it will go.

⑥ → Insert new upper part.
- Ensure the pins engage in the opening grooves.

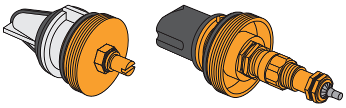
⑦ → Use a cordless screwdriver and tighten all screws.

⑧ → Insert the handwheel.

Assembly – Replacing the PB valve (d40, d50, d63)



Assembly – Replacing the PB valve (UP) (d20, d25, d32)



The individual steps are illustrated on the next page.

Replacing the PB valve (UP) (d20, d25, d32)

① **Material damage due to escaping medium!**
→ Before starting work: Turn off the water at the main tap.
→ Completely empty the pipeline.

→ Remove the cover rosette.

Remove the old valve

② → Open the valve as far as it will go.

③ → Use a spanner insert with AF18 and a ratchet key to loosen the nut on the upper part.

④ → Slightly tilt the ratchet key and pull out the upper part.

Install new valve

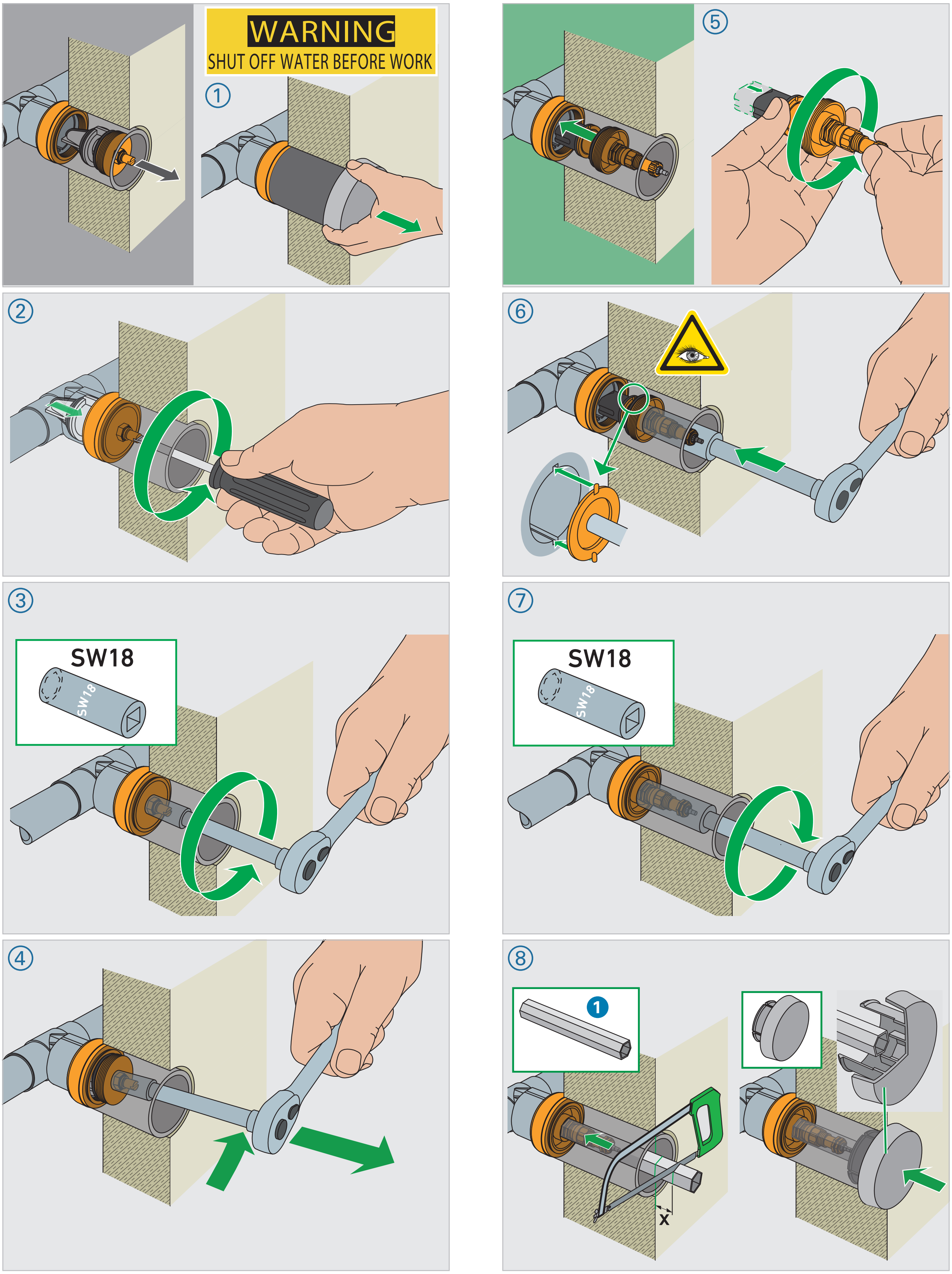
⑤ → Open the valve as far as it will go.

⑥ → Use a spanner insert with AF18 and a ratchet key to pick up the new valve body and insert it into the UP pipe.
- Ensure the pins engage in the opening grooves.

⑦ → Use a spanner insert with AF18 and a ratchet key to tighten the valve body, turning it clockwise.

⑧ → Insert the actuator rod ❶.
❶ d_a = 50 mm, d_i = 44 mm
→ Cut the actuator rod to the appropriate length: x = 20 mm
→ Install the new cover rosette with integrated actuation. Ensure the actuator rod engages in the cover rosette and is firmly seated.

Assembly – Replacing the PB valve (UP) (d20, d25, d32)



9.6.4 Assembly – Installing the PB valve (UP) (d20, d25, d32)

Install the PB valve (UP) with extension (d230, d25, d32)

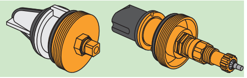
①
⚠ **Material damage due to escaping medium!**
→ Before starting work: Turn off the water at the main tap.
→ Completely empty the pipeline.

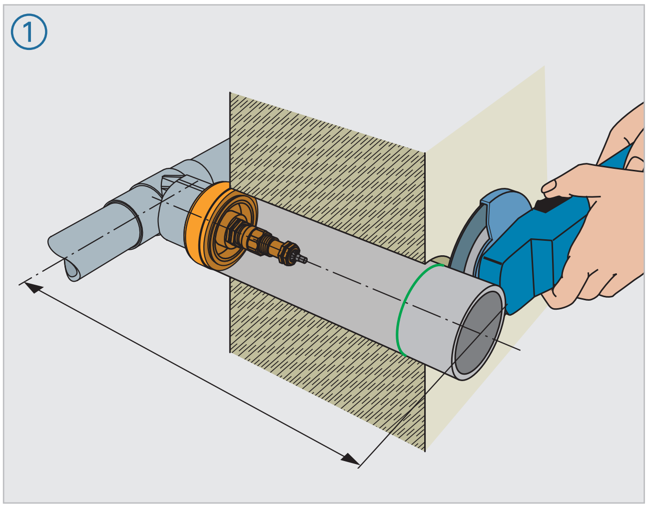
① → Cut extension pipe to length (length l = maximum 330 mm).

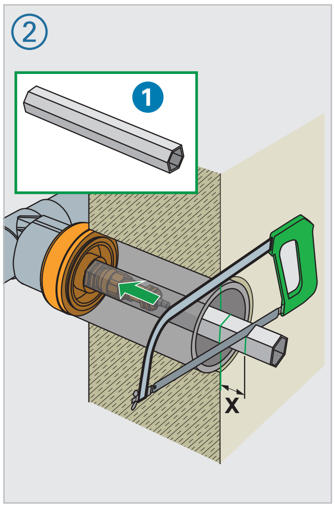
② → Insert the actuator rod ❶.
❶ d_a = 50 mm, d_i = 44 mm
→ Cut the actuator rod to the appropriate length (x = 20 mm).

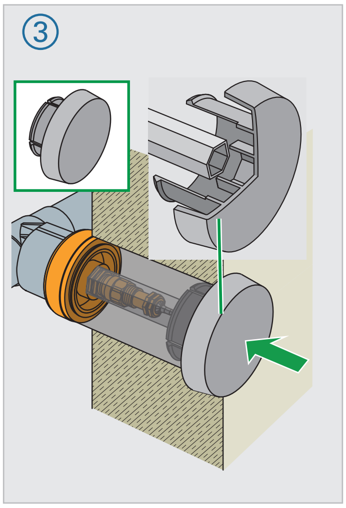
③ → Install the new cover rosette with integrated actuation.
- Ensure the actuator rod engages in the cover rosette and is firmly seated.

Assembly – Installing the PB valve (UP) (d20, d25, d32)







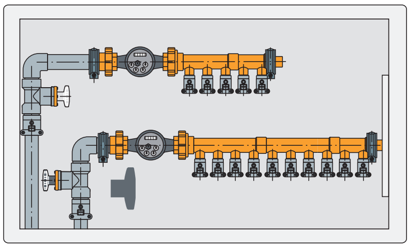
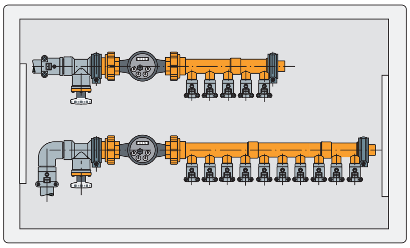
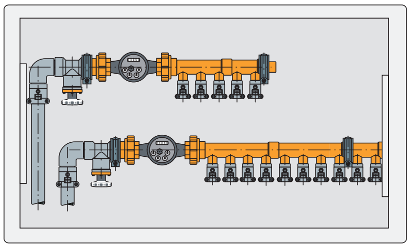


9.7 Assembly of the distributor

9.7.1 Arrangement of the distributors inside the distribution box

The fastening rails inside the distributor are individually adjustable.

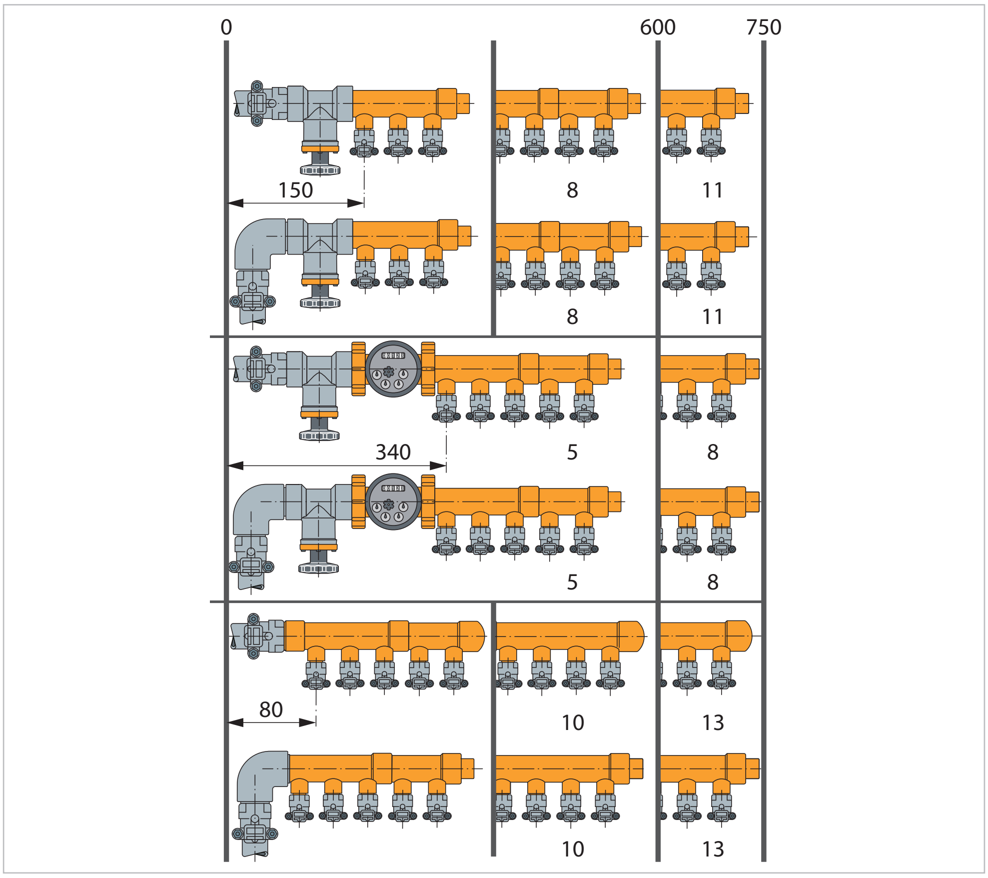
TV.46 **Arrangement of distributors (with or without water meter)**

Inlet from below	Inlet from the side and from below	Inlet from below
		
Valves installed vertically	Valves installed horizontally	Valves installed horizontally

Box size (outside dimension)	600	750
Inside dimension	550	700
Distributor with valve	8	11
Distributor with valve and water meter	5	8
Only distributor	10	13

TV.47
Number of distributor outlets inside the distribution box
for PB distributors d25 and metal distributors 3/4" and 1"

Example
Requirement: Distributor with 5 outlets, hot water meter and valve
Solution: Size of box 600 mm



GV.47
Number of distributor outlets inside the distribution box

10 Bending

NOTE! Risk of damaging the pipes due to improper bending!
→ Ensure the pipes do not kink when bending them.
Hot bending of PB pipes on the construction site is **not** permitted.
→ On the construction site, the PB pipes must be bend in **cold** condition.

10.1 How to bend INSTAFLEX pipes

Commercially available pipe bending tools can be used to shape the pipes.

☑ When moving from the floor level into the plane of the wall or when crossing into the plane of a wall, the minimum bending radius must be maintained.
☑ Make sure the pipe is not damaged or kinked during bending and assembly.
☑ Make sure to prevent impressions or compressions after bending the pipe.

10.2 Bending radii

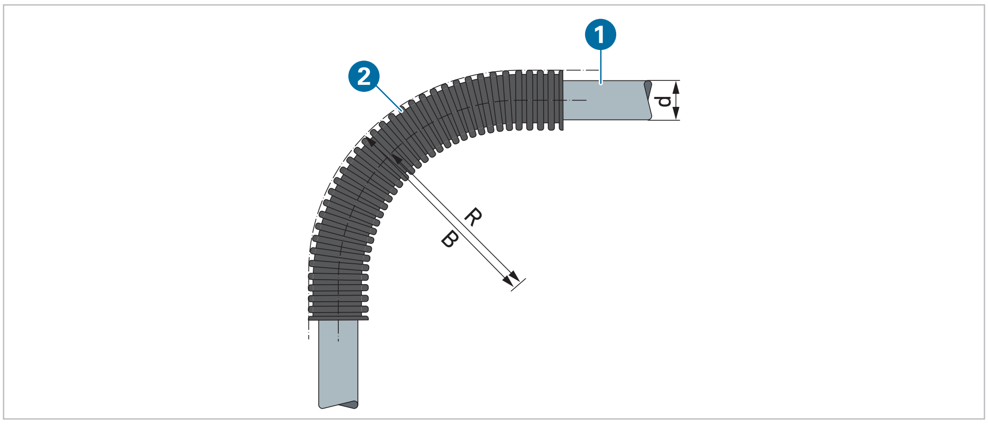
Minimum bending radii

☑ The bending radii must not be less than the minimum radius.

The minimum bending radius refers to the centre of the pipe (see tables on the next page).

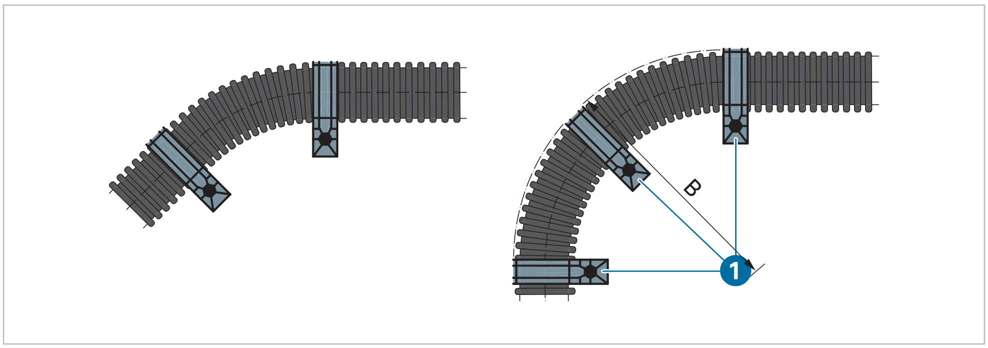
If the pipes must be bent **only briefly,** e.g. for inserting the pipe into a shaft, the pipes may be bent at an ambient temperature of 10°C with a bending radius of at least 15 × d. At an ambient temperature of 20°C, the minimum short-term bending radius is 9 × d.

+ Required fittings that deviate from the standard dimensions of 45° or 90° can be obtained from GF Piping Systems upon request.



GV.48
Minimum bending radius

1 Pipeline
2 Protective conduit
d Dimension of pipe
R Minimum bending radius
B Arc dimensions



GV.49
Attachment in the arc area

1 Attachment in the arc area
B Arc dimensions

- d16: R = 130 mm
- d20: R = 160 mm
- d25: R = 200 mm

The temperatures listed in the tables apply only to the bending process.

TV.48
Bending radii and arc dimensions d16 and d20

Pipe, Dimension d	With hydraulic cylinder (90°) 5 × d		Bent manually (90°) 10 × d	
	Bending radius R [mm]	Arc dimension B [mm]	Bending radius R [mm]	Arc dimension B [mm]
d16	80	125	128	201
d20	100	157	160	251

TV.49
Bending radii and arc dimensions d25 and d32

Pipe, Dimension d	With hydraulic cylinder (90°) 8 × d		Bent manually (90°) 10 × d	
	Bending radius R [mm]	Arc dimension B [mm]	Bending radius R [mm]	Arc dimension B [mm]
d25	200	314	250	392
d32	256	402	-	-

TV.50
Bending radii and arc dimensions d40 to d110

Pipe, Dimension d	With hydraulic cylinder (90°) 35 × d (at 10°C)		With hydraulic cylinder (90°) 20 × d (at 20°C)	
	Bending radius R [mm]	Arc dimension B [mm]	Bending radius R [mm]	Arc dimension B [mm]
d40	1400	2198	800	1256
d50	1750	2748	1000	1570
d63	2205	3462	1260	1978
d75	2625	4121	1500	2355
d90	3150	4946	1800	2826
d110	3850	6045	2200	3454

10.3 After the bending process

Starting with dimension d40, the pipes must not be subjected directly to the test pressure after bending.

The waiting period is:

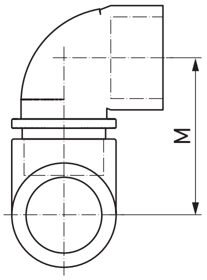
- At a pipe temperature of 10°C: 48 hours
- At a pipe temperature of 20°C: 18 hours

11 Fittings – Combinations – Dimensions

11.1 Fittings with HMS connections

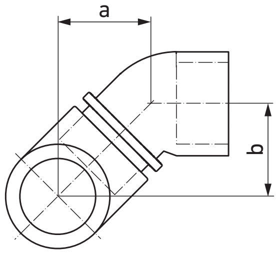
90° elbow – 90° elbow/Tee, equal (socket – spigot)

Dimension d	M [mm]
16	44
20	49
25	58
32	68
40	80
50	96
63	116



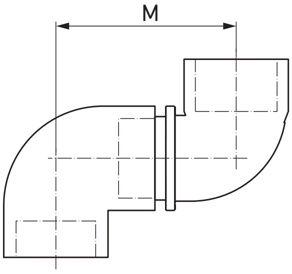
45° elbow – 90° elbow/Tee, equal (socket – spigot)

Dimension d	a/b [mm]
16	27
20	30
25	35
32	41
40	48
50	56
63	68



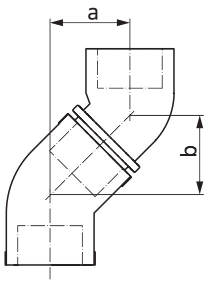
90° elbow – 90° elbow (socket – spigot)

Dimension d	M [mm]
16	44
20	49
25	58
32	68
40	80
50	96
63	116



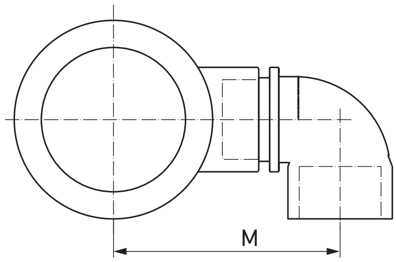
45° elbow – 45° elbow (socket – spigot)

Dimension d	a/b [mm]
16	25
20	26
25	30
32	35
40	41
50	47
63	56



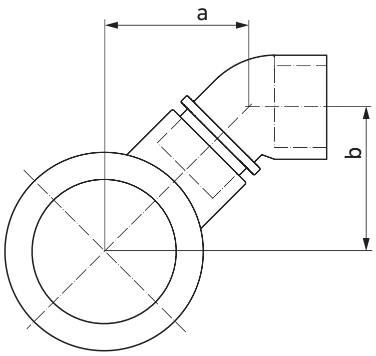
90° elbow/Tee, reduced (socket – spigot)

Dimension d	M [mm]
20-16-20	47
25-16-25	51
25-20-25	53
32-16-32	57
32-20-32	59
32-25-32	64
40-25-40	70
50-25-50	77
63-25-63	88



45° elbow/Tee, reduced (socket – spigot)

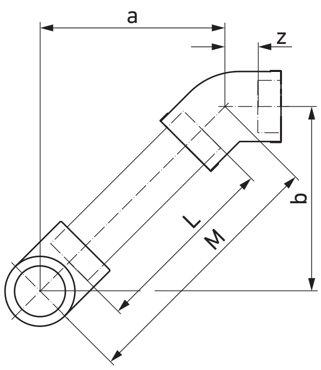
Dimension d	a/b [mm]
20-16-20	30
25-16-25	32
25-20-25	33
32-16-32	37
32-20-32	37
32-25-32	39
40-25-40	43
50-25-40	48
63-25-40	56



Minimum spacing between fittings

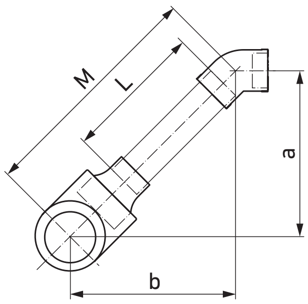
45° elbow – 90° elbow/Tee, equal

Dimension d	a/b [mm]	M min. [mm]	L [mm]
16	39	55	39
20	42	60	40
25	47	66	45
32	55	78	50
40	64	90	56
50	71	100	60
63	85	120	69
75	99	140	76
90	117	165	91
110	138	195	106



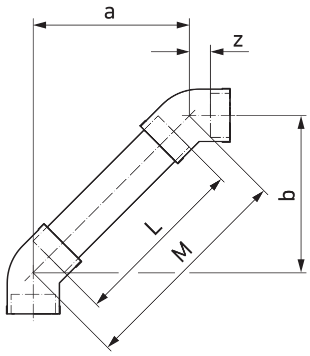
45° elbow – 45° elbow/Tee, equal/reduction

Dimension d	a/b [mm]	M min. [mm]	L [mm]
20-16	52	73	39
25-16	54	77	39
25-20	55	78	39
32-25	66	94	47
40-32	74	105	51
50-40	92	130	59
63-50	103	145	64
75-63	120	170	70
90-75	138	195	81
110-90	163	230	96



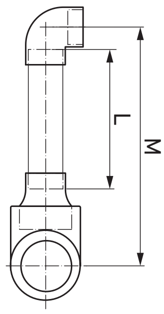
45° elbow – 45° elbow

Dimension d	a/b [mm]	M min. [mm]	L [mm]
16	35	50	38
20	37	52	38
25	42	60	46
32	50	70	50
40	57	80	56
50	60	85	57
63	71	100	66
75	85	120	80
90	95	135	91
110	113	160	108



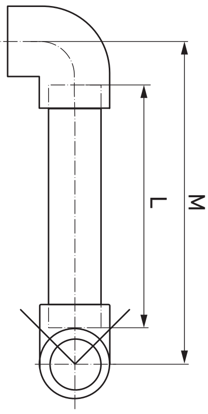
90° elbow – 90° elbow/ Tee, equal/reduction

Dimension d	M min. [mm]	L [mm]
20-16	78	40
25-16	82	40
25-20	85	40
32-25	102	48
40-32	115	53
50-40	140	59
63-50	160	67
75-63	195	78
90-75	225	88
110-90	270	106



90° elbow – 90° elbow/ Tee, equal

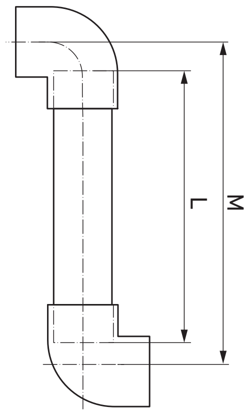
Dimension d	M min. [mm]	L [mm]
16	60	40
20	66	40
25	76	48
32	88	52
40	100	56
50	115	63
63	140	72
75	165	77
90	195	91
110	230	104



Pipe lengths if centre-to-centre dimension is specified

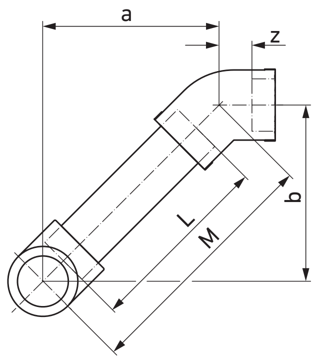
90° elbow/Tee, equal – 90° elbow/Tee, equal

Dimension d	16	20	25	32	40	50	63	75	90	110
M [mm]	Pipe length L [mm]									
80	60	54	52	44	-	-	-	-	-	-
100	80	74	72	64	56	-	-	-	-	-
120	100	94	92	84	76	68	-	-	-	-
150	130	124	122	114	106	98	82	-	-	-
180	160	154	152	144	136	128	112	92	-	-
210	190	184	182	174	166	158	142	122	106	-
250	230	224	222	214	206	198	182	162	146	124



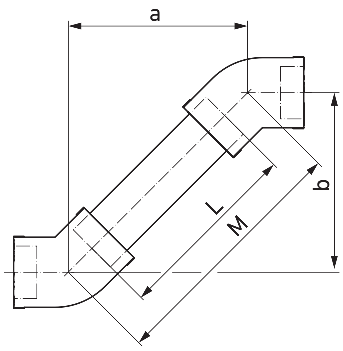
45° elbow – 90° elbow/Tee, equal

d	16	20	25	32	40	50	63	75	90	110	
a/b [mm]	Pipe length L [mm]										M [mm]
80	97	93	92	85	79	73	-	-	-	-	113
100	125	121	120	113	107	101	90	-	-	-	141
120	154	150	149	142	136	130	119	106	-	-	170
150	196	192	191	184	178	172	161	148	138	123	212
180	238	234	233	226	220	214	203	190	180	165	254
210	281	277	276	269	263	257	246	233	223	208	297
250	337	333	332	325	319	313	302	289	279	264	353



45° elbow – 45° elbow

d	16	20	25	32	40	50	63	75	90	110	
a/b [mm]	Pipe length L [mm]										M [mm]
80	101	99	99	93	89	85	79	-	-	-	113
100	129	127	127	121	117	113	107	101	97	-	141
120	258	156	156	150	146	142	136	130	126	118	170
150	200	198	198	192	188	184	178	172	168	160	212
180	242	240	240	234	230	226	220	214	210	202	254
210	285	283	283	277	273	269	263	257	253	245	297
250	341	339	339	333	329	325	319	313	309	301	353

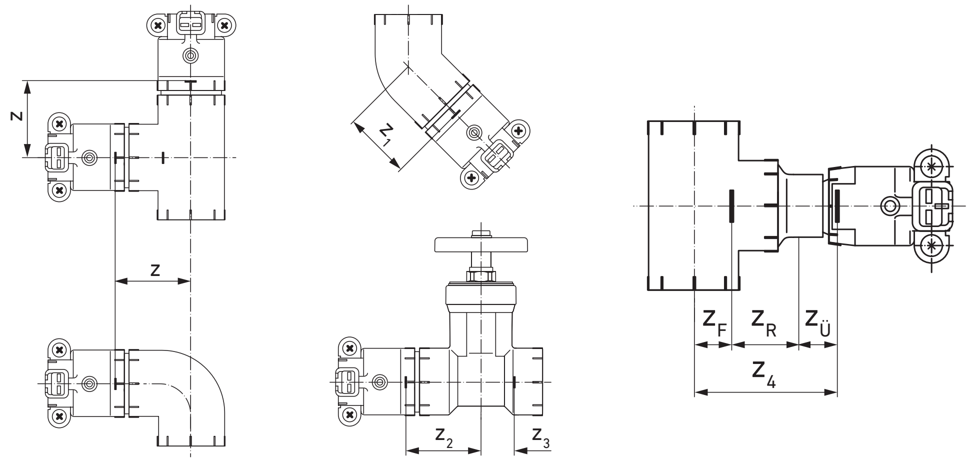


V

11.2 HMS fitting combinations with HWS transitions

$z4 = zF + zR + zÜ$

d	16	20	25	32	40	50	63			
Z	30	33	38	46	54	62	74	-	-	-
Z1	26	27	31	38	44	50	57	-	-	-
Z2	-	-	46	51	-	-	-	-	-	-
Z3	-	-	22	23	-	-	-	-	-	-

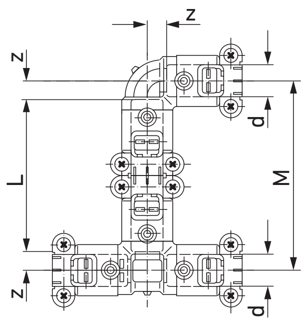


11.3 Fitting combinations with HWS fittings

11.3.1 Angles

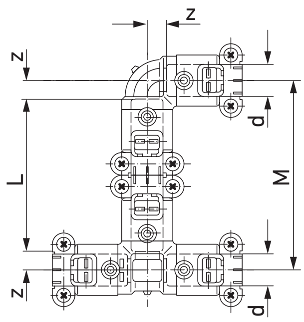
90° elbow/Tee, equal

Dimension d	M min. [mm]	z [mm]	L min. [mm]
16	96	10	76
20	110	14	82
25	118	16	86
32	122	18	86
40	140	22	96
50	158	29	100
63	178	36	102
75	226	45	136
90	256	54	148
110	294	66	162



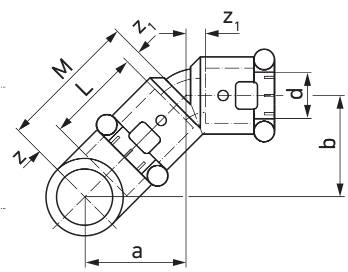
90° elbow/Tee, reduced

Dimension d	M min. [mm]	z [mm]	z1 [mm]	L min. [mm]
20-16-16	96	10	10	76
20-16-20	98	11	10	77
25-16-25	103	11	10	82
25-20-20	110	14	14	82
25-20-25	110	14	14	82
25-25-20	118	16	16	86
32-20-32	114	18	14	82
32-25-25	118	16	16	86
32-25-32	118	16	16	86
40-20-40	119	23	14	82
40-25-40	123	21	16	86
40-32-40	125	21	18	86
50-25-50	130	30	16	82
50-32-50	134	30	18	86
63-25-63	141	39	16	86
63-32-63	147	38	18	91



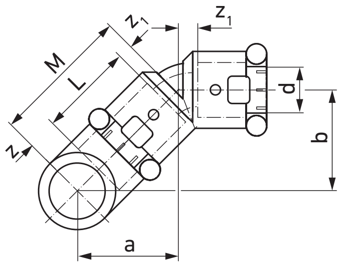
45° elbow/Tee, equal

Dimension d	a/b min. [mm]	M min. [mm]	z [mm]	z1 [mm]	L min. [mm]
16	66	93	10	6	78
20	72	102	14	7	80
25	78	110	16	8	86
32	80	113	18	9	86
40	92	130	22	11	96
50	101	143	29	14	100
63	110	156	36	17	104
75	145	205	45	21	138
90	163	230	54	25	150
110	184	260	66	31	163



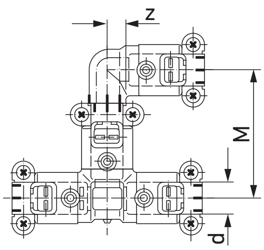
45° elbow/Tee, reduced

Dimension d	a/b min. [mm]	M min. [mm]	z [mm]	z1 [mm]	L min. [mm]
20-16-16	66	93	10	6	77
20-16-20	67	95	11	6	78
25-16-25	71	100	11	6	83
25-20-20	72	102	14	7	81
25-20-25	72	102	14	7	81
25-25-20	78	110	16	8	86
32-20-32	75	106	18	7	81
32-25-25	78	110	16	8	86
32-25-32	78	108	16	8	86
40-20-40	79	111	23	7	81
40-25-40	81	115	21	8	86
40-32-40	82	116	21	9	86
50-25-50	88	124	30	8	86
50-32-50	88	125	30	9	86
63-25-63	94	133	39	8	86
63-32-63	98	138	38	9	91



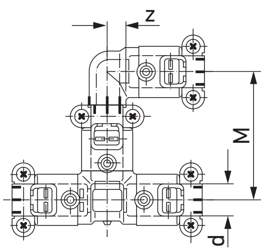
90° elbow (socket – spigot) – 90° elbow – 90° elbow/Tee, reduced (socket – spigot)

Dimension d	M min. [mm]	z [mm]
16	63	10
20	72	14
25	78	16
32	84	18
40	99	22
50	114	29
63	132	36



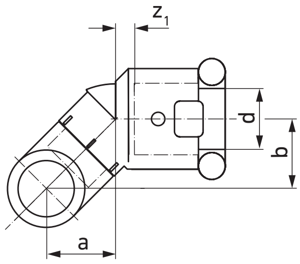
90° elbow/Tee, reduced (socket – spigot)

Dimension d	M min. [mm]	z [mm]
20-16-16	63	10
20-16-20	64	10
25-16-25	64	10
25-20-20	72	14
25-20-25	72	14
25-25-20	78	16
32-20-32	76	14
32-25-25	78	16
32-25-32	78	16
40-20-40	81	14
40-25-40	83	16
40-32-40	87	18
50-25-50	92	16
50-32-50	96	18
63-25-63	101	16
63-32-63	104	18



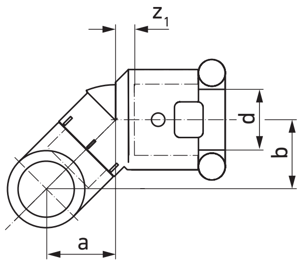
45° elbow/Tee, equal (socket – spigot)

Dimension d	a/b [mm]	z [mm]
16	42	6
20	48	7
25	52	8
32	55	9
40	63	11
50	74	14
63	81	17



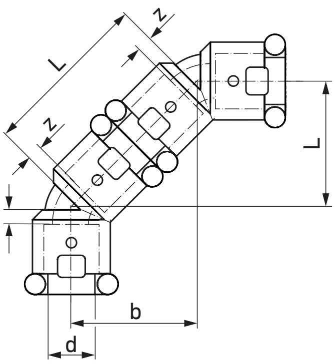
45° elbow/Tee, reduced (socket – spigot)

Dimension d	a/b [mm]	z [mm]
20-16-16	42	6
20-16-20	43	6
25-16-25	43	6
25-20-20	48	7
25-20-25	48	7
25-25-20	52	8
32-20-32	51	7
32-25-25	52	8
32-25-32	52	8
40-20-40	54	7
40-25-40	56	8
40-32-40	57	9
50-25-50	62	8
50-32-50	64	9
63-25-63	68	8
63-32-63	69	9



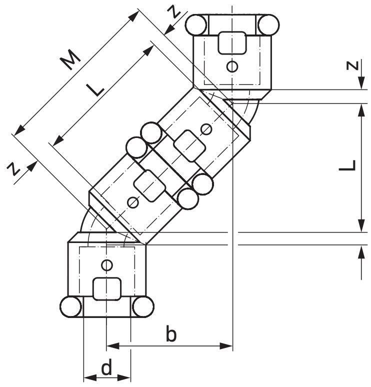
45° elbow – 45° elbow

Dimension d	a/b min. [mm]	M min. [mm]	z [mm]	L min. [mm]
16	64	90	6	78
20	67	94	7	80
25	72	102	8	86
32	74	104	9	86
40	84	118	11	96
50	91	128	14	100
63	98	138	17	104
75	127	180	21	138
90	141	200	25	150
110	159	225	31	163



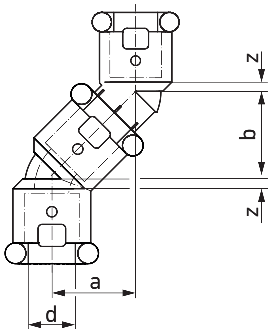
45° elbow – 45° elbow

Dimension d	a/b min. [mm]	M min. [mm]	z [mm]	L min. [mm]
16	64	90	6	78
20	67	94	7	80
25	72	102	8	86
32	74	104	9	86
40	84	118	11	96
50	91	128	14	100
63	98	138	17	104
75	127	180	21	138
90	141	200	25	150
110	159	225	31	163



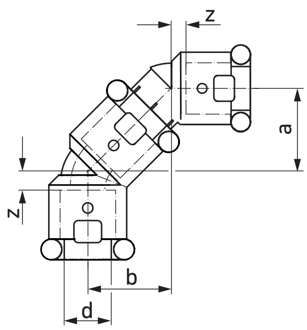
45° elbow – 45° elbow (socket – spigot)

Dimension d	a/b [mm]	z [mm]
16	40	6
20	43	7
25	46	8
32	49	9
40	55	11
50	63	14
63	68	17



45° elbow – 45° elbow (socket – spigot)

Dimension d	a/b [mm]	z [mm]
16	40	6
20	43	7
25	46	8
32	49	9
40	55	11
50	63	14
63	68	17



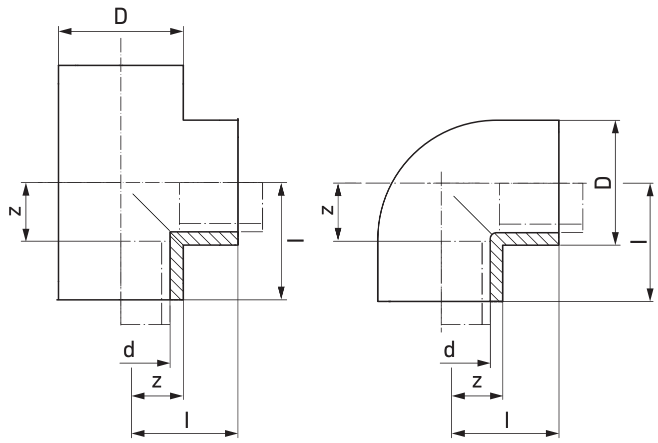
11.4 Fittings for socket fusion welding (HMS)

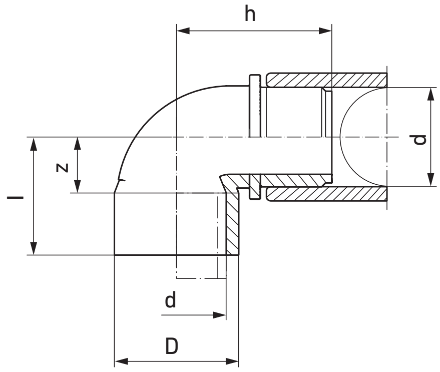
All dimensions in mm

11.4.1 Angles

90° elbow – 90° elbow (socket – spigot) – 90° elbow/Tee, equal

Dimension d	z	h	l	D
16	10	34	25	22
20	13	36	28	26
25	14	44	32	32
32	18	50	38	40
40	22	58	44	51
50	26	70	51	64
63	34	82	62	81
75	44	-	75	91
90	52	-	88	112
110	63	-	105	132

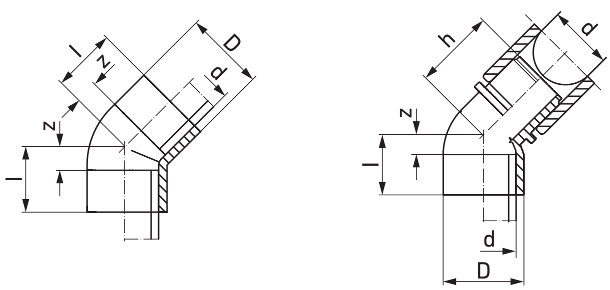




45° elbow – 45° elbow (socket – spigot)

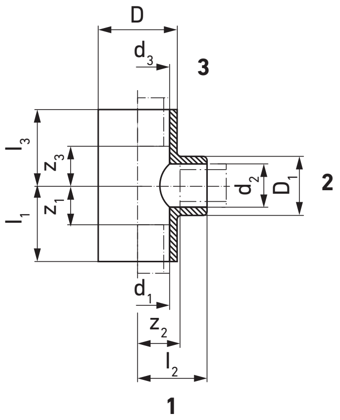
Dimension d	z	h	l	D
16	6	29	21	22
20	7	30	22	26
25	7	35	25	32
32	10	40	30	40
40	12	46	34	51
50	14	53	39	64
63	17	62	45	81
75	20	-	51	92
90	22	-	58	109
110	26	-	68	134

d16 – d110 d16 – d63



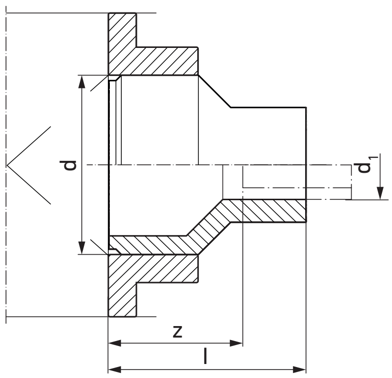
90° elbow/Tee, reduced

Dimension d	z_1/z_3	z_2	$l_{1.3}$	l_2	D	D
20-16-20	13	13	28	28	26	22
20-16-16	13	13	28	28	26	22
20-20-16	13	13	28	28	26	26
25-16-25	14	17	32	32	32	26
25-20-25	14	17	32	32	32	26
25-20-20	14/17	17	32	32	32	26
25-25-25	14	17	32	32	32	32
32-16-32	18	23	38	38	40	26
32-20-32	18	23	38	38	40	26
32-25-32	18	20	38	38	40	32
40-25-40	22	26	44	44	51	34
50-25-50	26	33	51	51	64	34
63-25-63	34	44	62	62	81	34

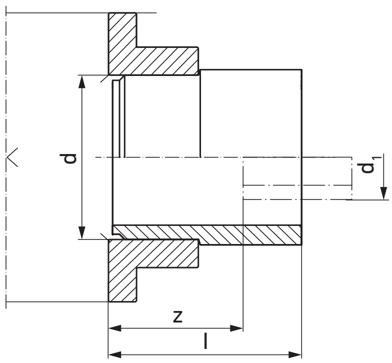


11.4.2 Reduction

Dimension d–d1	z	l
20-16	15	30
25-16	18	33
25-20	18	33
32-20	25	40
32-25	22	40
40-20	27	42
40-25	24	42
40-32	22	42
50-20	40	55
50-25	37	55
50-32	35	55
50-40	33	55

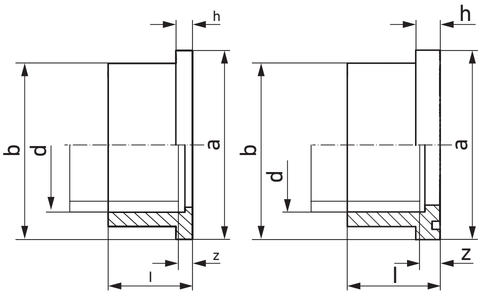


d–d1	z	l
63-20	43	58
63-25	40	58
63-32	38	58
63-40	36	58
63-50	33	58
75-63	39	67
90-63	46	74
90-75	43	74
110-63	58	86
110-75	55	86
110-90	50	86



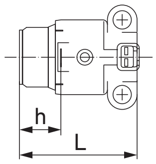
11.4.3 Flange adaptors flat/flange adaptors with groove

Dimension	flat		with groove	
d	z	l	z	l
16	5	20	8	23
20	5	20	8	23
25	5	23	8	26
32	5	25	8	28
40	5	27	10	32
50	5	30	10	35
63	5	33	10	38
75	4	35	9	40
90	6	42	11	47
110	7	49	13	55



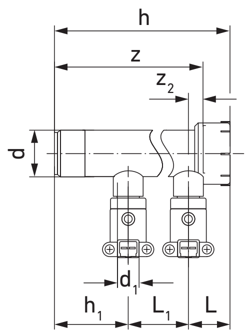
11.4.4 Transition for electrofusion welding (HWS)

Dimension d	h	L
16	23	60
20	22	61
25	25	67
32	29	71
40	32	79
50	36	85
63	43	94



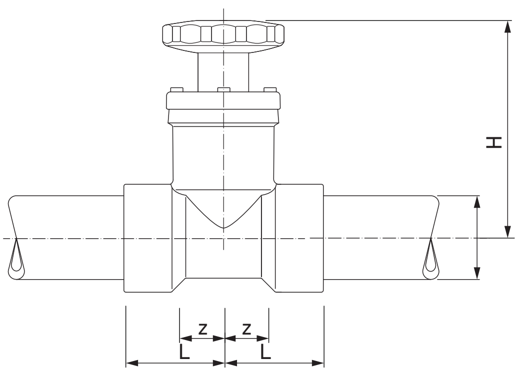
11.4.5 Distributor made of polybutene

Dimension d–d1		L	L1	h	h1	H	z	z1	z2
25-16	1 x	31	-	63	32	60	45	36	13
25-20	1 x	39	-	78	39	64	60	35	21
25-16	2x	31	45	108	32	60	90	36	13
25-16	3x	31	45	153	32	60	135	36	13
25-16	4x	31	45	198	32	60	180	36	13



11.4.6 PB valve (HMS)

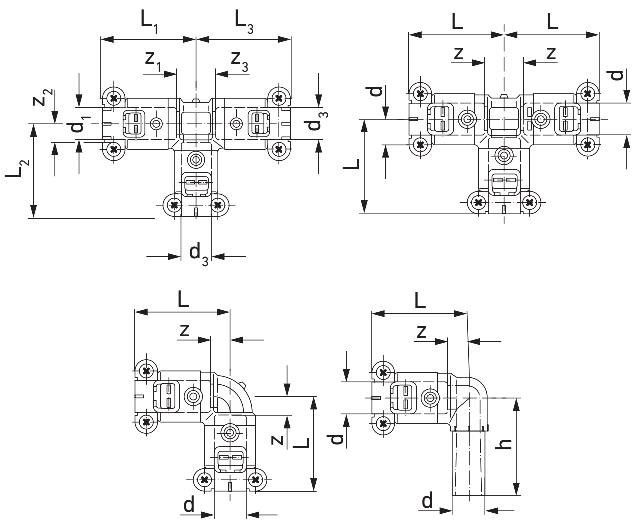
Dimension d	L	z	H
20	40	25	86
25	40	22	86
32	43	23	91
40	55	33	155
50	60	35	155
63	75	47	155



11.5 Fittings for electrofusion welding (HWS)

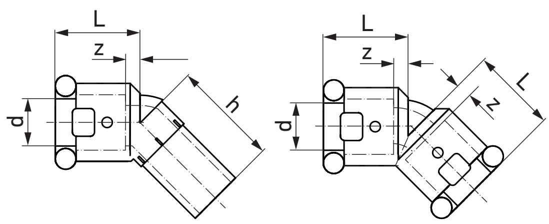
90° elbow/Tee, equal

Dimension d	L	z	H
16	47	10	53
20	54	14	58
25	58	16	62
32	60	18	66
40	69	22	77
50	78	29	85
63	86	36	96
75	112	45	-
90	127	54	-
110	146	66	-



Tee, reduced

Dimension d1-d2-d3	L1	L2	L3	z1	z2	z3
20-16-16	54	47	47	14	10	10
20-16-20	54	49	54	14	11	14
25-16-25	58	54	58	16	16	16
25-20-20	58	54	54	16	14	14
25-20-25	58	54	58	16	14	16
25-25-20	58	58	54	16	16	14
32-20-32	60	58	60	18	18	18
32-25-25	60	58	58	18	16	16
32-25-32	60	58	60	18	16	18
40-20-40	69	63	69	22	23	22
40-25-40	69	63	69	22	21	22
40-32-40	69	63	69	22	21	22
50-25-40	78	72	78	29	30	29
50-32-50	78	72	78	29	30	29
63-25-63	86	81	86	36	39	36
63-40-63	86	85	86	36	38	36

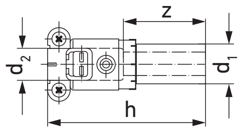


45° angle

Dimension d	L	z	H
16	44	6	50
20	46	7	54
25	50	8	57
32	51	9	60
40	58	11	67
50	63	14	75
63	68	17	79
75	88	21	-
90	98	25	-
110	111	31	-

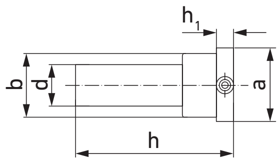
Reducers

Dimension d1-d2	h	z
20-16	83	45
25-16	83	46
25-20	86	47
32-16	86	48
32-20	84	45
32-25	89	47
40-20	102	62
40-25	104	62
40-32	95	53
50-20	102	62
50-25	104	62
50-32	95	53
50-40	103	56
63-20	102	62
63-25	104	62
63-32	95	53
63-40	103	56
63-50	106	57
75-63	129	78
90-63	128	77
90-75	143	76
110-63	135	84
110-75	150	83
110-90	165	92



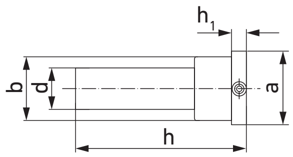
Flange adaptor with groove for O-ring

Dimension d	h
32	78/75
40	88/83
50	93/88
63	98/93
75	158/153
90	172/167
110	186/180



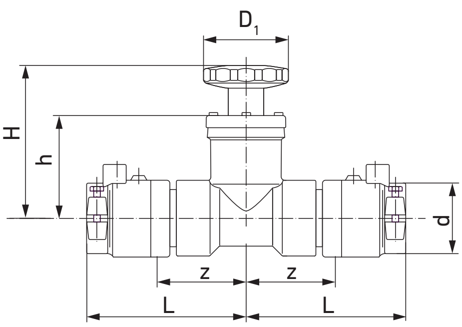
Flange adaptor, flat

Dimension d	h
d32 – d110	78/75 – 186/180



PB valve (HWS)

Dimension d	h	z
20	86	47
25	89	47
32	94	52
40	112	65
50	120	71
63	141	90



V

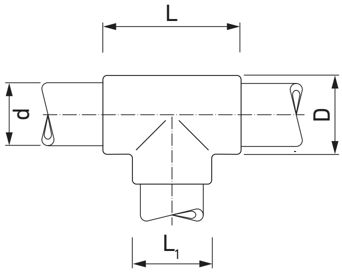
11.6 Diameters and spacings of pipe clips for INSTAFLEX fittings

INSTAFLEX pipes: When using pipe dimensions d16, d20, d25, d32, d40, d50, d63, d75, d90, d110, the diameter of the pipe corresponds to the pipe clips diameter.

11.6.1 INSTAFLEX fittings with HMS connection

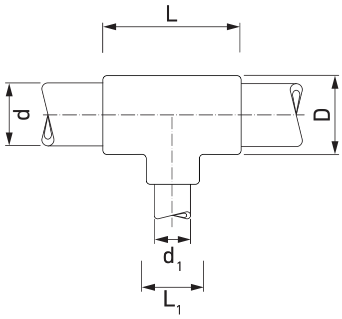
T 90° equal

Dimension d	D	D_1	L	L_1
25	32	-	64	32
32	40	-	76	45
40	51	-	88	55
50	64	-	102	70
63	81	-	124	90
75	92	-	150	100
90	114	-	176	120
110	134	-	212	140



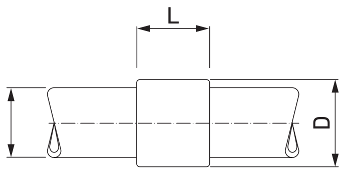
T 90° reduced

Dimension d	D	D_1	L	L_1
25-20-25	32	26	64	30
32-25-32	40	32	76	35
40-25-40	51	35	88	40
50-25-50	64	35	102	40
63-25-63	81	35	124	40



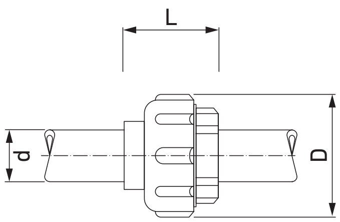
Socket

Dimension d	D	L
16	22	33
20	26	33
25	32	39
32	40	43
40	51	48
50	64	54
63	81	60
75	93	69
90	112	80
110	134	96



11.6.2 Threaded connectors

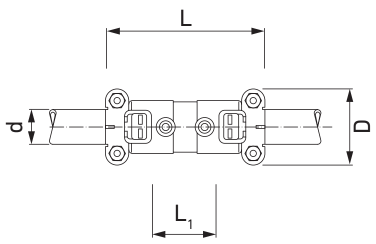
Dimension d	D	L
16	41	43
20	50	43
25	56	49
32	69	53
40	83	59
50	90	65
63	110	71



11.6.3 INSTAFLEX-Fittings with HWS connection

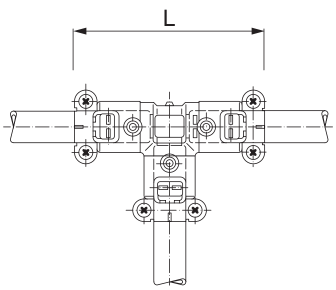
Socket

Dimension d	D	L	L_1
16	24	55	30
20	28	60	30
25	34	70	35
32	42	75	45
40	53	80	45
50	66	90	50
63	83	100	60
75	96	135	50
90	117	150	60
110	143	160	70



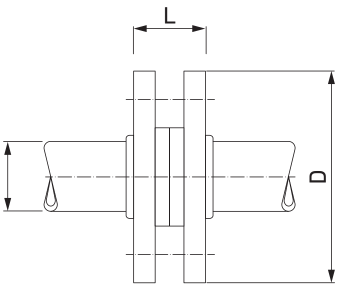
90° tee, equal/90° tee, reduced

Dimension d	L
16	95
20	110
25	120
32	125
40	140
50	160
63	175
75	225
90	255
110	295



11.6.4 Flange connections

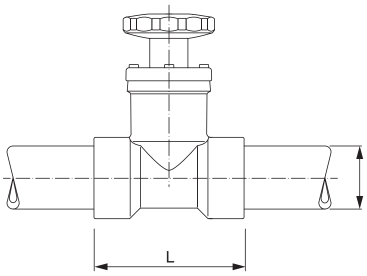
Dimension d	D	L
25	-	-
32	-	-
40	-	-
50	150	65
63	165	71
75	185	75
90	200	89
110	220	104

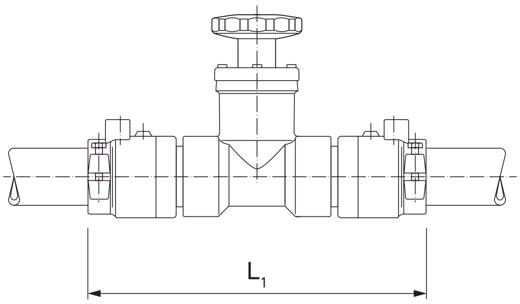


11.6.5 INSTAFLEX fittings

PB- valves

Dimension d	L	L_1
16	-	-
20	-	-
25	80	-
32	86	-
40	110	-
50	120	-
63	150	-

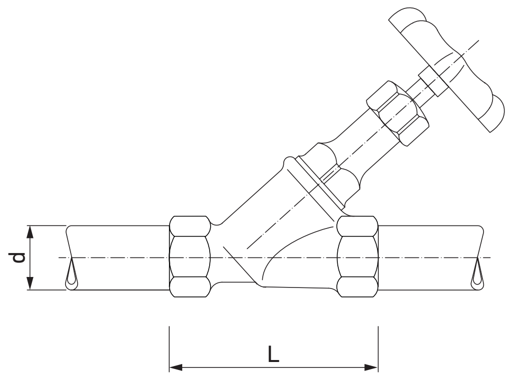




V

Poppet valves made of metal

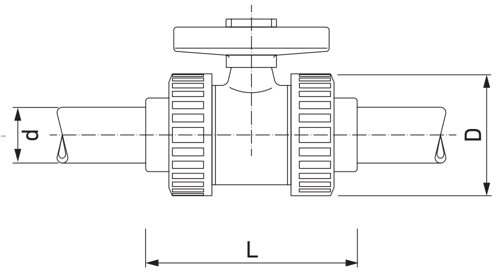
Dimension d	L	• not included in the INSTAFLEX delivery program
20 / ½	depending on the make	
25 / ¾		
32 / 1		
40 / 1¼		
50 / 1½		
63 / 2		



Ball valve 346

Dimension d	L	D
16	110	46
20	110	46
25	130	56
32	140	67
40	160	81
50	170	97
63	210	119

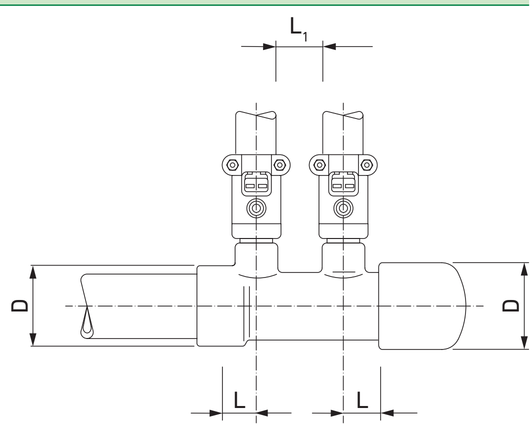
• with PB flange adaptors



11.6.6 INSTAFLEX distributor

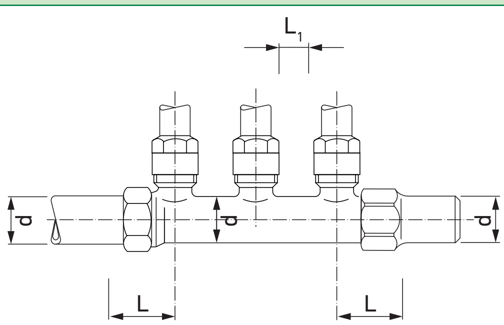
Distributor made of polybutene

Dimension d	D	L	D_1	L_1
25	32	15	26	20
32	40	15	34	20



Distributor made of metal

Dimension DN / d	L	L_1	d
DN20 / ¾″	≈ 35	15	26
DN25 / 1″	≈ 35	15	32



12 Maintenance and Repair

The INSTAFLEX system parts have been developed with the greatest possible safety in terms of long-term behaviour. The replacement of system components or the repair of pipes after a mechanical damage can easily be carried out with the appropriate knowledge.

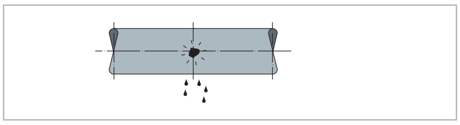
12.1 Repairing a pipe

The repair of a damaged pipe depends on the type of damage.

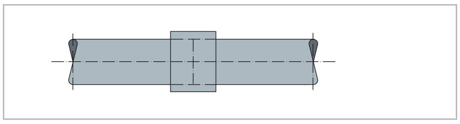
In case of minor damage by nails or screws, the pipe does not have to be cut out. In case of major damage, it is mandatory to replace the entire damaged part of the pipe.

12.1.1 Repairing minor damages

→ Cut the pipe at the damaged point.

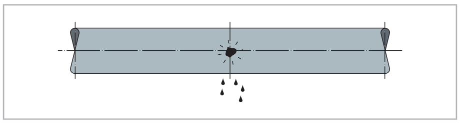


→ Reassemble the pipe with a connection fitting.

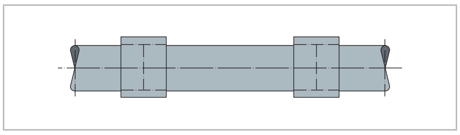


12.1.2 Repairing major damages

→ Remove the damaged part of the pipe.
→ and reinstall the new part of the pipe with two connection fittings.



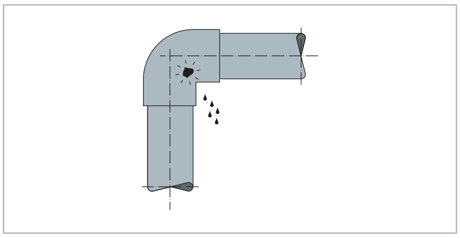
→ Reassemble the pipe with a connection fitting.



12.2 Repairing fittings

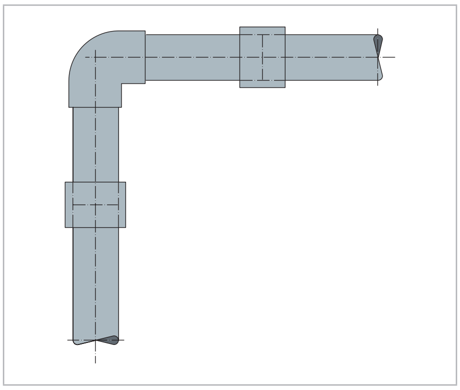
12.2.1 Replacing fittings

→ Cut out the applicable part of the pipeline and remove the damaged fitting.



→ Insert the new part of the pipeline including the fitting.

Two connecting fittings are used to connect the new part of the pipeline with the existing pipeline.

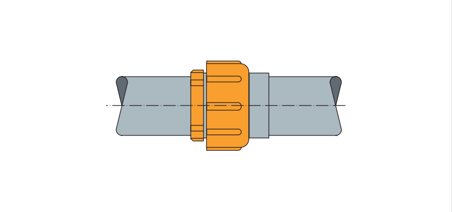


Threaded connectors

d16 to d63

These fittings are detachable connections and must not be installed inside the wall.

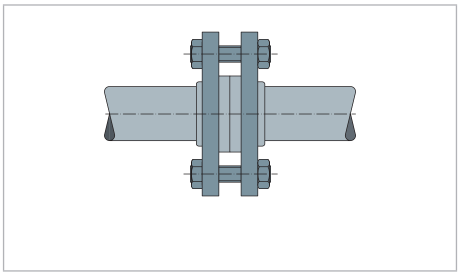
→ Weld the flange adaptors of the threaded connection with the heating element socket weld onto the open pipe ends.



Flange connections

d20 to d110

When using a flange connection, the procedure is the same as for a threaded connection.



12.2.2 Replacing pipes inside the distribution box

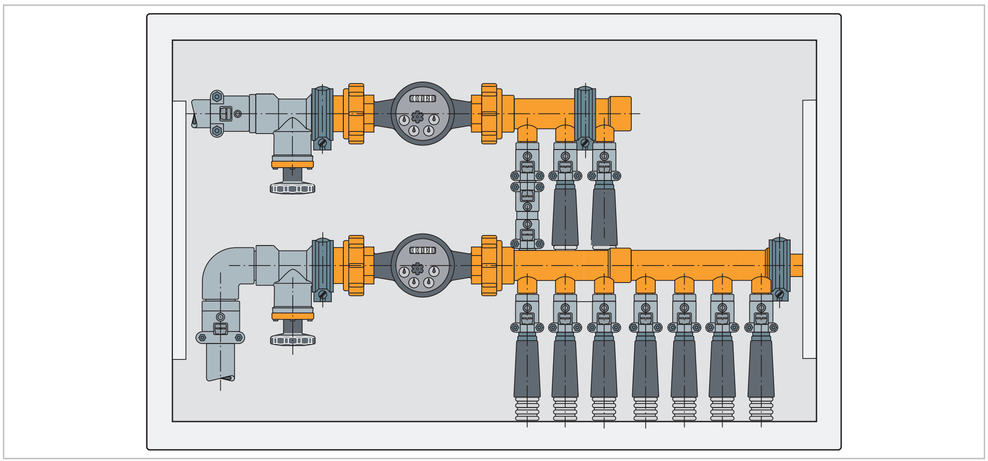
In order for the corresponding pipeline to be easily recognisable when replacing a pipe:

→ Label the consumer on the protective conduit of the pipeline.

→ Cut off the pipe that must be replaced approx. 5 cm below the distributor outlet.

→ Replace pipe and insert new pipe.

→ Connect the new pipe to the electrofusion socket.



GV.50
Distribution box

12.3 Material change and transitions to other systems and materials

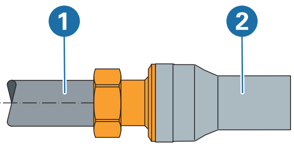
Transitions to third-party systems are not subject to the standard connections.
No warranty can be claimed for these transitional connections.

Repairs, reconstructions and renovations very often require a material or material change. This applies in particular to partial renovations (if pipes are renewed only in the basement for distribution purposes or only for replacing riser pipes), in mixed installations made of steel (galvanized), copper, stainless steel and various plastics, or if repairs are required (if only defective pipe sections are replaced). In these cases, material changes are inevitable.

The mixture of plastic pipelines with each other or with metal piping is feasible.

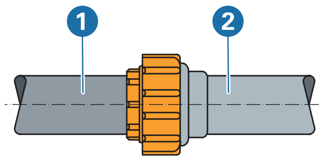
☑ If transitions from metal to metal are required, the direction of flow must be observed (displacement series: always change from the less noble to the more noble metal).

Transition Fitting TRF



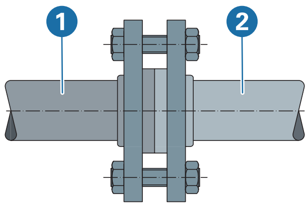
1 Metal pipe
2 PB pipe

Connection with flange adaptors



1 PE-/PP pipe with flange adaptor*
2 PB pipe

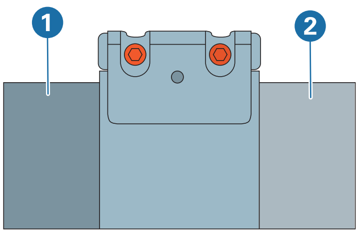
Flange connections with flange adaptors



1 PE-/PP pipe with flange adaptor*
2 PB pipe with flange adaptor*

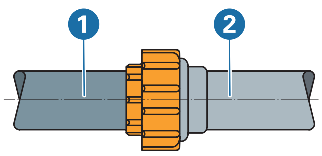
*Flange adaptors made of PE and PP are included in the applicable GF supply ranges.

Uniflex coupling



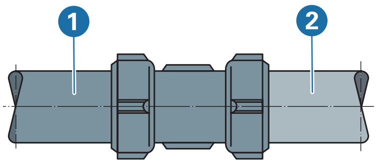
1 Metal pipe
2 PB pipe

Connection with metal thread



IG or AG
1 Metal pipe
2 PB pipe

Primofit



Operating conditions in connection with PB pipes

- Temperature: up to 60°C
- Pressure: up to 6 bar
- Duration: 5 years
- Stiffener for pipe series SDR 11

1 Metal pipe
2 PB pipe

12.4 Thawing frozen pipelines

For thawing frozen plastic pipes, the thermal thawing process is most suitable.

12.4.1 Thermal thawing

During thermal thawing, warm air is drawn through the gap between the pipe and the protective conduit. The thawing time depends on the length of the frozen pipe and the warm air flowing through the protective conduit. The thawing time may take up to two hours.

NOTE! Using excessively high temperatures will damage the pipe!
When using longer lines, simply injecting warm air into the pipes leads to a heat build-up. This will damage the pipe if the temperature is too high.
→ The warm air blown into the pipe must be sucked out at the end of the pipe.

Procedure

→ Open the connection to the fitting.
→ Blow in the warm air.
→ Suck the warm air through the protective conduit.

To avoid sucking in water, it is recommended to use a water filtration vacuum cleaner

Variant

→ Pressurise frozen line with max. 15 bar.
  ↳ By stretching the PB material, a small gap (cavity) is created between the pipe and the frozen water column.
  ↳ The water flowing through the cavity shortens the thawing process.
→ Pressurising the pipe.
→ Open the discharge fitting.

The smallest gap between the ice and the pipe wall accelerates the thawing process.

13 Applications

13.1 Swimming pools, thermal baths and geothermal baths

Swimming pools

Two groups of swimming pool installations must be considered:

- Water treatment
- Connecting pipes between the treatment system and the swimming pool

The connecting pipes between the water treatment system and the swimming pool must withstand the specific demands of the swimming pool water. Due to the excellent installation properties of PB pipes, INSTAFLEX also offers the user an optimum solution in swimming pool technology in this area as well. The materials used in the INSTAFLEX PB system (for pipes and fittings) and CR brass (transition fittings) are resistant to swimming pool water, which complies with the relevant valid standards. However, care should be taken that, depending on the nature of the system, chlorine may be added to the chlorination feed-in point.

The concentrations of up to 30 mg/l occurring at a chlorine shock, pose no threat to PB at a temperature of up to 40°C.

Thermal baths and geothermal baths

In this area of application, PB pipelines contribute to solving problems as well. For example, polybutene pipes often remain free of encrustation, where other materials become clogged by sediment deposits. When using hot water sources, PB pipes are ideal because of their high thermal capacity as a transport line.

13.2 Air conditioning

Building and room cooling, individually controllable, tailored to the needs of the user: INSTAFLEX also offers all the advantages of a modern pipeline system in this field of application. Optimal in the prefabrication of cooling pipelines and optimum connection parts for the cooling units allow efficient installation.

13.3 Pipelines for antifreeze and refrigerant

⚠ **Do not use in drinking water application!**

Glycol-based refrigerants are safe to use with polybutene pipes and fittings as well as non-ferrous metal fittings.

When using saline solutions as a refrigerant, PB pipes and fittings are non-hazardous, but the non-ferrous metal fittings must be used in nickel-plated version. Other refrigerants, such as Freon types must not be used.

Freezing protection for water up to approx. -10°C

Propylene glycol

☑ Compliance with the manufacturer's data is mandatory.

- Odourless and tasteless, absolutely non-toxic
- Dissolves well with water, no problem when flushing.

Glycerine

Mixture of 3 parts water and 1 part glycerine

- Does not mix well with water
- Residue is difficult to rinse

Saline solution, 10%

Subsequently, pipes must be flushed well

13.4 Rainwater systems

Use of roof drainage water through rainwater systems

The question whether roof drainage should be used in the home is cause for many controversial discussions. While authorities in Hamburg and Hesse propagate the use, the Federal Health Office advises against the use of roof drain water for domestic use. In this situation, it can only be recommended to weigh all arguments presented without prejudice. In the event that one decides to use the roof runoff water for domestic purposes, the following aspects must be taken into account:

- Roof drainage of rainwater systems causes hygienic problems.
- From a technical point of view, rainwater systems are feasible.
- The direct connection of rainwater systems with drinking water systems is prohibited. The separation of the rainwater system from the drinking water installation is necessary via a free outlet or a pipe interrupter A1 (see DIN 1988).
- The likelihood of confusion of rainwater with drinking water is especially a concern when children are involved (e.g. at the garden tap).
- A later cross-connection (direct connection) of the rainwater system to the drinking water installation is a major concern.
- The maintenance of rainwater systems by laymen is questionable.
- An economic benefit cannot be achieved.

Hygienic problems

When assessing rainwater systems from a hygienic point of view, it should first be pointed out that the actual rainwater is a minor problem.

A significant deterioration of the quality of rainwater occurs when this decline of quality is caused by animal excrement, such as bird droppings, and is further contaminated. This water must then be referred to as roof drainage.

The use of roof drainage water for body cleansing and for washing laundry is to be rejected for purely aesthetic reasons and from a hygienic point of view. When washing the laundry, it is to be expected that certain germs or spores survive the washing process, especially at low temperatures, and also outlive the subsequent drying process. The few previous studies cannot eliminate this risk.

Especially in hospitals, health and nursing homes as well as kindergartens and schools, the installation of rainwater systems is not recommended.

The German Federal Government comments as follows:

«The use of rainwater to save drinking water has been tested for several years. In the opinion of the Federal Health Office and based on the research so far, hygienic concerns against the rainwater use, e.g. because of the risk of contamination of the collected rainwater, cannot be dispelled.»

Design of the rainwater system

The design of a rainwater system is not a particular engineering problem for the skilled person. The roof runoff water flows through the downpipes into the collection tank. Using a pump system, the water is purified by the filter and is fed to the taps. Replenishment in dry periods is done via the drinking water network.

13.5 Pipelines for deionised water

Do not use in drinking water application!

Deionised water is treated, normal water, the solid contents of which originally existed in dissolved form were removed by suitable treatment processes (e.g. ion exchange, hence the name "deionised water").

Deionised water
- Osmosis water
- Counter or reverse osmosis water
- Deionisation water
- Demineralisation water

The dissolved gases present in natural water through the contact with the environment, such as oxygen, carbon dioxide, are still present in deionised water. As a result, deionised water experiences an increase in its aggressiveness towards metals because the salts (calcium = calcium carbonate) required for their protection no longer exist.

There is no aggressiveness to polybutene and other plastics.

Deionised water is divided into two groups: **Pure water** and **ultrapure water**

Pure water is used for the following purposes:
- Feedwater for steam generators
- Feedwater for steamers
- Feedwater for dishwashers
- Cold water for the compressed air production
- general applications in a laboratory
- Industrial-type laundries
- Generation of ultrapure water

When using partially desalinated water (pure water), CR brass fittings can be installed without special additional protection.

Partial desalination
For information on partial desalination, please contact GF Piping Systems.

Ultrapure water is used in the following areas:
- Pharmaceutical production
- Laboratory (trace analysis)
- Biotechnology
- Microelectronics (semiconductor industry)

Use of purified water
When using ultrapure water, we recommend the use of SYGEF HP (PVDF).

When using non-ferrous metal fittings in pure water systems, they must be chemically nickel-plated (layer thickness: 12 µm) due to the aggressiveness of the water.

V

13.6 Vacuum pipelines

When using pipes (vacuum), which are pressurised from the outside, in addition to the strength, stability must be also considered. The mechanical load at absolute vacuum corresponds to a pressure difference between internal and external pressure of a maximum of 1 bar (under standardatmosphere).

At a pressure difference, the dimensional stability of the pipe must be taken into account. It can be calculated with the **buckling formula** for cylindrical pipes.

$$P_K = \frac{E_c \cdot 10}{4 \cdot (1 - \mu^2)} \cdot \left(\frac{s}{r_m}\right)^3$$

P_K	critical buckling pressure [N/mm²]
E_C	Creep module [N/mm²]
μ	Poisson's ratio (plastics: 0.4)
s	Wall thickness [mm]
r_m	medium pipe radius [mm]

TV.51
Characteristic values for the creep module E_C for polybutene (PB)*

Temperature [°C]	20	60	70
Statistical value [N/mm²]	170	107	90

* for 25 years with SF 1.5

A pipe subject to absolute vacuum (max 1 bar) is dimensioned sufficiently if the permissible **differential vacuum** is at least 1 bar and the calculated minimum safety factor is SF 2.

Sample calculation

$$P_K = \frac{E_c \cdot 10}{4 \cdot (1 - \mu^2)} \cdot \left(\frac{s}{r_m}\right)^3$$

S Safety factor

$$P_K = \frac{170 \cdot 10}{4 \cdot (1 - 0{,}4^2) \cdot 2} \cdot \left(\frac{4{,}6}{22{,}7}\right)^3$$

Pipe d	50 × 4.6
SF	2
P_K	2.1 bar

TV.52
Differential vacuum

Pipe (PB)			permissible differential negative pressure (SF 2) [bar]		
External diameter d	**Wall thickness [mm]**	Temperature [°C]	20	60	70
		E_C [MPa]	170	107	90
d16	2.2		8.2	5.2	4.3
d20	2.8		8.7	5.5	4.6
d25	2.3		2.1	1.3	1.1
d32	2.9		2.0	1.3	1.1
d40	3.7		2.1	1.3	1.1
d50	4.6		2.1	1.3	1.1
d63	5.8		2.1	1.3	1.1

13.7 Sprinkler systems

13.7.1 Product description

The innovative sprinkler pipes are made of polybutene (PB) and are inserted into the raw concrete ceiling.

Approval

The INSTAFLEX pipes from GF are approved for the installation of the sprinkler system.

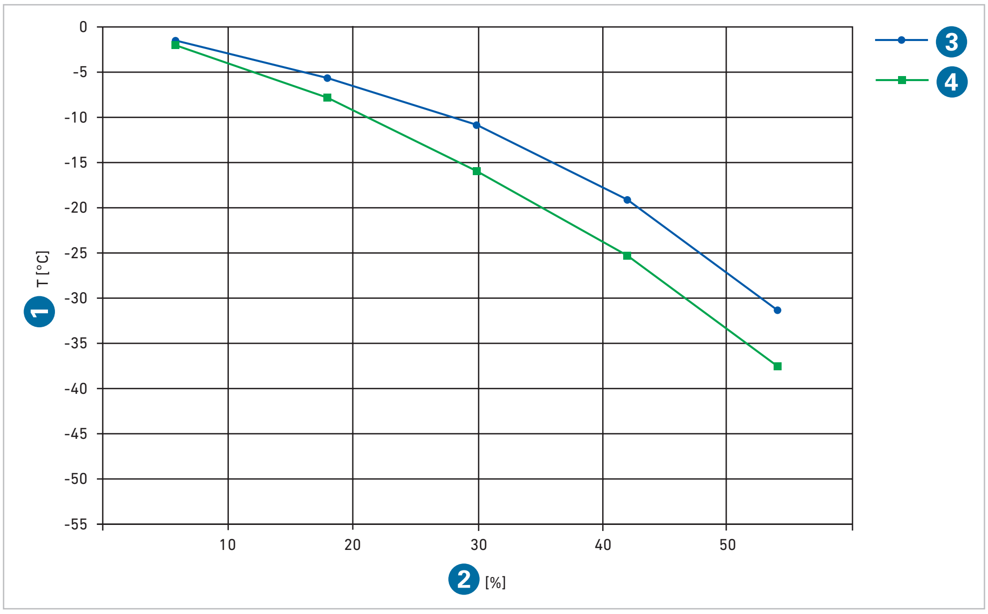
13.7.2 Applications

INSTAFLEX pipelines for sprinkler piping installations are very meaningful for the following objects:

- Buildings where the aesthetic impression is of great importance to architects/builders
- Underground garages (wet and dry lines)
- In buildings where the conditions of the object require the piping to be installed in the concrete floor

In storage buildings, where the use and the associated risk of fire can change at any time and the installation of the pipelines is mostly visible. In this case, plastic pipes are usually less useful.

13.7.3 Resistance



GV.51
Antifreeze

1. Temperature
2. Vol% antifreeze
3. Propylene glycol
4. Ethylene glycol

In combination with the antifreeze propylene glycol or ethylene glycol and a concentration of up to 50% thereof, the INSTAFLEX pipeline system is stable for application temperatures of up to 40°C. If copper metals are used, corrosion inhibitors must be added.

13.7.4 Instructions for the safe assembly

Inserting plastic pipes in sprinkler systems

Prerequisite for the use of plastic pipes and connections is the approval of the fire protection authorities.

- Fire code (BKZ) of the approved plumbing pipes: min. 4.2
- Nominal diameter for the plastic pipes: min. DN25

During the planning, assembly and when putting into operation, the compliance with the aspects is mandatory:

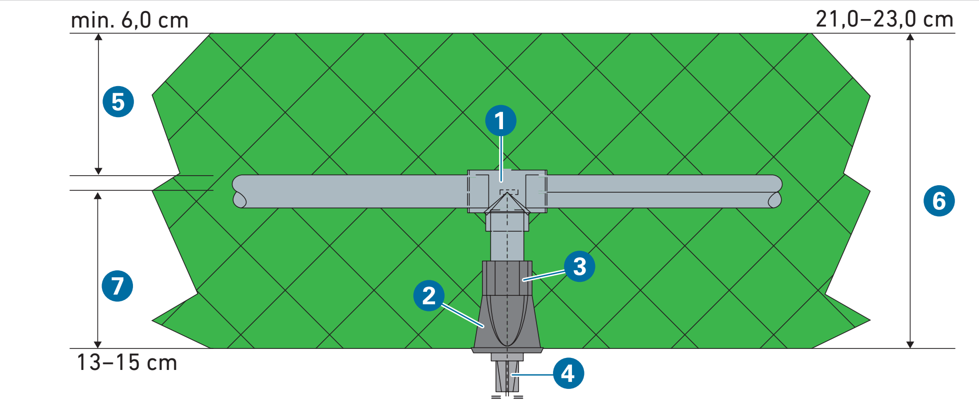
Planning and assembly

- ☑ Compliance with the GF installation requirement is mandatory.
- ☑ Only trained personnel provided by the company that is installing the sprinkler system shall be permitted to assemble the equipment. The staff must be trained in processing plastic material. The training certificate must be submitted to the fire protection authority together with the registration documents for the sprinkler system.
- ☑ For office and industrial uses: To ensure flexibility, the following measures must be observed:
  - The water capacity (W [l/min · m^2]) must be selected one level higher than the output specified in the applicable fire hazard category.
  - The protection area AS must not exceed 9 m^2 per sprinkler.
  - The spacing between sprinklers must not exceed 3 m.
- ☑ Pipelines concealed in the concrete must be installed between and attached to the reinforcement bars.
  - The pipes must be embedded in concrete 6 cm all around, compliant with EI 30 (nbb).
- ☑ Exposed plastic pipelines must be protected with fire resistant components according to EI 60 (nbb).
- Nominal diameter for the plastic pipes: min. DN25 (d32)
- ☑ The distance from the centreline of the plastic pipe to a solid walls or similar structure must be at least 30 cm (space requirement for repairs).
- ☑ The installation of the sprinkler system's main lines must remain exposed and the pipes must be made of steel.
- ☑ Flow detectors and flushing connections must remain exposed.
- ☑ Ensure the installation is carried out while pouring the concrete and during the shell construction phase. At that time, the pipes must be filled with water and pressurised up to a min. of 6 bar.

Acceptance and putting into operation

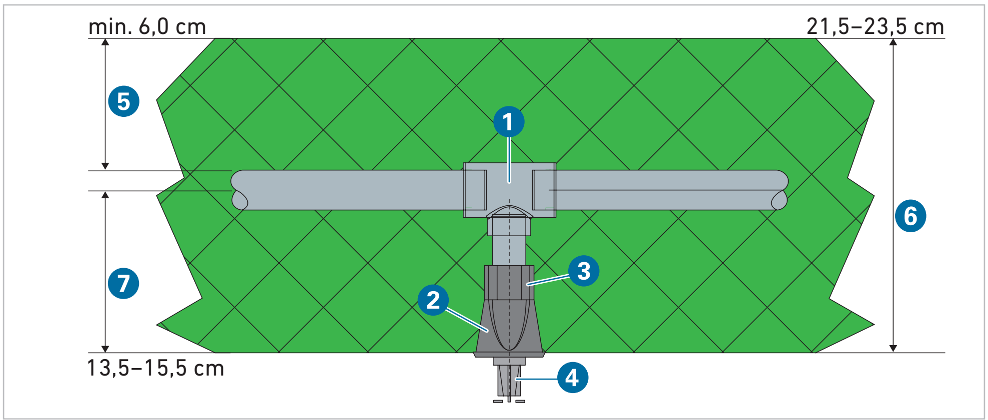
- ☑ Proceed with the pressure test and inspection of the installation before pouring the concrete, requesting the assistance of the site management. Log all findings and keep a written record.
  - Notify the fire protection authority of the inspection schedule well in advance.
- ☑ After the last welding task is completed: Pressurise the installation, using at least 15 bar.
- ☑ Clearly record the routing of embedded pipelines in the planning documents (CAD).
  - Markings on the ceiling can be omitted, however, it is recommended.
- ☑ An INSTAFLEX repair kit can be found in the sprinkler control panel.
- ☑ The construction management must be advised that embedding sprinkler pipes in concrete may cause problems over time (leaks due to accidental drillings, adjustments due to new room layout and changes in use). All of the above may lead to disproportionate expenditures.

13.7.5 Planning fundamentals



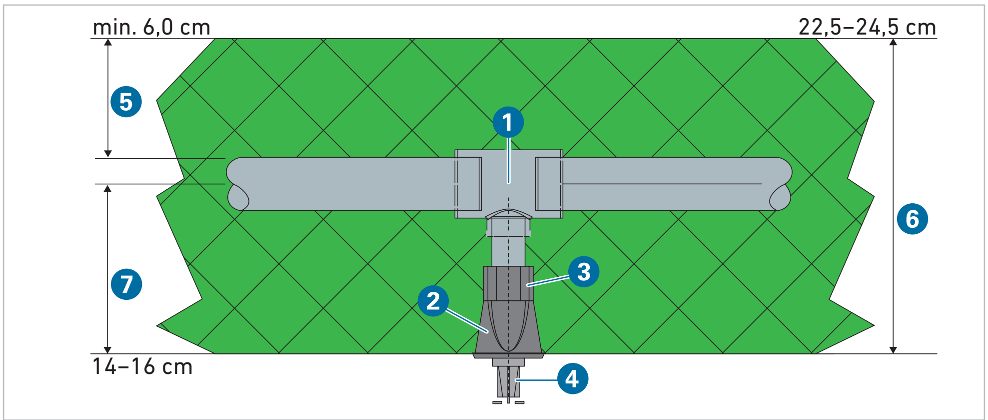
GV.52
Variant 1

1. Tee, equal d32
2. Sprinkler box 1/2" d32
3. Sprinkler box 1" d32
4. AP sprinkler 1/2"



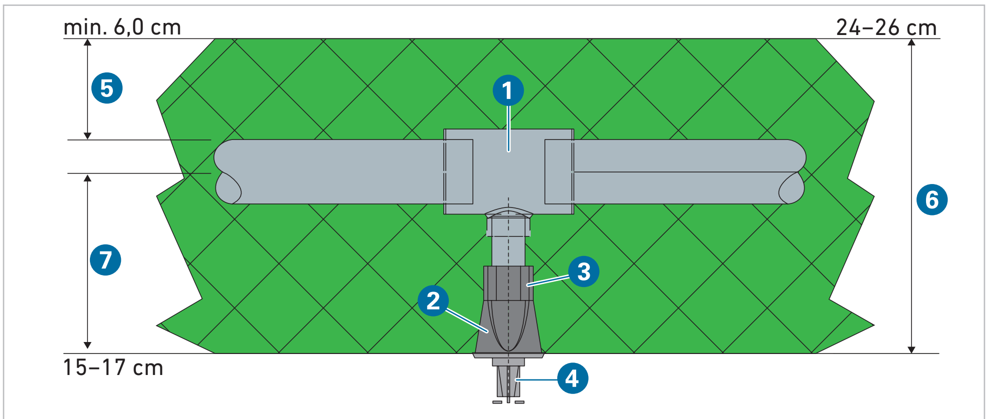
GV.53
Variant 2

1. Tee, reduced d40-32-40
2. Sprinkler box 1/2" d32
3. Sprinkler box 1" d32
4. AP sprinkler 1/2",
   AP sprinkler 1"
5. Distance to top of concrete
6. Ceiling thickness
7. Pipe axis



GV.54
Variant 3

1. Tee, reduced d50-32-50
2. Sprinkler box 1/2" d32
3. Sprinkler box 1" d32
4. AP sprinkler 1/2",
   AP sprinkler 1"
5. Distance to top of concrete
6. Ceiling thickness
7. Pipe axis

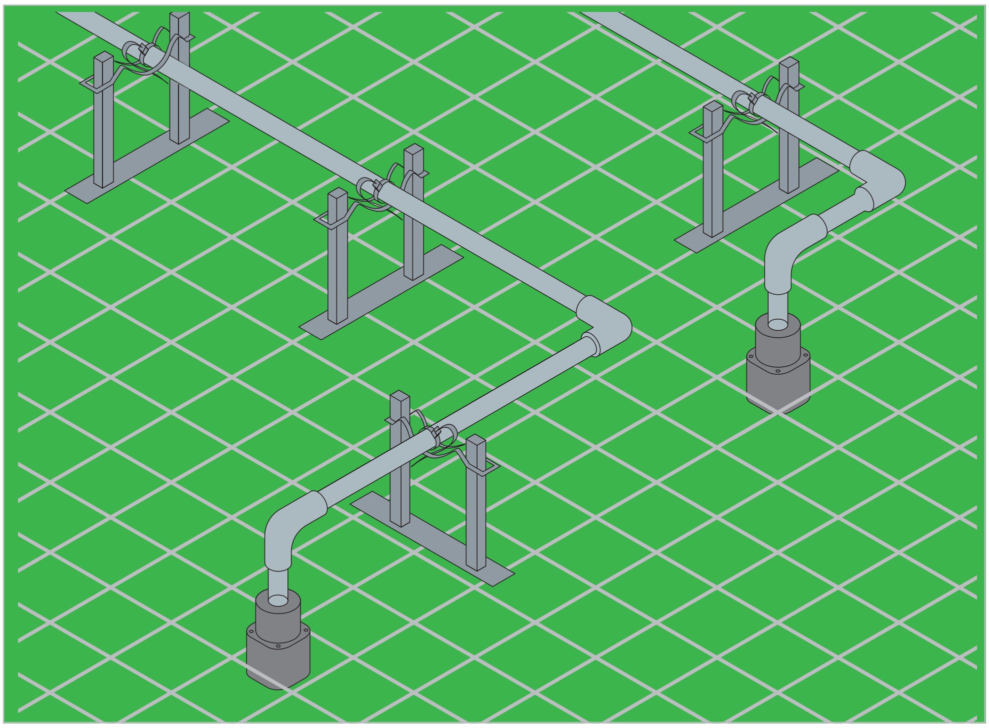


GV.55
Variant 4

1. Tee, reduced d63-32-63
2. Sprinkler box 1/2" d32
3. Sprinkler box 1" d32
4. AP sprinkler 1/2",
   AP sprinkler 1"
5. Distance to top of concrete
6. Ceiling thickness
7. Pipe axis

V

13.7.6 Installation and assembly



GV.56
General layout

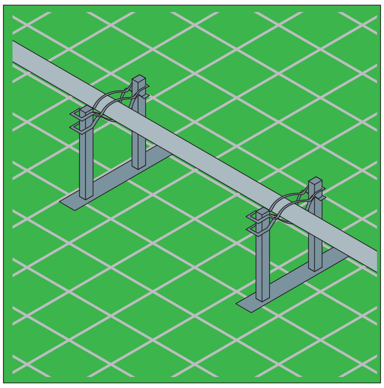
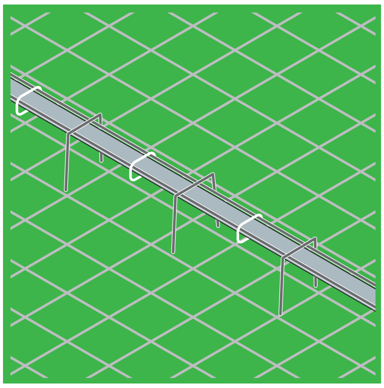
Marking and installing

→ Mount the sprinkler head before marking the lower reinforcement of the ceiling formwork
→ Install lower reinforcement.
→ Prefabricated pipelines must be installed into the ceiling formwork according to the layout plan. This will ensure the run of the pipes can be traced at any time for subsequent work.
→ Prefabricated sprinkler heads must be fixed at their specified locations.

Attachment

→ Use commercially available pipe clips or reinforcing bars.
→ Compliance with the spacing between the attachments is mandatory.

The attachment can be designed as shown below.

Using pipe support trays and pipe clips	Using reinforcing supports with cable ties
	

TV.53
Attachment variants

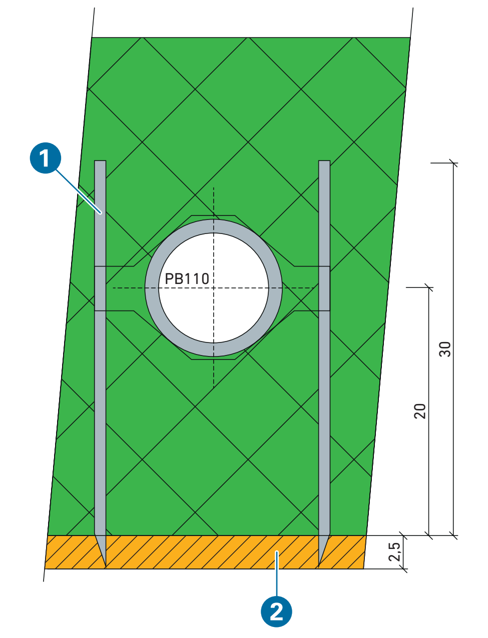
☑ The spacing between attachment must be observed.

Dimension d_a [mm]	Mounting distance Pipe clips [m]	Cable tie spacing [m]
32 / 40	1.50	0.50
50 / 63	1.75	0.50
>75	2.00	0.75

TV.54
With pipe saddle and pipe clips as pipe attachment

Dimension d_a [mm]	Mounting distance* (with cable ties) [m]
32 / 40	1.50
50 / 63	1.75
>75	2.00

Presentation



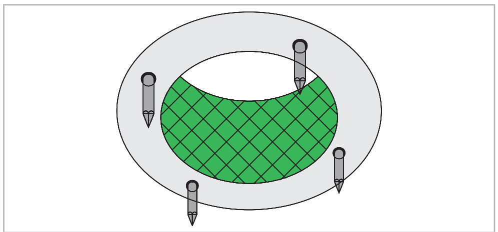
TV.55
With reinforcement blocks as pipe attachment

1. Posts made of CNS
2. Visible formwork

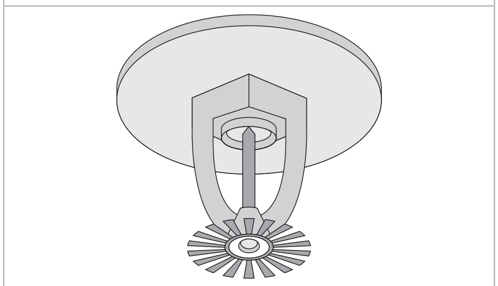
* Spacing between attachments according to manufacturer's information.

Completing the assembly

→ After removing the formwork:
Break off protruding nails of the sprinkler head's attachment.



→ Screw sprinkler nozzle including rosette into the sprinkler's connection. Use an extension if required.



There is one exception where the connection of the plastic sprinkler pipe is installed in the raw concrete ceiling (ceiling slot). Depending on the specified dimension, this connection consists of a threaded union, a flange connection or a transition brackets.

→ In order to comply with fire protection regulations, all main pipelines downstream of this connection must be made of metal.

13.7.7 Acceptance and pressure test

- ☑ One hour after the last welding is completed, the installation must be pressurised with at least 15 bar according to the GF factory specifications.
- ☑ The pressure test and the acceptance of the installation must be carried out prior to embedding the pipe in the concrete ceiling. This procedure must be recorded in writing.
- ☑ Ensure that the installation remains filled with water and pressurised at a minimum of 6 bar. This condition must be maintained while the concrete is being poured and during the entire pipe construction phase.
- ☑ Ensure the sprinkler heads are well secured, as they are subject to high forces during the pouring of the high-density (exposed) concrete.

Build

JRG Sanipex

V

JRG Sanipex

Overview

This chapter contains basic information about the JRG Sanipex system.

Additional technical and sales information

- For more information on the use and connection of other system components, piping and controls and instruments, see the chapters applicable to the appropriate systems.
- More technical information about this system and ordering information can be found on the GF website and in the sales catalogue.

1 System overview

1.1 System description

JRG Sanipex is a pipe-in-pipe installation system. The system consists of a water-carrying inner pipe made of cross-linked polyethylene (PE-X) in a protective and insulating conduit, which is installed directly from the basement or floor level distribution to the fitting connections. All water-carrying system parts (distributors, bends, valves, transitions) are made of corrosion resistant gunmetal.

The pipe-in-pipe technology enables the pipes to be installed directly into the concrete.
The water-carrying inner pipe of dimensions d12 and d16 – if it has been installed in the protective conduit – can be replaced without prising open the floor coverings and wall plates if damaged.

JRG Sanipex	Description
Pipe dimension	d12, d16, d20, d25, d32
Application area	Cold and hot water, HVAC, compressed air, greywater
Installation	above all, flush-mounted pipes from distributors to the location of the taps in pipe-in-pipe technology
Pipes	Pipes made of cross-linked polyethylene and multilayer composite pipes
Fittings and system parts	Gunmetal
Method	Crimped clamping connection

1.2 Approvals and quality assurance

The JRG Sanipex system is subject to constant inspection by internal and external bodies. These inspections range from quality assurance during production to ISO certification for environmental and process safety. The JRG Sanipex system meets the requirements for the most important applications in the building technology and is subject to constant monitoring by the licensing offices for drinking water installations on land and water.

System approvals
General information:
➨ Annex A , Section 'Approvals'
Up-to-date information on system approvals is available from Technical Support.

1.3 Scope and application areas

The installation system JRG Sanipex is intended for the following applications:
- Drinking water installations in the cold and hot water area
- Heating and air conditioning installations (only with diffusion-proof pipe)
- Greywater installations (rainwater and the like)
- Compressed air installations

JRG Sanipex is particularly suitable for connection lines in single and multi-family dwellings as well as large objects in sanitary, heating and compressed air installations.

Potential equalisation

The installation of the system is not a conductive metallic pipework. The installation cannot be used as a grounding conductor for electrical installations.

☑ The installation must **not** be used for potential equalisation purposes and must **not** be used as an earth connection.

§ **Responsibility for potential equalisation**
The installer of the electrical system is responsible for the correct implementation of the equipotential bonding.

DHW heaters

It is feasible to connect the system to **DHW heaters** without a metallic connection. In this case, restrictions do not apply if the water temperatures never exceed 70°C.
The use in conjunction with **flow DHW heaters** is permitted. However, only the manufacturer of the device is authorised to approve the use of the tankless water heaters.

☑ Compliance with the manufacturer's instructions for the devices is mandatory.

Protection of piping materials and connections

☑ If using flow DHW heater: Only use **thermostats** or **safety temperature limiter**, which ensure that the water temperature of 95°C is not exceeded at any point or at any time – not even when reheating.

☑ When using hydraulically controlled devices: Ensure that the **automatic switch-off** does not permit any pressures above 10 bar, even in case of the reheat effect.

Recommendation
If the temperature cannot be kept below 95°C or in older hydraulically controlled, electrically or gas-fired instantaneous water heaters, where the temperatures cannot be reliably maintained below 95°C, the following shall apply:
☑ A metallic connection with a length of at least 1.0 m shall be provided.

Fire extinguishing systems

When installing fire extinguishing pipes and sprinkler systems using JRG Sanipex system components:

☑ Compliance with local regulations and fire protection requirements is mandatory.

1.4 Properties and requirements

Service life limitation applicable to the installation
The water quality (pH value), the water constituents, as well as the operating conditions can have a direct influence on the service life of the installation, especially if chlorinated waters are being used.

1.4.1 Materials

Materials Polyethylene (PE-X) and gunmetal
Detail information:
➨ Part III 'The basics', Section 'Materials and jointing technology'

1.4.2 Hygienic properties

Verification of the system's hygienic safety is provided. The test certificate issued by the DVGW-Technologiezentrums Wasser – TZW (the German Water Centre – as part of DVGW e.V., the German Gas and Waterworks Association) proves that the plastic components comply with the KTW (official German recommendation concerning the levels of polymers in drinking water) recommendations by the German Federal Health Agency, the specifications of the Umweltbundesamtes (UBA) (Federal Environmental Agency) in Germany and the basic requirements of the Federal Food Control Institute according to ÖNORM B 5014, Part 1. This also applies to other institutions in the field of building technology and the shipbuilding industry, for example, ACS, SINTEF, BS 6920 and KIWA/ATA.

All plastic and metal components are continuously inspected in accordance with the recommendations mentioned above in order to ensure they meet national and international requirements, such as the DVGW worksheet W270.

Test certificate issued by the Fraunhofer Institute for the JRG Sanipex system
According to the test, all connecting parts of the system demonstrably fulfil the criteria of asepsis (dead space clearance: 0 KBE/cm^2).

1.4.3 Chemical resistance

The system exhibits a high chemical resistance to all natural drinking water substances (acc. to DIN 2000 and TrinkwV 2001), against disinfectants and cleaning agents (acc. toDVGW-Arbeitsblatt W291) and against corrosion inhibitors (acc. to DIN 1988, Part 4).

In addition to the utilisation for drinking water, the system can also be used for the liquid and gaseous media mentioned in [TV.1].

Suitability of the system
However, the suitability of the system is not limited to the defined chemical resistance mentioned above, but also depends on the use of the appropriate medium.
The characteristics of the medium may be changed by the pipes and fittings.

TV.1 **Media**

Medium	Classification	Max. operating temperature [°C]	Max. operating pressure [bar]
Drinking water	Cold water	0 – 20	10
	Hot water	20 – 70*	
Heating water	–	0 – 70*,**	
Softened water	pH neutral (0°fH)	0 – 70	
Rain water	pH value >6.0	0 – 40	
Osmosis treatment***	–	0 – 70	
VE water***	desalinated	70	
Cooling water****	40 Vol.% ethylene glycol, Antifrogen®, ethyl alcohol	–25 – 40**	
	25 Vol.% propylene glycol	–10 – 40**	
	Saline solutions	–20 – 40**	
Disinfectant solution*****	ready for use	40	
Compressed air	Class 1 acc. to DIN ISO 8573-1 • Residual oil content: 0.01 mg/m³ • oil and fat free	0 – 40	
	Class 2 and 3 acc. to DIN ISO 8573-1 • Residual oil content: 1.0 mg/m³ • Residual water content: 0.88 mg/m³ • Dew point: –20°C • low in oil and fat	0 – 40******	
Nitrogen	–	0 – 40******	
Vacuum	–	40	-0.8 p_a ≈0.2

* Short term peak temperature of 95°C during max. 150 h/a
** Only permissible with oxygen diffusion-tight pipes
*** Brass and gunmetal fittings release small amounts of metal ions into osmosis-treated water. If ion-free water is desired, additional treatment at the tap is required or RG fittings with epoxy coating inside (JRG Sanipex MT up to 30°C) should be used.
**** Higher concentrations must be requested.
***** Concentrations must be requested.
****** Not suitable for PB pipes

Requests concerning resistance in special cases
If the system must be used for applications or concentrations exceeding the values in the table, the resistance of the materials etc. must be checked and approved by GF JRG.
The following information is required in advance for testing and approval:
- Product and safety data sheet of the medium
- Operating temperature and pressure
- Concentration, exposure time, frequency and flow rate of the medium (even a sample, if required)

The use of the system for **medical gases** is **not** recommended.
Medical gases include gases that meet the requirements of the European Pharmacopoeia or which are anaesthetic gases, medical oxygen or medical carbonic acids. All of the above are approved according to the drug regulations as finished medicinal products.

1.4.4 Fire protection

Fire protection
General information on fire protection:
➠ Part IV 'Plan', Section 'Insulation, Fire protection'

Fire protection
Up-to-date information on fire protection for the system, including information on solutions, applications and product properties, can be found in the brochure **"Planungshilfe Rohrabschottung" (Planning aid pipe sealant).**

§ **Country-specific regulations**
Fire protection may be regulated differently in each countries by laws, directives, ordinances, standards, regulations and bulletins.
☑ Compliance with the local fire protection regulations is mandatory.

Fire protection solutions with JRG Sanipex

Solutions for fire protection with JRG Sanipex
Solutions and products for fire protection with JRG Sanipex can be found here:
➠ Chapter [6] 'Fire protection'

1.4.5 Soundproofing

The basics

Water pipes do not generate any noise if the nominal pipe dimension, design, fastening method and operation are correct. There are no test regulations specified in standards or other directives to determine or assess the noise behaviour in drinking water systems. Plastic piping systems exhibit advantages over metal pipe systems due to their corrosion resistance and flexibility.
By default, drinking water systems are designed so that the volumetric flow is 2 m/s for distribution lines (standard value, which is and may only be exceeded for certain line sections) and max. 4 m/s for discharge lines is maintained. These are flow velocities at which the inherent noise of the pipelines comparted to the noise generated by the fittings or other ambient noise is not noticeable. However, the noises resonating from sanitary equipment and fittings are being transmitted. Therefore, sound insulation – which absorbs the structure-borne noise reverberating from the building – must be added to the system components.

JRG Sanipex

The JRG Sanipex installation system is compliant with the requirement of DIN 4109 and SIA 181 (6.2006). However, this implies that the installation must be carried out according to the recognised rules of technology and the assembly instructions.

1.4.6 Insulation

Insulation

General information on insulation:

➨ Part IV 'Plan', Section 'Insulation, Fire protection'

Country-specific regulations

The insulation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.

☑ When it comes to insulation methods, compliance with the applicable rules and regulations is mandatory.

The basics

Insulation recommendations

If local specifications do not apply, the following instructions shall be considered as minimum requirements. A protective wrapping shall be wrapped around the pipelines, a thin insulating hose or a protective conduit shall be used. For most systems, a **pre-insulated** design (e.g. with 6 mm thick insulation) is available.

☑ Piping systems must always be insulated in order to prevent heat loss and/or heat absorption.

- Cold water pipeline: In order to prevent condensation, DHW heating and sound transmission
- Hot water, circulation and heating pipes: To reduce heat loss, absorb expansion and prevent sound transmission

☑ Select the insulation or sheathing according to the respective field of application.

☑ Ensure that the insulation does not cause corrosion to the piping materials.

Soundproofing

☑ The soundproofing may be subject to special requirements. Ensure that these potential prerequisites are considered in the design of the insulation.

Hygiene

Applying insulation to cold water pipes, for example, in order to prevent them from heating can improve the hygiene and help reduce the risk of legionella.

Planning fundamentals

The EnEV (German Energy Saving Ordinance) or DIN 1988 in Germany or the model regulations of the cantons in the energy sector (MuKEn) in Switzerland are available in the current version with comprehensive, detailed and practice-oriented documents. They are equally valid for new constructions, renovations and modernisations.

insulation according to EnEV 2017

Insulation according to EnEV 2017

Solutions and products for insulation according to EnEV can be found here:

➨ Chapter [5] 'Insulation according to EnEV 2017'

1.4.7 Protecting the installation

System components installed flush with the wall or walled in

Pipe installations flush with the wall are lines that are not easily accessible, for example, inside an in-wall installation, in a wall slot or in the concrete floor.

☑ Fittings and pipes must be insulated with a suitable material in order to absorb thermally induced changes in length, to prevent the transmission of sound, to preclude the formation of condensation, heat emission, heat loss or heating of the medium and other influences caused by building materials.

☑ Piping system and building structure must be separated from each other, for example, by using protective conduits made of PE, wrappings, insulating hoses or half shells with and without sheathing or a combination thereof.

☑ All system components must be protected from direct contact with oils, greases, solvents, solvent-based adhesives (adhesive tapes), foams, bitumen (also bituminous membranes). Furthermore, the components must not contact building materials such as screed, concrete, mortar or plaster.

Protection against environmental influences and building materials

Special measures apply to the following rooms:

- permanently or periodically wet rooms
  - Slaughterhouses, butcher shops (pressure washer)
  - Carwash
  - Tiled shower stalls, spa areas
  - Commercial kitchens
  - Rooms with risk of external water ingress
  - Swimming pools, sauna
- Areas subject to offensive gases or aggressive environments
  - Stables (ammonia)
  - Dairy factories/cheese dairies (nitric acid)
  - Swimming pools/swimming pool centres (chlorine, hydrochloric acid)
- Areas subject to uncontrollable environmental influences

Due to the moisture permeating the building materials and the resulting permanent wetness (e.g. in public showers and baths or commercial wet rooms), it is possible for an aggressive environment to form around the pipe.

☑ Appropriate precautions must be taken to protect the installation, e.g. by using the following measures:
  - Use of suitable anti-corrosion tapes (e.g. supplied by KEBU, Gyso or DENSO)
  - Wrapping the pipe with heat-shrinkable materials

☑ Ensure that pipes and fittings are dry when mounting.

Protection from UV radiation

☑ Appropriate precautions must be taken in order to prevent the installation from permanent exposure to UV rays.

When using the pipe-in-pipe system with protective conduit, this will ensure sufficient UV protection.
Sheathing with insulating material can assume the function of UV protection.

☑ Pipes and fittings must be shielded from direct sunlight and UV radiation.

☑ During transport and storage: Pipes and fittings must be covered after they have been removed from the original packing.

Protection against aggressive waters

Recommendation

☑ In areas with particularly aggressive waters: Installations must be easily accessible.

☑ Distribution lines in the single tap system (pipe-in-pipe) must be designed and installed such in order to ensure system components can be replaced at any time without damaging the building's structure.

V

1.4.8 Disinfection procedure

Disinfection

General information on common disinfection procedures:

➨ Part VI 'Operate', Chapter [4] 'Disinfection'

Information on the hygiene concept used at GF:

➨ Part II 'Plan – Build – Operate', Chapter [4] 'The Hycleen Concept'

Chlorine dioxide

The use of chlorine dioxide for chemical disinfection can severely limit the lifetime of the entire drinking water installation. Before implementation, the conditions must be recorded on site.

The water quality (pH value), the water constituents, as well as the operating conditions can have a direct influence on the service life of the installation, especially if chlorinated waters are being used.

1.5 Safe application and processing

- ☑ Only use the product as intended and in accordance with the defined areas of application and usage.
- ☑ Check compatibility of medium and material.
- ☑ Do not use the product if it is damaged or defective. Damaged product must be removed immediately.
- ☑ Use only approved accessories.
- ☑ Only trained personnel shall be permitted to assemble the product and accessories.
- ☑ All personnel shall be instructed on all applicable issues of local occupational safety and environmental regulations, in particular for pressurised piping. These instructions must be held on a regular basis.
- ☑ Compliance with the valid standards for drinking water and greywater installations as well as compliance with the regulations of the system manufacturer is mandatory.
- ☑ Compliance with the local water supply regulation is mandatory.
- ☑ Make sure that the piping system is installed correctly and inspected regularly.
- ☑ All installations must comply with the instructions specified in the technical documentation of the product.
- ☑ Compliance with the operating, maintenance and assembly instructions of the tools is mandatory.
- ☑ Tools must be used as intended and must not be applied for other purposes.
- ☑ When assembling the JRG Sanipex installation system, only JRG Sanipex mounting tools must be used.

Combination of JRG Sanipex MT with JRG Sanipex

In conjunction with JRG Sanipex, pipes of the JRG Sanipex MT system can also be used.

1.5.1 Transport and storage

For hygienic reasons, all openings in pipes, fittings, controls and instruments must be closed until final assembly.

- ☑ Ensure to protect the product against external force (shock, impact, vibration, etc.) during transport.
- ☑ Transport and/or store the product in unopened original packing.
- ☑ Protect the product from dust, dirt, moisture, heat and UV radiation.
- ☑ Ensure that the product is not damaged by mechanical or thermal influences.
- ☑ Before proceeding with the assembly, inspect the product for damage that may have occurred during the transport.

1.5.2 Installation and assembly

The JRG Sanipex System is suitable for the following types of installation:

- Surface or flush-mounted installations
- Installation in shafts and channels, on ceilings and on floors
- Installation in-wall, element, wood and lightweight constructions
- Installation in concrete (in the pipe-in-pipe system, with PE-X pipes)

1.5.3 Acceptance and putting into operation

§ **Country-specific regulations**

Acceptance and putting into operation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.

- ☑ When it comes to acceptance and putting into operation, compliance with the applicable rules and regulations is mandatory.

Acceptance, pressure test, flushing and putting into operation

General information and master copies of the test reports:

➨ Part V 'Build', Section 'Putting into operation'

1.5.4 Operation, maintenance, servicing, repair and decommissioning

☑ To ensure trouble-free operation: Check installation and all control and safety fittings regularly.

Risk of injury due to pressure or explosion!

If the system is not completely depressurised, media may escape uncontrolled from the installation.

☑ Before removal, maintenance, disassembly: Pipeline must be completely depressurised.

☑ If harmful, combustible or explosive media is used: Completely empty and flush the pipeline before disassembling it. Look for potential residues.

☑ Use appropriate measures to ensure the medium is collected properly.

Risk of injury due to media harmful to health and the environment!

Risk of personal injury or environmental damage due to uncontrolled escape of hazardous media.

☑ During maintenance, servicing, repair and decommissioning, prescribed protective clothing must be worn.

☑ Compliance with the media safety data sheets is mandatory.

☑ Collect leaking media and dispose of according to local regulations.

Risk of injury due to the use of unsuitable spare parts!

Damage to the installation and risk of injury.

☑ Only use replacement parts from the current product range during the installation and repairs.

1.5.5 Disposal

The entire JRG Sanipex MT product range is made from environmentally friendly and recyclable materials.

§ **Country-specific regulations**

Disposal and recycling may be regulated differently in each country by laws, ordinances, standards, regulations, and bulletins.

☑ When disposing of or recycling the product, the individual components and the packaging, compliance with the local regulations is mandatory.

☑ Before disposing of individual materials, they must be separated according to their recyclability, and whether these materials are considered normal waste or special waste.

2 System components

The JRG Sanipex installation system consists of cross-linked polyethylene pipes and fittings made of gunmetal. In addition, there are controls and instruments with direct transition to the system.

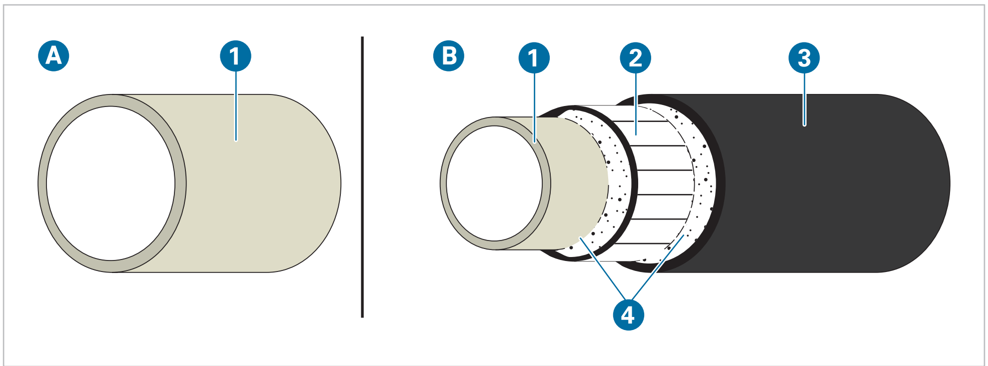
2.1 JRG Sanipex pipes

The 100% plastic pipes from the JRG Sanipex assortment, which are available pre-cut, in coils and in various designs (e.g. with insulation or in a protection conduit), consist either of radiation-crosslinked polyethylene (PE-Xc) or of peroxide crosslinked polyethylene (PE-Xa). Common to both variants are the hygienic properties of the base material. For use in heating or air conditioning installations, the PE-X pipe – which is specially tailored to these requirement – is equipped with an additional EVOH barrier, which reliably prevents oxygen permeability according to DIN 4726.

Processing JRG Sanipex MT pipes
JRG Sanipex MT multilayer composite pipes can also be processed in the dimensions d12 to d20.

2.1.1 Pipe construction and pipe labelling

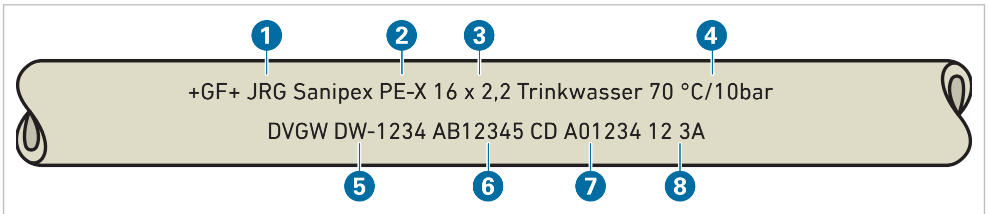
The pipes for the JRG Sanipex system are designed as follows.



GV.1
Pipe design
A 100% plastic pipe
1 PE-X pipe

B Multilayer composite pipe
1 Inliner (PE-X)
2 Aluminium pipe
3 Outer coating (PE-X)
4 Bonding agent

The pipes are marked as follows.



GV.2
Pipe marking

	Labelling (example)	Meaning
1	JRG Sanipex	Product name: Company name and system name
2	PE-X	Material code
3	16 × 2.2	Dimension: Outside diameter x wall thickness
4	70°C / 10 bar	Medium: Operating temperature/max. operating pressure
5	SVGW-.. / DVGW XX-123.. / ÖVGW X1.123..	Approval(s) and number(s)
6	AB 12345	Production location and production date
7	CD A01234	Order number
8	12 3A	Internal factory code

2.1.2 Technical data

JRG Sanipex

Feature	Pipe	PE-Xa, PE-Xc
Conditions in continuous operation (SF 1.5)		70°C, 10 bar (50 years)
Max. operating temperature [°C]		95 (briefly)
Max. operating pressure [bar]		10
Surface roughness k [mm]		0.007
Material constant C		12
Coefficient of thermal expansion α [mm/(m·K)]		0.18
Thermal conductivity [W/(m·K)]		0.38
Oxygen-tightness		acc. to DIN 4726 (only pipes with EVOH)
Processing temperature [°C]		up to –20
Density [kg/dm³]		~0.94
Fire code		CH: IV.2 (VKF) / D: B2 (DW 4102)
Building material class		D: B2 (DW 4102) / E (DW 13501-1)

Feature	Dimension	d12	d16	d20	d25	d32
Nominal width DN [mm]		8	12	15	20	25
Outside diameter d_a [mm]		12	16	20	25	32
Wall thickness s [mm]		1.7	2.2	2.8	3.5	4.4
Internal diameter d_i [mm]		8.6	11.6	14.4	18	23.2
Weight [g/m]		54	89	142	222	358
Cross section inside A [cm²]		0.58	1.06	1.63	2.54	4.23
Volume [l/m]		0.06	0.11	0.16	0.25	0.42
Fire load [MJ/m]		3.08	4.30	6.72	10.45	16.78

Bending radius	Dimension	d12	d16	d20	d25	d32
Bending radius R, not interchangeable: $5 \cdot d_a$ [mm]		60	80	100	125	160
Bending radius R, interchangeable: $8 \cdot d_a$ [mm]		96	128	160	200	256

Mounting distance	Dimension	d12	d16	d20	d25	d32
Mounting distances [mm]		1.0	1.0	1.0	1.0	1.5
Assembly with pipe saddles [m]		1.5	1.5	1.5	1.5	2.0

Protective conduits

Feature	Pipe	PE pipe
Density [kg/dm³]		~0.95
Tensile strength [N/mm²]		~25
Temperature resistance [°C]		100
Melt flow index		MFI 190/5: 0.4 g/10 min
Elongation at break [%]		600
Thermal conductivity [W/(m·K)]		0.45

Feature	Dimension	d12	d16	d20	d25	d32
Outside diameter d_a [mm]		18	25	29	34	42
Internal diameter d_i [mm]		14.6	20	23	29	36

Crimped clamping connection

Feature	Dimension	d12	d16	d20	d25	d32
Threads		M17 × 1.25	M22 × 1.5	M27 × 1.5	M34 × 2.0	M42 × 2.0

Material: Brass

2.2 Fittings

All fittings in the JRG Sanipex assortment are made of gunmetal (CC499K). In addition to this material's non-problematic material properties and low susceptibility to corrosion and incrustation, this material is especially known for its excellent hot water resistance and it has been used for decades for mouldings and fittings in the building technology.

2.3 Controls and instruments

Controls and instruments for the Sanipex system with special connections and transitions are available in the JRG Controls and Instruments program.

Information on controls and instruments
Technical product information:
➨ Part V 'Build', Section 'JRG Valves'

3 Tools

When processing the JRG Sanipex, special tools must be used depending on the pipe dimension. This will ensure that the correct and safe JRG Sanipex crimped clamping connection is created.

☑ Compliance with the tool's operating instruction is mandatory.

⚠ **Material damage and risk of injury when using unsuitable tools or non-original spare parts.**

→ Only use tools available from the current product range.
→ Tools must be used compliant with the operating instructions.
→ Only use replacement parts from the current product range.

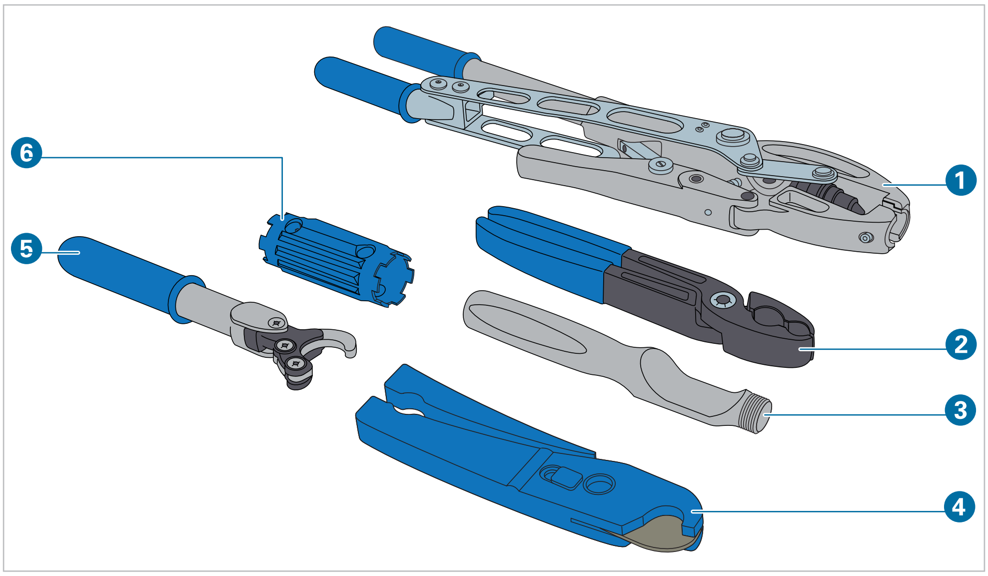
Care, testing and maintenance of tools

A flawlessly functioning tool is a basic prerequisite for a permanently sealed connection.

⚠ **Risk of injury and material damage due to poor care, incorrect testing and faulty maintenance.**

→ Tools must be maintained as specified in the operating instructions and their operation must be inspected regularly, at least once a year.

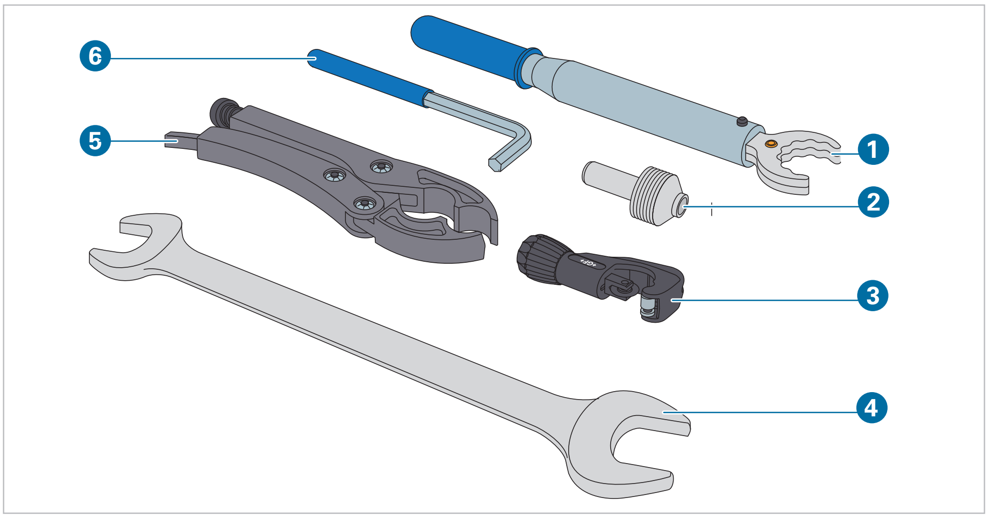
3.1 Assembly tools (d12 – d20)



GV.3
Assembly tools

1. Circlip pliers
2. Pipe wrench
3. Alignment gauge
4. Combination shears
5. Ratchet torque wrench
6. Socket mounting keys

3.2 Assembly tools (d25 – d32)



GV.4
Assembly tools

1. Torque wrench
2. Turn up device
3. Pipe cutter
4. Open-end spanner (SW27, SW32)
5. Pipe wrench
6. L-keys

4 Dimensioning

Simplified calculation method
Basic information, examples and sample tables for simplified calculation:
➨ Part IV 'Plan', Section 'Drinking water installation'

The product-specific data for the simplified calculation and the calculation method are available in this chapter.

4.1 Loading units

+ The loading unit (LU – previously abbreviated BW) designates the flow rate provided at the connection point upstream of the tap as a function of the intended use and the duration of use. The loading unit does not correspond to the withdrawal flow, listed in the respective product specification.

A loading unit LU is equal to a flow of 0.1 l/s.

4.1.1 Controls and instruments and equipment

TV.2
Loading units according to intended purpose
Source: SVGW Guidelines W3 Edition 2013

Usage Connections DN15 (½")	Volume flow Q_A per connection [l/s]	Volume flow Q_A per connection [l/min]	LU per port
Wash-hand basin, washing trough, vanity unit, bidet, cistern, vending machine, hairdresser, household dishwasher	0.1	6	1
Sink, utility sink, taps for balcony and terrace, washing trough, shower, standing and wall spout, household washing machine	0.2	12	2
Urinal flushing (automatic), bathtub	0.3	18	3
Tap for the garden or garage	0.5	30	5

TV.3
Loading units according to intended purpose
Source: EN 806-3:2006 (D)
Q_A Flow rate at the tapping fitting
Q_{min} Minimum flow rate at the tapping valve

Intended use Connections DN15 (½")	Volume flow per connection Q_A [l/s]	Volume flow per connection Q_{min} [l/s]	LU per port
Hand basin, washbasin, bidet, cistern	0.1	0.1	1
Household kitchen sink, household washing machine, dishwasher, sink, shower head	0.2	0.15	2
Urinal flush valve	0.3	0.15	3
Bathtub drain	0.4	0.3	4
Tap for the garden or garage	0.5	0.4	5
Commercial kitchen sink (DN20), Commercial bath spout	0.8	0.8	8
Flush valve (DN20)	1.5	1.0	15

4.1.2 JRG Sanipex pipes

TV.4 **Loading units applicable to JRG Sanipex pipes**

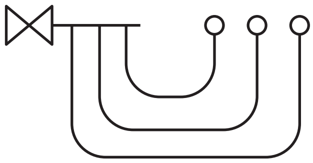
Description	Dimension							
Total loading units LU	1	2	3	4	5	8	14	35
Largest single value LU	–	1	–	–	4	5	–	–
$d_a \times s$ [mm]	12 × 1.7		16 × 2.2			20 × 2.8	25 × 3.5	32 × 4.4
d_i [mm]	8.6		11.6			14.4	18	23.2
Length of pipeline, recommended [m]	10	6	9	5	4	–	–	–
Controls and instruments	–	½"	½"			½"	¾"	1"

4.1.3 Installation with individual supply lines

> **Group of equipment/distribution at floor level**
> → A velocity of max. 4 m/s must be maintained.

Directional change with pipe bend

TV.5
Loading units (LU) for PE-Xa pipes



Max. developed length [m]	5		10		15	
Residential water meter	without	with	without	with	without	with
Loading unit (LU)	$[d_a \times s]$					
1	12 × 1.7	12 × 1.7	12 × 1.7	12 × 1.7	12 × 1.7	12 × 1.7
2	16 × 2.2	16 × 2.2	16 × 2.2	16 × 2.2	16 × 2.2	16 × 2.2
3	16 × 2.2	16 × 2.2	16 × 2.2	20 × 2.8	20 × 2.8	20 × 2.8
4	16 × 2.2	16 × 2.2	20 × 2.8	20 × 2.8	20 × 2.8	20 × 2.8
5	20 × 2.8	no counter	20 × 2.8	no counter	–	–
Pipe $d_a \times s$ [mm]	12 × 1.7	16 × 2.2	20 × 2.8			
Pipe d_i [mm]	8.6	11.6	14.4			
Instrument	½"	½"	½"			

Straight-seat shut-off valve ¾ "and distributor ¾" are taken into account in the calculation model.
Source: SVGW 2014

4.1.4 Installation with tees

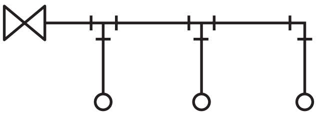
Group of equipment/distribution at floor level
→ A velocity of max. 3 m/s must be maintained.

Directional change with fittings

Max. developed length [m]	5		10		15	
Residential water meter	without	with	without	with	without	with
Loading unit (LU)	[$d_a \times s$]					
1	12 × 1.7	12 × 1.7	12 × 1.7	16 × 2.2	16 × 2.2	16 × 2.2
2	16 × 2.2	16 × 2.2	16 × 2.2	16 × 2.2	16 × 2.2	16 × 2.2
3	16 × 2.2	16 × 2.2	20 × 2.8	20 × 2.8	20 × 2.8	20 × 2.8
4	20 × 2.8	20 × 2.8	20 × 2.8	20 × 2.8	20 × 2.8	20 × 2.8
5	20 × 2.8	20 × 2.8	20 × 2.8	20 × 2.8	20 × 2.8	–
6	20 × 2.8	20 × 2.8	20 × 2.8	20 × 2.8	20 × 2.8	–
8	20 × 2.8	20 × 2.8	20 × 2.8	–	–	–
10	20 × 2.8	20 × 2.8	–	–	–	–
12	20 × 2.8	20 × 2.8	–	–	–	–
15	–	–	–	–	–	–
Pipe $d_a \times s$ [mm]	12 × 1.7	16 × 2.2	20 × 2.8			
Pipe d_i [mm]	8.6	11.6	14.4			
Instrument	½"	½"	½"			

Source: SVGW 2014, SVGW Certificate No.: 8611-1923

TV.6
Loading units (LU) for PE-Xa pipes



Pressure losses and discharge times

If using tee installations:
→ Calculate the discharge times and pressure losses.

For systems with individual tap locations:
→ The maximum length of 12 m of the pipe must not be exceeded.

4.2 Pressure loses for pipes

4.2.1 The basics

TV.7
Flow velocities

Designation	Value [m/s]	
	SVGW W3*	EN 806-3:2006**
Discharge pipeline	max. 4.0	4.0
Groups of equipment	max. 3.0	–
Pipelines on individual floor levels	max. 3.0	2.0
Distribution pipelines	max. 2.0	2.0

* recommended (acc. to SVGW - Swiss Gas and Wate Industry Association Guideline W3/2013)
** The values given are based on the following flow velocities:
Collective feed lines, risers, floor lines: max. 2.0 m/s
Single feeders: max. 4.0 m/s

4.2.2 Pressure losses applicable to JRG Sanipex pipes

A loading unit LU is equal to a flow of 0.1 l/s.

TV.8
Pressure losses applicable to JRG Sanipex pipes
LU 1 up to LU 5

Pipe, Dimension	Pressure loss [hPa/m pipe (= mbar/m)]					
	LU	1	2	3	4	5
	[l/s]	0.1	0.2	0.3	0.4	0.5
d12		56.5	190.8	388.8	–	–
d16		13.4	45.3	92.4	153.1	226.6
d20		4.8	16.1	32.7	54.2	80.2
d25		1.6	5.5	11.2	18.6	27.5
d32		0.5	1.6	3.3	5.5	8.1

4.2.3 Pressure losses at 10°C

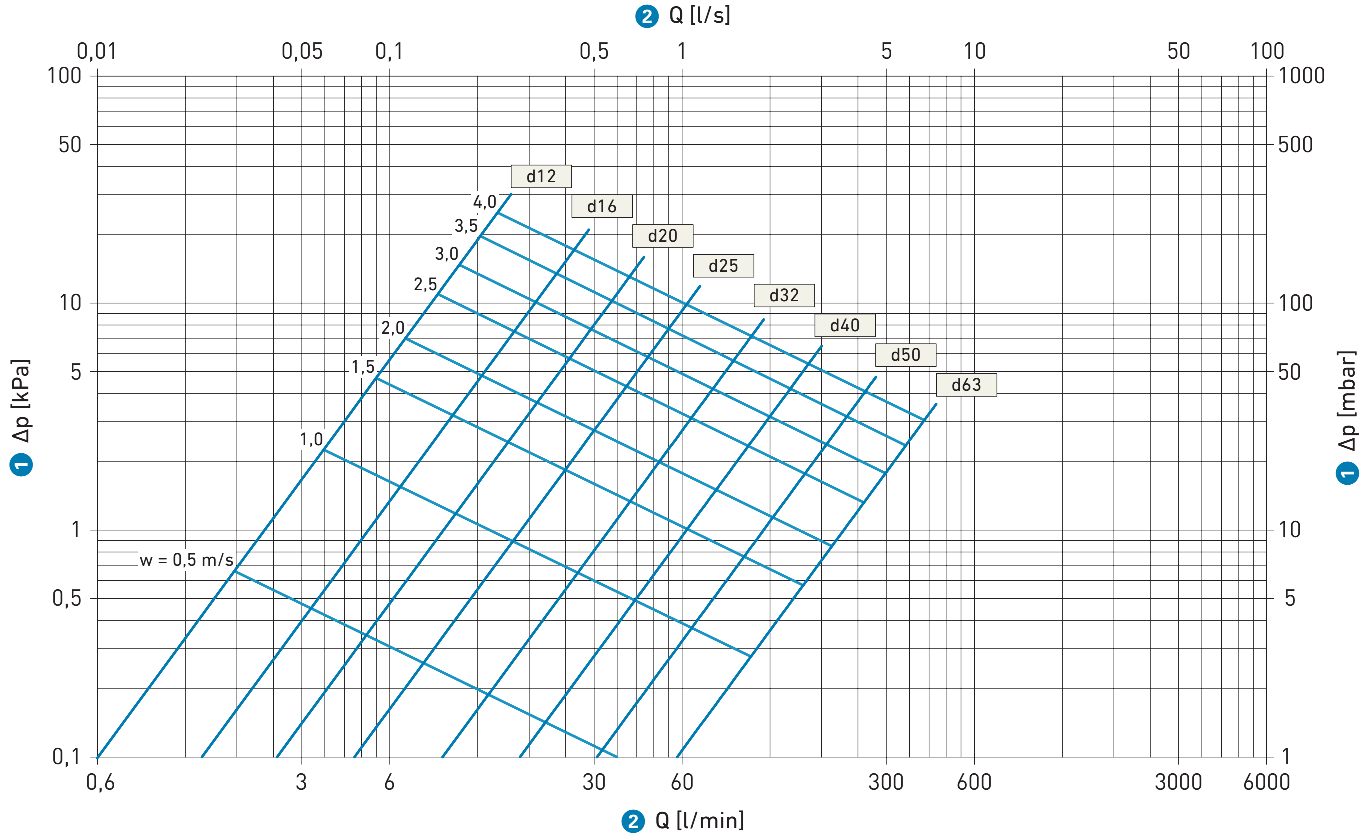
The basics

Designation	Value
Dimension	d12 – d63
Density ρ (water)	999.70 kg/m³
Water temperature	10°C
Surface roughness k (inner pipe)	0.007 mm
Viscosity	0.00131 Pa · s

TV.9
Design fundamentals

Pipe friction pressure drop as a function of the volumetric flow

The diagram and the tables show the pipe friction pressure drop R and the calculated flow velocity v as a function of the volumetric flow Q.



1 Pressure loss
2 Volumetric flow rate

Pressure losses at 10°C

TV.10 **Pipe friction pressure drop, flow velocity, peak flow**

d	12		16		20		25		32		40		50		63	
DN	8		12		15		20		25		32		40		50	
Q [l/s]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
0.01	0.2	1.0	0.1	0.2	0.1	0.1	–	–	–	–	–	–	–	–	–	–
0.02	0.3	3.3	0.2	0.8	0.1	0.3	0.1	0.1	–	–	–	–	–	–	–	–
0.03	0.5	6.8	0.3	1.6	0.2	0.6	0.1	0.2	–	–	–	–	–	–	–	–
0.04	0.7	11.3	0.4	2.7	0.2	1.0	0.2	0.3	–	–	–	–	–	–	–	–
0.05	0.9	16.7	0.5	4.0	0.3	1.4	0.2	0.5	0.1	0.1	–	–	–	–	–	–
0.06	1.0	23.0	0.6	5.5	0.4	1.9	0.2	0.7	0.1	0.2	0.1	0.1	–	–	–	–
0.07	1.2	30.2	0.7	7.2	0.4	2.5	0.3	0.9	0.2	0.3	0.1	0.1	–	–	–	–
0.08	1.4	38.2	0.8	9.1	0.5	3.2	0.3	1.1	0.2	0.3	0.1	0.1	–	–	–	–
0.09	1.5	46.9	0.9	11.2	0.6	4.0	0.4	1.4	0.2	0.4	0.1	0.1	–	–	–	–
0.10	1.7	56.5	0.9	13.4	0.6	4.8	0.4	1.6	0.2	0.5	0.2	0.2	0.1	0.1	–	–
0.15	2.6	115.1	1.4	27.4	0.9	9.7	0.6	3.3	0.4	1.0	0.2	0.3	0.1	0.1	–	–
0.20	3.4	190.8	1.9	45.3	1.2	16.1	0.8	5.5	0.5	1.6	0.3	0.6	0.2	0.2	0.1	0.1
0.25	4.3	282.3	2.4	67.1	1.5	23.8	1.0	8.1	0.6	2.4	0.4	0.8	0.2	0.3	0.2	0.1
0.30	5.2	388.8	2.8	92.4	1.8	32.7	1.2	11.2	0.7	3.3	0.5	1.1	0.3	0.4	0.2	0.1
0.35	–	–	3.3	121.1	2.1	42.9	1.4	14.7	0.8	4.3	0.5	1.5	0.3	0.5	0.2	0.2
0.40	–	–	3.8	153.1	2.5	54.2	1.6	18.6	0.9	5.5	0.6	1.9	0.4	0.6	0.2	0.2
0.45	–	–	4.3	188.3	2.8	66.7	1.8	22.8	1.1	6.8	0.7	2.3	0.4	0.8	0.3	0.3
0.50	–	–	4.7	226.6	3.1	80.2	2.0	27.5	1.2	8.1	0.8	2.8	0.5	1.0	0.3	0.3
0.55	–	–	5.2	267.9	3.4	94.9	2.2	32.5	1.3	9.6	0.8	3.3	0.5	1.1	0.3	0.4
0.60	–	–	–	–	3.7	110.5	2.4	37.9	1.4	11.2	0.9	3.8	0.6	1.3	0.4	0.4
0.65	–	–	–	–	4.0	127.2	2.6	43.6	1.5	12.9	1.0	4.4	0.6	1.5	0.4	0.5
0.70	–	–	–	–	4.3	144.9	2.8	49.6	1.7	14.7	1.1	5.0	0.7	1.7	0.4	0.6
0.75	–	–	–	–	4.6	163.5	2.9	56.0	1.8	16.6	1.1	5.7	0.7	2.0	0.5	0.6
0.80	–	–	–	–	4.9	183.1	3.1	62.7	1.9	18.6	1.2	6.4	0.8	2.2	0.5	0.7
0.85	–	–	–	–	5.2	203.7	3.3	69.8	2.0	20.6	1.3	7.1	0.8	2.4	0.5	0.8
0.90	–	–	–	–	–	–	3.5	77.1	2.1	22.8	1.4	7.8	0.9	2.7	0.6	0.9
0.95	–	–	–	–	–	–	3.7	84.8	2.2	25.1	1.4	8.6	0.9	3.0	0.6	1.0
1.00	–	–	–	–	–	–	3.9	92.8	2.4	27.4	1.5	9.4	1.0	3.2	0.6	1.1
1.05	–	–	–	–	–	–	4.1	101.1	2.5	29.9	1.6	10.2	1.0	3.5	0.6	1.2
1.10	–	–	–	–	–	–	–	–	2.6	32.4	1.7	11.1	1.1	3.8	0.7	1.3
1.15	–	–	–	–	–	–	–	–	2.7	35.1	1.7	12.0	1.1	4.1	0.7	1.4
1.20	–	–	–	–	–	–	–	–	2.8	37.8	1.8	12.9	1.2	4.5	0.7	1.5
1.25	–	–	–	–	–	–	–	–	3.0	40.6	1.9	13.9	1.2	4.8	0.8	1.6
1.30	–	–	–	–	–	–	–	–	3.1	43.5	2.0	14.9	1.3	5.1	0.8	1.7
1.35	–	–	–	–	–	–	–	–	3.2	46.5	2.0	15.9	1.3	5.5	0.8	1.8
1.40	–	–	–	–	–	–	–	–	3.3	49.6	2.1	17.0	1.4	5.9	0.9	1.9
1.45	–	–	–	–	–	–	–	–	3.4	52.7	2.2	18.1	1.4	6.2	0.9	2.1
1.50	–	–	–	–	–	–	–	–	3.5	55.9	2.3	19.2	1.5	6.6	0.9	2.2
1.55	–	–	–	–	–	–	–	–	3.7	59.3	2.3	20.3	1.5	7.0	0.9	2.3
1.60	–	–	–	–	–	–	–	–	3.8	62.6	2.4	21.5	1.6	7.4	1.0	2.4
1.65	–	–	–	–	–	–	–	–	3.9	66.1	2.5	22.7	1.6	7.8	1.0	2.6
1.70	–	–	–	–	–	–	–	–	4.0	69.7	2.6	23.9	1.7	8.2	1.0	2.7
1.75	–	–	–	–	–	–	–	–	–	–	2.6	25.1	1.7	8.7	1.1	2.9
1.80	–	–	–	–	–	–	–	–	–	–	2.7	26.4	1.7	9.1	1.1	3.0
1.85	–	–	–	–	–	–	–	–	–	–	2.8	27.7	1.8	9.5	1.1	3.2
1.90	–	–	–	–	–	–	–	–	–	–	2.9	29.0	1.8	10.0	1.2	3.3
1.95	–	–	–	–	–	–	–	–	–	–	3.0	30.4	1.9	10.5	1.2	3.5
2.00	–	–	–	–	–	–	–	–	–	–	3.0	31.8	1.9	10.9	1.2	3.6
2.10	–	–	–	–	–	–	–	–	–	–	–	–	2.0	11.9	1.3	3.9
2.20	–	–	–	–	–	–	–	–	–	–	–	–	2.1	12.9	1.3	4.3
2.30	–	–	–	–	–	–	–	–	–	–	–	–	2.2	14.0	1.4	4.6

d	12		16		20		25		32		40		50		63	
DN	8		12		15		20		25		32		40		50	
Q [l/s]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
2.40	–	–	–	–	–	–	–	–	–	–	–	–	2.3	15.1	1.5	5.0
2.50	–	–	–	–	–	–	–	–	–	–	–	–	2.4	16.2	1.5	5.3
2.60	–	–	–	–	–	–	–	–	–	–	–	–	2.5	17.4	1.6	5.7
2.70	–	–	–	–	–	–	–	–	–	–	–	–	2.6	18.5	1.7	6.1
2.80	–	–	–	–	–	–	–	–	–	–	–	–	2.7	19.8	1.7	6.5
2.90	–	–	–	–	–	–	–	–	–	–	–	–	2.8	21.0	1.8	6.9
3.00	–	–	–	–	–	–	–	–	–	–	–	–	2.9	22.3	1.8	7.4
3.10	–	–	–	–	–	–	–	–	–	–	–	–	3.0	23.6	1.9	7.8
3.20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.0	8.2
3.30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.0	8.7
3.40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.1	9.2
3.50	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.1	9.7
3.60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.2	10.1
3.70	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.3	10.6
3.80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.3	11.2
3.90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.4	11.7
4.00	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.4	12.2
4.10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.5	12.7
4.20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.6	13.3
4.30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.6	13.9
4.40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.7	14.4
4.50	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.8	15.0
4.60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.8	15.6
4.70	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.9	16.2
4.80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.9	16.8
4.90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3.0	17.4

4.2.4 Pressure losses at 60°C

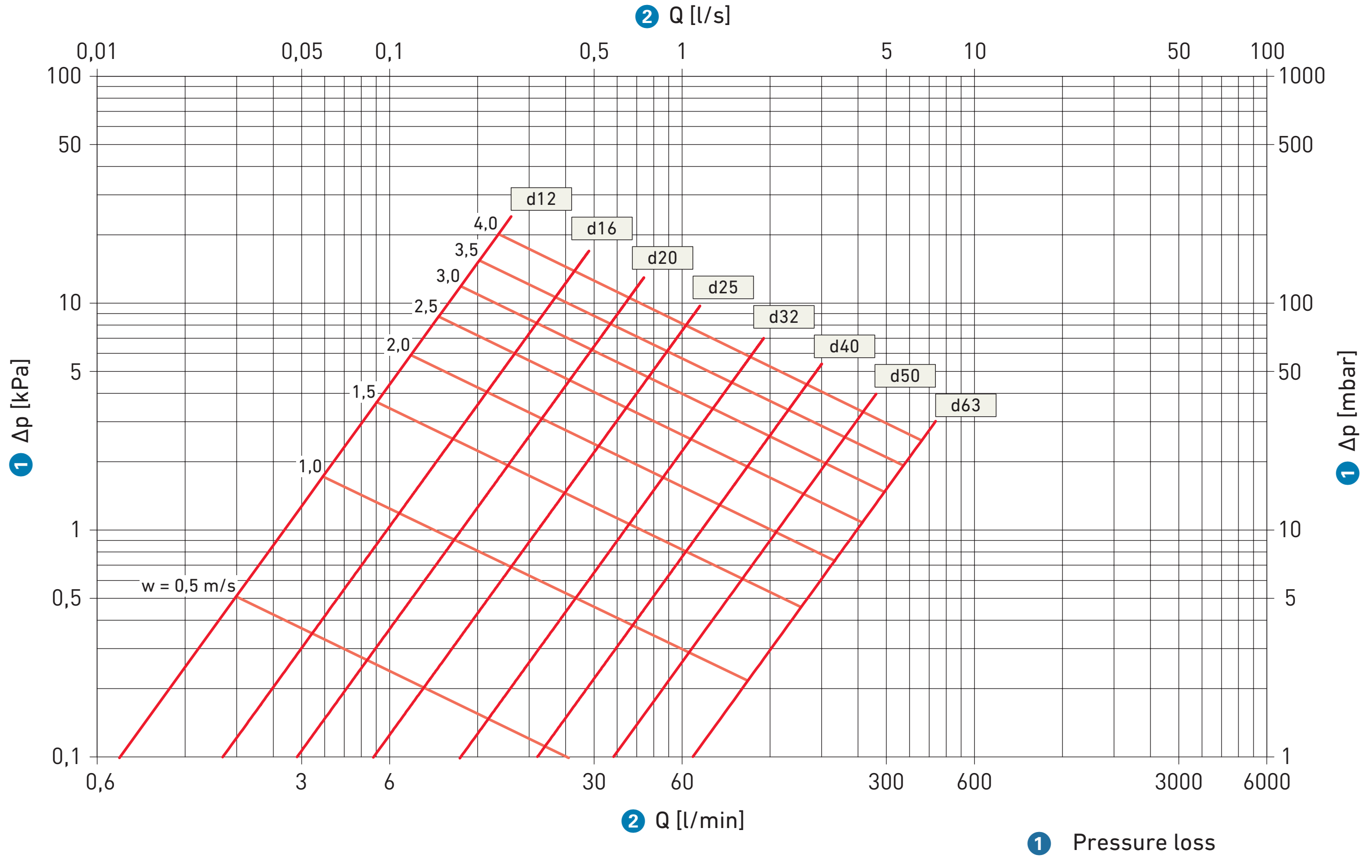
The basics

Designation	Value
Dimension	d12 – d63
Density ρ (water)	983.19 kg/m³
Water temperature	60°C
Surface roughness k (inner pipe)	0.007 mm
Viscosity	0.00476 Pa · s

TV.11
Design fundamentals

Pipe friction pressure drop as a function of the volumetric flow

The diagram and the tables show the pipe friction pressure drop R and the calculated flow velocity v as a function of the volumetric flow Q.



1 Pressure loss
2 Volumetric flow rate

Pressure losses at 60°C

TV.12 **Pipe friction pressure drop, flow velocity, peak flow**

d	12		16		20		25		32		40		50		63	
DN	8		12		15		20		25		32		40		50	
Q [l/s]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
0.01	0.2	0.7	0.1	0.2	0.1	0.1	–	–	–	–	–	–	–	–	–	–
0.02	0.3	2.5	0.2	0.6	0.1	0.2	0.1	0.1	–	–	–	–	–	–	–	–
0.03	0.5	5.1	0.3	1.2	0.2	0.4	0.1	0.1	–	–	–	–	–	–	–	–
0.04	0.7	8.6	0.4	2.0	0.2	0.7	0.2	0.2	0.1	0.1	–	–	–	–	–	–
0.05	0.9	12.8	0.5	3.0	0.3	1.1	0.2	0.4	0.1	0.1	–	–	–	–	–	–
0.06	1.0	17.7	0.6	4.2	0.4	1.5	0.2	0.5	0.1	0.1	0.1	0.1	–	–	–	–
0.07	1.2	23.3	0.7	5.5	0.4	1.9	0.3	0.7	0.2	0.2	0.1	0.1	–	–	–	–
0.08	1.4	29.5	0.8	7.0	0.5	2.5	0.3	0.8	0.2	0.2	0.1	0.1	–	–	–	–
0.09	1.5	36.4	0.9	8.6	0.6	3.0	0.4	1.0	0.2	0.3	0.1	0.1	–	–	–	–
0.10	1.7	43.9	0.9	10.4	0.6	3.7	0.4	1.3	0.2	0.4	0.2	0.1	–	–	–	–
0.15	2.6	90.5	1.4	21.4	0.9	7.6	0.6	2.6	0.4	0.8	0.2	0.3	0.1	0.1	–	–
0.20	3.4	151.1	1.9	35.8	1.2	12.6	0.8	4.3	0.5	1.3	0.3	0.4	0.2	0.1	–	–
0.25	4.3	224.9	2.4	53.2	1.5	18.8	1.0	6.4	0.6	1.9	0.4	0.6	0.2	0.2	0.2	0.1
0.30	5.2	311.3	2.8	73.7	1.8	26.0	1.2	8.9	0.7	2.6	0.5	0.9	0.3	0.3	0.2	0.1
0.35	–	–	3.3	97.0	2.1	34.2	1.4	11.7	0.8	3.4	0.5	1.2	0.3	0.4	0.2	0.1
0.40	–	–	3.8	123.0	2.5	43.4	1.6	14.8	0.9	4.4	0.6	1.5	0.4	0.5	0.2	0.2
0.45	–	–	4.3	151.8	2.8	53.6	1.8	18.3	1.1	5.4	0.7	1.8	0.4	0.6	0.3	0.2
0.50	–	–	4.7	183.1	3.1	64.6	2.0	22.1	1.2	6.5	0.8	2.2	0.5	0.8	0.3	0.3
0.55	–	–	5.2	217.0	3.4	76.6	2.2	26.2	1.3	7.7	0.8	2.6	0.5	0.9	0.3	0.3
0.60	–	–	–	–	3.7	89.5	2.4	30.6	1.4	9.0	0.9	3.1	0.6	1.1	0.4	0.3
0.65	–	–	–	–	4.0	103.2	2.6	35.2	1.5	10.4	1.0	3.5	0.6	1.2	0.4	0.4
0.70	–	–	–	–	4.3	117.7	2.8	40.2	1.7	11.8	1.1	4.0	0.7	1.4	0.4	0.5
0.75	–	–	–	–	4.6	133.2	2.9	45.5	1.8	13.4	1.1	4.6	0.7	1.6	0.5	0.5
0.80	–	–	–	–	4.9	149.4	3.1	51.0	1.9	15.0	1.2	5.1	0.8	1.8	0.5	0.6
0.85	–	–	–	–	5.2	166.4	3.3	56.8	2.0	16.7	1.3	5.7	0.8	2.0	0.5	0.6
0.90	–	–	–	–	–	–	3.5	62.9	2.1	18.5	1.4	6.3	0.9	2.2	0.6	0.7
0.95	–	–	–	–	–	–	3.7	69.3	2.2	20.4	1.4	7.0	0.9	2.4	0.6	0.8
1.00	–	–	–	–	–	–	3.9	75.9	2.4	22.4	1.5	7.6	1.0	2.6	0.6	0.9
1.05	–	–	–	–	–	–	4.1	82.8	2.5	24.4	1.6	8.3	1.0	2.9	0.6	0.9
1.10	–	–	–	–	–	–	–	–	2.6	26.5	1.7	9.1	1.1	3.1	0.7	1.0
1.15	–	–	–	–	–	–	–	–	2.7	28.7	1.7	9.8	1.1	3.4	0.7	1.1
1.20	–	–	–	–	–	–	–	–	2.8	31.0	1.8	10.6	1.2	3.6	0.7	1.2
1.25	–	–	–	–	–	–	–	–	3.0	33.3	1.9	11.4	1.2	3.9	0.8	1.3
1.30	–	–	–	–	–	–	–	–	3.1	35.7	2.0	12.2	1.3	4.2	0.8	1.4
1.35	–	–	–	–	–	–	–	–	3.2	38.2	2.0	13.0	1.3	4.5	0.8	1.5
1.40	–	–	–	–	–	–	–	–	3.3	40.7	2.1	13.9	1.4	4.8	0.9	1.6
1.45	–	–	–	–	–	–	–	–	3.4	43.4	2.2	14.8	1.4	5.1	0.9	1.7
1.50	–	–	–	–	–	–	–	–	3.5	46.1	2.3	15.7	1.5	5.4	0.9	1.8
1.55	–	–	–	–	–	–	–	–	3.7	48.8	2.3	16.7	1.5	5.7	0.9	1.9
1.60	–	–	–	–	–	–	–	–	3.8	51.7	2.4	17.7	1.6	6.1	1.0	2.0
1.65	–	–	–	–	–	–	–	–	3.9	54.6	2.5	18.6	1.6	6.4	1.0	2.1
1.70	–	–	–	–	–	–	–	–	4.0	57.6	2.6	19.7	1.7	6.8	1.0	2.2
1.75	–	–	–	–	–	–	–	–	–	–	2.6	20.7	1.7	7.1	1.1	2.3
1.80	–	–	–	–	–	–	–	–	–	–	2.7	21.8	1.7	7.5	1.1	2.5
1.85	–	–	–	–	–	–	–	–	–	–	2.8	22.9	1.8	7.9	1.1	2.6
1.90	–	–	–	–	–	–	–	–	–	–	2.9	24.0	1.8	8.2	1.2	2.7
1.95	–	–	–	–	–	–	–	–	–	–	3.0	25.1	1.9	8.6	1.2	2.8
2.00	–	–	–	–	–	–	–	–	–	–	3.0	26.3	1.9	9.0	1.2	3.0
2.10	–	–	–	–	–	–	–	–	–	–	–	–	2.0	9.9	1.3	3.2
2.20	–	–	–	–	–	–	–	–	–	–	–	–	2.1	10.7	1.3	3.5
2.30	–	–	–	–	–	–	–	–	–	–	–	–	2.2	11.6	1.4	3.8

d	12		16		20		25		32		40		50		63	
DN	8		12		15		20		25		32		40		50	
Q [l/s]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
2.40	–	–	–	–	–	–	–	–	–	–	–	–	2.3	12.5	1.5	4.1
2.50	–	–	–	–	–	–	–	–	–	–	–	–	2.4	13.4	1.5	4.4
2.60	–	–	–	–	–	–	–	–	–	–	–	–	2.5	14.4	1.6	4.7
2.70	–	–	–	–	–	–	–	–	–	–	–	–	2.6	15.4	1.7	5.1
2.80	–	–	–	–	–	–	–	–	–	–	–	–	2.7	16.4	1.7	5.4
2.90	–	–	–	–	–	–	–	–	–	–	–	–	2.8	17.5	1.8	5.8
3.00	–	–	–	–	–	–	–	–	–	–	–	–	2.9	18.6	1.8	6.1
3.10	–	–	–	–	–	–	–	–	–	–	–	–	3.0	19.7	1.9	6.5
3.20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.0	6.9
3.30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.0	7.3
3.40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.1	7.6
3.50	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.1	8.1
3.60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.2	8.5
3.70	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.3	8.9
3.80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.3	9.3
3.90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.4	9.8
4.00	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.4	10.2
4.10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.5	10.7
4.20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.6	11.1
4.30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.6	11.6
4.40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.7	12.1
4.50	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.8	12.6
4.60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.8	13.1
4.70	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.9	13.6
4.80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2.9	14.1
4.90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3.0	14.7

4.3 Pressure losses for system parts

The ζ values and the equivalent lengths of the pipelines were determined in accordance with the specifications of the SVGW (SV EN 1267).

Loading unit and ζ value
A loading unit **LU** is equal to a flow of 0.1 l/s.
The ζ value for w = 2 m/s, as shown in the table.

4.3.1 Simplified representation for 1 loading unit (LU)

TV.13 **Pressure losses in JRG Sanipex system parts**

JRG code	Designation		Symbol	Dimension	ζ value	Equivalent length of pipeline [m]
5400 5401 5402	JRG Sanipex box, single, 90°			1/2"-d12	1.2	0.35
				1/2"-d16	1.2	0.55
				1/2"-d20	1.2	0.70
				3/4"-d20	1.5	0.95
5404	JRG Sanipex box, 2-way, 90°	Discharge		1/2"-d16-d12	2.3	0.83
				1/2"-d16-d16	2.4	1.10
				1/2"-d20-d12	2.9	1.80
		Flow rate		1/2"-d16-d12	1.3	0.45
				1/2"-d16-d16	1.4	0.60
				1/2"-d20-d16	1.0	0.65
5415	Connections to controls and instruments, single			1/2"-d12-35 mm	2.1	0.60
				1/2"-d16-35 mm	2.2	1.05
				1/2"-d20-35 mm	3.0	1.85
				1/2"-d20-50 mm	2.1	1.30
5416	Connections to controls and instruments, double	Discharge		1/2"-d16-50 mm	2.6	1.20
		Flow rate		1/2"-d16-50 mm	2.0	0.90
5421 – 5427	Distributor including transition	Discharge		3/4"-d12	1.2	0.35
				3/4"-d16	1.0	0.45
				3/4"-d20	0.8	0.50
		Flow rate		3/4"	0.5	0.35
5520 – 5525	90° bend			d12	2.7	0.75
				d16	0.8	0.35
				d20	0.9	0.55
5463 – 5471	Tees (equal and reduced)	Flow rate		d12	2.4	0.65
				d16	0.4	0.20
				d20	0.7	0.45
5463 – 5471	Tees (equal and reduced)	Pipe branch		d12	3.4	0.95
				d16	1.2	0.55
				d20	1.6	1.00
5510	Coupling			d12	1.8	0.50
				d16	0.3	0.15
				d20	0.3	0.20
5437 5438	Shut-off valve			d12	0.6	0.15
				d16	7.7	3.30
				d20	7.7	4.60
5439	Angle seat valve			d16	2.9	1.20
				d20	2.9	1.70
5450	Residential water meter			d25	15.0	12.0

4.4 Discharge times

The discharge times indicate the time elapsed until a temperature of 40°C is reached at the tap (in accordance with SIA 385/2, 2015 edition) and signal the beginning of usability.
These discharge times apply to fully opened taps set to maximum “hot”. In the interests of economical water and energy consumption, these discharge times should not be set too high.

In order to keep the discharge losses within economically justifiable limits and at the same time to meet the comfort requirements of the hot water user, the requirements defined in [TV.14] for discharge periods apply.* The measurement itself is carried out with the fitting installed at the installation site.

If it is not possible to choose a distribution system that conveys the hot water from the hot water storage tank to the tap within a reasonable time (discharge time), a circulation pipeline or auxiliary heating system must be planned and installed, or the arrangement of the sanitary equipment and riser zones must be optimised.

TV.14
Discharge times – Requirements
* Excerpt from SIA 385/1

Sanitary fixtures	Discharge time t [s]	
	without keeping warm (e.g. without circulation)	with keeping warm (e.g. with circulation)
Vanity unit, wash-hand basin, bidet, showers, bathtubs, sink (kitchen), utility sink	15	10

According to EN 806-2 also applies to the intended operation:

- Drinking water, cold: Max. 30 s after full opening of a tapping point:
  - Temperature must not exceed 25 °C.
- Drinking water, hot: Max. 30 s after full opening of a tapping point:
  - Temperature must be min. 55 °C.

According to VDI 6003 the following values result for different sanitary objects:

TV.15
Discharge times – Requirements
* Excerpt from VDI 6003 (requirement levels = comfort criteria)

Sanitary fixtures	Useful temperature [°C]	Discharge time t [s]*		
		Requirement level		
		I	II	III
Vanity unit	40	60	18	10
Shower	42	~26	10	7
Bathtub	45	~26	12	9
Flushing	50	60	18	10
Bidet	40	–	15	15
Whirlpool / Large tub	50	–	10	10

Factors influencing the output times include the following

TV.16 **Factors for output times**

Desired comfort	(criteria)
Floor plan	Distance to sanitary objects, grouping
Number of strings supplying the apartment	
Planning, construction and operation • Compliant with regulations (according to TRWI) or not	• with or without circulation system • Running time of the circulation pump. If the circulation pump is switched off, the distribution lines for domestic hot water will inevitably cool down. Fixed discharge times are then no longer to be observed. • Correct sizing of the circulation system, based on the product-specific resistance coefficients of the piping system.
Floor installation type	• Distribution with single supply line • Tee installation • Pipeline in series • Ring pipeline
Supply type hot water	• Individual supply line • Group supply: decentralized or centralized in apartments • Central supply: Storage system or storage charging system

Calculation

Calculating the discharge time

➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [12] 'Dimensioning'

The discharge times must be matched to the pipe dimension, length of the pipeline and the volume flows. Especially when using energy-saving mixers (flow restrictors), the effective volumetric flow must always be determined and converted (acc. to SIA 385/2, Issue 2015, Annex G), because the reduced volumetric flow results in a longer discharge time.

The calculation is based on the standard SIA 385/1, which contains the fundamental principles and requirements for domestic hot water systems. The calculation is also based on the standard SIA 385/2, which describes the hot water demand, the overall requirements and the design, such as the calculation of the discharge times.

Discharge times applicable to JRG Sanipex PE-X pipe

The table does not consider fittings but only pipes.

- Input variables: Outside diameter d, wall thickness s_w
- Calculated quantities: [l/m], max. length of pipeline [m], discharge times [s/m]

TV.17 **Discharge times and lengths – JRG Sanipex PE-X pipe**

Pipe, Dimension				max. feasible duration of the discharge times [s] of						Discharge time [s] for each 1 m length of pipeline		
			[s]	15			10			Cold phase + warm-up phase		
			[l/s_w]	0.1	0.2	0.3	0.1	0.2	0.3	0.1	0.2	0.3
DN	d	s_w	[l/m]	max. length of pipeline [mm]						[s]		
8	12	1.7	0.055	13.5	27.0	40.6	9.0	18.0	27.0	1.1	0.6	0.4
12	16	2.2	0.106	7.1	14.1	21.2	4.7	9.4	14.1	2.1	1.1	0.7
15	20	2.8	0.163	4.6	9.2	13.8	3.0	6.1	9.2	3.3	1.6	1.1

4.5 Change in length and expansion compensation

Due to heat and depending on the material, pipelines expand to varying degrees. Even if the temperatures of the medium (e.g. drinking water) exceeds room temperature, this causes a thermal expansion and must be taken into account in the design of the installation.

How to calculate the change in length
In order to calculate the change in length, product and material-specific values are required:
➨ Technical data for system, Chapter [2.1]

This thermally induced change in length can be **compensated** during the installation and mounting of the pipe. Suitable measures are:

- Directional changes of the pipeline
- Providing expansion space
- Installation of expansion joints
- Setting the fixed points and floating points

The bending and torsional forces occurring during the operation of a pipeline are safely absorbed, taking into account the above-mentioned measures. The following parameters have a significant influence on the expansion compensation:

- Material
- Structural conditions
- Operating conditions

Minor changes in length of the pipelines, especially if using smaller dimensions, can be compensated for by the elasticity of the piping system or with a corresponding insulation.

For larger piping systems, the changes in length must be absorbed by the **expansion joints**: Insulations, flexible pipe legs and U-shaped expansion loops compensate for the thermally induced change in length. The required measures for GF's plastic piping systems are – depending on the type of installation:

Medium	Cold water	Hot water/circulation/heater	
Dimension	d16 – d110	d16 – d26	d32 – d110
Length of pipeline L ≤12 m	If using insulated pipelines, compensation for the change in length does **not** require floating points and fixed points		
Length of pipeline L ≥12 m	If using insulated pipelines, compensation for the change in length does **not** require floating points and fixed points		Compensation for the change in length requires floating points and fixed points

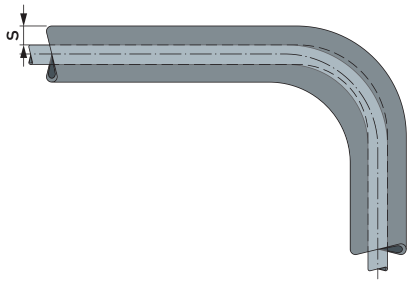
TV.18
Measures for the expansion compensation for plastic pipelines made by GF

4.5.1 Compensation for the change in length by using insulation

When using insulation in order to compensate for the change in length, the minimum insulation thickness **s** must be at least 1.5 times the length change. From the calculated amounts of the change in length, the insulation thickness per meter of straight pipeline length is calculated according to the following formula:

$$s = 1.5 \cdot \Delta l$$

s Insulation thickness, min.
Δl Change in length



Installations with temperatures up to 60°C (ΔT = 50 K), a length change Δl of 1.3 mm must be taken into account for each meter of straight pipe. This equals to an insulation thickness of 2.0 mm per meter of straight pipe length.

Insulation
General information on insulation:
➨ Part IV 'Plan', Section 'Insulation, Fire protection'
Information about insulation when installing riser pipes:
➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [13] 'Installation and attachment'

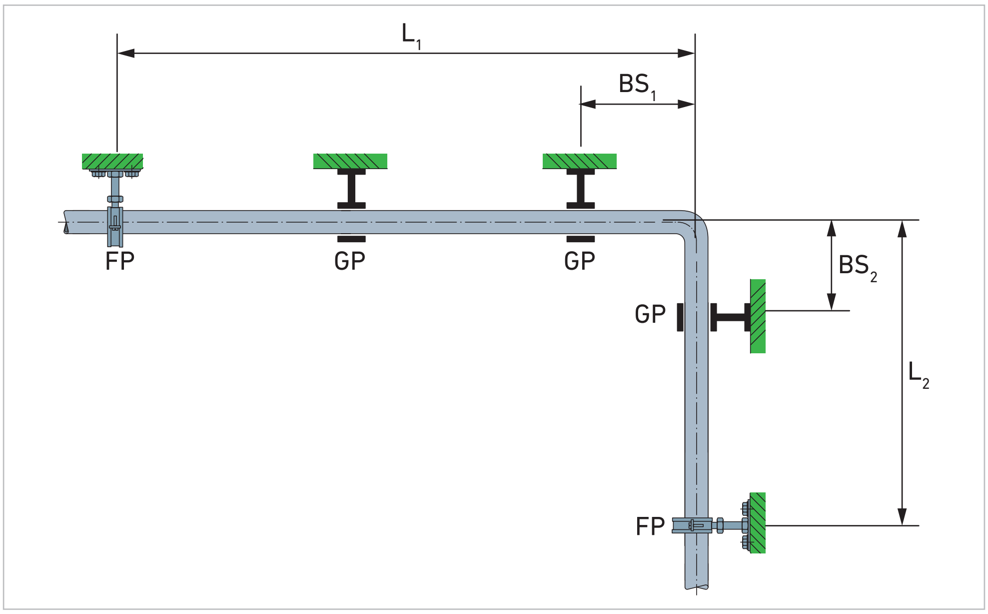
4.5.2 Compensation for the change in length by using expansion joints

Flexible pipe legs and **U-shaped expansion loops** are used as **expansion joints**. In order to ensure the function of the 2D expansion loop, **fixed points** and **floating points** (with sliding pipe clips) are installed.

Fixed points can be created at a suitable location along the pipeline, using a commercially available, precisely fitting fixed point clips or a system-specific solution (e.g. fixed point clip in combination with a system-specific fixed-point pipe clip).

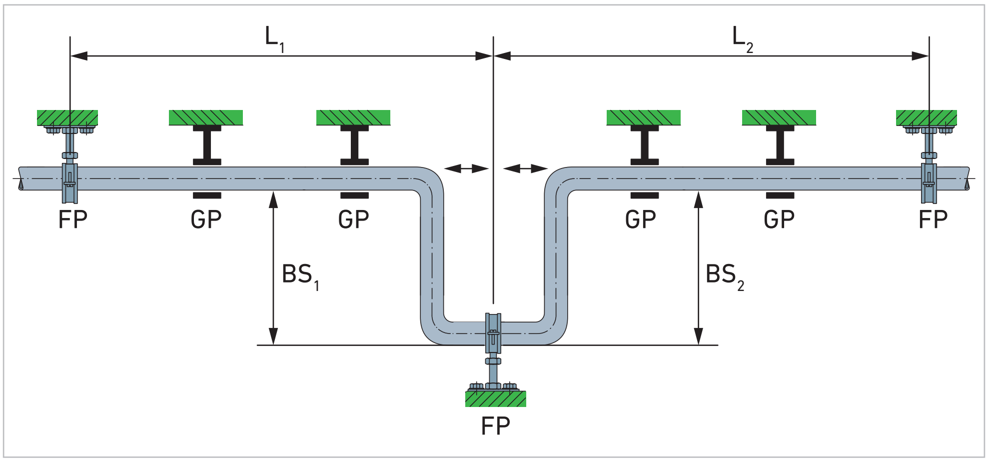
The **pipe clip** must assume the shape of the pipe and, when tightening the clip, the actual pipe diameter must not be constrict by more than 0.5 mm.

Examples – Basic design of a flexible pipe leg and U-shaped expansion loop



GV.5
Flexible pipe leg

FP Fixed point
GP Floating point (with sliding pipe clip)
BS Flexible pipe leg
L Pipe length between fixed point and deflection



GV.6
U-shaped expansion loop

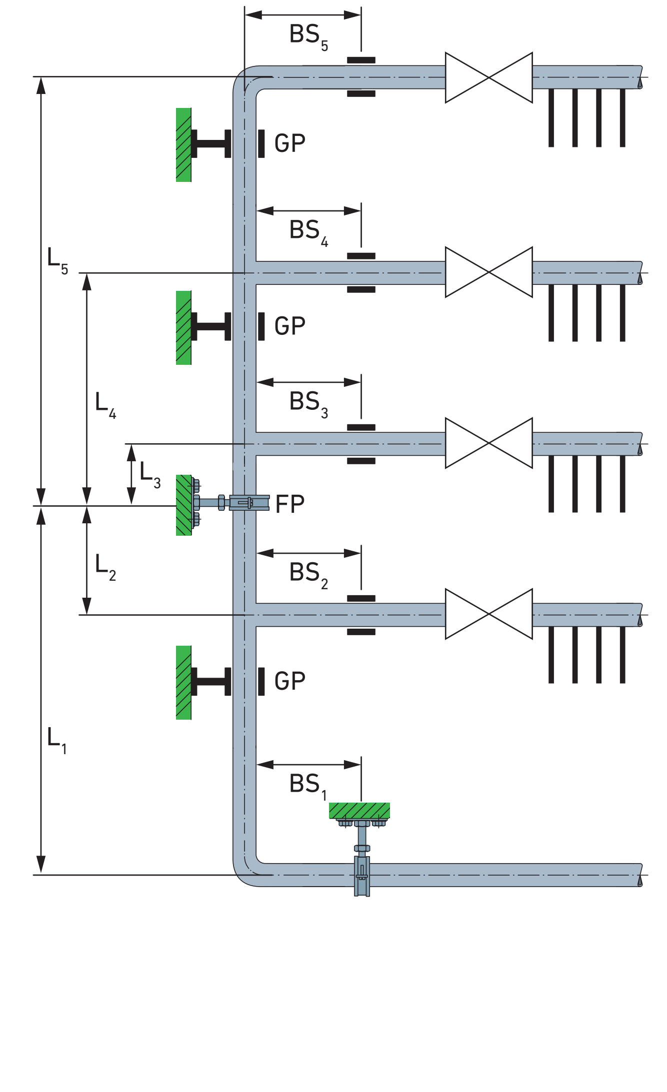
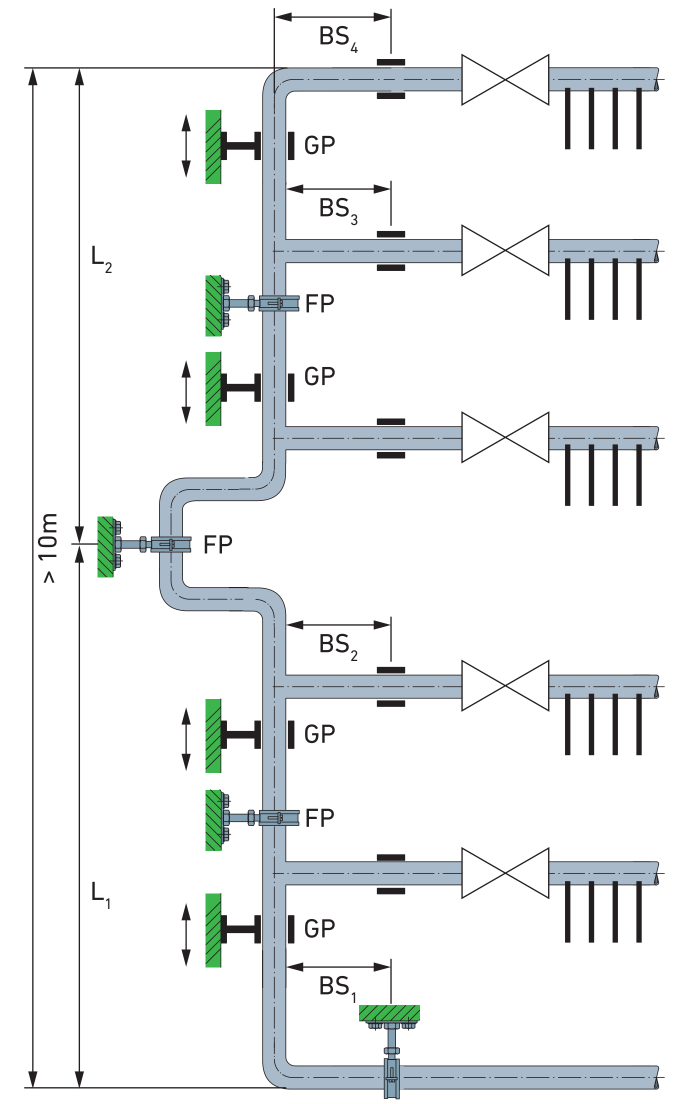
FP Fixed point
GP Floating point (with sliding pipe clip)
BS Flexible pipe leg
L Pipe length between fixed point and deflection

4.5.3 Fixed points and floating points when using riser pipes

If riser pipes are leading up to several storeys and accordingly have multiple fixed points (FP), the change in length between the individual fixed points must be absorbed by the flexible pipe leg (BS). The sliding pipe clamp mounted to the horizontal pipe affects the **vertical** expansion of the pipe similar to a fixed point (FP).

Examples – Basic design of fixed points and floating points

TV.19 **Spacing of fixed points and floating points in a riser pipe**

Riser pipe up to a height of 10 m	Riser pipe starting at a height of 10 m
	
Up to a **riser pipe height of 5 m,** neither a U-shaped expansion loop nor a fixed point shall be installed along the riser pipe. Up to a **riser pipe height of 10 m,** a U-shaped expansion loop can be omitted. In the middle of the riser pipe, however, a fixed point (FP) must be installed.	Starting at a **riser pipe height of 10 m,** a U-shaped expansion loop with fixed points (FP) must be installed at intervals of 10 m.

L_{1-5}	Pipe length between fixed point and deflection
FP	Fixed point
BS_{1-5}	Flexible pipe leg
GP	Floating point (with sliding pipe clip)

4.5.4 How to calculate the change in length

The **change in length of a pipeline** and the corresponding design of the flexible pipe leg and U-shaped expansion loop also depend on the material used. When calculating the change in length, this must be taken into account by using corresponding material-dependent parameters.

The **calculation of the length of the flexible pipe leg** depends on the design of the flexible pipe leg:

- If using a **flexible pipe leg** in order to compensate for an extension, or if a branch line is used, the length of the flexible pipe leg must be calculated.
- If a **U-shaped expansion loop** is used to compensate for the expansion, the length of both flexible pipe legs that form the U-shaped expansion loop must be calculated.

Material constant and coefficient of thermal expansion

In order to calculate the change in length, product and material-specific values are required:

➨ Technical data for system, Chapter. [2.1]

How to calculate the change in length

The thermally induced **change in length** Δl of pipes is calculated (in non-resisting installations) from the **temperature difference** ΔT and the **pipe length** L, using the following formula:

$$\Delta l = \alpha \cdot L \cdot \Delta T$$

Symbol	Meaning	Unit	Remark
L	Length of pipeline	[m]	–
α	Linear coefficient of thermal expansion	[mm/(m·K)]	product/material-specific
Δl	Change in length	[mm]	–
ΔT	Temperature difference	[K]	–

Sample calculation using a plastic pipe (PB)

The length of the pipeline is 7 m. The thermally induced change in length of this pipe section must be absorbed by a flexible pipe leg. The difference between the installation temperature and the maximum operating temperature is 60 K (10 to 70°C).

Plastic pipe, PE-X, Dimension	d40
Length of pipeline L	7.0 m
Linear coefficient of thermal expansion α	0.2 mm/(m·K)
Temperature difference ΔT	60 K

How to calculate the change in length

- with linear coefficient of thermal expansion α = 0.2 mm/(m·K)

$$\Delta l = \alpha \cdot L \cdot \Delta T$$

$$\Delta l = 0.2\ [mm/(m \cdot K)] \cdot 7\ [m] \cdot 60\ [K]$$

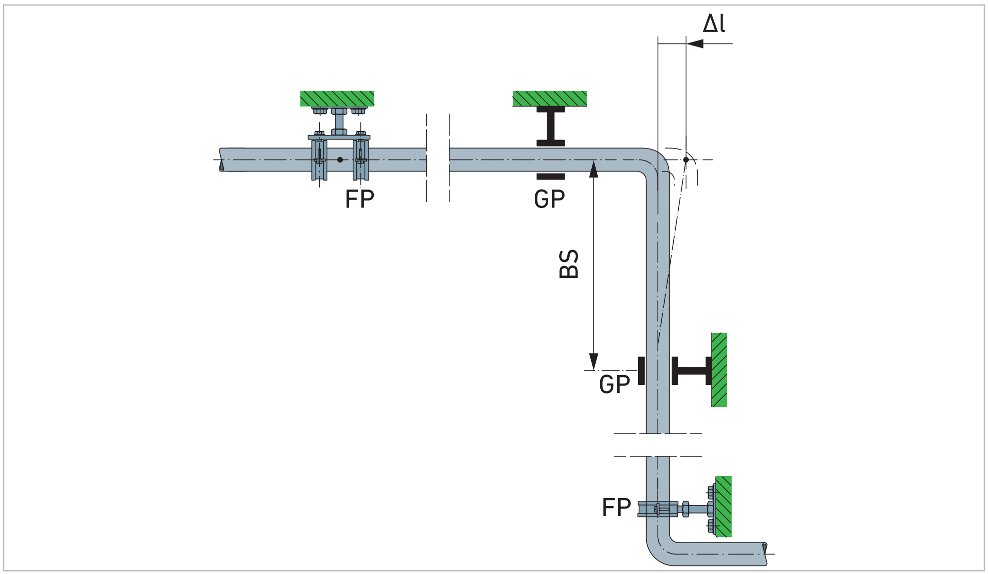
$$\Delta l = 84,.\ mm$$

4.5.5 Calculation of the flexible pipe leg

Calculation of the length of the flexible pipe leg

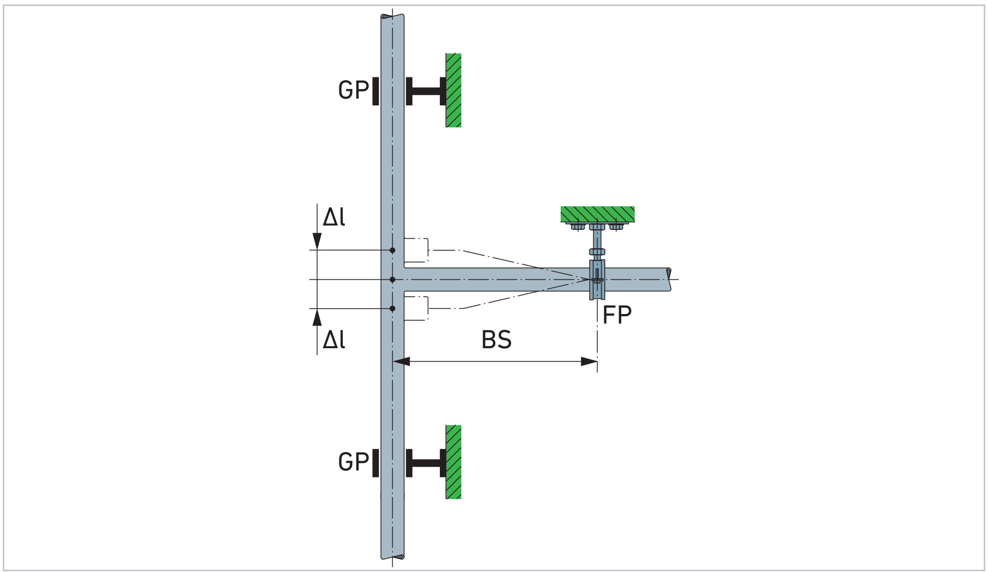
Due to the thermally induced change in length **Δl** , a pipeline shifts a pipe bend by a value **Δl**. This change must be absorbed by a flexible pipe leg with a length equal to **BS**.

Length of flexible pipe leg



GV.7
Length of flexible pipe leg
GP Floating point
FP Fixed point
BS Length of flexible pipe leg

Length of flexible pipe leg intended to use for the branch line



GV.8
Length of flexible pipe leg
GP Floating point
FP Fixed point
BS Length of flexible pipe leg

The **length of the flexible pipe leg** BS is calculated from the **change in length** Δl and the **outside diameter** d of the pipe, using the following formula:

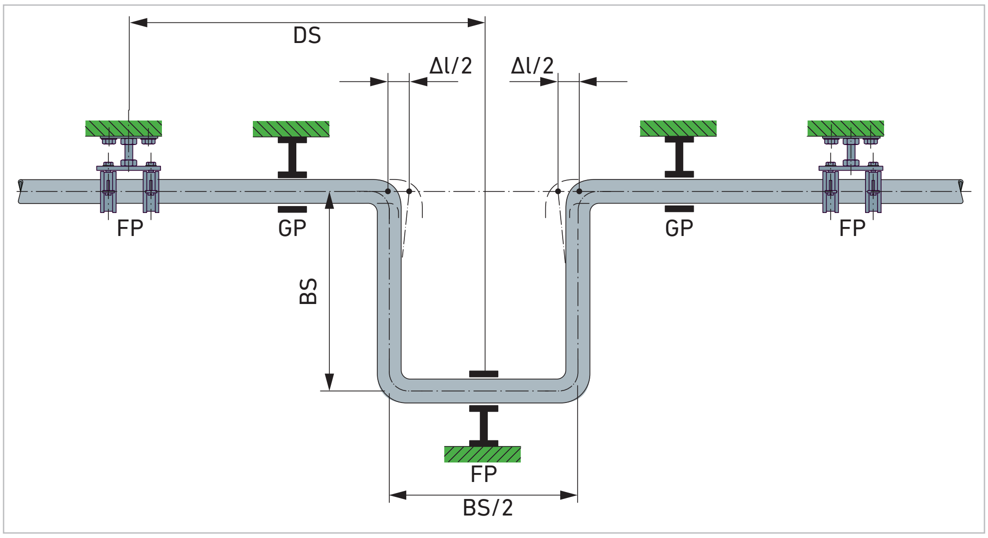
$$BS = C \cdot \sqrt{d \cdot \Delta l}$$

Symbol	Meaning	Unit	Remark
BS	Length of flexible pipe leg	[mm]	–
d	Outside diameter of pipe	[mm]	–
Δl	Change in length	[mm]	–
C	Material constant	–	product/material-specific

Calculation of the length of the flexible pipe leg in a U-shaped expansion loop

Due to the thermally induced change in length, **Δl** a pipe displaces a U-shaped loop at both bends by half the value **Δl**. This change must be absorbed by the two flexible pipe legs **BS**.

Length of the U-shaped expansion loop



GV.9
Length of the U-shaped expansion loop

GP Floating point
FP Fixed point
BS Length of flexible pipe leg
DS Length of the 2D expansion loop

Sample calculation using a plastic pipe (PE-X)
The length of the pipeline is 7 m. The thermally induced change in length of this pipe section must be absorbed by a flexible pipe leg. The difference between the installation temperature and the maximum operating temperature is ~60 K.

Plastic pipe, PE-X, Dimension	d40
Material constant C	12
Change in length Δl	84 mm

Calculation of the length of the flexible pipe leg
- with linear coefficient of thermal expansion α = 0.2 mm/(m·K)

$$BS = C \cdot \sqrt{d \cdot \Delta l}$$

$$BS = 12 \cdot \sqrt{(40\ mm \cdot 84.0\ mm)}$$

$$BS = 696\ mm$$

In order to simplify the determination of the required length of the flexible pipe leg, a material-specific diagram can also be used to determine the length of the flexible pipe leg.

When comparing this result with the result of a metal pipe – which has the same dimension – the size of a flexible pipe leg made of metal will be significantly larger. The explanation for this is the much higher material constant C for metal pipes than the material constant C for a PB pipe.

4.6 Diagrams – Change in length and length of flexible pipe leg

4.6.1 Change in length

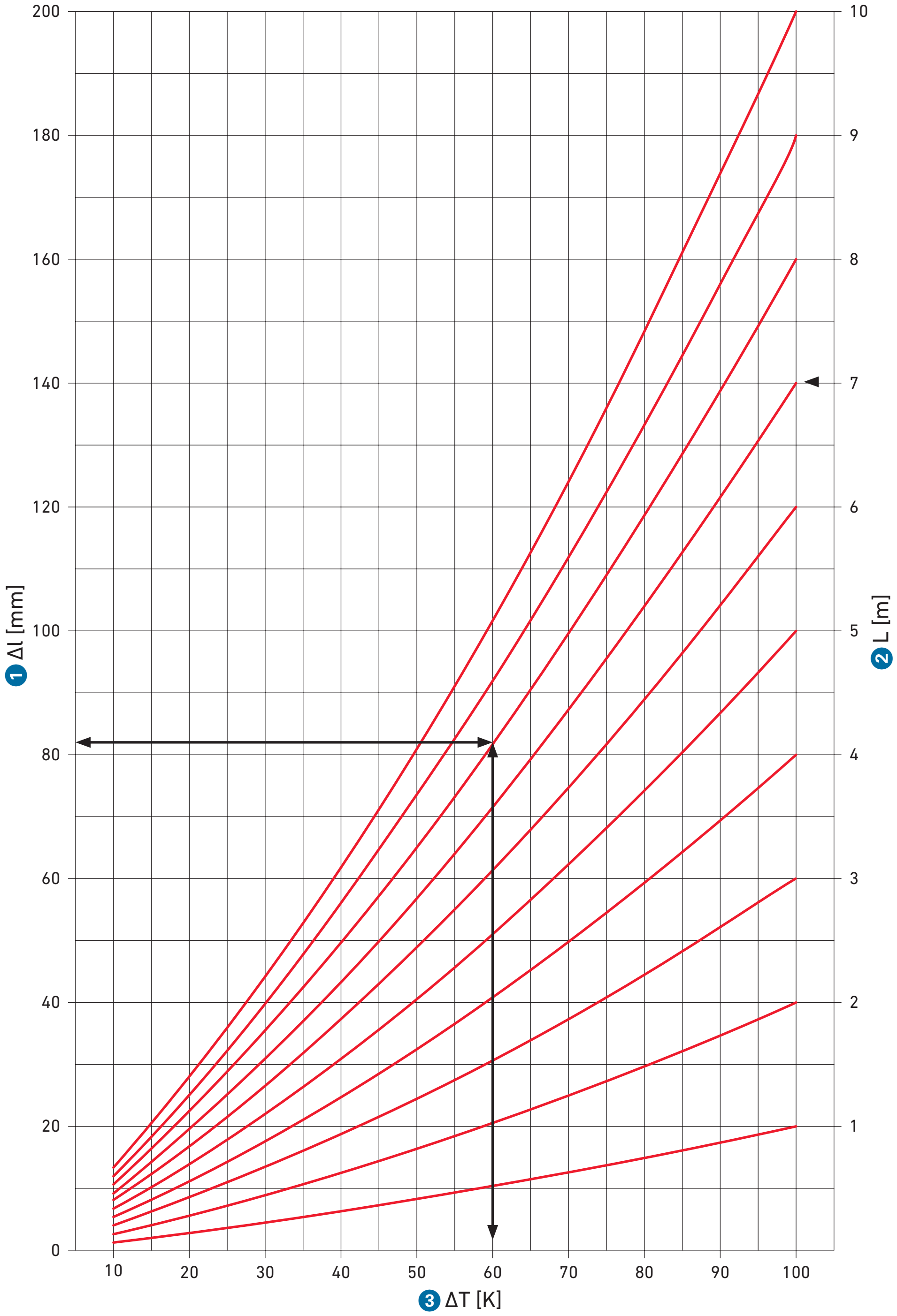
The diagram shows the length expansion of JRG Sanipex pipes as a function of the temperature and length of the pipe, if installed without resistance.

How to read the table

- with non-linear coefficient of thermal expansion

Plastic pipe, PE-X, Dimension	d40
Length of pipeline L	7.0 m
Non-linear coefficient of thermal expansion α, at 20°	0.14 mm/(m·K)
Non-linear coefficient of thermal expansion α, at 100°	0.20 mm/(m·K)
Temperature difference ΔT	60 K

Δl = 81.6 mm (if α = 0.17 mm/(m·K)



GV.10
Change in length – JRG Sanipex pipe (PE-X)
with **non-linear** coefficient of thermal expansion
1 Change in length
2 Length of pipeline
3 Temperature difference

TV.20 **Thermally induced change in length (with linear coefficient of thermal expansion) – JRG Sanipex MT pipes (PE-X)**

Length of pipeline [m]		Temperature difference ΔT [K]						
		10	20	30	40	50	60 ▼	70
		Change in length [mm]						
1		2	4	6	8	10	12	14
2		4	8	12	16	20	24	28
3		6	12	18	24	30	36	42
4		8	16	24	32	40	48	56
5		10	20	30	40	50	60	70
6		12	24	36	48	60	72	84
7	▶	14	28	42	56	70	84	98
8		16	32	48	64	80	96	112
9		18	36	54	72	90	108	126
10		20	40	60	80	100	120	140
20		40	80	120	160	200	240	280
30		60	120	180	240	300	360	420
40		80	160	240	320	400	480	560
50		100	200	300	400	500	600	700

▶ Example for L = 8 m and ΔT = 60 K

4.6.2 Length of flexible pipe leg

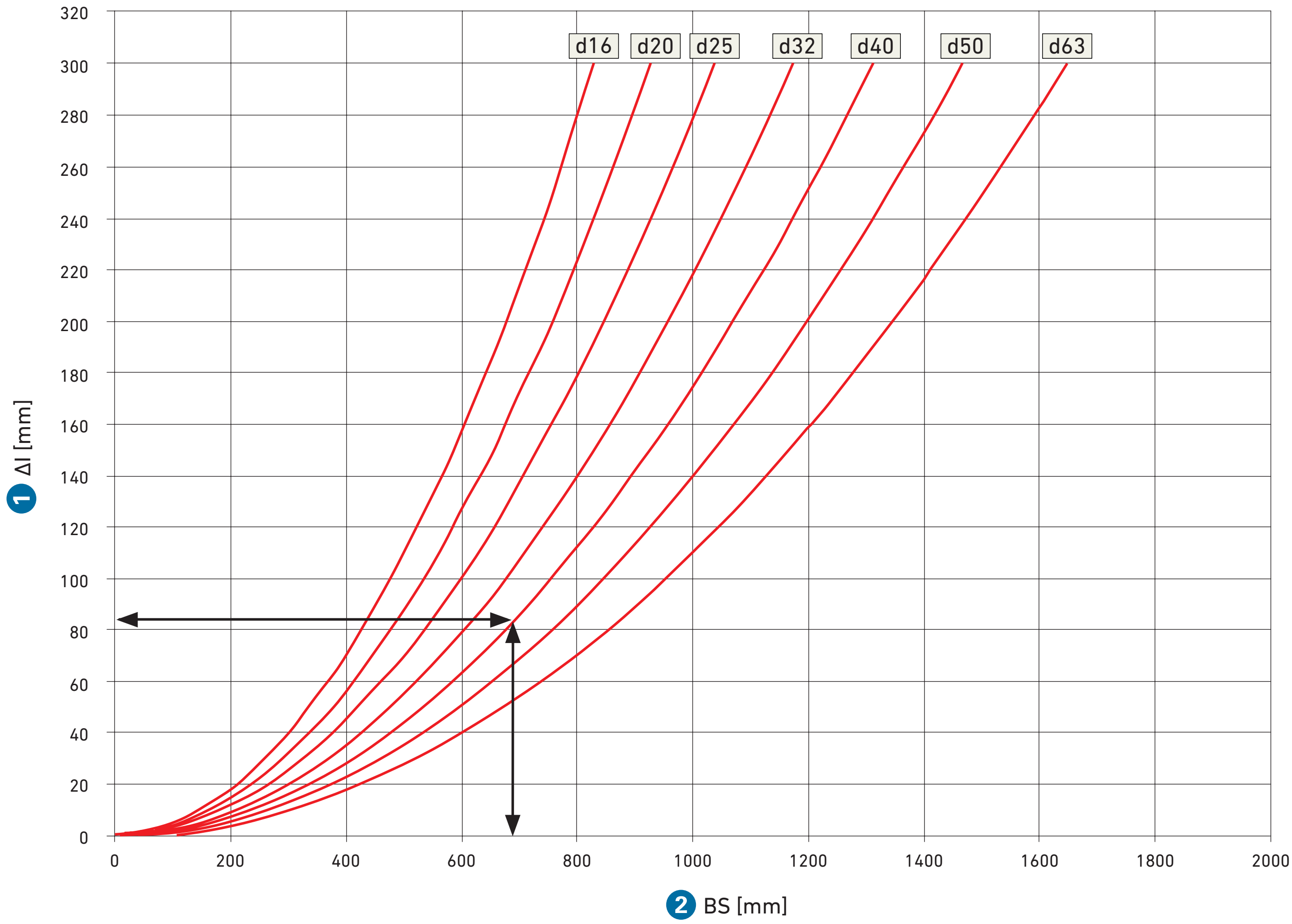
The length of the flexible pipe leg is derived from the pipe's change in length.

How to read the table

- with **linear** coefficient of thermal expansion α = 0.2 mm/(m·K)

Plastic pipe, PE-X, Dimension	d40
Material constant C	12
Change in length Δl	84 mm

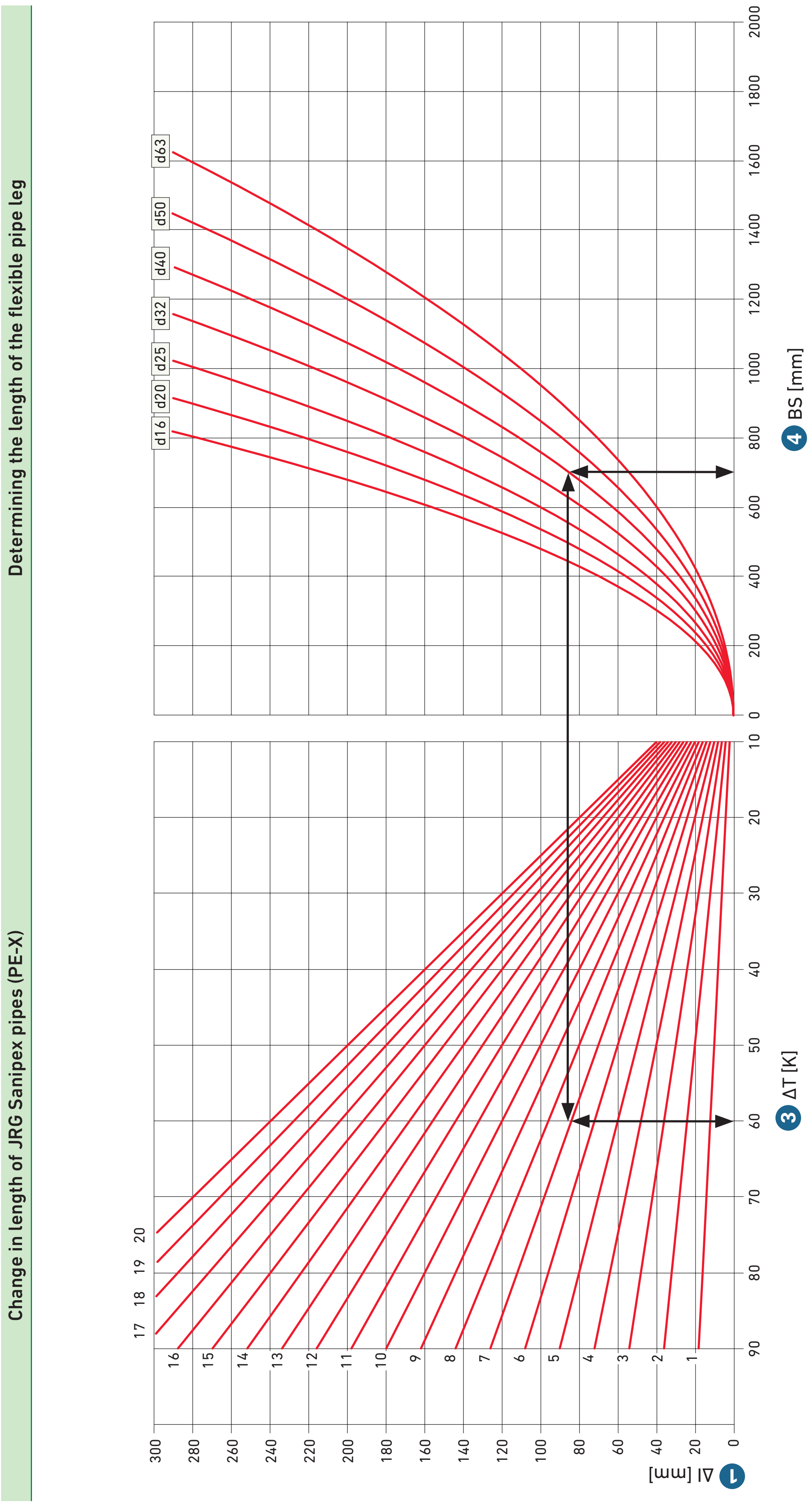
BS = 696 mm



GV.11
Length of flexible pipe leg
1 Change in length of the pipe
2 Length of flexible pipe leg

Graphic determination of the length of flexible pipe leg

The length of the flexible pipe leg can be determined with the two combined diagrams.



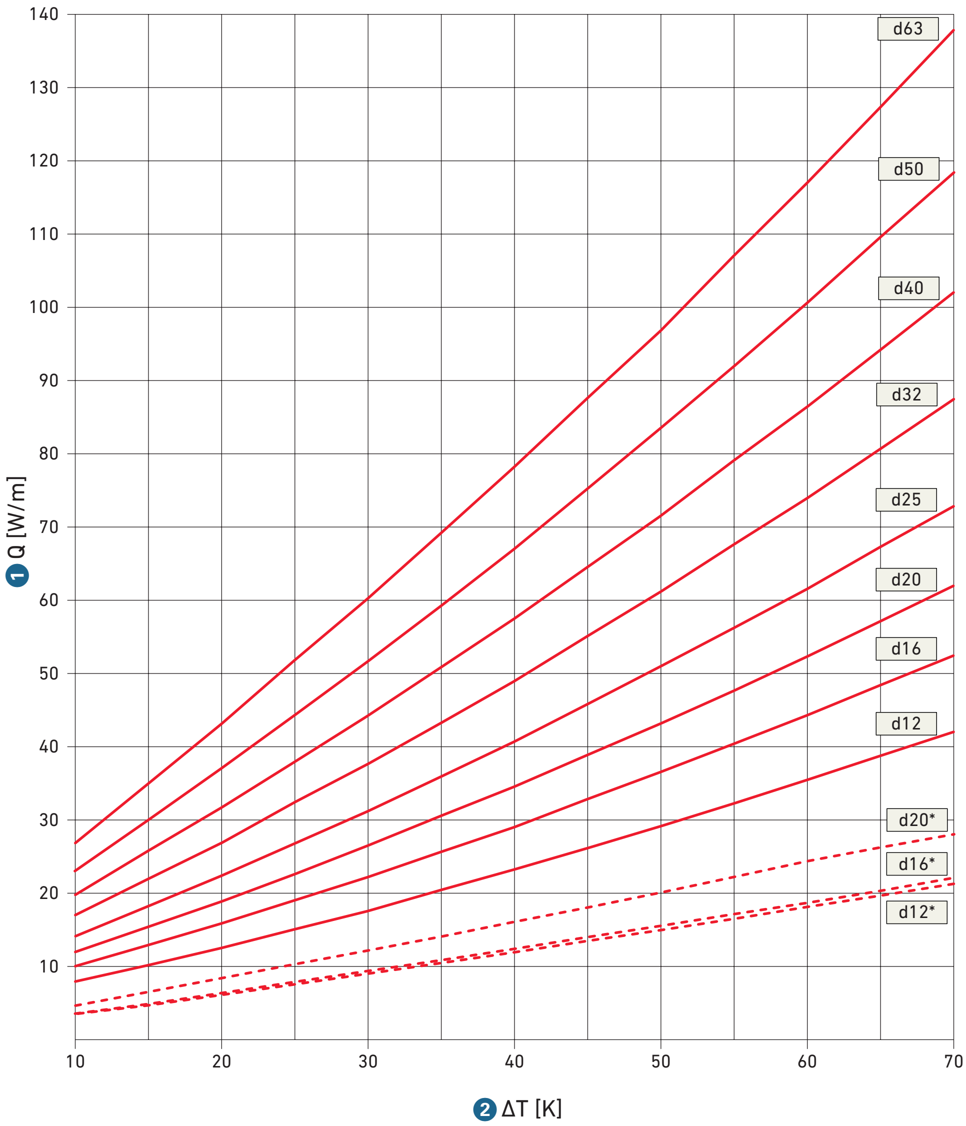
How to use the diagram

1. Read off temperature difference 3.
2. Select the length of pipeline 2.
3. Read change of length 1.
4. Read off the pipe dimension.
5. Read length of the flexible pipe leg 4.

1 Change in length
2 Length of pipeline
3 Temperature difference
4 Length of flexible pipe leg

4.7 Heat emission and insulation

JRG Sanipex pipe (PE-X)

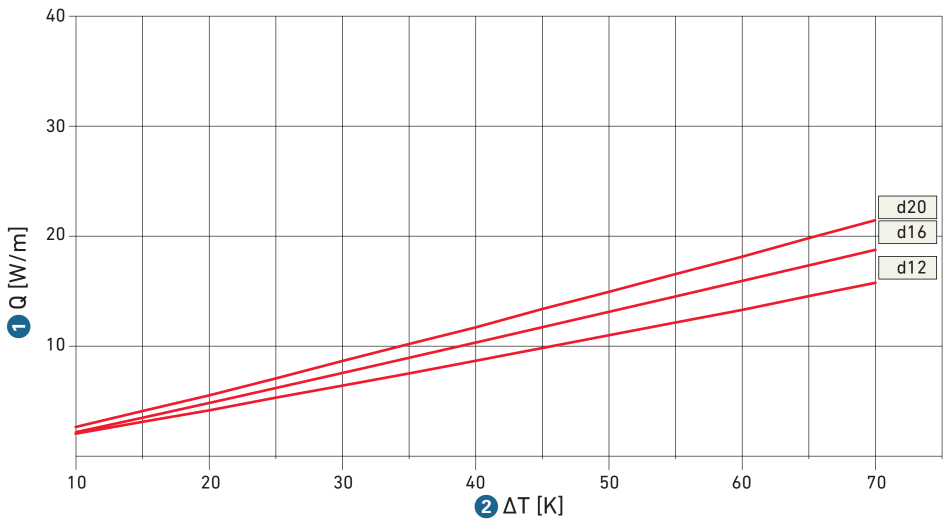


GV.12
**Heat emission –
JRG Sanipex pipe (PE-X)**

1. Heat emission
2. Temperature difference

* inside the protective conduit

JRG Sanipex pipe, pre-insulated, 6 mm

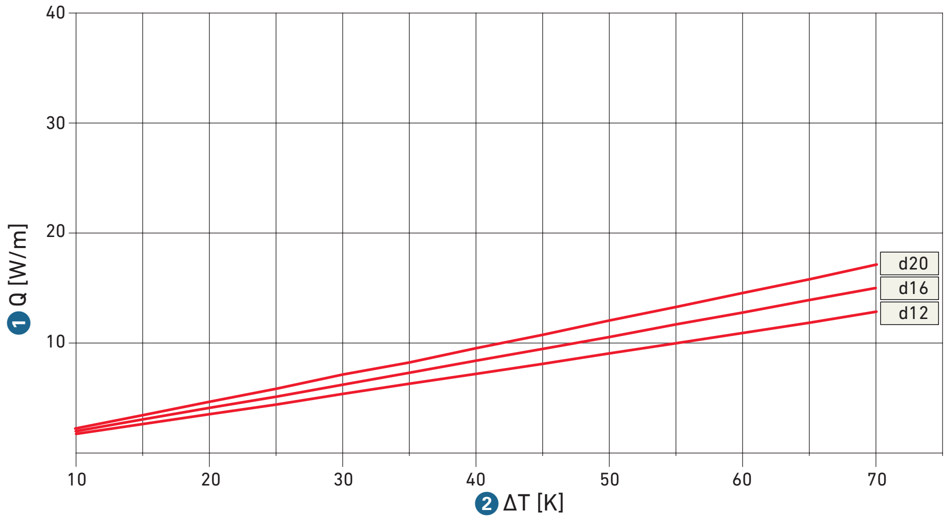


GV.13
**Heat emission –
JRG Sanipex pipe,
pre-insulated**

Graph showing a 6 mm insulation with WLG 035

1. Heat emission
2. Temperature difference

JRG Sanipex pipe, pre-insulated, 10 mm

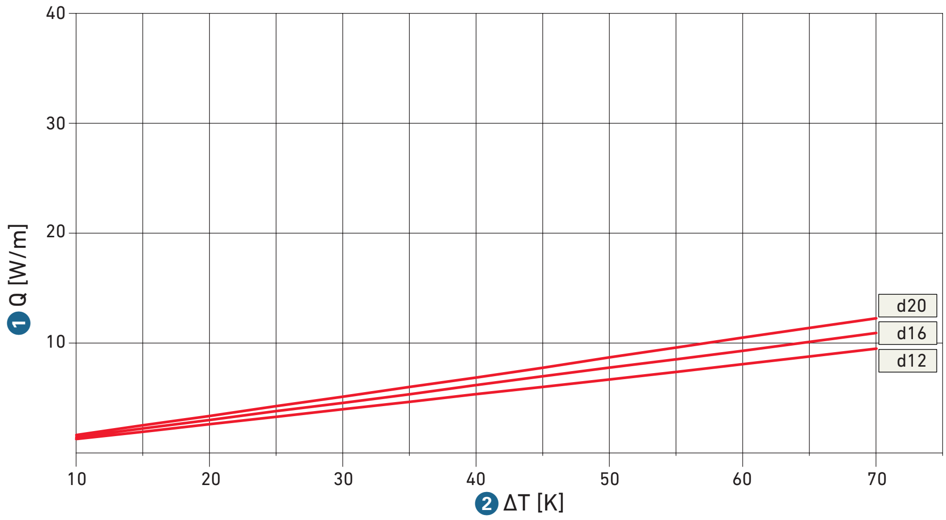


GV.14
Heat emission – JRG Sanipex pipe, pre-insulated

Graph showing a 10 mm insulation with WLG 035

1. Heat emission
2. Temperature difference

JRG Sanipex pipe, pre-insulated, 20 mm

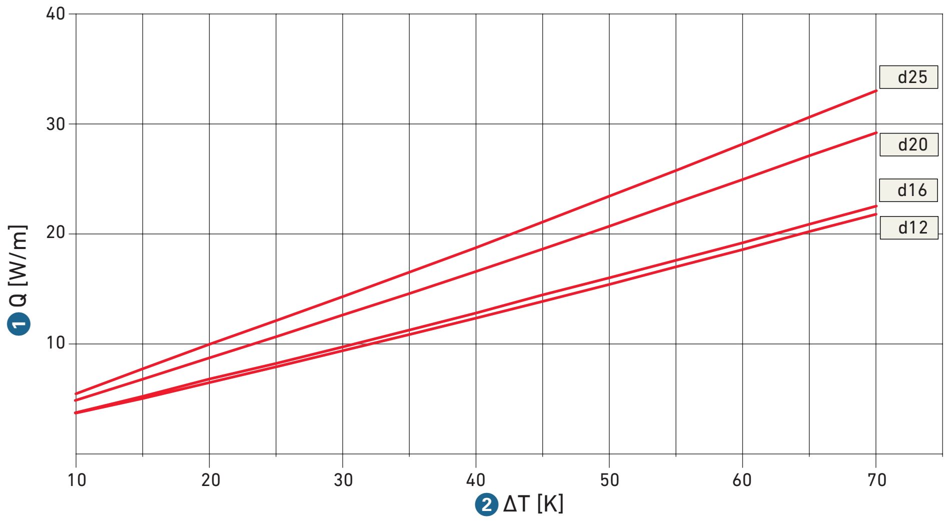


GV.15
Heat emission – JRG Sanipex pipe, pre-insulated

Graph showing a 20 mm insulation with WLG 035

1. Heat emission
2. Temperature difference

JRG Sanipex Calor pipe, in protective conduit



GV.16
Heat emission – JRG Sanipex Calor pipe, inside the protective conduit

1. Heat emission
2. Temperature difference

5 Insulation according to EnEV 2017

Insulation

General information on insulation:

➨ Part IV 'Plan', Section 'Insulation, Fire protection'

§ Country-specific regulations

The insulation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.

☑ When it comes to insulation methods, compliance with the applicable rules and regulations is mandatory.

The Energy Saving Ordinance (EnEV) requires limiting the heat output of heat distribution and hot water pipes. It replaces the previous Heating Installations Ordinance (HeizAnlV) and the Thermal Insulation Ordinance (WSchVO). The EnEV has been valid in **Germany** for building applications or submitted building notices since 01.02.2002, the current, revised version is the EnEV 2017. For new construction and modernization of heat distribution and hot water pipes and their fittings in buildings, these insulation regulations must be observed.

5.1 Insulation requirements of the EnEV 2017

The requirements are defined in table [TV.21] defined:

- Heating pipes and their fittings: according to lines 1 to 2
- Hot water pipes and fittings: according to lines 1 to 5
- Refrigerant distribution/chilled water lines: according to line 8

TV.21 **Insulation requirement of the EnEV 2017, Table 1**

Minimum insulation requirement	Rows	Type of pipes and fittings	Minimum thickness of the insulation layer [mm]*.
100%	1	Inner diameter d_i 22 mm	20
100%	2	Inner diameter$_{di}$ over 22 mm to 35 mm	30
100%	3	Inner diameter$_{di}$ over 35 mm to 100 mm	= Internal diameter
100%	4	Inner diameter d_i over 100 mm	100
50%	5	Lines and fittings according to lines 1 to 4 In wall and ceiling penetrations, in the intersection area of lines, at line connection points, at central line network distributors	50% of the requirements of lines 1 to 4
50%	6	Heat distribution lines according to lines 1 to 4, which were installed after January 31, 2002 in building components between heated rooms of different users	50% of the requirements of lines 1 to 4
6 mm	7	Lines according to line 6 in the floor structure	6
6 mm	8	Refrigeration distribution and chilled water piping and fittings of room air conditioning and air conditioning refrigeration systems.	6

Source: EnEV 2017, Table 1, Annex 5 (to Section 10 (2), Section 14 (5) and Section 15 (4))
* related to a thermal conductivity of $\lambda = 0.035$ W/(m K)

V

Supplementary information

1.

In cases of §10 par. 2 and §14 par. 5:

→ comply with the requirements of lines ❶ to ❼, unless otherwise specified in other provisions of the EnEV 2017.

In cases of §15 par. 4:

→ comply with the requirements of line ❽, unless otherwise specified in other provisions of the EnEV 2017.

If in cases of §14 par. 5 heat distribution and hot water pipes border on outside air:

→ Insulate these pipes with twice the minimum thickness according to lines ❶ to ❹⚡

2.

In cases of §14 par. 5:

→ **[TV.21] not** apply insofar as heat distribution lines according to lines ❶to❹ are located in heated rooms or in building components between heated rooms of a user and their heat output can be influenced by exposed shut-off devices.

In cases of §10 par. 2 and §14 par. 5:

→ Data in table **[TV.21]** do not apply to hot water pipes up to 3 liters, which are neither included in the circulation circuit nor equipped with electric trace heating and are located in heated rooms (stubs).

Although there are no legal requirements here, insulation should be used for reasons of corrosion protection, to prevent cracking and flowing noises, to insulate structure-borne noise and to reduce the thermal load.

3.

For materials with thermal conductivities other than 0.035 W/(m K):

→ Convert minimum thicknesses of insulation layers accordingly. For conversion and thermal conductivity, use the calculation methods and values contained in the recognized rules of technology.

Proof must be provided by the manufacturer.

4.

For heat distribution and hot water pipes as well as cold distribution and cold water pipes:

The minimum thicknesses of the insulation layers according to **[TV.21]** may be reduced if an equivalent limitation of heat dissipation or heat absorption is also ensured with other pipe insulation arrangements and taking into account the insulating effect of the pipe walls.

5.1.1 Minimum thickness of insulation layers

The minimum thickness of the insulation layers, which are based on the inner diameter di, are related to a thermal conductivity of λ = 0.035 W/(m K) (WLG 035) (see in the following tables: red highlights). The following tables show the minimum insulation thicknesses for different thermal conductivities λ.

TV.22 **Minimum thickness of the insulation layer for pipes with 100% requirement ([TV.21], line ❶-❹)**

Thermal conductivity λ [W/(m K)]	16 x 2.25 12	20 x 2.50 15	26 x 3.00 20	32 x 3.00 25	40 x 3.50 32
0,025	11	11	12	17	18
0,030	15	15	16	23	24
0,035	**20**	**20**	**20**	**30**	**30**
0,040	26	26	25	38	38
0,050	44	41	39	59	57

TV.23 **Minimum thickness of the insulation layer for pipes with 50% requirement ([TV.21], line ❺-❻)**

Thermal conductivity λ [W/(m K)]	16 x 2.25 12	20 x 2.50 15	26 x 3.00 20	32 x 3.00 25	40 x 3.50 32
0,025	6	6	6	6	6
0,030	8	8	8	12	12
0,035	10	10	10	15	15
0,040	13	13	12	18	18
0,050	20	19	18	27	27

5.2 Insulation of drinking water pipes (cold)

Insulation of drinking water pipes (cold) is not covered by the EnEV 2017 covered. If there is no risk of legionella due to heating of the cold water, the insulation requirements according to DIN 1988-200 Table 8.

Insulation of drinking water pipes (cold)

➨ Part IV 'Plan', Section 'Insulation, Fire protection', Chapter [1.3] 'Insulating drinking water pipes (cold)')

However, in order to minimize the risk of legionella, the insulation thicknesses according to EnEV 2017, Annex 5, Table 1 in conjunction with DVGW W 551 and DVGW W 553 are recommended. During stagnation periods, even insulation cannot provide sufficient protection against heating.

Actions:

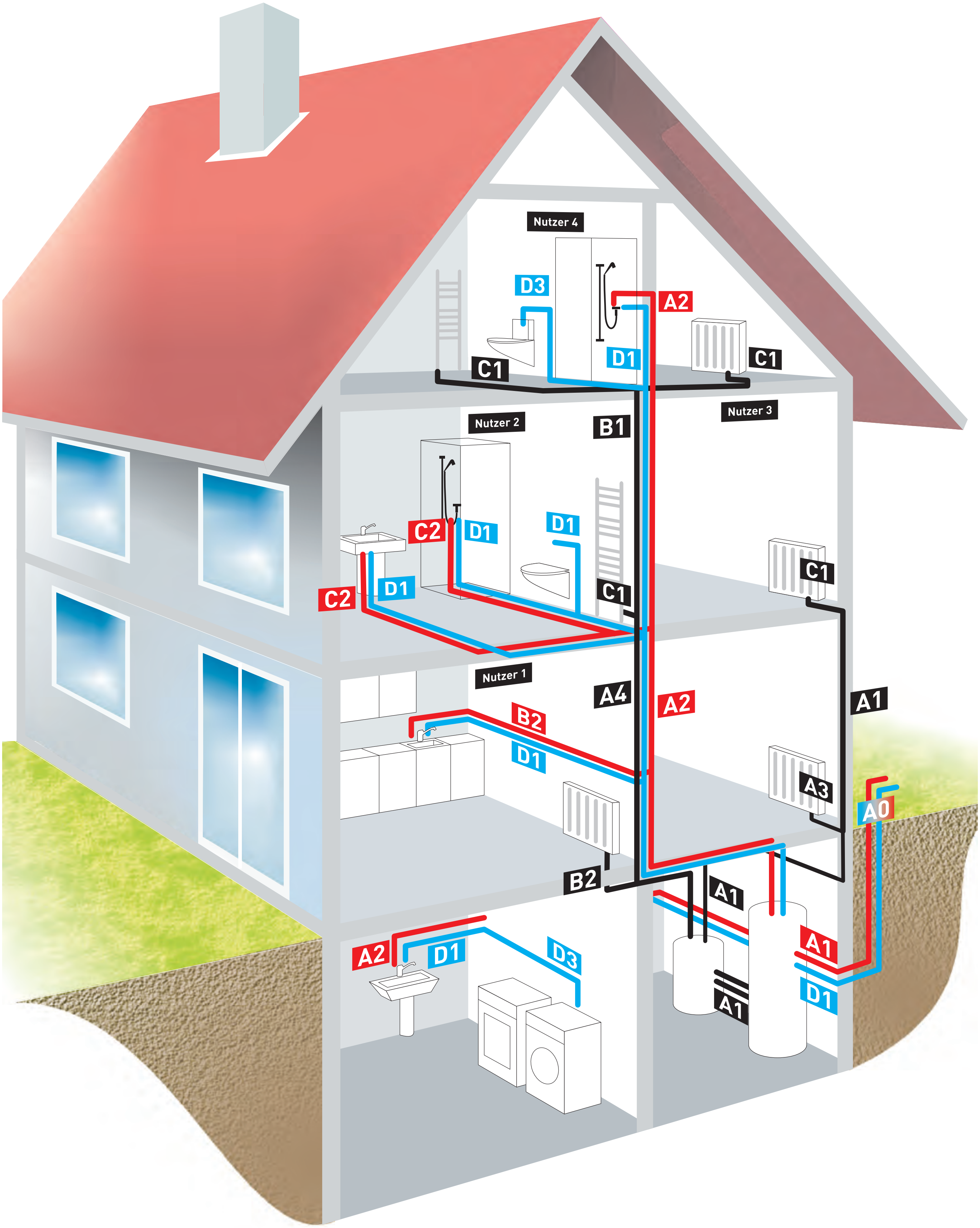
→ Protect cold drinking water systems from inadmissible heating and, if necessary, condensation.

→ Locate cold-flowing potable water lines at a sufficient distance from heat sources. If this is not possible, insulate the pipes so that the heating does not adversely affect the drinking water's quality.

Inadequately insulated cold water pipes can also cause condensation to form on the surface of the insulation layer, and unsuitable materials can become damp through. Therefore, closed-cell or comparable materials with high water vapor diffusion resistance should be used. All joints, cuts, seams and end points must be sealed water vapor-tight.

5.3 Application

Due to these insulation regulations, heating and hot water pipes and their fittings in single-family and multi-family houses must be insulated, as shown in the following examples.



TV.24 **Heating and hot water pipes according to EnEV 2017**

Area	Installation situation pipelines	Insulation requirements [mm], for WLG 035
A0	• Heat distribution lines laid directly adjacent to the outside air	200% insulation
A1	• In exterior walls • In unheated rooms • Basement distribution pipelines	100% insulation ([TV.21], line 1 to 4)
A2	• Hot water pipes with/without circulation pipes • Circulation pipelines • Hot water pipes in basements with/without electrical trace heating	
A3	• Heating pipes in the room's floor structure intended for permanent residence of persons, against unheated rooms or ground or outside air.	
A4	• Distribution lines for the supply of several parties	
B1	• Pipes between heated rooms of different users	50% minimum insulation requirement ([TV.21], line 5 to 6)
B2	• Pipes and fittings in wall and ceiling openings • In areas where pipes are crossing • At pipe connection points • At pipe connection points • For central line network distributors	
C1	• Heating pipes in the floor structure between heated rooms of different users	6 ([TV.21], line 7 to 8)
C2	• No requirements for the minimum thickness of the insulation layer are imposed on heat distribution lines located in heated rooms or in components between heated rooms of a user and their heat emission can be influenced by exposed shut-off devices • Hot water pipes up to the inner diameter of 22 mm, which are neither included in the circulation circuit nor equipped with electric trace heating, are also exempt from these requirements	No requirement* (see "Supplementary information" in [TV.21])

* **NOTE:** This type of installation does not meet sound insulation requirements (prevention of structure-borne sound transmission). The thermal mobility of the pipeline (linear expansion) must also be ensured. Insulation is required to prevent structure-borne noise, cracking and flowing noises and the heating of other components. This is therefore recommended from a construction and economic point of view, even in this case, although the regulation text of the EnEV 2017 does not mandatorily require this.

TV.25 **Cold water pipes according to EnEV 2017**

Area	Installation situation pipelines	Insulation requirements [mm], for WLG 035
D1	• Pipes next to hot water pipes • Pipes in wall recesses next to hot water pipes • Pipes in the duct next to hot water pipes	10
D2	• Lines freely laid in heated room	6
D3	• Lines freely laid in unheated space • Pipes in the duct without hot water pipes • Lines in the wall slot, riser • Pipes on concrete ceilings	6

1. For materials with thermal conductivities other than 0.035 W/(m K):

→ Convert minimum thicknesses of insulation layers accordingly. For conversion and thermal conductivity, use the calculation methods and values contained in the recognized rules of technology.

Proof must be provided by the manufacturer.

2. Piping in areas subject to frost:

If pipelines are located in frost-prone areas, even insulation cannot provide sufficient and permanent protection against freezing during downtimes. They must be drained or otherwise protected (e.g. by trace heating). Details are regulated by the VDI guidelines VDI 2055 or VDI 2069.

3. In conjunction with DVGW W551 and DVGW W553 the insulation thicknesses according to EnEV 2017 are also recommended for **cold water pipes** to minimize the risk of legionella.

5.4 Insulation according to EnEV 2017 - Solutions with JRG Sanipex

The pre-insulated pipes of the JRG Sanipex system meet according to EN 12667 a thermal conductivity of 0.035 W/(m K). This meets the highest requirements for thermal insulation of piping systems. This also means that the pipe packages in the overall structure are significantly slimmer than most competitor solutions, which use insulation with λ = 0.040 W/(m K), while retaining the same thermal insulation properties. This also has a positive effect on the flexibility of the piping system.

Insulation and fire protection with Sanipex

The insulation of the JRG Sanipex system meets the requirements of class E according to EN 13501-1.

Fire protection
See the legal requirements as they apply to fire protection (prevention of the transmission of fire and smoke to other fire compartments) in the amended state building codes and the introductory decrees of technical building regulations (ETB).
General information on fire protection:
➨ Part IV 'Plan', Section 'Insulation, Fire protection'

TV.26 **Heating and hot water pipes according to EnEV 2017 ([TV.21])**

Area	Installation situation pipelines	Insulation requirements [mm], for WLG 035	Sanipex [Art.no.]
A0	Details: see table [TV.24]	200% insulation	Solution must be provided by the customer
A1		100% insulation ([TV.21], line 1 to 4)	4606.216, 4606.220, 4606.226, 5710.212, 5710.216, 5710.220
A2			
A3			
A4			
B1		50% minimum insulation requirement ([TV.21], line 5 to 6)	4606.116, 4606.120, 4606.126, 5710.112, 5710.116, 5710.120
B2			
C1		6 mm ([TV.21], line 7 to 8)	4606.016, 4606.020, 4606.026, 5710.012, 5710.016, 5710.020
C2		No requirement* (see "Supplementary information" in [TV.21])	4602.016, 4602.020, 5706.012, 5706.016, 5706.020, 5706.025, 5711.012, 5711.016, 5716.012, 5716.016, 5716.020

TV.27 **Cold water pipes according to EnEV 2017**

Area	Installation situation pipelines	Insulation requirements [mm], for WLG 035	Sanipex [Art.no.]
D1	Details: see table [TV.25]	10	4606.116, 4606.120, 4606.126, 5710.112, 5710.116, 5710.120
D2		6	4606.016, 4606.020, 4606.026, 5710.012, 5710.016, 5710.020
D3		6	4606.016, 4606.020, 4606.026, 5710.012, 5710.016, 5710.020

5.4.1 Application criteria applicable to pre-insulated JRG Sanipex pipes

Pipes with 6 mm insulation

- Consisting of pipe and insulation
- Delivery in coils, 50 m long (100 m for dimension d12)
- Concentric pipe insulation made of polyethylene foam with closed-cell material structure
- Insulation thickness 6 mm, WLG 035
- With durable, seamless foil coating, colour grey
- Building material class E

Can be used e.g. for:

- Drinking water pipes cold according to DIN 1988-2 (Table 9)
- Pipes of central heating systems in the floor structure between heated rooms of different users according to EnEV 2017 (Annex 5, Table 1, line 7)
- Refrigeration distribution and chilled water pipes according to EnEV 2017 (Annex 5, Table 1, line 8)

In addition, uninterrupted impact sound insulation is necessary.

Pipes with 10 mm insulation (50% EnEV)

- Consisting of pipe and insulation
- Delivery in coils, 50 m long (100 m for dimension d12)
- Concentric pipe insulation made of polyethylene foam with closed-cell material structure
- Insulation thickness 10 mm, WLG 035
- With durable, seamless foil coating, colour grey
- Building material class E

Can be used e.g. for:

- Heating and hot water pipes with insulation requirements 50% according to EnEV 2017 (Annex 5, Table 1, Lines 5 and 6).

In order to minimise the risk of legionella, the insulation thicknesses according to EnEV 2017 in conjunction with DVGW W551 and DVGW W553 are also recommended for cold water pipes. In addition, uninterrupted impact sound insulation is necessary.

Pipes d16 to d20 with 20 mm insulation (100% EnEV)

- Consisting of pipe and insulation
- Delivery in coils, 50 m long
- Concentric pipe insulation made of polyethylene foam with closed-cell material structure
- Insulation thickness 20 mm, WLG 035
- With durable, seamless foil coating, colour grey
- Building material class E

Can be used e.g. for:

- Heating and hot water pipes with insulation requirements 100% according to EnEV 2017 (Annex 5, Table 1, Line 1).

In order to minimise the risk of legionella, the insulation thicknesses according to EnEV 2017 in conjunction with DVGW W551 and DVGW W553 are also recommended for cold water pipes. In addition, uninterrupted impact sound insulation is necessary.

6 Fire protection

Fire protection
See the legal requirements as they apply to fire protection (prevention of the transmission of fire and smoke to other fire compartments) in the amended state building codes and the introductory decrees of technical building regulations (ETB).
General information on fire protection:
➨ Part IV 'Plan', Section 'Insulation, Fire protection'

§ Country-specific regulations

The insulation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.

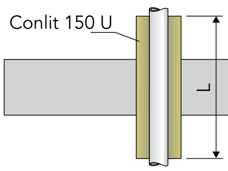
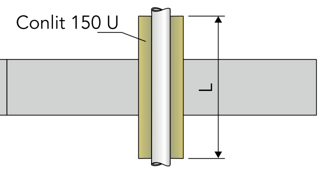
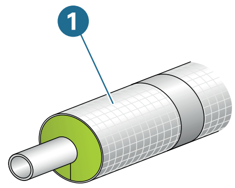
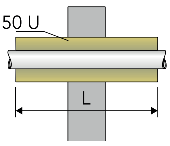
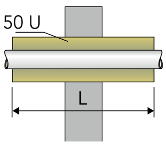
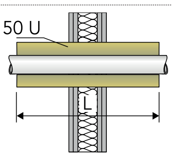
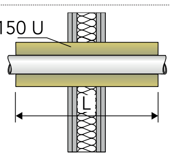
☑ When it comes to insulation methods, compliance with the applicable rules and regulations is mandatory.

6.1 Implementation with Rockwool

R30 to R90 pipe penetrations for JRG installation systems with non-combustible media, e.g. drinking water, heating

Fire protection with Rockwool
For more information, see the Rockwool Planning Guide and the Rockwool website.

TV.28 **Components and implementation**

Component F 30 to F 90 Thickness [mm]	F 30	F 60 F 90	
Solid ceiling min. 150	 L ≥ 1000 mm; WD [2]		
Solid wall min. 100	 L ≥ 1000 mm; WD [2]		❶ ROCKWOOL 800 / Teclit PS Cold Minimum thickness: 30 mm
Lightweight partition min. 100	 L ≥ 1000 mm; WD [2]		

Design variant according to ROCKWOOL abP P-3276/4140-MPA BS.

TV.29 **System and components**

System	Pipe dimension	Conlit 150 U		ROCKWOOL 800 [1), 2), 3)] Teclit PS Cold [1), 2), 3)]			
	Diameter, outside Da [mm]	Type [3)]	Insulation thickness [4)] s [mm]	Core drilling THK [mm]	EnEV 100%, warm, type	EnEV 50%, warm, type	DIN 1988-200, cold, type [3)]
JRG Sanipex PE-Xa [5)]	12	12/24	24	60	15/20	15/20	15/20
	16	16/22	22	60	18/20	18/20	18/20
	20	20/20	20	60	22/20	22/20	22/20
	25	25/17,5	17.5	60	28/20	28/20	28/20
	32	32/24	24	80	35/30	35/20	35/30
	40	40/20	20	80	42/40	42/20	42/40
	50	50/25	25	100	54/40	54/30	54/40
	63	63/33,5	33.5	130	64/50	64/30	64/50

Notes and special installation conditions

1) In individual cases, the minimum insulation thickness that can be supplied is specified.

2) The insulation shell ROCKWOOL 800 or Teclit PS Cold can be used as further insulation.

3) For cold pipes, a vapor barrier must be installed according to DIN 1988-200. Therefore, only use fire protection pipe shell Conlit 150 U, insulation shell ROCKWOOL 800 or Teclit PS Cold.

4) Insulation thickness after EnEV 50% as well as according to DIN 1988-200 suitable for core drill diameter DK

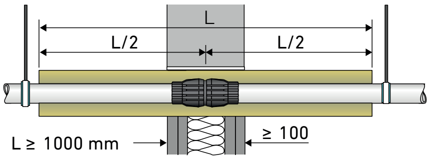
5) Sheathing (such as protective pipes or factory insulation) must be removed in the lead-through area.

All boundary conditions of the specified general building inspection test certificates (abP) must be taken into account.

R30 to R120 partitioning in solid walls, lightweight partition walls and solid ceilings

Further instructions for installing the JRG pipe connector in wall and ceiling penetrations:

➨ starting at P P-3726/4140-MPA BS, Annex 19



GV.17
Assembly of the JRG pipe connector

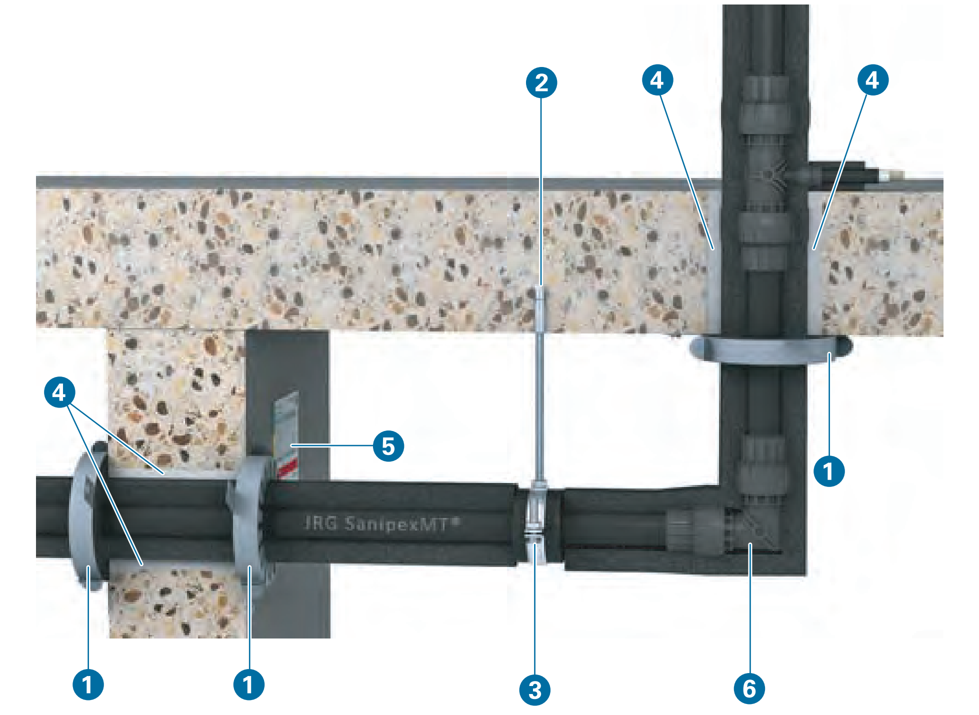
6.2 Implementation with BIS Walraven

6.2.1 BIS Pacifyre AWM II Fire Protection Sleeve

- with synthetic rubber, insulation up to ≤43 mm

Benefits

- Zero distance between identical cuffs possible
- Offset installation possible
- Flexible annular gap closure possible
- Suitable for installation in damp rooms
- Installation possible without additional fasteners, by bending over and inserting the lugs into the fresh concrete or mortar
- To be mounted on both sides of the wall or on the underside of the ceiling
- Complete system: Mounting material included in the scope of delivery



GV.18
Product overview

1. Pipe penetration seal with BIS Pacifyre AWM II fire protection collar
2. Fire-tested anchor technology, e.g. with BIS drop-in anchor, BIS metal expansion anchor, etc.
3. Fire protection tested pipe clamps, e.g. with BISMAT Flasch, BISMAT 2000 or BIS HD heavy duty clamp incl. fire protection tested threaded rod/pin (≥M8)
4. Residual gap closure with Tangit FP 440 Fire Protection Joint Filler or BIS Pacifyre FPM Fire Protection Mortar or BIS Pacifyre SML/MLAR Strip
5. Marking all BIS Pacifyre pipe penetration seals with the BIS Pacifyre and Tangit FP universal label
6. Synthetic rubber insulation up to ≤43 mm thickness

Field of application and use

TV.30 **Application range according to ABZ Z-19.17.-1194**

Component	Wall	≥100 mm
	Ceiling	≥150 mm
Pipe system	Sanipex classic	to d63

Approved insulation

- Synthetic rubber insulation up to 43 mm thickness in the area of wall and ceiling penetration
- PE sound insulation hose up to 4 mm thickness
- One layer of BIS Pacifyre SML/MLAR Strip in full component thickness (sound insulation)

§ **ABZ**

☑ The installation guidelines and specifications of the ABZ must be observed.

More information

For further information, please refer to the **BIS Walraven + GF special brochure**, the **BIS Planning Helper** and the BIS Walraven website.

TV.31
Application

Dimension of pipe	**Cuff size, Art.no.**					
Diameter, outside Da [mm]	Without insulation	Item no.	EnEV 50%,	Item no.	EnEV 100%	Item no.
16	15	213 4 032032	40	213 4 040042	63	213 4 063065
20	20	213 4 032032	40	213 4 040042	63	213 4 063065
25	25	213 4 032032	63	213 4 063065	90	213 4 090092
26	25	213 4 032032	63	213 4 063065	90	213 4 090092
32	32	213 4 032032	63	213 4 063065	90	213 4 090092
40	40	213 4 040042	75	213 4 075077	110	213 4 110112
50	50	213 4 050042	75	213 4 075077	110	213 4 110112
63	63	213 4 063065	110	213 4 110112	125	213 4 125125

TV.32
Partitioning in ceilings and walls

Partitioning in ceilings

Partitioning in walls

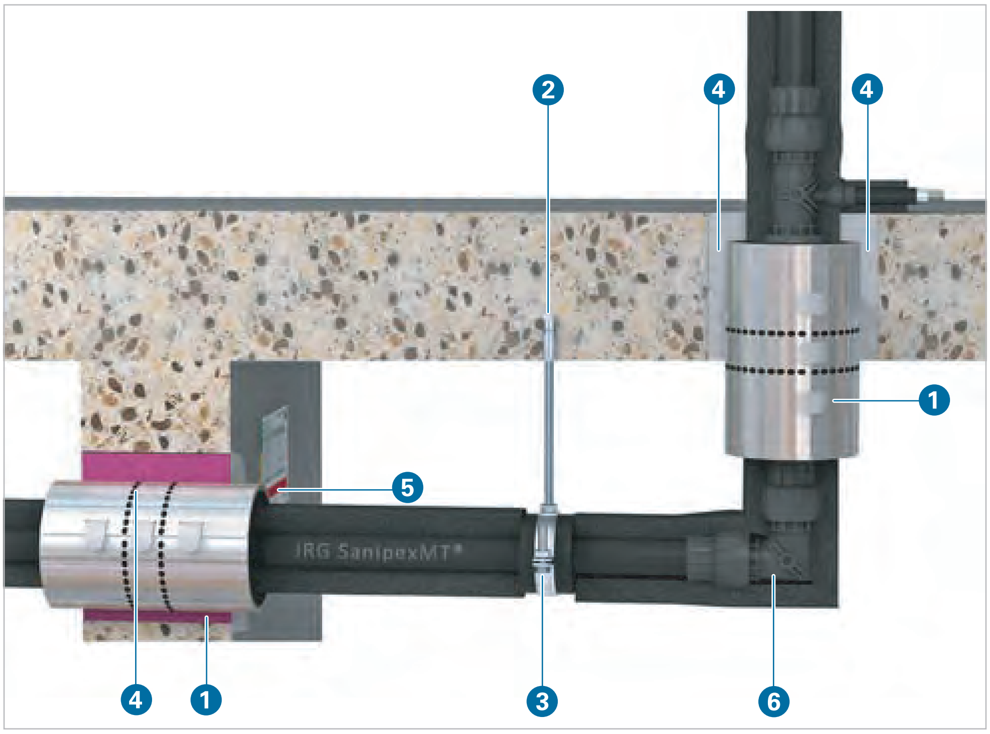
V

6.2.2 BIS Pacifyre MK II Fire Protection Sleeve

- with synthetic rubber, insulation ≤44 mm

Benefits

- Zero distance between identical cuffs possible
- No tools, no drilling, therefore very easy to install
- Place the sleeve around the pipe, close it - done!
- Only one sleeve for wall penetration seals up to 150 mm wall thickness
- Sound insulation test certificate from IBP (Fraunhofer Institute)
- High flexibility due to low protrusions



GV.19
Product overview

1. Pipe penetration seal with BIS Pacifyre MK II fire protection collar
2. Fire-tested anchor technology, e.g. with BIS drop-in anchor, BIS metal expansion anchor, etc.
3. Fire protection tested pipe clamps, e.g. with BISMAT Flasch, BISMAT 2000 or BIS HD heavy duty clamp incl. fire protection tested threaded rod/pin (≥M8)
4. Residual gap closure with Tangit FP 440 Fire Protection Joint Filler or BIS Pacifyre FPM Fire Protection Mortar or BIS Pacifyre SML/MLAR Strip
5. Marking all BIS Pacifyre pipe penetration seals with the BIS Pacifyre and Tangit FP universal label
6. Synthetic rubber insulation up to ≤44 mm thickness

Field of application and use

TV.33 **Application range according to ABZ Z-19.17.-1737**

Component	Wall	≥100 mm
	Ceiling	≥150 mm
Pipe system	Sanipex classic	to d63

Approved insulation

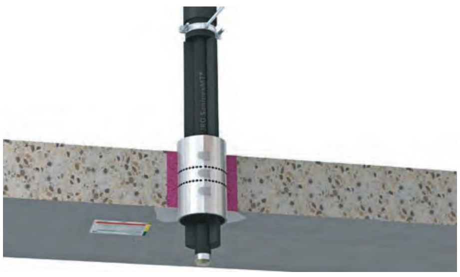
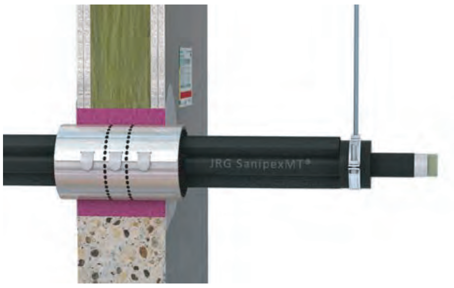
- Synthetic rubber insulation up to 44 mm thickness in the area of wall and ceiling penetration

§ **ABZ**
☑ The installation guidelines and specifications of the ABZ must be observed.

More information
For further information, please refer to the **BIS Walraven + GF special brochure**, the **BIS Planning Helper** and the BIS Walraven website.

TV.34 **Application**

Diameter, tube	Diameter of cuff		Item no.	Recommended core drilling with Tangit FP 550	Recommended core drilling with BIS Pacifyre FPM Fire Protection Mortar
outside Da [mm]	inside [mm]	outside [mm]		[mm]	[mm]
16	15	40	215 1 015017	61	71
20	18	43	215 1 018020	61	71
25	24	55	215 4 024026	76	86
32	30	61	215 4 030032	81	91
40	39	70	215 4 039041	91	101
50	48	79	215 4 048050	101	111
52	51	82	215 4 051053	101	111
56	54	85	215 4 054056	106	116
63	63	94	215 4 063065	116	126

Partitioning in ceilings	Partitioning in walls
	

TV.35
Partitioning in ceilings and walls

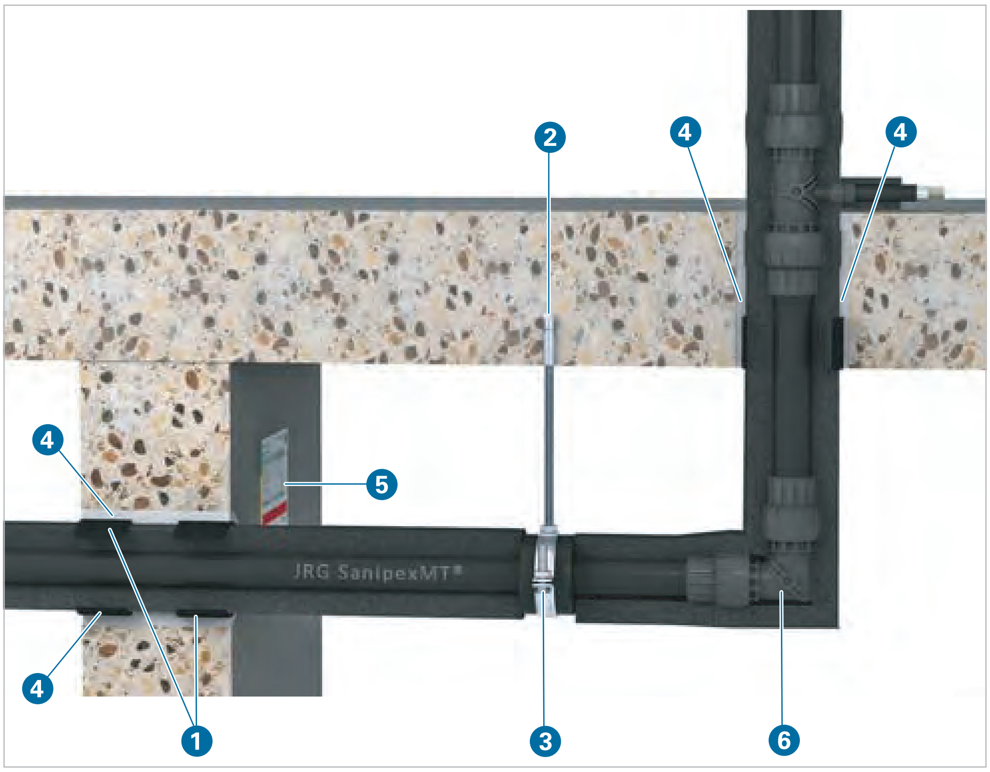
V

6.2.3 BIS Pacifyre IWM III Fire Protection Sleeve

- with synthetic rubber, insulation ≤32mm

Benefits

- Art.no. 213 6 0510 125 or 213 6 050 625
- Zero spacing between identical drums possible
- No tools, no drilling required
- Easy and efficient processing: Wrap the tape around the tube, push it into the component - done!
- No offcuts, as free dimensional adjustment is possible on the construction site
- Low space requirement due to small number of layers; thus optimal for areas that are difficult to access
- Flush with wall/ceiling
- High flexibility due to self-adhesive tape
- Suitable for installation in damp rooms



GV.20
Product overview

1. Pipe penetration seal with BIS Pacifyre IWM III fire protection collar
2. Fire-tested anchor technology, e.g. with BIS drop-in anchor, BIS metal expansion anchor, etc.
3. Fire protection tested pipe clamps, e.g. with BISMAT Flasch, BISMAT 2000 or BIS HD heavy duty clamp incl. fire protection tested threaded rod/pin (≥M8)
4. Residual gap closure with Tangit FP 440 Fire Protection Joint Filler or BIS Pacifyre FPM Fire Protection Mortar or BIS Pacifyre SML/MLAR Strip
5. Marking all BIS Pacifyre pipe penetration seals with the BIS Pacifyre and Tangit FP universal label
6. Synthetic rubber insulation up to ≤44 mm thickness

Field of application and use

TV.36 **Application range according to ABZ Z-19.17.-1884**

Component	Wall	≥100 mm
	Ceiling	≥150 mm
Pipe system	Sanipex classic	to d63

Approved insulation

- Synthetic rubber insulation up to 32 mm thickness in the area of wall and ceiling penetration
- One layer of BIS Pacifyre SML/MLAR Strip in full component thickness (sound insulation)

§ **ABZ**

☑ The installation guidelines and specifications of the ABZ must be observed.

More information

For further information, please refer to the **BIS Walraven + GF special brochure**, the **BIS Planning Helper** and the BIS Walraven website.

TV.37 **Application**

Diameter, tube outside Da [mm]	Pipes without insulation: Number of layers	Pipes without insulation: Length [mm]	Pipes with synthetic rubber insulation: Number of layers	Strip length [mm] for insulation thickness D [mm]: D =13	D =19	D =25
Sanipex classic						
16	1	76	1	157	195	233
20	1	88	1	170	208	245
25	1	104	1	186	223	261
32	1	126	1	208	245	283
40	1	151	2	440	516	591
50	1	183	2	503	578	654
63	1	222	2	588	660	735

TV.38 **Partitioning in ceilings and walls**

Partitioning in ceilings

Partitioning in walls

6.3 Example of "zero" distance

Approved distances between Silenta Premium and Sanipex MT

According to the general type approval (Z-19.53-2331) point 2.2.2 or Annex 30: "... The spacing for pipes of pipe group L (GF Silenta Premium) with an outside diameter ≤110mm, the pipe collar Pacifyre AWM II and the penetration seal according to general building approval no. Z-19.17-1884 Pacifyre IWM III or general building authority test certificate no. P-MPA-E-17-012 to "Sanipex MT composite pipes" with an outer diameter ≤63mm in a 150 mm thick solid ceiling may be reduced to "0" ..."

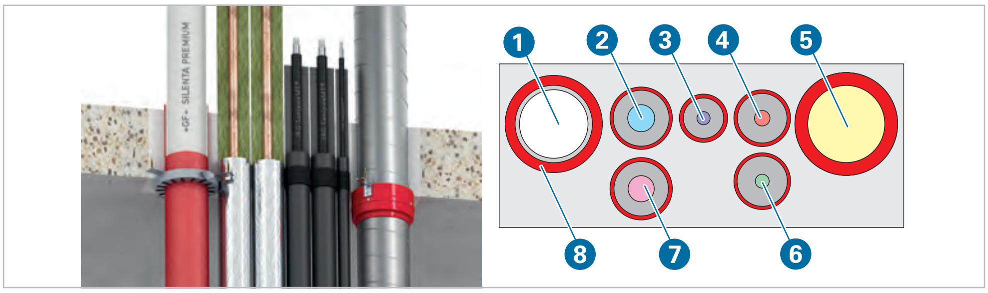
Silenta Premium ≤100 mm with 4-5 PE sound insulation hose - to - Sanipex MT ≤63 mm with K-Flex ST Plus synthetic rubber insulation thickness 11-32 mm with Pacifyre IWM III fire protection tape or Sanipex MT ≤63 mm with Rockwool 800 insulation thickness 20-70 mm.

Fire tests with third-party penetration seals with the aim of achieving a reduced installation distance of "zero" mm between the "third-party penetration seals" and the above-mentioned Pacifyre penetration seals.

TV.39 **Application***

Position	Pipe type	Insulation	Partitioning measure
1	Silenta Premium, ≤110 mm	PE sound insulation hose	Pacifyre AWM II Pacifyre IWM III
2	Sanipex MT, ≤63 mm	Synthetic rubber, ≤39 mm	Pacifyre IWM III
	Sanipex classic ≤40 mm	Insulation thickness according to test report	
	Sanipex MT, ≤63 mm	Rockwool 800, ≤70 mm or Rockwool Conlit 150 U	Rockwool 800 or Rockwool Conlit 150 U
3	Copper or carbon steel, ≤108 mm	Rockwool 800, ≤70 mm or Rockwool Conlit 150 U	Rockwool 800 or Rockwool Conlit 150 U
	Copper or carbon steel, ≤54 mm	Synthetic rubber, ≤21.5 mm	Pacifyre M Pipe Jacket
4	Spiral duct, ≤160 mm	-	Shut-off device according to DIN 18017-3, Wildeboer

* Tested combinations on the basis of the test report No. 21 0006816 dated 04.05.2015 of the MPA NRW, Erwitte field office



GV.21
Zero distance

1. Wastewater
2. Heating, return line
3. Drinking water, circulation
4. Drinking water, hot
5. Exhaust air (DIN EN 18017)
6. Drinking water, cold
7. Heating, supply line
8. Partitioning measure

The "larger distances" required by the DIBt specifications can often not be implemented in practice. Inspired by these facts, penetration seals for non-combustible and combustible pipes were tested in such a way that a distance of "zero" mm can be maintained between the individual penetration seals as well as between the penetration seal and the building component reveal.

For this purpose, practical installation situations were installed in accredited test institutes and tested in accordance with DIN 4102 or EN 1366 tested. The test setup included, for example, Sanipex pipes insulated with synthetic rubber, the Silenta Premium pipe, Sanipex and copper or carbon steel pipes insulated with rock wool, and shut-off devices according to DIN 18017-3. Permitted combinations are listed in DIN 18017-3 Table 1-7.

Additional technical and sales information

→ Please direct inquiries to the GF field service or to: technik.de@walraven.co

7 Installation

Installation of pipelines
General technical information on installation types:
➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [13] 'Installation and attachment'
➨ Part V 'Build', Section 'Installation'

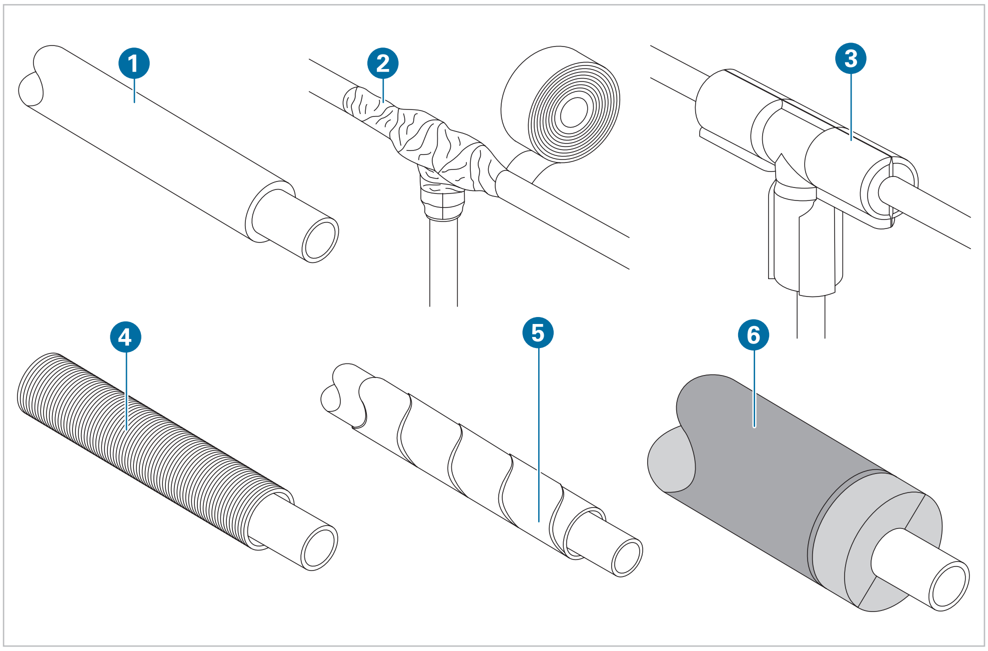
The JRG Sanipex System is suitable for the following types of installation:
- Surface or flush-mounted installations
- Installation in shafts and channels, on ceilings and on floors
- Installation in-wall, element, wood and lightweight constructions
- Installation in concrete (in the pipe-in-pipe system, with PE-X pipes)

7.1 Protection against environmental influences and building materials

System components flush-mounted or concealed behind a wall:
☑ In order to absorb thermally induced changes in length, to prevent the transmission of sound, to avoid the formation of condensation, to preclude heat dissipation, heat loss or to heat the medium and to protect from other building material influences, fittings or pipes must be covered with a suitable materials or they must be separated entirely from the structure of the building.

In permanently or periodically damp rooms, in areas subject to aggressive gases or other offensive environment and under uncontrollable environmental influences:
☑ Appropriate precautions must be taken to protect the installation, e.g. by using the following measures:
  - Use of suitable anti-corrosion tapes (e.g. supplied by KEBU, Gyso or DENSO)
  - Wrapping the pipe with heat-shrinkable materials

☑ Ensure that pipes and fittings are dry when mounting.
☑ All system components must be protected from direct contact with oils, greases, solvents, solvent-based adhesives (adhesive tapes), foams, bitumen (also bituminous membranes). Furthermore, the components must not contact building materials such as screed, concrete, mortar or plaster.
☑ Piping system and building structure must be separated from each other, for example, by using protective conduits made of PE, wrappings, insulating hoses or half shells with and without sheathing or a combination thereof.



GV.22
Safety measures
1 pre-insulated pipe
2 Pipe with wrapping
3 Half shells
4 Protective conduit
5 Wrapping
6 Sheathing

V

7.2 Installation flush with wall

☑ Compliance with the general requirements for installing pipes flush with the wall.
☑ Threaded connections installed flush with the wall must be protected from moisture and contamination.

7.3 Installation in concrete ceiling

JRG Sanipex pipes inside the protective conduit may be cast in solid structures.
☑ Compliance with the general requirements for installing pipes in concrete ceilings is mandatory.
☑ Do not install or pour threaded connections or fittings into the pipe.
If the JRG Sanipex installation accessories are used during the installation, the conditions can be met.
☑ Do not exceed 6 directional change for one 90° turn.
☑ Bending radius R ≥ 8 · d must be maintained.
☑ The protective conduits must cover the entire length of the pipe.
☑ If installing in a cavity: Pipes must be secured properly, especially in the areas where directional changes take place.
☑ Make sure to prevent dirt from settling between the protective conduit and the inner pipe.

7.4 Installation in a pipe shaft, basement distributor and riser pipes

☑ Compliance with the general requirements for installing pipes is mandatory.

Change in length, bending and 2D expansion loops, fixed and floating points
☑ When installing, observe the change in the length of the pipes, the resulting flexible pipe leg and 2D expansion loop, and the required fixed points.

7.5 Installation on top of a concrete ceiling

☑ Compliance with the general requirements for installing pipes on concrete ceilings is mandatory.

8 Attachment

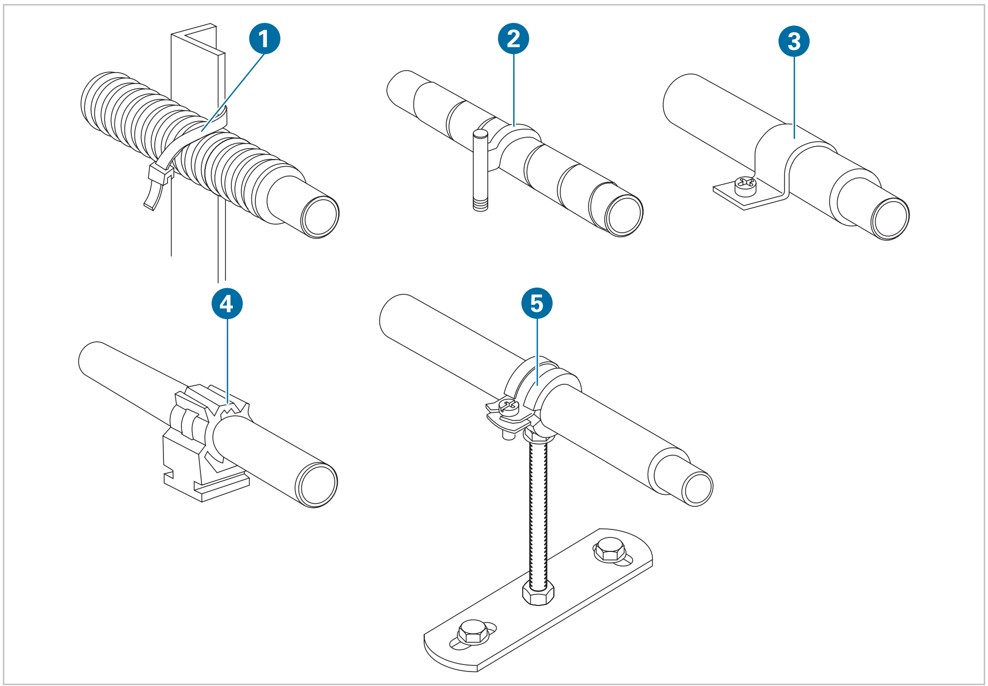
Pipeline attachment

General information:

➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [13] 'Installation and attachment'

8.1 Attachment components

JRG Sanipex installations can be installed using attachment components from our systems or with commercially available fasteners.



GV.23
Pipe attachments

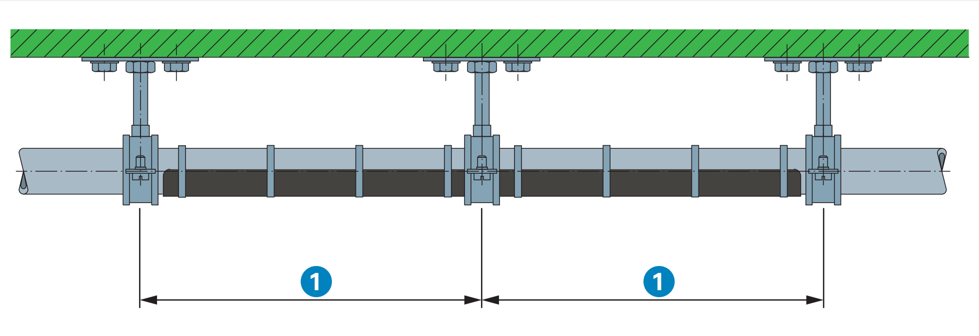
1. Pipe binders
2. Dowel hooks
3. Pipe clip
4. Pipe clips
5. Pipe clips

8.2 Attachment using pipe clips

In general, Sanipex pipelines **do not** require pipe saddles or protective conduits. However, when **PE-X pipes** are installed in **plain view**, it is recommended to use them.

NOTE! Damaged pipes due to eexcessively spaced mounting distances!
Excessive spacing between the attachments can lead to deformation and weakening of the material as well as vibrations (formation of noise).

☑ Mounting distances **(BA)** must be maintained.
☑ Observe the change in length and allow for appropriate expansion compensation.



GV.24
Mounting distances (BA)
1 Mounting distance

TV.40
Mounting distances (recommended)

Pipe, Dimension		BA [m]	
d	DN	PE-X pipe	with pipe saddle
12	8	1.0	1.5
16	12	1.0	1.5
20	15	1.0	1.5
25	20	1.0	1.5
32	25	1.5	2.0

Attachment when installing “pipe-in-pipe”

NOTE! Noise emissions due to pressure surges!
Pressure surges on quick-action fittings can cause noise emissions.
→ When using a “**pipe-to-pipe**” **installation** made of JRG Sanipex pipelines, appropriate precautions must be taken.

Recommendation for mounting distance
Moreover, we recommend a maximum mounting distance of 60 cm when installing with a protective conduit (“pipe-in-pipe” installation).

☑ Ensure the pipes do not kink.

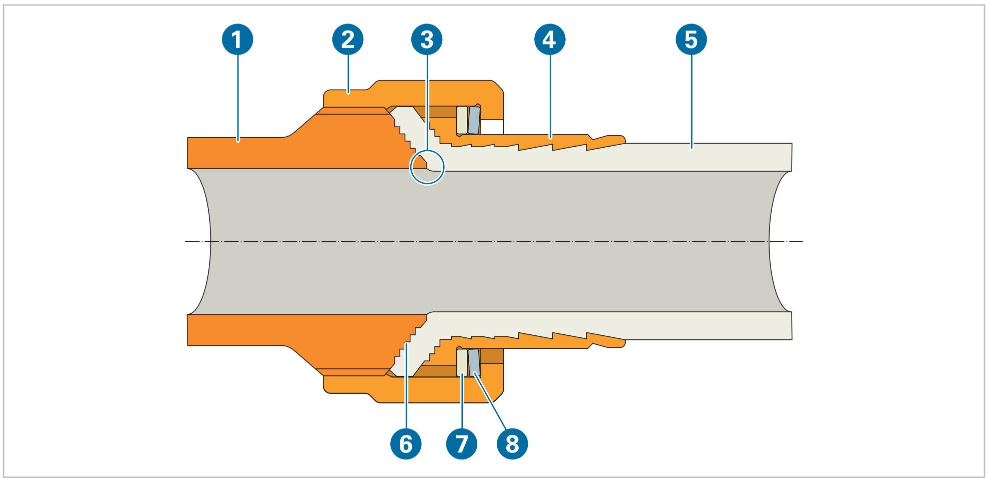
9 Connection

Jointing technology
General information:
➡ Part III 'The basics', Section 'Materials and jointing technology'

9.1 Crimped clamping connection

The JRG Sanipex crimped clamping connection is a secure, dead-space-free connection without stiffeners required at maximum flow. The connections can be released again at any time and do not require additional sealing material.

JRG Sanipex crimped clamping connection comprises the following components:



GV.25
JRG Sanipex crimped clamping connection

1. JRG Sanipex fitting (gunmetal)
2. Coupling nut (brass)
3. Without dead space
4. Clamping ring
5. PE-X pipe
6. Jointing face
7. Sliding washer
8. Belleville washer

The JRG Sanipex crimped clamping connector is mounted on the PE-X pipe with the circlip pliers and then bolted to the fitting with the ratchet torque wrench. The sliding washer prevents the inner pipe from rotating when tightened.

The Belleville washer ensures even pressure on the dead space-free jointing face.

10 Assembly

JRG Sanipex pipes (d12 – d20) can also be connected to JRG Sanipex fittings.

☑ Compliance with the tool's operating instruction is mandatory.

☑ Ensure the assembly tools are working properly.

WARNING! Risk of injury due to incorrect operation of the shears.
If operating the combination shears improperly, there is a risk of injury in the area of the shear's end stops.
→ Use tools only as shown in the operating instructions.

NOTE! Leaks in the pipe and water damage due to cutting to the incorrect length!
→ Ensure the pipe end is cut straight.
→ Ensure the pipe end is not out-of-round.

The individual assembly sequences for different dimensions are shown on the following pages.

10.1 Assembly – Pipes d12 – d20

The individual steps are illustrated on the next page.

Assemble pipes d12 – d20

Cutting the pipe

① → Use the combination shear to shorten the protective conduit and PE-X pipe.

② → Determine the length of the protective conduit that must be shortened.
The optimal length is about 5 cm of the pipe to be connected (distance × between the pin of the combination shear and the handle end).

③ → Cut protective conduit to length, using the pipe cutter integrated in the handle of the combi-scissors.
↳ The PE-X pipe is shortened.
→ Inspect pipe.
- "OK" = correct / "NO" = wrong

Installing the crimped clamping connector

④ → Open the clamping lever and the operating lever of the circlip pliers.
→ Push the crimped clamping connector over the mandrel of the circlip pliers so that the screw thread points in the direction of the mandrel (in the picture to the right). For this, note the illustration on the inside of the pliers.

⑤ → Guide the PE-X pipe up to the mandrel of the circlip pliers.
→ Close the clamp lever of the circlip pliers.
↳ The PE-X pipe is attached in place.

⑥ → Close the operating lever of the circlip pliers.
↳ The PE-X pipe is connected to the crimped clamping connector.

! NOTE! After expanding JRG Sanipex pipes made of PE-X, the connection must be completed immediately.

⑦ → Open the operating lever of the circlip pliers.
↳ The crimping screw connection is released.
→ Remove PE-X pipe.
↳ The PE-X pipe can be mounted on a fitting with a JRG Sanipex connection.

Check crimped pipe end

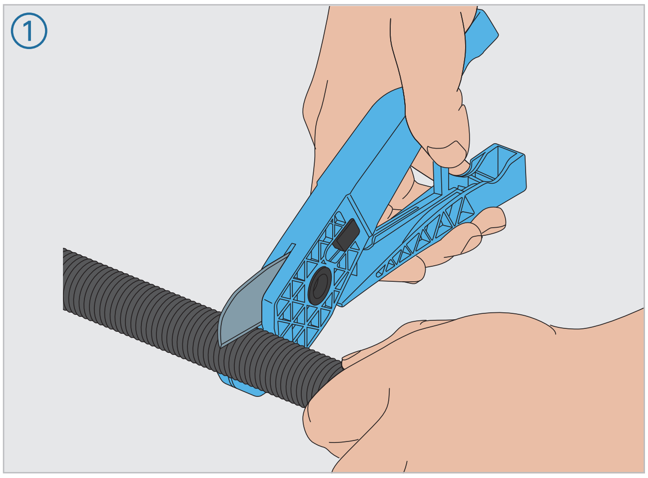
⑧ → Check dimension x.
The dimension of the established connection must not be less than ×.
- d12 × 1.7: 2.5 mm
- d16 × 2.2: 3.0 mm
- d20 × 2.8: 3.5 mm

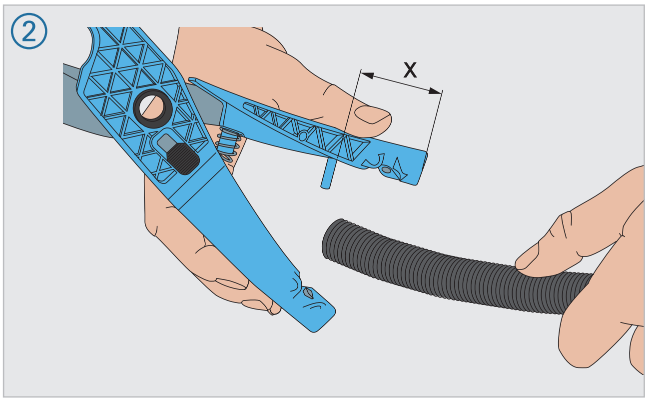
→ If the dimension x is too short: Check circlip pliers.

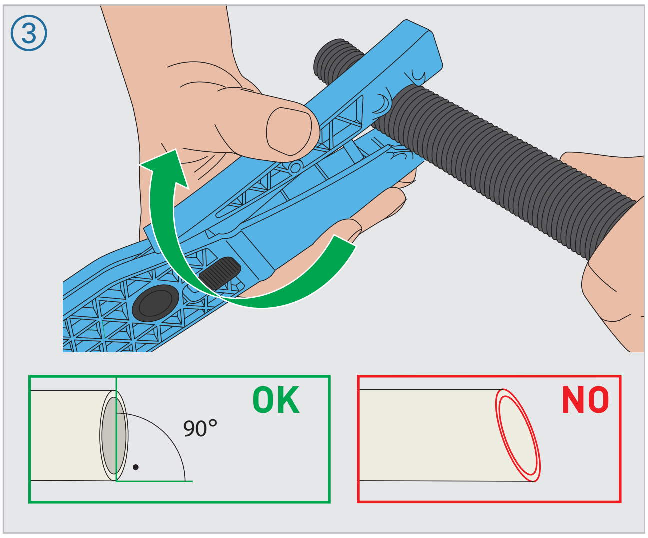
Assemble pipe to fitting

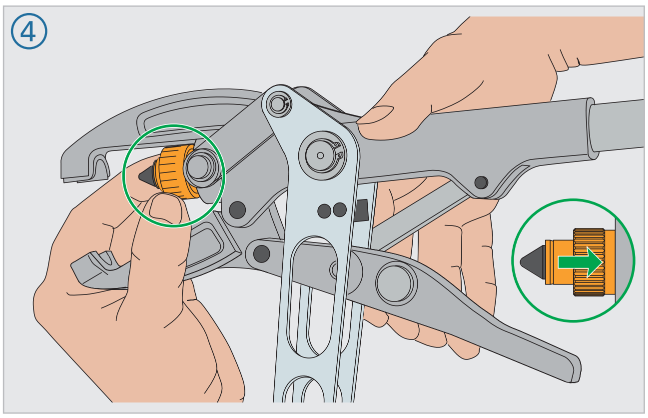
⑨ Der JRG Sanipex ratchet torque wrench is used exclusively for tightening JRG Sanipex crimped clamp connectors. The torques are permanently set at the factory.
→ Screw the crimped clamp connector onto the fitting manually.
→ Tighten the threaded connection using the ratchet torque wrench until a “click” can be felt and heard.
→ Mark finished connections with the marking pen.

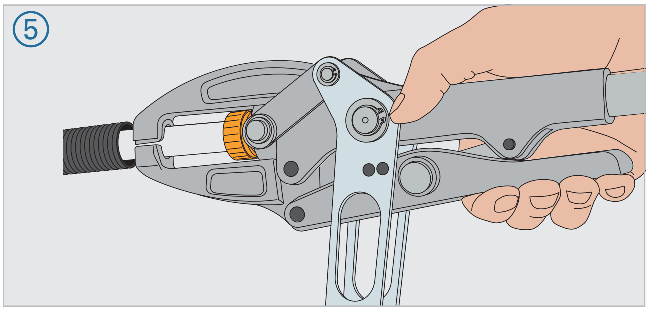
Assembly – Assembling pipes d12 – d20

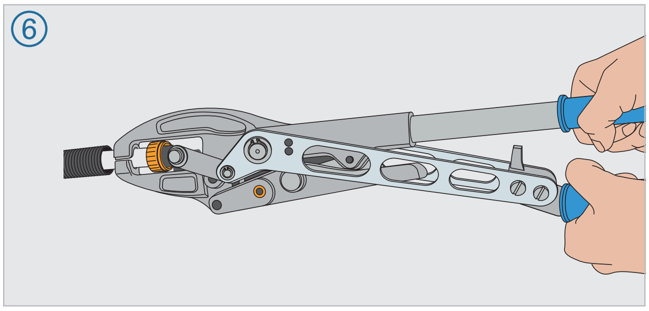


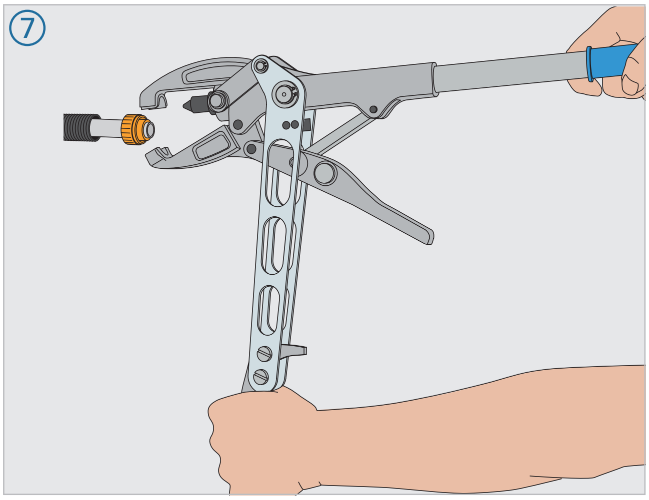


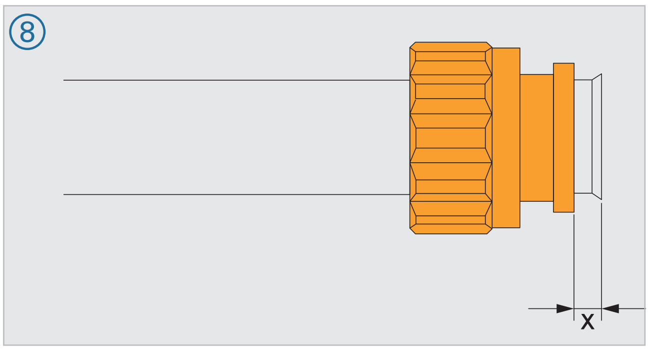


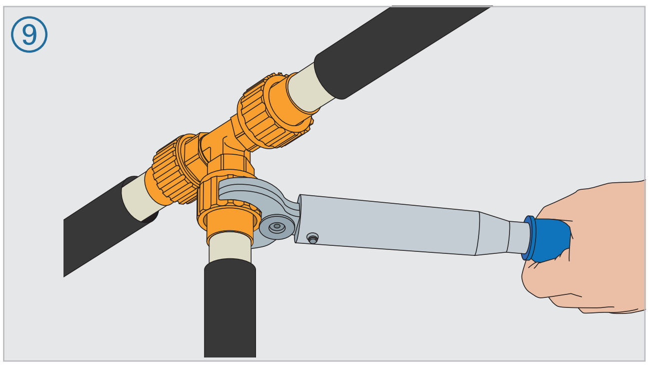












10.2 Assembly – Pipes d25 – d32

The individual steps are illustrated on the next page.

Assemble pipes d25 – d32

Cutting the pipe

① → Use pipe cutter to cut PE-X pipe.
→ Inspect pipe.
- "OK" = correct / "NO" = wrong

Installing the crimped clamping connector

② → Use the torque wrench to hold the JRG Sanipex crimped clamping connector.
→ Screw the turn up device into the crimping clamp connector.

③ → Use the L-key to hand-tighten the turn up device while canting it slightly.

④ → Hold the end of the pipe with pipe wrench.

⑤ → Use the turn up device to screw the JRG Sanipex crimping clamp connector as far as will go onto the cut pipe end (right-hand thread).
→ Use the L-key to unscrew the turn up device again.

⑥ → Rotate the turn up device and screw it into the crimping clamp connector manually.

⑦ → Use the torque wrench to hold the crimped clamping connector.
→ Use the L-key to tighten the turn up device again.

Check crimped pipe end

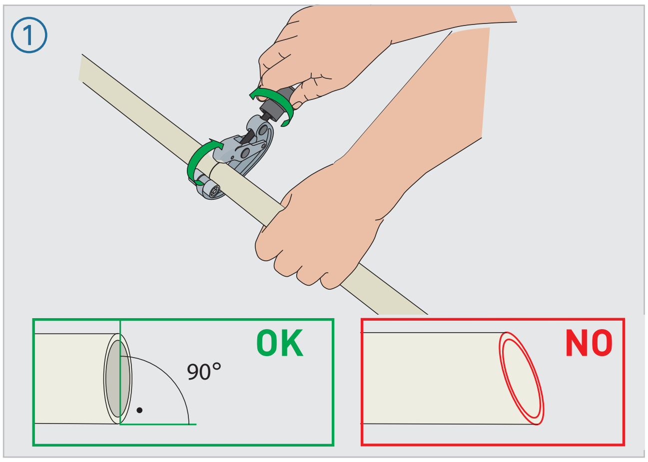
⑧ → Check dimension **x**.
The dimension **x** of the established connection must not be less than the value **×**.
- d25 × 3.5: 4.0 mm
- d32 × 4.4: 6.0 mm

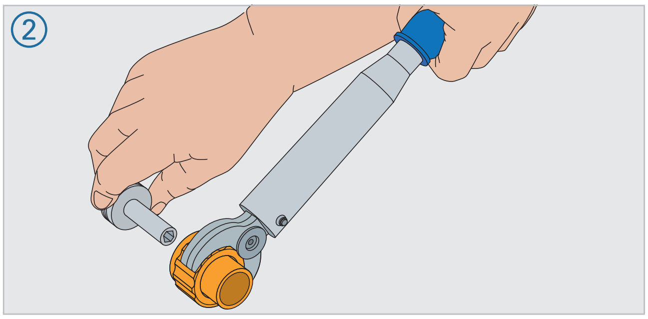
→ If the dimension **x** is too short: Check circlip pliers.

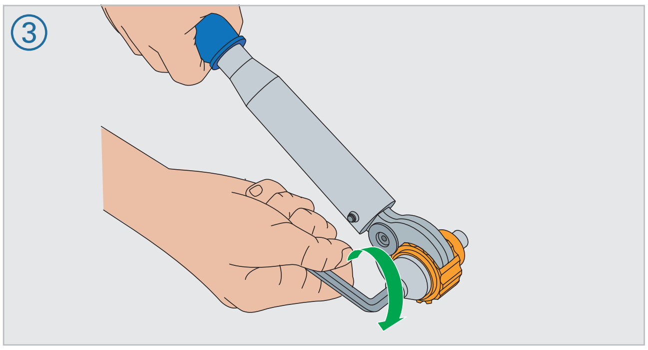
Assemble pipe to fitting

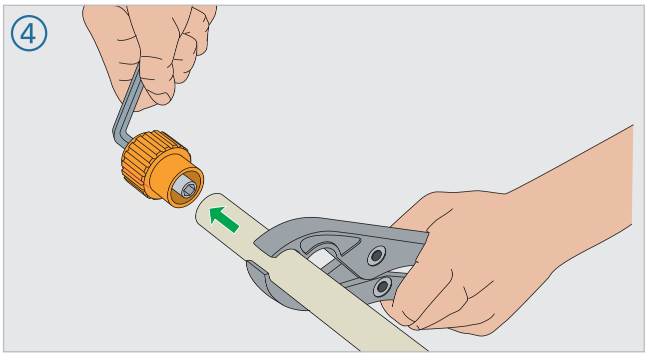
⑨ Der JRG Sanipex ratchet torque wrench is used exclusively for tightening JRG Sanipex crimped clamp connectors. The torques are permanently set at the factory.
→ Screw the crimping clamp connector onto the fitting manually.
→ Use the torque wrench and the open-end spanner to tighten the threaded connection until a “click” can be felt and heard.

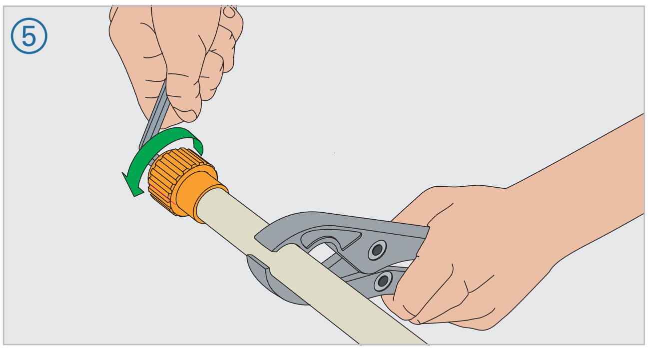
Assembly – Assembling pipes d25 – d32

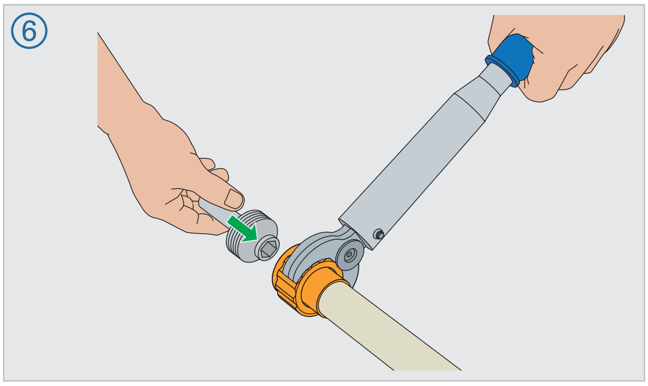


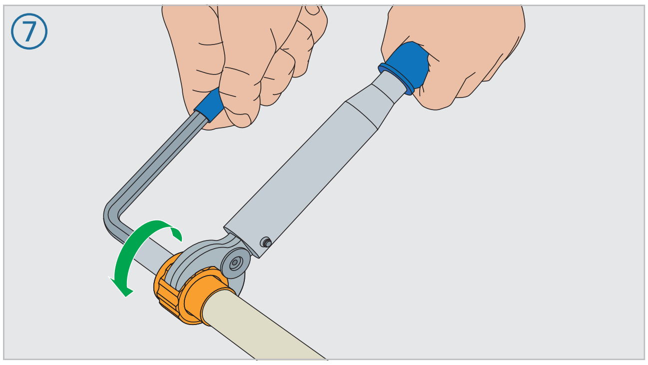


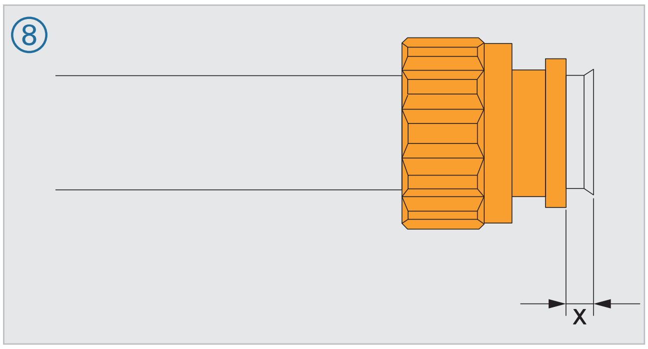


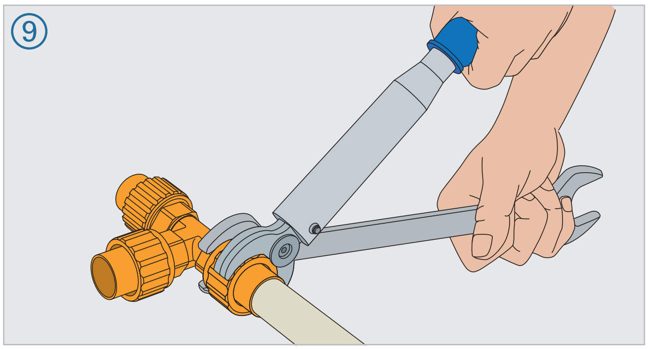












11 Bending

JRG Sanipex pipes can be bent by hand without the use of bending tools.

☑ Compliance with minimum bending radii listed to the table is mandatory.

TV.41 **Minimum bending radii**

Designation	PE-Xa, PE-Xc				
Nominal width DN [mm]	8	12	15	20	25
Outside diameter d_a [mm]	12	16	20	25	32
Bending radius R, not interchangeable: $5 \cdot d_a$ [mm]	60	80	100	125	160
Bending radius R, interchangeable: $8 \cdot d_a$ [mm]	96	128	160	200	256

NOTE! Risk of damaging the pipes due to improper bending!

→ Ensure the pipes do not kink when bending them.

12 Fittings – Combinations – Dimensions

Since the **z dimension method** is usually **not** used when working on the pipe-in-pipe installation, it is not necessary to specify the centre-to-centre distance for special fitting combinations.

The exact dimensions of the fittings are included in the delivery program.

Build

JRG Sanipex MT

V

JRG Sanipex MT

Overview

This chapter contains basic information about the JRG Sanipex MT system.

Additional technical and sales information

- For more information on the use and connection of other system components, piping and controls and instruments, see the chapters applicable to the appropriate systems.
- More technical information about this system and ordering information can be found on the GF website and in the sales catalogue.

1 System overview

1.1 System description

JRG Sanipex MT is an installation system made of cross-linked PE-X multilayer composite pipes and fittings. The fittings are manufactured in a special two-layer plastic injection moulding process. Transition fittings and system instruments are made of gunmetal. All materials are benign, hygienically clean and comply with the applicable legal requirements.

The JRG Sanipex MT system is characterised by its high corrosion resistance. The design of the pipe connection is free of dead spaces and, in addition to multiple safety features, the system offers full flow capacity without cross-sectional constriction. JRG Sanipex MT threated connections are detachable and reusable.

The special tools reduce assembly times.

JRG Sanipex MT	Description
Pipe dimension	d16, d20, d26, d32, d40, d50, d63
Application area	Cold and hot water, HVAC, compressed air, greywater
Installation	Surface and flush-mounted installations throughout the building
Pipes	Multilayer composite pipes and pipes made of cross-linked polyethylene
Fittings and system parts	Gunmetal and plastic
Method	Crimped clamping connection

1.2 Approvals and quality assurance

The JRG Sanipex MT system is subject to constant control by internal and external authoritative bodies. These inspections range from quality assurance during production to ISO certification for environmental and process safety. The JRG Sanipex MT system meets the requirements for the most important applications in the building technology and is subject to constant monitoring by the licensing offices for drinking water, heating and compressed air installations on land and sea.

System approvals
General information:
➨ Annex A , Section 'Approvals'
Up-to-date information on system approvals is available from Technical Support.

1.3 Scope and application areas

The installation system JRG Sanipex MT is intended for the following applications:

- Drinking water installations in the cold and hot water area
- Heating and air conditioning installations (only with diffusion-proof pipe)
- Greywater installations (rainwater, etc.)
- Compressed air installations

The system is suitable for distribution lines, riser pipes and connection pipelines in single and multi-family dwellings as well as in sanitary, heating and compressed air installations of large objects.

Potential equalisation

The installation of the system is not a conductive metallic pipework. The installation cannot be used as a grounding conductor for electrical installations.

☑ The installation must **not** be used for potential equalisation purposes and must **not** be used as an earth connection.

§ **Responsibility for potential equalisation**
The installer of the electrical system is responsible for the correct implementation of the equipotential bonding.

DHW heaters

It is feasible to connect the system to **DHW heaters** without a metallic connection. In this case, restrictions do not apply if the water temperatures never exceed 70°C.

The use in conjunction with **flow DHW heaters** is permitted. However, only the manufacturer of the device is authorised to approve the use of the tankless water heaters.

☑ Compliance with the manufacturer's instructions for the devices is mandatory.

Protection of piping materials and connections

☑ If using flow DHW heater: Only use **thermostats** or **safety temperature limiter**, which ensure that the water temperature of 95°C is not exceeded at any point or at any time – not even when reheating.

☑ When using hydraulically controlled devices: Ensure that the **automatic switch-off** does not permit any pressures above min. 10 bar, even in case of the reheat effect.

Recommendation
If the temperature cannot be kept below 95°C or in older hydraulically controlled, electrically or gas-fired instantaneous water heaters, where the temperatures cannot be reliably maintained below 95°C, the following shall apply:
☑ A metallic connection with a length of at least 1.0 m shall be provided.

Fire extinguishing systems

When installing fire extinguishing pipes and sprinkler systems using JRG Sanipex MT system components:

☑ Compliance with local regulations and fire protection requirements is mandatory.

1.4 Properties and requirements

Service life limitation applicable to the installation
The water quality (pH value), the water constituents, as well as the operating conditions can have a direct influence on the service life of the installation, especially if chlorinated waters are being used.

1.4.1 Materials

Materials polyethylene (PE-X), polyphenylsulfone (PPSU), gunmetal and EPDM
Detail information:
➨ Part III 'The basics', Section 'Materials and jointing technology'

1.4.2 Hygienic properties

Verification of the system's hygienic safety is provided. The test certificate issued by the DVGW-Technologiezentrums Wasser – TZW (the German Water Centre – as part of DVGW e.V., the German Gas and Waterworks Association) proves that the plastic components comply with the KTW (official German recommendation concerning the levels of polymers in drinking water) recommendations by the German Federal Health Agency, the specifications of the Umweltbundesamtes (UBA) (Federal Environmental Agency) in Germany and the basic requirements of the Federal Food Control Institute according to ÖNORM B 5014, Part 1.
This also applies to other institutions in the field of building technology and the shipbuilding industry, for example, ACS, SINTEF, BS 6920 and KIWA/ATA.

All plastic and metal components are continuously inspected in accordance with the recommendations mentioned above in order to ensure they meet national and international requirements, such as the DVGW worksheet W270.

Test certificate issued by the Fraunhofer Institute for the JRG Sanipex MT system
According to the test, all connecting parts of the system demonstrably fulfil the criteria of asepsis (dead space clearance: 0 KBE/cm^2).

1.4.3 Chemical resistance

The system exhibits a high chemical resistance to all natural drinking water substances (acc. to DIN 2000 and TrinkwV 2001), against disinfectants and cleaning agents (acc. to DVGW-Arbeitsblatt W291) and against corrosion inhibitors (acc. to DIN 1988, Part 4).

In addition to the utilisation for drinking water, the system can also be used for the liquid and gaseous media mentioned in [TV.1].

Suitability of the system
However, the suitability of the system is not limited to the defined chemical resistance mentioned above, but also depends on the use of the appropriate medium.
The characteristics of the medium may be changed by the pipes and fittings.

TV.1 **Media**

Medium	Classification	Max. operating temperature [°C]	Max. operating pressure [bar]
Drinking water	Cold water	0 – 20	
	Hot water	20 – 70*	
Heating water	–	0 – 70*,**	
Softened water	pH neutral (0°fH)	0 – 70	
Rain water	pH value >6.0	0 – 40	
Osmosis treatment***	–	0 – 70	
VE water***	desalinated	70	
Cooling water****	40 Vol.% ethylene glycol, Antifrogen®, ethyl alcohol	–25 – 40**	
	25 Vol.% propylene glycol	–10 – 40**	
	Saline solutions	–20 – 40**	10
Disinfectant solution*****	ready for use	40	
Compressed air	Class 1 acc. to DIN ISO 8573-1 • Residual oil content: 0.01 mg/m³ • oil and fat free	0 – 40	
	Class 2 and 3 acc. to DIN ISO 8573-1 • Residual oil content: 1.0 mg/m³ • Residual water content: 0.88 mg/m³ • Dew point: -20°C • low in oil and fat	0 – 40******	
Nitrogen	–	0 – 40******	
Vacuum	–	40	-0.8 p_a ≈0.2

* Short term peak temperature of 95°C during max. 150 h/a
** Only permissible with oxygen diffusion-tight pipes
*** Brass and gunmetal fittings release small amounts of metal ions into osmosis-treated water. If ion-free water is desired, additional treatment at the tap is required or RG fittings with epoxy coating inside (JRG Sanipex MT up to 30°C) should be used.
**** Higher concentrations must be requested.
***** Concentrations must be requested.
****** Not suitable for PB pipes

Requests concerning resistance in special cases

If the system must be used for applications or concentrations exceeding the values in the table, the resistance of the materials etc. must be checked and approved by GF JRG. The following information is required in advance for testing and approval:

- Product and safety data sheet of the medium
- Operating temperature and pressure
- Concentration, exposure time, frequency and flow rate of the medium (even a sample, if required)

The use of the system for **medical gases** is **not** recommended.
Medical gases include gases that meet the requirements of the European Pharmacopoeia or which are anaesthetic gases, medical oxygen or medical carbonic acids. All of the above are approved according to the drug regulations as finished medicinal products.

1.4.4 Fire protection

Fire protection
General information on fire protection:
➨ Part IV 'Plan', Section 'Insulation, Fire protection'

Fire protection
Up-to-date information on fire protection for the system, including information on solutions, applications and product properties, can be found in the brochure **“Planungshilfe Rohrabschottung” (Planning aid pipe sealant)**.

§ **Country-specific regulations**
Fire protection may be regulated differently in each countries by laws, directives, ordinances, standards, regulations and bulletins.
☑ Compliance with the local fire protection regulations is mandatory.

Fire protection - solutions with Sanipex MT

Solutions for fire protection with Sanipex MT
Solutions and products for fire protection with Sanipex MT can be found here:
➨ Chapter [6] 'Fire protection'

1.4.5 Soundproofing

The basics

Water pipes do not generate any noise if the nominal pipe dimension, design, fastening method and operation are correct. There are no test regulations specified in standards or other directives to determine or assess the noise behaviour in drinking water systems.
Plastic piping systems exhibit advantages over metal pipe systems due to their corrosion resistance and flexibility.
By default, drinking water systems are designed so that the volumetric flow is 2 m/s for distribution lines (standard value, which is and may only be exceeded for certain line sections) and max. 4 m/s for discharge lines is maintained. These are flow velocities at which the inherent noise of the pipelines comparted to the noise generated by the fittings or other ambient noise is not noticeable. However, the noises resonating from sanitary equipment and fittings are being transmitted. Therefore, sound insulation – which absorbs the structure-borne noise reverberating from the building – must be added to the system components.

JRG Sanipex MT

The JRG Sanipex MT installation system is compliant with the requirement of DIN 4109 and SIA 181 (6.2006). However, this implies that the installation must be carried out according to the recognised rules of technology and the installation instructions.

1.4.6 Insulation

Insulation
General information on insulation:
➨ Part IV 'Plan', Section 'Insulation, Fire protection'

Country-specific regulations
The insulation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.
☑ When it comes to insulation methods, compliance with the applicable rules and regulations is mandatory.

The basics

Insulation recommendations
If local specifications do not apply, the following instructions shall be considered as minimum requirements. A protective wrapping shall be wrapped around the pipelines, a thin insulating hose or a protective conduit shall be used. For most systems, a **pre-insulated** design (e.g. with 6 mm thick insulation) is available.

☑ Piping systems must always be insulated in order to prevent heat loss and/or heat absorption.
- Cold water pipes; Preventing condensation, DHW heating and sound transmission
- Hot water, circulation and heating pipes: To reduce heat loss, absorb expansion and prevent sound transmission

☑ Select the insulation or sheathing according to the respective field of application.
☑ Ensure that the insulation does not cause corrosion to the piping materials.

Soundproofing
☑ The soundproofing may be subject to special requirements. Ensure that these potential prerequisites are considered in the design of the insulation.

Hygiene
Applying insulation to cold water pipes, for example, in order to prevent them from heating can improve the hygiene and help reduce the risk of legionella.

Planning fundamentals
The EnEV (German Energy Saving Ordinance) or DIN 1988 in Germany or the model regulations of the cantons in the energy sector (MuKEn) in Switzerland are available in the current version with comprehensive, detailed and practice-oriented documents. They are equally valid for new constructions, renovations and modernisations.

Insulation according to EnEV 2017

Insulation according to EnEV 2017
Solutions and products for insulation according to EnEV can be found here:
➨ Chapter [5] 'Insulation according to EnEV 2017'

1.4.7 Protecting the installation

System components installed flush with the wall or walled in

Pipe installations flush with the wall are lines that are not easily accessible, for example, inside an in-wall installation, in a wall slot or in the concrete floor.

☑ Fittings and pipes must be insulated with a suitable material in order to absorb thermally induced changes in length, to prevent the transmission of sound, to preclude the formation of condensation, heat emission, heat loss or heating of the medium and other influences caused by building materials.

☑ Piping system and building structure must be separated from each other, for example, by using protective conduits made of PE, wrappings, insulating hoses or half shells with and without sheathing or a combination thereof.

☑ All system components must be protected from direct contact with oils, greases, solvents, solvent-based adhesives (adhesive tapes), foams, bitumen (also bituminous membranes). Furthermore, the components must not contact building materials such as screed, concrete, mortar or plaster.

Protection against environmental influences and building materials

Special measures apply to the following rooms:

- permanently or periodically wet rooms
  - Slaughterhouses, butcher shops (pressure washer)
  - Carwash
  - Tiled shower stalls, spa areas
  - Commercial kitchens
  - Rooms with risk of external water ingress
  - Swimming pools, sauna
- Areas subject to offensive gases or aggressive environments
  - Stables (ammonia)
  - Dairy factories/cheese dairies (nitric acid)
  - Swimming pools/swimming pool centres (chlorine, hydrochloric acid)
- Areas subject to uncontrollable environmental influences

Due to the moisture permeating the building materials and the resulting permanent wetness (e.g. in public showers and baths or commercial wet rooms), it is possible for an aggressive environment to form around the pipe.

☑ Appropriate precautions must be taken to protect the installation, e.g. by using the following measures:
  - Use of suitable anti-corrosion tapes (e.g. supplied by KEBU, Gyso or DENSO)
  - Wrapping the pipe with heat-shrinkable materials

☑ Ensure that pipes and fittings are dry when mounting.

Protection from UV radiation

☑ Appropriate precautions must be taken in order to prevent the installation from permanent exposure to UV rays.

When using the pipe-in-pipe system with protective conduit, this will ensure sufficient UV protection.
Sheathing with insulating material can assume the function of UV protection.

☑ Pipes and fittings must be shielded from direct sunlight and UV radiation.

☑ During transport and storage: Pipes and fittings must be covered after they have been removed from the original packing.

Protection against aggressive waters

Recommendation

☑ In areas with particularly aggressive waters: Installations must be easily accessible.

☑ Distribution lines in the single tap system (pipe-in-pipe) must be designed and installed such in order to ensure system components can be replaced at any time without damaging the building's structure.

1.4.8 Disinfection procedure

Disinfection
General information on common disinfection procedures:
➨ Part VI 'Operate', Chapter [4] 'Disinfection'
Information on the hygiene concept used at GF:
➨ Part II 'Plan – Build – Operate', Chapter [4] 'Disinfection'

Chlorine dioxide

The use of chlorine dioxide for chemical disinfection can severely limit the lifetime of the entire drinking water installation. Before implementation, the conditions must be recorded on site.

The water quality (pH value), the water constituents, as well as the operating conditions can have a direct influence on the service life of the installation, especially if chlorinated waters are being used.

1.5 Safe application and processing

☑ Only use the product as intended and in accordance with the defined areas of application and usage.
☑ Check compatibility of medium and material.
☑ Do not use the product if it is damaged or defective. Damaged product must be removed immediately.
☑ Use only approved accessories.
☑ Only trained personnel shall be permitted to assemble the product and accessories.
☑ All personnel shall be instructed on all applicable issues of local occupational safety and environmental regulations, in particular for pressurised piping. These instructions must be held on a regular basis.
☑ Compliance with the valid standards for drinking water and greywater installations as well as compliance with the regulations of the system manufacturer is mandatory.
☑ Compliance with the local water supply regulation is mandatory.
☑ Make sure that the piping system is installed correctly and inspected regularly.
☑ All installations must comply with the instructions specified in the technical documentation of the product.
☑ Compliance with the operating, maintenance and assembly instructions of the tools is mandatory.
☑ Tools must be used as intended and must not be applied for other purposes.
☑ When assembling the JRG Sanipex MT installation system, only JRG Sanipex MT mounting tools must be used.

Combination of JRG Sanipex MT with JRG Sanipex

In conjunction with JRG Sanipex MT, pipes of the JRG Sanipex system can also be used.

1.5.1 Transport and storage

For hygienic reasons, all openings in pipes, fittings, controls and instruments must be closed until final assembly.
☑ Ensure to protect the product against external force (shock, impact, vibration, etc.) during transport.
☑ Transport and/or store the product in unopened original packing.
☑ Protect the product from dust, dirt, moisture, heat and UV radiation.
☑ Ensure that the product is not damaged by mechanical or thermal influences.
☑ Before proceeding with the assembly, inspect the product for damage that may have occurred during the transport.

1.5.2 Installation and assembly

The JRG Sanipex MT System is suitable for the following types of installation:

- Surface or flush-mounted installations
- Installation in shafts and channels, on ceilings and on floors
- Installation in-wall, element, wood and lightweight constructions
- Installation in concrete (in the pipe-in-pipe system, with PE-X pipes)

1.5.3 Acceptance and putting into operation

§ **Country-specific regulations**

Acceptance and putting into operation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.
☑ When it comes to acceptance and putting into operation, compliance with the applicable rules and regulations is mandatory.

Acceptance, pressure test, flushing and putting into operation

General information and master copies of the test reports:
➨ Part V 'Build', Section 'Putting into operation'

1.5.4 Operation, maintenance, servicing, repair and decommissioning

☑ To ensure trouble-free operation: Check installation and all control and safety fittings regularly.

Risk of injury due to pressure or explosion!
If the system is not completely depressurised, media may escape uncontrolled from the installation.

☑ Before removal, maintenance, disassembly: Pipeline must be completely depressurised.
☑ If harmful, combustible or explosive media is used: Completely empty and flush the pipeline before disassembling it. Look for potential residues.
☑ Use appropriate measures to ensure the medium is collected properly.

Risk of injury due to media harmful to health and the environment!
Risk of personal injury or environmental damage due to uncontrolled escape of hazardous media.

☑ During maintenance, servicing, repair and decommissioning, prescribed protective clothing must be worn.
☑ Compliance with the media safety data sheets is mandatory.
☑ Collect leaking media and dispose of according to local regulations.

Risk of injury due to the use of unsuitable spare parts!
Damage to the installation and risk of injury.

☑ Only use replacement parts from the current product range during the installation and repairs.

1.5.5 Disposal

The entire JRG Sanipex MT product range is made from environmentally friendly and recyclable materials.

§ **Country-specific regulations**
Disposal and recycling may be regulated differently in each country by laws, ordinances, standards, regulations, and bulletins.

☑ When disposing of or recycling the product, the individual components and the packaging, compliance with the local regulations is mandatory.

☑ Before disposing of individual materials, they must be separated according to their recyclability, and whether these materials are considered normal waste or special waste.

2 System components

The JRG Sanipex MT installation system consists of multilayer composite pipes as well as plastic fittings and gunmetal. In addition, there are controls and instruments with direct transition to the system.

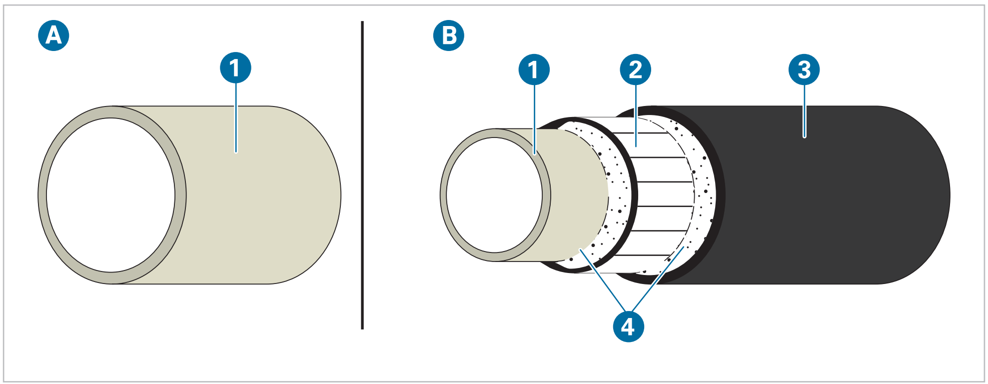
2.1 JRG Sanipex MT Pipes

The JRG Sanipex MT multilayer composite pipes consist of several layers. These multilayer composite pipes are available pre-cut, in coils and in various designs (e.g. with insulation or in a protective conduit). Inside there is a hygienic, medium-carrying layer of radiation-cured polyethylene (PE-Xc). The outer layer, which protects the pipe from mechanical stress, is also made of PE-X. Between the outer layer and the pipe is an aluminium support conduit, butt-welded longitudinally. A bonding agents, also based on PE, permanently joins the other two layers. In addition, the aluminium layer eliminates the otherwise negatively perceived longitudinal expansion properties and short mounting distances in plastic pipes and makes the pipe resistant to bending. In addition, the pipe is thereby oxygen diffusion-tight.

Processing JRG Sanipex pipes
JRG Sanipex PE-X pipes can also be processed in the dimensions d16 to d25.

2.1.1 Pipe construction and pipe labelling

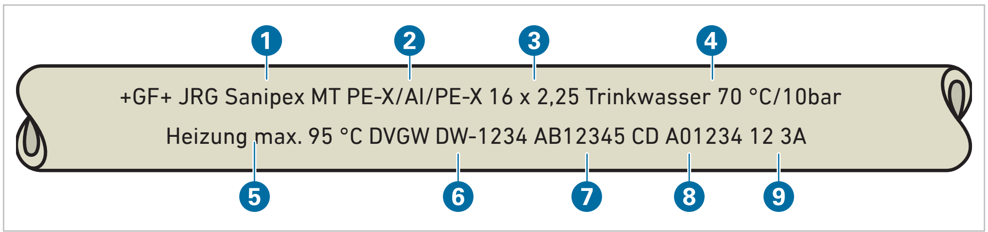
The pipes for the JRG Sanipex MT system are designed as illustrated below.



GV.1
Pipe design
A 100% plastic pipe
1 PE-X pipe

B Multilayer composite pipe
1 Inliner (PE-X)
2 Aluminium pipe
3 Outer coating (PE-X)
4 Bonding agent

The pipes are marked as follows.



GV.2
Pipe marking

	Labelling (example)	Meaning
1	JRG Sanipex MT	Product name: Company name and system name
2	PE-X / Al / PE-X	Material code
3	16 × 2.25	Dimension: Outside diameter x wall thickness
4	70°C / 10 bar	Medium: Operating temperature/max. operating pressure
5	max. 95°C	Heater: max. temperature
6	SVGW-.. / DVGW XX-123.. / ÖVGW X1.123..	Approval(s) and number(s)
7	AB 12345	Production location and production date
8	CD A01234	Order number
9	12 3A	Internal factory code

2.1.2 Technical data

JRG Sanipex MT

Feature	Pipe	Multilayer composite pipe (PE-X / Al / PE-X)
Conditions in continuous operation		70°C, 10 bar (50 years)
Max. operating temperature [°C]		95 (briefly)
Max. operating pressure [bar]		10
Surface roughness k [mm]		0.007
Material constant C		33
Coefficient of thermal expansion α [mm/(m·K)]		0.024
Thermal conductivity [W/(m·K)]		0.43
Oxygen-tightness		acc. to DIN 4726
Processing temperature [°C]		up to −20
Density [kg/dm³]		~0.95
Fire code		CH: IV.2 (VKF)
Building material class		D: B2 (DW 4102) / E (DW 13501-1)

Feature	Dimension	d12	d16	d20	d25	d32	d40	d50	d63
Nominal width DN [mm]		8	12	15	20	25	32	40	50
Outside diameter d_a [mm]		12	16	20	26	32	40	50	63
Wall thickness s [mm]		1,7	2.25	2.5	3	3	3.5	4	4.5
Internal diameter d_i [mm]		8,6	11.5	15	20	26	33	42	54
Weight [g/m]		69	134	185	285	393	605	886	1265
Cross section inside A [cm²]		0,58	1.04	1.77	3.14	5.31	8.55	13.50	22.90
Volume [l/m]		0,06	0.104	0.177	0.314	0.531	0.855	1.350	2.230
Fire load [MJ/m]		2,10	3.36	4.54	7.42	8.23	12.14	16.83	21.18
Bending radius	**Dimension**	d12	d16	d20	d26	d32	d40	d50	d63
Bending radius R, with tool: 3.5 · d_a [mm]		–	56	70	91	112	140	176	221
Bending radius R, manually: 5 · d_a [mm]		60	80	100	–	–	–	–	–
Mounting distance	**Dimension**	d12	d16	d20	d26	d32	d40	d50	d63
Mounting distances [mm]		1	1	1	1.5	2.0	2.0	2.5	2.5
Assembly with pipe saddles [m]		–	–	–	2	2	3	3.5	3.5
Assembly under increased mechanical load (with additional stabilisation) [m]		1	1	1	1.5	2.0	2.0	2.5	2.5

Protective conduits

Feature	Pipe	PE pipe
Density [kg/dm³]		~0.95
Tensile strength [N/mm²]		~25
Temperature resistance [°C]		100
Melt flow index		MFI 190/5: 0.4 g/10 min
Elongation at break [%]		600
Thermal conductivity [W/(m·K)]		0.45

Feature	Dimension	d16	d20
Outside diameter d_a [mm]		25	29
Internal diameter d_i [mm]		20	23

2.2 Fittings

All fittings in the JRG Sanipex MT assortment, which do not require a metallic sealing thread, are manufactured in a special two-layer plastic injection moulding process. That is to say, the fittings are produced as a fitting-in-fitting unit. The medium-conducting, white inner layer, consists of the high-performance plastic polyphenylsulfone (PPSU). This material, which is known for its low susceptibility to cracking and excellent resistance to hot water, has proven to be well-suited for mouldings in building technology and is characterised above all by excellent corrosion resistance and low incrustation. The extremely rugged design, that is to say, the special impact resistance and impact strength are just as natural as the excellent resistance to hydrolysis and chemicals – even at high temperatures. In addition to the absolutely benign hygienic and physiological properties, this is another reason why PPSU is also used in the medical sector.

In order to further increase the mechanical load capacity, each fitting is given a black outer coating made of glass fibre reinforced polyamide (PA-GF30).

All threaded fittings, transition fittings and system fittings are made of gunmetal (CC499K). In terms of corrosion and chemical resistance, all afore-mentioned fittings have properties similar to those of fittings made of PPSU.

2.3 Controls and instruments

Controls and instruments for the Sanipex MT system with special connections and transitions are available in the JRG Controls and Instruments program.

Information on controls and instruments
Technical product information:
➨ Part V 'Build', Section 'JRG Valves'

3 Tools

When processing the JRG Sanipex MT, special tools must be used depending on the pipe dimension. This will ensure that the correct and safe JRG Sanipex MT crimped clamping connection is created.

☑ Compliance with the tool's operating instruction is mandatory.

⚠ **Material damage and risk of injury when using unsuitable tools or non-original spare parts.**

→ Only use tools available from the current product range.
→ Tools must be used compliant with the operating instructions.
→ Only use replacement parts from the current product range.

Expanding pliers, battery-powered expanding tools, hydraulic expanding tools

With these tools, pipes from d16/DN12 to d63/DN50 can be cut and expanded. All calibration and deburring operations are eliminated.

Hydraulic cylinders

The hydraulic cylinder can be used to process pipes from d16/DN12 to d63/DN50. Furthermore, the manual bending tool can be used to process pipes from d16/DN12 to d26/DN20.

Ratchet torque wrench

The JRG Sanipex MT ratchet torque wrench, is used exclusively to tighten the JRG Sanipex MT crimped clamping connector. The torques are set at the factory. The ratchet torque wrenches are maintenance free when used as intended.

Care, testing and maintenance of tools

A flawlessly functioning tool is a basic prerequisite for a permanently sealed connection.

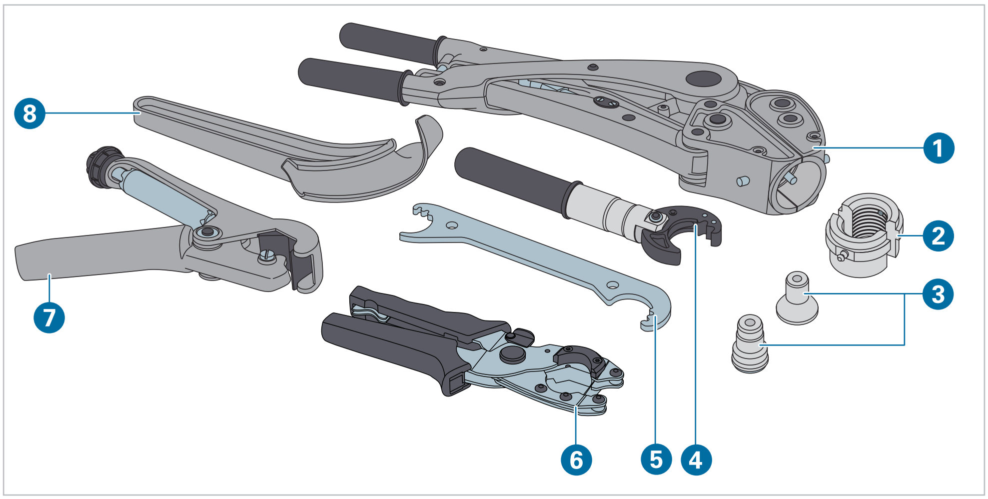
⚠ **Risk of injury and material damage due to poor care, incorrect testing and faulty maintenance.**

→ Tools must be maintained as specified in the operating instructions and their operation must be inspected regularly, at least once a year.

3.1 Assembly tools

☑ Compliance with the tool's operating instruction is mandatory.

The **expanding pliers** as well as other tools are available in a tool box.



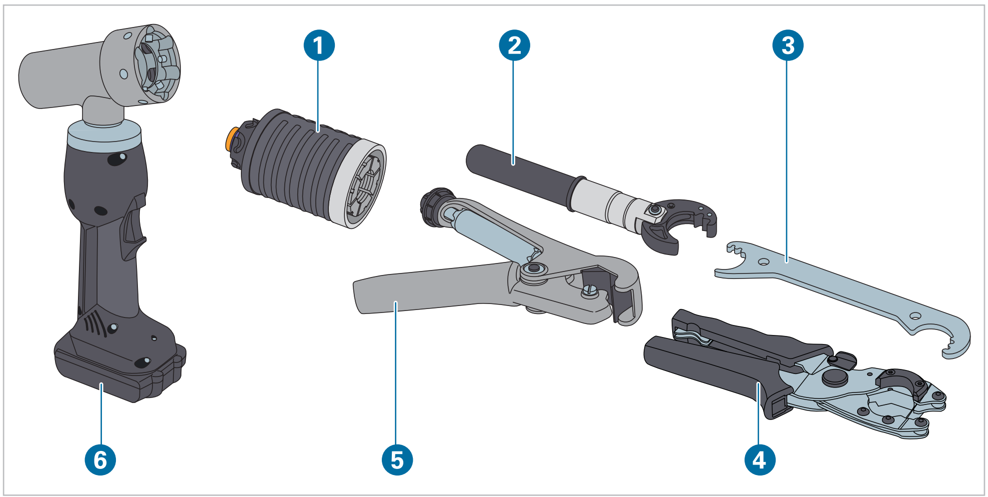
GV.3
Assembly tools

1. Expanding pliers
2. Clamping jaws
3. Expanding mandrel
4. Ratchet torque wrench
5. Backup wrench
6. Combination shears
7. Pipe cutter
8. Manual pipe bender

3.2 Battery-powered expanding unit

☑ Compliance with the tool's operating instruction is mandatory.

The **battery-powered expanding unit** as well as other tools are available in a tool box.



GV.4
Battery-powered expanding unit

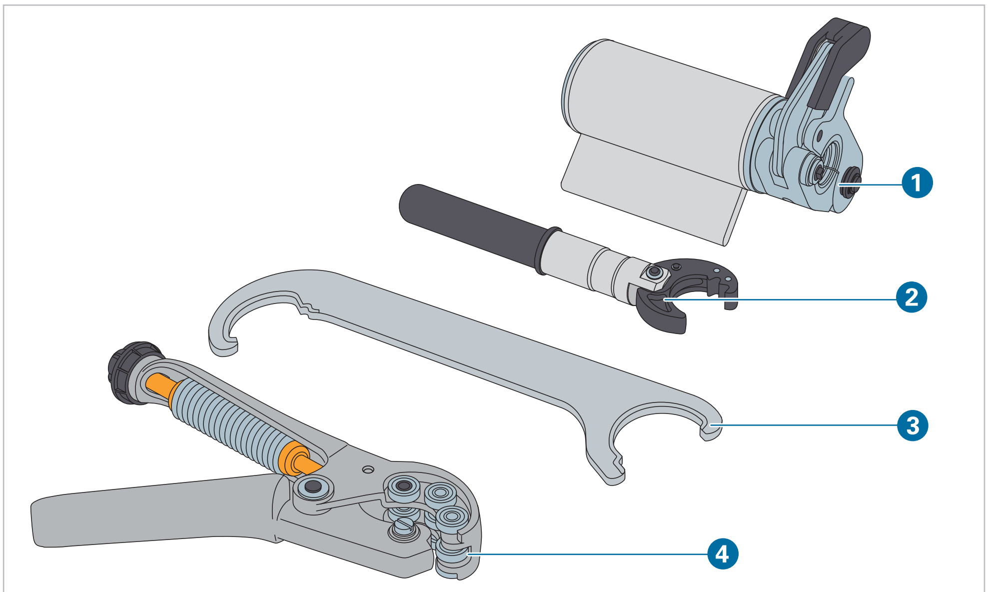
1. Expansion head
2. Ratchet torque wrench
3. Backup wrench
4. Combination shears
5. Pipe cutter
6. Battery-powered expanding unit

3.3 Hydraulic expanding unit

☑ Compliance with the tool's operating instruction is mandatory.

The **hydraulic expanding unit** as well as other tools are available in a tool box.

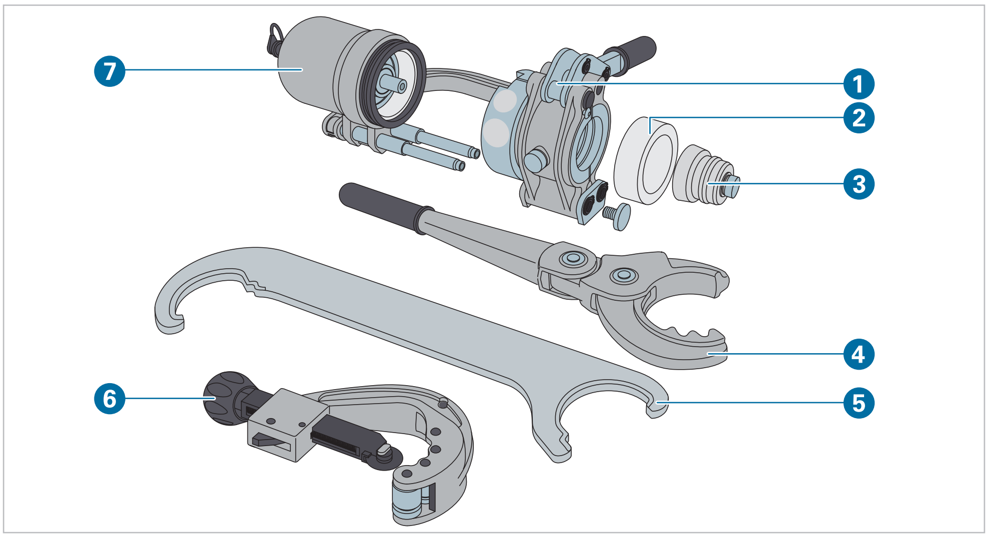
Expanding unit (d26 – d40)



GV.5
Expanding unit d26 – d40

1. Expanding unit
2. Ratchet torque wrench
3. Backup wrench
4. Pipe cutter

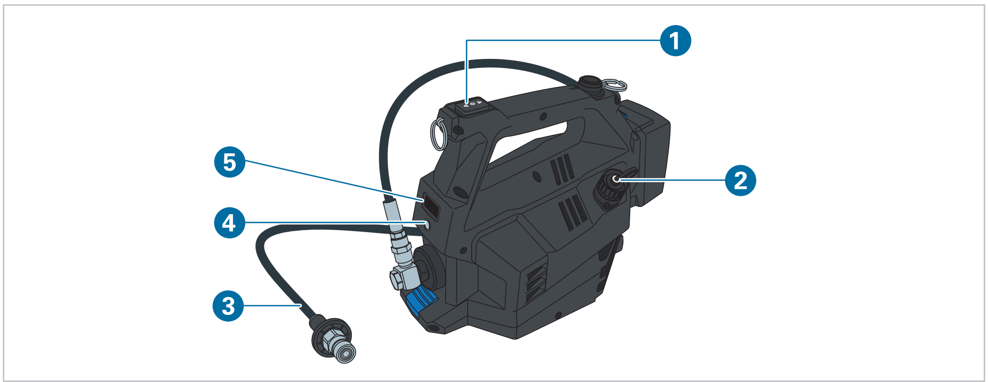
Expanding unit (d50 – d63)



GV.6
Expanding unit d50 – d63

1. Drilling clamping unit
2. Pipe scraper
3. Expanding mandrel
4. Ratchet torque wrench
5. Backup wrench
6. Pipe cutter
7. Expanding unit

Battery-powered hydraulic pump



GV.7
Battery-powered hydraulic pump

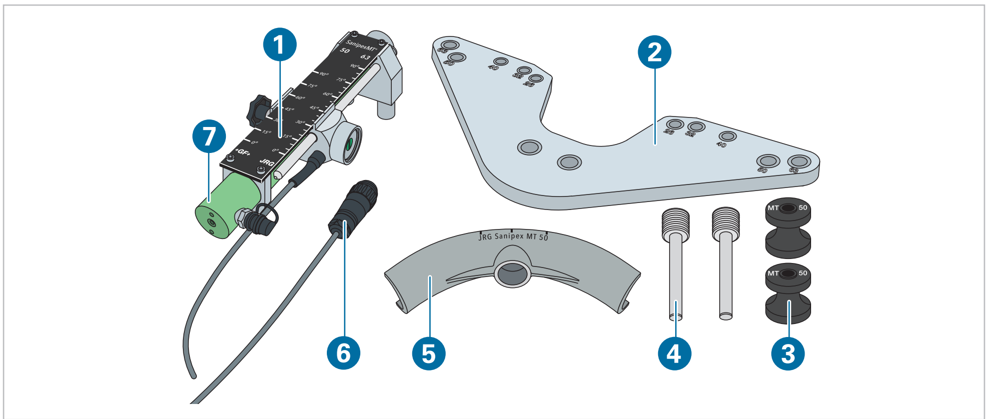
1. Expansion operating button
2. Connection for hydraulic cylinder
3. Hydraulic hose
4. Menu selection button
5. Display

3.4 Hydraulic cylinders

☑ Compliance with the tool's operating instruction is mandatory.

The **hydraulic cylinder** as well as other tools are available in a tool box.

Hydraulic cylinder (d16 – d63)



GV.8
Components

1. Scale
2. Base plate
3. Bending rollers
4. Mounting bolts
5. Pipe bender
6. Control cable
7. Cylinder

4 Dimensioning

Simplified calculation method
Basic information, examples and sample tables for simplified calculation:
➨ Part IV 'Plan', Section 'Drinking water installation'

The product-specific data for the simplified calculation and the calculation method are available in this chapter.

4.1 Loading units

The loading unit (LU – previously abbreviated BW) designates the flow rate provided at the connection point upstream of the tap as a function of the intended use and the duration of use. The loading unit does not correspond to the withdrawal flow, listed in the respective product specification.

A loading unit LU is equal to a flow of 0.1 l/s.

4.1.1 Controls and instruments and equipment

TV.2
Loading units according to intended purpose
Source: SVGW Guidelines W3 Edition 2013

Usage Connections DN15 (½")	Volume flow Q_A per connection [l/s]	[l/min]	LU per port
Wash-hand basin, washing trough, vanity unit, bidet, cistern, vending machine, hairdresser, household dishwasher	0.1	6	1
Sink, utility sink, taps for balcony and terrace, washing trough, shower, standing and wall spout, household washing machine	0.2	12	2
Urinal flushing (automatic), bathtub	0.3	18	3
Tap for the garden or garage	0.5	30	5

TV.3
Loading units according to intended purpose
Source: EN 806-3:2006 (D)
Q_A Flow rate at the tapping fitting
Q_{min} Minimum flow rate at the tapping valve

Intended use Connections DN15 (½")	Volume flow per connection Q_A [l/s]	Q_{min} [l/s]	LU per port
Hand basin, washbasin, bidet, cistern	0.1	0.1	1
Household kitchen sink, household washing machine, dishwasher, sink, shower head	0.2	0.15	2
Urinal flush valve	0.3	0.15	3
Bathtub drain	0.4	0.3	4
Tap for the garden or garage	0.5	0.4	5
Commercial kitchen sink (DN20), Commercial bath spout	0.8	0.8	8
Flush valve (DN20)	1.5	1.0	15

4.1.2 JRG Sanipex MT Pipes

TV.4 **Loading units applicable to JRG Sanipex MT pipes**

Designation	Dimension										
Total LU	1	2	3	4	5	10	20	55	180	540	1300
Largest single value LU	–	1	–	–	4	5	8	–	–	–	–
$d_a \times s$ [mm]	12 × 1.7			16 × 2.25		20 × 2.5	26 × 3.0	32 × 3	40 × 3.5	50 × 4	63 × 4.5
d_i [mm]	8.6			12		15	20	26	33	42	54
Length of pipeline, recommended [m]	10	6	9	5	4	–	–	–	–	–	–
Controls and instruments	–	½"		½"		½"	¾"	1"	1¼"	1½"	2"

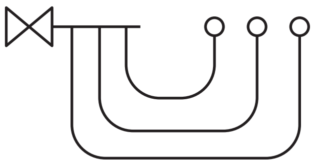
4.1.3 Installation with individual supply lines

Group of equipment/distribution at floor level
→ A velocity of max. 4 m/s must be maintained.

Directional change with pipe bend

Max. developed length [m]	5		10		15	
Residential water meter	without	with	without	with	without	with
Loading unit (LU)	$[d_a \times s]$					
1	16 × 2.25	16 × 2.25	16 × 2.25	16 × 2.25	16 × 2.25	16 × 2.25
2	16 × 2.25	16 × 2.25	16 × 2.25	16 × 2.25	16 × 2.25	16 × 2.25
3	16 × 2.25	16 × 2.25	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5
4	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5
5	20 × 2.5	no counter	20 × 2.5	no counter	20 × 2.5	no counter
Pipe $d_a \times s$ [mm]	16 × 2.25	20 × 2.5				
Pipe d_i [mm]	11.5	15.0				
Instrument	½"	½"				

TV.5
Loading units (LU) applicable to multilayer composite pipe PE-Xc / Al / PE-Xb



Straight-seat shut-off valve ¾ "and distributor ¾" are taken into account in the calculation model.
Source: SVGW 2014

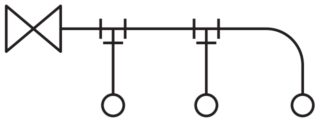
4.1.4 Installation with tees

Group of equipment/distribution at floor level
→ A velocity of max. 3 m/s must be maintained.

Directional change with pipe bend

Max. developed length [m]	5		10		15	
Residential water meter	without	with	without	with	without	with
Loading unit (LU)	$[d_a \times s]$					
1	16 × 2.25	16 × 2.25	16 × 2.25	16 × 2.25	16 × 2.25	16 × 2.25
2	16 × 2.25	16 × 2.25	16 × 2.25	16 × 2.25	16 × 2.25	20 × 2.5
3	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5
4	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5
5	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	26 × 3
6	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	26 × 3
8	20 × 2.5	20 × 2.5	20 × 2.5	26 × 3	26 × 3	26 × 3
10	20 × 2.5	20 × 2.5	26 × 3	26 × 3	26 × 3	26 × 3
12	20 × 2.5	26 × 3	26 × 3	26 × 3	26 × 3	26 × 3
15	26 × 3	26 × 3	26 × 3	26 × 3	26 × 3	26 × 3
Pipe $d_a \times s$ [mm]	16 × 2.25	20 × 2.5	26 × 3	32 × 3	40 × 3.5	–
Pipe d_i [mm]	11.6	15.0	20.0	26.0	33.0	–
Instrument	½"	½"	¾"	1"	1¼"	–

TV.6
Loading units (LU) applicable to multilayer composite pipe PE-Xc / Al / PE-Xb



4.1.5 Installation with tees

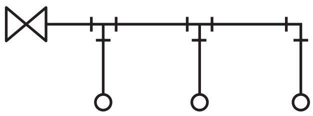
Group of equipment/distribution at floor level
→ A velocity of max. 3 m/s must be maintained.

Directional change with fittings

Max. developed length [m]	5	10	15	20	35
Loading unit (LU)	$[d_a \times s]$				
1	16 × 2.25	16 × 2.25	16 × 2.25	16 × 2.25	20 × 2.5
2	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5
3	26 × 3	26 × 3	26 × 3	26 × 3	26 × 3
4	26 × 3	26 × 3	26 × 3	26 × 3	26 × 3
6	26 × 3	26 × 3	26 × 3	26 × 3	32 × 3
8	26 × 3	26 × 3	26 × 3	32 × 3	32 × 3
10	26 × 3	26 × 3	32 × 3	32 × 3	32 × 3
15	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3
20	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3
30	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3
50	32 × 3	32 × 3	32 × 3	40 × 3.5	40 × 3.5
70	32 × 3	40 × 3.5	40 × 3.5	40 × 3.5	40 × 3.5
90	40 × 3.5	40 × 3.5	40 × 3.5	40 × 3.5	40 × 3.5
120	40 × 3.5	40 × 3.5	40 × 3.5	40 × 3.5	40 × 3.5
150	40 × 3.5	40 × 3.5	40 × 3.5	40 × 3.5	40 × 3.5
Pipe $d_a \times s$ [mm]	16 × 2.25	20 × 2.5	26 × 3	32 × 3	40 × 3.5
Pipe d_i [mm]	11.5	15.0	20.0	26.0	33.0
Instrument	½"	½"	¾"	1"	1¼"

Source: SVGW Sa 02/2014; SVGW Certificate No.: 0406-4834

TV.7
Loading units (LU) applicable to multilayer composite pipe PE-Xc / Al / PE-Xb



V

4.2 Pressure loses for pipes

4.2.1 The basics

TV.8
Flow velocities

Designation	Value [m/s]	
	SVGW W3*	EN 806-3:2006**
Discharge pipeline	max. 4.0	4.0
Groups of equipment	max. 3.0	–
Pipelines on individual floor levels	max. 3.0	2.0
Distribution pipelines	max. 2.0	2.0

* recommended (acc. to SVGW - Swiss Gas and Wate Industry Association Guideline W3/2013)
** The values given are based on the following flow velocities:
Collective feed lines, risers, floor lines: max. 2.0 m/s
Single feeders: max. 4.0 m/s

4.2.2 Pressure losses applicable to JRG Sanipex MT pipes

A loading unit LU is equal to a flow of 0.1 l/s.

TV.9
Pressure losses applicable to JRG Sanipex MT pipes
LU 1 to LU 8

Pipe, Dimension	Pressure loss [hPa/m pipe (= mbar/m)]						
	LU*	1	2	3	4	5	8
	[l/s]	0.1	0.2	0.3	0.4	0.5	0.8
d16		13.5	44.5	91.0	150.5	–	–
d20		4.0	12.5	26.0	42.5	63.0	–
d26		–	–	6.6	11.0	16.0	36.5
d32		–	–	–	–	4.6	10.5
d40		–	–	–	–	–	3.5
d50		–	–	–	–	–	–
d63		–	–	–	–	–	–

* Volumetric flow rate according to W3 diagram 1 / largest LU = 4

TV.10
Pressure losses applicable to JRG Sanipex MT pipes
Volumetric flow rates from 1.5 to 4.0 l/s)

Pipe, Dimension	Pressure loss [hPa/m pipe (= mbar/m)]						
	LU*	–					
	[l/s]	1.5	2.0	2.5	3.0	3.5	4.0
d16		–	–	–	–	–	–
d20		–	–	–	–	–	–
d26		–	–	–	–	–	–
d32		31.5	52.0	–	–	–	–
d40		10.0	17.0	25.0	–	–	–
d50		3.0	5.5	8.0	11.0	–	–
d63		–	1.5	2.5	3.5	4.5	5.5

* Volumetric flow rate according to W3 diagram 1 / largest LU = 4

4.2.3 Pressure losses at 10°C

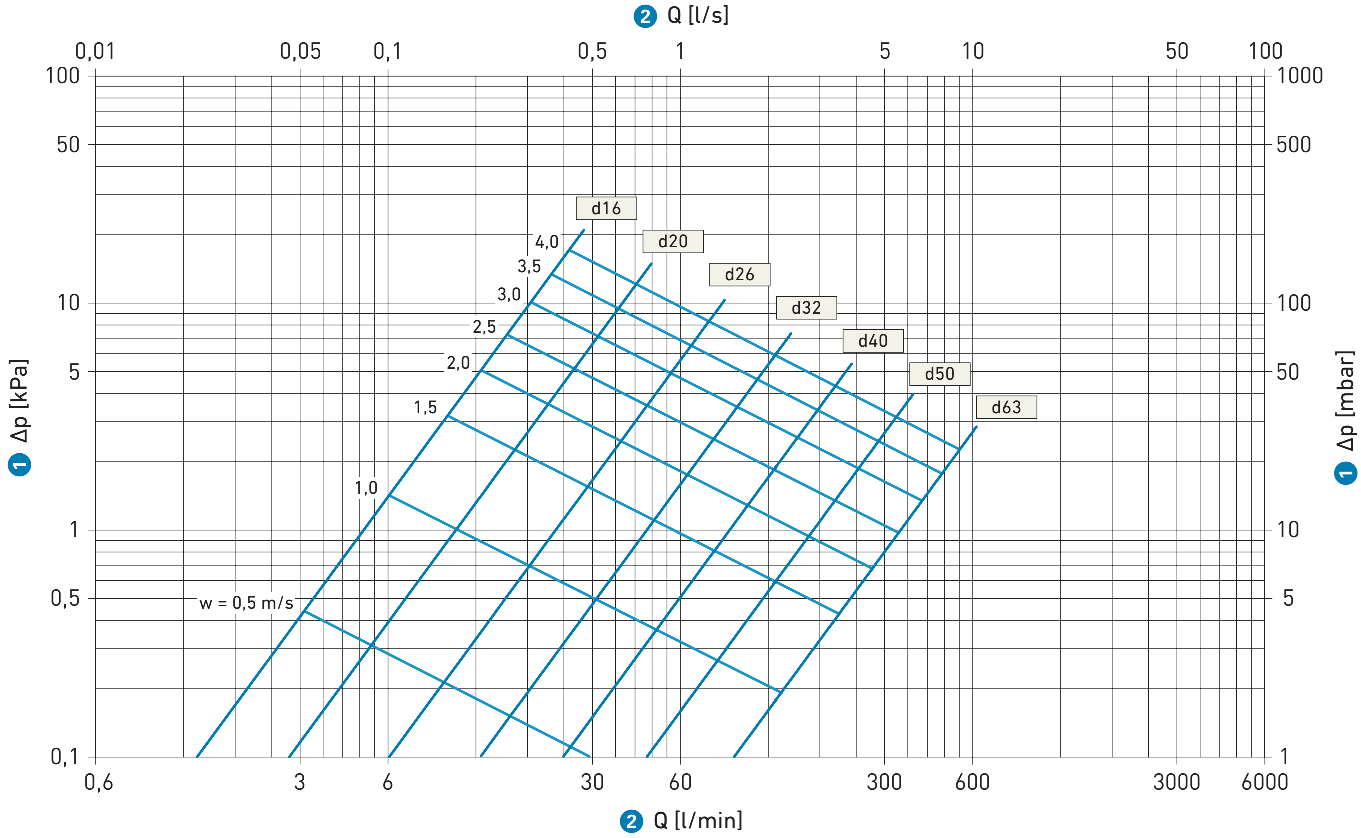
The basics

TV.11
Design fundamentals

Designation	Value
Dimension	d16 – d63
Density ρ (water)	999.70 kg/m³
Water temperature	10°C
Surface roughness k (inner pipe)	0.007 mm
Viscosity	0.00131 Pa · s

Pipe friction pressure drop as a function of the volumetric flow

The diagram and the tables show the pipe friction pressure drop R and the calculated flow velocity v as a function of the volumetric flow Q.



1 Pressure loss
2 Volumetric flow rate

V

Pressure losses at 10°C

TV.12 **Pipe friction pressure drops, flow velocity, peak flow**

d	16		20		26		32		40		50		63	
DN	12		15		20		25		32		40		50	
Q [l/s]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
0.01	0.1	0.2	0.1	0.1	–	–	–	–	–	–	–	–	–	–
0.02	0.2	0.8	0.1	0.2	0.1	0.1	–	–	–	–	–	–	–	–
0.03	0.3	1.7	0.2	0.5	0.1	0.1	–	–	–	–	–	–	–	–
0.04	0.4	2.8	0.2	0.8	0.1	0.2	0.1	0.1	–	–	–	–	–	–
0.05	0.5	4.1	0.3	1.2	0.2	0.3	0.1	0.1	–	–	–	–	–	–
0.06	0.6	5.7	0.3	1.6	0.2	0.4	0.1	0.1	–	–	–	–	–	–
0.07	0.7	7.5	0.4	2.1	0.2	0.5	0.1	0.1	–	–	–	–	–	–
0.08	0.8	9.5	0.5	2.6	0.3	0.7	0.2	0.2	0.1	0.1	–	–	–	–
0.09	0.9	11.6	0.5	3.2	0.3	0.8	0.2	0.2	0.1	0.1	–	–	–	–
0.10	1.0	14.0	0.6	3.9	0.3	1.0	0.2	0.3	0.1	0.1	–	–	–	–
0.15	1.4	28.5	0.8	8.0	0.5	2.0	0.3	0.6	0.2	0.2	0.1	0.1	–	–
0.20	1.9	47.3	1.1	13.2	0.6	3.3	0.4	0.9	0.2	0.3	0.1	0.1	–	–
0.25	2.4	69.9	1.4	19.5	0.8	4.9	0.5	1.4	0.3	0.4	0.2	0.1	–	–
0.30	2.9	96.3	1.7	26.9	1.0	6.8	0.6	1.9	0.4	0.6	0.2	0.2	0.1	0.1
0.35	3.4	126.3	2.0	35.3	1.1	8.9	0.7	2.5	0.4	0.8	0.3	0.3	0.2	0.1
0.40	3.9	159.6	2.3	44.6	1.3	11.2	0.8	3.2	0.5	1.0	0.3	0.3	0.2	0.1
0.45	4.3	196.3	2.5	54.8	1.4	13.8	0.8	3.9	0.5	1.2	0.3	0.4	0.2	0.1
0.50	4.8	236.2	2.8	66.0	1.6	16.6	0.9	4.7	0.6	1.5	0.4	0.5	0.2	0.1
0.55	–	–	3.1	78.0	1.8	19.6	1.0	5.6	0.6	1.8	0.4	0.6	0.2	0.2
0.60	–	–	3.4	90.8	1.9	22.8	1.1	6.5	0.7	2.1	0.4	0.6	0.3	0.2
0.65	–	–	3.7	104.6	2.1	26.3	1.2	7.5	0.8	2.4	0.5	0.7	0.3	0.2
0.70	–	–	4.0	119.1	2.2	29.9	1.3	8.5	0.8	2.7	0.5	0.8	0.3	0.3
0.75	–	–	4.2	134.4	2.4	33.8	1.4	9.6	0.9	3.1	0.5	1.0	0.3	0.3
0.80	–	–	4.5	150.5	2.5	37.8	1.5	10.7	0.9	3.4	0.6	1.1	0.3	0.3
0.85	–	–	4.8	167.5	2.7	42.1	1.6	11.9	1.0	3.8	0.6	1.2	0.4	0.4
0.90	–	–	–	–	2.9	46.5	1.7	13.2	1.1	4.2	0.6	1.3	0.4	0.4
0.95	–	–	–	–	3.0	51.2	1.8	14.5	1.1	4.6	0.7	1.5	0.4	0.4
1.00	–	–	–	–	3.2	56.0	1.9	15.9	1.2	5.1	0.7	1.6	0.4	0.5
1.05	–	–	–	–	3.3	61.0	2.0	17.3	1.2	5.5	0.8	1.7	0.5	0.5
1.10	–	–	–	–	3.5	66.2	2.1	18.8	1.3	6.0	0.8	1.9	0.5	0.6
1.15	–	–	–	–	3.7	71.5	2.2	20.3	1.3	6.5	0.8	2.0	0.5	0.6
1.20	–	–	–	–	3.8	77.1	2.3	21.9	1.4	7.0	0.9	2.2	0.5	0.7
1.25	–	–	–	–	4.0	82.8	2.4	23.5	1.5	7.5	0.9	2.4	0.5	0.7
1.30	–	–	–	–	–	–	2.4	25.2	1.5	8.0	0.9	2.5	0.6	0.8
1.35	–	–	–	–	–	–	2.5	26.9	1.6	8.6	1.0	2.7	0.6	0.8
1.40	–	–	–	–	–	–	2.6	28.7	1.6	9.1	1.0	2.9	0.6	0.9
1.45	–	–	–	–	–	–	2.7	30.5	1.7	9.7	1.0	3.1	0.6	0.9
1.50	–	–	–	–	–	–	2.8	32.4	1.8	10.3	1.1	3.2	0.7	1.0
1.55	–	–	–	–	–	–	2.9	34.3	1.8	10.9	1.1	3.4	0.7	1.0
1.60	–	–	–	–	–	–	3.0	36.3	1.9	11.5	1.2	3.6	0.7	1.1
1.65	–	–	–	–	–	–	3.1	38.3	1.9	12.2	1.2	3.8	0.7	1.1
1.70	–	–	–	–	–	–	–	–	2.0	12.8	1.2	4.0	0.7	1.2
1.75	–	–	–	–	–	–	–	–	2.0	13.5	1.3	4.2	0.8	1.3
1.80	–	–	–	–	–	–	–	–	2.1	14.2	1.3	4.5	0.8	1.3
1.85	–	–	–	–	–	–	–	–	2.2	14.9	1.3	4.7	0.8	1.4
1.90	–	–	–	–	–	–	–	–	2.2	15.6	1.4	4.9	0.8	1.5
1.95	–	–	–	–	–	–	–	–	2.3	16.3	1.4	5.1	0.9	1.5
2.00	–	–	–	–	–	–	–	–	2.3	17.1	1.4	5.4	0.9	1.6
2.10	–	–	–	–	–	–	–	–	2.5	18.6	1.5	5.8	0.9	1.7
2.20	–	–	–	–	–	–	–	–	2.6	20.2	1.6	6.3	1.0	1.9
2.30	–	–	–	–	–	–	–	–	2.7	21.8	1.7	6.9	1.0	2.1

d	16		20		26		32		40		50		63	
DN	12		15		20		25		32		40		50	
Q [l/s]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
2.40	–	–	–	–	–	–	–	–	2.8	23.5	1.7	7.4	1.0	2.2
2.50	–	–	–	–	–	–	–	–	2.9	25.3	1.8	7.9	1.1	2.4
2.60	–	–	–	–	–	–	–	–	3.0	27.1	1.9	8.5	1.1	2.5
2.70	–	–	–	–	–	–	–	–	–	–	1.9	9.1	1.2	2.7
2.80	–	–	–	–	–	–	–	–	–	–	2.0	9.7	1.2	2.9
2.90	–	–	–	–	–	–	–	–	–	–	2.1	10.3	1.3	3.1
3.00	–	–	–	–	–	–	–	–	–	–	2.2	10.9	1.3	3.3
3.10	–	–	–	–	–	–	–	–	–	–	2.2	11.6	1.4	3.5
3.20	–	–	–	–	–	–	–	–	–	–	2.3	12.2	1.4	3.7
3.30	–	–	–	–	–	–	–	–	–	–	2.4	12.9	1.4	3.9
3.40	–	–	–	–	–	–	–	–	–	–	2.5	13.6	1.5	4.1
3.50	–	–	–	–	–	–	–	–	–	–	2.5	14.3	1.5	4.3
3.60	–	–	–	–	–	–	–	–	–	–	2.6	15.1	1.6	4.5
3.70	–	–	–	–	–	–	–	–	–	–	2.7	15.8	1.6	4.7
3.80	–	–	–	–	–	–	–	–	–	–	2.7	16.6	1.7	5.0
3.90	–	–	–	–	–	–	–	–	–	–	2.8	17.3	1.7	5.2
4.00	–	–	–	–	–	–	–	–	–	–	2.9	18.1	1.7	5.4
4.10	–	–	–	–	–	–	–	–	–	–	3.0	18.9	1.8	5.7
4.20	–	–	–	–	–	–	–	–	–	–	3.0	19.7	1.8	5.9
4.30	–	–	–	–	–	–	–	–	–	–	3.1	20.6	1.9	6.2
4.40	–	–	–	–	–	–	–	–	–	–	–	–	1.9	6.4
4.50	–	–	–	–	–	–	–	–	–	–	–	–	2.0	6.7
4.60	–	–	–	–	–	–	–	–	–	–	–	–	2.0	6.9
4.70	–	–	–	–	–	–	–	–	–	–	–	–	2.1	7.2
4.80	–	–	–	–	–	–	–	–	–	–	–	–	2.1	7.5
4.90	–	–	–	–	–	–	–	–	–	–	–	–	2.1	7.7
5.00	–	–	–	–	–	–	–	–	–	–	–	–	2.2	8.0
5.10	–	–	–	–	–	–	–	–	–	–	–	–	2.2	8.3
5.20	–	–	–	–	–	–	–	–	–	–	–	–	2.3	8.6
5.30	–	–	–	–	–	–	–	–	–	–	–	–	2.3	8.9
5.40	–	–	–	–	–	–	–	–	–	–	–	–	2.4	9.2
5.50	–	–	–	–	–	–	–	–	–	–	–	–	2.4	9.5
5.60	–	–	–	–	–	–	–	–	–	–	–	–	2.4	9.8
5.70	–	–	–	–	–	–	–	–	–	–	–	–	2.5	10.1
5.80	–	–	–	–	–	–	–	–	–	–	–	–	2.5	10.4
5.90	–	–	–	–	–	–	–	–	–	–	–	–	2.6	10.7
6.00	–	–	–	–	–	–	–	–	–	–	–	–	2.6	11.0
6.10	–	–	–	–	–	–	–	–	–	–	–	–	2.7	11.4
6.20	–	–	–	–	–	–	–	–	–	–	–	–	2.7	11.7
6.30	–	–	–	–	–	–	–	–	–	–	–	–	2.8	12.0
6.40	–	–	–	–	–	–	–	–	–	–	–	–	2.8	12.4
6.50	–	–	–	–	–	–	–	–	–	–	–	–	2.8	12.7
6.60	–	–	–	–	–	–	–	–	–	–	–	–	2.9	13.1
6.70	–	–	–	–	–	–	–	–	–	–	–	–	2.9	13.4
6.80	–	–	–	–	–	–	–	–	–	–	–	–	3.0	13.8
6.90	–	–	–	–	–	–	–	–	–	–	–	–	3.0	14.1
7.00	–	–	–	–	–	–	–	–	–	–	–	–	3.1	14.5

4.2.4 Pressure losses at 60°C

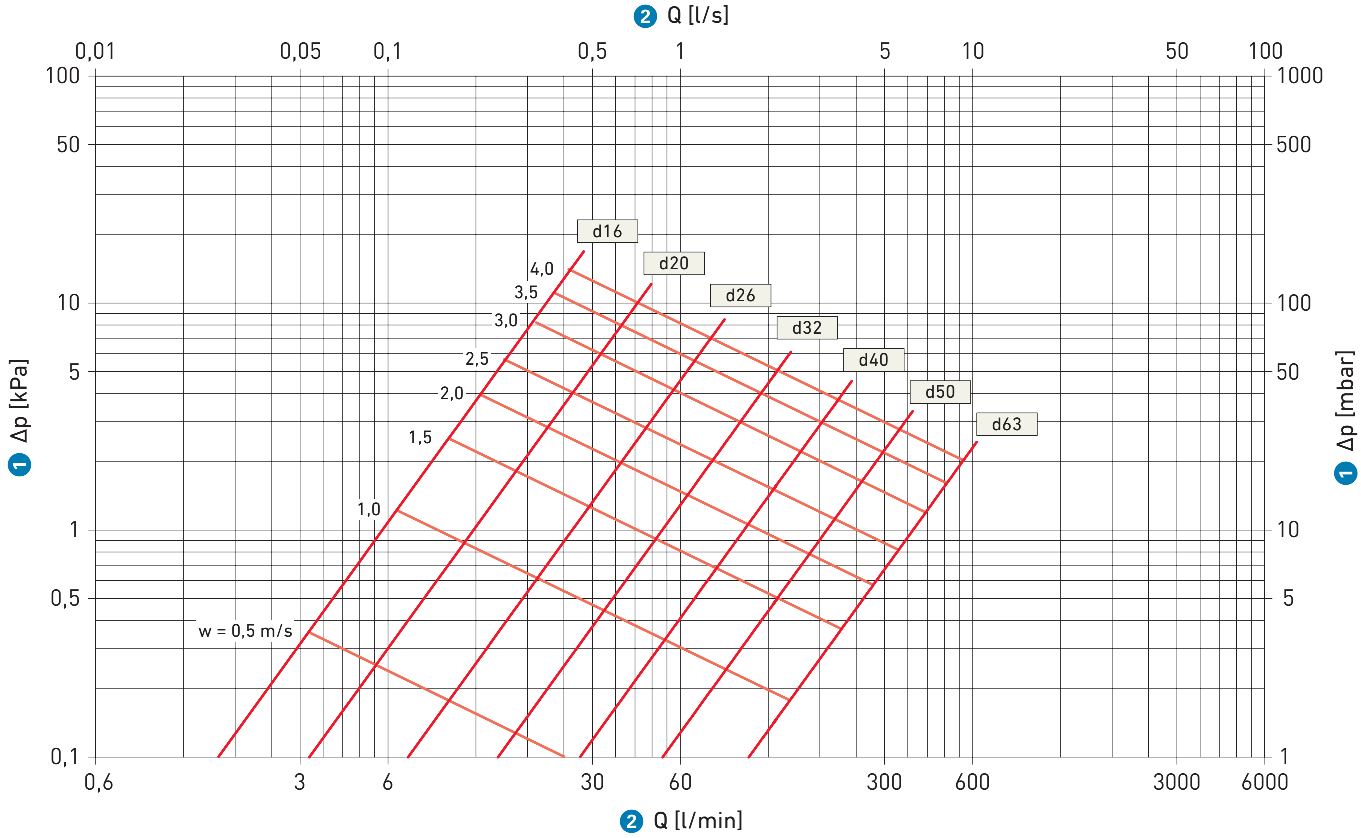
TV.13
Design fundamentals

The basics

Designation	Value
Dimension	d16 – d63
Density ρ (water)	983.19 kg/m³
Water temperature	60°C
Surface roughness k (inner pipe)	0.007 mm
Viscosity	0.000476 Pa · s

Pipe friction pressure drop as a function of the volumetric flow

The diagram and the tables show the pipe friction pressure drop R and the calculated flow velocity v as a function of the volumetric flow Q.



1 Pressure loss
2 Volumetric flow rate

Pressure losses at 60°C

TV.14 **Pipe friction pressure drop, flow velocity, peak flow (source: DIN 1988, Part 3)**

d	16		20		26		32		40		50		63	
DN	12		15		20		25		32		40		50	
Q [l/s]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
0.01	0.10	0.2	–	–	–	–	–	–	–	–	–	–	–	–
0.02	0.19	0.6	0.11	0.2	–	–	–	–	–	–	–	–	–	–
0.03	0.29	1.3	0.17	0.4	0.10	0.1	–	–	–	–	–	–	–	–
0.04	0.39	2.1	0.23	0.6	0.13	0.1	–	–	–	–	–	–	–	–
0.05	0.48	3.2	0.28	0.9	0.16	0.2	0.09	0.1	–	–	–	–	–	–
0.06	0.58	4.4	0.34	1.2	0.19	0.3	0.11	0.1	–	–	–	–	–	–
0.07	0.67	5.7	0.40	1.6	0.22	0.4	0.13	0.1	–	–	–	–	–	–
0.08	0.77	7.3	0.45	2.0	0.25	0.5	0.15	0.1	–	–	–	–	–	–
0.09	0.87	9.0	0.51	2.5	0.29	0.6	0.17	0.2	0.11	0.1	–	–	–	–
0.10	0.96	10.8	0.57	3.0	0.32	0.8	0.19	0.2	0.12	0.1	–	–	–	–
0.15	1.44	22.3	0.85	6.2	0.48	1.6	0.28	0.4	0.18	0.1	–	–	–	–
0.20	1.93	37.3	1.13	10.4	0.64	2.6	0.38	0.7	0.23	0.2	0.14	0.1	–	–
0.25	2.41	55.5	1.41	15.4	0.80	3.9	0.47	1.1	0.29	0.3	0.18	0.1	–	–
0.30	2.89	76.8	1.70	21.4	0.95	5.3	0.57	1.5	0.35	0.5	0.22	0.2	–	–
0.35	3.37	101.1	1.98	28.1	1.11	7.0	0.66	2.0	0.41	0.6	0.25	0.2	0.15	0.1
0.40	3.85	128.3	2.26	35.7	1.27	8.9	0.75	2.5	0.47	0.8	0.29	0.3	0.17	0.1
0.45	4.33	158.2	2.55	44.0	1.43	11.0	0.85	3.1	0.53	1.0	0.32	0.3	0.20	0.1
0.50	4.81	190.9	2.83	53.1	1.59	13.3	0.94	3.8	0.58	1.2	0.36	0.4	0.22	0.1
0.55	–	–	3.11	62.9	1.75	15.8	1.04	4.5	0.64	1.4	0.40	0.4	0.24	0.1
0.60	–	–	3.40	73.5	1.91	18.4	1.13	5.2	0.70	1.7	0.43	0.5	0.26	0.2
0.65	–	–	3.68	84.8	2.07	21.2	1.22	6.0	0.76	1.9	0.47	0.6	0.28	0.2
0.70	–	–	3.96	96.7	2.23	24.2	1.32	6.8	0.82	2.2	0.51	0.7	0.31	0.2
0.75	–	–	4.24	109.4	2.39	27.4	1.41	7.7	0.88	2.5	0.54	0.8	0.33	0.2
0.80	–	–	4.53	122.7	2.55	30.7	1.51	8.7	0.94	2.8	0.58	0.9	0.35	0.3
0.85	–	–	4.81	136.7	2.71	34.2	1.60	9.7	0.99	3.1	0.61	1.0	0.37	0.3
0.90	–	–	–	–	2.86	37.9	1.70	10.7	1.05	3.4	0.65	1.1	0.39	0.3
0.95	–	–	–	–	3.02	41.7	1.79	11.8	1.11	3.7	0.69	1.2	0.41	0.3
1.05	–	–	–	–	3.34	49.9	1.98	14.1	1.23	4.5	0.76	1.4	0.46	0.4
1.10	–	–	–	–	3.50	54.2	2.07	15.3	1.29	4.9	0.79	1.5	0.48	0.5
1.15	–	–	–	–	3.66	58.6	2.17	16.6	1.34	5.3	0.83	1.6	0.50	0.5
1.20	–	–	–	–	3.82	63.3	2.26	17.9	1.40	5.7	0.87	1.8	0.52	0.5
1.25	–	–	–	–	3.98	68.0	2.35	19.2	1.46	6.1	0.90	1.9	0.55	0.6
1.30	–	–	–	–	4.14	73.0	2.45	20.6	1.52	6.5	0.94	2.0	0.57	0.6
1.35	–	–	–	–	–	–	2.54	22.1	1.58	7.0	0.97	2.2	0.59	0.7
1.40	–	–	–	–	–	–	2.64	23.5	1.64	7.5	1.01	2.3	0.61	0.7
1.45	–	–	–	–	–	–	2.73	25.1	1.70	8.0	1.05	2.5	0.63	0.7
1.50	–	–	–	–	–	–	2.83	26.6	1.75	8.4	1.08	2.6	0.65	0.8
1.55	–	–	–	–	–	–	2.92	28.2	1.81	9.0	1.12	2.8	0.68	0.8
1.60	–	–	–	–	–	–	3.01	29.9	1.87	9.5	1.15	3.0	0.70	0.9
1.65	–	–	–	–	–	–	3.11	31.5	1.93	10.0	1.19	3.1	0.72	0.9
1.70	–	–	–	–	–	–	3.20	33.3	1.99	10.6	1.23	3.3	0.74	1.0
1.75	–	–	–	–	–	–	3.30	35.0	2.05	11.1	1.26	3.5	0.76	1.0
1.80	–	–	–	–	–	–	3.39	36.8	2.10	11.7	1.30	3.7	0.79	1.1
1.85	–	–	–	–	–	–	3.48	38.7	2.16	12.3	1.34	3.8	0.81	1.1
1.50	–	–	–	–	–	–	2.83	26.6	1.75	8.4	1.08	2.6	0.65	0.8
1.55	–	–	–	–	–	–	2.92	28.2	1.81	9.0	1.12	2.8	0.68	0.8
1.60	–	–	–	–	–	–	3.01	29.9	1.87	9.5	1.15	3.0	0.70	0.9
1.65	–	–	–	–	–	–	3.11	31.5	1.93	10.0	1.19	3.1	0.72	0.9
1.70	–	–	–	–	–	–	–	–	1.99	10.6	1.23	3.3	0.74	1.0
1.75	–	–	–	–	–	–	–	–	2.05	11.1	1.26	3.5	0.76	1.0
1.80	–	–	–	–	–	–	–	–	2.10	11.7	1.30	3.7	0.79	1.1
1.85	–	–	–	–	–	–	–	–	2.16	12.3	1.34	3.8	0.81	1.1

d	16		20		26		32		40		50		63	
DN	12		15		20		25		32		40		50	
Q [l/s]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
1.90	–	–	–	–	–	–	–	–	2.22	12.9	1.37	4.0	0.83	1.2
1.95	–	–	–	–	–	–	–	–	2.28	13.5	1.41	4.2	0.85	1.3
2.00	–	–	–	–	–	–	–	–	2.34	14.1	1.44	4.4	0.87	1.3
2.10	–	–	–	–	–	–	–	–	2.46	15.4	1.52	4.8	0.92	1.4
2.20	–	–	–	–	–	–	–	–	2.57	16.7	1.59	5.2	0.96	1.6
2.30	–	–	–	–	–	–	–	–	2.69	18.1	1.66	5.7	1.00	1.7
2.40	–	–	–	–	–	–	–	–	2.81	19.5	1.73	6.1	1.05	1.8
2.50	–	–	–	–	–	–	–	–	2.92	21.0	1.80	6.6	1.09	2.0
2.60	–	–	–	–	–	–	–	–	3.04	22.5	1.88	7.0	1.14	2.1
2.70	–	–	–	–	–	–	–	–	3.16	24.1	1.95	7.5	1.18	2.2
2.80	–	–	–	–	–	–	–	–	–	–	2.02	8.0	1.22	2.4
2.90	–	–	–	–	–	–	–	–	–	–	2.09	8.6	1.27	2.6
3.00	–	–	–	–	–	–	–	–	–	–	2.17	9.1	1.31	2.7
3.10	–	–	–	–	–	–	–	–	–	–	2.24	9.6	1.35	2.9
3.20	–	–	–	–	–	–	–	–	–	–	2.31	10.2	1.40	3.0
3.30	–	–	–	–	–	–	–	–	–	–	2.38	10.8	1.44	3.2
3.40	–	–	–	–	–	–	–	–	–	–	2.45	11.4	1.48	3.4
3.50	–	–	–	–	–	–	–	–	–	–	2.53	12.0	1.53	3.6
3.60	–	–	–	–	–	–	–	–	–	–	2.60	12.6	1.57	3.8
3.70	–	–	–	–	–	–	–	–	–	–	2.67	13.2	1.62	3.9
3.80	–	–	–	–	–	–	–	–	–	–	2.74	13.9	1.66	4.1
3.90	–	–	–	–	–	–	–	–	–	–	2.81	14.5	1.70	4.3
4.00	–	–	–	–	–	–	–	–	–	–	2.89	15.2	1.75	4.5
4.10	–	–	–	–	–	–	–	–	–	–	2.96	15.9	1.79	4.7
4.20	–	–	–	–	–	–	–	–	–	–	3.03	16.6	1.83	4.9
4.30	–	–	–	–	–	–	–	–	–	–	3.10	17.3	1.88	5.2
4.40	–	–	–	–	–	–	–	–	–	–	–	–	1.92	5.4
4.50	–	–	–	–	–	–	–	–	–	–	–	–	1.96	5.6
4.60	–	–	–	–	–	–	–	–	–	–	–	–	2.01	5.8
4.70	–	–	–	–	–	–	–	–	–	–	–	–	2.05	6.0
4.80	–	–	–	–	–	–	–	–	–	–	–	–	2.10	6.3
4.90	–	–	–	–	–	–	–	–	–	–	–	–	2.14	6.5
5.00	–	–	–	–	–	–	–	–	–	–	–	–	2.18	6.7
5.10	–	–	–	–	–	–	–	–	–	–	–	–	2.23	7.0
5.20	–	–	–	–	–	–	–	–	–	–	–	–	2.27	7.2
5.30	–	–	–	–	–	–	–	–	–	–	–	–	2.31	7.5
5.40	–	–	–	–	–	–	–	–	–	–	–	–	2.36	7.7
5.50	–	–	–	–	–	–	–	–	–	–	–	–	2.40	8.0
5.60	–	–	–	–	–	–	–	–	–	–	–	–	2.45	8.2
5.70	–	–	–	–	–	–	–	–	–	–	–	–	2.49	8.5
5.80	–	–	–	–	–	–	–	–	–	–	–	–	2.53	8.8
5.90	–	–	–	–	–	–	–	–	–	–	–	–	2.58	9.0
6.00	–	–	–	–	–	–	–	–	–	–	–	–	2.62	9.3
6.10	–	–	–	–	–	–	–	–	–	–	–	–	2.66	9.6
6.20	–	–	–	–	–	–	–	–	–	–	–	–	2.71	9.9
6.30	–	–	–	–	–	–	–	–	–	–	–	–	2.75	10.2
6.40	–	–	–	–	–	–	–	–	–	–	–	–	2.79	10.5
6.50	–	–	–	–	–	–	–	–	–	–	–	–	2.84	10.8
6.60	–	–	–	–	–	–	–	–	–	–	–	–	2.88	11.1
6.70	–	–	–	–	–	–	–	–	–	–	–	–	2.93	11.4
6.80	–	–	–	–	–	–	–	–	–	–	–	–	2.97	11.7
6.90	–	–	–	–	–	–	–	–	–	–	–	–	3.01	12.0
7.00	–	–	–	–	–	–	–	–	–	–	–	–	3.06	12.3
7.10	–	–	–	–	–	–	–	–	–	–	–	–	3.10	12.6

4.3 Pressure losses for system parts

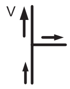
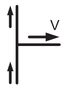
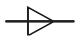
The ζvalues and the equivalent length of the pipelines were determined in accordance with the specifications of the SVGW (SV EN 1267).

Loading unit and ζ value
A loading unit **LU** is equal to a flow of 0.1 l/s.
The ζvalue for w = 2 m/s, as shown in the table.

4.3.1 Simplified representation for 1 loading unit (LU)

TV.15 **Pressure losses in JRG Sanipex MT system parts**

JRG code	Designation		Symbol[a]	Dimension	ζ value	Equivalent length of pipeline [m]
4630, 4632	JRG Sanipex MT box, 90°			1/2"-d16	1.3	0.45
				1/2"-d20	1.3	0.55
				3/4"-d20	1.6	0.65
4634	JRG Sanipex MT box, 2-way, 90°	Discharge		1/2"-d16-d16	4.0	1.40
				1/2"-d20-d16	3.2	1.10
		Flow rate		1/2"-d16-d16	1.5	0.55
				1/2"-d20-d16	0.7	0.25
				1/2"-d16-35 mm	3.0	1.05
4610	Connections to controls and instruments, single			1/2"-d16-35 mm	3.3	1.40
				1/2"-d20-50 mm	2.1	0.90
				3/4"-d26-50 mm	1.7	0.90
4611	Connections to controls and instruments, double	Discharge		1/2"-d16-d16-50 mm	2.7	1.00
		Flow rate		1/2"-d16-d16-50 mm	2.1	0.75
4640, 4645	Distributor including transition	Discharge		3/4"-d16	1.0	0.35
				3/4"-d20	0.8	0.35
		Flow rate		3/4"	0.5	–
4670, 4671, 4672	90° angle			d16	2.1	0.75
				d20	1.9	0.85
				d26	1.8	–
				d32	1.7	–
				d40	1.6	–
				d50	0.8	–
				d63	0.9	–
4676	45° angle			d20	0.7	0.30
				d26	0.6	–
				d32	0.6	–
				d40	0.6	–
				d50	0.4	–
				d63	0.5	–
–	90° pipe bend, with (manual) bending tool			d16	0.2	0.05
				d20	0.3	0.15
				d26	0.3	–
				d32	0.4	–
				d40	0.4	–
4607	90° pipe bend			d50	0.6	–
				d63	0.5	–

JRG code	Designation		Symbol[a]	Dimension	ζ value	Equivalent length of pipeline [m]
–	45° pipe bend, with (manual) bending tool			d16	0.1	0.05
				d20	0.2	0.10
				d26	0.2	–
				d32	0.3	–
				d40	0.3	–
4608	45° pipe bend			d50	0.5	–
				d63	0.4	–
4650, 4652, 4654, 4655	Tee (equal and reduced)	Flow rate		d16	0.5	0.15
				d20	0.5	0.20
				d26	0.3	–
				d32	0.2	–
				d40	0.3	–
				d50	0.2	–
				d63	0.3	–
4650, 4652, 4654, 4655	Tee (equal and reduced)	Pipe branch		d16	2.4	0.80
				d20	2.1	0.90
				d26	1.9	–
				d32	1.8	–
				d40	1.7	–
				d50	1.2	–
				d63	1.2	–
4690	Coupling			d16	0.3	0.10
				d20	0.3	0.15
				d26	0.4	–
				d32	0.5	–
				d40	0.5	–
				d50	1.2	–
				d63	1.2	–
4730	Reduction			d20	0.2	0.05
				d26	0.2	–
				d32	0.1	–
				d40	0.2	–
				d50	0.4	–
				d63	0.5	–

a The formula symbol v for flow velocity indicates the location of the relevant reference velocity in the fitting and connecting piece.

4.4 Discharge times

The discharge times indicate the time elapsed until a temperature of 40°C is reached at the tap (in accordance with SIA 385/2, 2015 edition) and signal the beginning of usability. These discharge times apply to fully opened taps set to maximum "hot". In the interests of economical water and energy consumption, these discharge times should not be set too high.

In order to keep the discharge losses within economically justifiable limits and at the same time to meet the comfort requirements of the hot water user, the requirements defined in [TV.16] for discharge periods apply.* A fitting installed at the installation site is used to carry out the measurement.

If it is not possible to choose a distribution system that conveys the hot water from the hot water storage tank to the tap within a reasonable time (discharge time), a circulation pipeline or auxiliary heating system must be planned and installed, or the arrangement of the sanitary equipment and riser zones must be optimised.

TV.16
Discharge times – Requirements
* Excerpt from SIA 385/1

Sanitary fixtures	Discharge time t [s]	
	without keeping warm (e.g. without circulation)	with keeping warm (e.g. with circulation)
Vanity unit, wash-hand basin, bidet, showers, bathtubs, sink (kitchen), utility sink	15	10

According to EN 806-2 also applies to the intended operation:

- Drinking water, cold: Max. 30 s after full opening of a tapping point:
  - Temperature must not exceed 25 °C.
- Drinking water, hot: Max. 30 s after full opening of a tapping point:
  - Temperature must be min. 55 °C.

According to VDI 6003 the following values result for different sanitary objects:

TV.17
Discharge times – Requirements
* Excerpt from VDI 6003 (requirement levels = comfort criteria)

Sanitary fixtures	Useful temperature [°C]	Discharge time t [s]*		
		Requirement level		
		I	II	III
Vanity unit	40	60	18	10
Shower	42	~26	10	7
Bathtub	45	~26	12	9
Flushing	50	60	18	10
Bidet	40	–	15	15
Whirlpool / Large tub	50	–	10	10

Factors influencing the output times include the following

TV.18 **Factors for output times**

Desired comfort	(criteria)
Floor plan	Distance to sanitary objects, grouping
Number of strings supplying the apartment	
Planning, construction and operation • Compliant with regulations (according to TRWI) or not	• with or without circulation system • Running time of the circulation pump. If the circulation pump is switched off, the distribution lines for domestic hot water will inevitably cool down. Fixed discharge times are then no longer to be observed. • Correct sizing of the circulation system, based on the product-specific resistance coefficients of the piping system.
Floor installation type	• Distribution with single supply line • Tee installation • Pipeline in series • Ring pipeline
Supply type hot water	• Individual supply line • Group supply: decentralized or centralized in apartments • Central supply: Storage system or storage charging system

Calculation

Calculating the discharge time
➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [12] 'Dimensioning'

The discharge times must be matched to the pipe dimension, length of the pipeline and the volume flows. Especially when using energy-saving mixers (flow restrictors), the effective volumetric flow must always be determined and converted (acc. to SIA 385/2, Issue 2015, Annex G), because the reduced volumetric flow results in a longer discharge time.

The calculation is based on the standard SIA 385/1, which contains the fundamental principles and requirements for domestic hot water systems. The calculation is also based on the standard SIA 385/2, which describes the hot water demand, the overall requirements and the design, such as the calculation of the discharge times.

Discharge times applicable to JRG Sanipex MT multilayer composite pipe

The table does not include fittings but only pipes.

- Input variables: Outside diameter d, wall thickness s_w
- Calculated sizes: [l/m], max. pipe length [m], discharge times [s/m]

TV.19 **Discharge times and lengths – JRG Sanipex MT multilayer composite pipe**

Pipe, Dimension				max. feasible duration of the discharge times [s] of						Discharge time [s] for each 1 m length of pipeline		
				15			10			Cold phase + warm-up phase		
			[l/s_w]	0.1	0.2	0.3	0.1	0.2	0.3	0.1	0.2	0.3
DN	d	s_w	[l/m]	max. length of pipeline [m]						[s]	[s]	[s]
8	12	1,7	0,055	13,5	27,0	40,6	9,0	18,0	27,0	1,1	0,6	0,4
12	16	2.25	0.104	7.2	14.4	21.6	4.8	9.6	14.4	2.1	1.0	0.7
15	20	2.5	0.177	4.2	8.4	12.7	2.8	5.6	8.4	3.5	1.8	1.2

4.5 Change in length and expansion compensation

Due to heat and depending on the material, pipelines expand to varying degrees. Even if the temperatures of the medium (e.g. drinking water) exceeds room temperature, this causes a thermal expansion and must be taken into account in the design of the installation.

How to calculate the change in length
In order to calculate the change in length, product and material-specific values are required:
➨ Technical data for system, Chapter. [2.1]

This thermally induced change in length can be compensated during the installation and mounting of the pipe. Suitable measures are:

- Directional changes of the pipeline
- Providing expansion space
- Installation of expansion joints
- Setting the fixed points and floating points

The bending and torsional forces occurring during the operation of a pipeline are safely absorbed, taking into account the above-mentioned measures. The following parameters have a significant influence on the expansion compensation:

- Material
- Structural conditions
- Operating conditions

Minor changes in length of the pipelines, especially if using smaller dimensions, can be compensated for by the elasticity of the piping system or with a corresponding insulation.

For larger piping systems, the changes in length must be absorbed by the **expansion joints**: Insulations, flexible pipe legs and U-shaped expansion loops compensate for the thermally induced change in length. The required measures for GF's plastic piping systems are – depending on the type of installation:

TV.20
Measures for the expansion compensation for plastic pipelines made by GF

Medium	Cold water	Hot water/circulation/heater	
Dimension	d12 – d63	d16 – d26	d32 – d63
Length of pipeline L ≤12 m	If using insulated pipelines, compensation for the change in length does **not** require floating points and fixed points		
Length of pipeline L ≥12 m	If using insulated pipelines, compensation for the change in length does **not** require floating points and fixed points		Compensation for the change in length requires floating points and fixed points

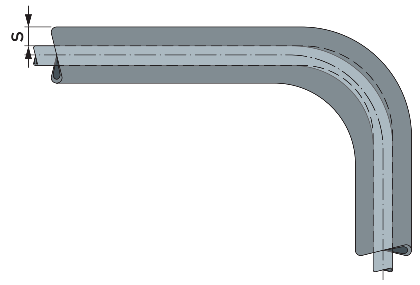
V

4.5.1 Compensation for the change in length by using insulation

When using insulation in order to compensate for the change in length, the minimum insulation thickness **s** must be at least 1.5 times the length change. From the calculated amounts of the change in length, the insulation thickness per meter of straight pipeline length is calculated according to the following formula:

$$s = 1.5 \cdot \Delta l$$

s Insulation thickness, min.
Δl Change in length



Installations with temperatures up to 60°C (ΔT = 50 K), a change in length Δl of 1.3 mm must be taken into account for each meter of straight pipe. This equals to an insulation thickness of 2.0 mm per meter of straight pipe length.

Insulation

General information on insulation:

➨ Part IV 'Plan', Section 'Insulation, Fire protection'

Information about insulation when installing riser pipes:

➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [13] 'Installation and attachment'

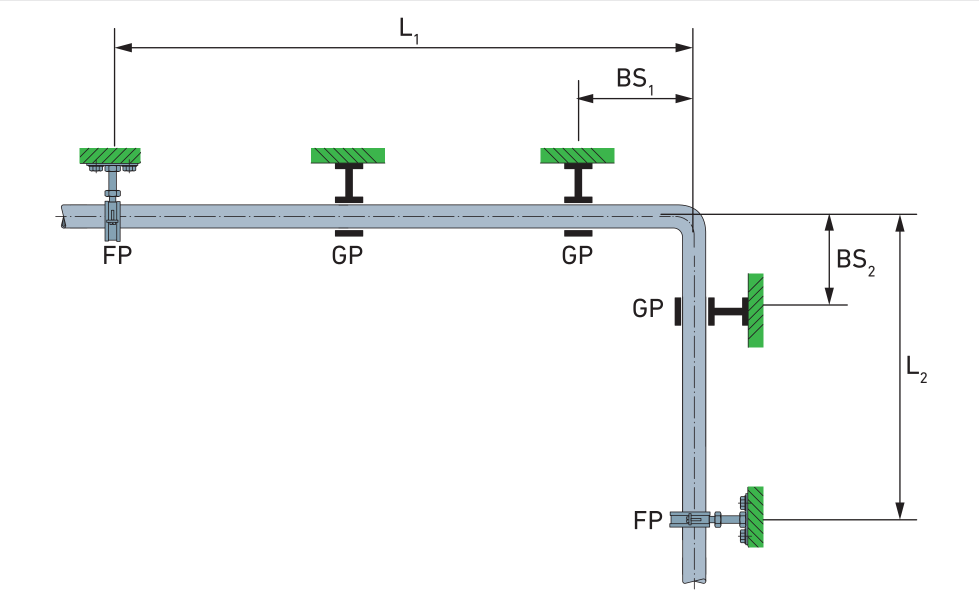
4.5.2 Compensation for the change in length by using expansion joints

Flexible pipe legs and **U-shaped expansion loops** are used as **expansion joints**. In order to ensure the function of the 2D expansion loop, **fixed points** and **floating points** (with sliding pipe clips) are installed.

Fixed points can be created at a suitable location along the pipeline, using a commercially available, precisely fitting fixed point clips or a system-specific solution (e.g. fixed point clip in combination with a system-specific fixed-point pipe clip).

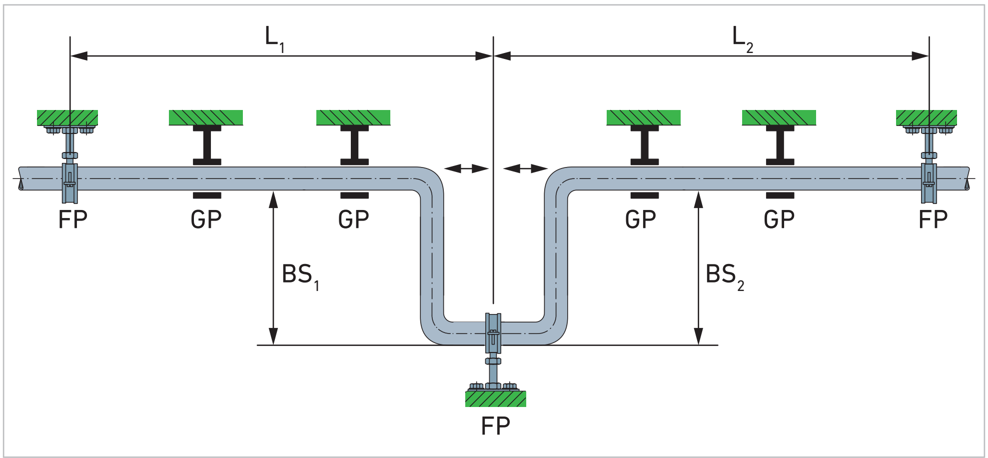
The **pipe clip** must assume the shape of the pipe and, when tightening the clip, the actual pipe diameter must not be constrict by more than 0.5 mm.

Examples – Basic design of a flexible pipe leg and U-shaped expansion loop



GV.9
Flexible pipe leg

FP Fixed point
GP Floating point (with sliding pipe clip)
BS Flexible pipe leg
L Pipe length between fixed point and deflection



GV.10
U-shaped expansion loop

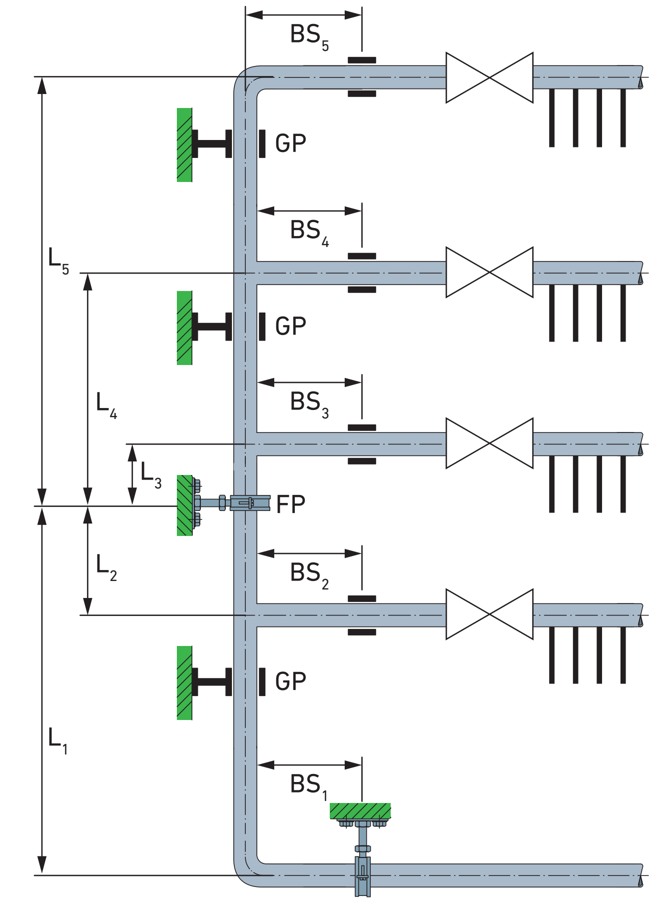
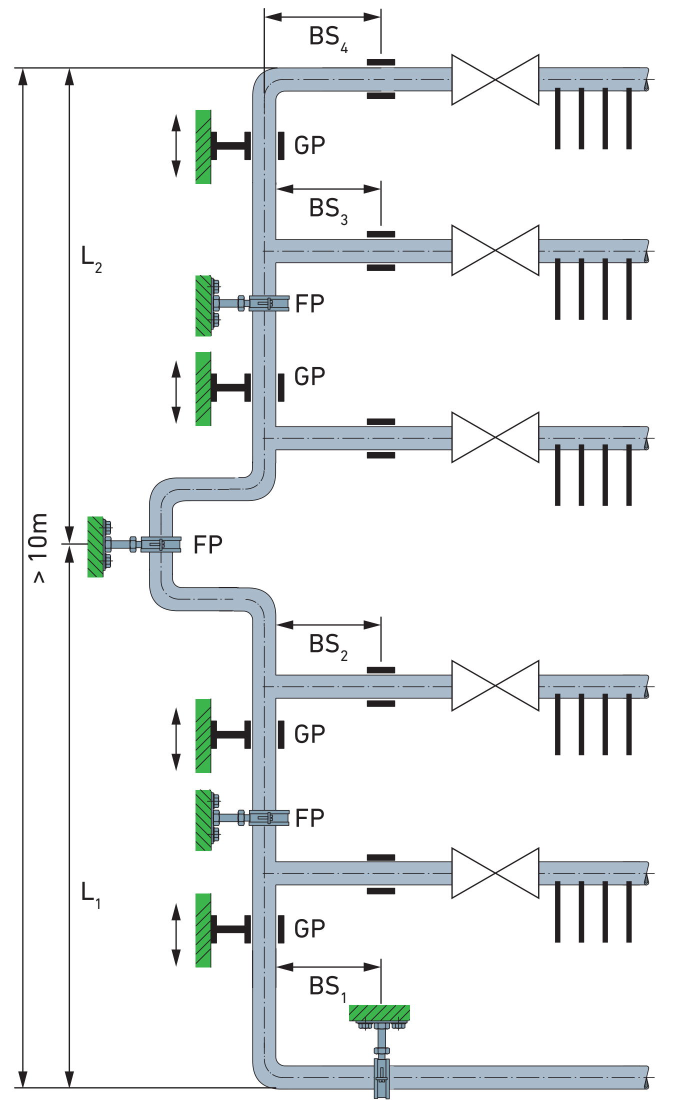
FP Fixed point
GP Floating point (with sliding pipe clip)
BS Flexible pipe leg
L Pipe length between fixed point and deflection

4.5.3 Fixed points and floating points when using riser pipes

If riser pipes are leading up to several storeys and accordingly have multiple fixed points, the change in length between the individual fixed points must be absorbed by the flexible pipe leg (BS). The sliding pipe clamp (GS) mounted to the horizontal pipe affects the **vertical** expansion of the pipe similar to a fixed point (FP).

Examples – Basic design of fixed points and floating points

TV.21 **Layout of fixed points and sliding clamps for riser pipes**

Riser pipe up to a height of 10 m	Riser pipe starting at a height of 10 m
	
Up to a **riser pipe height of 5 m,** neither a U-shaped expansion loop nor a fixed point shall be installed along the riser pipe. Up to a **riser pipe height of 10 m,** a U-shaped expansion loop can be omitted. In the middle of the riser pipe, however, a fixed point (FP) must be installed.	Starting at a **riser pipe height of 10 m,** a U-shaped expansion loop with fixed points (FP) must be installed at intervals of 10 m.

L_{1-5} Pipe length between fixed point and deflection
FP Fixed point
BS_{1-5} Flexible pipe leg
GP Floating point (with sliding pipe clip)

4.5.4 How to calculate the change in length

The **change in length of a pipeline** and the corresponding design of the flexible pipe leg and U-shaped expansion loop also depend on the material used. When calculating the change in length, this must be taken into account by using corresponding material-dependent parameters.

The **calculation of the length of the flexible pipe leg** depends on the design of the flexible pipe leg:

- If using a **flexible pipe leg** in order to compensate for an extension, or if a branch line is used, the length of the flexible pipe leg must be calculated.
- If a **U-shaped expansion loop** is used to compensate for the expansion, the length of both flexible pipe legs that form the U-shaped expansion loop must be calculated.

Material constant and coefficient of thermal expansion

In order to calculate the change in length, product and material-specific values are required:

➨ Technical data for system, Chapter. [2.1]

How to calculate the change in length

The thermally induced **change in length** Δl of pipes is calculated (in non-resisting installations) from the **temperature difference** ΔT and the **pipe length** L, using the following formula:

$$\Delta l = \alpha \cdot L \cdot \Delta T$$

Symbol	Meaning	Unit	Remark
L	Length of pipeline	[m]	–
α	Linear coefficient of thermal expansion	[mm/(m·K)]	product/material-specific
Δl	Change in length	[mm]	–
ΔT	Temperature difference	[K]	–

Example on how to calculate a multilayer composite pipe

The length of the pipeline is 7 m. The thermally induced change in length of this pipe section must be absorbed by a flexible pipe leg. The difference between the installation temperature and the maximum operating temperature is 60 K (10 to 70°C).

Multilayer composite pipe, Sanipex MT, Dimension	d40
Length of pipeline L	7 m
Linear coefficient of thermal expansion α	0.024 mm/(m·K)
Temperature difference ΔT	60 K

How to calculate the change in length

$$\Delta l = \alpha \cdot L \cdot \Delta T$$

$$\Delta l = 0.024\ [mm/(m{\cdot}K)] \cdot 7\ [m] \cdot 60\ [K]$$

$$\Delta l = 10.08\ mm$$

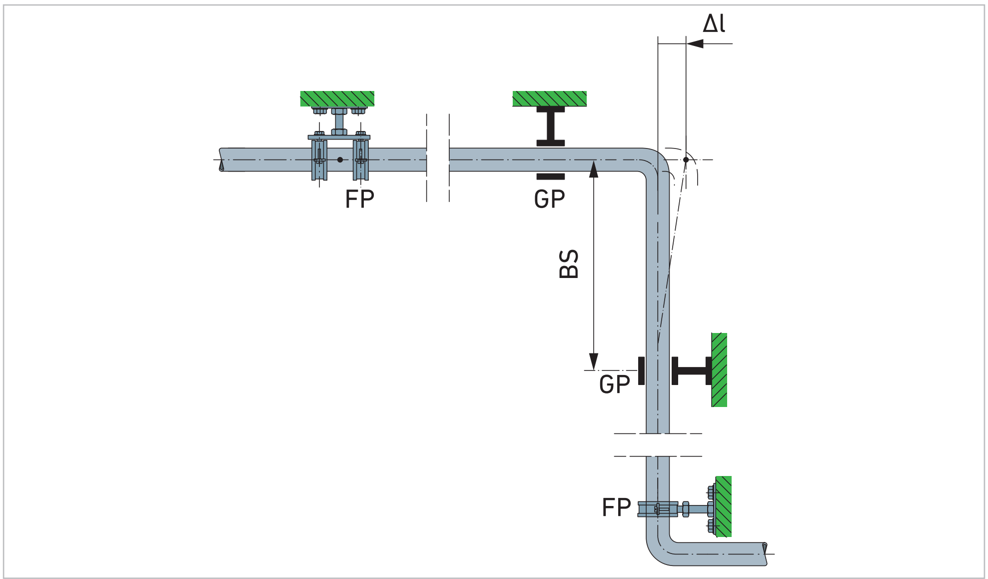
V

4.5.5 Calculation of the length of the flexible pipe leg

Calculation of the length of the flexible pipe leg

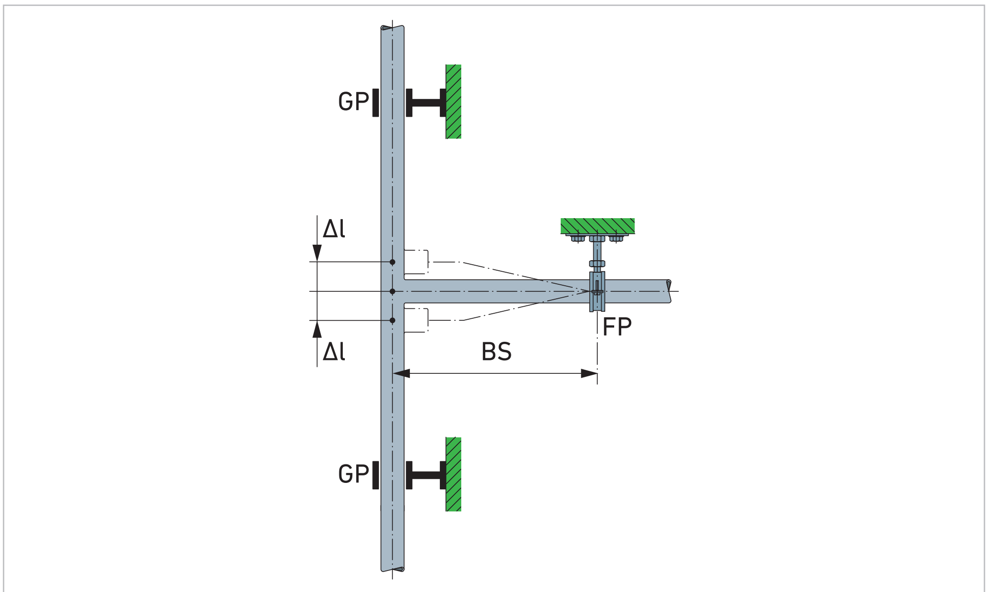
Due to the thermally induced change in length **Δl** , a pipeline shifts a pipe bend by a value **Δl**. This change must be absorbed by a flexible pipe leg with a length equal to **BS**.

Length of flexible pipe leg



GV.11
Length of flexible pipe leg
GP Floating point
FP Fixed point
BS Length of flexible pipe leg

Length of flexible pipe leg intended to use for the branch line



GV.12
Length of flexible pipe leg
GP Floating point
FP Fixed point
BS Length of flexible pipe leg

The **length of the flexible pipe leg** BS is calculated from the **change in length** Δl and the **outside diameter** d of the pipe, using the following formula:

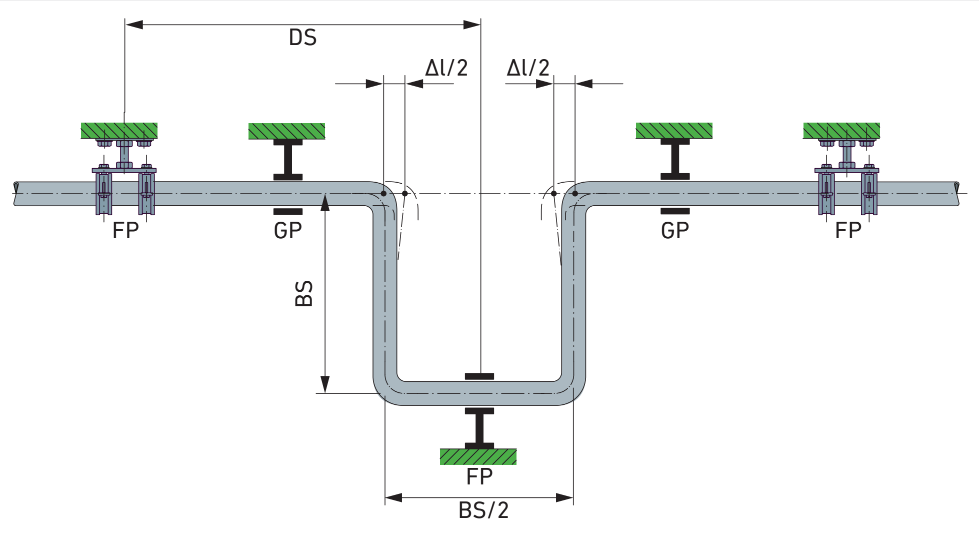
$$BS = C \cdot \sqrt{d \cdot \Delta l}$$

Symbol	Meaning	Unit	Remark
BS	Length of flexible pipe leg	[mm]	–
d	Outside diameter of pipe	[mm]	–
Δl	Change in length	[mm]	–
C	Material constant	–	product/material-specific

Calculation of the length of the flexible pipe leg in a U-shaped expansion loop

Due to the thermally induced change in length, **Δl** a pipe displaces a U-shaped loop at both bends by half the value **Δl**. This change must be absorbed by the two flexible pipe legs **BS**.

Length of the U-shaped expansion loop



GV.13
Length of the U-shaped expansion loop

GP Floating point
FP Fixed point
BS Length of flexible pipe leg
DS Length of the 2D expansion loop

Example on how to calculate a multilayer composite pipe

The length of the pipeline is 7 m. The thermally induced change in length of this pipe section must be absorbed by a flexible pipe leg. The difference between the installation temperature and the maximum operating temperature is ~60 K.

Sanipex MT Pipe, Dimension	d40
Material constant C	33
Change in length Δl	10.08 mm

Calculation of the length of the flexible pipe leg

$$BS = C \cdot \sqrt{d \cdot \Delta l}$$

$$BS = 33 \cdot \sqrt{(40\ mm \cdot 10.08\ mm)}$$

$$BS = 660\ mm$$

In order to simplify the determination of the required length of the flexible pipe leg, a material-specific diagram can also be used to determine the length of the flexible pipe leg.

When comparing this result with the result of a metal pipe – which has the same dimension – the size of a flexible pipe leg made of metal will be significantly larger. The explanation for this is the much higher material constant C for metal pipes than the material constant C for a PB pipe.

4.6 Diagrams – Change in length and length of flexible pipe leg

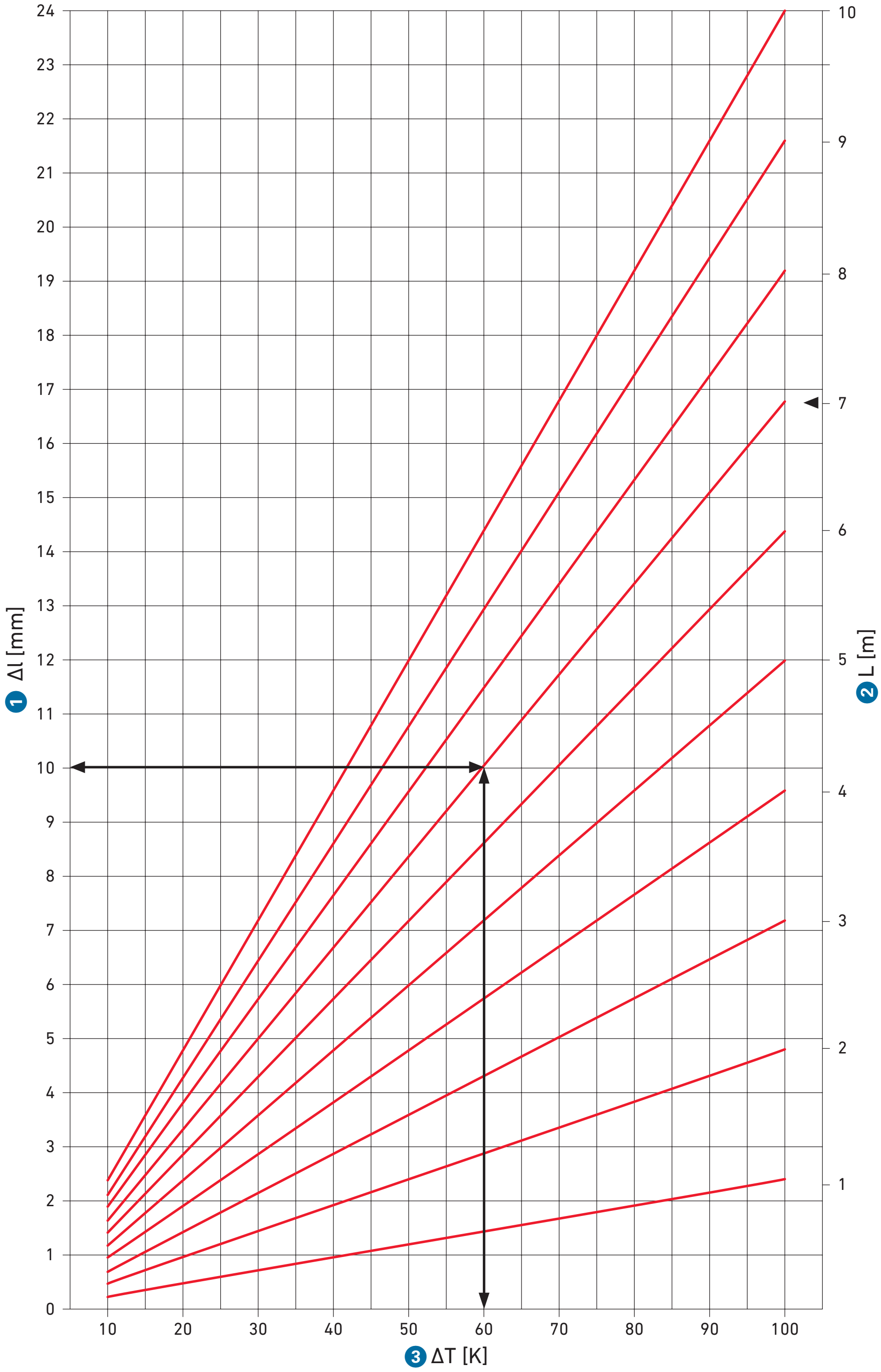
4.6.1 Change in length

The diagram shows the length expansion of JRG Sanipex MT pipes as a function of the temperature and length of the pipe, if installed without resistance.

How to read the table

Sanipex MT, Dimension	d40
Length of pipeline L	7 m
Linear coefficient of thermal expansion α	0.024 mm/(m·K)
Temperature difference ΔT	60 K

Δl = 10.08 mm



GV.14
Change in length – JRG Sanipex MT Pipes

1 Change in length
2 Length of pipeline
3 Temperature difference

TV.22 **Thermally induced change in length (with linear coefficient of thermal expansion) – JRG Sanipex MT pipes**

Length of pipeline [m]	Temperature difference ΔT [K]						
	10	20	30	40	50	60 ▼	70
	Change in length [mm]						
1	0.2	0.5	0.7	1.0	1.2	1.4	1.7
2	0.5	1.0	1.4	1.9	2.4	2.9	3.4
3	0.7	1.4	2.2	2.9	3.6	4.3	5.0
4	1.0	1.9	2.9	3.8	4.8	5.8	6.7
5	1.2	2.4	3.6	4.8	6.0	7.2	8.4
6	1.4	2.9	4.3	5.8	7.2	8.6	10.1
7 ▶	1.7	3.4	5.0	6.7	8.4	10.1	11.8
8	1.9	3.8	5.8	7.7	9.6	11.5	13.4
9	2.2	4.3	6.5	8.6	10.8	13.0	15.1
10	2.4	4.8	7.2	9.6	12.0	14.4	16.8
20	4.8	9.6	14.4	19.2	24.0	28.8	33.6
30	7.2	14.4	21.6	28.8	36.0	43.2	50.4
40	9.6	19.2	28.8	38.4	48.0	57.6	67.2
50	12.0	24.0	36.0	48.0	60.0	72.0	84.0

▶ Example for L = 7 m: ΔT = 60 K

V

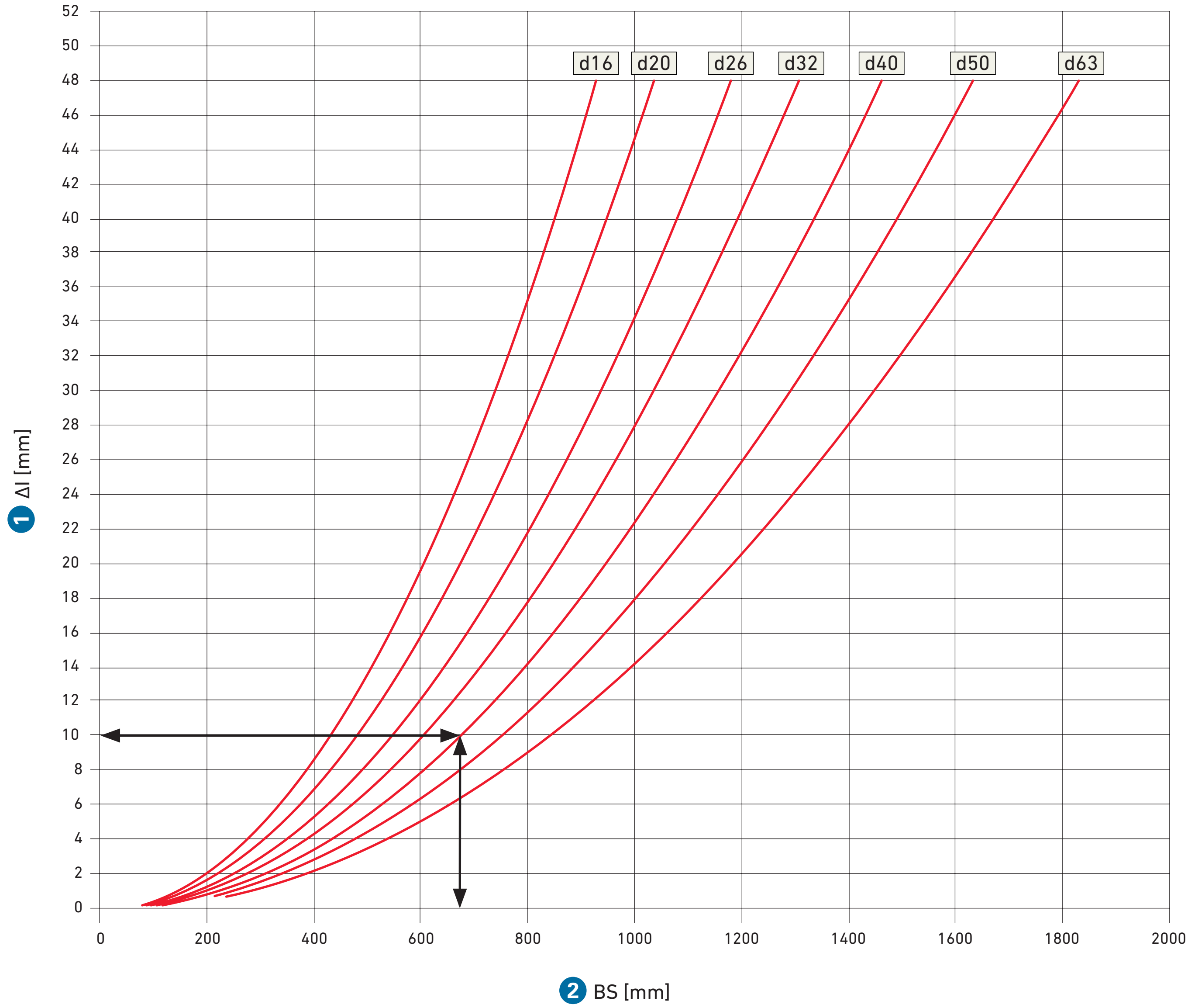
4.6.2 Length of flexible pipe leg

The length of the flexible pipe leg is derived from the pipe's change in length.

How to read the table

Sanipex MT Pipe, Dimension	d40
Material constant C	33
Change in length Δl	10.08 mm

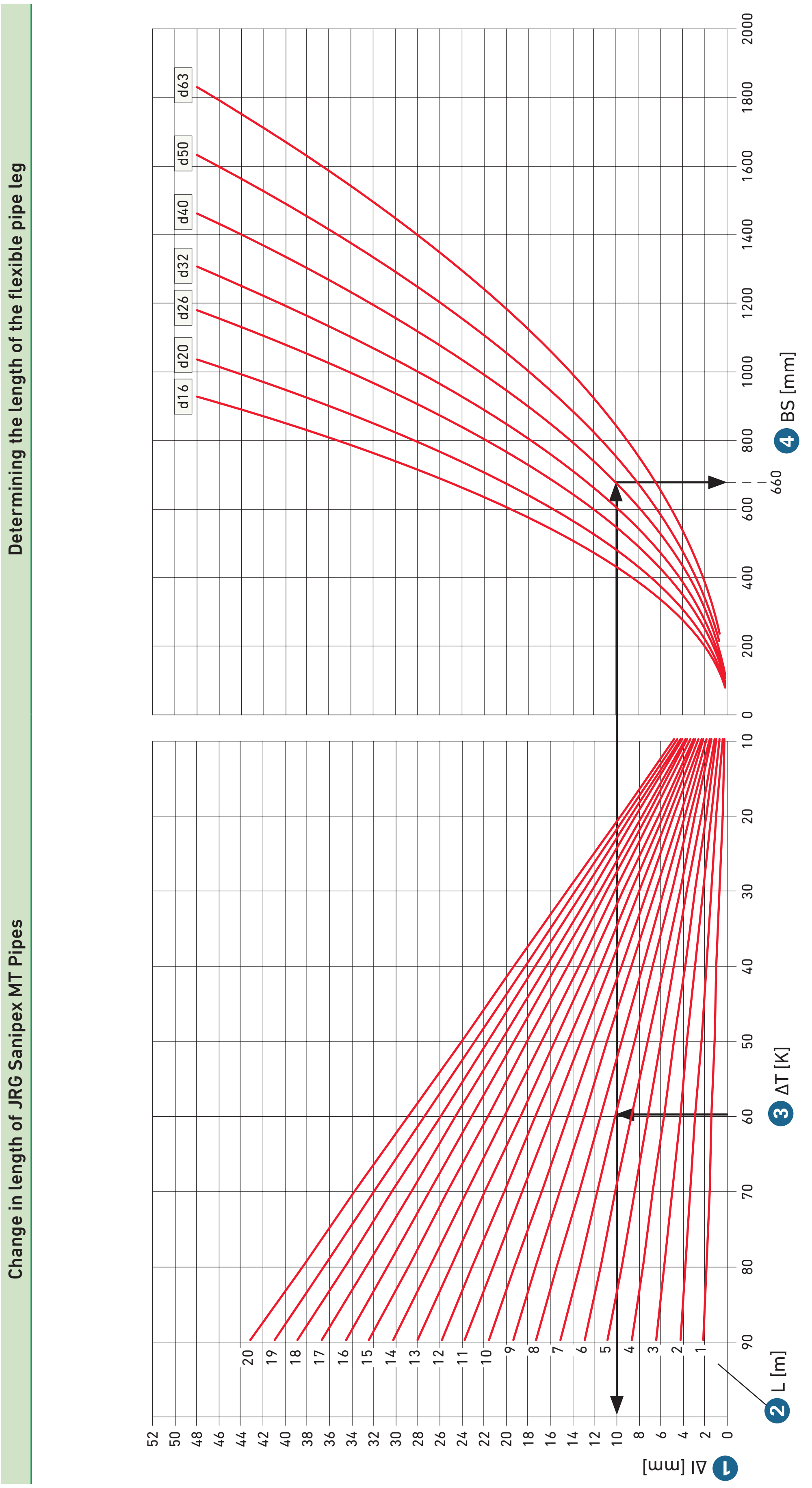
BS = 660 mm



GV.15
Length of flexible pipe leg
1 Change in length of the pipe
2 Length of flexible pipe leg

Graphic determination of the length of flexible pipe leg

The length of the flexible pipe leg can be determined with the two combined diagrams.



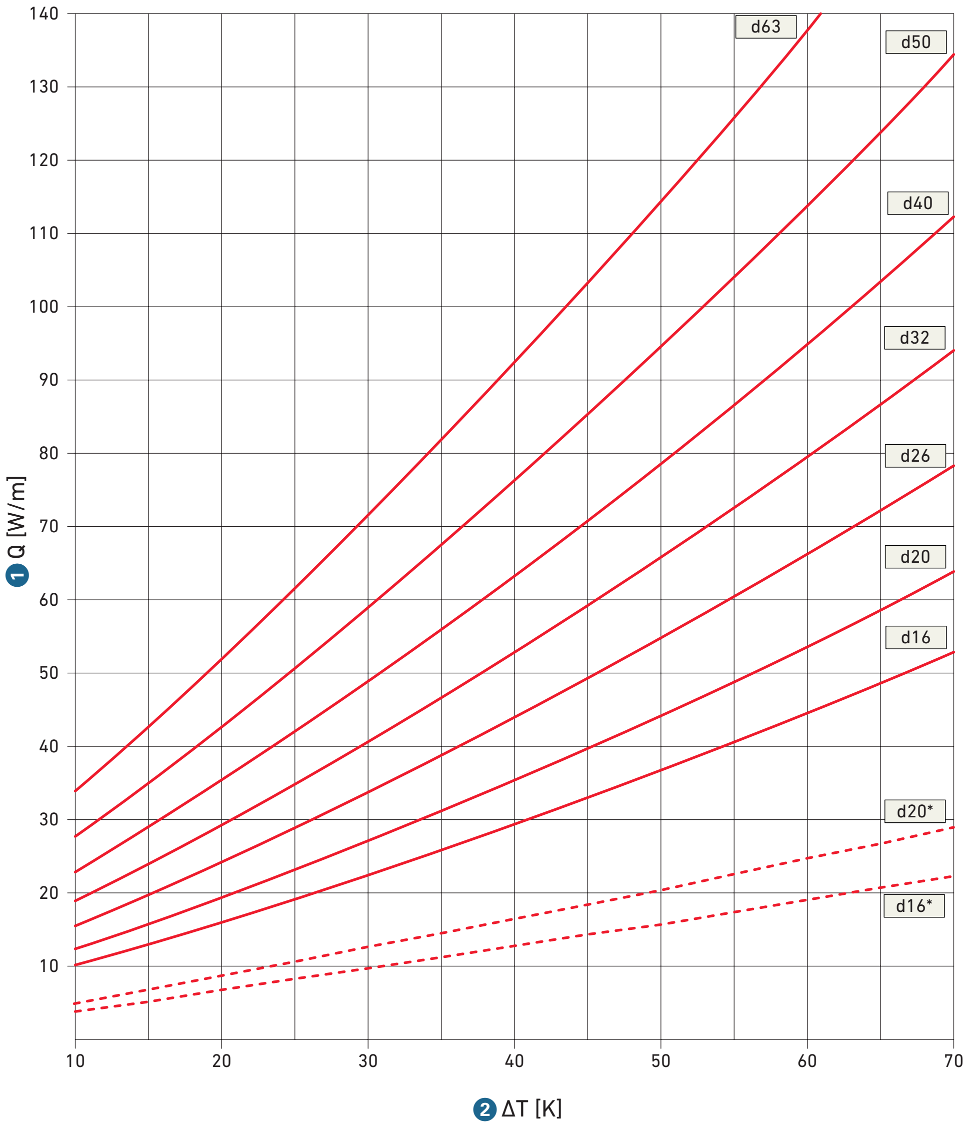
How to use the diagram

1. Read off temperature difference 3 .
2. Select the length of pipeline 2.
3. Read change of length 1 .
4. Read off the pipe dimension.
5. Read length of the flexible pipe leg 4 .

1 Change in length
2 Length of pipeline
3 Temperature difference
4 Length of flexible pipe leg

4.7 Heat emission and insulation

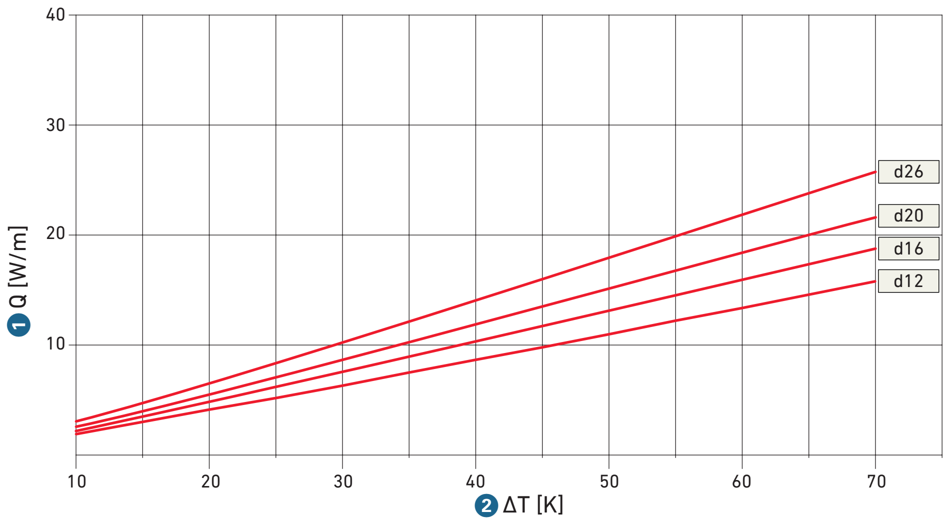
JRG Sanipex MT pipe, with/without PE protective conduit



GV.16
Heat emission – JRG Sanipex MT pipe, with/without PE protective conduit

- * inside the protective conduit
- 1 Heat emission
- 2 Temperature difference

JRG Sanipex MT Multilayer composite pipe, pre-insulated, 6 mm

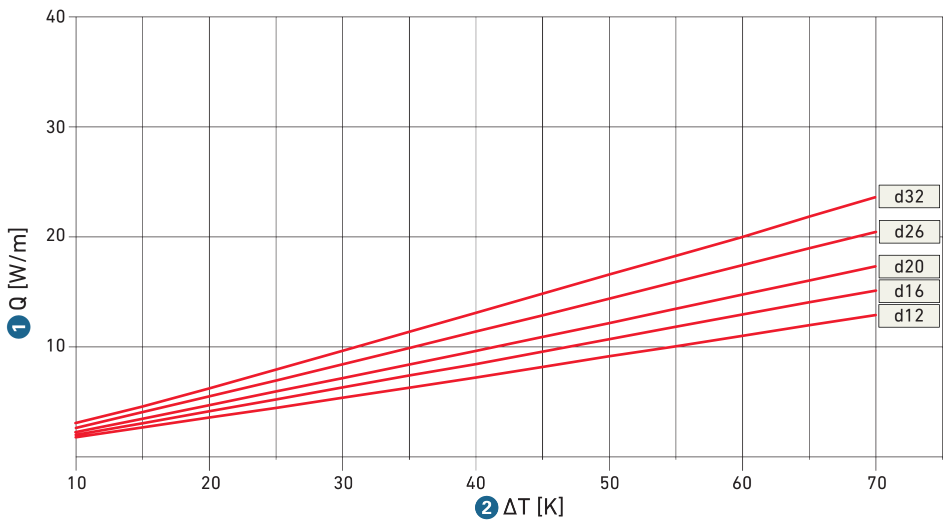


GV.17
Heat emission – JRG Sanipex MT multilayer composite pipe, pre-insulated

Graph showing a 6 mm insulation with WLG 035

- 1 Heat emission
- 2 Temperature difference

JRG Sanipex MT Multilayer composite pipe, pre-insulated, 10 mm

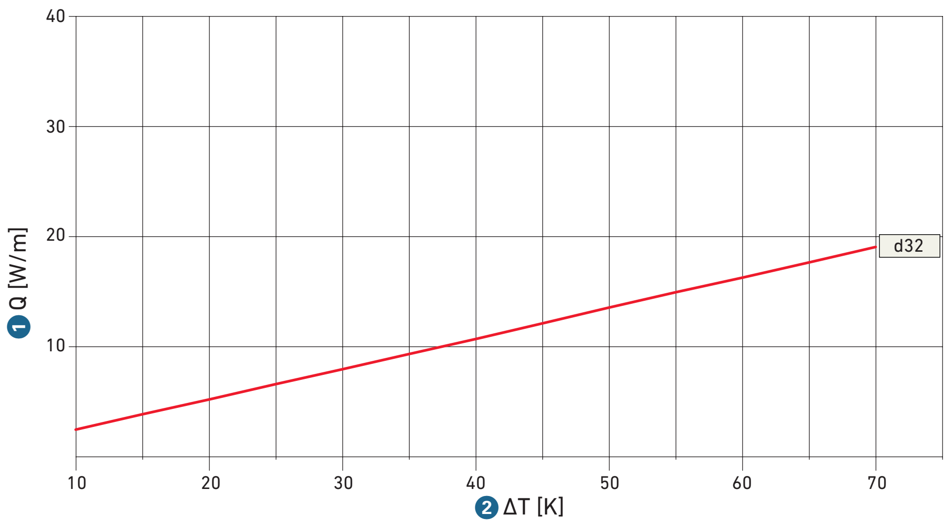


GV.18
**Heat emission –
JRG Sanipex MT multilayer composite pipe, pre-insulated**

Graph showing a 10 mm insulation with WLG 035

1. Heat emission
2. Temperature difference

JRG Sanipex MT Multilayer composite pipe, pre-insulated, 15 mm

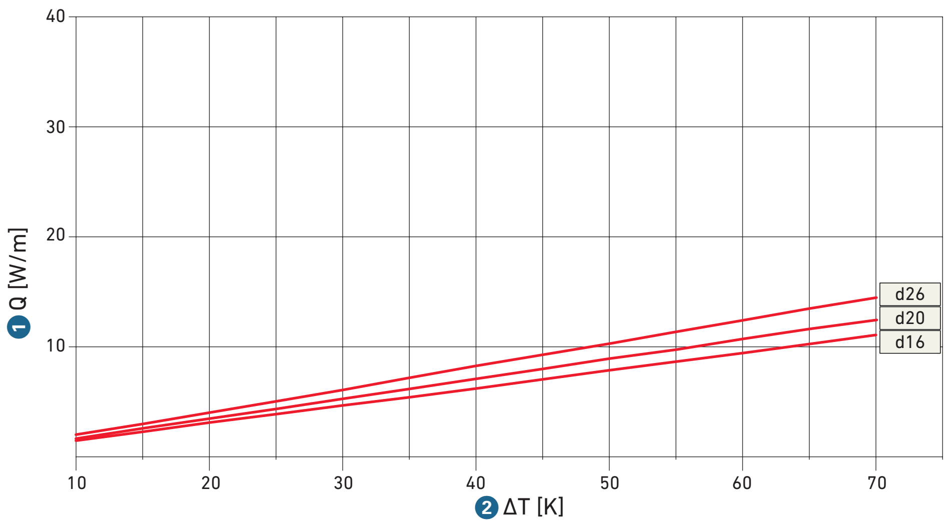


GV.19
**Heat emission –
JRG Sanipex MT multilayer composite pipe, pre-insulated**

Graph showing a 15 mm insulation with WLG 035

1. Heat emission
2. Temperature difference

JRG Sanipex MT Multilayer composite pipe, pre-insulated, 20 mm



GV.20
**Heat emission –
JRG Sanipex MT multilayer composite pipe, pre-insulated**

Graph showing a 20 mm insulation with WLG 035

1. Heat emission
2. Temperature difference

5 Insulation according to EnEV 2017

Insulation
General information on insulation:
➨ Part IV 'Plan', Section 'Insulation, Fire protection'

Country-specific regulations
The insulation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.
☑ When it comes to insulation methods, compliance with the applicable rules and regulations is mandatory.

The Energy Saving Ordinance (EnEV) requires limiting the heat output of heat distribution and hot water pipes. It replaces the previous Heating Installations Ordinance (HeizAnlV) and the Thermal Insulation Ordinance (WSchVO). The EnEV has been valid in **Germany** for building applications or submitted building notices since 01.02.2002, the current, revised version is the EnEV 2017. For new construction and modernization of heat distribution and hot water pipes and their fittings in buildings, these insulation regulations must be observed.

5.1 Insulation requirements of the EnEV 2017

The requirements are defined in table [TV.23] defined:
- Heating pipes and their fittings: according to lines 1 to 2
- Hot water pipes and fittings: according to lines 1 to 5
- Refrigerant distribution/chilled water lines: according to line 8

TV.23 **Insulation requirement of the EnEV 2017, Table 1**

Minimum insulation requirement	Rows	Type of pipes and fittings	Minimum thickness of the insulation layer [mm]*.
100%	1	Inner diameter d_i 22 mm	20
100%	2	Inner diameter$_{di}$ over 22 mm to 35 mm	30
100%	3	Inner diameter$_{di}$ over 35 mm to 100 mm	= Internal diameter
100%	4	Inner diameter d_i over 100 mm	100
50%	5	Lines and fittings according to lines 1 to 4 In wall and ceiling penetrations, in the intersection area of lines, at line connection points, at central line network distributors	50% of the requirements of lines 1 to 4
50%	6	Heat distribution lines according to lines 1 to 4, which were installed after January 31, 2002 in building components between heated rooms of different users	50% of the requirements of lines 1 to 4
6 mm	7	Lines according to line 6 in the floor structure	6
6 mm	8	Refrigeration distribution and chilled water piping and fittings of room air conditioning and air conditioning refrigeration systems.	6

Source: EnEV 2017, Table 1, Annex 5 (to Section 10 (2), Section 14 (5) and Section 15 (4))
* related to a thermal conductivity of λ = 0.035 W/(m K)

Supplementary information

1.

In cases of §10 par. 2 and §14 par. 5:

→ Comply with the requirements of lines 1 to 7, unless otherwise specified in other provisions of the EnEV 2017.

In cases of §15 par. 4:

→ Comply with the requirements of line 8, unless otherwise specified in other provisions of the EnEV 2017.

If in cases of §14 par. 5 heat distribution and hot water pipes border on outside air:

→ Insulate these pipes with twice the minimum thickness according to lines 1 to 4 ⚡

2.

In cases of §14 par. 5:

→ [TV.23] **not** apply insofar as heat distribution lines according to lines 1 to 4 are located in heated rooms or in building components between heated rooms of a user and their heat output can be influenced by exposed shut-off devices.

In cases of §10 par. 2 and §14 par. 5:

→ Data in table [TV.23] do not apply to hot water pipes up to 3 liters, which are neither included in the circulation circuit nor equipped with electric trace heating and are located in heated rooms (stubs).

Although there are no legal requirements here, insulation should be used for reasons of corrosion protection, to prevent cracking and flowing noises, to insulate structure-borne noise and to reduce the thermal load.

3.

For materials with thermal conductivities other than 0.035 W/(m K):

→ Convert minimum thicknesses of insulation layers accordingly. For conversion and thermal conductivity, use the calculation methods and values contained in the recognized rules of technology.

Proof must be provided by the manufacturer.

4.

For heat distribution and hot water pipes as well as cold distribution and cold water pipes:

The minimum thicknesses of the insulation layers according to [TV.23] may be reduced if an equivalent limitation of heat dissipation or heat absorption is also ensured with other pipe insulation arrangements and taking into account the insulating effect of the pipe walls.

5.1.1 Minimum thickness of insulation layers

The minimum thickness of the insulation layers, which are based on the inner diameter di, are related to a thermal conductivity of λ = 0.035 W/(m K) (WLG 035) (see in the following tables: red highlights). The following tables show the minimum insulation thicknesses for different thermal conductivities λ.

TV.24 **Minimum thickness of the insulation layer for pipes with 100% requirement** ([TV.23], **line ❶-❹**)

Thermal conductivity λ [W/(m K)]	16 x 2.25 12	20 x 2.50 15	26 x 3.00 20	32 x 3.00 25	40 x 3.50 32
0,025	11	11	12	17	18
0,030	15	15	16	23	24
0,035	**20**	**20**	**20**	**30**	**30**
0,040	26	26	25	38	38
0,050	44	41	39	59	57

TV.25 **Minimum thickness of the insulation layer for pipes with 50% requirement** ([TV.23], **line ❺-❻**)

Thermal conductivity λ [W/(m K)]	16 x 2.25 12	20 x 2.50 15	26 x 3.00 20	32 x 3.00 25	40 x 3.50 32
0,025	6	6	6	6	6
0,030	8	8	8	12	12
0,035	**10**	**10**	**10**	**15**	**15**
0,040	13	13	12	18	18
0,050	20	19	18	27	27

5.2 Insulation of drinking water pipes (cold)

Insulation of drinking water pipes (cold) is not covered by the EnEV 2017 covered. If there is no risk of legionella due to heating of the cold water, the insulation requirements according to DIN 1988-200 Table 8.

Insulation of drinking water pipes (cold)
➨ Part IV 'Plan', Section 'Insulation, Fire protection', Chapter [1.3] 'Insulating drinking water pipes (cold)')

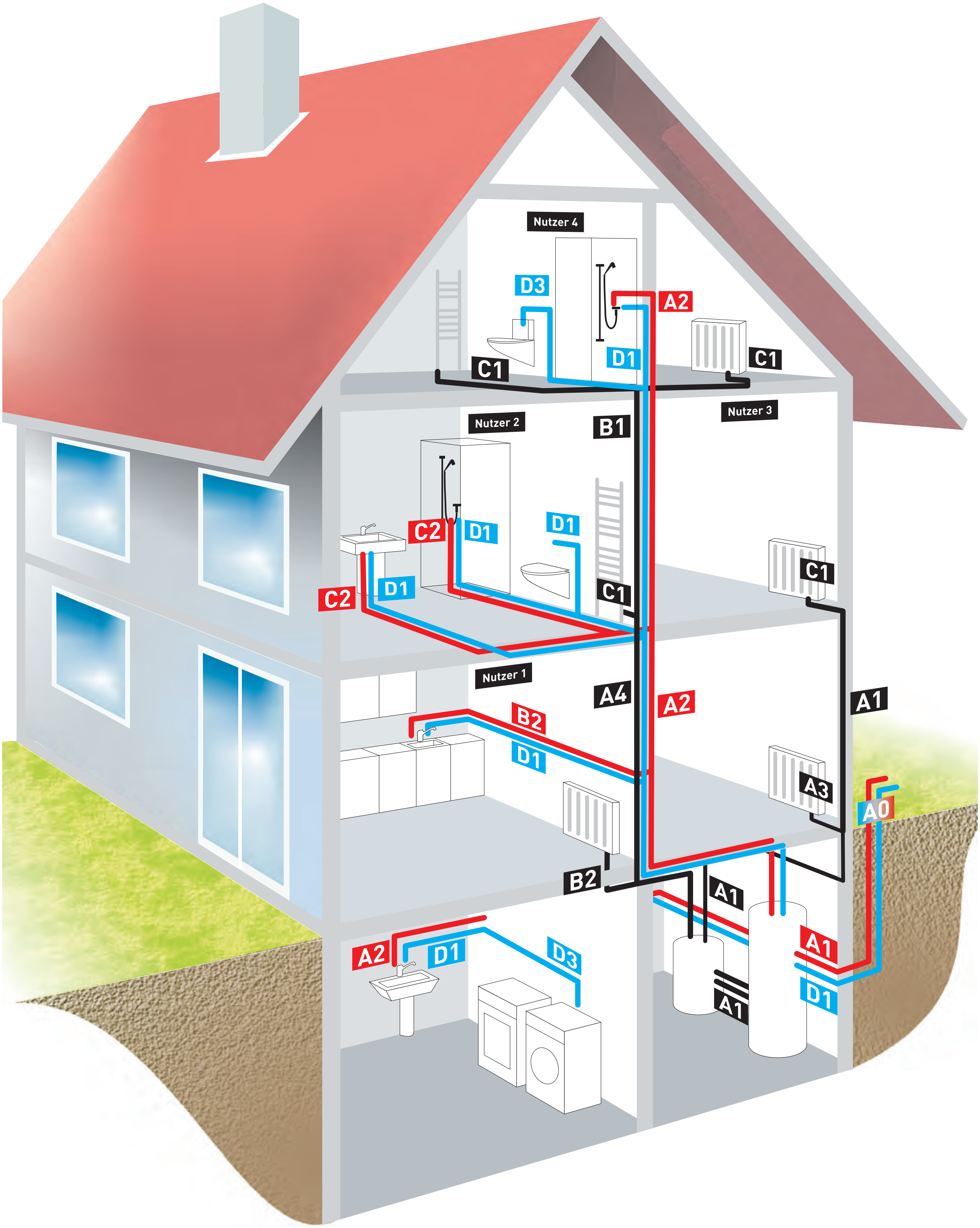
However, in order to minimize the risk of legionella, the insulation thicknesses according to EnEV 2017, Annex 5, Table 1 in conjunction with DVGW W 551 and DVGW W 553 are recommended. During stagnation periods, even insulation cannot provide sufficient protection against heating.

Actions:
→ Protect cold drinking water systems from inadmissible heating and, if necessary, condensation.
→ Locate cold-flowing potable water lines at a sufficient distance from heat sources. If this is not possible, insulate the pipes so that the heating does not adversely affect the drinking water's quality.

Inadequately insulated cold water pipes can also cause condensation to form on the surface of the insulation layer, and unsuitable materials can become damp through. Therefore, closed-cell or comparable materials with high water vapor diffusion resistance should be used. All joints, cuts, seams and end points must be sealed water vapor-tight.

5.3 Application

Due to these insulation regulations, heating and hot water pipes and their fittings in single-family and multi-family houses must be insulated, as shown in the following examples.



TV.26 **Heating and hot water pipes according to EnEV 2017**

Area	Installation situation pipelines	Insulation requirements [mm], for WLG 035
A0	• Heat distribution lines laid directly adjacent to the outside air	200% insulation
A1	• In exterior walls • In unheated rooms • Basement distribution pipelines	100% insulation ([TV.23], line 1 to 4)
A2	• Hot water pipes with/without circulation pipes • Circulation pipelines • Hot water pipes in basements with/without electrical trace heating	
A3	• Heating pipes in the room's floor structure intended for permanent residence of persons, against unheated rooms or ground or outside air.	
A4	• Distribution lines for the supply of several parties	
B1	• Pipes between heated rooms of different users	50% minimum insulation requirement ([TV.23], line 5 to 6)
B2	• Pipes and fittings in wall and ceiling openings • In areas where pipes are crossing • At pipe connection points • At pipe connection points • For central line network distributors	
C1	• Heating pipes in the floor structure between heated rooms of different users	6 ([TV.23], line 7 to 8)
C2	• No requirements for the minimum thickness of the insulation layer are imposed on heat distribution lines located in heated rooms or in components between heated rooms of a user and their heat emission can be influenced by exposed shut-off devices • Hot water pipes up to the inner diameter of 22 mm, which are neither included in the circulation circuit nor equipped with electric trace heating, are also exempt from these requirements	No requirement* (see "Supplementary information" in [TV.23])

* **NOTE:** This type of installation does not meet sound insulation requirements (prevention of structure-borne sound transmission). The thermal mobility of the pipeline (linear expansion) must also be ensured. Insulation is required to prevent structure-borne noise, cracking and flowing noises and the heating of other components. This is therefore recommended from a construction and economic point of view, even in this case, although the regulation text of the EnEV 2017 does not mandatorily require this.

TV.27 **Cold water pipes according to EnEV 2017**

Area	Installation situation pipelines	Insulation requirements [mm], for WLG 035
D1	• Pipes next to hot water pipes • Pipes in wall recesses next to hot water pipes • Pipes in the duct next to hot water pipes	10
D2	• Lines freely laid in heated room	6
D3	• Lines freely laid in unheated space • Pipes in the duct without hot water pipes • Lines in the wall slot, riser • Pipes on concrete ceilings	6

1. For materials with thermal conductivities other than 0.035 W/(m K):

→ Convert minimum thicknesses of insulation layers accordingly. For conversion and thermal conductivity, use the calculation methods and values contained in the recognized rules of technology.

Proof must be provided by the manufacturer.

2. Piping in areas subject to frost:

If pipelines are located in frost-prone areas, even insulation cannot provide sufficient and permanent protection against freezing during downtimes. They must be drained or otherwise protected (e.g. by trace heating). Details are regulated by the VDI guidelines VDI 2055 or VDI 2069.

3. In conjunction with DVGW W551 and DVGW W553 the insulation thicknesses according to EnEV 2017 are also recommended for **cold water pipes** to minimize the risk of legionella.

V

5.4 Insulation according to EnEV 2017 - Solutions with JRG Sanipex MT

The pre-insulated pipes of the JRG Sanipex MT system comply with EN 12667 a thermal conductivity of 0.035 W/(m K). This meets the highest requirements for thermal insulation of piping systems. This also means that the pipe packages in the overall structure are significantly slimmer than most competitor solutions, which use insulation with λ = 0.040 W/(m K), while retaining the same thermal insulation properties. This also has a positive effect on the flexibility of the piping system.

Insulation and fire protection with Sanipex

The insulation of the JRG Sanipex system meets the requirements of class E according to EN 13501-1.

Fire protection
See the legal requirements as they apply to fire protection (prevention of the transmission of fire and smoke to other fire compartments) in the amended state building codes and the introductory decrees of technical building regulations (ETB).
General information on fire protection:
➨ Part IV 'Plan', Section 'Insulation, Fire protection'

TV.28 **Heating and hot water pipes according to EnEV 2017** ([TV.23])

Area	Installation situation pipelines	Insulation requirements [mm], for WLG 035	Sanipex MT [Art.No.]
A0	Details: see table [TV.26]	200% insulation	Solution must be provided by the customer
A1 A2 A3 A4		100% insulation ([TV.23], line 1 to 4)	4606.216, 4606.220, 4606.226, 5710.212, 5710.216, 5710.220
B1 B2		50% minimum insulation requirement ([TV.23], line 5 to 6)	4606.116, 4606.120, 4606.126, 5710.112, 5710.116, 5710.120
C1		6 mm ([TV.23], line 7 to 8)	4606.016, 4606.020, 4606.026, 5710.012, 5710.016, 5710.020
C2		No requirement* (see "Supplementary information" at [TV.23])	4602.016, 4602.020, 5706.012, 5706.016, 5706.020, 5706.025, 5711.012, 5711.016, 5716.012, 5716.016, 5716.020

TV.29 **Cold water pipes according to EnEV 2017**

Area	Installation situation pipelines	Insulation requirements [mm], for WLG 035	Sanipex MT [Art.No.]
D1	Details: see table [TV.27]	10	4606.116, 4606.120, 4606.126, 5710.112, 5710.116, 5710.120
D2		6	4606.016, 4606.020, 4606.026, 5710.012, 5710.016, 5710.020
D3		6	4606.016, 4606.020, 4606.026, 5710.012, 5710.016, 5710.020

5.4.1 Application criteria applicable to JRG Sanipex MT pipes

Pipes d12 to d26 with 6 mm insulation / pipes d32 with 10 mm insulation

- Consisting of pipe and insulation
- Delivery in coils, 50 m long (100 m for dimension d12)
- Concentric pipe insulation made of polyethylene foam with closed-cell material structure
- Insulation thickness 6 mm, WLG 035
- With durable, seamless foil coating, colour grey
- Building material class E

Can be used e.g. for:

- Drinking water pipes cold according to DIN 1988-2 (Table 9)
- Pipes of central heating systems in the floor structure between heated rooms of different users according to EnEV 2017 (Annex 5, Table 1, line 7)
- Refrigeration distribution and chilled water pipes according to EnEV 2017 (Annex 5, Table 1, line 8)

In addition, uninterrupted impact sound insulation is necessary.

Pipes d12 to d26 with 10 mm insulation / pipes d32 with 15 mm insulation (50% EnEV)

- Consisting of pipe and insulation
- Delivery in coils, 50 m long (100 m for dimension d12)
- Concentric pipe insulation made of polyethylene foam with closed-cell material structure
- Insulation thickness 10 mm, WLG 035
- With durable, seamless foil coating, colour grey
- Building material class E

Can be used e.g. for:

- Heating and hot water pipes with insulation requirements 50% according to EnEV 2017 (Annex 5, Table 1, Lines 5 and 6).

In order to minimise the risk of legionella, the insulation thicknesses according to EnEV 2017 in conjunction with DVGW W551 and DVGW W553 are also recommended for cold water pipes. In addition, uninterrupted impact sound insulation is necessary.

Pipes d16 to d26 with 20 mm insulation (100% EnEV)

- Consisting of pipe and insulation
- Delivery in coils, 50 m long
- Concentric pipe insulation made of polyethylene foam with closed-cell material structure
- Insulation thickness 20 mm, WLG 035
- With durable, seamless foil coating, colour grey
- Building material class E

Can be used e.g. for:

- Heating and hot water pipes with insulation requirements 100% according to EnEV 2017 (Annex 5, Table 1, Line 1).

In order to minimise the risk of legionella, the insulation thicknesses according to EnEV 2017 in conjunction with DVGW W551 and DVGW W553 are also recommended for cold water pipes. In addition, uninterrupted impact sound insulation is necessary.

5.5 Insulation shells for Sanipex MT

The precisely fitting insulation shells enable fast, precise installation and ensure the best insulation values, which means they fit seamlessly into the overall system philosophy. In addition, they have a sound-insulating effect, which contributes to the comfort of living.

TV.30
Technical specification

Material	Expanded polypropylene, anthracite
Specific density	45-50 kg/m3
Thermal conductivity	0.035 W/(mK) according to EN 12667
Building material class	B2 according to DIN 4102 or E according to EN 13501-1

TV.31 **Insulating shells**

	Sanipex MT						
	Outer diameter	Diameter inside	Min. diameter outside, for PWH (according to DIN 1988-200 and EnEV 100%, for **λ = 0.035 W/(mK)**	**Insulating shells** Outer diameter	**Pipe insulation** (e.g. Rockwool 800) Outer diameter	Designation at Rockwool	Roller pipe, pre-insulated, EnEV 100%
DN [mm]	d_a [mm]	d_i [mm]		d_a [mm]	d_a [mm]		d_a [mm]
d16	16	11.5	56	58	58	18/20	56
d20	20	15	60	62	62	22/20	60
d26	26	20	66	68	68	28/20	66
d32	32	26	92	95	95	35/30	–
d40	40	33	100	122	122	42/40	–
d50	50	42	126	134	134	54/40	–
d63	63	54	162	164	164	64/50	–

6 Fire protection

Fire protection

See the legal requirements as they apply to fire protection (prevention of the transmission of fire and smoke to other fire compartments) in the amended state building codes and the introductory decrees of technical building regulations (ETB).

General information on fire protection:

➨ Part IV 'Plan', Section 'Insulation, Fire protection'

§ **Country-specific regulations**

The insulation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.

☑ When it comes to insulation methods, compliance with the applicable rules and regulations is mandatory.

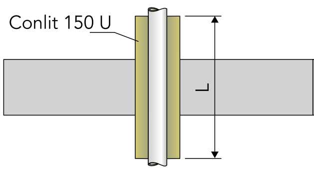
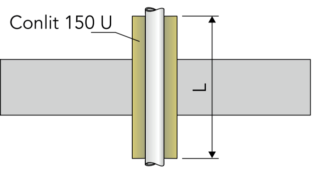
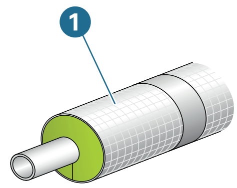
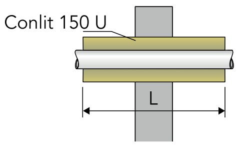
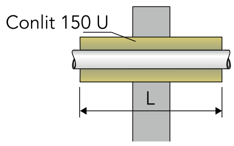
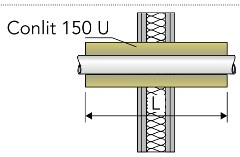
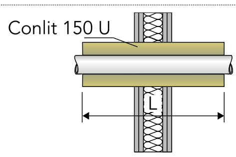
6.1 Implementation with Rockwool

R30 to R90 pipe penetrations for JRG installation systems with non-combustible media, e.g. drinking water, heating

Fire protection with Rockwool

For more information, see the Rockwool Planning Guide and the Rockwool website.

TV.32 **Components and implementation**

Component F 30 to F 90 **Thickness [mm]**	F 30	F 60 F 90	
Solid ceiling min. 150	 L ≥ 1000 mm; WD 2)		 ❶ ROCKWOOL 800 / Teclit PS Cold Minimum thickness: 30 mm
Solid wall min. 100	 L ≥ 1000 mm; WD 2)		
Lightweight partition min. 100	 L ≥ 1000 mm; WD 2)		

Design variant according to ROCKWOOL abP P-3276/4140-MPA BS.

TV.33 **System and components**

System	Pipe dimension	Conlit 150 U		ROCKWOOL 800 [1), 2), 3)] Teclit PS Cold [1), 2), 3)]			
	Diameter, outside Da [mm]	Type [3)]	Insulation thickness [4)] s [mm]	Core drilling THK [mm]	EnEV 100%, warm, type	EnEV 50%, warm, type	DIN 1988-200, cold, type [3)]
JRG Sanipex MT PE-X/Al/PE-X [5)]	16	16/22	22	60	18/20	18/20	18/20
	20	20/20	20	60	22/20	22/20	22/20
	26	26/17	17	60	28/20	28/20	28/20
	32	32/24	24	80	35/30	35/20	35/30
	40	40/20	20	80	42/40	42/20	42/40
	50	50/25	25	100	54/40	54/30	54/40
	63	63/33,5	33,5	130	64/50	64/30	64/50

Notes and special installation conditions

1) In individual cases, the minimum insulation thickness that can be supplied is specified.

2) The insulation shell ROCKWOOL 800 or Teclit PS Cold can be used as further insulation.

3) For cold pipes, a vapor barrier must be installed according to DIN 1988-200. Therefore, only use fire protection pipe shell Conlit 150 U, insulation shell ROCKWOOL 800 or Teclit PS Cold.

4) Insulation thickness after EnEV 50% as well as according to DIN 1988-200 suitable for core drill diameter DK

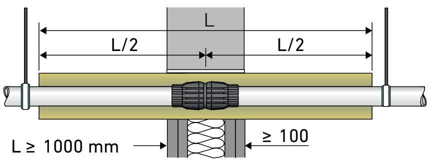
5) Sheathing (such as protective pipes or factory insulation) must be removed in the lead-through area.

All boundary conditions of the specified general building inspection test certificates (abP) must be taken into account.

R30 to R120 partitioning in solid walls, lightweight partition walls and solid ceilings

Further instructions for installing the JRG pipe connector in wall and ceiling penetrations:

➨ starting at P P-3726/4140-MPA BS, Annex 19



GV.21
Assembly of the JRG pipe connector

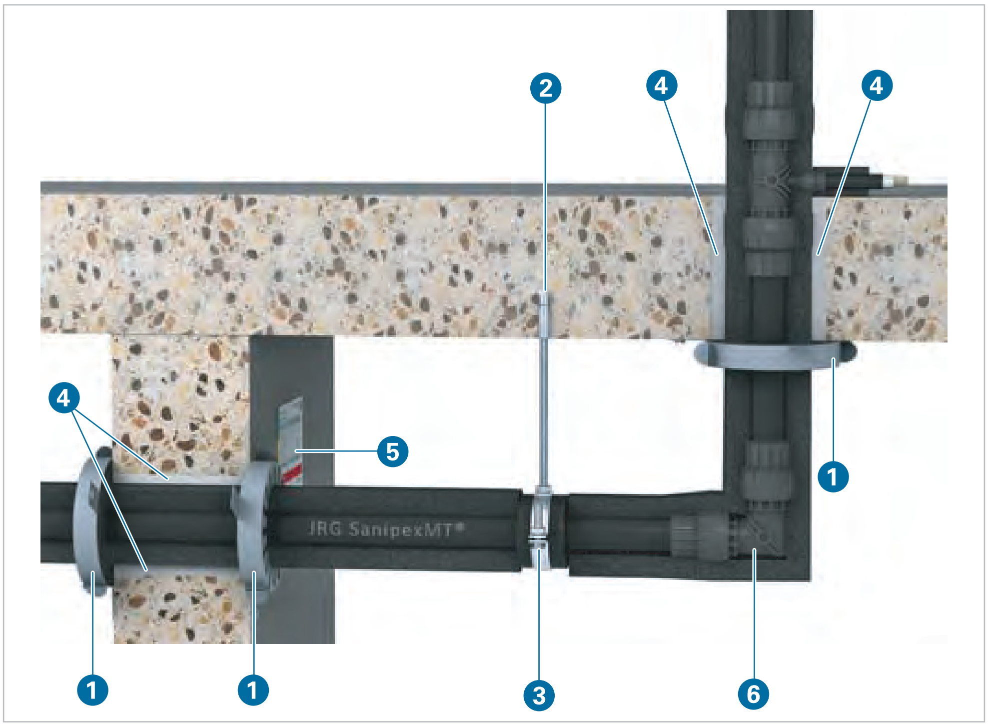
6.2 Implementation with BIS Walraven

6.2.1 BIS Pacifyre AWM II Fire Protection Sleeve

- with synthetic rubber, insulation up to ≤43 mm

Benefits

- Zero distance between identical cuffs possible
- Offset installation possible
- Flexible annular gap closure possible
- Suitable for installation in damp rooms
- Installation possible without additional fasteners, by bending over and inserting the lugs into the fresh concrete or mortar
- To be mounted on both sides of the wall or on the underside of the ceiling
- Complete system: Mounting material included in the scope of delivery



GV.22
Product overview

1. Pipe penetration seal with BIS Pacifyre AWM II fire protection collar
2. Fire-tested anchor technology, e.g. with BIS drop-in anchor, BIS metal expansion anchor, etc.
3. Fire protection tested pipe clamps, e.g. with BISMAT Flasch, BISMAT 2000 or BIS HD heavy duty clamp incl. fire protection tested threaded rod/pin (≥M8)
4. Residual gap closure with Tangit FP 440 Fire Protection Joint Filler or BIS Pacifyre FPM Fire Protection Mortar or BIS Pacifyre SML/MLAR Strip
5. Marking all BIS Pacifyre pipe penetration seals with the BIS Pacifyre and Tangit FP universal label
6. Synthetic rubber insulation up to ≤43 mm thickness

Field of application and use

TV.34 **Application range according to ABZ Z-19.17.-1194**

Component	Wall	≥100 mm
	Ceiling	≥150 mm
Pipe system	Sanipex MT	to d63

Approved insulation

- Synthetic rubber insulation up to 43 mm thickness in the area of wall and ceiling penetration
- PE sound insulation hose up to 4 mm thickness
- One layer of BIS Pacifyre SML/MLAR Strip in full component thickness (sound insulation)

§ **ABZ**

☑ The installation guidelines and specifications of the ABZ must be observed.

More information

For further information, please refer to the **BIS Walraven + GF special brochure**, the **BIS Planning Helper** and the BIS Walraven website.

TV.35
Application

Dimension of pipe	**Cuff size, Art.no.**					
Diameter, outside Da [mm]	Without insulation	Item no.	EnEV 50%,	Item no.	EnEV 100%	Item no.
16	15	213 4 032032	40	213 4 040042	63	213 4 063065
20	20	213 4 032032	40	213 4 040042	63	213 4 063065
25	25	213 4 032032	63	213 4 063065	90	213 4 090092
26	25	213 4 032032	63	213 4 063065	90	213 4 090092
32	32	213 4 032032	63	213 4 063065	90	213 4 090092
40	40	213 4 040042	75	213 4 075077	110	213 4 110112
50	50	213 4 050042	75	213 4 075077	110	213 4 110112
63	63	213 4 063065	110	213 4 110112	125	213 4 125125

TV.36
Partitioning in ceilings and walls

Partitioning in ceilings

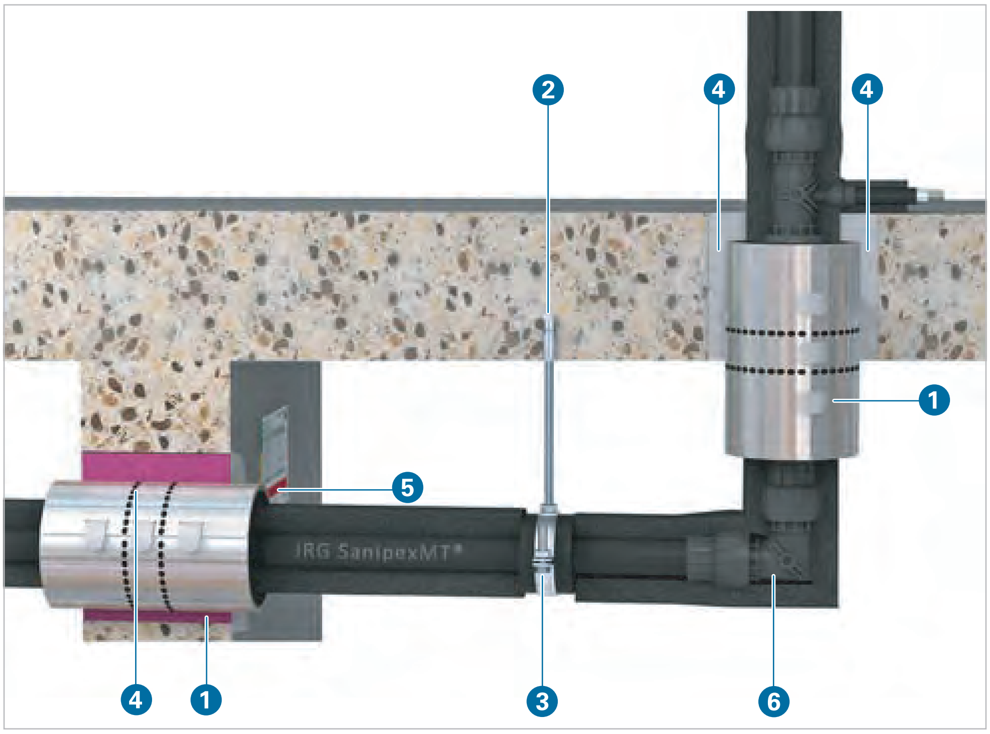
Partitioning in walls

6.2.2 BIS Pacifyre MK II Fire Protection Sleeve

- with synthetic rubber, insulation ≤44 mm

Benefits

- Zero distance between identical cuffs possible
- No tools, no drilling, therefore very easy to install
- Place the sleeve around the pipe, close it - done!
- Only one sleeve for wall penetration seals up to 150 mm wall thickness
- Sound insulation test certificate from IBP (Fraunhofer Institute)
- High flexibility due to low protrusions



GV.23
Product overview

1. Pipe penetration seal with BIS Pacifyre MK II fire protection collar
2. Fire-tested anchor technology, e.g. with BIS drop-in anchor, BIS metal expansion anchor, etc.
3. Fire protection tested pipe clamps, e.g. with BISMAT Flasch, BISMAT 2000 or BIS HD heavy duty clamp incl. fire protection tested threaded rod/pin (≥M8)
4. Residual gap closure with Tangit FP 440 Fire Protection Joint Filler or BIS Pacifyre FPM Fire Protection Mortar or BIS Pacifyre SML/MLAR Strip
5. Marking all BIS Pacifyre pipe penetration seals with the BIS Pacifyre and Tangit FP universal label
6. Synthetic rubber insulation up to ≤44 mm thickness

Field of application and use

TV.37 **Application range according to ABZ Z-19.17.-1737**

Component	Wall	≥100 mm
	Ceiling	≥150 mm
Pipe system	Sanipex MT	to d63

Approved insulation

- Synthetic rubber insulation up to 44 mm thickness in the area of wall and ceiling penetration

§ **ABZ**

☑ The installation guidelines and specifications of the ABZ must be observed.

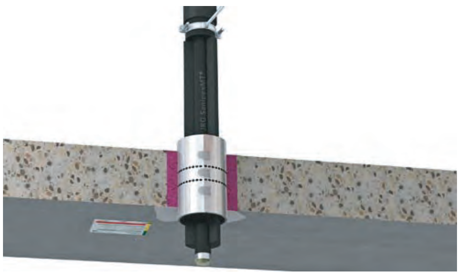
More information

For further information, please refer to the **BIS Walraven + GF special brochure**, the **BIS Planning Helper** and the BIS Walraven website.

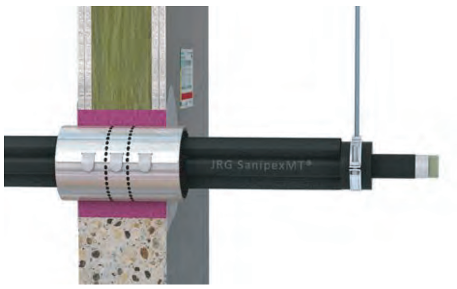
TV.38 **Application**

Diameter, tube outside Da [mm]	Diameter of cuff inside [mm]	Diameter of cuff outside [mm]	Item no.	Recommended core drilling with Tangit FP 550 [mm]	Recommended core drilling with BIS Pacifyre FPM Fire Protection Mortar [mm]
16	15	40	215 1 015017	61	71
20	18	43	215 1 018020	61	71
25	24	55	215 4 024026	76	86
32	30	61	215 4 030032	81	91
40	39	70	215 4 039041	91	101
50	48	79	215 4 048050	101	111
52	51	82	215 4 051053	101	111
56	54	85	215 4 054056	106	116
63	63	94	215 4 063065	116	126

Partitioning in ceilings



Partitioning in walls



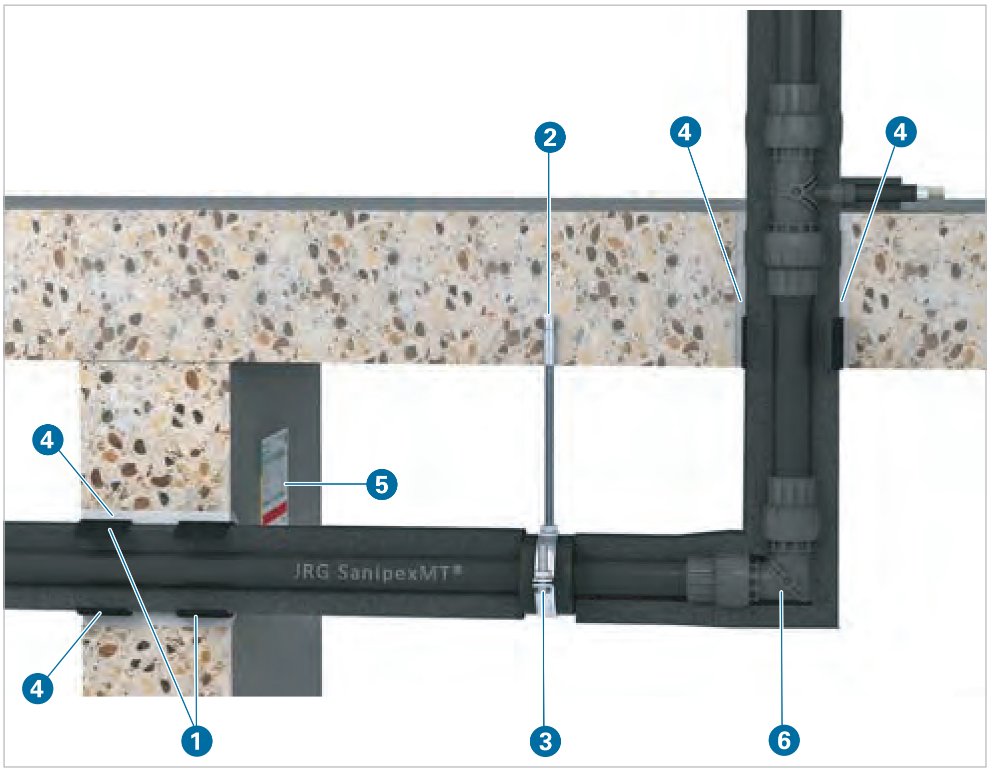
TV.39 **Partitioning in ceilings and walls**

6.2.3 BIS Pacifyre IWM III Fire Protection Sleeve

- with synthetic rubber, insulation ≤32mm

Benefits

- Art.no. 213 6 0510 125 or 213 6 050 625
- Zero spacing between identical drums possible
- No tools, no drilling required
- Easy and efficient processing: Wrap the tape around the tube, push it into the component - done!
- No offcuts, as free dimensional adjustment is possible on the construction site
- Low space requirement due to small number of layers; thus optimal for areas that are difficult to access
- Flush with wall/ceiling
- High flexibility due to self-adhesive tape
- Suitable for installation in damp rooms



GV.24
Product overview

1. Pipe penetration seal with BIS Pacifyre IWM III fire protection collar
2. Fire-tested anchor technology, e.g. with BIS drop-in anchor, BIS metal expansion anchor, etc.
3. Fire protection tested pipe clamps, e.g. with BISMAT Flasch, BISMAT 2000 or BIS HD heavy duty clamp incl. fire protection tested threaded rod/pin (≥M8)
4. Residual gap closure with Tangit FP 440 Fire Protection Joint Filler or BIS Pacifyre FPM Fire Protection Mortar or BIS Pacifyre SML/MLAR Strip
5. Marking all BIS Pacifyre pipe penetration seals with the BIS Pacifyre and Tangit FP universal label
6. Synthetic rubber insulation up to ≤44 mm thickness

Field of application and use

TV.40 **Application range according to ABZ Z-19.17.-1884**

Component	Wall	≥100 mm
	Ceiling	≥150 mm
Pipe system	Sanipex MT	to d40

Approved insulation

- Synthetic rubber insulation up to 32 mm thickness in the area of wall and ceiling penetration
- One layer of BIS Pacifyre SML/MLAR Strip in full component thickness (sound insulation)

§ **ABZ**

☑ The installation guidelines and specifications of the ABZ must be observed.

More information

For further information, please refer to the **BIS Walraven + GF special brochure**, the **BIS Planning Helper** and the BIS Walraven website.

TV.41
Application

Diameter, tube	Pipes without insulation		Pipes with synthetic rubber insulation			
outside Da [mm]	Number of layers	Length [mm]	Number of layers	Strip length [mm] for insulation thickness D [mm]		
				D =13	D =19	D =25
Sanipex MT						
16	2	126	2	289	365	440
20	2	151	2	315	390	465
25	2	183	2	346	421	497
32	2	227	2	390	465	541
40	2	277	2	440	516	591
50	1	183	2	503	578	654
63	1	222	2	588	660	735

TV.42
Partitioning in ceilings and walls

Partitioning in ceilings	Partitioning in walls
	

6.3 Implementation with Hilti

The Sanipex MT system in combination with the Hilti fire protection bandage CFS-B is approved by the building authorities (abZ) for the following applications Z-19.53 2218 for the following applications:

- Solid ceilings, thickness: ≥150 mm
- Solid walls, thickness: ≥100 mm
- Lightweight partition walls (LTW), thickness: ≥100 mm

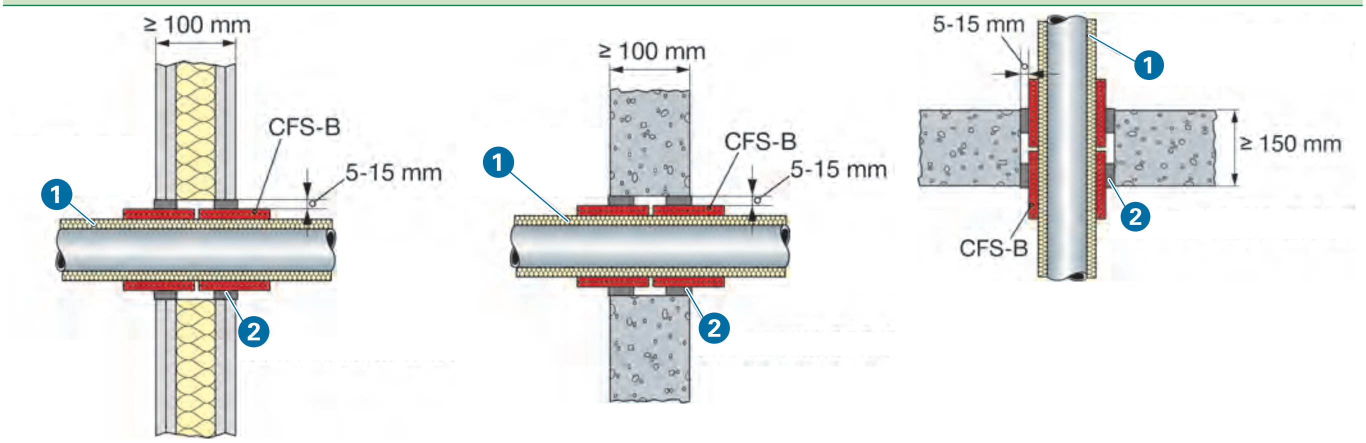
The Sanipex MT system falls into pipe groups D and C and can therefore be installed in the following configurations.

More information
Further information can be found in the **special brochure HILTI + GF**, in the **HILTI Planning Helper** and on the HILTI website: www.hilti.de

6.3.1 Configurations with Hilti fire protection bandage CFS-B

TV.43 **Installation options and details**

Lightweight partition	Solid wall	Solid ceiling



1 Synthetic rubber insulation
2 25 mm Hilti CFS-S ACR

TV.44 **Installation options and details with Hilti fire protection bandage CFS-B - wall**

Sanipex MT [mm]	Walls [mm]		Details	
	LTW, ≥100	Solid, ≥100	Pipe group	Insulation thickness [mm]
16	•	•	D	8–32
20	•	•	D	8–32
26	•	•	D	8–32
32	•	•	C	8–32
40	•	•	C	36,5*
50	•	•	C	37,5*
63	•	•	C	39,5**

* 150 mm LTW/solid wall: min. Insulation thickness 9 mm for pipe group C
** 200 mm solid wall: min. Insulation thickness 9 mm for pipe group C

TV.45 **Installation options and details with Hilti fire protection bandage CFS-B - ceiling**

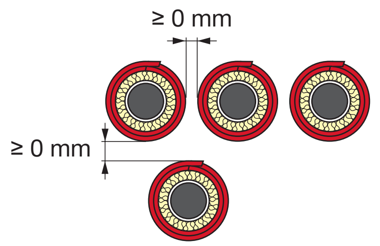
Sanipex MT [mm]	Ceiling [mm]	Details	
	Solid, ≥150	Pipe group	Insulation thickness [mm]
16	•	D	8–32
20	•	D	8–32
26	•	D	8–32
32	•	C	8–32
40	•	C	9–32
50	•	C	9–37,5
63	•	C	9,5–39,5

The remaining opening between the wall or ceiling and the insulated Sanipex MT pipe must be completely filled with dimensionally stable, non-combustible building materials such as concrete, cement mortar (Hilti fire protection mortar CP636) or gypsum mortar to the thickness of the building component.

Optionally, a maximum 15 mm wide annular gap on both sides of the component may be filled to a depth of at least 25 mm with gypsum or Hilti Fire Protection Sealant CFS-S ACR.

6.3.2 Zero clearance with Hilti fire protection bandage CFS-B

Sanipex MT pipes insulated with Hilti fire protection bandage CFS-B may be installed at zero distance from each other if they are installed in 150 mm thick solid components (wall, ceiling) or up to an outer pipe diameter of 40 mm in 100 mm thick solid components.



GV.25
Zero distance

6.4 Example of "zero" distance

Approved distances between Silenta Premium and Sanipex MT

According to the general type approval (Z-19.53-2331) point 2.2.2 or Annex 30: "... The spacing for pipes of pipe group L (GF Silenta Premium) with an outside diameter ≤110mm, the pipe collar Pacifyre AWM II and the penetration seal according to general building approval no. Z-19.17-1884 Pacifyre IWM III or general building authority test certificate no. P-MPA-E-17-012 to "Sanipex MT composite pipes" with an outer diameter ≤63mm in a 150 mm thick solid ceiling may be reduced to "0" ..."

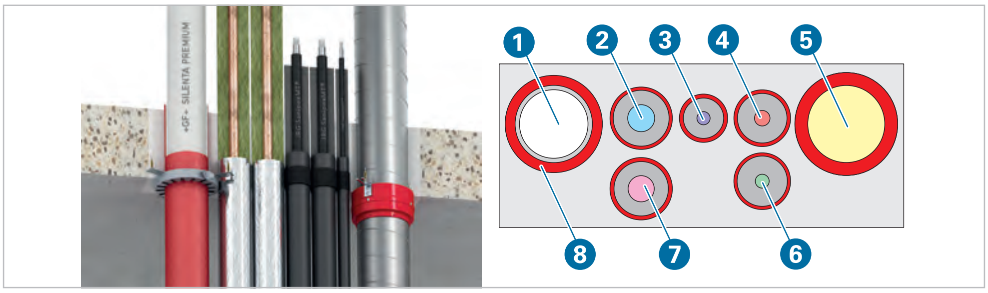
Silenta Premium ≤100 mm with 4-5 PE sound insulation hose - to - Sanipex MT ≤63 mm with K-Flex ST Plus synthetic rubber insulation thickness 11-32 mm with Pacifyre IWM III fire protection tape or Sanipex MT ≤63 mm with Rockwool 800 insulation thickness 20-70 mm.

Fire tests with third-party penetration seals with the aim of achieving a reduced installation distance of "zero" mm between the "third-party penetration seals" and the above-mentioned Pacifyre penetration seals.

TV.46 **Application***

Position	Pipe type	Insulation	Partitioning measure
1	Silenta Premium, ≤110 mm	PE sound insulation hose	Pacifyre AWM II Pacifyre IWM III
2	Sanipex MT, ≤63 mm Sanipex classic ≤40 mm	Synthetic rubber, ≤39 mm Insulation thickness according to test report	Pacifyre IWM III
	Sanipex MT, ≤63 mm	Rockwool 800, ≤70 mm or Rockwool Conlit 150 U	Rockwool 800 or Rockwool Conlit 150 U
3	Copper or carbon steel, ≤108 mm	Rockwool 800, ≤70 mm or Rockwool Conlit 150 U	Rockwool 800 or Rockwool Conlit 150 U
	Copper or carbon steel, ≤54 mm	Synthetic rubber, ≤21.5 mm	Pacifyre M Pipe Jacket
4	Spiral duct, ≤160 mm	-	Shut-off device according to DIN 18017-3, Wildeboer

* Tested combinations on the basis of the test report No. 21 0006816 dated 04.05.2015 of the MPA NRW, Erwitte field office



GV.26 **Zero distance**

1. Wastewater
2. Heating, return line
3. Drinking water, circulation
4. Drinking water, hot
5. Exhaust air (DIN EN 18017)
6. Drinking water, cold
7. Heating, supply line
8. Partitioning measure

The "larger distances" required by the DIBt specifications can often not be implemented in practice. Inspired by these facts, penetration seals for non-combustible and combustible pipes were tested in such a way that a distance of "zero" mm can be maintained between the individual penetration seals as well as between the penetration seal and the building component reveal.

For this purpose, practical installation situations were installed in accredited test institutes and tested in accordance with DIN 4102 or EN 1366 tested. The test setup included, for example, Sanipex pipes insulated with synthetic rubber, the Silenta Premium pipe, Sanipex and copper or carbon steel pipes insulated with rock wool, and shut-off devices according to DIN 18017-3. Permitted combinations are listed in DIN 18017-3 Table 1-7.

Additional technical and sales information

→ Please direct inquiries to the GF field service or to: technik.de@walraven.co

7 Installation

Installation of pipelines
General technical information on installation types:
➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [13] 'Installation and attachment'
➨ Part V 'Build', Section 'Installation'

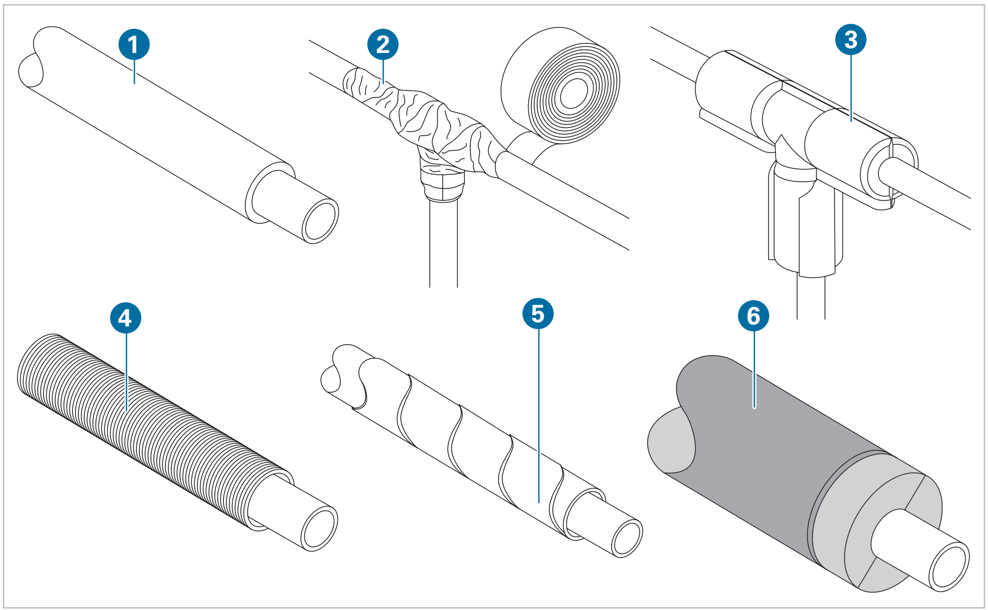
The JRG Sanipex MT System is suitable for the following types of installation:
- Surface or flush-mounted installations
- Installation in shafts and channels, on ceilings and on floors
- Installation in-wall, element, wood and lightweight constructions

7.1 Protection against environmental influences and building materials

System components flush-mounted or concealed behind a wall:
☑ In order to absorb thermally induced changes in length, to prevent the transmission of sound, to avoid the formation of condensation, to preclude heat dissipation, heat loss or to heat the medium and to protect from other building material influences, fittings or pipes must be covered with a suitable materials or they must be separated entirely from the structure of the building.

In permanently or periodically damp rooms, in areas subject to aggressive gases or other offensive environment and under uncontrollable environmental influences:
☑ Appropriate precautions must be taken to protect the installation, e.g. by using the following measures:
  - Use of suitable anti-corrosion tapes (e.g. supplied by KEBU, Gyso or DENSO)
  - Wrapping the pipe with heat-shrinkable materials

☑ Ensure that pipes and fittings are dry when mounting.
☑ All system components must be protected from direct contact with oils, greases, solvents, solvent-based adhesives (adhesive tapes), foams, bitumen (also bituminous membranes). Furthermore, the components must not contact building materials such as screed, concrete, mortar or plaster.
☑ Piping system and building structure must be separated from each other, for example, by using protective conduits made of PE, wrappings, insulating hoses or half shells with and without sheathing or a combination thereof.



GV.27
Safety measures

1. pre-insulated pipe
2. Pipe with wrapping
3. Half shells
4. Protective conduit
5. Wrapping
6. Sheathing

Insulating shells
Information on the insulation shells for Sanipex MT can be found here:
➨ Chapter [5.5] 'Insulation shells for Sanipex MT'

7.2 Installation flush with wall

☑ Compliance with the general requirements for installing pipes flush with the wall.
☑ Threaded connections installed flush with the wall must be protected from moisture and contamination.

7.3 Installation in concrete ceiling

NOTE! Damage to the installation when poring the concrete ceiling.
→ Embedding the JRG Sanipex MT multilayer composite pipes in solid wall and ceiling concrete constructions is **not** permitted.

7.4 Installation in a pipe shaft, basement distributor and riser pipes

☑ Compliance with the general requirements for installing pipes is mandatory.

Change in length, bending and 2D expansion loops, fixed and floating points

☑ When installing, observe the change in the length of the pipes, the resulting flexible pipe leg and 2D expansion loop, and the required fixed points.

7.5 Installation on top of a concrete ceiling

☑ Compliance with the general requirements for installing pipes on concrete ceilings is mandatory.

8 Attachment

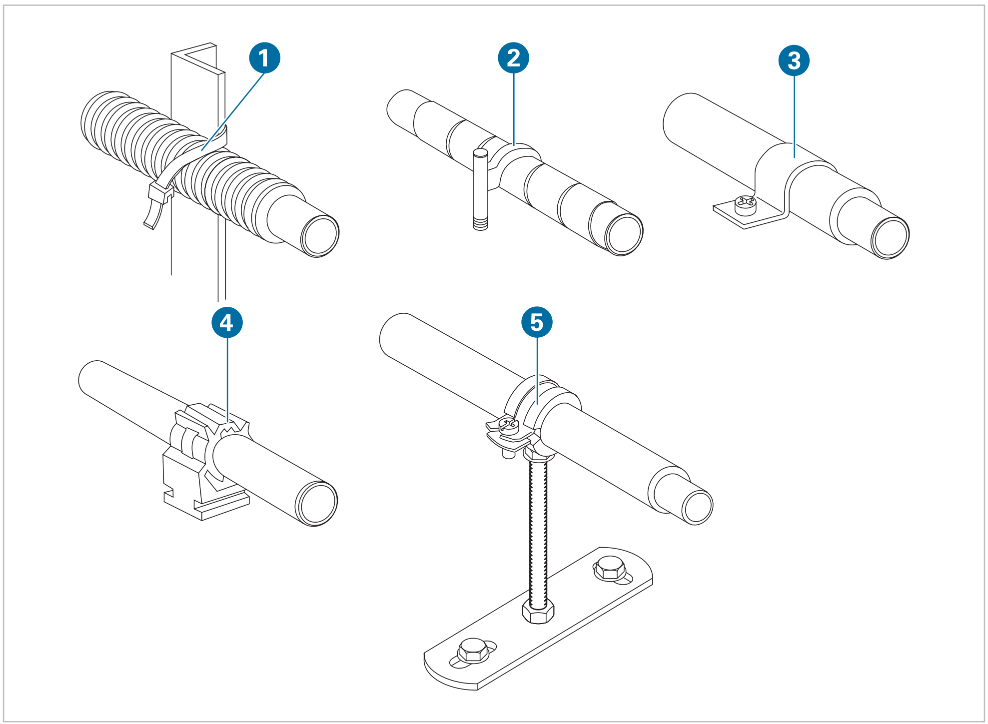
Pipeline attachment

General information:

➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [13] 'Installation and attachment'

8.1 Attachment components

JRG Sanipex MT installations can be installed using attachment components from our systems or with commercially available fasteners.



GV.28
Pipe attachments

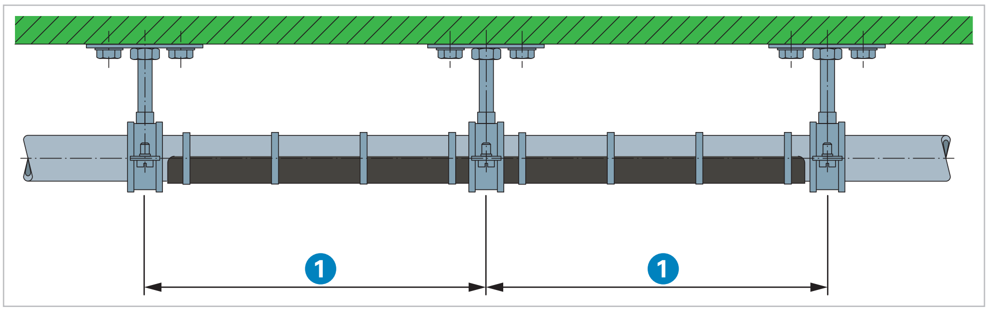
1. Pipe binders
2. Dowel hooks
3. Pipe clip
4. Pipe clips
5. Pipe clips

8.2 Attachment using pipe clips

In general, JRG Sanipex MT pipelines installed above ground **do not** require pipe saddles or protective conduits. When using pipe saddles, however, the mounting distances can be increased.

NOTE! Damaged pipes due to excessively spaced mounting distances!
Excessive spacing between the attachments can lead to deformation and weakening of the material as well as vibrations (formation of noise).

- ☑ Mounting distances **(BA)** must be maintained.
- ☑ Observe the change in length and allow for appropriate expansion compensation.



GV.29
Mounting distances (BA)
1 Mounting distance

TV.47
Mounting distances (recommended)

Pipe, Dimension d	DN	BA [m] Multilayer composite pipe: without pipe saddle	with pipe saddle	at **increased mechanical** load: with **additional** pipe saddle
16	12	1.0	2.00	1.00
20	15	1.0	2.00	1.00
26	20	1.50	2.00	1.50
32	25	2.00	3.00	2.00
40	32	2.00	3.00	2.00
50	40	2.50	3.50	2.50
63	50	2.50	3.50	2.50

If installed flush, as in-wall installation and on concrete ceiling

When installing JRG Sanipex MT pipes d16 to d26:

- ☑ A mounting distance of 80 cm must be maintained.
- ☑ Observe the change in length and allow for appropriate expansion compensation.

Stabilisation at increased mechanical loads

If an increased mechanical load in a particular installation zone must be into consideration or if the specified mounting distances (BA) are not feasible, we recommend additionally stabilising the JRG Sanipex MT pipelines. For this purpose, commercial pipe saddles, protective conduit, etc. can be used.

Attachment when installing “pipe-in-pipe”

NOTE! Noise emissions due to pressure surges!
Pressure surges on quick-action fittings can cause noise emissions.
→ When using a **“pipe-to-pipe” installation** made of JRG Sanipex MT pipelines, appropriate precautions must be taken.

Recommendation for mounting distance
Moreover, we recommend a maximum mounting distance of 60 cm when installing with a protective conduit (“pipe-in-pipe” installation).

- ☑ Ensure the pipes do not kink.

V

9 Connection

Jointing technology

General information:

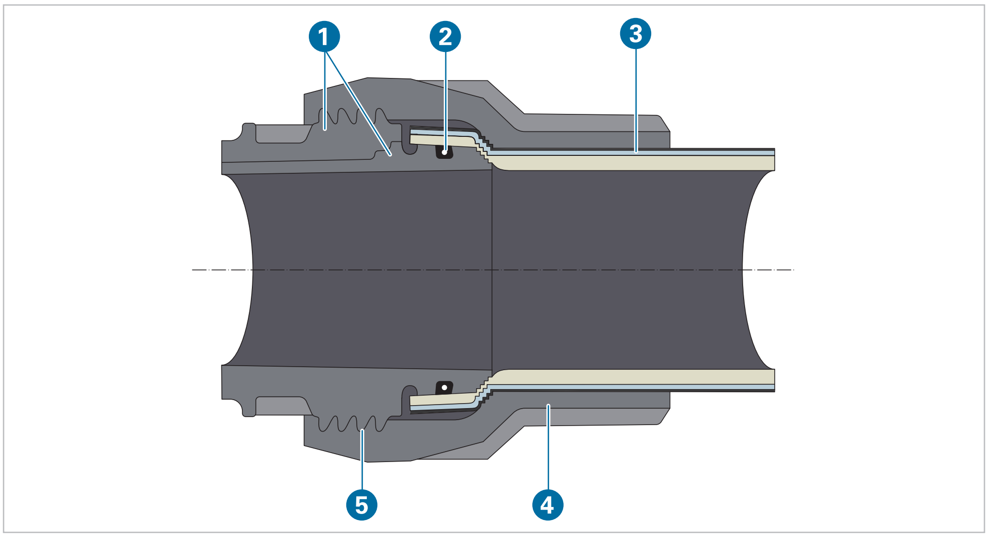
➨ Part III 'The basics', Section 'Materials and jointing technology'

9.1 Crimped clamping connection

The JRG Sanipex MT crimped clamping connection is a secure, dead-space-free connection without stiffeners required at maximum flow. The connections can be released again at any time and can be reused.

Depending on the material, a JRG Sanipex MT crimped clamping connection comprises the following components:

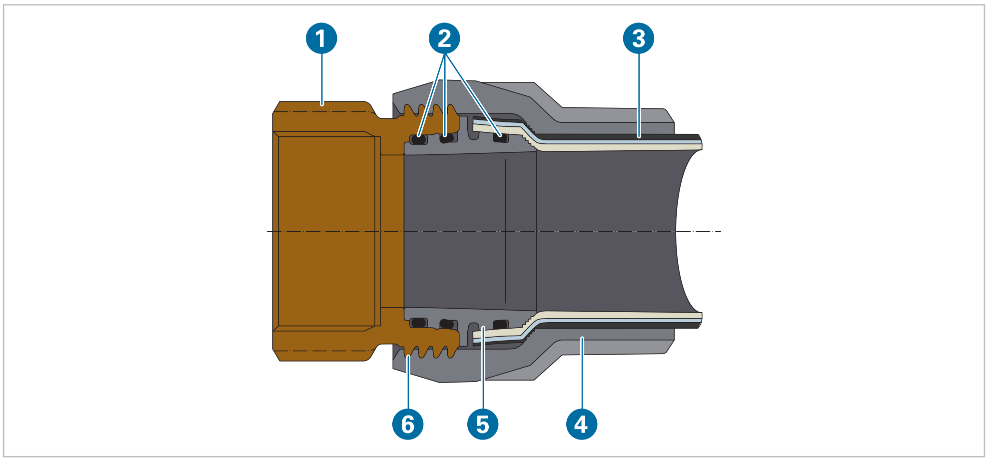
Crimped clamping connector made of plastic



GV.30
Crimped clamping connector, plastic

1. Fitting (plastic)
2. O-ring
3. JRG Sanipex MT pipe
4. Coupling nut
5. Buttress thread

Crimped clamping connector made of gunmetal



GV.31
Crimped clamping connector, with adaptor

1. Fitting (red bonze)
2. O-rings
3. JRG Sanipex MT pipe
4. Coupling nut
5. Plastic cone stub adaptor
6. Buttress thread

10 Assembly

JRG Sanipex pipes d16 to d25 can also be connected to JRG Sanipex MT fittings (use only manual expanding pliers and applicable expanding mandrels).

☑ Compliance with the tool's operating instruction is mandatory.

☑ Ensure the assembly tools are working properly.

10.1 Preparing the pipe

WARNING! Risk of injury due to incorrect operation of the shears.

If operating the combination shears improperly, there is a risk of injury in the area of the shear's end stops.

→ Use tools only as shown in the operating instructions.

NOTE! Leaks in the pipe and water damage due to cutting to the incorrect length!

→ Ensure the pipe end is cut straight.

→ Ensure the pipe end is not out-of-round.

Assembly – Preparing the pipe

Cutting the pipe

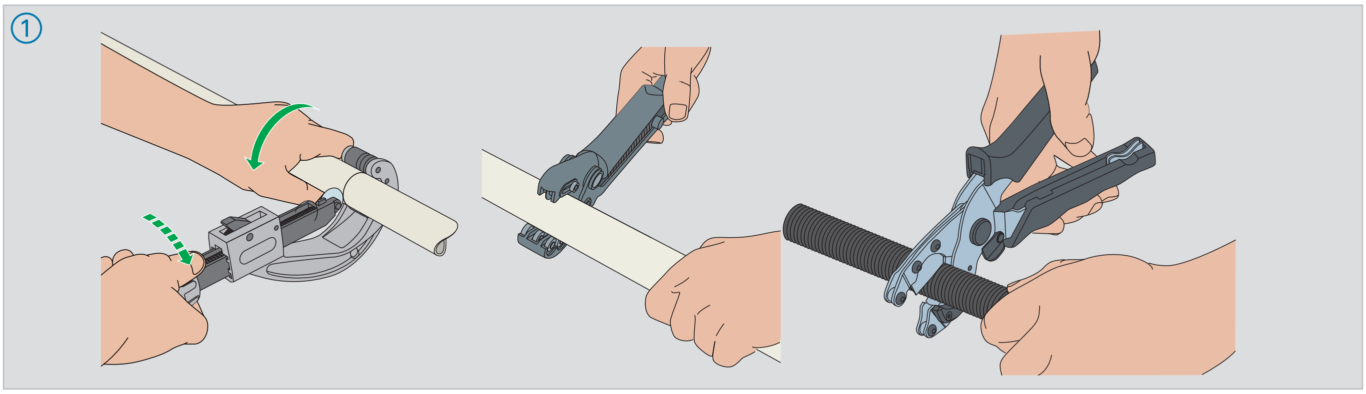
① → Use a sharp pipe cutter to cut the JRG Sanipex MT pipe to the desired length.

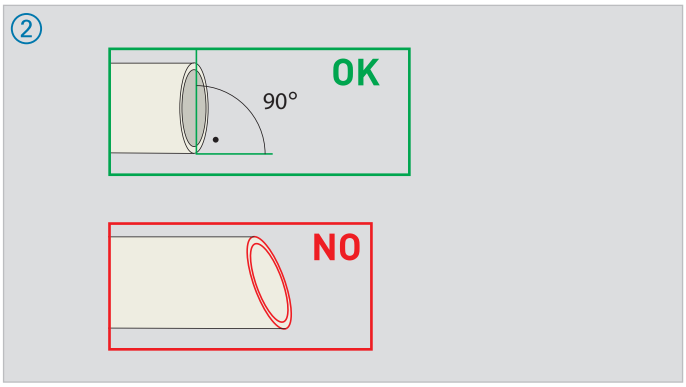
② → Inspect pipe.
- "OK" = correct / "NO" = wrong

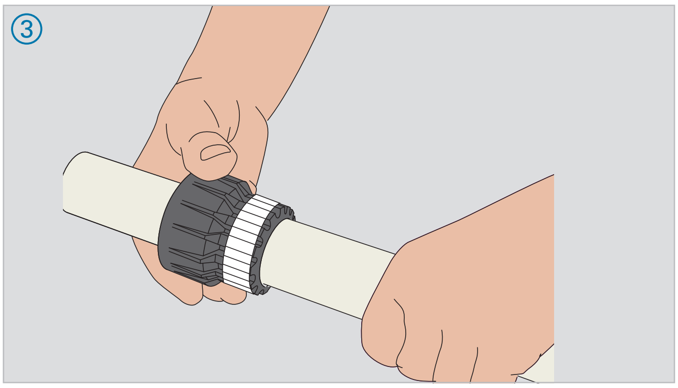
③ → Push the coupling nut onto the JRG Sanipex MT pipe.

After preparing the pipe (cutting to length), the pipe can be widened and connected to fittings using the **expanding pliers**, the **battery-powered expanding unit** or the **hydraulic expanding tool**, depending on the dimension.

Assembly – Preparing the pipe







10.2 Expand the pipe using expanding pliers

☑ Compliance with the tool's operating instruction is mandatory.

The individual steps are illustrated on the next page.

Assembly - Extend the pipe using expanding pliers

Prepare expanding tool - Change expanding mandrel

① → Close the working lever slightly and hold it in this position.
↳ This relieves the load on the locking mechanism.
→ Press guide pin.
↳ The expanding mandrel is released.

② → Slide the desired expanding mandrel over the guide pin.
→ Press the guide pin and push the expanding mandrel up to the stop.
↳ The change of the expanding mandrel is completed when the guide pin is released and the marking (see arrow) can be seen on the guide pin.

Preparing the expanding tool - Changing the clamping jaws

③ → Press side release/lock pins.
↳ The inserted clamping jaws at the top or bottom are released.
→ Change the clamping jaw.

④ → Remove the clamping jaw from the guide.
→ Insert the desired clamping jaw into the guide until it engages completely.
→ Release the release/lock pin again.

Proceed with the expansion – d16 – d32

⑤ → Ensure that the expanding mandrel corresponding to the pipe and the jaws also matches the dimension are used.
→ After slipping on the coupling nut, insert the pipe as far as it will go over the expanding mandrel and into the expanding pliers.

⑥ → Close clamping lever.

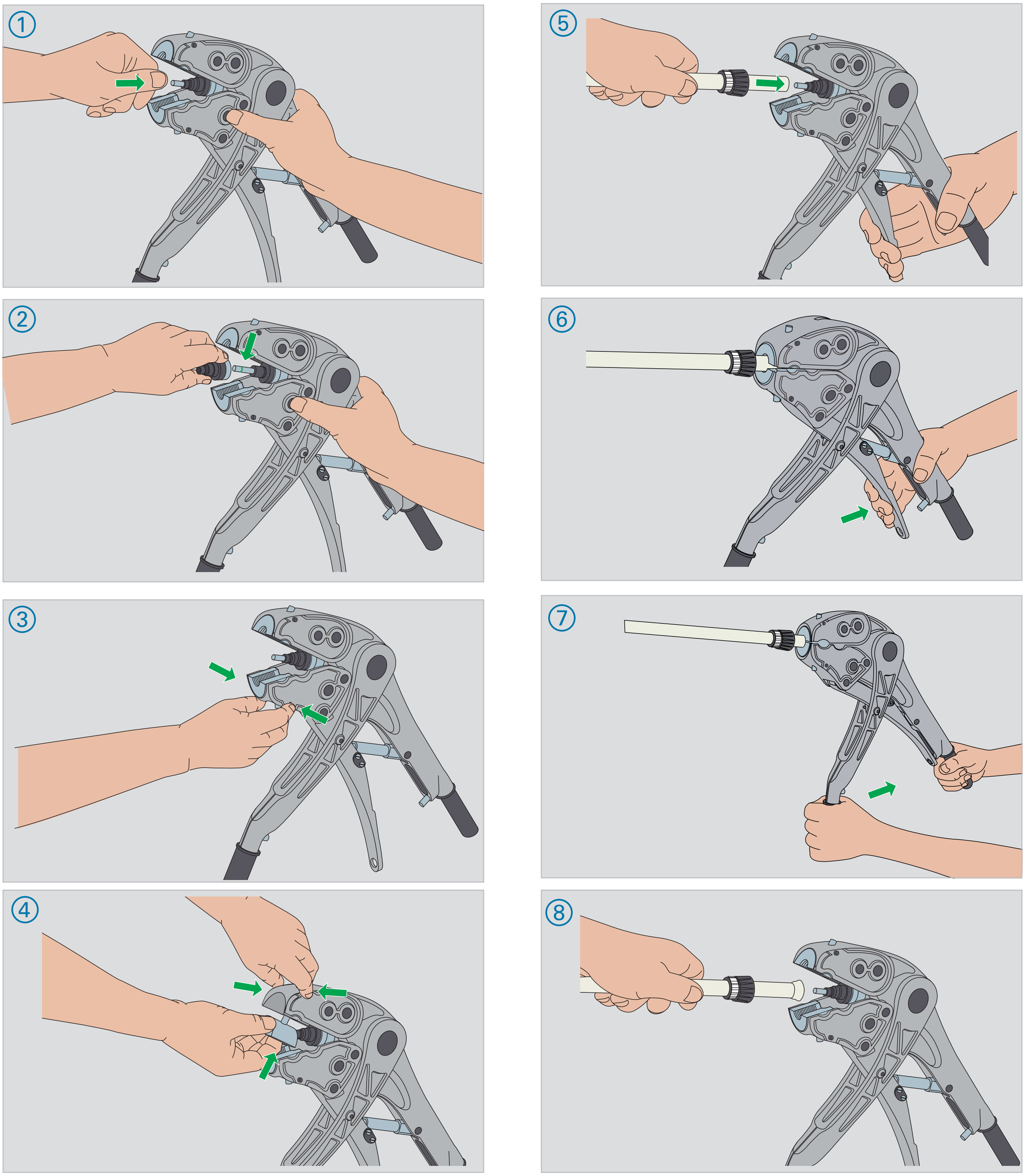
⑦ → Close working lever.
↳ Pipe is expanded.

NOTE! Expanding JRG Sanipex MT pipes made of PE-X.
After expanding JRG Sanipex MT pipes made of PE-X, the connection must be completed immediately.

⑧ → Open working lever.
↳ Crimped pipe end is released.

NOTE! Clamp jaws may drop to the ground when loosening the clamping unit.
If the clamping unit must be loosened without pipe expansion being carried out: Carefully release the lever; otherwise, due to the quick opening speed, the clamping jaws may drop to the ground.

Assembly – Expanding the pipe using expanding pliers



10.3 Expanding the pipe using a battery-powered expanding unit

☑ Compliance with the tool's operating instruction is mandatory.
☑ Ensure the battery-powered expanding unit is working properly.

The individual steps are illustrated on the next page.

Assembly – Use the battery-powered expanding unit to expand the pipe (d16 – d40)

Prepare the expanding unit

① → Insert the expansion head and lock it in place.

Proceed with the expansion

② → Insert the pipe into the expansion head as far as it will go.

③ **NOTE! Leaks in the pipe and water damage due to incorrect insertion.**
→ Ensure the pipe end is inserted as far as it will go.

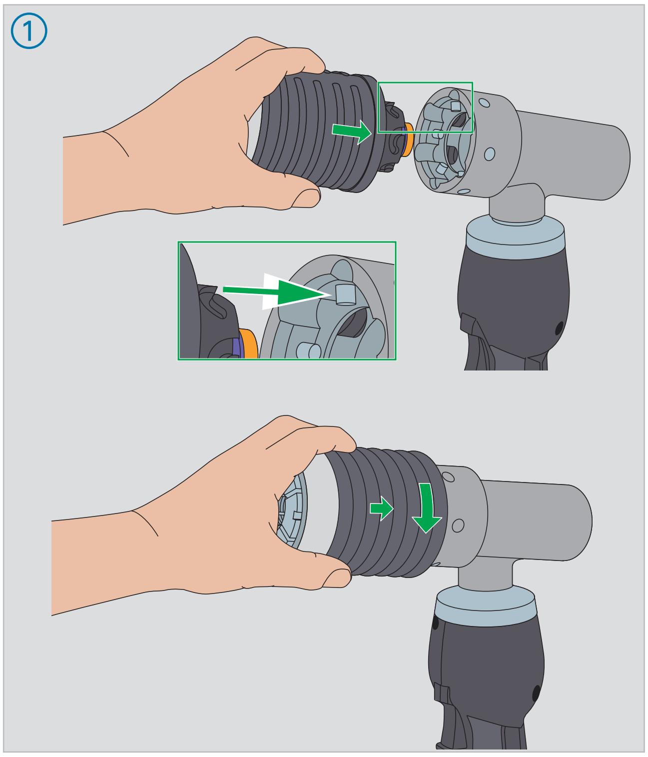
→ Start the expanding process by pressing the control switch.
→ Keep the switch pressed until the operating sound stops.
↳ The expansion process is completed.

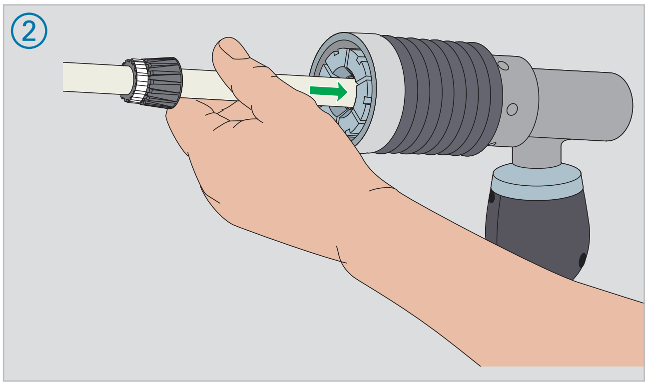
④ → Pull back expansion head manually.
↳ The crimped pipe end is released.
→ Remove the JRG Sanipex MT pipe from the expanding unit.
↳ The pipe end is crimped.

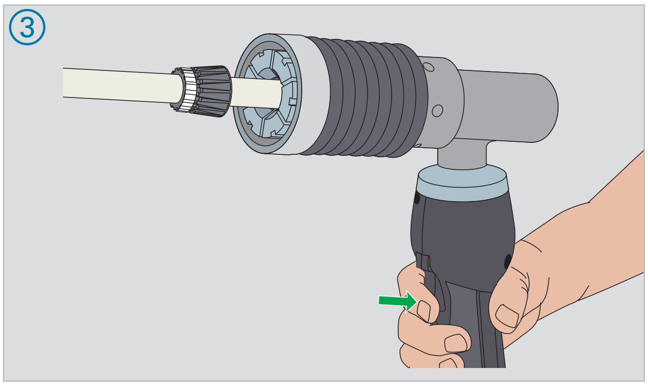
Replace the expansion head

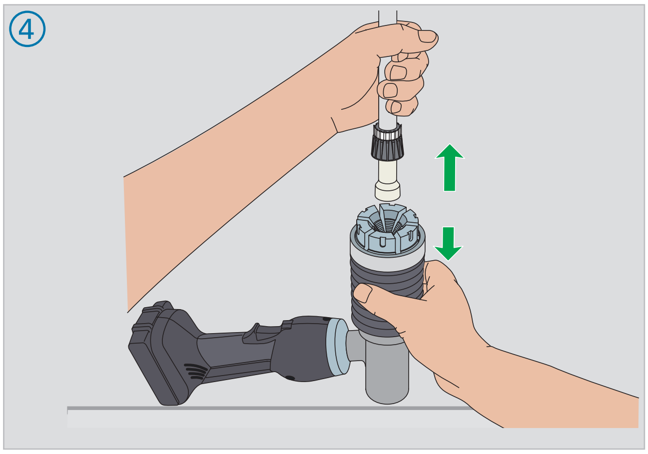
⑤ → Release the locking mechanism of the assembly tool.
→ Remove the expansion head.

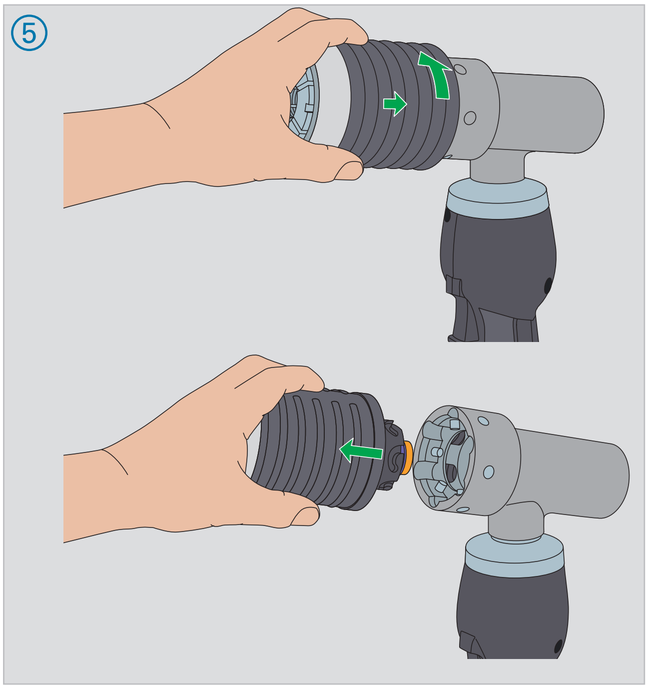
Assembly – Use the battery-powered expanding unit to expand the pipe (d16 – d40)

① 

② 

③ 

④ 

⑤ 

10.4 Expand the pipe using a hydraulic expanding unit

☑ Compliance with the tool’s operating instruction is mandatory.
☑ Ensure the hydraulic expanding unit is working properly.

10.4.1 Expand – d26 – d40

DANGER! Risk of injury due to incorrect operation.
In the area of the end stops of the clamping lever there is a risk of injury due to improper operation.
→ When handling the clamping lever, watch your fingers.

Assembly – Use the hydraulic expanding unit to expand the pipe (d26 – d40)

◯ → Connect the hydraulic hose to the hydraulic power pack.

Proceed with the expansion

① → Insert the pipe end into the expansion head as far as it will go.
→ Ensure the expanding mandrel has the same dimension as the clamping jaws. Note the colour coding.

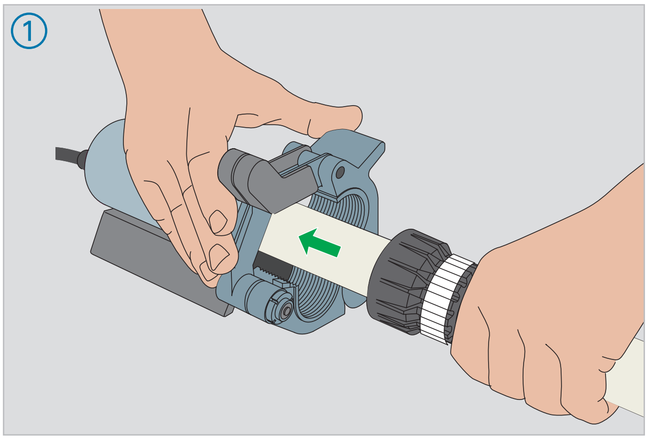
② → Press the pipe against the end stop of the expanding mandrel and close the clamping unit.

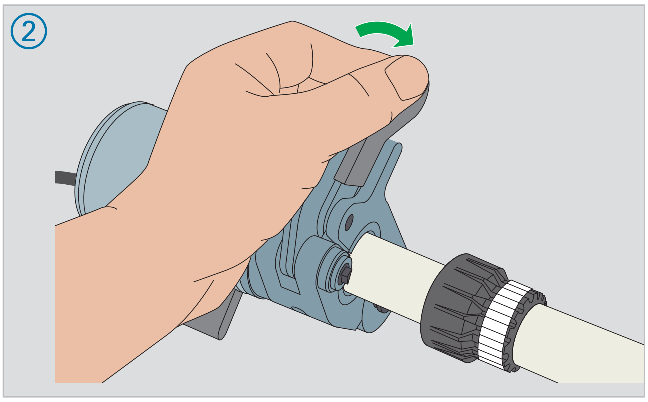
③ → Start the expanding process by pressing the start button on the hydraulic power pack.
→ Keep the start button pressed until 130 bar is reached and the expansion process is completed with an audible “click!”.
↳ The expanding process is completed when the expanding mandrel is fully retracted.

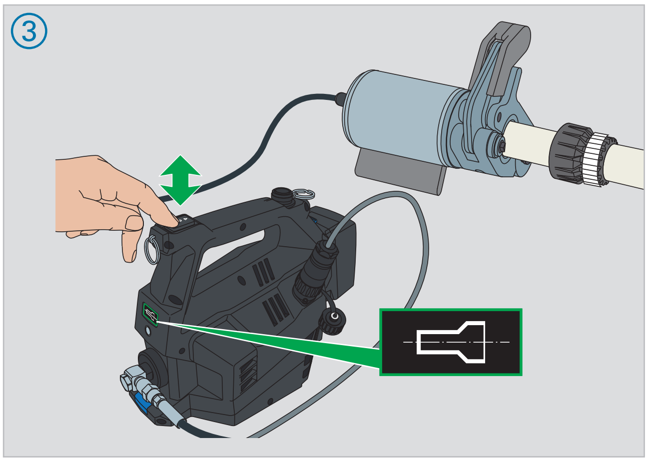
④ → Open clamping lever.

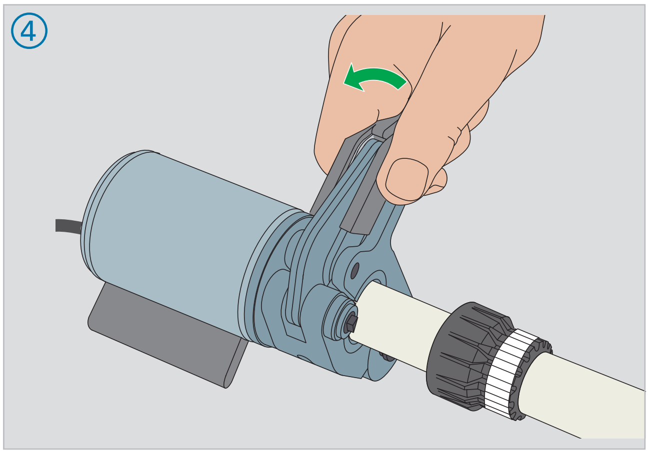
⑤ → Remove the crimped pipe from the expanding unit.

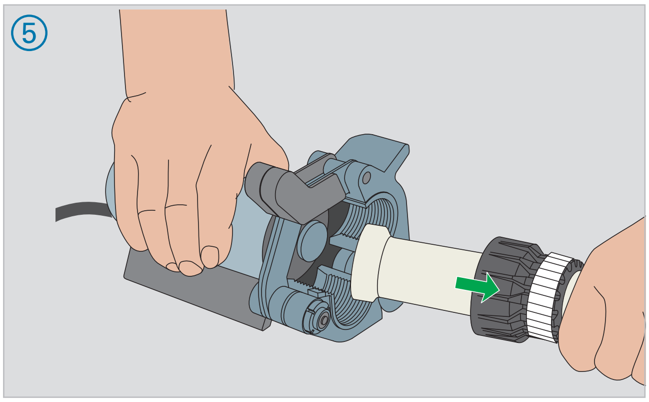
Assembly – Using the hydraulic expanding unit to expand the pipe (d26 – d40)







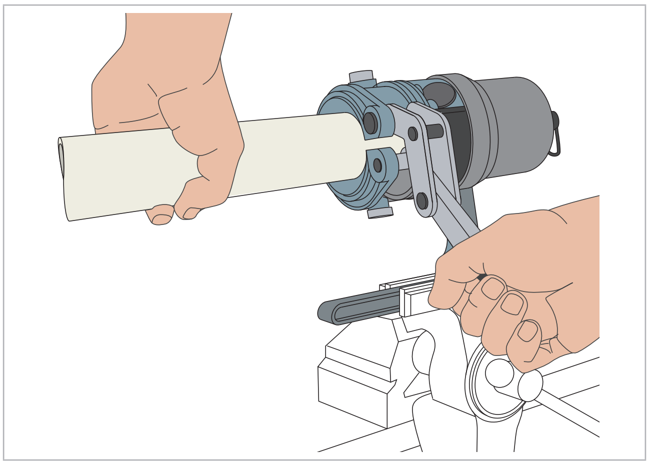




10.4.2 Expand – d50 – d63

NOTE! Wrong crimped length due to chamfering or deburring of the pipe.
→ Do not chamfer or deburr pipe when cutting the pipe to length.

To make work easier, the expanding unit can also be clamped in a vice.



The individual steps are illustrated on the next page.

Assembly – Use the hydraulic expanding unit to expand the pipe (d50 – d63)

◯ → Connect the hydraulic hose to the hydraulic power pack.

Setting up the expanding unit

① → Insert scraper rings.

② → Pull the expanding mandrel across the piston rod.

③ → Hand-tighten the knurled-head screw.

DANGER! Risk of injury due to incorrect operation.
→ Use tools only as shown in the operating instructions.

④ → Push the clamping unit over the joining rods.
→ Press the groove of the clamping jaws against the ring claw of the working cylinder.
→ Ensure the expanding mandrel has the same dimension as the clamping jaws. Note the colour coding.

⑤ → Hand-tighten the front knurled-head screw.

Proceed with the expansion

⑥ → Insert the pipe end into the expansion head as far as it will go.
→ Ensure the pipe is parallel to the expanding unit before closing the clamping lever.

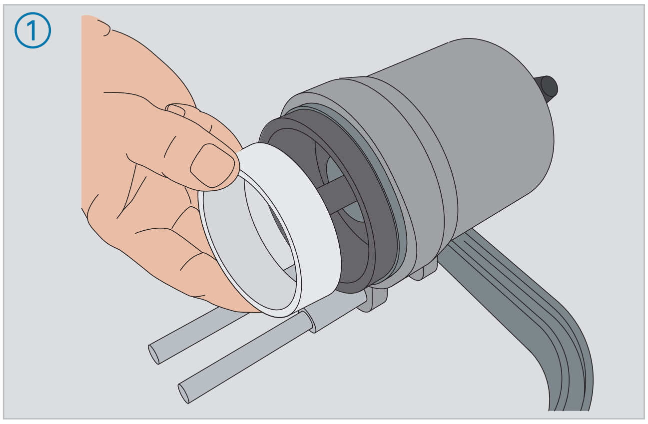
⑦ → Press the pipe against the end stop of the expanding mandrel and close the clamping unit.

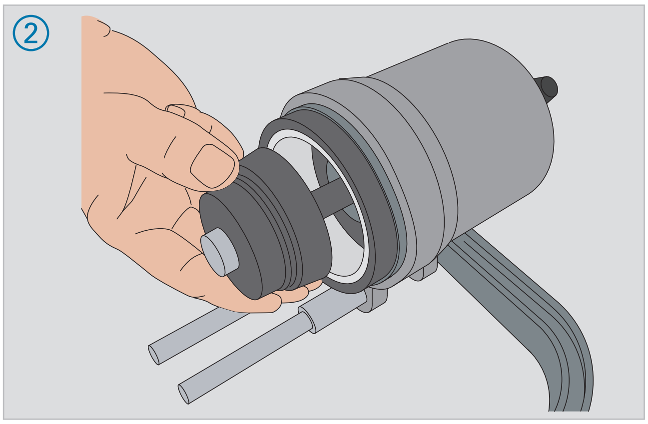
End the expansion process

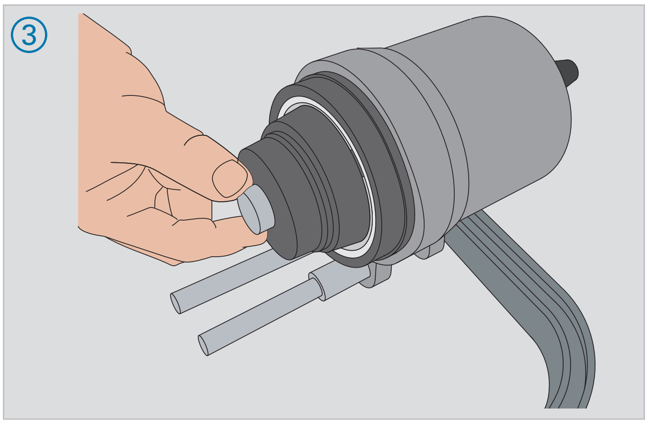
⑧ → Start the expanding process by pressing the start button on the hydraulic power pack.
↳ The expanding process is completed with an audible “click!”.
↳ The expanding process is completed when the expanding mandrel is fully retracted.

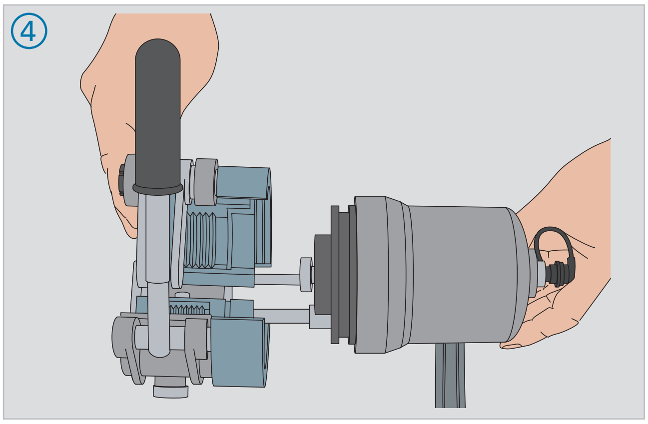
⑨ → Open clamping lever.

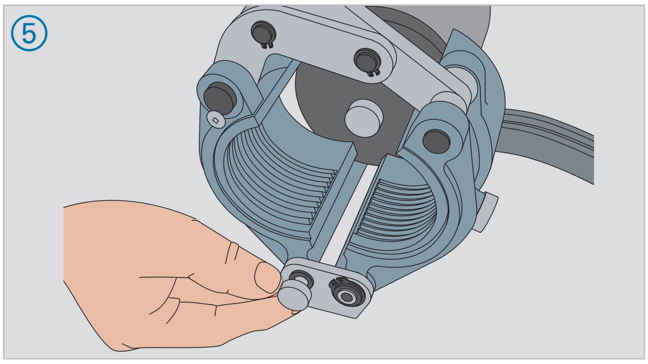
Assembly – Using the hydraulic expanding unit to expand the pipe (d50 – d63)

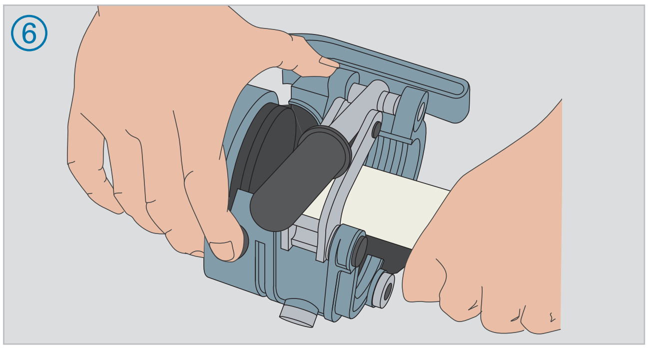


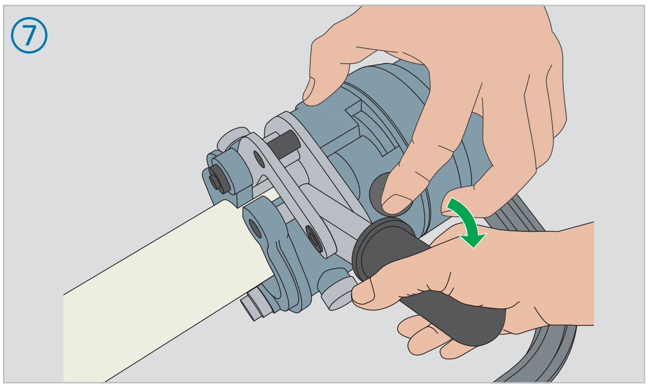


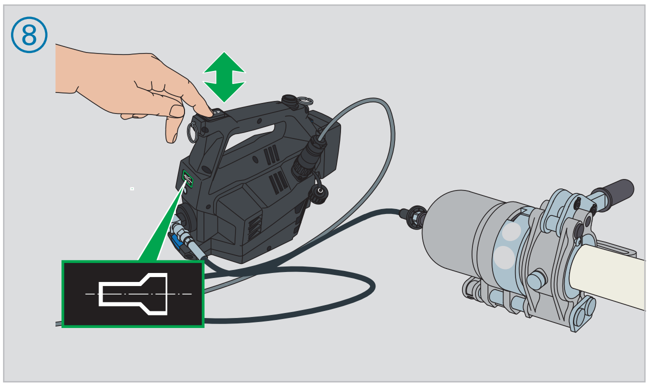


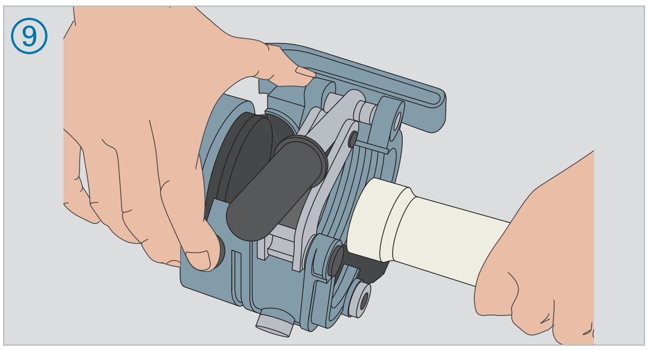












10.5 Assembly and inspection

☑ Compliance with the tool's operating instruction is mandatory.

Der JRG Sanipex MT ratchet torque wrench is used exclusively for tightening JRG Sanipex MT crimped clamp connectors. The applicable torques are permanently set at the factory.

Optical connector control

The optical connector control VCC (Visual Connection Control) supports the processor in the final inspection of the installation.

The applied torque of the JRG Sanipex MT torque wrench leaves an imprint on the white band and detaches it. By subsequently removing the band after installation, the installer confirms correct installation according to the installation instructions.

The new nuts make processing even safer by greatly simplifying the final visual inspection of the installation.

The individual steps are illustrated on the next page.

Assembly - Mount the pipe onto the fitting and inspect the assembly

Assemble pipe to fitting

① → Place the crimped pipe onto the fitting.

② → Check pipe flange and clamp connection (d16 to d63).
↳ The O-ring on the fitting must be **completely** covered by the pipe flange.
- "OK" = correct / "NO" = wrong

NOTE! The pipe's crimped end is shaped incorrectly.
→ If pipe flange is not crimped correctly, do **not** crimp the pipe end again.
→ If a crimped pipe end is cut too short, repeat the process.

→ Hand tighten coupling nut.

Tighten the connection and check

③ → Tighten the coupling nut using the ratchet torque wrench until a "click" can be felt and heard.
- To counteract, set the backup wrench onto the fitting.

Check crimped pipe end

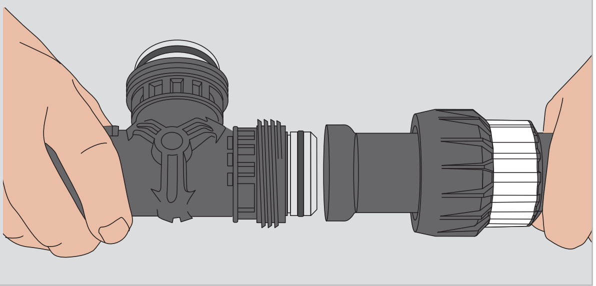
④ → Check connection.
- "OK" = correct / "NO" = wrong

At d16 to d40:
→ Remove attached or detached band.
→ In case of multiple use of the fittings: Document the use of the torque wrench with a yellow marker pen.

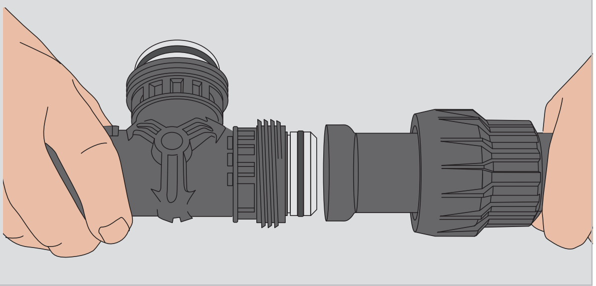
When using d50 and d63:
→ Note the following:
- The safety ring is visible: Connection **not** tightened.
- The safety ring is not visible anymore: Connection tightened.

Assembly – Mount the pipe onto the fitting and inspect the assembly

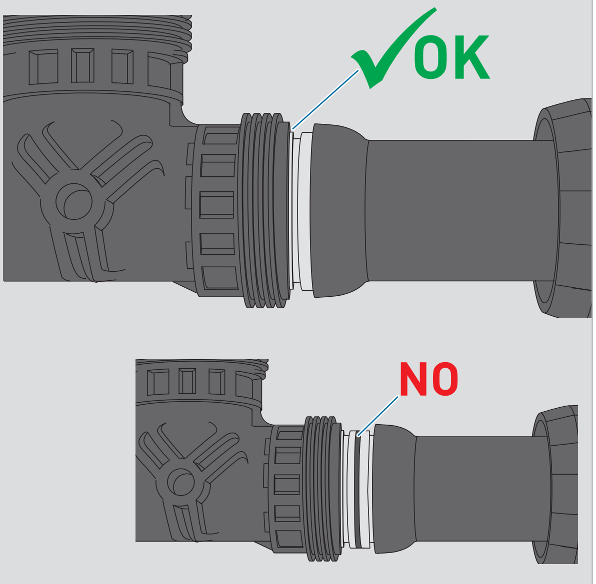
① d16 – d40



① d50 – d63



②



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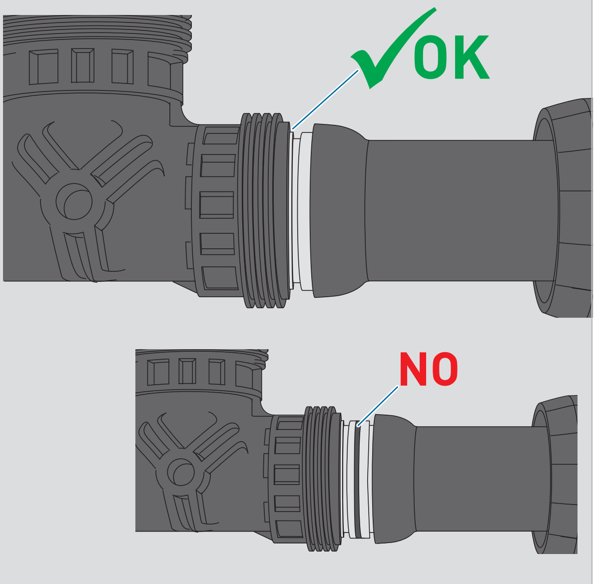

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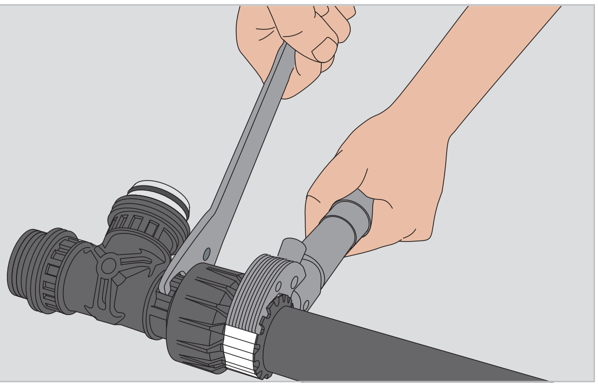

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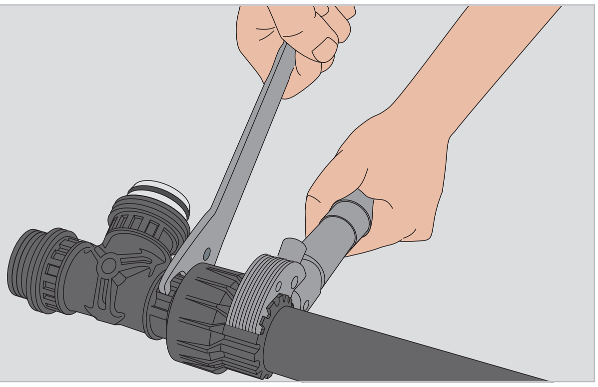

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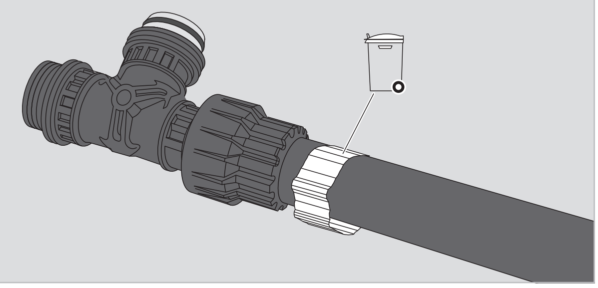

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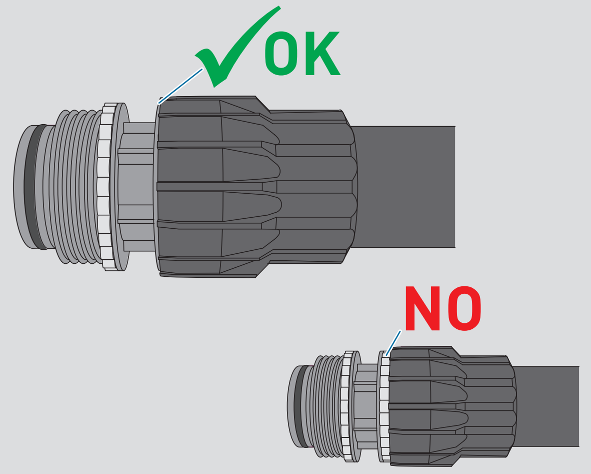


11 Bending

11.1 Bending methods

Manual bending using a die

The JRG Sanipex MT pipe in the dimensions d16, d20 and d26 can be bent manually.

☑ Ensure the bending radius is not less then 5 · d.

Hydraulic cylinders or bending springs

Commercially available hydraulic cylinders can be used, considering the following aspects.

☑ The shape of the bending gauge must correspond with the outside diameter of the JRG Sanipex MT pipe.

☑ Do not use internal bending springs.

☑ Ensure the bending radius is not less then 3.5 · d.

JRG Sanipex MT hydraulic cylinders

JRG Sanipex MT hydraulic cylinders have the bending radius of 3.5 · d.

- The JRG Manual pipe bender is also suitable for bending dimensions d16, d20 and d26.
- When using the hydraulic cylinder, the dimensions d16 to d63 can be bent.

TV.48 **Dimensions for 30°, 45°, 60°, 90° – bending radius 3.5 · d**

Pipe, Dimension		Bending radius [mm]	Radian BM [mm] 90 °	Hydraulic cylinder	Manual pipe bender			
				Radian BM [mm]				
d_a [mm]	DN			1/6 (90 °)	2/3 (90 °)	1/3 (60 °)	1/4 (45 °)	1/6 (30 °)
16	12	56	88	15	56	32	23	15
20	15	70	110	18	70	40	29	19
26	20	91	143	24	91	53	38	24
32	25	112	176	29				
40	32	140	220	37				
50	40	176						
63	50	221						

Design-related dimensional deviations are taken into account.

NOTE! Risk of damaging the pipes due to improper bending!

→ Ensure the pipes do not kink when bending them.

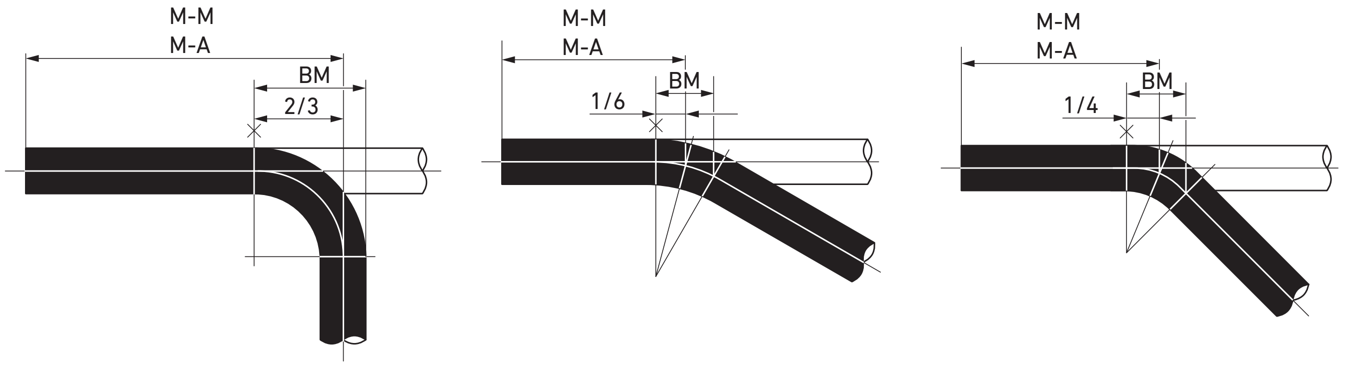
11.2 Bending, using a manual pipe bender

☑ Compliance with the tool's operating instruction is mandatory.
☑ Start of bend: **Start** of the pipe bend

Dimensions for pipe bend: ➨ Table [TV.48]

TV.49 **Start of bends at pipe bend**

90° bend	30° bend	45° bend
→ Indicate the dimension **centre/centre** (or **centre/outside**) on the straight pipe. → Measure the 2/3 radian **BM** in the direction of the start of the bend again and mark it.	→ Same procedure. → However, measure the 1/6 radian **BM** in the direction of the start of the bend again and mark it.	→ Same procedure. → However, measure the 1/4 radian **BM** in the direction of the start of the bend again and mark it.



M–M Dimension centre/centre
M–A Centre/outside dimension

Bend using manual pipe bender

Determine start of bend

○ → Mark the pipe bend as shown. ➨ Tab. [TV.49]

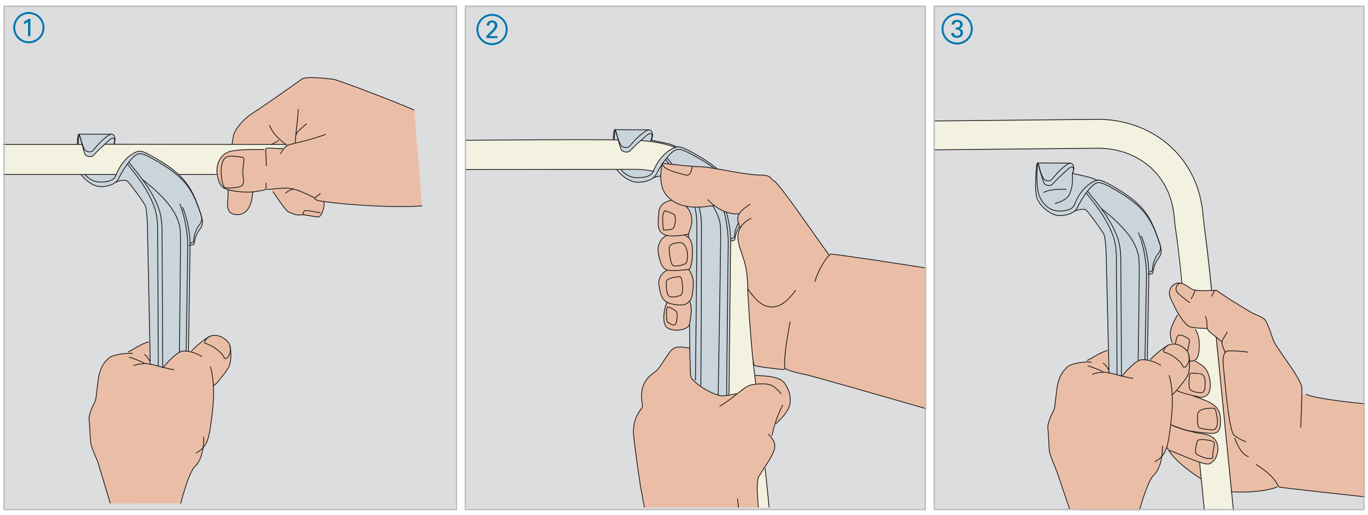
Pipe bending

① → Insert pipe into the manual pipe bender.
- Observe start of bend.

② → Bend the pipe.
- While doing so, guide the pipe as close as possible to the manual pipe bender.

③ → Remove the finished pipe bend from the manual pipe bender.

Bend using manual pipe bender



11.3 Bending with Hand bending tool 2 - d

☑ Compliance with the tool's operating instruction is mandatory.
☑ Start of bend: **Start** of the pipe bend

The individual steps are illustrated on the next page.

Bend with hand bending tool (2 - d)

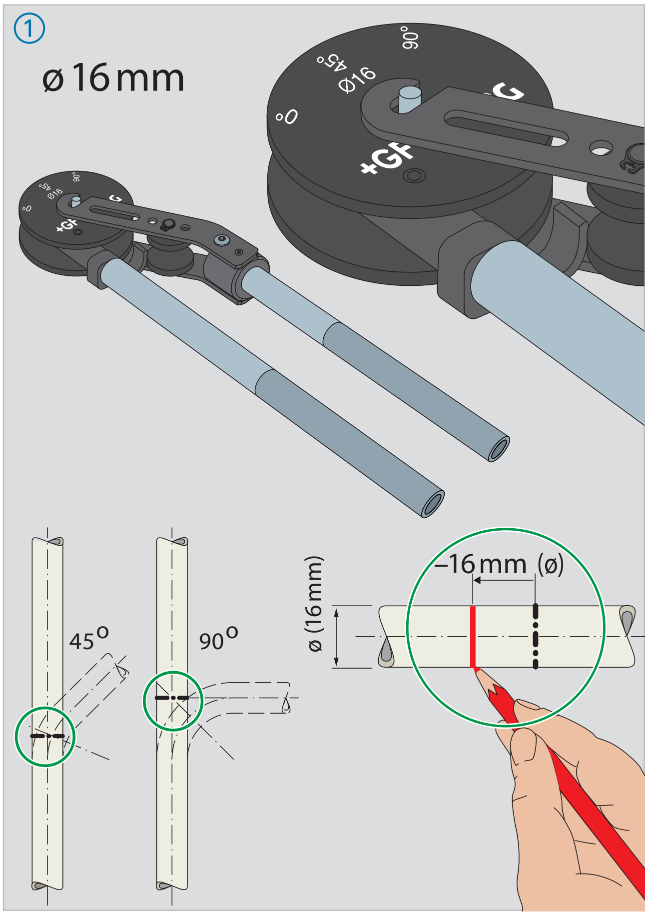
① → Mark the desired dimension for the center of the bend on the pipe and, depending on the dimension, measure back the necessary take-off dimension (for d16 = 16 mm and for d20 = 20 mm) and transfer it to the pipe.

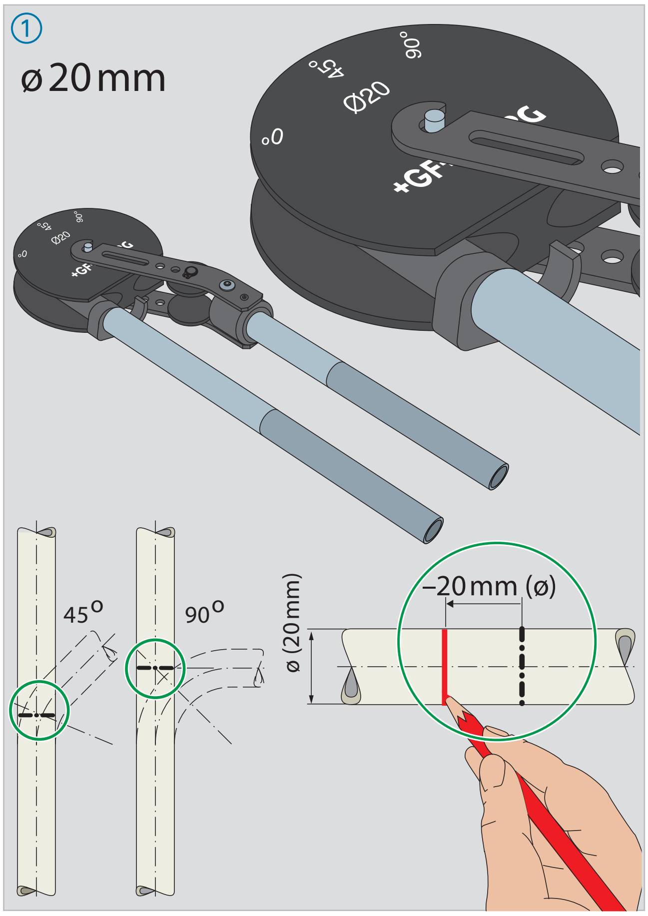
② → Apply the hand bending tool.
- Make sure that the 0° mark coincides with the marked start of the bend.

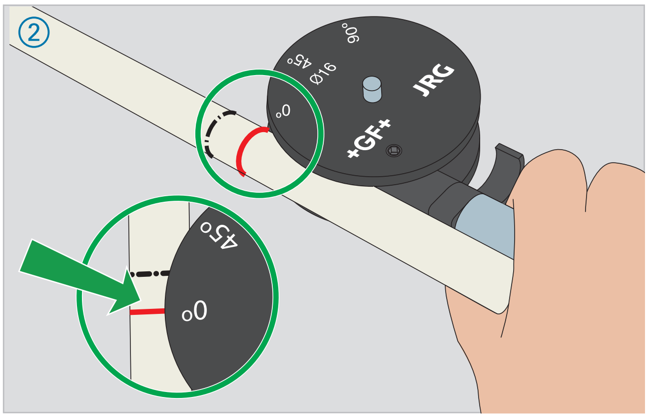
③ → Close the tube safety device and apply the bending lever.

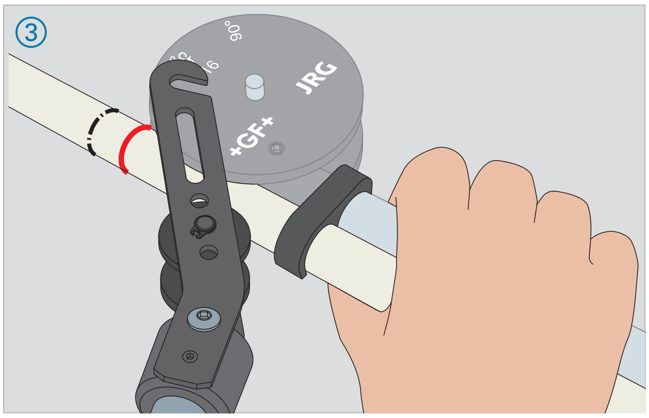
④ → Bend the tube to the desired angle.

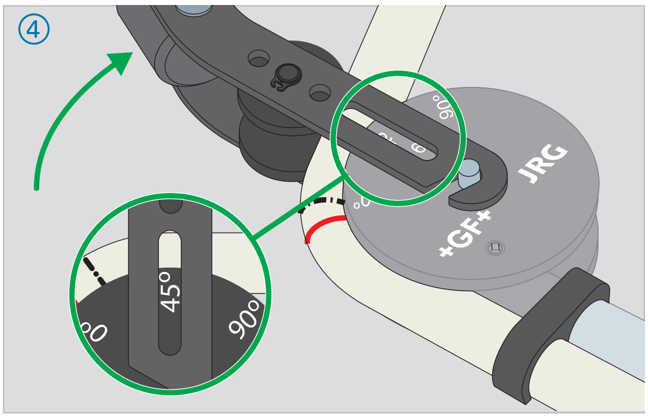
⑤ → If necessary, the tube must be re-bent.

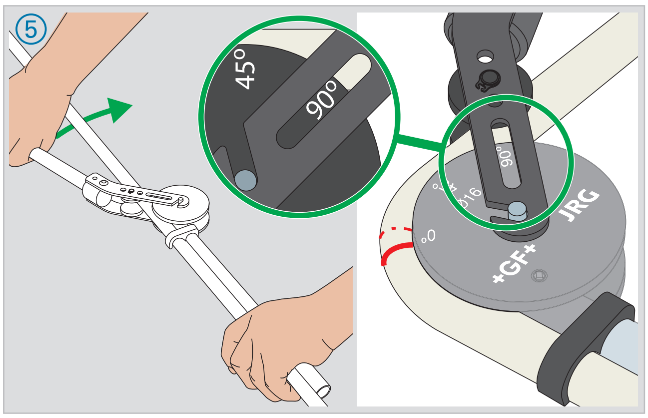

1
ø 16 mm
45°
90°
ø (16 mm)
16 mm (ø)


1
ø 20 mm
45°
90°
ø (20 mm)
20 mm (ø)


2
JRG
+GF+
0°
45°


3
JRG
+GF+


4
JRG
+GF+
0°
45°
90°

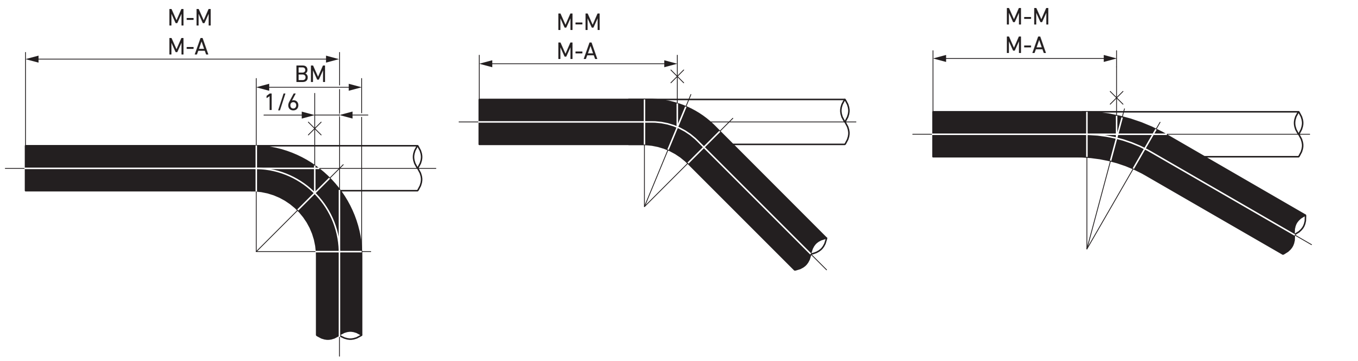

5
45°
90°
JRG
+GF+

11.4 Bending using a hydraulic cylinder

☑ Compliance with the tool's operating instruction is mandatory.
☑ Start of bend: **Centre** of pipe bend
Dimensions for pipe bend: ➨ Table [TV.48]

TV.50 **Start of bends at pipe bend**

90° bend	45° bend	30° bend
→ Mark pipe bend as shown. → Indicate the dimension **centre/centre** (or **centre/outside**) on the straight pipe. → Measure the 1/6 radian **BM** in the direction of the start of the bend again and mark it.	When bending along the centre of the pipe bend, the geometric changes in length can be neglected.	When bending along the centre of the pipe bend, the geometric changes in length can be neglected.



M–M	Dimension centre/centre
M–A	Centre/outside dimension

> **The individual steps for d26 to d63 are illustrated on the next page.**
> **The illustrations show the new pipe bender.**

Bending using a hydraulic cylinder

Determine centre of bend

◯ → Mark the pipe bend as shown. ➨ Tab. [TV.50]

Set up hydraulic cylinder

① → Place the hydraulic cylinder onto the base plate.

② → Insert the dimensional scale.

③ → Insert adaptor nipple (use only d26 to d40).

④ → Insert the appropriate bending gauge onto the adaptor nipple.

⑤ → Insert mandrel in bending roller.
→ Insert bending rollers in the applicable bore hole.

⑥ → Connect the hydraulic coupling to the hydraulic nipple of the bending tool.

⑦ → Connect the control cable of the bending tool to the connector socket of the hydraulic unit.

Bending procedure

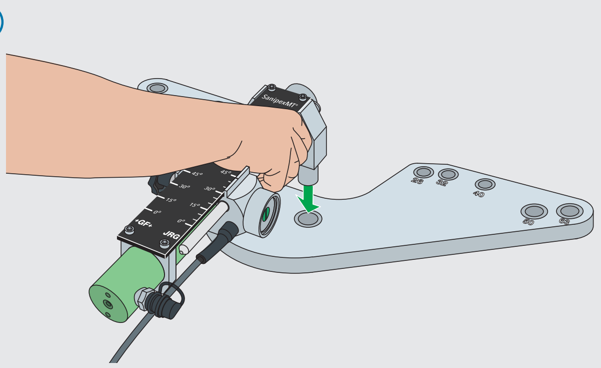
⑧ → Determine bending angle.
→ Set the slide to the appropriate dimension and angle and use the set screw to tighten the slide.

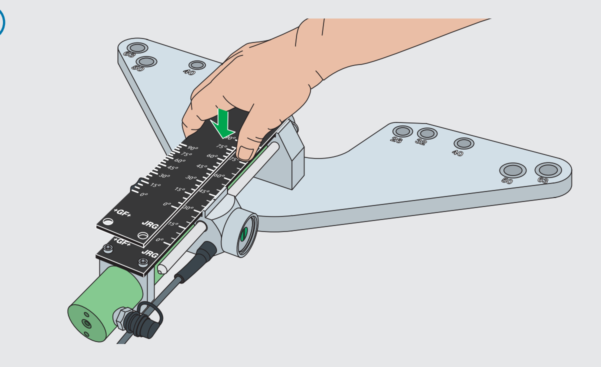
⑨ → Mark the centre of the bend on the pipe. ➨ Table [TV.49]
→ Insert pipe into the bending gauge. Observe the centre of the bend.
☑ The pipe must protrude beyond the bending rollers.

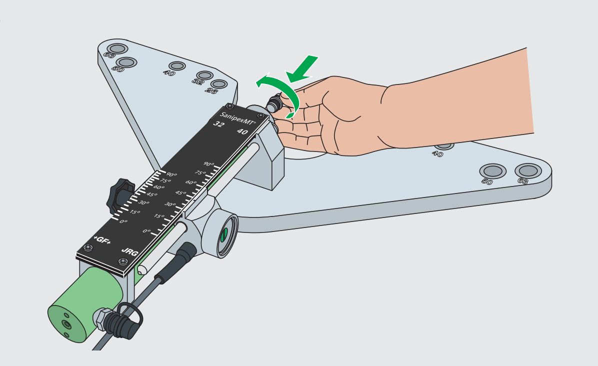
⑩ → Press and keep the start button on the hydraulic cylinder depressed
↳ The bending tool performs the bending operation.

⑪ ↳ The bending tool stops the bending process automatically when the set bending angle is reached.

Bending using a hydraulic cylinder (d26 – d63)

1


2


3


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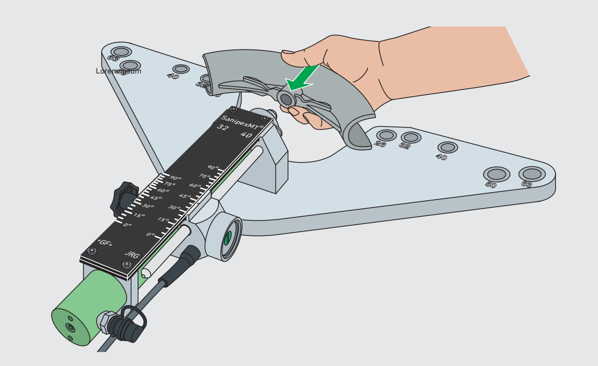
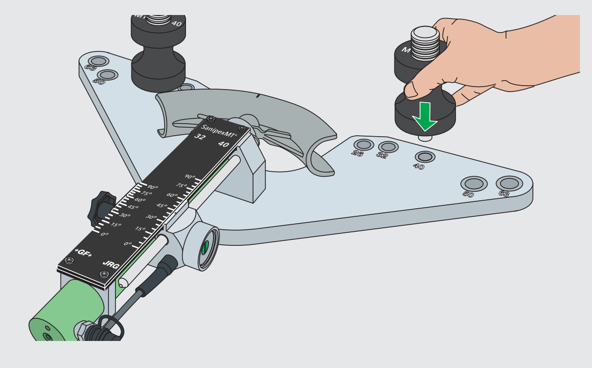
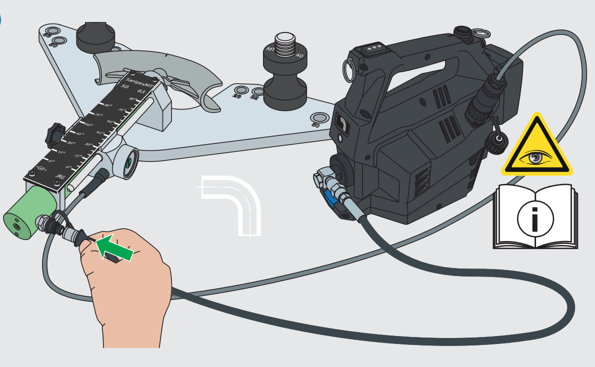
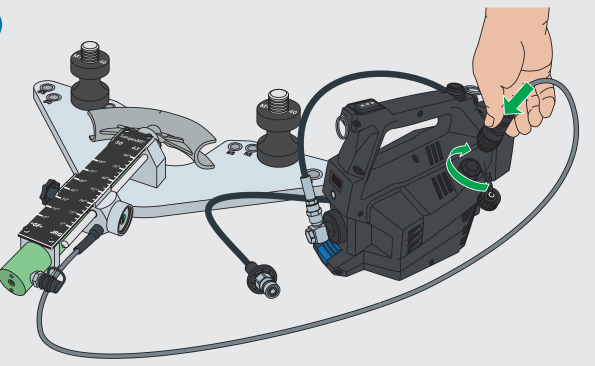
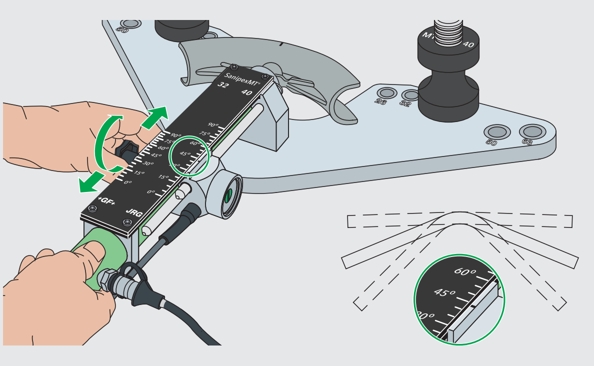


5


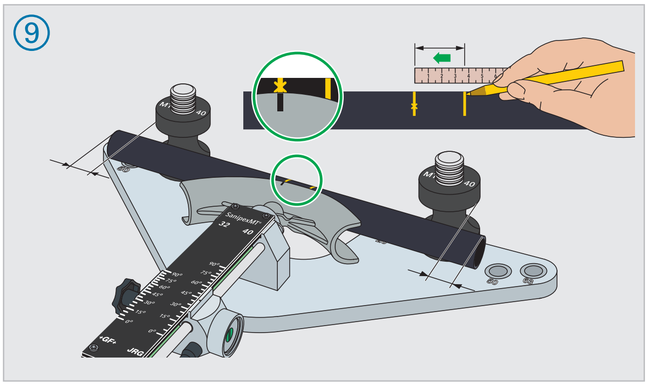
6


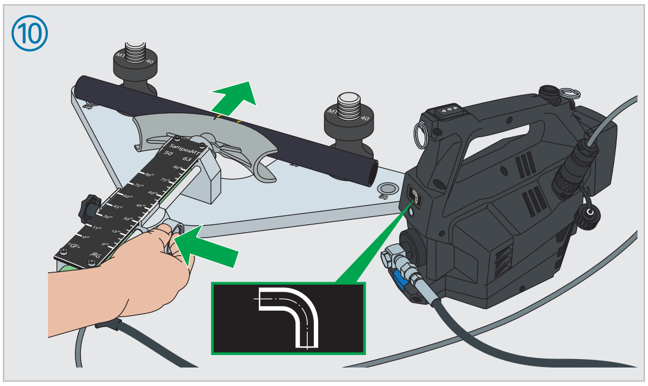
7


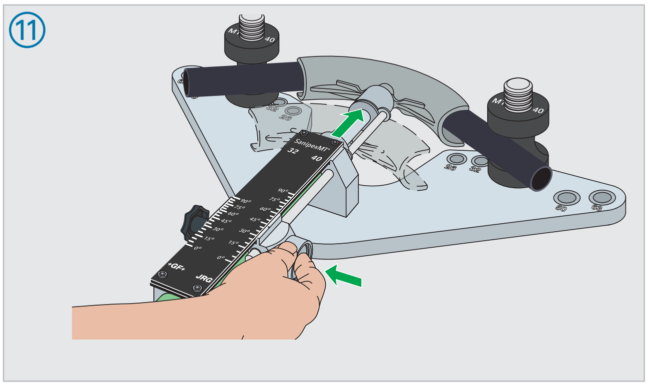
8


Bending using a hydraulic cylinder ▶▶

Bending using a hydraulic cylinder







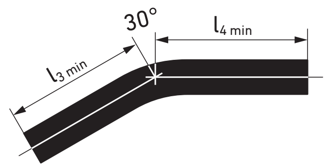
12 Fittings – Combinations – Dimensions

12.1 Combination without fittings

Bending radius = 3.5 · d (using hydraulic cylinder)

30° bend made of composite pipe

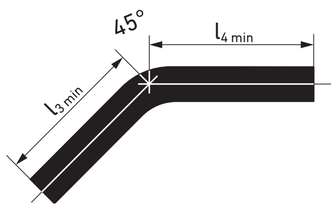
Angles α	d	16	16*	20	20*	26	26*	32	40	50	63
	DN	12	12	15	15	20	20	25	32	40	50
		[mm]									
30 °	l_{3min}	60	71	65	74	80	105	102	115	120	122
	l_{4min}	60	71	65	74	80	105	102	115	120	122



* using expanding pliers 4804

45° bend from composite pipe

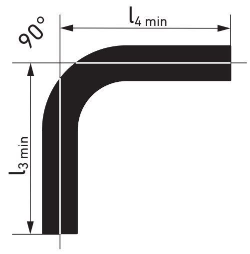
Angles α	d	16	16*	20	20*	26	26*	32	40	50	63
	DN	12	12	15	15	20	20	25	32	40	50
		[mm]									
45 °	l_{3min}	63	72	63	74	90	95	98	139	125	160
	l_{4min}	63	72	63	74	90	95	98	139	125	125



* using expanding pliers 4804

90° bend from composite pipe

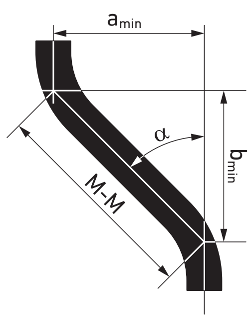
Angles α	d	16	16*	20	20*	26	26*	32	40	50	63
	DN	12	12	15	15	20	20	25	32	40	50
		[mm]									
90 °	l_{3min}	91	102	108	117	136	160	165	215	172	220
	l_{4min}	91	102	108	117	136	160	165	215	172	220



* using expanding pliers 4804

Combination of bends made of composite pipe

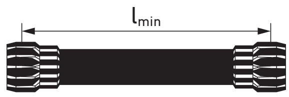
Angles α	d	16	16*	20	20*	26	26*	32	40	50	63
	DN	12	12	15	15	20	20	25	32	40	50
		[mm]									
30 °	a_{min}	65	40	65	45	87	63	112	130	160	200
	b_{min}	113	69	113	78	151	108	194	225	277	346
	M–M	130	80	130	90	174	125	224	260	320	400
45 °	a_{min}	103	63	111	80	141	100	163	215	250	300
	b_{min}	103	63	111	80	141	100	163	215	250	300
	M–M	146	89	159	113	199	142	230	304	354	424
60 °	a_{min}	130	80	138	106	176	149	220	287	334	400
	b_{min}	75	46	80	61	102	86	127	166	193	231
	M–M	150	92	160	122	203	172	254	331	386	462
90 °	a_{min}	195	145	200	185	245	225	320	410	491	600
	b_{min}	16	16	20	20	26	26	32	40	50	63
	M–M	195	145	200	185	245	225	320	410	494	603



* using manual pipe bender 4806

Minimum dimension of a straight pipe section with MT nuts

d	16	16*	20	20*	26	26*	32	40	50	63
DN	12	12	15	15	20	20	25	32	40	50
	[mm]									
l_{min}	71	87	88	104	114	120	137	164	201	243



* using expanding pliers 4804

V

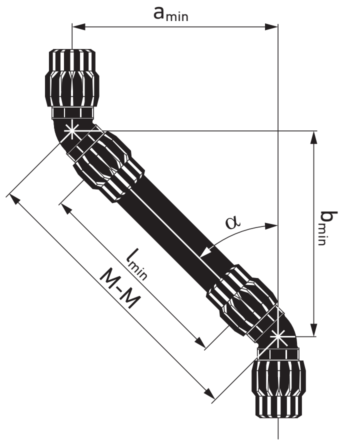
12.2 Combination with fittings

Fitting combination with 45° elbow/45° elbow (4676/4676)

Angles α	d	20	20*	26	26*	32	40	50	63
	DN	15	15	20	20	25	32	40	50
		[mm]							
	z dimension	44	44	54	54	64	74	94	112
45 ° 4676	a_{min}	93	102	119	123	142	168	209	251
	b_{min}	93	102	119	123	142	168	209	251
	l_{min}	88	100	114	120	137	164	201	243
	M–M	132	144	168	174	201	238	295	355

* using expanding pliers 4804

M–M Dimension centre/centre

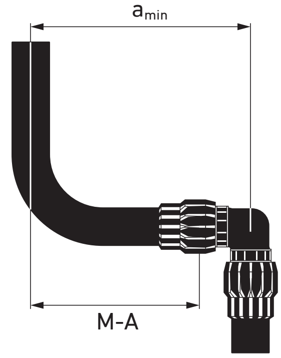


Combination 90° pipe bend with 90° angle (4607) and tee (4650)

Angles α	d	16	16*	20	20*	26	26*	32	40	50	63
	DN	12	12	15	15	20	20	25	32	40	50
		[mm]									
	z dimension	28	28	32	32	39	39	45	55	63	79
90 ° 4607 / 4670	a_{min}	119	131	140	150	175	199	210	270	292	308
	M–A	91	103	108	118	136	160	165	215	229	273

* using expanding pliers 4804

M–A Centre/outside dimension



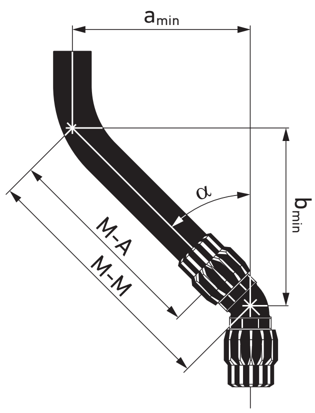
Combination 45° pipe bend with 45° angle (4676)

Angles α	d	20	20*	26	26*	32	40	50	63
	DN	15	15	20	20	25	32	40	50
		[mm]							
	z dimension	22	22	27	27	32	37	47	56
45 ° 4608 / 4676	a_{min}	60	67	83	88	92	124	145	165
	b_{min}	60	67	83	88	92	124	156	182
	M–M	85	95	117	124	130	176	205	234
	M–A	63	73	90	97	98	139	158	178

* using expanding pliers 4804

M–M Dimension centre/centre

M–A Centre/outside dimension

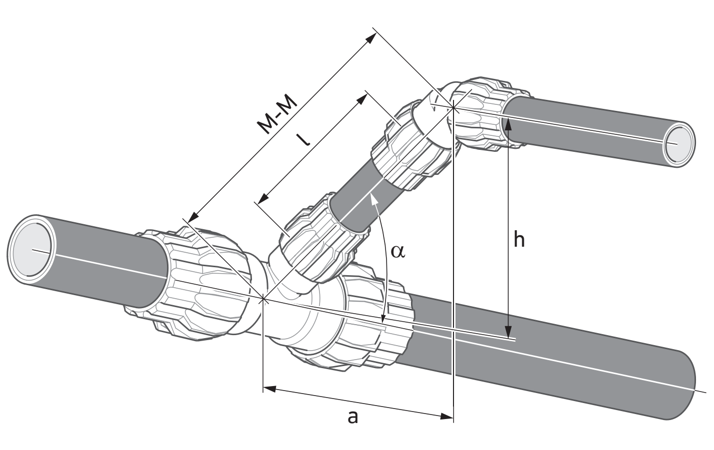


12.3 Combination with fitting changing elevation

Fitting changing elevation

Equal tee and 45° angle (4650/4676)

90° angle and 45° angle (4670/4676)



Pipe section fallen short of minimum dimension

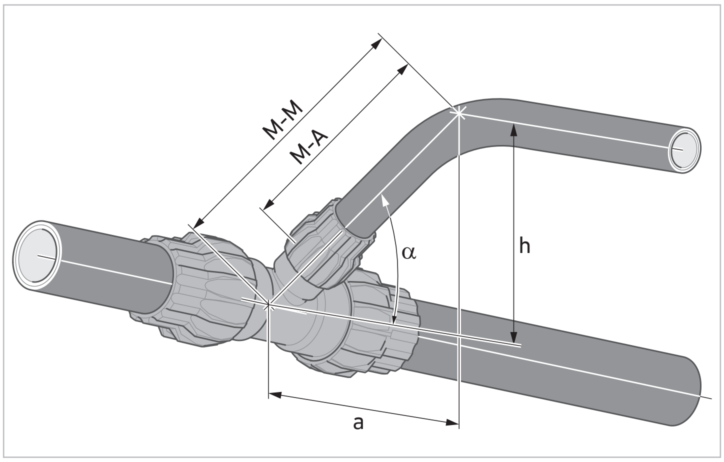
M–M Dimension centre/centre

Fitting changing elevation DN		20 / 15	26 / 20	32 / 25	40 / 32	50 / 40	63 / 50
z dimension [mm]		52	66	77	92	110	135
h_{min} [mm]		99	127	151	181	217	264
h [mm]	M–M [mm]	Pipe dimension l [mm]					
100	141	89					
110	156	104					
120	170	118					
130	184	132	118				
140	198	146	132				
150	212	160	146				
160	226	174	160	149			
170	240	188	174	163			
180	255	203	189	178			
190	269	217	203	192	177		
200	283	231	217	206	191		
210	297	245	231	220	205		
220	311	259	245	234	219	201	
230	325	273	259	248	233	215	
240	339	287	273	262	247	229	
250	354	302	288	277	262	244	
260	368	316	302	291	276	258	
270	382	330	316	305	290	272	247
280	396	344	330	319	304	286	261
290	410	358	344	333	318	300	275
300	424	372	358	347	332	314	289
310	438	386	372	361	346	328	303
320	453	401	387	376	361	343	318
330	467	415	401	390	375	357	332
340	481	429	415	404	389	371	346
350	495	443	429	418	403	385	360
360	509	457	443	432	417	399	374
370	523	471	457	446	431	413	388
380	537	485	471	460	445	427	402

Fitting changing elevation

Equal tee and 45° pipe bend
(4650/45° pipe bend)

90° angle and 45° pipe bend
(4670/45° pipe bend)



Pipe section fallen short of minimum dimension

Minimum dimension of the flexible pipe leg with hydraulic cylinder 4852 without subsequent cutting

M–M Dimension centre/centre
M–A Centre/outside dimension

Fitting changing elevation DN		16	20	26	32	40	50	63
		12	15	20	25	32	40	50
z dimension [mm]		27	31	39	45	55	63	79
h_{min} [mm]		64	66	91	101	137	158	182
h [mm]	M–M [mm]	Flexible pipe leg l (M–A) [mm]						
80	113	86	82					
90	127	100	96					
100	141	114	110	102				
110	156	129	125	117	111			
120	170	143	139	131	125			
130	184	157	153	145	139			
140	198	171	167	159	153	143		
150	212	185	181	173	167	157		
160	226	199	195	187	181	171	163	
170	240	213	209	201	195	185	177	
180	255	228	224	216	210	200	192	
190	269	242	238	230	224	214	206	190
200	283	256	252	244	238	228	220	204
210	297	270	266	258	252	242	234	218
220	311	284	280	272	266	256	248	232
230	325	298	294	286	280	270	262	246
240	339	312	308	300	294	284	276	260
250	354	327	323	315	309	299	291	275
260	368	341	337	329	323	313	305	289
270	382	355	351	343	337	327	319	303
280	396	369	365	357	351	341	333	317
290	410	383	379	371	365	355	347	331
300	424	397	393	385	379	369	361	345
310	438	411	407	399	393	383	375	359
320	453	426	422	414	408	398	390	374
330	467	440	436	428	422	412	404	388
340	481	454	450	442	436	426	418	402
350	495	468	464	456	450	440	432	416
360	509	482	478	470	464	454	446	430
370	523	496	492	484	478	468	460	444
380	537	510	506	498	492	482	474	458

Fitting changing elevation

Equal tee and 30° pipe bend (4650/30° pipe bend)

90° angle and 30° pipe bend (4670/30° pipe bend)

Pipe section fallen short of minimum dimension

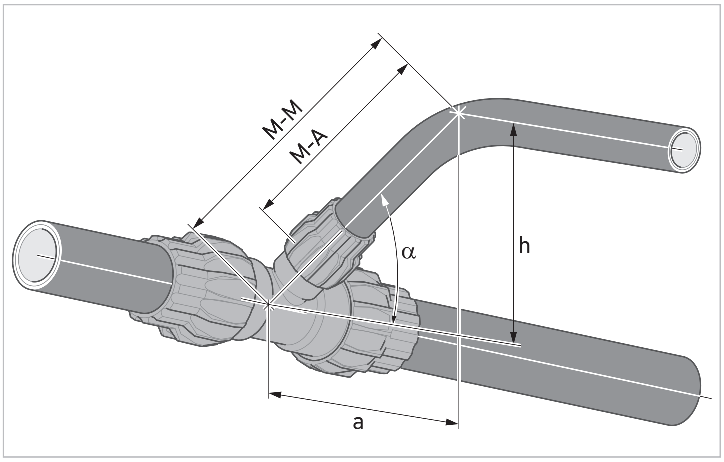
Minimum dimension of the flexible pipe leg with hydraulic cylinder 4852 without subsequent cutting

M–M Dimension centre/centre

M–A Centre/outside dimension

☑ Using the bending tool to create a 30° pipe bend.

a = h × 1.732

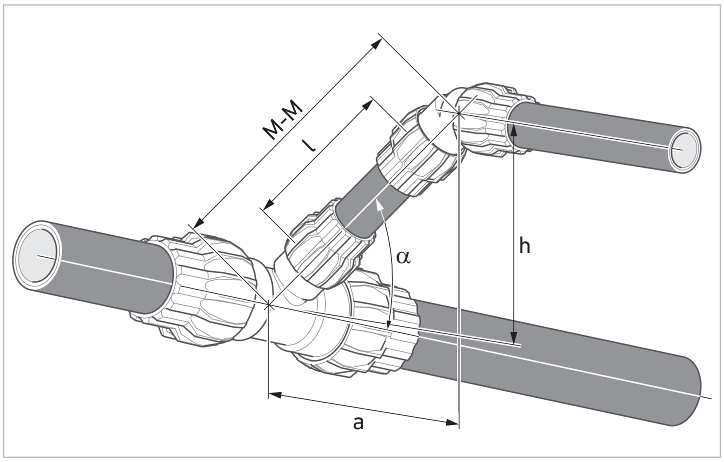


Fitting changing elevation DN		16	20	26	32	40	50	63
		12	15	20	25	32	40	50
z dimension [mm]		27	31	39	45	55	63	79
h_{min} [mm]		44	48	60	74	85	109	119
h [mm]	M–M [mm]	Flexible pipe leg l (M–A) [mm]						
80	160	133	129	121	115			
90	180	153	149	141	135	125		
100	200	173	169	161	155	145		
110	220	193	189	181	175	165	157	
120	240	213	209	201	195	185	177	161
130	260	233	229	221	215	205	197	181
140	280	253	249	241	235	225	217	201
150	300	273	269	261	255	245	237	221
160	320	293	289	281	275	265	257	241
170	340	313	309	301	295	285	277	261
180	360	333	329	321	315	305	297	281
190	380	353	349	341	335	325	317	301
200	400	373	369	361	355	345	337	321
210	420	393	389	381	375	365	357	341
220	440	413	409	401	395	385	377	361
230	460	433	429	421	415	405	397	381
240	480	453	449	441	435	425	417	401
250	500	473	469	461	455	445	437	421
260	520	493	489	481	475	465	457	441
270	540	513	509	501	495	485	477	461
280	560	533	529	521	515	505	497	481
290	580	553	549	541	535	525	517	501
300	600	573	569	561	555	545	537	521
310	620	593	589	581	575	565	557	541
320	640	613	609	601	595	585	577	561
330	660	633	629	621	615	605	597	581
340	680	653	649	641	635	625	617	601
350	700	673	669	661	655	645	637	621
360	720	693	689	681	675	665	657	641
370	740	713	709	701	695	685	677	661
380	760	733	729	721	715	705	697	681

Fitting changing elevation

Equal tee, reduction and 45° bend (4650/4730/4676)

90° bend, reduction and 45° bend (4670/4730/4676)



▇ Pipe section fallen short of minimum dimension

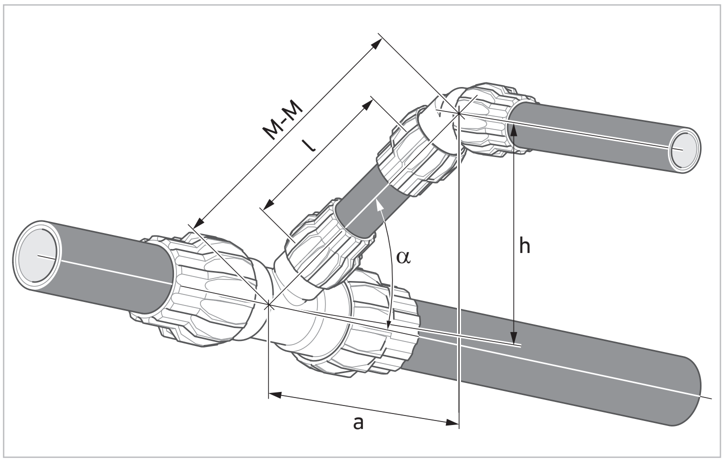
M–M Dimension centre/centre

Fitting changing elevation DN		26-20 / 20-15	32-20 / 25-20	32-26 / 25-20	40-20 / 32-15	40-26 / 32-20	40-32 / 32-25
z dimension [mm]		99	118	122	137	143	145
h_{min} [mm]		133	146	167	159	182	199
h [mm]	M–M [mm]	Pipe dimension l [mm]					
100	141						
110	156						
120	170						
130	184						
140	198	99					
150	212	113	94				
160	226	127	108		89		
170	240	141	122	118	103		
180	255	156	137	133	118		
190	269	170	151	147	132	126	
200	283	184	165	161	146	140	138
210	297	198	179	175	160	154	152
220	311	212	193	189	174	168	166
230	325	226	207	203	188	182	180
240	339	240	221	217	202	196	194
250	354	255	236	232	217	211	209
260	368	269	250	246	231	225	223
270	382	283	264	260	245	239	237
280	396	297	278	274	259	253	251
290	410	311	292	288	273	267	265
300	424	325	306	302	287	281	279
310	438	339	320	316	301	295	293
320	453	354	335	331	316	310	308
330	467	368	349	345	330	324	322
340	481	382	363	359	344	338	336
350	495	396	377	373	358	352	350
360	509	410	391	387	372	366	364
370	523	424	405	401	386	380	378
380	537	438	419	415	400	394	392

Fitting changing elevation

Equal tee, reduction and 45° bend (4650/4730/4676)

90° bend, reduction and 45° bend (4670/4730/4676)



Pipe section fallen short of minimum dimension

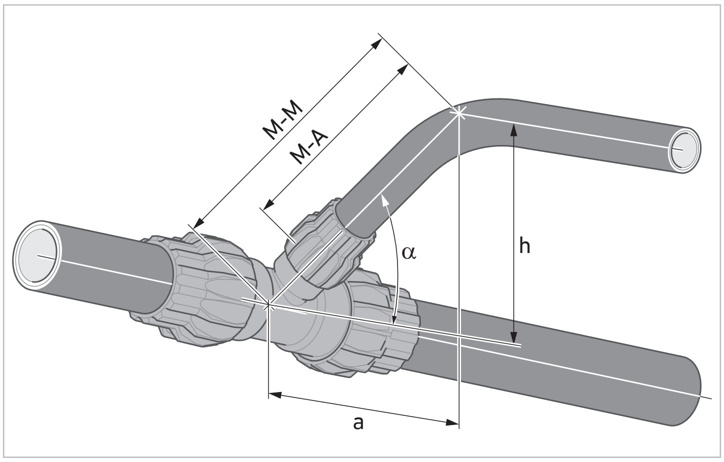
M–M Dimension centre/centre

Fitting changing elevation DN		50-26	50-32	50-40	63-26	63-32	63-40	63-50
		40-20	40-25	40-32	50-20	50-25	50-32	50-40
z dimension [mm]		160	165	175	189	196	205	227
h_{min} [mm]		193	214	240	214	235	261	302
h [mm]	M–M [mm]	Pipe dimension l [mm]						
100	141							
110	156							
120	170							
130	184							
140	198							
150	212							
160	226							
170	240							
180	255							
190	269							
200	283	123						
210	297	137						
220	311	152	146		123			
230	325	166	160		137			
240	339	180	174	165	151	144		
250	354	194	189	179	165	158		
260	368	208	203	193	179	172	163	
270	382	222	217	207	193	186	177	
280	396	236	231	221	207	200	191	
290	410	251	245	235	222	214	205	
300	424	265	259	249	236	228	220	
310	438	279	273	264	250	243	234	212
320	453	293	288	278	264	257	248	226
330	467	307	302	292	278	271	262	240
340	481	321	316	306	292	285	276	254
350	495	335	330	320	306	299	290	268
360	509	350	344	334	321	313	304	283
370	523	364	358	348	335	327	319	297
380	537	378	372	363	349	342	333	311

Fitting changing elevation

Equal tee, reduction and 45° pipe bend (4650/4730/45° pipe bend)

90° angle, reduction and 45° pipe bend (4670/4730/45° pipe bend)



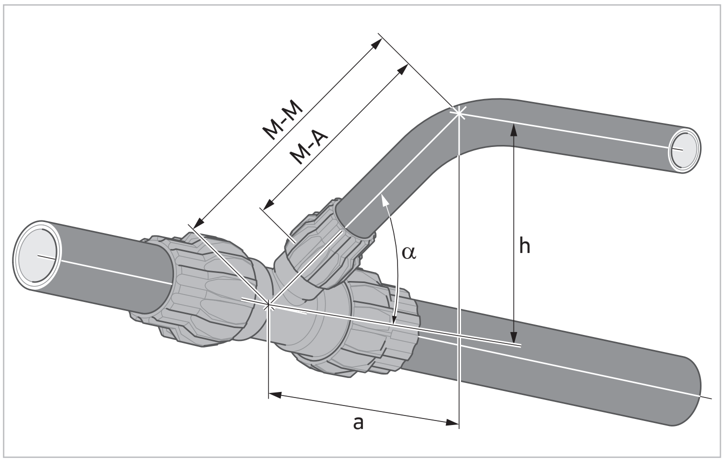
(dark grey)	Pipe section fallen short of minimum dimension
(light grey)	Minimum dimension of the flexible pipe leg with hydraulic cylinder 4852 without subsequent cutting
M–M	Dimension centre/centre
M–A	Centre/outside dimension

Fitting changing elevation DN		20-16 15-12	26-16 20-12	26-20 20-15	32-16 25-12	32-20 25-20	32-26 25-20	40-16 32-12	40-20 32-15	40-26 32-20	40-32 32-25
z dimension [mm]		62	81	78	97	95	95	116	116	116	113
h_{min} [mm]		88	101	100	113	112	131	127	127	146	149
h [mm]	M–M [mm]	Flexible pipe leg l (M–A) [mm]									
100	141	79		63							
110	156	94	75	78							
120	170	108	89	92	73	75					
130	184	122	103	106	87	89		68	68		
140	198	136	117	120	101	103	103	82	82		
150	212	150	131	134	115	117	117	96	96	96	99
160	226	164	145	148	129	131	131	110	110	110	113
170	240	178	159	162	143	145	145	124	124	124	127
180	255	193	174	177	158	160	160	139	139	139	142
190	269	207	188	191	172	174	174	153	153	153	156
200	283	221	202	205	186	188	188	167	167	167	170
210	297	235	216	219	200	202	202	181	181	181	184
220	311	249	230	233	214	216	216	195	195	195	198
230	325	263	244	247	228	230	230	209	209	209	212
240	339	277	258	261	242	244	244	223	223	223	226
250	354	292	273	276	257	259	259	238	238	238	241
260	368	306	287	290	271	273	273	252	252	252	255
270	382	320	301	304	285	287	287	266	266	266	269
280	396	334	315	318	299	301	301	280	280	280	283
290	410	348	329	332	313	315	315	294	294	294	297
300	424	362	343	346	327	329	329	308	308	308	311
310	438	376	357	360	341	343	343	322	322	322	325
320	453	391	372	375	356	358	358	337	337	337	340
330	467	405	386	389	370	372	372	351	351	351	354
340	481	419	400	403	384	386	386	365	365	365	368
350	495	433	414	417	398	400	400	379	379	379	382
360	509	447	428	431	412	414	414	393	393	393	396
370	523	461	442	445	426	428	428	407	407	407	410
380	537	475	456	459	440	442	442	421	421	421	424

Fitting changing elevation

Equal tee, reduction and 45° pipe bend (4650/4730/45° pipe bend)

90° angle, reduction and 45° pipe bend (4670/4730/45° pipe bend)



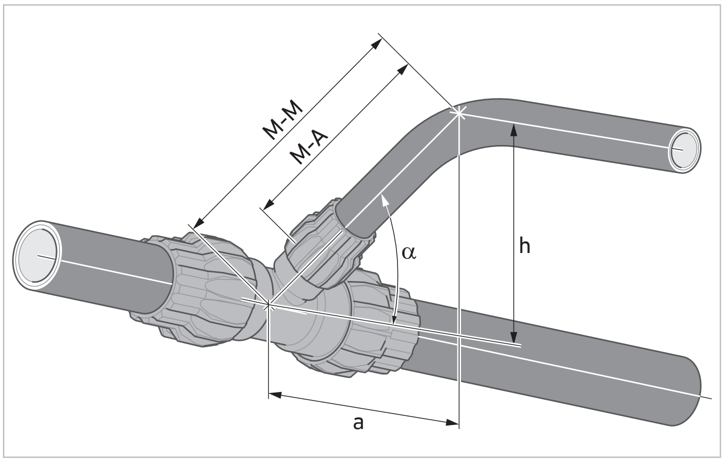
▇	Pipe section fallen short of minimum dimension
M–M	Dimension centre/centre
M–A	Centre/outside dimension

Fitting changing elevation DN		50-26	50-32	50-40	63-26	63-32	63-40	63-50
		40-20	40-25	40-32	50-20	50-25	50-32	50-40
z dimension [mm]		133	133	138	162	164	168	180
h_{min} [mm]		157	163	196	178	185	217	239
h [mm]	M–M [mm]	Flexible pipe leg l (M–A) [mm]						
100	141							
110	156							
120	170							
130	184							
140	198							
150	212							
160	226	93						
170	240	107	107					
180	255	122	122		93			
190	269	136	136		107	105		
200	283	150	150	145	121	119		
210	297	164	164	159	135	133		
220	311	178	178	173	150	147	143	
230	325	192	192	187	164	161	158	
240	339	206	206	202	178	176	172	160
250	354	221	221	216	192	190	186	174
260	368	235	235	230	206	204	200	188
270	382	249	249	244	220	218	214	202
280	396	263	263	258	234	232	228	216
290	410	277	277	272	249	246	242	231
300	424	291	291	286	263	260	257	245
310	438	305	305	301	277	275	271	259
320	453	320	320	315	291	289	285	273
330	467	334	334	329	305	303	299	287
340	481	348	348	343	319	317	313	301
350	495	362	362	357	333	331	327	315
360	509	376	376	371	348	345	341	330
370	523	390	390	385	362	359	356	344
380	537	404	404	400	376	374	370	358

Fitting changing elevation

Equal tee, reduction and 30° pipe bend (4650/4730/30° pipe bend)

90° angle, reduction and 30° pipe bend (4670/4730/30° pipe bend)



Dark grey: Pipe section fallen short of minimum dimension

Light grey: Minimum dimension of the flexible pipe leg with hydraulic cylinder 4852 without subsequent cutting

M–M Dimension centre/centre
M–A Centre/outside dimension

☑ Using the bending tool to create a 30° pipe bend.

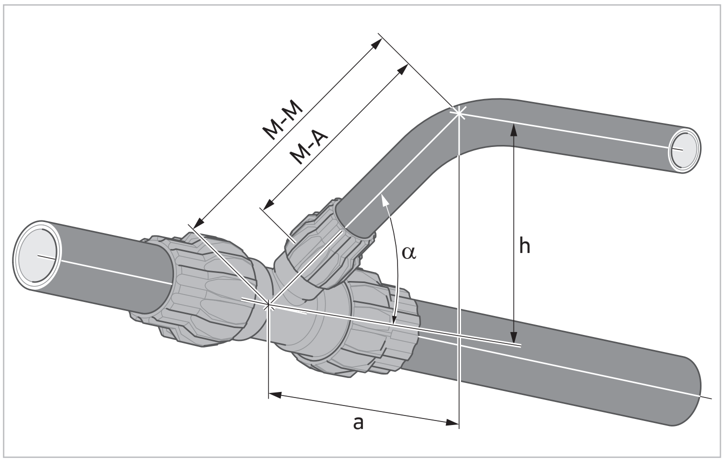
a = h · 1.732

Fitting changing elevation DN		20-16 / 15-12	26-16 / 20-12	26-20 / 20-15	32-16 / 25-12	32-20 / 25-20	32-26 / 25-20	40-16 / 32-12	40-20 / 32-15	40-26 / 32-20	40-32 / 32-25
z dimension [mm]		62	80	78	97	95	95	116	116	116	113
h_{min} [mm]		61	70	72	79	80	88	88	91	98	108
h [mm]	M–M [mm]	Flexible pipe leg l (M–A) [mm]									
80	160	98	80	82	63	65					
90	180	118	100	102	83	85	85	64			
100	200	138	120	122	103	105	105	84	84	84	
110	220	158	140	142	123	125	125	104	104	104	107
120	240	178	160	162	143	145	145	124	124	124	127
130	260	198	180	182	163	165	165	144	144	144	147
140	280	218	200	202	183	185	185	164	164	164	167
150	300	238	220	222	203	205	205	184	184	184	187
160	320	258	240	242	223	225	225	204	204	204	207
170	340	278	260	262	243	245	245	224	224	224	227
180	360	298	280	282	263	265	265	244	244	244	247
190	380	318	300	302	283	285	285	264	264	264	267
200	400	338	320	322	303	305	305	284	284	284	287
210	420	358	340	342	323	325	325	304	304	304	307
220	440	378	360	362	343	345	345	324	324	324	327
230	460	398	380	382	363	365	365	344	344	344	347
240	480	418	400	402	383	385	385	364	364	364	367
250	500	438	420	422	403	405	405	384	384	384	387
260	520	458	440	442	423	425	425	404	404	404	407
270	540	478	460	462	443	445	445	424	424	424	427
280	560	498	480	482	463	465	465	444	444	444	447
290	580	518	500	502	483	485	485	464	464	464	467
300	600	538	520	522	503	505	505	484	484	484	487
310	620	558	540	542	523	525	525	504	504	504	507
320	640	578	560	562	543	545	545	524	524	524	527
330	660	598	580	582	563	565	565	544	544	544	547
340	680	618	600	602	583	585	585	564	564	564	567
350	700	638	620	622	603	605	605	584	584	584	587
360	720	658	640	642	623	625	625	604	604	604	607
370	740	678	660	662	643	645	645	624	624	624	627
380	760	698	680	682	663	665	665	644	644	644	647

Fitting changing elevation

Equal tee, reduction and 30° pipe bend (4650/4730/30° pipe bend)

90° angle, reduction and 30° pipe bend (4670/4730/30° pipe bend)



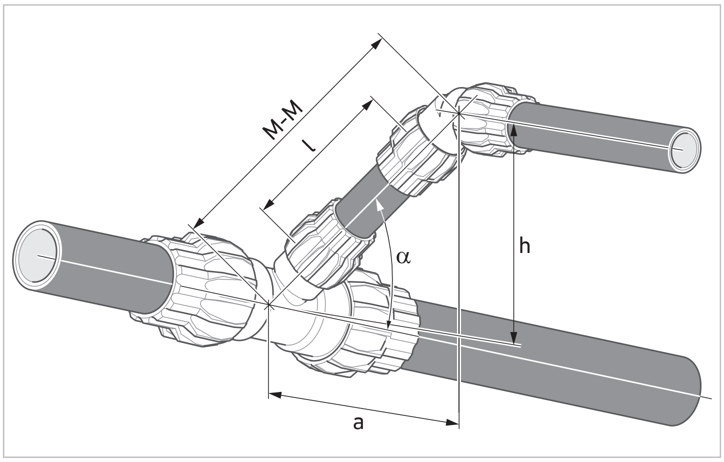
(grey box) Pipe section fallen short of minimum dimension
M–M Dimension centre/centre
M–A Centre/outside dimension
☑ Using the bending tool to create a 30° pipe bend.
a = h × 1.732

Fitting changing elevation DN		50-26	50-32	50-40	63-26	63-32	63-40	63-50
		40-20	40-25	40-32	50-20	50-25	50-32	50-40
z dimension [mm]		133	133	138	162	164	168	180
h_{min} [mm]		106	118	126	121	133	141	166
h [mm]	M–M [mm]	Flexible pipe leg l (M–A) [mm]						
80	160							
90	180							
100	200							
110	220	87						
120	240	107	107					
130	260	127	127	122	99			
140	280	147	147	142	119	116		
150	300	167	167	162	139	136	132	
160	320	187	187	182	159	156	152	
170	340	207	207	202	179	176	172	
180	360	227	227	222	199	196	192	181
190	380	247	247	242	219	216	212	201
200	400	267	267	262	239	236	232	221
210	420	287	287	282	259	256	252	241
220	440	307	307	302	279	276	272	261
230	460	327	327	322	299	296	292	281
240	480	347	347	342	319	316	312	301
250	500	367	367	362	339	336	332	321
260	520	387	387	382	359	356	352	341
270	540	407	407	402	379	376	372	361
280	560	427	427	422	399	396	392	381
290	580	447	447	442	419	416	412	401
300	600	467	467	462	439	436	432	421
310	620	487	487	482	459	456	452	441
320	640	507	507	502	479	476	472	461
330	660	527	527	522	499	496	492	481
340	680	547	547	542	519	516	512	501
350	700	567	567	562	539	536	532	521
360	720	587	587	582	559	556	552	541
370	740	607	607	602	579	576	572	561
380	760	627	627	622	599	596	592	581

Fitting changing elevation

Reduced tee and 45° bend (4652/4676)

90° angle and 45° angle (4670/4676)



Pipe section fallen short of minimum dimension

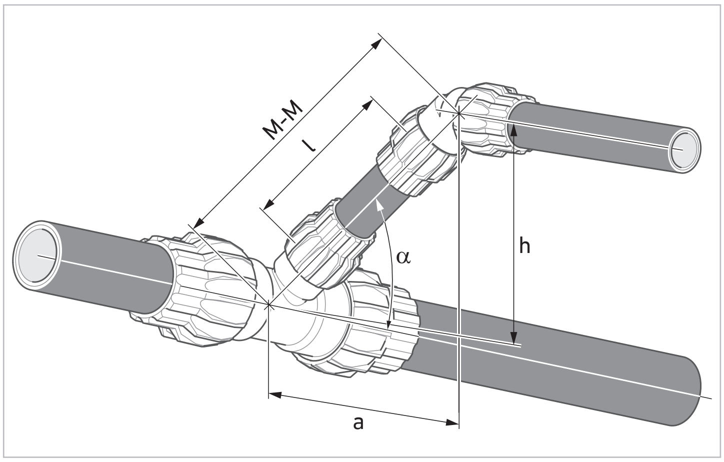
M–M Dimension centre/centre

Fitting changing elevation DN		20-20-16 15-15-12	26-20-20 20-15-15	26-20-26 20-15-20	26-26-20 20-20-15	32-20-32 25-15-25	32-26-26 25-20-20	32-26-32 25-20-25	40-26-40 32-20-32	40-32-32 32-25-25	40-32-40 32-25-32
z dimension [mm]		52	57	56	66	61	71	71	77	84	84
h_{min} [mm]		99	103	102	127	106	131	131	135	156	156
h [mm]	M–M [mm]	Pipe dimension l [mm]									
100	141	89								57	
110	156	104	99	100		95				72	
120	170	118	113	114		109				86	
130	184	132	127	128	118	123				100	
140	198	146	141	142	132	137	127	127	121	114	
150	212	160	155	156	146	151	141	141	135	128	
160	226	174	169	170	160	165	155	155	149	142	142
170	240	188	183	184	174	179	169	169	163	156	156
180	255	203	198	199	189	194	184	184	178	171	171
190	269	217	212	213	203	208	198	198	192	185	185
200	283	231	226	227	217	222	212	212	206	199	199
210	297	245	240	241	231	236	226	226	220	213	213
220	311	259	254	255	245	250	240	240	234	227	227
230	325	273	268	269	259	264	254	254	248	241	241
240	339	287	282	283	273	278	268	268	262	255	255
250	354	302	297	298	288	293	283	283	277	270	270
260	368	316	311	312	302	307	297	297	291	284	284
270	382	330	325	326	316	321	311	311	305	298	298
280	396	344	339	340	330	335	325	325	319	312	312
290	410	358	353	354	344	349	339	339	333	326	326
300	424	372	367	368	358	363	353	353	347	340	340
310	438	386	381	382	372	377	367	367	361	354	354
320	453	401	396	397	387	392	382	382	376	369	369
330	467	415	410	411	401	406	396	396	390	383	383
340	481	429	424	425	415	420	410	410	404	397	397
350	495	443	438	439	429	434	424	424	418	411	411
360	509	457	452	453	443	448	438	438	432	425	425
370	523	471	466	467	457	462	452	452	446	439	439
380	537	485	480	481	471	476	466	466	460	453	453

Fitting changing elevation

Reduced tee and 45° bend (4652/4676)

90° angle and 45° angle (4670/4676)



Pipe section fallen short of minimum dimension

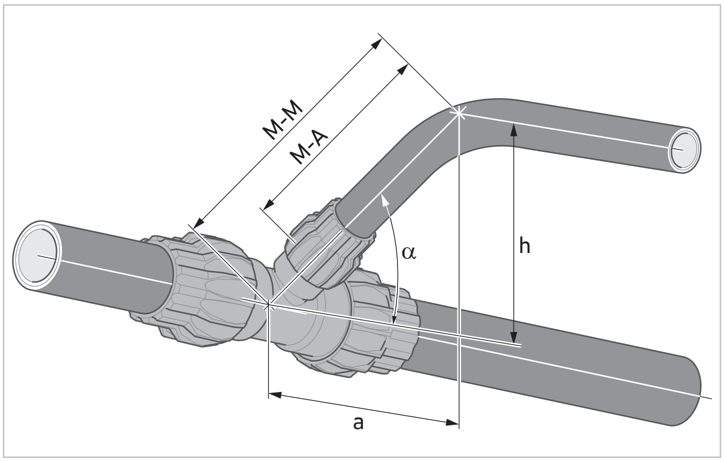
M–M Dimension centre/centre

Fitting changing elevation DN		50-26-50 40-20-40	50-32-50 40-25-40	50-40-50 40-32-40	63-26-63 50-20-50	63-32-63 50-25-50	63-40-63 50-32-50	63-50-63 50-40-50
z dimension [mm]		73	80	89	82	89	97	116
h_{min} [mm]		135	157	183	141	164	188	226
h [mm]	M–M [mm]	Pipe dimension l [mm]						
100	141							
110	156							
120	170							
130	184							
140	198	125						
150	212	139			130			
160	226	153	146		144			
170	240	167	160		158	151		
180	255	182	175		173	166		
190	269	196	189	180	187	180	172	
200	283	210	203	194	201	194	186	
210	297	224	217	208	215	208	200	
220	311	238	231	222	229	222	214	
230	325	252	245	236	243	236	228	209
240	339	266	259	250	257	250	242	223
250	354	281	274	265	272	265	257	238
260	368	295	288	279	286	279	271	252
270	382	309	302	293	300	293	285	266
280	396	323	316	307	314	307	299	280
290	410	337	330	321	328	321	313	294
300	424	351	344	335	342	335	327	308
310	438	365	358	349	356	349	341	322
320	453	380	373	364	371	364	356	337
330	467	394	387	378	385	378	370	351
340	481	408	401	392	399	392	384	365
350	495	422	415	406	413	406	398	379
360	509	436	429	420	427	420	412	393
370	523	450	443	434	441	434	426	407
380	537	464	457	448	455	448	440	421

Fitting changing elevation

Reduced tee and 45° pipe bend (4652/4608)

90° angle and 45° pipe bend (4670/4608)



Pipe section fallen short of minimum dimension

Minimum dimension of the flexible pipe leg with hydraulic cylinder 4852 without subsequent cutting

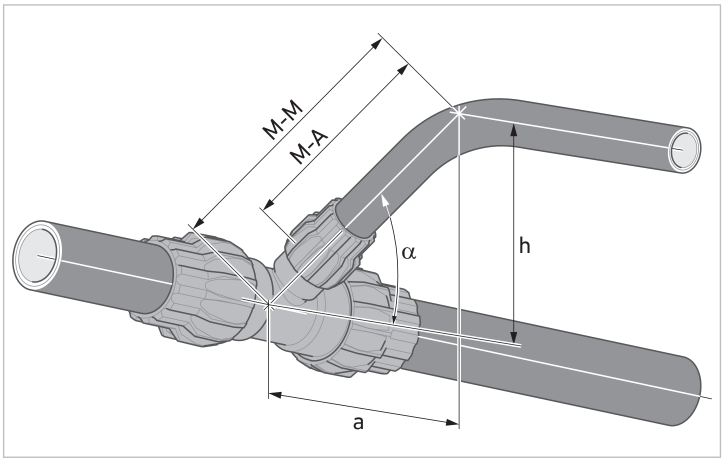
M–M Dimension centre/centre
M–A Centre/outside dimension

Fitting changing elevation DN		20-16-16 15-12-12	20-16-20 15-12-15	20-20-16 15-15-12	26-16-26 20-12-20	26-20-20 20-15-15	26-20-26 20-15-20	26-26-20 20-20-15	32-16-32 25-12-25	32-20-32 25-15-25	32-26-26 25-20-20	32-26-32 25-20-25
z dimension [mm]		29	29	31	34	35	35	39	38	40	44	44
h_{min} [mm]		65	65	66	69	69	69	91	71	73	95	95
h [mm]	M–M [mm]	Flexible pipe leg l (M–A) [mm]										
80	113	84	84	82	79	78	78		75	73		
90	127	98	98	96	93	92	92		89	87		
100	141	112	112	110	107	106	106	102	103	101	97	97
110	156	127	127	125	122	121	121	117	118	116	112	112
120	170	141	141	139	136	135	135	131	132	130	126	126
130	184	155	155	153	150	149	149	145	146	144	140	140
140	198	169	169	167	164	163	163	159	160	158	154	154
150	212	183	183	181	178	177	177	173	174	172	168	168
160	226	197	197	195	192	191	191	187	188	186	182	182
170	240	211	211	209	206	205	205	201	202	200	196	196
180	255	226	226	224	221	220	220	216	217	215	211	211
190	269	240	240	238	235	234	234	230	231	229	225	225
200	283	254	254	252	249	248	248	244	245	243	239	239
210	297	268	268	266	263	262	262	258	259	257	253	253
220	311	282	282	280	277	276	276	272	273	271	267	267
230	325	296	296	294	291	290	290	286	287	285	281	281
240	339	310	310	308	305	304	304	300	301	299	295	295
250	354	325	325	323	320	319	319	315	316	314	310	310
260	368	339	339	337	334	333	333	329	330	328	324	324
270	382	353	353	351	348	347	347	343	344	342	338	338
280	396	367	367	365	362	361	361	357	358	356	352	352
290	410	381	381	379	376	375	375	371	372	370	366	366
300	424	395	395	393	390	389	389	385	386	384	380	380
310	438	409	409	407	404	403	403	399	400	398	394	394
320	453	424	424	422	419	418	418	414	415	413	409	409
330	467	438	438	436	433	432	432	428	429	427	423	423
340	481	452	452	450	447	446	446	442	443	441	437	437
350	495	466	466	464	461	460	460	456	457	455	451	451
360	509	480	480	478	475	474	474	470	471	469	465	465
370	523	494	494	492	489	488	488	484	485	483	479	479
380	537	508	508	506	503	502	502	498	499	497	493	493

Fitting changing elevation

Reduced tee and 45° pipe bend (4652/4608)

90° angle and 45° pipe bend (4670/4608)



Pipe section fallen short of minimum dimension

Minimum dimension of the flexible pipe leg with hydraulic cylinder 4852 without subsequent cutting

M–M Dimension centre/centre

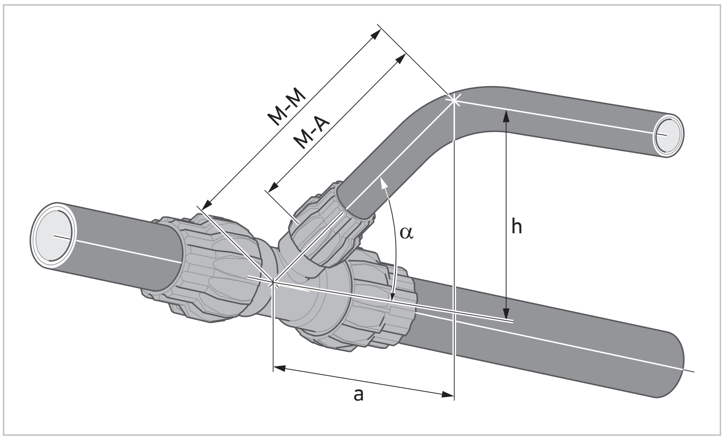
M–A Centre/outside dimension

Fitting changing elevation DN		40-26-40	40-32-32	40-32-40	50-26-50	50-32-50	50-40-50	63-26-63	63-32-63	63-40-63	63-50-63
		32-20-32	32-25-25	32-25-32	40-20-40	40-25-40	40-32-40	50-20-50	50-25-50	50-32-50	50-40-50
z dimension [mm]		50	52	52	46	48	52	55	57	60	69
h_{min} [mm]		99	106	106	146	147	150	164	166	168	175
h [mm]	M–M [mm]	Flexible pipe leg l (M–A) [mm]									
80	113										
90	127										
100	141	91	89								
110	156	106	104	104							
120	170	120	118	118							
130	184	134	132	132							
140	198	148	146	146							
150	212	162	160	160	166	164	160				
160	226	176	174	174	180	178	174				
170	240	190	188	188	194	192	188	185	183	180	
180	255	205	203	203	209	207	203	200	198	195	186
190	269	219	217	217	223	221	217	214	212	209	200
200	283	233	231	231	237	235	231	228	226	223	214
210	297	247	245	245	251	249	245	242	240	237	228
220	311	261	259	259	265	263	259	256	254	251	242
230	325	275	273	273	279	277	273	270	268	265	256
240	339	289	287	287	293	291	287	284	282	279	270
250	354	304	302	302	308	306	302	299	297	294	285
260	368	318	316	316	322	320	316	313	311	308	299
270	382	332	330	330	336	334	330	327	325	322	313
280	396	346	344	344	350	348	344	341	339	336	327
290	410	360	358	358	364	362	358	355	353	350	341
300	424	374	372	372	378	376	372	369	367	364	355
310	438	388	386	386	392	390	386	383	381	378	369
320	453	403	401	401	407	405	401	398	396	393	384
330	467	417	415	415	421	419	415	412	410	407	398
340	481	431	429	429	435	433	429	426	424	421	412
350	495	445	443	443	449	447	443	440	438	435	426
360	509	459	457	457	463	461	457	454	452	449	440
370	523	473	471	471	477	475	471	468	466	463	454
380	537	487	485	485	491	489	485	482	480	477	468

Fitting changing elevation

Reduced tee and 30° pipe bend (4652/30° pipe bend)

90° angle and pipe 30° pipe bend (4670/30° pipe bend)



- (dark grey) Pipe section fallen short of minimum dimension
- (light grey) Minimum dimension of the flexible pipe leg with hydraulic cylinder 4852 without subsequent cutting

M–M Dimension centre/centre
M–A Centre/outside dimension

☑ Using the bending tool to create a 30° pipe bend.

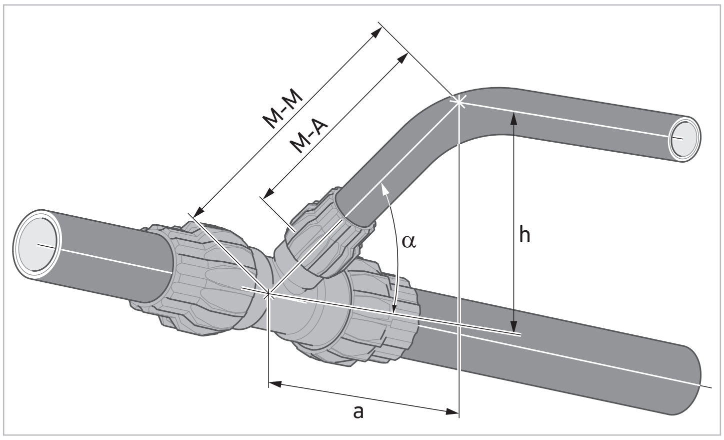
a = h × 1.732

Fitting changing elevation		20-16-20	20-16-20	20-20-16	26-16-26	26-20-20	26-20-26	26-26-20	32-16-32	32-20-32	32-26-26	32-26-32
DN		15-12-12	15-12-15	15-15-12	20-12-20	20-15-15	20-15-20	20-20-15	25-12-25	25-15-25	25-20-20	25-20-25
z dimension [mm]		29	29	31	33	35	35	39	38	40	44	44
h_{min} [mm]		45	45	48	47	50	50	60	49	53	62	62
h [mm]	M–M [mm]	Flexible pipe leg l (M–A) [mm]										
50	100	71	71	69	67	65	65		62			
60	120	91	91	89	87	85	85	81	82	80		
70	140	111	111	109	107	105	105	101	102	100	96	96
80	160	131	131	129	127	125	125	121	122	120	116	116
90	180	151	151	149	147	145	145	141	142	140	136	136
100	200	171	171	169	167	165	165	161	162	160	156	156
110	220	191	191	189	187	185	185	181	182	180	176	176
120	240	211	211	209	207	205	205	201	202	200	196	196
130	260	231	231	229	227	225	225	221	222	220	216	216
140	280	251	251	249	247	245	245	241	242	240	236	236
150	300	271	271	269	267	265	265	261	262	260	256	256
160	320	291	291	289	287	285	285	281	282	280	276	276
170	340	311	311	309	307	305	305	301	302	300	296	296
180	360	331	331	329	327	325	325	321	322	320	316	316
190	380	351	351	349	347	345	345	341	342	340	336	336
200	400	371	371	369	367	365	365	361	362	360	356	356
210	420	391	391	389	387	385	385	381	382	380	376	376
220	440	411	411	409	407	405	405	401	402	400	396	396
230	460	431	431	429	427	425	425	421	422	420	416	416
240	480	451	451	449	447	445	445	441	442	440	436	436
250	500	471	471	469	467	465	465	461	462	460	456	456
260	520	491	491	489	487	485	485	481	482	480	476	476
270	540	511	511	509	507	505	505	501	502	500	496	496
280	560	531	531	529	527	525	525	521	522	520	516	516
290	580	551	551	549	547	545	545	541	542	540	536	536
300	600	571	571	569	567	565	565	561	562	560	556	556
310	620	591	591	589	587	585	585	581	582	580	576	576
320	640	611	611	609	607	605	605	601	602	600	596	596
330	660	631	631	629	627	625	625	621	622	620	616	616
340	680	651	651	649	647	645	645	641	642	640	636	636
350	700	671	671	669	667	665	665	661	662	660	656	656
360	720	691	691	689	687	685	685	681	682	680	676	676
370	740	711	711	709	707	705	705	701	702	700	696	696
380	760	731	731	729	727	725	725	721	722	720	716	716

Fitting changing elevation

Reduced tee and 30° pipe bend (4652/30° pipe bend)

90° angle and pipe 30° pipe bend (4670/30° pipe bend)



Pipe section fallen short of minimum dimension (dark grey)

Minimum dimension of the flexible pipe leg with hydraulic cylinder 4852 without subsequent cutting (light grey)

M–M Dimension centre/centre
M–A Dimension centre/outside

☑ Using the bending tool to create a 30° pipe bend.

a = h × 1.732

Fitting changing elevation DN		40-26-40	40-32-32	40-32-40	50-26-50	50-32-50	50-40-50	63-26-63	63-32-63	63-40-63	63-50-63
		32-20-32	32-25-25	32-25-32	40-20-40	40-25-40	40-32-40	50-20-50	50-25-50	50-32-50	50-40-50
z dimension [mm]		50	52	52	46	48	52	55	57	60	69
h_{min} [mm]		65	77	77	63	75	84	68	80	88	111
h [mm]	M–M [mm]	Flexible pipe leg l (M–A) [mm]									
50	100										
60	120										
70	140	90	88		94			85			
80	160	110	108	108	114	112		105	103		
90	180	130	128	128	134	132	128	125	123	120	
100	200	150	148	148	154	152	148	145	143	140	
110	220	170	168	168	174	172	168	165	163	160	151
120	240	190	188	188	194	192	188	185	183	180	171
130	260	210	208	208	214	212	208	205	203	200	191
140	280	230	228	228	234	232	228	225	223	220	211
150	300	250	248	248	254	252	248	245	243	240	231
160	320	270	268	268	274	272	268	265	263	260	251
170	340	290	288	288	294	292	288	285	283	280	271
180	360	310	308	308	314	312	308	305	303	300	291
190	380	330	328	328	334	332	328	325	323	320	311
200	400	350	348	348	354	352	348	345	343	340	331
210	420	370	368	368	374	372	368	365	363	360	351
220	440	390	388	388	394	392	388	385	383	380	371
230	460	410	408	408	414	412	408	405	403	400	391
240	480	430	428	428	434	432	428	425	423	420	411
250	500	450	448	448	454	452	448	445	443	440	431
260	520	470	468	468	474	472	468	465	463	460	451
270	540	490	488	488	494	492	488	485	483	480	471
280	560	510	508	508	514	512	508	505	503	500	491
290	580	530	528	528	534	532	528	525	523	520	511
300	600	550	548	548	554	552	548	545	543	540	531
310	620	570	568	568	574	572	568	565	563	560	551
320	640	590	588	588	594	592	588	585	583	580	571
330	660	610	608	608	614	612	608	605	603	600	591
340	680	630	628	628	634	632	628	625	623	620	611
350	700	650	648	648	654	652	648	645	643	640	
360	720	670	668	668	674	672	668	665	663	660	
370	740	690	688	688	694	692	688	685	683	680	
380	760	710	708	708	714	712	708	705	703	700	

Build

iFIT

V

iFIT

Overview

This chapter contains basic information about the iFIT system.

Additional technical and sales information

- For more information on the use and connection of other system components, piping and controls and instruments, see the chapters applicable to the appropriate systems.
- More technical information about this system and ordering information can be found on the GF website and in the sales catalogue.

1 System overview

1.1 System description

iFIT is an installation system with polybutene and multilayer composite pipes as well as polyphenylsulfone (PPSU) and dezincification-resistant brass modules. The adaptor module technology is a plug-in system that enables safe assembly operations with a minimum number of tools required and no electrical energy.

The modular iFIT system makes it possible to work with just a few assortment parts, regardless of dimensions. Two dimensions each fit on the connection section of a module (main body).

iFIT	Description
Pipe dimension	d16, d20, d25, d32
Application area	Cold and hot water, HVAC, greywater
Installation	Surface and flush-mounted pipes, pipe-in-pipe technology
Pipes	Polybutene pipes and multilayer composite pipes
Fittings and system parts	Dezincification-resistant, low lead brass and plastic
Method	Push-fit technology with adaptor module technology

1.2 Approvals and quality assurance

The iFIT system is subject to constant inspection by internal and external bodies. These inspections range from quality assurance during production to ISO certification for environmental and process safety. The iFIT system meets the requirements for the most important applications in the building technology and is subject to constant monitoring by the licensing offices for drinking water and heating installations on land and sea.

System approvals
General information:
➨ Annex A , Section 'Approvals'
Up-to-date information on system approvals is available from Technical Support.

1.3 Scope and application area

The installation system iFIT is intended for the following applications:

- Drinking water installations in the cold and hot water area
- Grey water installations
- Heating and air conditioning installations (only with diffusion-proof pipe)

iFIT is suitable for distribution lines, riser pipes and connection pipelines in single and multi-family dwellings as well as in sanitary, heating installations.

Potential equalisation

The installation of the system is not a conductive metallic pipework. The installation cannot be used as a grounding conductor for electrical installations.

☑ The installation must **not** be used for equipotential bonding purposes and must **not** be used as an earth connection.

§ **Responsibility for equipotential bonding**
The installer of the electrical system is responsible for the correct implementation of the equipotential bonding.

DHW heaters

It is feasible to connect the system to **water heaters** without a metallic connection. In this case, restrictions do not apply if the water temperatures never exceed 70°C.

The use in conjunction with **flow DHW heaters** is permitted. However, only the manufacturer of the device is authorised to approve the use of the tankless water heaters.

☑ Compliance with the manufacturer's instructions for the devices is mandatory.

Protection of piping materials and connections

☑ If using flow DHW heater: Only use **thermostats** or **safety temperature limiter**, which ensure that the water temperature of 95°C is not exceeded at any point or at any time – not even when reheating.

☑ When using hydraulically controlled devices: Ensure that the **automatic switch-off** does not permit any pressures above 10 bar, even in case of the reheat effect.

Recommendation
If the temperature cannot be kept below 95°C or in older hydraulically controlled, electrically or gas-fired instantaneous water heaters, where the temperatures cannot be reliably maintained below 95°C, the following shall apply:

☑ A metallic connection with a length of at least 1.0 m shall be provided.

Fire extinguishing systems

When installing fire extinguishing pipes and sprinkler systems using iFIT system components:

☑ Compliance with local regulations and fire protection requirements is mandatory.

1.4 Properties and requirements

Service life limitation applicable to the installation
The water quality (pH value), the water constituents, as well as the operating conditions can have a direct influence on the service life of the installation, especially if chlorinated waters are being used.

1.4.1 Materials

Materials polyethylene (PE-RT), polyphenylsulfone (PPSU), brass and EPDM
Detail information:
➨ Part III 'The basics', Section 'Materials and jointing technology'

1.4.2 Hygienic properties

Verification of the system's hygienic safety is provided. The test certificate of the German DVGW Technology Centre for Water (TZW) has proven that the plastic components comply with the KTW recommendations of the Federal Health Office in Germany and the requirements of the Federal Environmental Agency (UBA) in Germany and the basic requirements of the Federal Food Control Institute according to ÖNORM B 5014, Part 1. This also applies to other institutions in the field of building technology and the shipbuilding industry, such as ACS, SINTEF, BS 6920 and KIWA/ATA.

All plastic and metal components are continuously inspected in accordance with the recommendations mentioned above in order to ensure they meet national and international requirements, such as the DVGW worksheet W270.

1.4.3 Chemical resistance

The system exhibits a high chemical resistance to all natural drinking water substances (acc. to DIN 2000 and TrinkwV 2001), against disinfectants and cleaning agents (acc. to DVGW-Arbeitsblatt W291) and against corrosion inhibitors (acc. to DIN 1988, Part 4).

In addition to the utilisation for drinking water, the system can also be used for the liquid and gaseous media mentioned in [TV.1].

Suitability of the system
However, the suitability of the system is not limited to the defined chemical resistance mentioned above, but also depends on the use of the appropriate medium.
The characteristics of the medium may be changed by the pipes and fittings.

TV.1 **Media**

Medium	Classification	Max. operating temperature [°C]	Max. operating pressure [bar]
Drinking water	Cold water	0 – 20	10
	Hot water	20 – 70*	
Heating water	–	0 – 70*,**	
Softened water	pH neutral (0°fH)	0 – 70	
Rain water	pH value >6.0	0 – 40	
Osmosis treatment***	–	0 – 70	
VE water***	desalinated	70	
Cooling water****	40 Vol.% ethylene glycol, Antifrogen®, ethyl alcohol	–25 – 40**	
	25 Vol.% propylene glycol	–10 – 40**	
	Saline solutions	–20 – 40**	
Disinfectant solution*****	ready for use	40	
Vacuum	–	40	-0.8 p_a ≈0.2

* Short-term peak temperature of 95°C during max. 150 h/a
** Only permissible with oxygen diffusion-tight pipes
*** Brass and red bronze fittings release small amounts of metal ions into osmosis-treated water. If ion-free water is required, additional treatment at the tap is required, or RG fittings with epoxy coating inside should be used.
**** Higher concentrations must be requested.
***** Concentrations must be requested.

Requests concerning resistance in special cases
If the system must be used for applications or concentrations exceeding the values in the table, the resistance of the materials etc. must be checked and approved by GF JRG.
The following information is required in advance for testing and approval:

- Product and safety data sheet of the medium
- Operating temperature and pressure
- Concentration, exposure time, frequency and flow rate of the medium (even a sample, if required)

The use of the system for **medical gases** is **not** recommended.
Medical gases include gases that meet the requirements of the European Pharmacopoeia or which are anaesthetic gases, medical oxygen or medical carbonic acids. All of the above are approved according to the drug regulations as finished medicinal products.

1.4.4 Fire protection

Fire protection
General information on fire protection:
➨ Part IV 'Plan', Section 'Insulation, Fire protection'

Fire protection
Up-to-date information on fire protection for the system, including information on solutions, applications and product properties, can be found in the brochure **“Planungshilfe Rohrabschottung” (Planning aid pipe sealant)**.

§ **Country-specific regulations**
Fire protection may be regulated differently in each countries by laws, directives, ordinances, standards, regulations and bulletins.
☑ Compliance with the local fire protection regulations is mandatory.

Fire protection - solutions with iFIT

Solutions for fire protection with iFIT
Solutions and products for fire protection with iFIT can be found here:
➨ Chapter [6] 'Fire protection'

1.4.5 Soundproofing

The basics

Water pipes do not generate any noise if the nominal pipe dimension, design, fastening method and operation are correct. There are no test regulations specified in standards or other directives to determine or assess the noise behaviour in drinking water systems. Plastic piping systems exhibit advantages over metal pipe systems due to their corrosion resistance and flexibility.
By default, drinking water systems are designed so that the volumetric flow is 2 m/s for distribution lines (standard value, which is and may only be exceeded for certain line sections) and max. 4 m/s for discharge lines is maintained. These are flow velocities at which the inherent noise of the pipelines comparted to the noise generated by the fittings or other ambient noise is not noticeable. However, the noises resonating from sanitary equipment and fittings are being transmitted. Therefore, sound insulation—which absorbs the structure-borne noise reverberating from the building—must be added to the system components.

iFIT

The iFIT installation system is compliant with the requirement of DIN 4109 and SIA I81 (6.2006). However, this implies that the installation must be carried out according to the recognised rules of technology and the assembly instructions.

1.4.6 Insulation

Insulation

General information on insulation:

➨ Part IV 'Plan', Section 'Insulation, Fire protection'

Country-specific regulations

The insulation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.

☑ When it comes to insulation methods, compliance with the applicable rules and regulations is mandatory.

The basics

Insulation recommendations

If local specifications do not apply, the following instructions shall be considered as minimum requirements. A protective wrapping shall be wrapped around the pipelines, a thin insulating hose or a protective conduit shall be used. For most systems, a **pre-insulated** design (e.g. with 6 mm thick insulation) is available.

☑ Piping systems must always be insulated in order to prevent heat loss and/or heat absorption.
- Cold water pipeline: In order to prevent condensation, DHW heating and sound transmission
- Hot water, circulation and heating pipes: To reduce heat loss, absorb expansion and prevent sound transmission

☑ Select the insulation or sheathing according to the respective field of application.

☑ Ensure that the insulation does not cause corrosion to the piping materials.

Soundproofing

☑ The soundproofing may be subject to special requirements. Ensure that these potential prerequisites are considered in the design of the insulation.

Hygiene

Applying insulation to cold water pipes, for example, in order to prevent them from heating can improve the hygiene and help reduce the risk of legionella.

Planning fundamentals

The EnEV (German Energy Saving Ordinance) or DIN 1988 in Germany or the model regulations of the cantons in the energy sector (MuKEn) in Switzerland are available in the current version with comprehensive, detailed and practice-oriented documents. They are equally valid for new constructions, renovations and modernisations.

Insulation according to EnEV 2017

Insulation according to EnEV 2017

Solutions and products for insulation according to EnEV can be found here:

➨ Chapter [5] 'Insulation according to EnEV 2017'

1.4.7 Protecting the installation

System components installed flush with the wall or walled in

Pipe installations flush with the wall are lines that are not easily accessible, for example, inside an in-wall installation, in a wall slot or in the concrete floor.

☑ Fittings and pipes must be insulated with a suitable material in order to absorb thermally induced changes in length, to prevent the transmission of sound, to preclude the formation of condensation, heat emission, heat loss or heating of the medium and other influences caused by building materials.

☑ Piping system and building structure must be separated from each other, for example, by using protective conduits made of PE, wrappings, insulating hoses or half shells with and without sheathing or a combination thereof.

☑ All system components must be protected from direct contact with oils, greases, solvents, solvent-based adhesives (adhesive tapes), foams, bitumen (also bituminous membranes). Furthermore, the components must not contact building materials such as screed, concrete, mortar or plaster.

Protection against environmental influences and building materials

Special measures apply to the following rooms:

- permanently or periodically wet rooms
  - Slaughterhouses, butcher shops (pressure washer)
  - Carwash
  - Tiled shower stalls, spa areas
  - Commercial kitchens
  - Rooms with risk of external water ingress
  - Swimming pools, saunas
- Areas subject to offensive gases or aggressive environments
  - Stables (ammonia)
  - Dairy factories/cheese dairies (nitric acid)
  - Swimming pools/swimming pool centres (chlorine, hydrochloric acid)
- Areas subject to uncontrollable environmental influences

Due to the moisture permeating the building materials and the resulting permanent wetness (e.g. in public showers and baths or commercial wet rooms), it is possible for an aggressive environment to form around the pipe.

☑ Appropriate precautions must be taken to protect the installation, e.g. by using the following measures:
  - Use of suitable anti-corrosion tapes (e.g. supplied by KEBU, Gyso or DENSO)
  - Wrapping the pipe with heat-shrinkable materials

☑ Ensure that pipes and fittings are dry when mounting.

Protection from UV radiation

☑ Appropriate precautions must be taken in order to prevent the installation from permanent exposure to UV rays.

When using the pipe-in-pipe system with protective conduit, this will ensure sufficient UV protection.
Sheathing with insulating material can assume the function of UV protection.

☑ Pipes and fittings must be shielded from direct sunlight and UV radiation.

☑ During transport and storage: Pipes and fittings must be covered after they have been removed from the original packing.

Protection against aggressive waters

Recommendation

☑ In areas with particularly aggressive waters: Installations must be easily accessible.

☑ Distribution lines in the single tap system (pipe-in-pipe) must be designed and installed such in order to ensure system components can be replaced at any time without damaging the building's structure.

1.4.8 Disinfection procedure

Disinfection

General information on common disinfection procedures:

➨ Part VI 'Operate', Chapter [4] 'Disinfection'

Information on the hygiene concept used at GF:

➨ Part II 'Plan – Build – Operate', Chapter [4] 'Disinfection'

Chlorine dioxide

The use of chlorine dioxide for chemical disinfection can severely limit the lifetime of the entire drinking water installation. Before implementation, the conditions must be recorded on site.

The water quality (pH value), the water constituents, as well as the operating conditions can have a direct influence on the service life of the installation, especially if chlorinated waters are being used.

1.5 Safe application and processing

- ☑ Only use the product as intended and in accordance with the defined areas of application and usage.
- ☑ Check compatibility of medium and material.
- ☑ Do not use the product if it is damaged or defective. Damaged product must be removed immediately.
- ☑ Use only approved accessories.
- ☑ Only trained personnel shall be permitted to assemble the product and accessories.
- ☑ All personnel shall be instructed on all applicable issues of local occupational safety and environmental regulations, in particular for pressurised piping. These instructions must be held on a regular basis.
- ☑ Compliance with the valid standards for drinking water and grey water installations as well as compliance with the regulations of the system manufacturer is mandatory.
- ☑ Compliance with the local water supply regulation is mandatory.
- ☑ Make sure that the piping system is installed correctly and inspected regularly.
- ☑ All installations must comply with the instructions specified in the technical documentation of the product.
- ☑ Compliance with the operating, maintenance and assembly instructions of the tools is mandatory.
- ☑ Tools must be used as intended and must not be applied for other purposes.
- ☑ When assembling the iFIT installation system, only iFIT assembly tools must be used.

1.5.1 Transport and storage

For hygienic reasons, all openings in pipes, fittings, controls and instruments must be closed until final assembly.

- ☑ Ensure to protect the product against external force (shock, impact, vibration, etc.) during transport.
- ☑ Transport and/or store the product in unopened original packing.
- ☑ Protect the product from dust, dirt, moisture, heat and UV radiation.
- ☑ Ensure that the product is not damaged by mechanical or thermal influences.
- ☑ Before proceeding with the assembly, inspect the product for damage that may have occurred during the transport.

1.5.2 Installation and assembly

The iFIT System is suitable for the following types of installation:

- Surface or flush-mounted installations
- Installation in shafts and channels, on ceilings and on floors
- Installation in-wall, element, wood and lightweight constructions
- Installation in concrete (in the pipe-in-pipe system, with PB pipes)

1.5.3 Acceptance and putting into operation

§ **Country-specific regulations**

Acceptance and putting into operation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.

- ☑ When it comes to acceptance and putting into operation, compliance with the applicable rules and regulations is mandatory.

Acceptance, pressure test, flushing and putting into operation

General information and master copies of the test reports:

➨ Part V 'Build', Section 'Putting into operation'

1.5.4 Operation, maintenance, servicing, repair and decommissioning

☑ To ensure trouble-free operation: Check installation and all control and safety fittings regularly.

Risk of injury due to pressure or explosion.

If the system is not completely depressurised, media may escape uncontrolled from the installation.

☑ Before removal, maintenance, disassembly: Pipeline must be completely depressurised.

☑ If harmful, combustible or explosive media is used: Completely empty and flush the pipeline before disassembling it. Look for potential residues.

☑ Use appropriate measures to ensure the medium is collected properly.

Risk of injury due to media harmful to health and the environment.

Risk of personal injury or environmental damage due to uncontrolled escape of hazardous media.

☑ During maintenance, servicing, repair and decommissioning, prescribed protective clothing must be worn.

☑ Compliance with the media safety data sheets is mandatory.

☑ Collect leaking media and dispose of according to local regulations.

Risk of injury due to the use of unsuitable spare parts.

Damage to the installation and risk of injury.

☑ Only use replacement parts from the current product range during the installation and repairs.

1.5.5 Disposal

The entire iFIT product range is made from environmentally friendly and recyclable materials.

§ **Country-specific regulations**

Disposal and recycling may be regulated differently in each country by laws, ordinances, standards, regulations, and bulletins.

☑ When disposing of or recycling the product, the individual components and the packaging, compliance with the local regulations is mandatory.

☑ Before disposing of individual materials, they must be separated according to their recyclability, and whether these materials are considered normal waste or special waste.

2 System components

The iFIT installation system consists of homogenous polybutene pipes or multilayer composite pipes and fittings made of plastic as well as dezincification-resistant and low lead brass. In addition, there are controls and instruments with direct transition to the system.

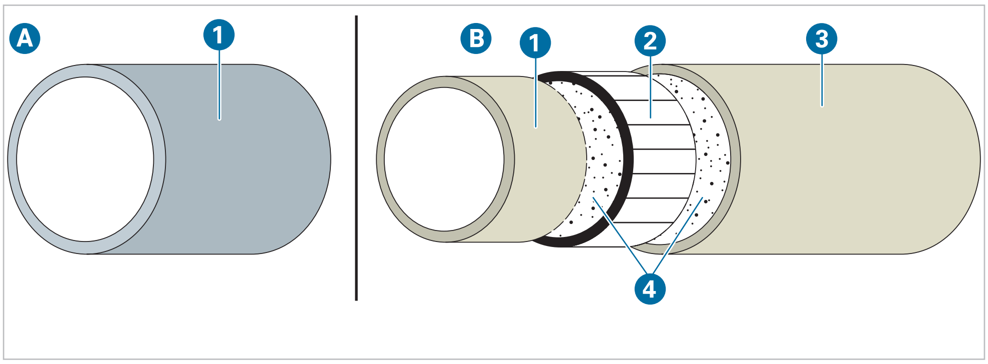
2.1 iFIT pipes

The **iFIT multilayer composite pipes** consist of several layers. These multilayer composite pipes are available pre-cut, in coils and in various designs (e.g. with insulation or in a protective conduit). Inside is a hygienically perfect medium-carrying layer made of heat-resistant polyethylene (PE-RT). The outer layer, which protects the pipe from mechanical stress, is also made of PE-RT. Between the outer layer and the pipe is an aluminium support conduit, butt-welded longitudinally. A bonding agents, also based on PE, permanently joins the other two layers. In addition, the aluminium layer eliminates the otherwise negatively perceived longitudinal expansion properties and short mounting distances in plastic pipes and makes the pipe resistant to bending. In addition, the pipe is thereby oxygen diffusion-tight.

The **100% plastic pipe** from the iFIT assortment, which are available pre-cut and in coils as well as in various designs (e.g. with protective conduit), are made of homogeneous polybutene (PB). In addition to its flexibility, it stands above all else and is characterised by the hygienic properties of the base material.

2.1.1 Pipe construction and pipe labelling

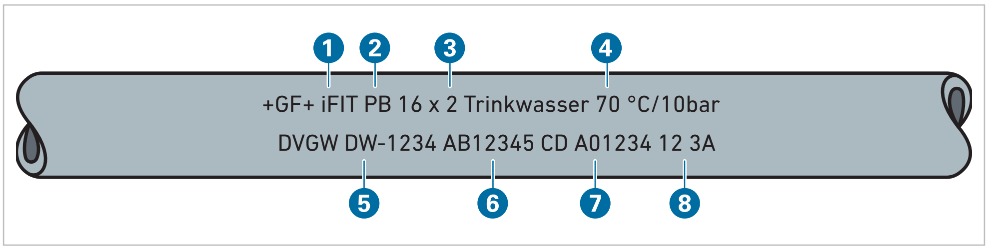
The pipes for the iFIT system are designed as follows.



GV.1
Pipe design
A 100% plastic pipe
1 PB pipe

B Multilayer composite pipe
1 Inliner (PE-RT)
2 Aluminium pipe
3 Outer coating (PE-RT)
4 Bonding agent

The pipes are marked as follows.



GV.2
Pipe marking

Labelling (example)		Meaning
1	iFIT	Product name: Company name and system name
2	PB	Material code
3	16 × 2	Dimension: Outside diameter x wall thickness
4	70°C / 10 bar	Medium: Operating temperature/ max. operating pressure
5	SVGW-.. / DVGW XX-123.. / ÖVGW X1.123..	Approval(s) and number(s)
6	AB 12345	Production location and production date
7	CD A01234	Order number
8	12 3A	Internal factory code

2.1.2 Technical Data

iFIT

Feature	Pipe	Polybutene (PB)	Multilayer composite pipe (PE-RT / Al / PE)
Conditions in continuous operation		70°C, 10 bar (50 years)	
Max. operating temperature [°C]		95 (briefly)	
Max. operating pressure [bar]		10	
Surface roughness k [mm]		0.007	
Material constant C		10	33
Coefficient of thermal expansion α [mm/(m·K)]		0.130	0.024
Thermal conductivity [W/(m·K)]		0.32	0.45
Oxygen-tightness		–	acc. to DIN 4726
Processing temperature [°C]		up to –10	up to –20
Density [kg/dm³]		~0.95	
Fire code		IV.2 (acc. to VKF)	
Building material class		D: B2 (DW 4102) / E (DW 13501-1)	

	Pipe	Polybutene pipe (PB)			Multilayer composite pipe (PE-RT / Al / PE)			
Feature	**Dimension**	d16	d20	d25	d16	d20	d25	d32
Nominal width DN		12	15	20	12	16	20	25
Outside diameter da [mm]		16	20	25	16	20	25	32
Wall thickness [mm]		2	2	2.5	2	2	2.5	3
Internal diameter d_i [mm]		12	16	20	12	16	20	26
Weight [g/m]		83	115	175	102	137	233	365
Cross section inside A [cm²]		1.13	2.01	3.14	1.13	2.01	3.14	5.31
Content [l/m]		0.113	0.201	0.314	0.113	0.201	0.314	0.523
Fire load [MJ/m]		3.65	5.06	7.70	3.36	4.54	7.42	8.23

	Pipe	Polybutene pipe (PB)			Multilayer composite pipe (PE-RT / Al / PE)			
Bending radius	**Dimension**	d16	d20	d25	d16	d20	d25	d32
Bending radius R, interchangeable: 8 · d_a [mm]		128	160	200	–	–	–	–
Bending radius R, manually: 5 · d_a [mm]		–	–	–	80	100	200	–
Bending radius R, with tool: 3.5 · d_a [mm]		–	–	–	56	70	98	112

	Pipe	Polybutene pipe (PB)			Multilayer composite pipe (PE-RT / Al / PE)			
Mounting distance	**Dimension**	d16	d20	d25	d16	d20	d25	d32
Mounting distances [mm]		1.0	1.0	1.0	1.0	1.0	1.5	2.0
Assembly with pipe saddles		1.5	1.5	2.5	1.5	1.5	2.0	2.5

Protective conduits

Feature	Pipe	PE pipe
Density [kg/dm³]		~0.95
Tensile strength [N/mm²]		~25
Temperature resistance [°C]		100
Melt flow index		MFI 190/5: 0.4 g / 10 min
Elongation at break [%]		600
Thermal conductivity [W/(m·K)]		0.45

Feature	Dimension	d16	d20	d25
Outside diameter d_a [mm]		25	29	34
Internal diameter d_i [mm]		20	23	29

2.2 Fittings

All iFIT fittings, which do not require a metallic sealing thread, are made from the high-performance plastic polyphenylsulfone (PPSU). This material, which is known for its low susceptibility to cracking and excellent resistance to hot water, has proven to be well-suited for fittings in building technology and is characterised above all by excellent corrosion resistance and low incrustation. The extremely rugged design, that is to say, the special impact resistance and impact strength are just as natural as the excellent resistance to hydrolysis and chemicals – even at high temperatures. In addition to the absolutely benign hygienic and physiological properties, this is another reason why PPSU is also used in the medical sector.

To further increase the mechanical load capacity, in addition, the iFIT adaptors are protected by a glass-fibre reinforced polyamide (PA-GF30).

All threaded fittings are made of dezincification-resistant and low lead brass(CW 725R).
In terms of corrosion and chemical resistance, all afore-mentioned fittings have properties similar to those of fittings made of PPSU.

2.3 Controls and instruments

Controls and instruments for the iFIT system with special connections and transitions are available in the JRG Controls and Instruments program.

Information on controls and instruments
Technical product information:
➨ Part V 'Build', Section 'JRG Valves'

3 Tools

Depending on the pipe dimension, special tools are used to fabricate iFIT for a correct and secure iFIT connection.

☑ Compliance with the tool's operating instruction is mandatory.

⚠ **Material damage and risk of injury when using unsuitable tools or non-original spare parts.**

→ Only use tools available from the current product range.
→ Tools must be used compliant with the operating instructions.
→ Only use replacement parts from the current product range.

Care, testing and maintenance of tools

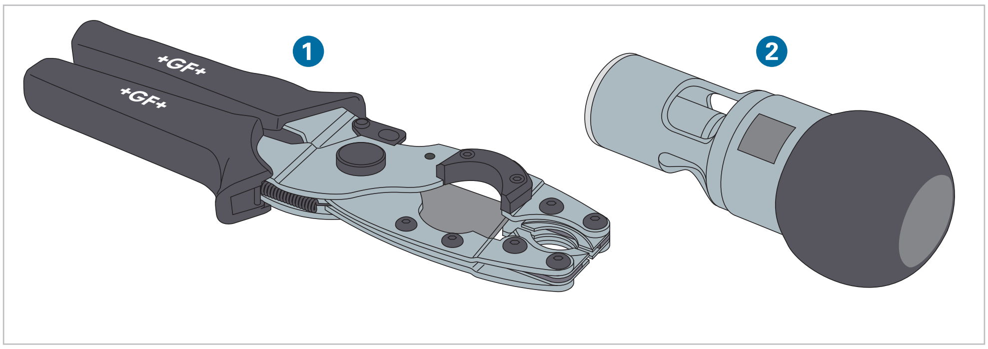
A flawlessly functioning tool is a basic prerequisite for a permanently sealed connection.

⚠ **Risk of injury and material damage due to poor care, incorrect testing and faulty maintenance.**

→ Tools must be maintained as specified in the operating instructions and their operation must be inspected regularly, at least once a year.

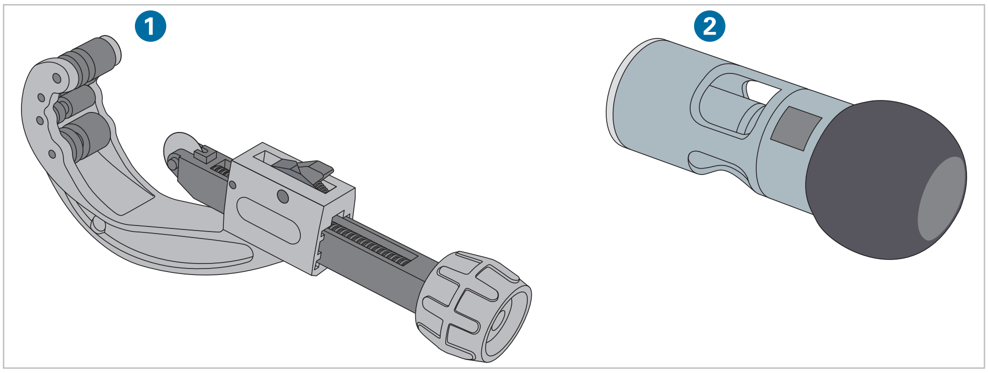
3.1 Assembly tools (d16/d20)

The tools needed to make a correct and secure iFIT push-fit are available in an iFIT assembly case.



GV.3
Assembly tools (d16 – d20)
1 Pipe shears
2 Chamfering tool

3.2 Assembly tools (d25/d32)



GV.4
Assembly tools (d25 – d32)
1 Pipe cutter
2 Chamfering tool

4 Dimensioning

Simplified calculation method
Basic information, examples and sample tables for simplified calculation:
➨ Part IV 'Plan', Section 'Drinking water installation'

The product-specific data for the simplified calculation and the calculation method are available in this chapter.

4.1 Loading units

+ The loading unit (LU – formerly abbreviated BW) designates the flow rate provided at the connection point upstream of the tap as a function of the intended use and the duration of use. The loading unit does not correspond to the withdrawal flow from the respective product specification.

A loading unit LU is equal to a flow of 0.1 l/s.

4.1.1 Controls and instruments and equipment

TV.2
Loading units according to intended purpose
Source: SVGW Guidelines W3 Edition 2013

Usage Connections DN15 (½")	Volume flow Q_A per connection [l/s]	 [l/min]	LU per port
Wash-hand basin, washing trough, vanity unit, bidet, cistern, vending machine, hairdresser, household dishwasher	0.1	6	1
Sink, utility sink, taps for balcony and terrace, washing trough, shower, standing and wall spout, household washing machine	0.2	12	2
Urinal flushing (automatic), bathtub	0.3	18	3
Tap for the garden or garage	0.5	30	5

TV.3
Loading units according to intended purpose
Source: EN 806-3:2006 (D)
Q_A Flow rate at the tapping fitting
Q_{min} Minimum flow rate at the tapping valve

Intended use Connections DN15 (½")	Volume flow per connection Q_A [l/s]	 Q_{min} [l/s]	LU per port
Hand basin, washbasin, bidet, cistern	0.1	0.1	1
Household kitchen sink, household washing machine, dishwasher, sink, shower head	0.2	0.15	2
Urinal flush valve	0.3	0.15	3
Bathtub drain	0.4	0.3	4
Tap for the garden or garage	0.5	0.4	5
Commercial kitchen sink (DN20), Commercial bath spout	0.8	0.8	8
Flush valve (DN20)	1.5	1.0	15

4.1.2 PB pipes and multilayer composite pipes (PE-RT)

TV.4
Loading units for PB and multilayer composite pipes

Designation	Dimension					
Loading units, total	3	4	5	13	25	55
Loading units, largest individual value	–	–	4	5	8	–
$d_a \times s$ [mm]		16 × 2.0		20 × 2.0	25 × 2.5	32 × 3.0
d_i [mm]		12		16	20	26
Length of pipeline, recommended [m]	9	5	4		–	
Instrument GN		½"		¾"	¾"	1"

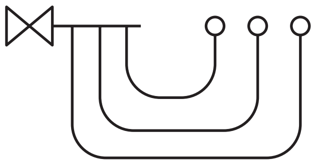
4.1.3 Installation with discharge line

Group of equipment/distribution at floor level
→ A velocity of max. 4 m/s must be maintained.

Directional change with pipe bend

Max. developed length [m]	5		10		15	
Residential water meter	without	with	without	with	without	with
Loading unit (LU)	[d_a × s]					
1	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2
2	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2	20 × 2
3	16 × 2	20 × 2	20 × 2	20 × 2	20 × 2	20 × 2
4	20 × 2	20 × 2	20 × 2	20 × 2	20 × 2	–
5	20 × 2	no counter	20 × 2	no counter	20 × 2	no counter
Pipe d_a × s [mm]	16 × 2	20 × 2				
Pipe d_i [mm]	12.0	16.0				
Instrument	½"	½"				

TV.5
Loading units (LU) applicable to multilayer composite pipe PE-RT/AI/PE-HD



Straight-seat shut-off valve ¾ "and distributor ¾" are taken into account in the calculation model.
Source: SVGW 2014

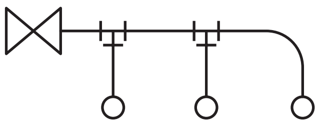
4.1.4 Installation with tees

Group of equipment/distribution at floor level
→ A velocity of max. 3 m/s must be maintained.

Directional change with pipe bend

Max. developed length [m]	5		10		15	
Residential water meter	without	with	without	with	without	with
Loading unit (LU)	[d_a × s]					
1	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2
2	16 × 2	16 × 2	16 × 2	20 × 2	20 × 2	20 × 2
3	20 × 2	20 × 2	20 × 2	20 × 2	20 × 2	25 × 2.5
4	20 × 2	20 × 2	20 × 2	20 × 2	20 × 2	25 × 2.5
5	20 × 2	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5
6	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	32 × 3
8	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	32 × 3
10	25 × 2.5	25 × 2.5	25 × 2.5	32 × 3	32 × 3	32 × 3
12	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3
15	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3
Pipe d_a × s [mm]	16 × 2	20 × 2	25 × 2.5	32 × 3		
Pipe d_i [mm]	12.0	16.0	20.0	26.0		
Instrument	½"	½"	¾“	1“		

TV.6
Loading units (LU) applicable to multilayer composite pipe PE-RT/AI/PE-HD



4.1.5 Installation with tees

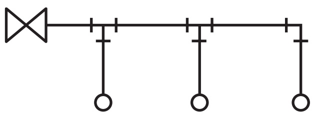
> **Group of equipment/distribution at floor level**
> → A velocity of max. 3 m/s must be maintained.

Directional change with fittings

Max. developed length [m]	5		10		15	
Residential water meter	without	with	without	with	without	with
Loading unit (LU)	$[d_a \times s]$					
1	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2
2	20 × 2	20 × 2	20 × 2	20 × 2	20 × 2	20 × 2
3	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5
4	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5
5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5
6	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	32 × 3
8	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	32 × 3
10	25 × 2.5	25 × 2.5	25 × 2.5	32 × 3	32 × 3	32 × 3
12	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3
15	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3
Pipe $d_a \times s$ [mm]	16 × 2	20 × 2	25 × 2.5	32 × 3		
Pipe d_i [mm]	12.0	16.0	20.0	26.0		
Instrument	½"	½"	¾"	1"		

Source: SVGW Sa 02/2014; SVGW Certificate No.: 0406-4834

TV.7
Loading units (LU) applicable to multilayer composite pipe PE-RT/AI/PE-HD



4.1.6 Installation with discharge line

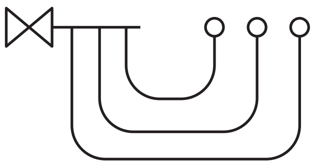
> **Group of equipment/distribution at floor level**
> → A velocity of max. 4 m/s must be maintained.

Directional change with pipe bend

Max. developed length [m]	5		10		15	
Residential water meter	without	with	without	with	without	with
Loading unit (LU)	$[d_a \times s]$					
1	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2
2	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2	20 × 2
3	16 × 2	20 × 2	20 × 2	20 × 2	20 × 2	20 × 2
4	20 × 2	20 × 2	20 × 2	20 × 2	20 × 2	–
5	20 × 2	no counter	20 × 2	no counter	20 × 2	no counter
Pipe $d_a \times s$ [mm]	16 × 2	20 × 2				
Pipe d_i [mm]	12.0	16.0				
Instrument	½"	½"				

Straight-seat shut-off valve ¾ "and distributor ¾" are taken into account in the calculation model.

TV.8
Loading units (LU) for iFIT pipes (PB)



V

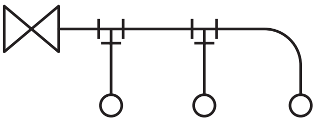
4.1.7 Installation with tees

Group of equipment/distribution at floor level
→ A velocity of max. 3 m/s must be maintained.

Directional change with pipe bend

Max. developed length [m]	5		10		15	
Residential water meter	without	with	without	with	without	with
Loading unit (LU)	[$d_a \times s$]					
1	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2
2	16 × 2	16 × 2	16 × 2	20 × 2	20 × 2	20 × 2
3	20 × 2	20 × 2	20 × 2	20 × 2	20 × 2	25 × 2.5
4	20 × 2	20 × 2	20 × 2	20 × 2	20 × 2	25 × 2.5
5	20 × 2	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5
6	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	–
8	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	–
10	25 × 2.5	25 × 2.5	25 × 2.5	–	–	–
12	–	–	–	–	–	–
15	–	–	–	–	–	–
Pipe $d_a \times s$ [mm]	16 × 2	20 × 2	25 × 2.5	–		
Pipe d_i [mm]	12.0	16.0	20.0	–		
Instrument	½"	½"	¾"	–		

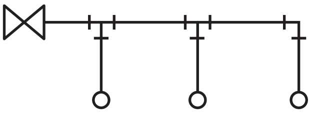
TV.9
Loading units (LU) for iFIT pipes (PB)



Directional change with fittings

Max. developed length [m]	5		10		15	
Residential water meter	without	with	without	with	without	with
Loading unit (LU)	[$d_a \times s$]					
1	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2
2	20 × 2	20 × 2	20 × 2	20 × 2	20 × 2	20 × 2
3	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5
4	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5
5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5
6	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	–
8	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	25 × 2.5	–
10	25 × 2.5	25 × 2.5	25 × 2.5	–	–	–
12	–	–	–	–	–	–
15	–	–	–	–	–	–
Pipe $d_a \times s$ [mm]	16 × 2	20 × 2	25 × 2.5	–		
Pipe d_i [mm]	12.0	16.0	20.0	–		
Instrument	½"	½"	¾"	–		

TV.10
Loading units (LU) for iFIT pipes (PB)



Source: SVGW 2014; SVGW Certificate No.: 0406-4834

4.2 Pressure losses for pipes

4.2.1 The basics

TV.11
Flow velocities

Designation	Value [m/s]	
	SVGW W3*	EN 806-3:2006**
Discharge pipeline	max. 4.0	4.0
Groups of equipment	max. 3.0	–
Pipelines on individual floor levels	max. 3.0	2.0
Distribution pipelines	max. 2.0	2.0

* recommended (acc. to SVGW - Swiss Gas and Wate Industry Association Guideline W3/2013)
** The values given are based on the following flow velocities:
Collective feed lines, risers, floor lines: max. 2.0 m/s
Single feeders: max. 4.0 m/s

4.2.2 Pressure losses for iFIT pipes

A loading unit LU is equal to a flow of 0.1 l/s.

TV.12
Pressure losses for iFIT PB pipes
LU 1 up to LU 5

Pipe, Dimension		Pressure loss [hPa/m pipe (= mbar/m)]				
	LU	1	2	3	4	8
	[l/s]	0.1	0.2	0.3	0.4	0.5
d16		13.3	44.5	91.0	150.5	–
d20		3.8	12.5	26.0	42.5	63.0
d25		–	–	6.6	11.0	16.0
d32		–	–	–	–	4.6

TV.13
Pressure losses for iFIT multilayer composite pipe
LU 1 up to LU 5

Pipe, Dimension		Pressure loss [hPa/m pipe (= mbar/m)]				
	LU	1	2	3	4	5
	[l/s]	0.1	0.2	0.3	0.4	0.5
d16		13.3	44.5	91.0	150.5	–
d20		3.8	12.5	26.0	42.5	63.0
d25		–	–	6.6	11.0	16.0
d32		–	–	–	–	4.6

4.2.3 Pressure losses at 10°C

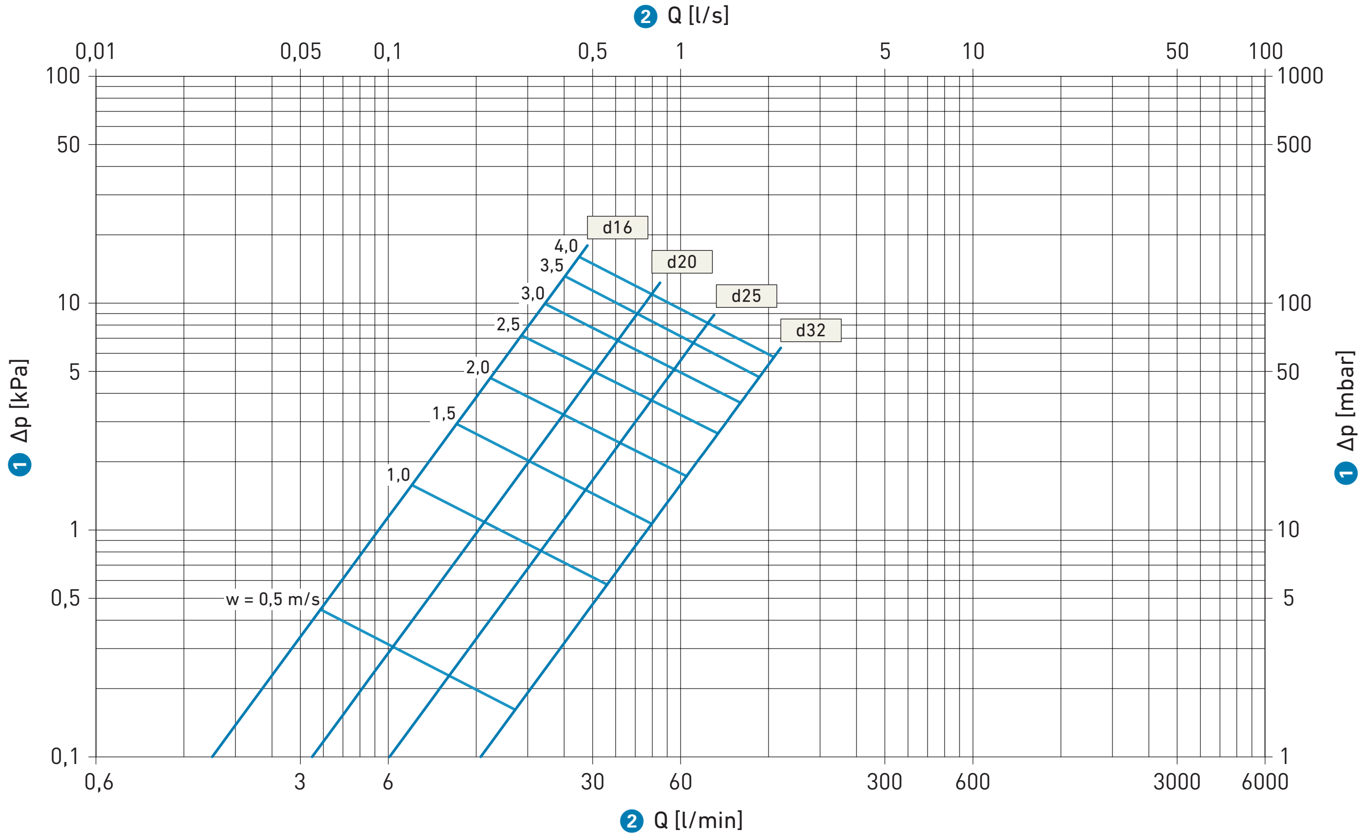
The basics

Designation	Value
Dimension	d16 – d32
Density ρ (water)	999.70 kg/m^3
Water temperature	10°C
Surface roughness k (inner pipe)	0.007 mm
Viscosity	0.00131 Pa · s

TV.14
Design fundamentals

Pipe friction pressure drop as a function of the volumetric flow

The diagram and the tables show the pipe friction pressure drop R and the calculated flow velocity v as a function of the volumetric flow Q.



1 Pressure loss
2 Volumetric flow rate

Pressure losses at 10°C

TV.15 **Pipe friction pressure drop, flow velocity, peak flow**

d	16		20		25		32	
DN	12		15		20		25	
Q [l/s]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
0.01	0.1	0.2	0.0	0.1	–	–	–	–
0.02	0.2	0.7	0.1	0.2	–	–	–	–
0.03	0.3	1.4	0.1	0.3	0.1	0.1	–	–
0.04	0.4	2.3	0.2	0.6	0.1	0.2	–	–
0.05	0.4	3.4	0.2	0.8	0.2	0.3	–	–
0.06	0.5	4.7	0.3	1.2	0.2	0.4	–	–
0.07	0.6	6.1	0.3	1.5	0.2	0.5	0.1	0.1
0.08	0.7	7.7	0.4	1.9	0.3	0.7	0.2	0.2
0.09	0.8	9.5	0.4	2.4	0.3	0.8	0.2	0.2
0.10	0.9	11.4	0.5	2.9	0.3	1.0	0.2	0.3
0.15	1.3	23.3	0.7	5.8	0.5	2.0	0.3	0.6
0.20	1.8	38.5	1.0	9.7	0.6	3.3	0.4	0.9
0.25	2.2	57.0	1.2	14.3	0.8	4.9	0.5	1.4
0.30	2.7	78.5	1.5	19.7	1.0	6.8	0.6	1.9
0.35	3.1	102.9	1.7	25.9	1.1	8.9	0.7	2.5
0.40	3.5	130.1	2.0	32.7	1.3	11.2	0.8	3.2
0.45	4.0	160.0	2.2	40.2	1.4	13.8	0.8	3.9
0.50	–	–	2.5	48.4	1.6	16.6	0.9	4.7
0.55	–	–	2.7	57.2	1.8	19.6	1.0	5.6
0.60	–	–	3.0	66.6	1.9	22.8	1.1	6.5
0.65	–	–	3.2	76.7	2.1	26.3	1.2	7.5
0.70	–	–	3.5	87.4	2.2	29.9	1.3	8.5
0.75	–	–	3.7	98.6	2.4	33.8	1.4	9.6
0.80	–	–	4.0	110.4	2.5	37.8	1.5	10.7
0.85	–	–	–	–	2.7	42.1	1.6	11.9
0.90	–	–	–	–	2.9	46.5	1.7	13.2
0.95	–	–	–	–	3.0	51.2	1.8	14.5
1.00	–	–	–	–	3.2	56.0	1.9	15.9
1.05	–	–	–	–	3.3	61.0	2.0	17.3
1.10	–	–	–	–	3.5	66.2	2.1	18.8
1.15	–	–	–	–	3.7	71.5	2.2	20.3
1.20	–	–	–	–	3.8	77.1	2.3	21.9
1.25	–	–	–	–	4.0	82.8	2.4	23.5
1.30	–	–	–	–	–	–	2.4	25.2
1.35	–	–	–	–	–	–	2.5	26.9
1.40	–	–	–	–	–	–	2.6	28.7
1.45	–	–	–	–	–	–	2.7	30.5
1.50	–	–	–	–	–	–	2.8	32.4
1.55	–	–	–	–	–	–	2.9	34.3
1.60	–	–	–	–	–	–	3.0	36.3
1.65	–	–	–	–	–	–	3.1	38.3
1.70	–	–	–	–	–	–	3.2	40.3
1.75	–	–	–	–	–	–	3.3	42.4
1.80	–	–	–	–	–	–	3.4	44.6
1.85	–	–	–	–	–	–	3.5	46.8
1.90	–	–	–	–	–	–	3.6	49.0
1.95	–	–	–	–	–	–	3.7	51.3
2.00	–	–	–	–	–	–	3.8	53.6
2.10	–	–	–	–	–	–	4.0	58.4

4.2.4 Pressure losses at 60°C

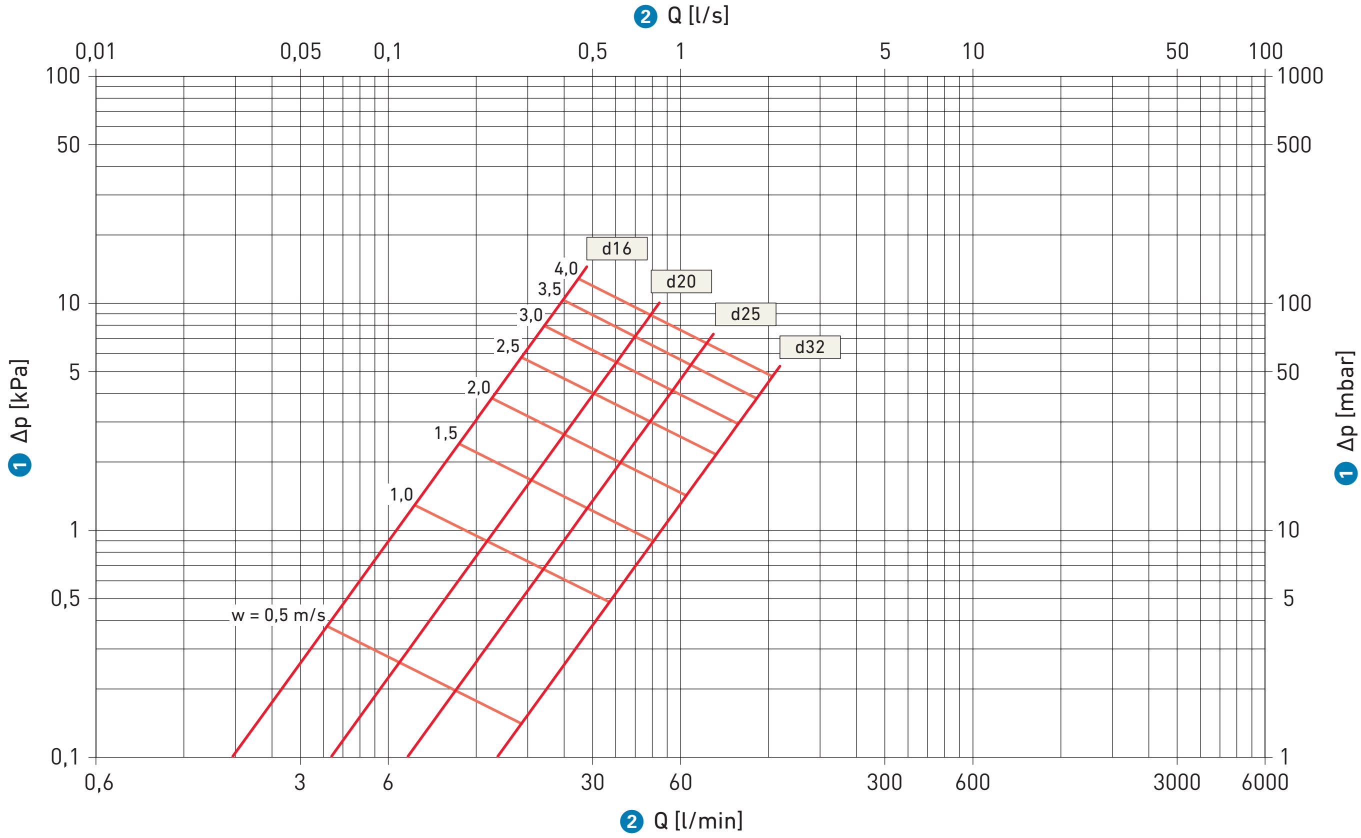
TV.16
Design fundamentals

The basics

Designation	Value
Dimension	d16 – d32
Density ρ (water)	983.19 kg/m³
Water temperature	60°C
Surface roughness k (inner pipe)	0.007 mm
Viscosity	0.00476 Pa · s

Pipe friction pressure drop as a function of the volumetric flow

The diagram and the tables show the pipe friction pressure drop R and the calculated flow velocity v as a function of the volumetric flow Q.



1 Pressure loss
2 Volumetric flow rate

Pressure losses at: 60°C

TV.17 **Pipe friction pressure drop, flow velocity, peak flow**

d	16		20		25		32	
DN	12		15		20		25	
Q [l/s]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
0.01	0.1	0.1	–	–	–	–	–	–
0.02	0.2	0.5	0.1	0.1	–	–	–	–
0.03	0.3	1.0	0.1	0.3	0.1	0.1	–	–
0.04	0.4	1.7	0.2	0.4	0.1	0.1	–	–
0.05	0.4	2.6	0.2	0.6	0.2	0.2	–	–
0.06	0.5	3.6	0.3	0.9	0.2	0.3	–	–
0.07	0.6	4.7	0.3	1.2	0.2	0.4	0.1	0.1
0.08	0.7	5.9	0.4	1.5	0.3	0.5	0.2	0.1
0.09	0.8	7.3	0.4	1.8	0.3	0.6	0.2	0.2
0.10	0.9	8.8	0.5	2.2	0.3	0.8	0.2	0.2
0.15	1.3	18.2	0.7	4.6	0.5	1.6	0.3	0.4
0.20	1.8	30.4	1.0	7.6	0.6	2.6	0.4	0.7
0.25	2.2	45.2	1.2	11.3	0.8	3.9	0.5	1.1
0.30	2.7	62.6	1.5	15.7	1.0	5.3	0.6	1.5
0.35	3.1	82.4	1.7	20.6	1.1	7.0	0.7	2.0
0.40	3.5	104.5	2.0	26.2	1.3	8.9	0.8	2.5
0.45	4.0	128.9	2.2	32.3	1.4	11.0	0.8	3.1
0.50	–	–	2.5	38.9	1.6	13.3	0.9	3.8
0.55	–	–	2.7	46.1	1.8	15.8	1.0	4.5
0.60	–	–	3.0	53.9	1.9	18.4	1.1	5.2
0.65	–	–	3.2	62.1	2.1	21.2	1.2	6.0
0.70	–	–	3.5	70.9	2.2	24.2	1.3	6.8
0.75	–	–	3.7	80.2	2.4	27.4	1.4	7.7
0.80	–	–	4.0	89.9	2.5	30.7	1.5	8.7
0.85	–	–	–	–	2.7	34.2	1.6	9.7
0.90	–	–	–	–	2.9	37.9	1.7	10.7
0.95	–	–	–	–	3.0	41.7	1.8	11.8
1.00	–	–	–	–	3.2	45.7	1.9	12.9
1.05	–	–	–	–	3.3	49.9	2.0	14.1
1.10	–	–	–	–	3.5	54.2	2.1	15.3
1.15	–	–	–	–	3.7	58.6	2.2	16.6
1.20	–	–	–	–	3.8	63.3	2.3	17.9
1.25	–	–	–	–	4.0	68.0	2.4	19.2
1.30	–	–	–	–	–	–	2.4	20.6
1.35	–	–	–	–	–	–	2.5	22.1
1.40	–	–	–	–	–	–	2.6	23.5
1.45	–	–	–	–	–	–	2.7	25.1
1.50	–	–	–	–	–	–	2.8	26.6
1.55	–	–	–	–	–	–	2.9	28.2
1.60	–	–	–	–	–	–	3.0	29.9
1.65	–	–	–	–	–	–	3.1	31.5
1.70	–	–	–	–	–	–	3.2	33.3
1.75	–	–	–	–	–	–	3.3	35.0
1.80	–	–	–	–	–	–	3.4	36.8
1.85	–	–	–	–	–	–	3.5	38.7
1.90	–	–	–	–	–	–	3.6	40.6
1.95	–	–	–	–	–	–	3.7	42.5
2.00	–	–	–	–	–	–	3.8	44.4
2.10	–	–	–	–	–	–	4.0	48.5

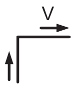
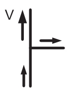
4.3 Pressure losses for system parts

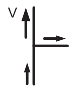
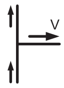
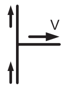
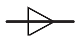
The ζ values and the equivalent lengths of the pipelines were determined in accordance with the specifications of the SVGW (SV EN 1267).

Loading unit and ζ value
A loading unit **LU** is equal to a flow of 0.1 l/s.
The ζ value for w = 2 m/s, as shown in the table.

4.3.1 Simplified representation for 1 loading unit (LU)

TV.18 **Pressure losses in iFIT system parts**

Item number	Designation		Symbol	Dimension	ζ value	Equivalent length of pipeline [m]
762.101.224 762.101.225	Box, single, 90°			1/2"-d16	5.4	2.56
				1/2"-d20	7.2	4.81
				3/4"-d16	5.5	2.65
				3/4"-d20	8.0	5.30
762.101.226	Box, double, 90°	Discharge		1/2"-d16-d16	6.5	3.08
				1/2"-d20-d16	6.1	2.89
		Flow rate		1/2"-d16-d16	4.9	2.32
				1/2"-d20-d16	4.2	1.99
762.101.018 762.101.019	Connections to controls and instruments, single			1/2"-d16	5.5	2.61
				1/2"-d20	8.8	5.88
				3/4"-d16	5.6	2.65
				3/4"-d20	8.1	5.41
762.101.022	Connections to controls and instruments, double	Discharge		1/2"-d16-d16	6.8	3.22
				1/2"-d20-d16	6.0	2.84
		Flow rate		3/4"-d16-d16	4.7	2.23
				3/4"-d20-d16	3.8	1.80
762.101.230 762.101.231 762.101.232	Distributor including transition	Discharge		3/4"-d16	3.0	1.42
				3/4"-d20	4.2	2.80
		Flow rate		3/4"	0.5	0.35
762.101.046 762.101.179	90° angle			d16	6.3	2.98
				d20	8.7	5.81
				d25	5.2	4.88
				d32	11.0	12.57
	Pipe bend 90°, bent manually			d16	0.1	0.05
				d20	0.1	0.06
				d25	0.1	0.09
				d32	0.1	0.10
762.101.180	45° angle			d25	3.5	3.29
				d32	7.4	8.46
	Pipe bend 45°, bent manually			d16	0.1	0.05
				d20	0.1	0.06
				d25	0.1	0.09
				d32	0.1	0.10
762.101.042 762.101.181	Tees	Flow rate		d16	3.8	1.80
				d20	4.8	3.21
				d25	2.8	2.36
				d32	6.4	7.32

Item number	Designation		Symbol	Dimension	ζ value	Equivalent length of pipeline [m]
762.101.183 762.101.185 762.101.187	Tee, reduced	Flow rate		d20-d16	3.1	1.47
				d25-d16	2.5	1.18
				d25-d20	3.4	2.27
				d32-d16	2.5	1.18
				d32-d20	3.4	2.27
				d32-d25	2.6	2.44
762.101.042 762.101.181	Tees	Pipe branch		d16	6.4	3.03
				d20	9.5	6.34
				d25	5.5	5.16
				d32	12.4	14.17
762.101.183 762.101.185 762.101.187	Tee, reduced	Pipe branch		d20-d16	4.6	2.18
				d25-d16	3.1	1.47
				d25-d20	5.0	3.34
				d32-d16	3.2	1.52
				d32-d20	4.7	3.14
				d32-d25	4.9	4.60
762.101.044 762.101.175	Coupling			d16	3.7	1.75
				d20	4.7	3.14
				d25	2.8	2.63
				d32	6.7	7.66
762.101.044 762.101.175 762.101.177	Reduction			d20-d16	3.1	1.47
				d25-d16	2.5	1.18
				d25-d20	3.4	2.27
				d32-d16	2.5	1.18
				d32-d20	3.3	2.20
				d32-d25	2.7	2.53

4.4 Discharge times

The discharge times indicate the time elapsed until a temperature of 40°C is reached at the tap (in accordance with SIA 385/2, 2015 edition) and signal the beginning of usability. These discharge times apply to fully opened taps set to maximum "hot". In the interests of economical water and energy consumption, these discharge times should not be set too high.

In order to keep the discharge losses within economically justifiable limits and at the same time to meet the comfort requirements of the hot water user, the requirements defined in [TV.19] for discharge periods apply.* The measurement itself is carried out with the fitting installed at the installation site.

If it is not possible to choose a distribution system that conveys the hot water from the hot water storage tank to the tap within a reasonable time (discharge time), a circulation pipeline or auxiliary heating system must be planned and installed, or the arrangement of the sanitary equipment and riser zones must be optimised.

TV.19
Discharge times – Requirements
* Excerpt from SIA 385/1

Sanitary fixtures	Discharge time t [s]	
	without keeping warm (e.g. without circulation)	with keeping warm (e.g. with circulation)
Vanity unit, wash-hand basin, bidet, showers, bathtubs, sink (kitchen), utility sink	15	10

According to EN 806-2 also applies to the intended operation:

- Drinking water, cold: Max. 30 s after full opening of a tapping point:
  - Temperature must not exceed 25 °C.
- Drinking water, hot: Max. 30 s after full opening of a tapping point:
  - Temperature must be min. 55 °C.

According to VDI 6003 the following values result for different sanitary objects:

TV.20
Discharge times – Requirements
* Excerpt from VDI 6003 (requirement levels = comfort criteria)

Sanitary fixtures	Useful temperature [°C]	Discharge time t [s]*		
		Requirement level		
		I	II	III
Vanity unit	40	60	18	10
Shower	42	~26	10	7
Bathtub	45	~26	12	9
Flushing	50	60	18	10
Bidet	40	–	15	15
Whirlpool / Large tub	50	–	10	10

Factors influencing the output times include the following

TV.21 **Factors for output times**

Desired comfort	(criteria)
Floor plan	Distance to sanitary objects, grouping
Number of strings supplying the apartment	
Planning, construction and operation • Compliant with regulations (according to TRWI) or not	• with or without circulation system • Running time of the circulation pump. If the circulation pump is switched off, the distribution lines for domestic hot water will inevitably cool down. Fixed discharge times are then no longer to be observed. • Correct sizing of the circulation system, based on the product-specific resistance coefficients of the piping system.
Floor installation type	• Distribution with single supply line • Tee installation • Pipeline in series • Ring pipeline
Supply type hot water	• Individual supply line • Group supply: decentralized or centralized in apartments • Central supply: Storage system or storage charging system

Calculation

Calculating the discharge time

➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [12] 'Dimensioning'

The discharge times must be matched to the pipe dimension, length of the pipeline and the volume flows. Especially when using energy-saving mixers (flow restrictors), the effective volumetric flow must always be determined and converted (acc. to SIA 385/2, Issue 2015, Annex G), because the reduced volumetric flow results in a longer discharge time.

The calculation is based on the standard SIA 385/1, which contains the fundamental principles and requirements for domestic hot water systems. The calculation is also based on the standard SIA 385/2, which describes the hot water demand, the overall requirements and the design, such as the calculation of the discharge times.

Discharge times for iFIT-PB pipe and iFIT multilayer composite pipe

The table does not consider fittings but only pipes.

- Input variables: Outside diameter d, wall thickness s_w
- Calculated quantities: [l/m], max. length of pipeline [m], discharge times [s/m]

TV.22 **Discharge times and lengths – iFIT-PB pipe and iFIT multilayer composite pipe**

Pipe, Dimension				max. feasible duration of the discharge times [s] of						Discharge time [s] for each 1 m length of pipeline		
			[s]	15			10			Cold phase + warm-up phase		
			[l/s_w]	0.1	0.2	0.3	0.1	0.2	0.3	0.1	0.2	0.3
DN	d	s_w	[l/m]	max. length of pipeline [mm]						[s]		
12	16	2.0	0.113	6.6	13.2	19.8	4.4	8.8	13.2	2.3	1.1	0.8
15	20	2.0	0.201	3.7	7.4	11.1	2.4	4.9	7.4	4.0	2.0	1.3

4.5 Change of length and compensation for expansion

Due to heat and depending on the material, pipelines expand to varying degrees. Even if the temperatures of the medium (e.g. drinking water) exceeds room temperature, this causes a thermal expansion and must be taken into account in the design of the installation.

How to calculate the change in length
In order to calculate the change in length, product and material-specific values are required:
➨ Technical data for system, Chapter [2.1]

This thermally induced change in length can be compensated during the installation and mounting of the pipe. Suitable measures are:

- Directional changes of the pipeline
- Providing expansion space
- Installation of expansion joints
- Setting the fixed points and floating points

The bending and torsional forces occurring during the operation of a pipeline are safely absorbed, taking into account the above-mentioned measures. The following parameters have a significant influence on the expansion compensation:

- Material
- Structural conditions
- Operating conditions

Minor changes in length of the pipelines, especially if using smaller dimensions, can be compensated for by the elasticity of the piping system or with a corresponding insulation.

For larger piping systems, the changes in length must be absorbed by the **expansion joints**: Insulations, flexible pipe legs and U-shaped expansion loops compensate for the thermally induced change in length. The required measures for GF's plastic piping systems are – depending on the type of installation:

TV.23
Measures for the expansion compensation for plastic pipelines made by GF

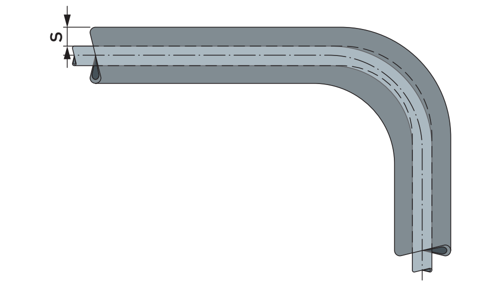
Medium	Cold water	Hot water/circulation/heater	
Dimension	d16 – d110	d16 – d26	d32 – d110
Length of pipeline L ≤12 m	If using insulated pipelines, compensation for the change in length does **not** require floating points and fixed points		
Length of pipeline L ≥12 m	If using insulated pipelines, compensation for the change in length does **not** require floating points and fixed points		Compensation for the change in length requires floating points and fixed points

4.5.1 Compensation for the change in length by using insulation

When having to compensate for the change in length due to the insulation, the minimum insulation thickness **s** must be at least 1.5 times the length change. From the calculated amounts of the change in length, the insulation thickness per meter of straight pipeline length is calculated according to the following formula:

$$s = 1.5 \cdot \Delta l$$

s Insulation thickness, min.
Δl Change in length



Installations with temperatures up to 60°C (ΔT = 50 K), a change in length Δl of 1.3 mm must be taken into account for each meter of straight pipe. This equals to an insulation thickness of 2.0 mm per meter of straight pipe length.

Insulation

General information on insulation:

➨ Part IV 'Plan', Section 'Insulation, Fire protection'

Information about insulation when installing riser pipes:

➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [13] 'Installation and attachment'

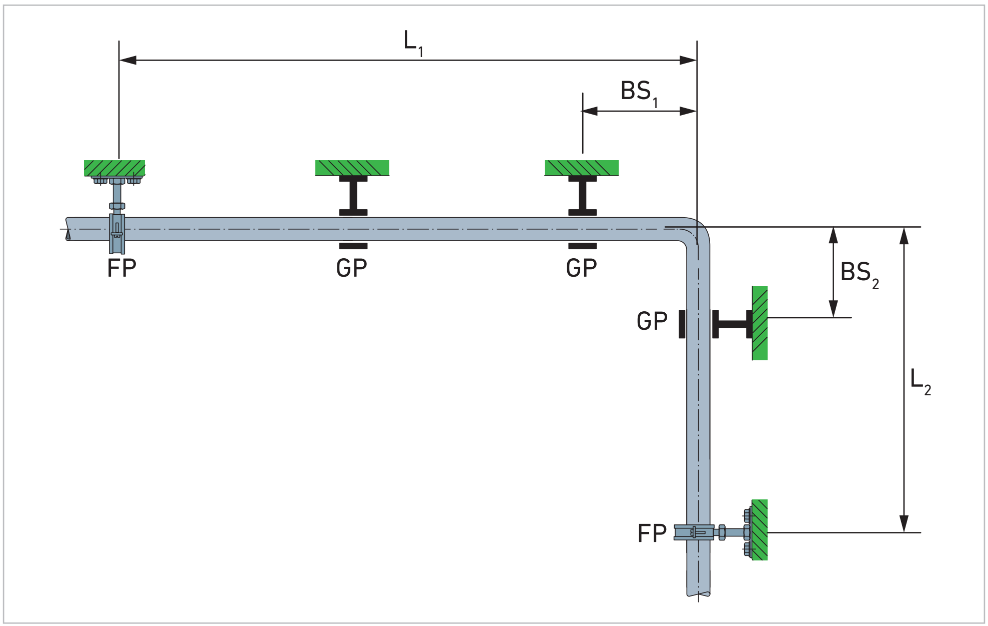
4.5.2 Compensation for the change in length by using expansion joints

Flexible pipe legs and **U-shaped expansion loops** are used as **expansion joints**. In order to ensure the function of the 2D expansion loop, **fixed points** and **floating points** (with sliding pipe clips) are installed.

Fixed points can be created at a suitable location along the pipeline, using a commercially available, custom-fit fixed point clips or a system-specific solution (e.g. fixed point clip in combination with a fixed-point pipe clip of the system used).

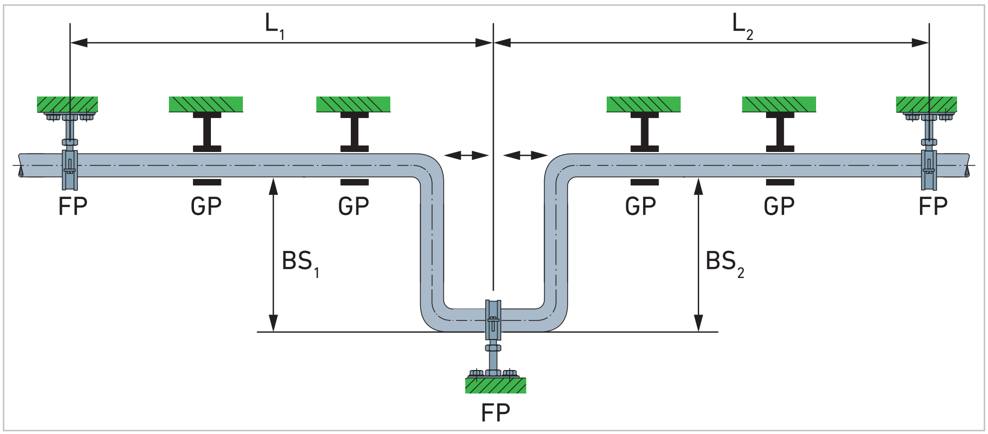
The **pipe clip** must assume the shape of the pipe and, when tightening the clip, the actual pipe diameter must not be constrict by more than 0.5 mm.

Examples – Basic design of a flexible pipe leg and U-shaped expansion loop



GV.5
Flexible pipe leg

FP Fixed point
GP Floating point (with sliding pipe clip)
BS Flexible pipe leg
L Pipe length between fixed point and deflection



GV.6
U-shaped expansion loop

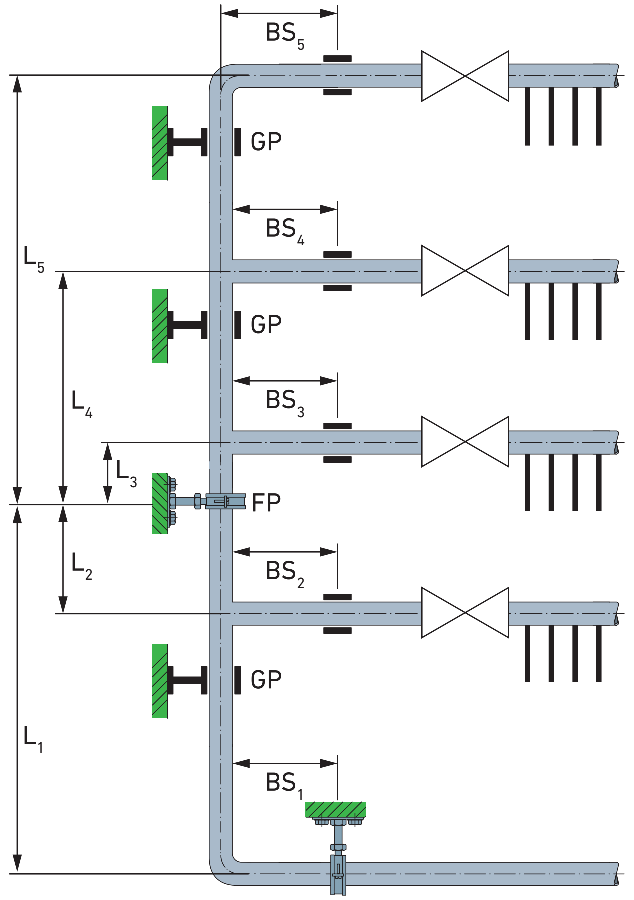
FP Fixed point
GP Floating point (with sliding pipe clip)
BS Flexible pipe leg
L Pipe length between fixed point and deflection

4.5.3 Fixed points and floating points when using riser pipes

If riser pipes are leading up to several storeys and accordingly have multiple fixed points, the change in length between the individual fixed points must be absorbed by the flexible pipe leg (BS). The sliding pipe clamp (GS) mounted to the horizontal pipe affects the **vertical** expansion of the pipe similar to a fixed point (FP).

Examples – Basic design of fixed points and floating points

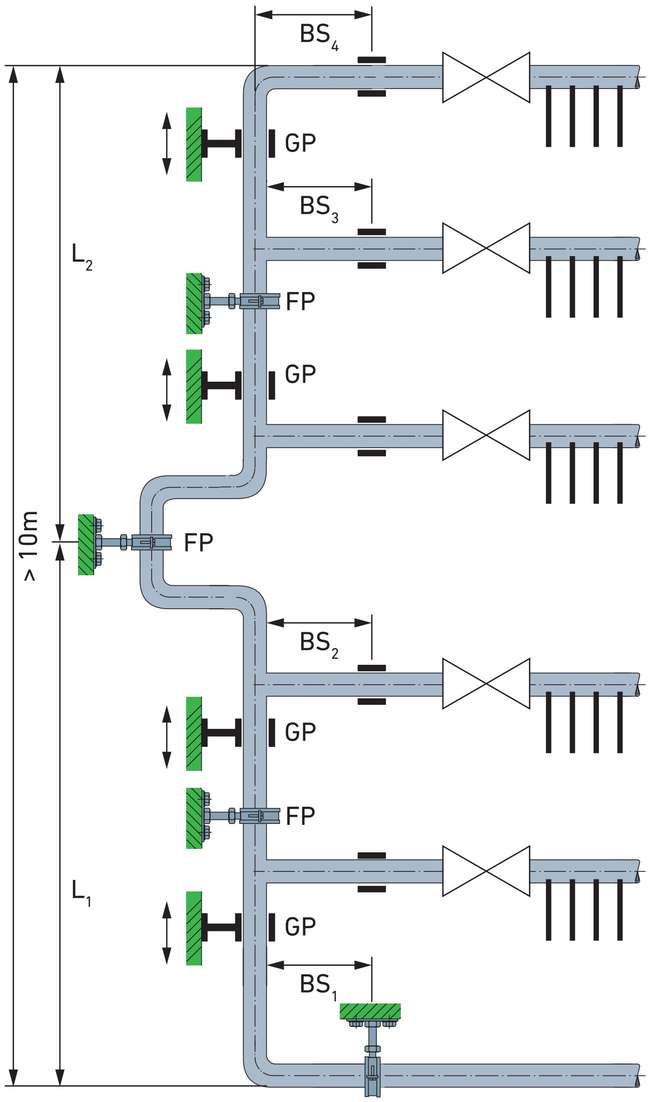
Riser pipe up to a height of 10 m



Up to a **riser pipe height of 5 m,** neither a U-shaped expansion loop nor a fixed point shall be installed along the riser pipe.

Up to a **riser pipe height of 10 m,** a U-shaped expansion loop can be omitted. In the middle of the riser pipe, however, a fixed point (FP) must be installed.

Riser pipe starting at a height of 10 m



Starting at a **riser pipe height of 10 m,** a U-shaped expansion loop with fixed points (FP) must be installed at intervals of 10 m.

L_{1-5}	Pipe length between fixed point and deflection
FP	Fixed point
BS_{1-5}	Flexible pipe leg
GP	Floating point (with sliding pipe clip)

4.5.4 How to calculate the change in length

The **change in length of a pipeline** and the corresponding design of the flexible pipe leg and U-shaped expansion loop also depend on the material used. When calculating the change in length, this must be taken into account by using corresponding material-dependent parameters. The **calculation of the length of the flexible pipe leg** depends on the design of the flexible pipe leg:

- If using a **flexible pipe leg** in order to compensate for an extension, or if a branch line is used, the length of the flexible pipe leg must be calculated.
- If a **U-shaped expansion loop** is used to compensate for the expansion, the length of both flexible pipe legs that form the U-shaped expansion loop must be calculated.

Material constant and coefficient of thermal expansion
In order to calculate the change in length, product and material-specific values are required:
➨ Technical data for system, Chapter [2.1]

How to calculate the change in length

The thermally induced **change in length** Δl of pipes is calculated (in non-resisting installations) from the **temperature difference** ΔT and the **pipe length** L, using the following formula:

$$\Delta l = \alpha \cdot L \cdot \Delta T$$

Symbol	Meaning	Unit	Remark
L	Length of pipeline	[m]	–
α	Linear coefficient of thermal expansion	[mm/(m·K)]	product-/material-specific
Δl	Change in length	[mm]	–
ΔT	Temperature difference	[K]	–

Sample calculation using a plastic pipe (PB)
The length of the pipeline is 7 m. The thermally induced change in length of this pipe section must be absorbed by a flexible pipe leg. The difference between the installation temperature and the maximum operating temperature is 60 K (10° to 70°C).

Example 1: Plastic pipe, PB

PB pipe, Dimension	d16
Length of pipeline L	7 m
Temperature difference ΔT	60 K)
Linear coefficient of thermal expansion α	0.13 mm/(m·K)

How to calculate the change in length

$$\Delta l = \alpha \cdot L \cdot \Delta T$$

$$\Delta l = 0.13\ [mm/(m \cdot K)] \cdot 7\ [m] \cdot 60\ [K]$$

$$\Delta l = 54.6\ mm$$

Example 2: Multilayer composite pipe, PE-RT

PE-RT pipe, dimension	d16
Length of pipeline L	7 m
Temperature difference ΔT	60 K)
Linear coefficient of thermal expansion α	0.024 mm/(m·K)

How to calculate the change in length

$$\Delta l = \alpha \cdot L \cdot \Delta T$$

$$\Delta l = 0.024\ [mm/(m \cdot K)] \cdot 7\ [m] \cdot 60\ [K]$$

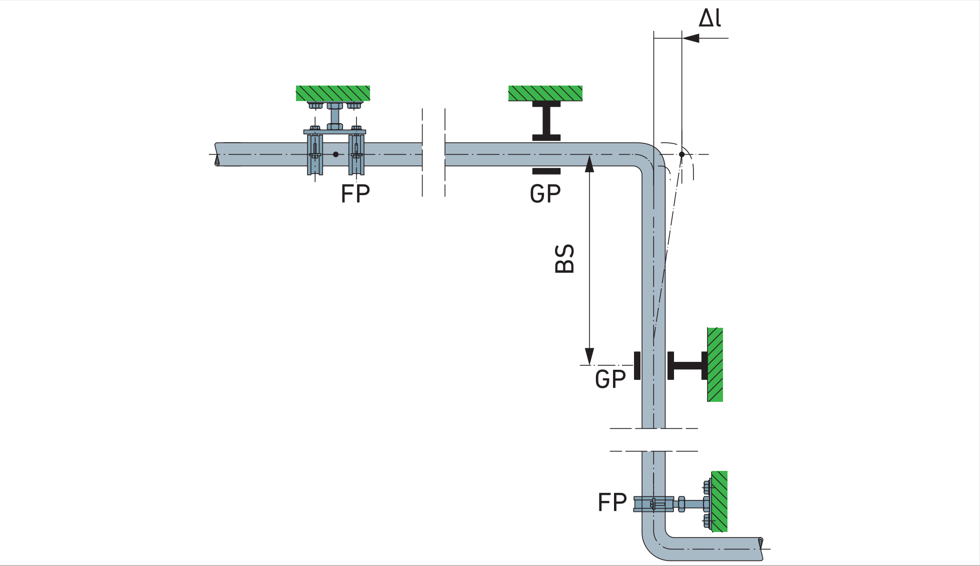
$$\Delta l = 10.08\ mm$$

4.5.5 Calculation of the flexible pipe leg

Calculation of the length of the flexible pipe leg

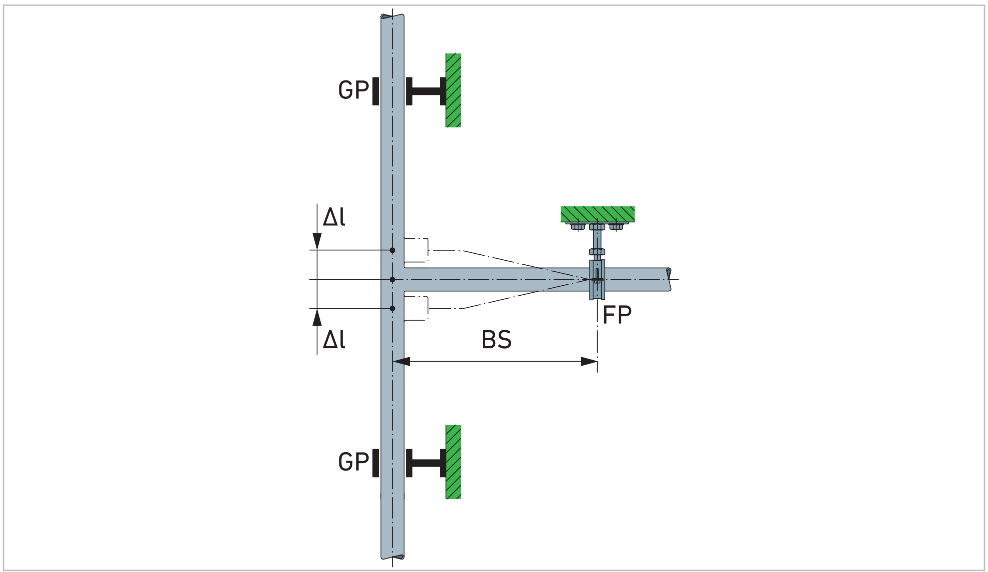
Due to the thermally induced change in length **Δl** , a pipeline shifts a pipe bend by a value **Δl**.
This change must be absorbed by a flexible pipe leg with a length equal to $\mathbf{L}_{BS}$.

Length of flexible pipe leg



GV.7
Length of flexible pipe leg
GP Floating point
FP Fixed point
BS Length of flexible pipe leg

Length of flexible pipe leg intended to use for the branch line



GV.8
Length of flexible pipe leg
GP Floating point
FP Fixed point
BS Length of flexible pipe leg

The **length of the flexible pipe leg** BS is calculated from the **change in length** Δl and the **outside diameter** d of the pipe, using the following formula:

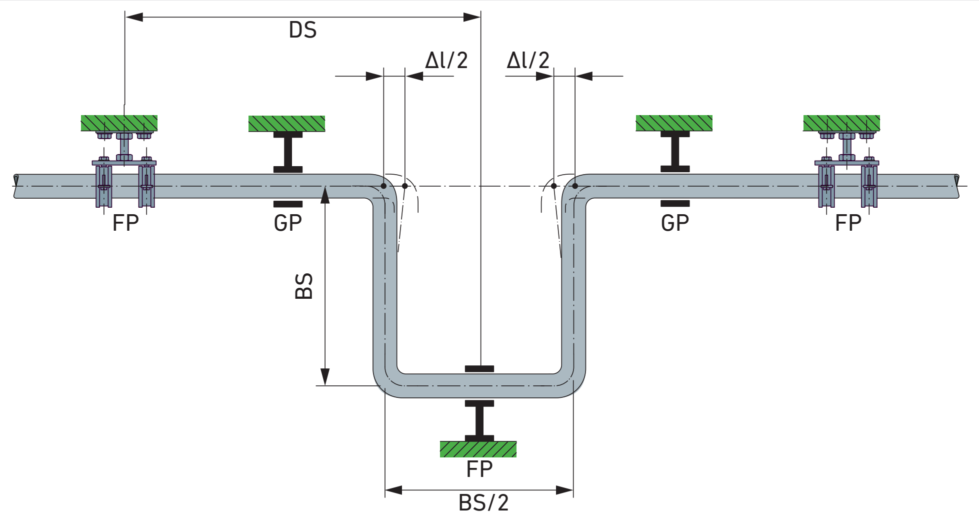
$$BS = C \cdot \sqrt{d \cdot \Delta l}$$

Symbol	Meaning	Unit	Remark
BS	Length of flexible pipe leg	[mm]	–
d	Outside diameter of pipe	[mm]	–
Δl	Change in length	[mm]	–
C	Material constant	–	product/material-specific

Calculation of the length of the flexible pipe leg in a U-shaped expansion loop

Due to the thermally induced change in length **Δl** a pipe displaces a U-shaped loop at both bends by half the value **Δl**. This change must be absorbed by the two flexible pipe legs **BS**.

Length of the U-shaped expansion loop



GV.9
Length of the U-shaped expansion loop

GP Floating point
FP Fixed point
BS Length of flexible pipe leg
DS Length of the 2D expansion loop

Sample calculation using a plastic pipe (PB pipe)

The length of the pipeline is 7 m. The thermally induced change in length of this pipe section must be absorbed by a flexible pipe leg. The difference between the installation temperature and the maximum operating temperature is 60 K.

Example 1: Plastic pipe, PB

PB pipe, Dimension	d16
Material constant C	10
Change in length Δl	54.6 mm

Calculation of the length of the flexible pipe leg

$$BS = C \cdot \sqrt{d \cdot \Delta l}$$

$$BS = 10 \cdot \sqrt{(16\text{ mm} \cdot 54.6\text{ mm})}$$

$$BS = 295\text{ mm}$$

Example 2: Multilayer composite pipe, PE-RT

PE-RT pipe, dimension	d16
Material constant C	33
Change in length Δl	10.08 mm

Calculation of the length of the flexible pipe leg

$$BS = C \cdot \sqrt{d \cdot \Delta l}$$

$$BS = 33 \cdot \sqrt{(16\text{ mm} \cdot 10.08\text{ mm})}$$

$$BS = 419.1\text{ mm}$$

In order to simplify the determination of the required length of the flexible pipe leg, a material-specific diagram can also be used to determine the length of the flexible pipe leg. When comparing this result with the result of a metal pipe—which has the same dimension—the size of a flexible pipe leg made of metal will be significantly larger. The explanation for this is the much higher material constant C for metal pipes than the material constant C for a plastic pipe.

4.6 Diagrams – Change in length and length of flexible pipe leg

4.6.1 Change in length

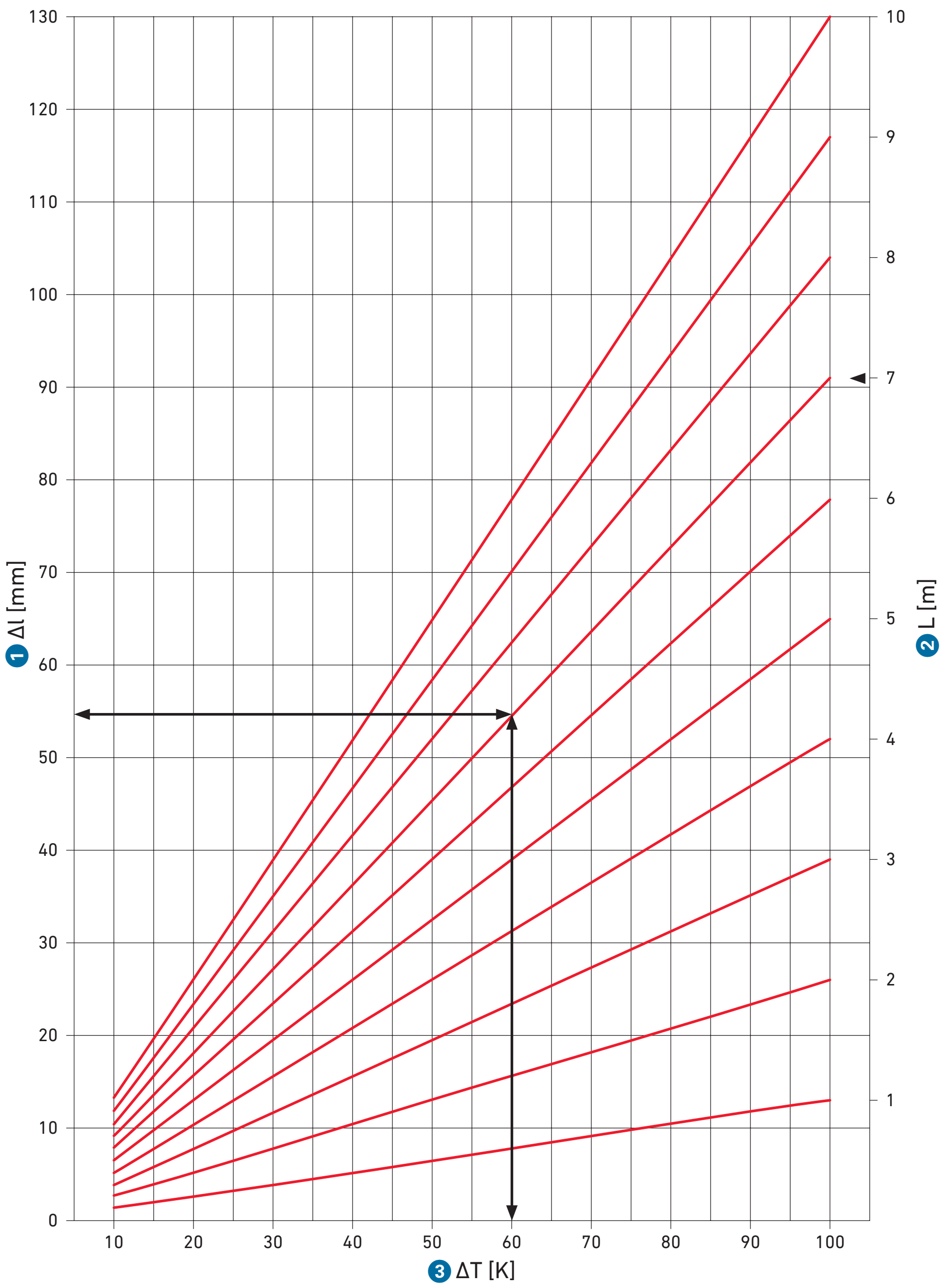
iFIT PB pipes

The diagram shows the length expansion of iFIT PB pipes as a function of the temperature and length of the pipe, if installed without resistance.

How to read the table

Plastic pipe, PB pipe, Dimension	d16
Length of pipeline L	7.0 m
Linear coefficient of thermal expansion α	0.13 mm/(m·K)
Temperature difference ΔT	60 K

Δl = 54.6 mm



GV.10
Change in length – iFIT pipes (PB)

1. Change in length
2. Length of pipeline
3. Temperature difference

iFIT PB pipes

TV.24 **Thermally induced change of length – iFIT PB pipes**

Length of pipeline [m]	Temperature difference ΔT [K]						
	10	20	30	40	50	60 ▼	70
	Change in length [cm]						
1	0.1	0.3	0.4	0.5	0.7	0.8	0.9
2	0.3	0.5	0.8	1.0	1.3	1.6	1.8
3	0.4	0.8	1.2	1.6	2.0	2.3	2.7
4	0.5	1.0	1.6	2.1	2.6	3.1	3.6
5	0.7	1.3	2.0	2.6	3.3	3.9	4.6
6	0.8	1.6	2.3	3.1	3.9	4.7	5.5
7 ▶	0.9	1.8	2.7	3.6	4.6	5.5	6.4
8	1.0	2.1	3.1	4.2	5.2	6.2	7.3
9	1.2	2.3	3.5	4.7	5.9	7.0	8.2
10	1.3	2.6	3.9	5.2	6.5	7.8	9.1
20	2.6	5.2	7.8	10.4	13.0	15.6	18.2
30	3.9	7.8	11.7	15.6	19.5	23.4	27.3
40	5.2	10.4	15.6	20.8	26.0	31.2	36.4
50	6.5	13.0	19.5	26.0	32.5	39.0	45.5

▶ Example for L = 7 m: ΔT = 60 K

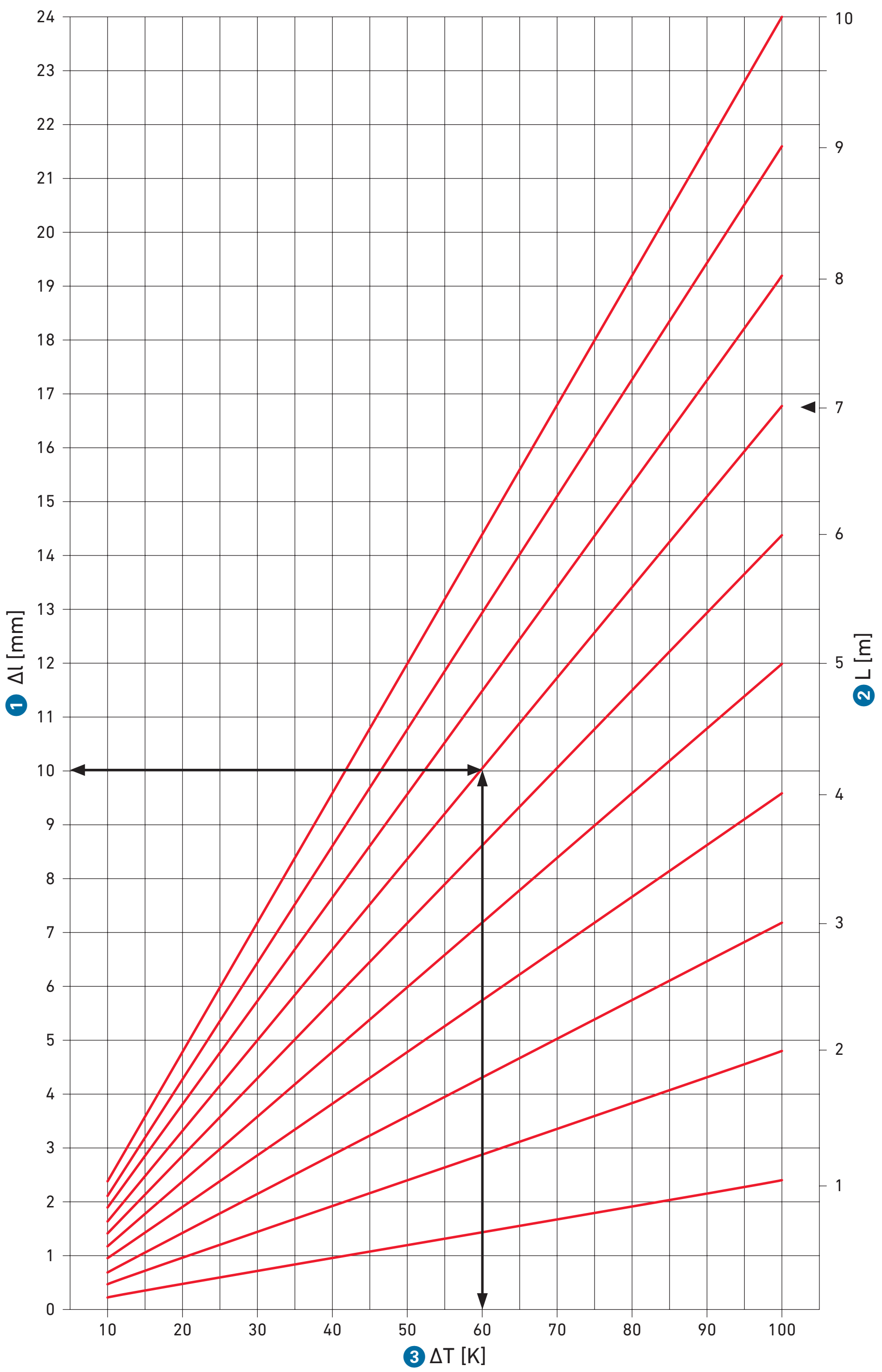
iFIT multilayer composite pipes (PE-RT)

The diagram shows the longitudinal expansion of iFIT multi-layer composite pipes
as a function of the temperature and length of the pipe when installed without resistance.

How to read the table

Multilayer composite pipe (PE-RT), Dimension	d16
Length of pipeline L	7.0 m
Linear coefficient of thermal expansion α	0.024 mm/(m·K)
Temperature difference ΔT	60 K

$\Delta l = 10.08$ mm



GV.11
Change in length - iFIT pipes (PE-RT)

1. Change in length
2. Length of pipeline
3. Temperature difference

V

iFIT multilayer composite pipes (PE-RT)

TV.25 **Thermally induced change of length – iFIT pipes (PE-RT)**

Length of pipeline [m]	Temperature difference ΔT [K]						
	10	20	30	40	50	60 ▼	70
	Change in length [mm]						
1	0.2	0.5	0.7	1.0	1.2	1.4	1.7
2	0.5	1.0	1.4	1.9	2.4	2.9	3.4
3	0.7	1.4	2.2	2.9	3.6	4.3	5.0
4	1.0	1.9	2.9	3.8	4.8	5.8	6.7
5	1.2	2.4	3.6	4.8	6.0	7.2	8.4
6	1.4	2.9	4.3	5.8	7.2	8.6	10.1
7 ▶	1.7	3.4	5.0	6.7	8.4	10.1	11.8
8	1.9	3.8	5.8	7.7	9.6	11.5	13.4
9	2.2	4.3	6.5	8.6	10.8	13.0	15.1
10	2.4	4.8	7.2	9.6	12.0	14.4	16.8
20	4.8	9.6	14.4	19.2	24.0	28.8	33.6
30	7.2	14.4	21.6	28.8	36.0	43.2	50.4
40	9.6	19.2	28.8	38.4	48.0	57.6	67.2
50	12.0	24.0	36.0	48.0	60.0	72.0	84.0

▶ Example for L = 7 m: ΔT = 60 K

4.6.2 Length of flexible pipe leg

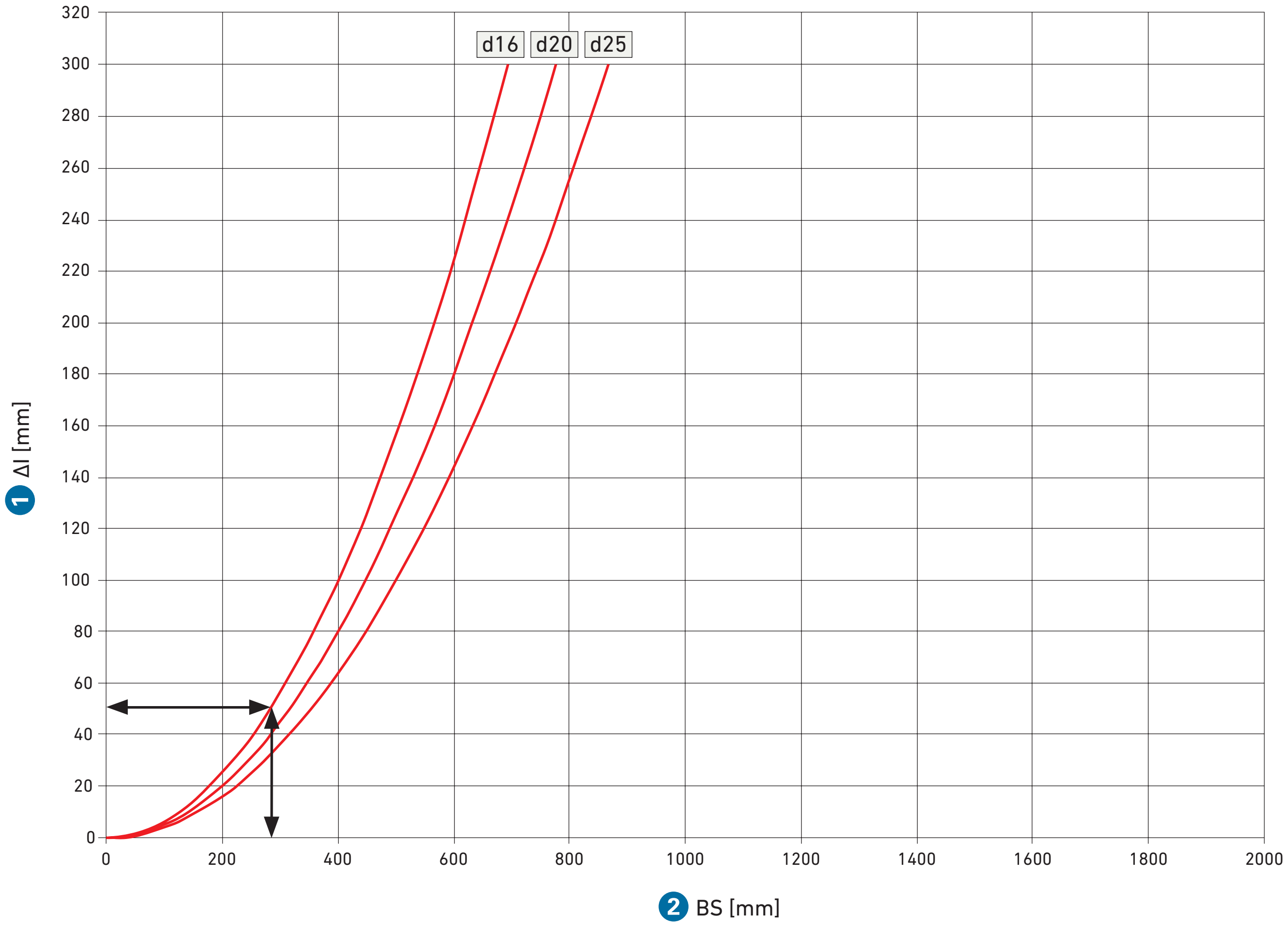
iFIT PB pipes

The length of the flexible pipe leg is derived from the pipe's change in length:

How to read the table

Plastic pipe, PB pipe, Dimension	d16
Material constant C	10
Change in length Δl	54.6 mm

BS = 295 mm

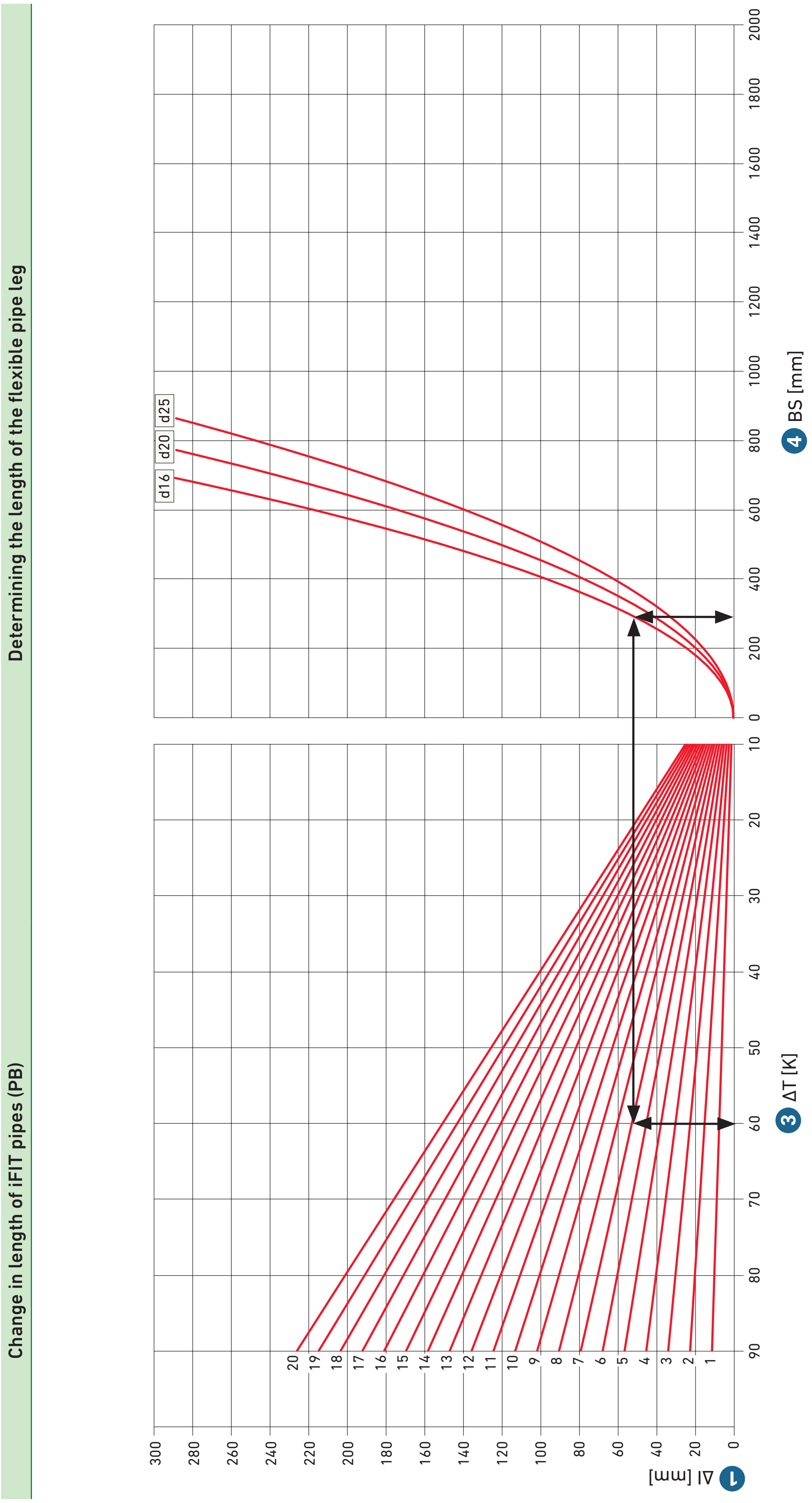


GV.12
Length of flexible pipe leg

1. Change in length of the pipe
2. Length of flexible pipe leg

Graphic determination of the length of flexible pipe leg – iFIT PB pipes

The length of the flexible pipe leg can be determined with the two combined diagrams.



How to use the diagram

1. Read off temperature difference ③.
2. Select the length of pipeline ②.
3. Read change of length ①.
4. Read off the pipe dimension.
5. Read length of the flexible pipe leg ④.

① Change in length
② Length of pipeline
③ Temperature difference
④ Length of flexible pipe leg

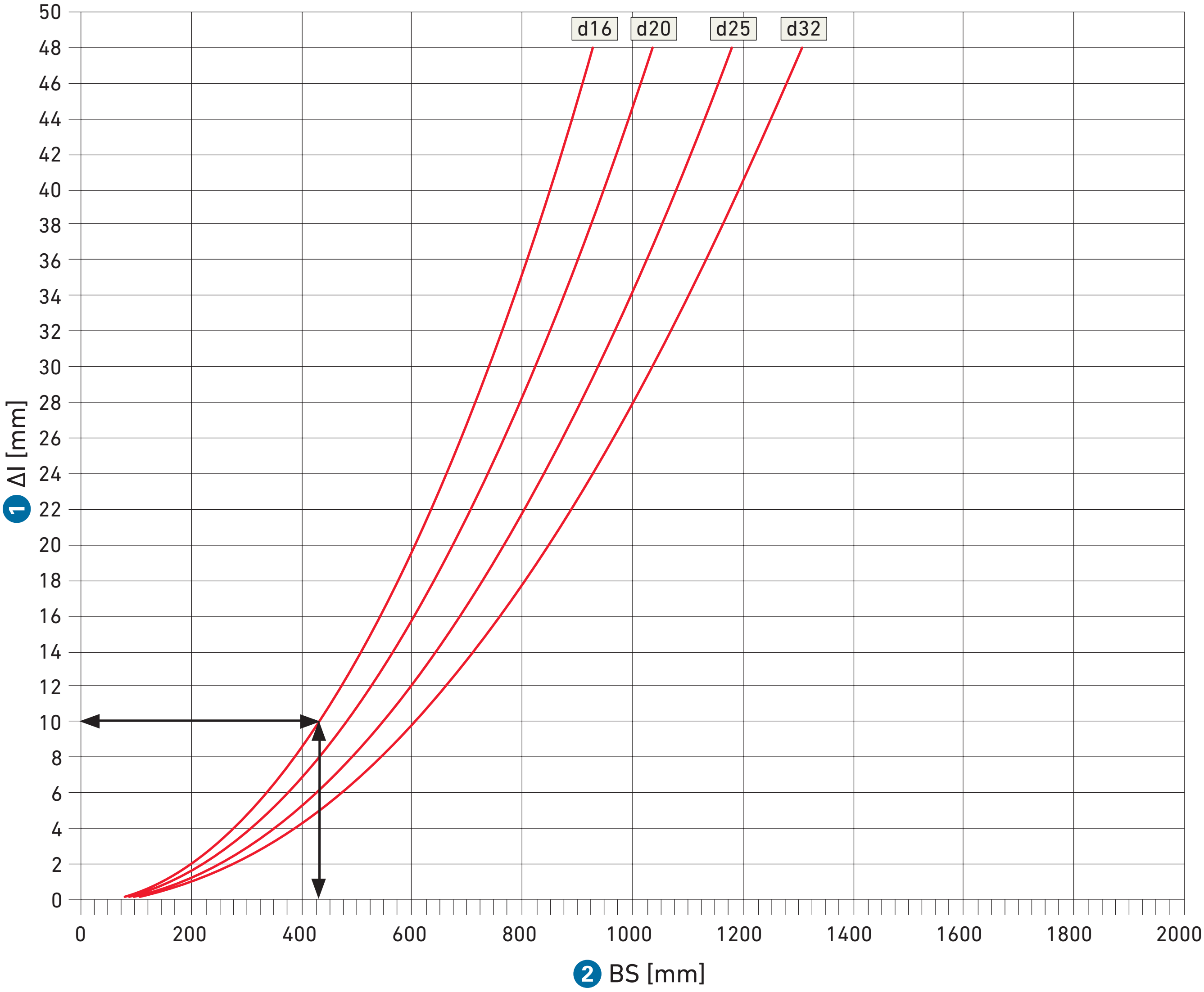
iFIT multilayer composite pipes (PE-RT)

The length of the flexible pipe leg is derived from the pipe's change in length:

How to read the table

PE-RT pipe, dimension	d16
Material constant C	33
Change in length Δl	10.08 mm

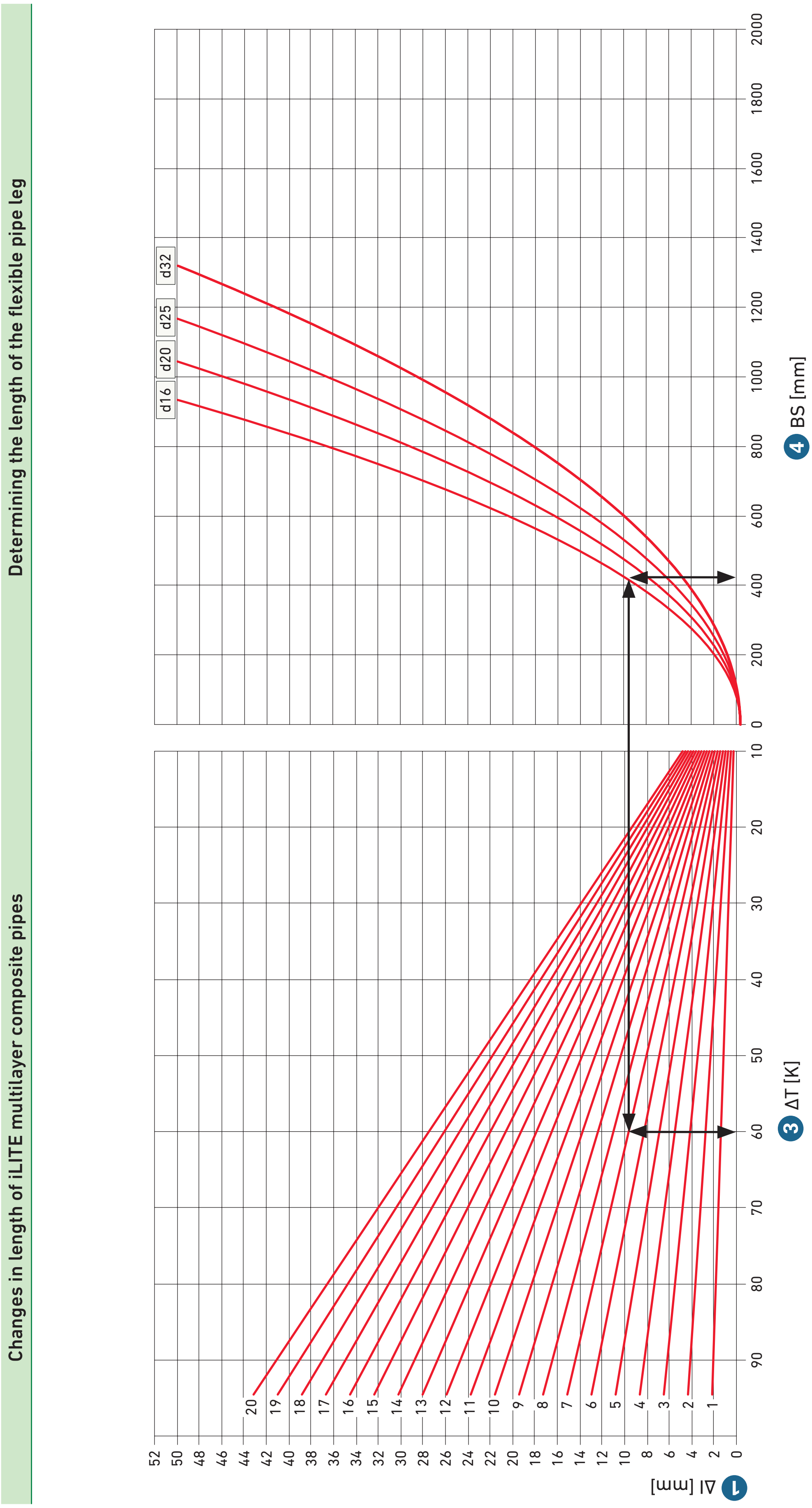
BS = 419.1 mm



GV.13
Length of flexible pipe leg
1 Change in length of the pipe
2 Length of flexible pipe leg

Graphic determination of the length of flexible pipe leg – iFIT multilayer composite pipes (PE-RT)

The length of the flexible pipe leg can be determined with the two combined diagrams.



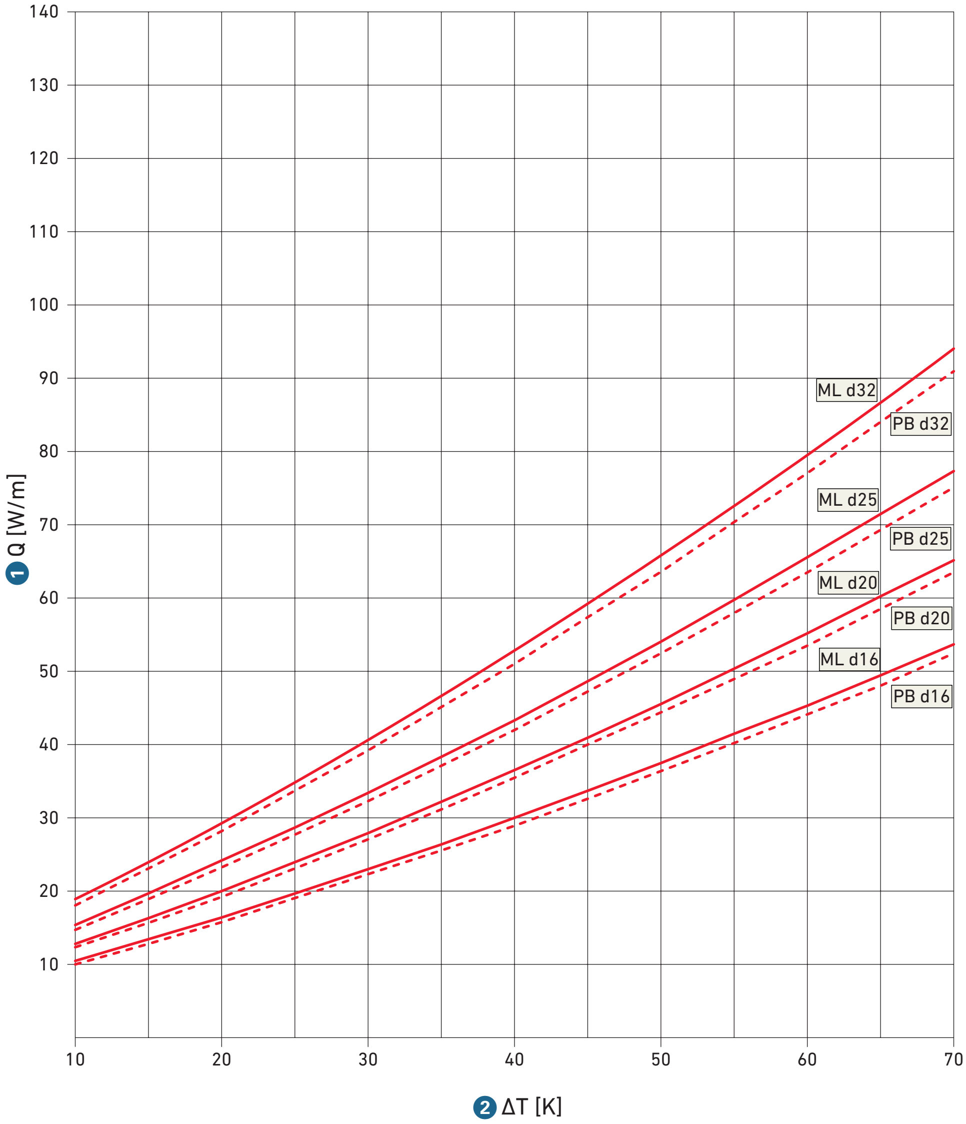
How to use the diagram

1. Read off temperature difference ❸.
2. Select the length of pipeline ❷.
3. Read change of length ❶.
4. Read off the pipe dimension.
5. Read length of the flexible pipe leg ❹.

❶ Change in length
❷ Length of pipeline
❸ Temperature difference
❹ Length of flexible pipe leg

4.7 Heat emission – iFIT pipes

iFIT PB and multilayer composite pipe

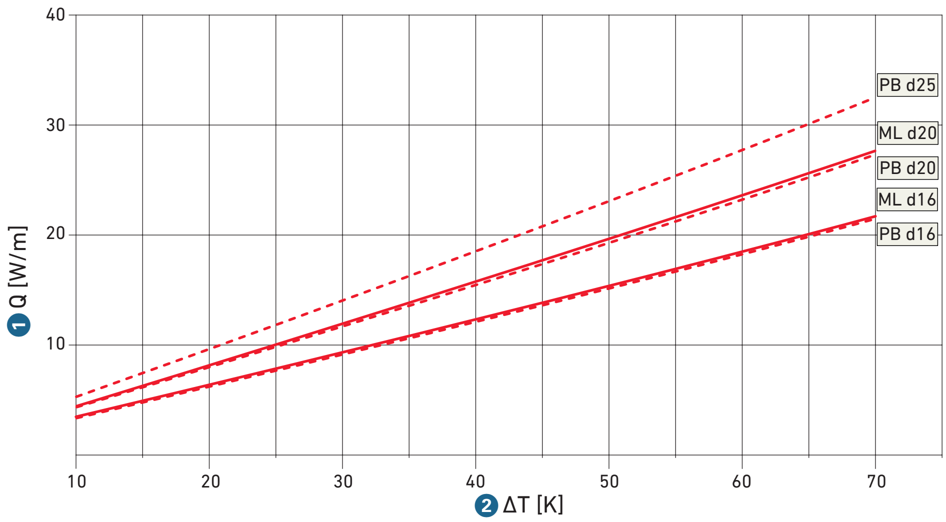


GV.14
Heat emission – iFIT PB and multilayer composite pipe

1 Heat emission
2 Temperature difference
ML Multilayer composite pipe
PB PB pipe

V

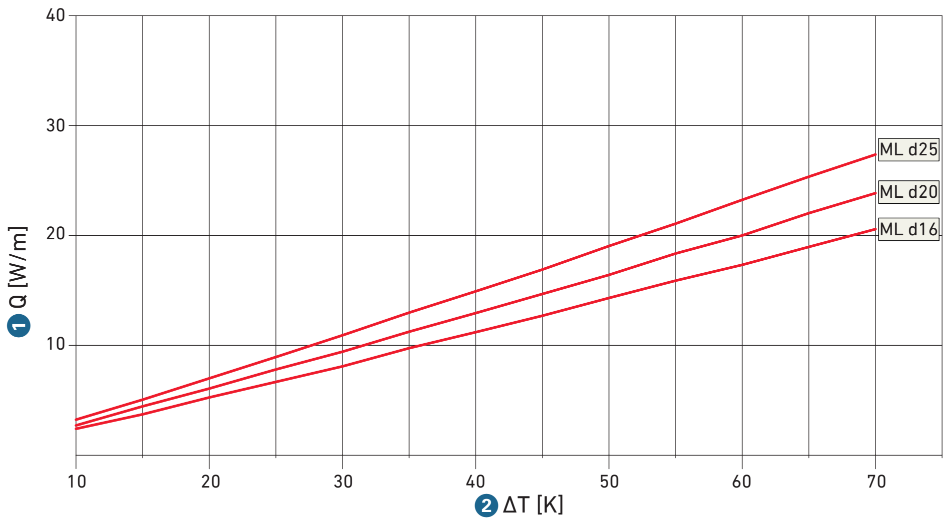
iFIT PB and multilayer composite pipe, with PE protective conduit



GV.15
Heat emission – iFIT PB and multilayer composite pipe, with PE protective conduit

1 Heat emission
2 Temperature difference
ML Multilayer composite pipe
PB PB pipe

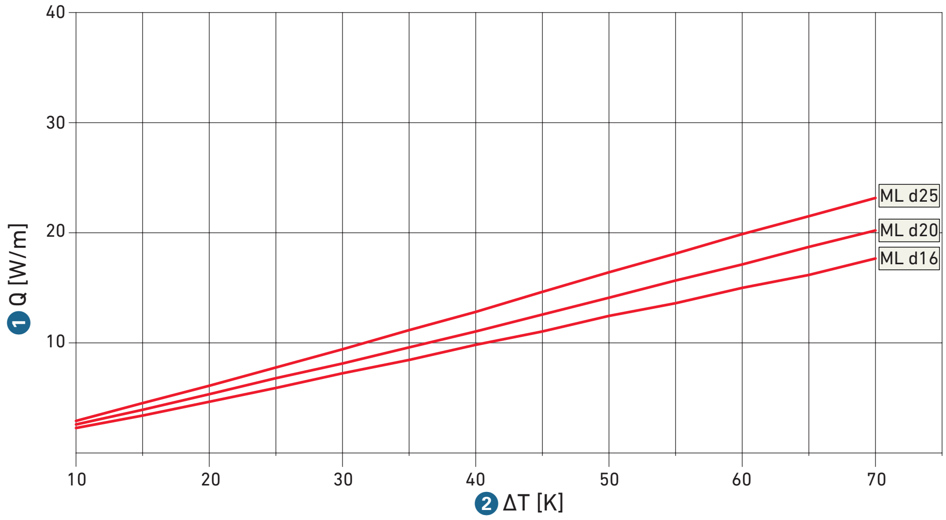
iFIT multilayer composite pipe, pre-insulated, 6 mm



GV.16
Heat emission – iFIT multilayer composite pipe, pre-insulated

Graph showing a 6 mm insulation with WLG 040
1 Heat emission
2 Temperature difference
ML Multilayer composite pipe

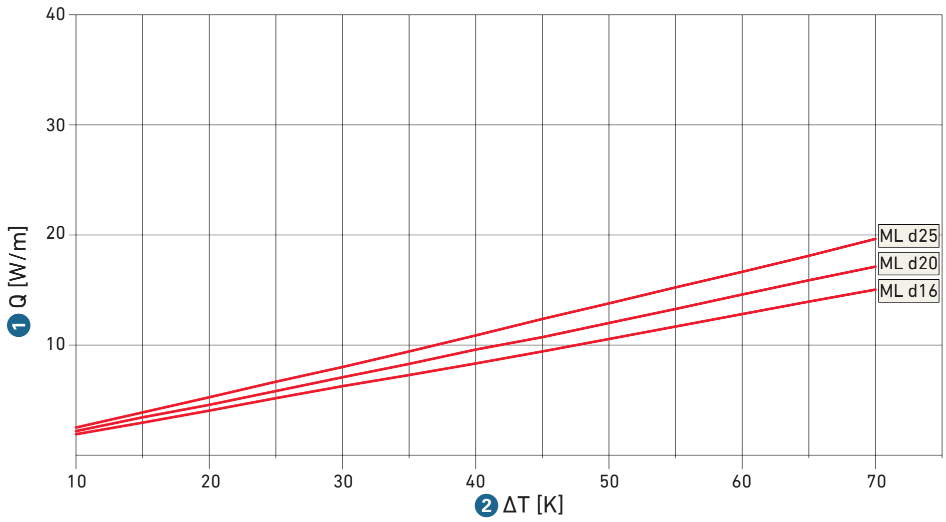
iFIT multilayer composite pipe, pre-insulated, 9 mm



GV.17
Heat emission – iFIT multilayer composite pipe, pre-insulated

Graph showing a 9 mm insulation with WLG 040
1 Heat emission
2 Temperature difference
ML Multilayer composite pipe

iFIT multilayer composite pipe, pre-insulated, 13 mm



GV.18
Heat emission – iFIT multilayer composite pipe, pre-insulated

Graph showing a 13 mm insulation with WLG 040
1 Heat emission
2 Temperature difference
ML Multilayer composite pipe

5 Insulation according to EnEV 2017

Insulation
General information on insulation:
➨Part IV 'Plan', Section 'Insulation, Fire protection'

Country-specific regulations

The insulation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.

☑ When it comes to insulation methods, compliance with the applicable rules and regulations is mandatory.

The Energy Saving Ordinance (EnEV) requires limiting the heat output of heat distribution and hot water pipes. It replaces the previous Heating Installations Ordinance (HeizAnlV) and the Thermal Insulation Ordinance (WSchVO). The EnEV has been valid in **Germany** for building applications or submitted building notices since 01.02.2002, the current, revised version is the EnEV 2017. For new construction and modernization of heat distribution and hot water pipes and their fittings in buildings, these insulation regulations must be observed.

5.1 Insulation requirements of the EnEV 2017

The requirements are defined in table [TV.26] defined:

- Heating pipes and their fittings: according to lines 1 to 2
- Hot water pipes and fittings: according to lines 1 to 5
- Refrigerant distribution/chilled water lines: according to line 8

TV.26 **Insulation requirement of the EnEV 2017, Table 1**

Minimum insulation requirement	Rows	Type of pipes and fittings	Minimum thickness of the insulation layer [mm]*.
100%	1	Inner diameter d_i 22 mm	20
100%	2	Inner diameter$_{di}$ over 22 mm to 35 mm	30
100%	3	Inner diameter$_{di}$ over 35 mm to 100 mm	= Internal diameter
100%	4	Inner diameter d_i over 100 mm	100
50%	5	Lines and fittings according to lines 1 to 4 In wall and ceiling penetrations, in the intersection area of lines, at line connection points, at central line network distributors	50% of the requirements of lines 1 to 4
50%	6	Heat distribution lines according to lines 1 to 4, which were installed after January 31, 2002 in building components between heated rooms of different users	50% of the requirements of lines 1 to 4
6 mm	7	Lines according to line 6 in the floor structure	6
6 mm	8	Refrigeration distribution and chilled water piping and fittings of room air conditioning and air conditioning refrigeration systems.	6

Source: EnEV 2017, Table 1, Annex 5 (to Section 10 (2), Section 14 (5) and Section 15 (4))
* related to a thermal conductivity of λ = 0.035 W/(m K)

Supplementary information

1.

In cases of §10 par. 2 and §14 par. 5:

→ Comply with the requirements of lines ❶ to ❼, unless otherwise specified in other provisions of the EnEV 2017.

In cases of §15 par. 4:

→ Comply with the requirements of line ❽, unless otherwise specified in other provisions of the EnEV 2017.

If in cases of §14 par. 5 heat distribution and hot water pipes border on outside air:

→ Insulate these pipes with twice the minimum thickness according to lines ❶ to ❹ϟ

2.

In cases of §14 par. 5:

→ [TV.26] **not** apply insofar as heat distribution lines according to lines ❶to❹ are located in heated rooms or in building components between heated rooms of a user and their heat output can be influenced by exposed shut-off devices.

In cases of §10 par. 2 and §14 par. 5:

→ Data in table [TV.26] do not apply to hot water pipes up to 3 liters, which are neither included in the circulation circuit nor equipped with electric trace heating and are located in heated rooms (stubs).

Although there are no legal requirements here, insulation should be used for reasons of corrosion protection, to prevent cracking and flowing noises, to insulate structure-borne noise and to reduce the thermal load.

3.

For materials with thermal conductivities other than 0.035 W/(m K):

→ Convert minimum thicknesses of insulation layers accordingly. For conversion and thermal conductivity, use the calculation methods and values contained in the recognized rules of technology.

Proof must be provided by the manufacturer.

4.

For heat distribution and hot water pipes as well as cold distribution and cold water pipes:

The minimum thicknesses of the insulation layers according to [TV.26] may be reduced if an equivalent limitation of heat dissipation or heat absorption is also ensured with other pipe insulation arrangements and taking into account the insulating effect of the pipe walls.

5.1.1 Minimum thickness of insulation layers

The minimum thickness of the insulation layers, which are based on the inner diameter di, are related to a thermal conductivity of λ = 0.035 W/(m K) (WLG 035) (see in the following tables: red highlights). The following tables show the minimum insulation thicknesses for different thermal conductivities λ.

TV.27 **Minimum thickness of the insulation layer for pipes with 100% requirement** ([TV.26], **line 1-4**)

Thermal conductivity λ [W/(m K)]	16 x 2.25 12	20 x 2.50 15	26 x 3.00 20	32 x 3.00 25	40 x 3.50 32
0,025	11	11	12	17	18
0,030	15	15	16	23	24
0,035	**20**	**20**	**20**	**30**	**30**
0,040	26	26	25	38	38
0,050	44	41	39	59	57

TV.28 **Minimum thickness of the insulation layer for pipes with 50% requirement** ([TV.26], **line 5-6**)

Thermal conductivity λ [W/(m K)]	16 x 2.25 12	20 x 2.50 15	26 x 3.00 20	32 x 3.00 25	40 x 3.50 32
0,025	6	6	6	6	6
0,030	8	8	8	12	12
0,035	10	10	10	15	15
0,040	13	13	12	18	18
0,050	20	19	18	27	27

5.2 Insulation of drinking water pipes (cold)

Insulation of drinking water pipes (cold) is not covered by the EnEV 2017 covered. If there is no risk of legionella due to heating of the cold water, the insulation requirements according to DIN 1988-200 Table 8.

Insulation of drinking water pipes (cold)
➨ Part IV 'Plan', Section 'Insulation, Fire protection', Chapter [1.3] 'Insulating drinking water pipes (cold)')

However, in order to minimize the risk of legionella, the insulation thicknesses according to EnEV 2017, Annex 5, Table 1 in conjunction with DVGW W 551 and DVGW W 553 are recommended. During stagnation periods, even insulation cannot provide sufficient protection against heating.

Actions:

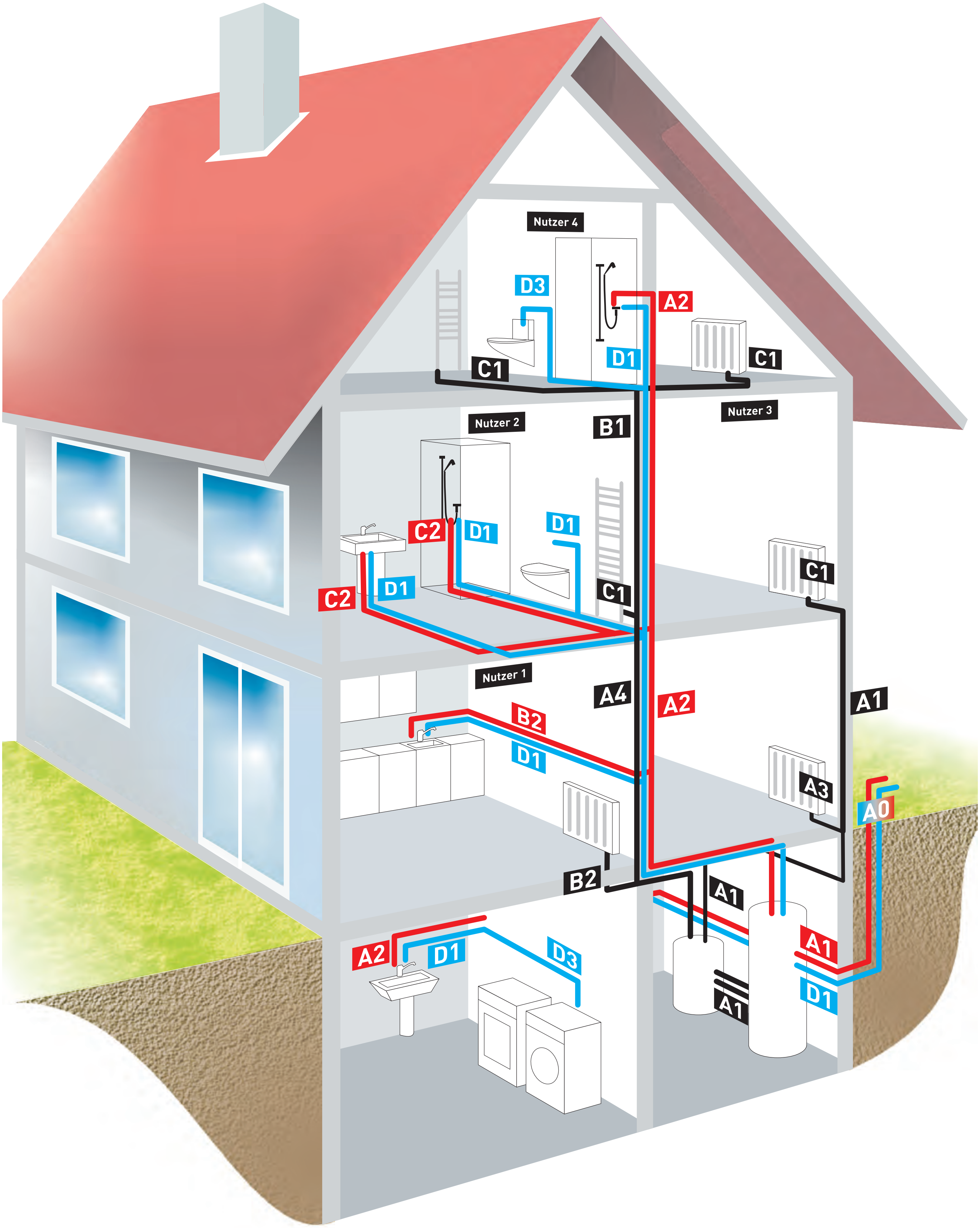
→ Protect cold drinking water systems from inadmissible heating and, if necessary, condensation.

→ Locate cold-flowing potable water lines at a sufficient distance from heat sources. If this is not possible, insulate the pipes so that the heating does not adversely affect the drinking water's quality.

Inadequately insulated cold water pipes can also cause condensation to form on the surface of the insulation layer, and unsuitable materials can become damp through. Therefore, closed-cell or comparable materials with high water vapor diffusion resistance should be used. All joints, cuts, seams and end points must be sealed water vapor-tight.

5.3 Application

Due to these insulation regulations, heating and hot water pipes and their fittings in single-family and multi-family houses must be insulated, as shown in the following examples.



TV.29 **Heating and hot water pipes according to EnEV 2017**

Area	Installation situation pipelines	Insulation requirements [mm], for WLG 035
A0	• Heat distribution lines laid directly adjacent to the outside air	200% insulation
A1	• In exterior walls • In unheated rooms • Basement distribution pipelines	100% insulation ([TV.26], line 1 to 4)
A2	• Hot water pipes with/without circulation pipes • Circulation pipelines • Hot water pipes in basements with/without electrical trace heating	
A3	• Heating pipes in the room's floor structure intended for permanent residence of persons, against unheated rooms or ground or outside air.	
A4	• Distribution lines for the supply of several parties	
B1	• Pipes between heated rooms of different users	50% minimum insulation requirement ([TV.26], line 5 to 6)
B2	• Pipes and fittings in wall and ceiling openings • In areas where pipes are crossing • At pipe connection points • At pipe connection points • For central line network distributors	
C1	• Heating pipes in the floor structure between heated rooms of different users	6 ([TV.26], line 7 to 8)
C2	• No requirements for the minimum thickness of the insulation layer are imposed on heat distribution lines located in heated rooms or in components between heated rooms of a user and their heat emission can be influenced by exposed shut-off devices • Hot water pipes up to the inner diameter of 22 mm, which are neither included in the circulation circuit nor equipped with electric trace heating, are also exempt from these requirements	No requirement* (see "Supplementary information" in [TV.26])

* **NOTE:** This type of installation does not meet sound insulation requirements (prevention of structure-borne sound transmission). The thermal mobility of the pipeline (linear expansion) must also be ensured. Insulation is required to prevent structure-borne noise, cracking and flowing noises and the heating of other components. This is therefore recommended from a construction and economic point of view, even in this case, although the regulation text of the EnEV 2017 does not mandatorily require this.

TV.30 **Cold water pipes according to EnEV 2017**

Area	Installation situation pipelines	Insulation requirements [mm], for WLG 035
D1	• Pipes next to hot water pipes • Pipes in wall recesses next to hot water pipes • Pipes in the duct next to hot water pipes	10
D2	• Lines freely laid in heated room	6
D3	• Lines freely laid in unheated space • Pipes in the duct without hot water pipes • Lines in the wall slot, riser • Pipes on concrete ceilings	6

1. For materials with thermal conductivities other than 0.035 W/(m K):

→ Convert minimum thicknesses of insulation layers accordingly. For conversion and thermal conductivity, use the calculation methods and values contained in the recognized rules of technology.

Proof must be provided by the manufacturer.

2. Piping in areas subject to frost:

If pipelines are located in frost-prone areas, even insulation cannot provide sufficient and permanent protection against freezing during downtimes. They must be drained or otherwise protected (e.g. by trace heating). Details are regulated by the VDI guidelines VDI 2055 or VDI 2069.

3. In conjunction with DVGW W551 and DVGW W553 the insulation thicknesses according to EnEV 2017 are also recommended for **cold water pipes** to minimize the risk of legionella.

5.3.1 Application criteria applicable to pre-insulated iFIT pipes

Pipes d16 to d25 with 6 mm insulation

- Consisting of pipe and insulation
- Delivery in a coil, 50 m long (25 m for dimension d25)
- Concentric pipe insulation made of polyethylene foam with closed-cell material structure
- Insulation thickness 6 mm, WLG 035
- With durable, seamless foil coating, colour: white
- Building material class E

Suitable for cold drinking water pipes according to DIN 1988-2 (Table 9) and for central heating pipes in the floor structure between heated rooms of different users according to EnEV 2017 (Annex 5, Table 1, Line 7) as well as cold distribution and cold water pipes according to EnEV 2017 (Annex 5, Table 1, Line 8). In addition, uninterrupted impact sound insulation is necessary.

Pipes d16 to d25 with 10 mm insulation (50% EnEV)

- Consisting of pipe and insulation
- Delivery in a coil, 50 m long (25 m for dimension d25)
- Concentric pipe insulation made of polyethylene foam with closed-cell material structure
- Insulation thickness 10 mm, WLG 035
- With durable, seamless foil coating, colour: white
- Building material class E

Suitable e.g. for heating and hot water pipes with insulation requirements 50% according to EnEV 2017 (Annex 5, Table 1, Lines 5 and 6). In order to minimise the risk of legionella, the insulation thicknesses according to EnEV 2017 in conjunction with DVGW W551 and DVGW W553 are also recommended for cold water pipes. In addition, uninterrupted impact sound insulation is necessary.

6 Fire protection

> **Fire protection**
> See the legal requirements as they apply to fire protection (prevention of the transmission of fire and smoke to other fire compartments) in the amended state building codes and the introductory decrees of technical building regulations (ETB).
> General information on fire protection:
> ➨ Part IV 'Plan', Section 'Insulation, Fire protection'

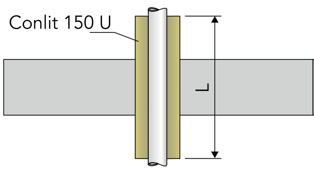
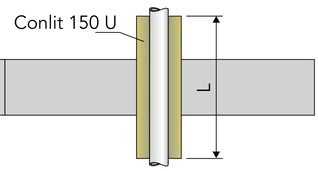
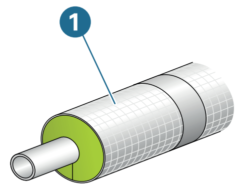
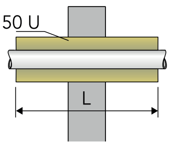
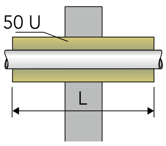
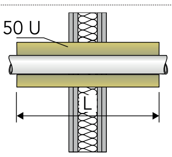
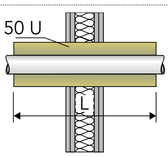
> § **Country-specific regulations**
> The insulation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.
> ☑ When it comes to insulation methods, compliance with the applicable rules and regulations is mandatory.

6.1 Implementation with Rockwool

R30 to R90 pipe penetrations for JRG installation systems with non-combustible media, e.g. drinking water, heating

> **Fire protection with Rockwool**
> For more information, see the Rockwool Planning Guide and the Rockwool website.

TV.31 **Components and implementation**

Component F 30 to F 90 **Thickness [mm]**	F 30	F 60 / F 90	
Solid ceiling min. 150	 L ≥ 1000 mm; WD 2)		 1 ROCKWOOL 800 / Teclit PS Cold Minimum thickness: 30 mm
Solid wall min. 100	 L ≥ 1000 mm; WD 2)		
Lightweight partition min. 100	 L ≥ 1000 mm; WD 2)		

Design variant according to ROCKWOOL abP P-3276/4140-MPA BS.

TV.32 **System and components**

System	Pipe dimension	Conlit 150 U		ROCKWOOL 800 [1), 2), 3)] Teclit PS Cold [1), 2), 3)]			
	Diameter, outside Da [mm]	Type [3)]	Insulation thickness [4)] s [mm]	Core drilling THK [mm]	EnEV 100%, warm, type	EnEV 50%, warm, type	DIN 1988-200, cold, type [3)]
iFIT PE-HD/Al/ PE-RT [5)]	16	16/22	22	60	18/20	18/20	18/20
	20	20/20	20	60	22/20	22/20	22/20
	25	25/17,5	17,5	60	28/20	28/20	28/20
	32	32/24	24	80	35/30	35/20	35/30

Notes and special installation conditions

1) In individual cases, the minimum insulation thickness that can be supplied is specified.

2) The insulation shell ROCKWOOL 800 or Teclit PS Cold can be used as further insulation.

3) For cold pipes, a vapor barrier must be installed according to DIN 1988-200. Therefore, only use fire protection pipe shell Conlit 150 U, insulation shell ROCKWOOL 800 or Teclit PS Cold.

4) Insulation thickness after EnEV 50% as well as according to DIN 1988-200 suitable for core drill diameter DK

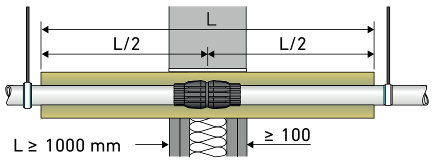
5) Sheathing (such as protective pipes or factory insulation) must be removed in the lead-through area.

All boundary conditions of the specified general building inspection test certificates (abP) must be taken into account.

R30 to R120 partitioning in solid walls, lightweight partition walls and solid ceilings

Further instructions for installing the JRG pipe connector in wall and ceiling penetrations:

➨ starting at P P-3726/4140-MPA BS, Annex 19



GV.19
Assembly of the JRG pipe connector

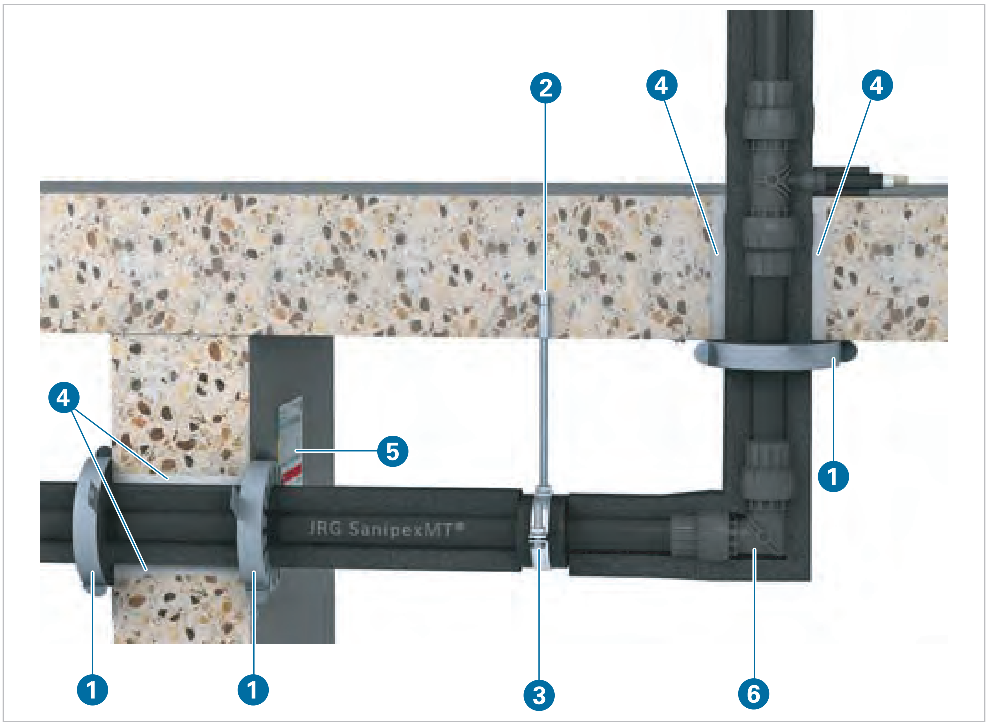
6.2 Implementation with BIS Walraven

6.2.1 BIS Pacifyre AWM II Fire Protection Sleeve

- with synthetic rubber, insulation up to ≤43 mm

Benefits

- Zero distance between identical cuffs possible
- Offset installation possible
- Flexible annular gap closure possible
- Suitable for installation in damp rooms
- Installation possible without additional fasteners, by bending over and inserting the lugs into the fresh concrete or mortar
- To be mounted on both sides of the wall or on the underside of the ceiling
- Complete system: Mounting material included in the scope of delivery



GV.20
Product overview

1. Pipe penetration seal with BIS Pacifyre AWM II fire protection collar
2. Fire-tested anchor technology, e.g. with BIS drop-in anchor, BIS metal expansion anchor, etc.
3. Fire protection tested pipe clamps, e.g. with BISMAT Flasch, BISMAT 2000 or BIS HD heavy duty clamp incl. fire protection tested threaded rod/pin (≥M8)
4. Residual gap closure with Tangit FP 440 Fire Protection Joint Filler or BIS Pacifyre FPM Fire Protection Mortar or BIS Pacifyre SML/MLAR Strip
5. Marking all BIS Pacifyre pipe penetration seals with the BIS Pacifyre and Tangit FP universal label
6. Synthetic rubber insulation up to ≤43 mm thickness

Field of application and use

TV.33 **Application range according to ABZ Z-19.17.-1194**

Component	Wall	≥100 mm
	Ceiling	≥150 mm
Pipe system	iFIT	to d32

Approved insulation

- Synthetic rubber insulation up to 43 mm thickness in the area of wall and ceiling penetration
- PE sound insulation hose up to 4 mm thickness
- One layer of BIS Pacifyre SML/MLAR Strip in full component thickness (sound insulation)

§ **ABZ**

☑ The installation guidelines and specifications of the ABZ must be observed.

More information

For further information, please refer to the **BIS Walraven + GF special brochure**, the **BIS Planning Helper** and the BIS Walraven website.

TV.34 **Application**

Dimension of pipe	**Cuff size, Art.no.**					
Diameter, outside Da [mm]	Without insulation	Item no.	EnEV 50%,	Item no.	EnEV 100%	Item no.
16	15	213 4 032032	40	213 4 040042	63	213 4 063065
20	20	213 4 032032	40	213 4 040042	63	213 4 063065
25	25	213 4 032032	63	213 4 063065	90	213 4 090092
26	25	213 4 032032	63	213 4 063065	90	213 4 090092
32	32	213 4 032032	63	213 4 063065	90	213 4 090092

TV.35 **Partitioning in ceilings and walls**

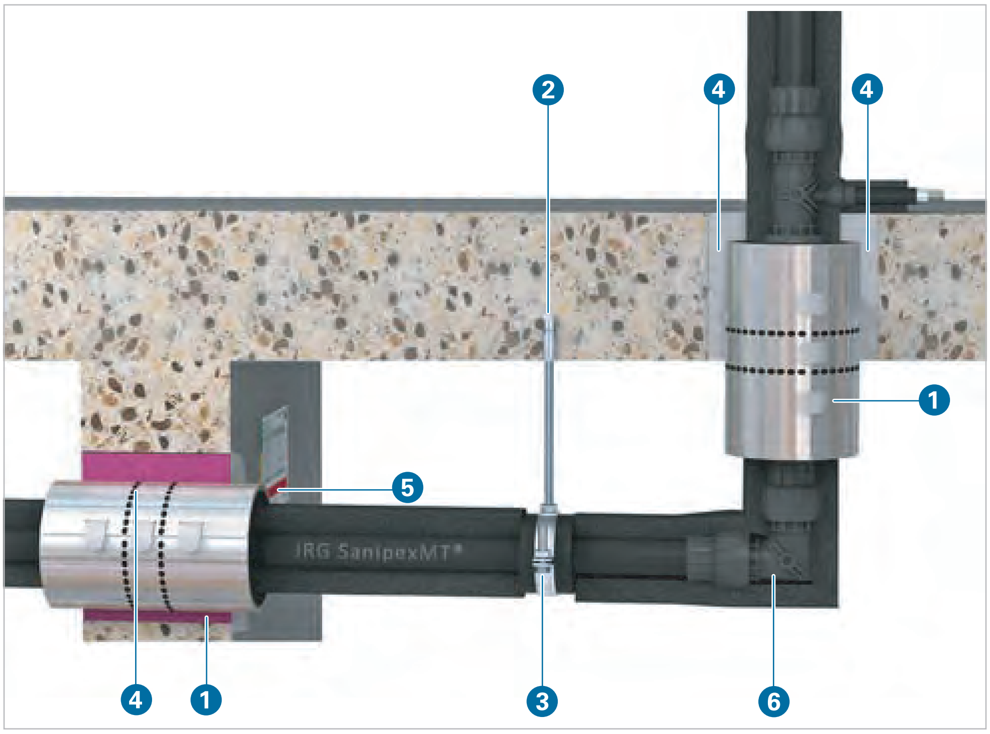
Partitioning in ceilings	Partitioning in walls
	

6.2.2 BIS Pacifyre MK II Fire Protection Sleeve

- with synthetic rubber, insulation ≤44 mm

Benefits

- Zero distance between identical cuffs possible
- No tools, no drilling, therefore very easy to install
- Place the sleeve around the pipe, close it - done!
- Only one sleeve for wall penetration seals up to 150 mm wall thickness
- Sound insulation test certificate from IBP (Fraunhofer Institute)
- High flexibility due to low protrusions



GV.21
Product overview

1. Pipe penetration seal with BIS Pacifyre MK II fire protection collar
2. Fire-tested anchor technology, e.g. with BIS drop-in anchor, BIS metal expansion anchor, etc.
3. Fire protection tested pipe clamps, e.g. with BISMAT Flasch, BISMAT 2000 or BIS HD heavy duty clamp incl. fire protection tested threaded rod/pin (≥M8)
4. Residual gap closure with Tangit FP 440 Fire Protection Joint Filler or BIS Pacifyre FPM Fire Protection Mortar or BIS Pacifyre SML/MLAR Strip
5. Marking all BIS Pacifyre pipe penetration seals with the BIS Pacifyre and Tangit FP universal label
6. Synthetic rubber insulation up to ≤44 mm thickness

Field of application and use

TV.36 **Application range according to ABZ Z-19.17.-1737**

Component	Wall	≥100 mm
	Ceiling	≥150 mm
Pipe system	iFIT	to d32

Approved insulation

- Synthetic rubber insulation up to 44 mm thickness in the area of wall and ceiling penetration

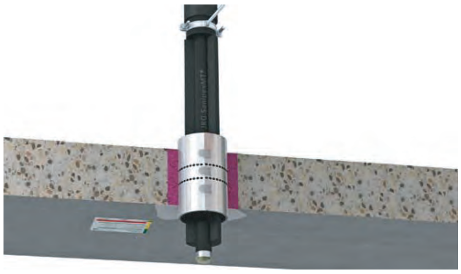
§ **ABZ**
☑ The installation guidelines and specifications of the ABZ must be observed.

More information
For further information, please refer to the **BIS Walraven + GF special brochure**, the **BIS Planning Helper** and the BIS Walraven website.

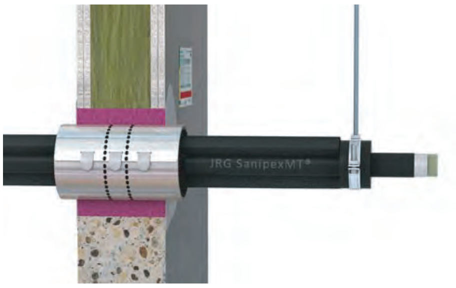
TV.37 **Application**

Diameter, tube	Diameter of cuff		Item no.	Recommended core drilling with Tangit FP 550	Recommended core drilling with BIS Pacifyre FPM Fire Protection Mortar
outside Da [mm]	inside [mm]	outside [mm]		[mm]	[mm]
16	15	40	215 1 015017	61	71
20	18	43	215 1 018020	61	71
25	24	55	215 4 024026	76	86
32	30	61	215 4 030032	81	91

Partitioning in ceilings



Partitioning in walls



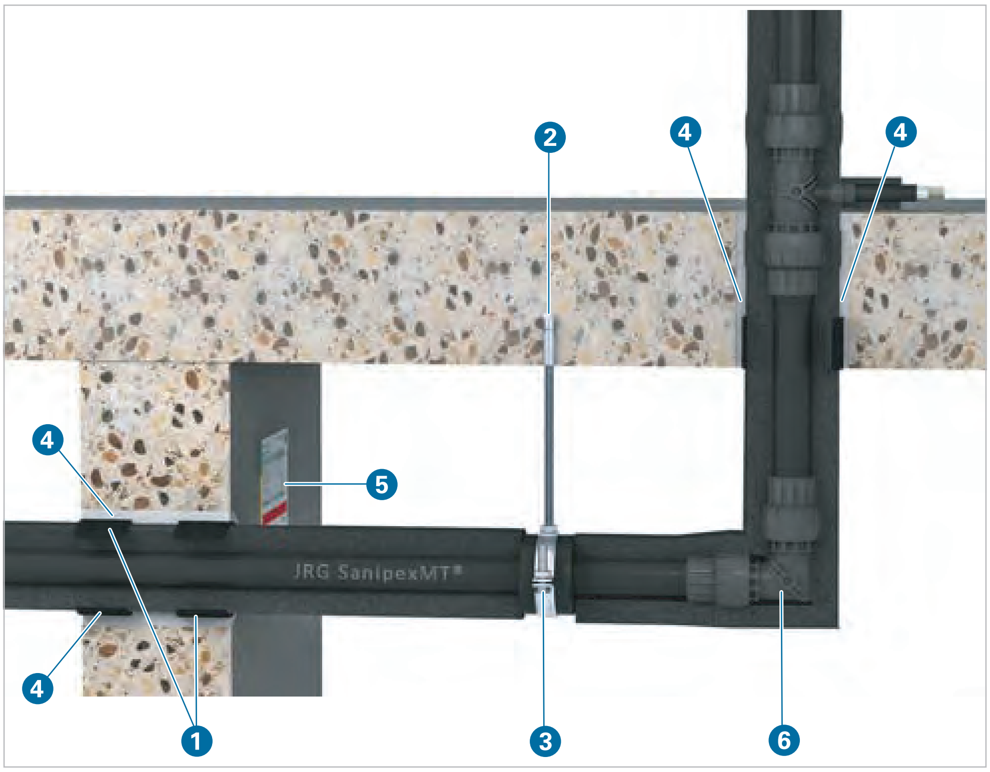
TV.38
Partitioning in ceilings and walls

6.2.3 BIS Pacifyre IWM III Fire Protection Sleeve

- with synthetic rubber, insulation ≤32mm

Benefits

- Art.no. 213 6 0510 125 or 213 6 050 625
- Zero spacing between identical drums possible
- No tools, no drilling required
- Easy and efficient processing: Wrap the tape around the tube, push it into the component - done!
- No offcuts, as free dimensional adjustment is possible on the construction site
- Low space requirement due to small number of layers; thus optimal for areas that are difficult to access
- Flush with wall/ceiling
- High flexibility due to self-adhesive tape
- Suitable for installation in damp rooms



GV.22
Product overview

1. Pipe penetration seal with BIS Pacifyre IWM III fire protection collar
2. Fire-tested anchor technology, e.g. with BIS drop-in anchor, BIS metal expansion anchor, etc.
3. Fire protection tested pipe clamps, e.g. with BISMAT Flasch, BISMAT 2000 or BIS HD heavy duty clamp incl. fire protection tested threaded rod/pin (≥M8)
4. Residual gap closure with Tangit FP 440 Fire Protection Joint Filler or BIS Pacifyre FPM Fire Protection Mortar or BIS Pacifyre SML/MLAR Strip
5. Marking all BIS Pacifyre pipe penetration seals with the BIS Pacifyre and Tangit FP universal label
6. Synthetic rubber insulation up to ≤44 mm thickness

V

Field of application and use

TV.39 **Application range according to ABZ Z-19.17.-1884**

Component	Wall	≥100 mm
	Ceiling	≥150 mm
Pipe system	iFIT	to d32

Approved insulation

- Synthetic rubber insulation up to 32 mm thickness in the area of wall and ceiling penetration
- One layer of BIS Pacifyre SML/MLAR Strip in full component thickness (sound insulation)

§ **ABZ**

☑ The installation guidelines and specifications of the ABZ must be observed.

More information

For further information, please refer to the **BIS Walraven + GF special brochure**, the **BIS Planning Helper** and the BIS Walraven website.

TV.40
Application

Diameter, tube	Pipes without insulation		Pipes with synthetic rubber insulation			
outside Da [mm]	Number of layers	Length [mm]	Number of layers	Strip length [mm] for insulation thickness D [mm]		
				D =13	D =19	D =25
iFIT						
16	1	76	1	157	195	233
20	1	88	1	170	208	245
25	1	104	1	186	223	261
32	1	126	1	208	245	283

TV.41
Partitioning in ceilings and walls

Partitioning in ceilings

Partitioning in walls

6.3 Implementation with Hilti

The partitioning of the iFIT system with flexible synthetic rubber insulation is covered by the Hilti CFS-B fire protection bandage.

The penetration seal of the iFIT system in conjunction with the Hilti fire protection bandage CFS-B is approved by the general building authorities (abZ) for the following applications Z-19.53 2218 for the following applications:

- Solid ceilings, thickness: ≥150 mm
- Solid walls, thickness: ≥100 mm
- Lightweight partition walls (LTW), thickness: ≥100 mm

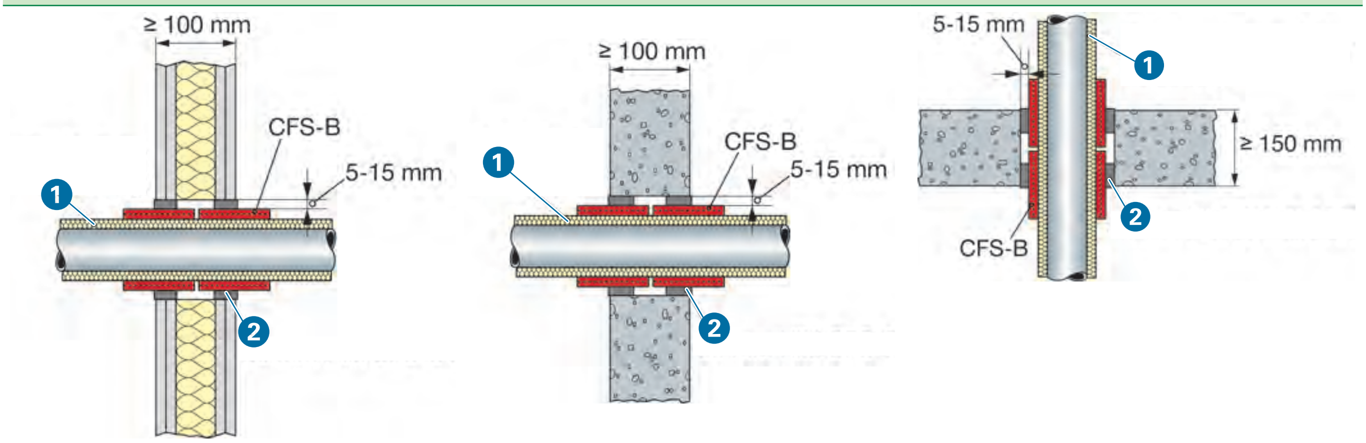
The iFIT system falls into pipe group D and can therefore be installed in the following configurations.

More information
Further information can be found in the **special brochure HILTI + GF**, in the **HILTI Planning Helper** and on the HILTI website: www.hilti.de

6.3.1 Configurations with Hilti fire protection bandage CFS-B

TV.42 **Installation options and details**

Lightweight partition	Solid wall	Solid ceiling



1 Synthetic rubber insulation
2 25 mm Hilti CFS-S ACR

TV.43 **Installation options and details with Hilti fire protection bandage CFS-B - wall**

iFIT [mm]	Walls [mm]		Ceiling [mm]	Details	
	LTW ≥100	Solid ≥100	Solid ≥150	Pipe group	Insulation thickness [mm]
16	•	•	•	D	8–32
20	•	•	•	D	8–32
25	•	•	•	D	8–32
32	Solutions possible with HILTI fire protection brick CFS-BL P or HILTI fire protection foam CFS-F X				

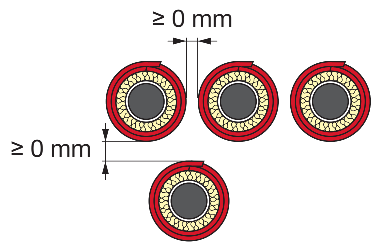
* 150 mm LTW/solid wall: min. insulation thickness 9 mm for pipe group C
** 200 mm solid wall: min. insulation thickness 9 mm for pipe group C

The remaining opening between the wall or ceiling and the insulated iFIT pipe must be completely filled with dimensionally stable, non-combustible building materials such as concrete, cement mortar (Hilti fire protection mortar CP636) or gypsum mortar to the thickness of the building component.

Optionally, a maximum 15 mm wide annular gap on both sides of the component may be filled to a depth of at least 25 mm with gypsum or Hilti Fire Protection Sealant CFS-S ACR.

6.3.2 Zero clearance with Hilti fire protection bandage CFS-B

iFIT pipes insulated with Hilti fire protection bandage CFS-B may be installed at zero distance from each other if they are installed in 150 mm thick solid components (wall, ceiling) or up to an outer pipe diameter of 40 mm in 100 mm thick solid components.



GV.23
Zero distance

7 Installation

Installation of pipelines

General technical information on installation types:

➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [13] 'Installation and attachment'

➨ Part V 'Build', Section 'Installation'

The iFIT System is suitable for the following types of installation:

- Surface or flush-mounted installations
- Installation in shafts and channels, on ceilings and on floors
- Installation in-wall, element, wood and lightweight constructions
- Installation in concrete (in the pipe-in-pipe system, with PB pipes)

7.1 Protection against environmental influences and building materials

System components flush-mounted or concealed behind a wall:

☑ In order to absorb thermally induced changes in length, to prevent the transmission of sound, to avoid the formation of condensation, to preclude heat dissipation, heat loss or to heat the medium and to protect from other building material influences, fittings or pipes must be covered with a suitable materials or they must be separated entirely from the structure of the building.

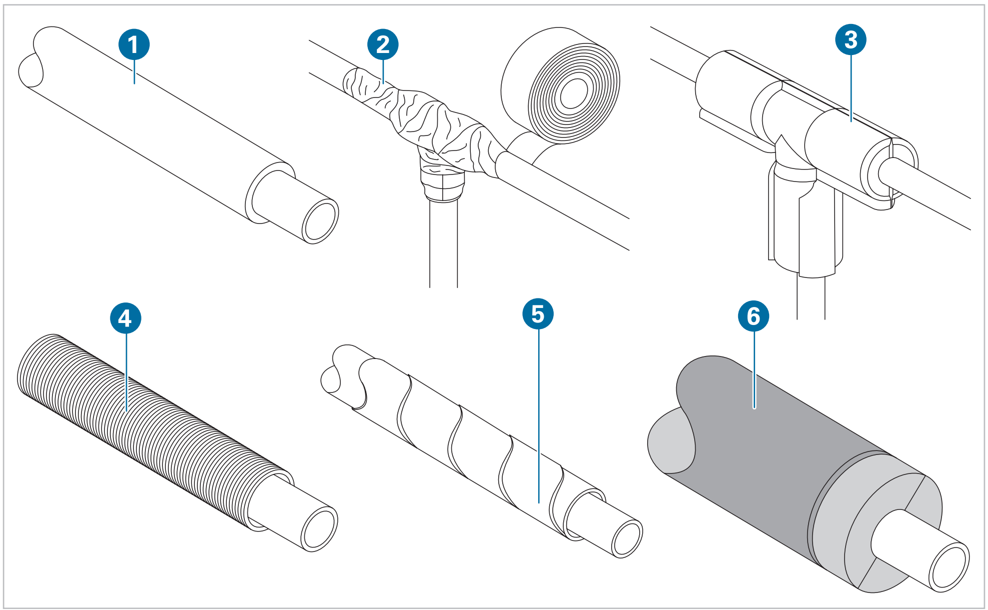
In permanently or periodically damp rooms, in areas subject to aggressive gases or other offensive environment and under uncontrollable environmental influences:

☑ Appropriate precautions must be taken to protect the installation, e.g. by using the following measures:
  - Use of suitable anti-corrosion tapes (e.g. supplied by KEBU, Gyso or DENSO)
  - Wrapping the pipe with heat-shrinkable materials

☑ Ensure that pipes and fittings are dry when mounting.

☑ All system components must be protected from direct contact with oils, greases, solvents, solvent-based adhesives (adhesive tapes), foams, bitumen (also bituminous membranes). Furthermore, the components must not contact building materials such as screed, concrete, mortar or plaster.

☑ Piping system and building structure must be separated from each other, for example, by using protective conduits made of PE, wrappings, insulating hoses or half shells with and without sheathing or a combination thereof.



GV.24
Safety measures

1. Pre-insulated pipe
2. Pipe with wrapping
3. Half shells
4. Protective conduit
5. Wrapping
6. Sheathing

7.2 Installation flush with wall

☑ Compliance with the general requirements for installing pipes flush with the wall.
☑ Threaded connections installed flush with the wall must be protected from moisture and contamination.

7.3 Installation in concrete ceiling

iFIT pipes inside the protective conduit may be cast in solid structures.
☑ Do not install or pour threaded connections or fittings into the pipe.
☑ Compliance with the general requirements for installing pipes in concrete ceilings is mandatory.
If the JRG iFIT installation accessories are used during the installation, the conditions can be met.
☑ Do not exceed 6 directional change for one 90° turn.
☑ Bending radius $R \geq 8 \cdot d$ must be maintained.
☑ The protective conduits must cover the entire length of the pipe.
☑ If installing in a cavity: Pipes must be secured properly, especially in the areas where directional changes take place.
☑ Make sure to prevent dirt from settling between the protective tube and the inner pipe.

7.4 Installation in a pipe shaft, basement distributor and riser pipes

☑ Compliance with the general requirements for installing pipes is mandatory.

Change in length, bending and 2D expansion loops, fixed and floating points
☑ When installing, observe the change in the length of the pipes, the resulting flexible pipe leg and 2D expansion loop, and the required fixed points.

7.5 Installation on top of a concrete ceiling

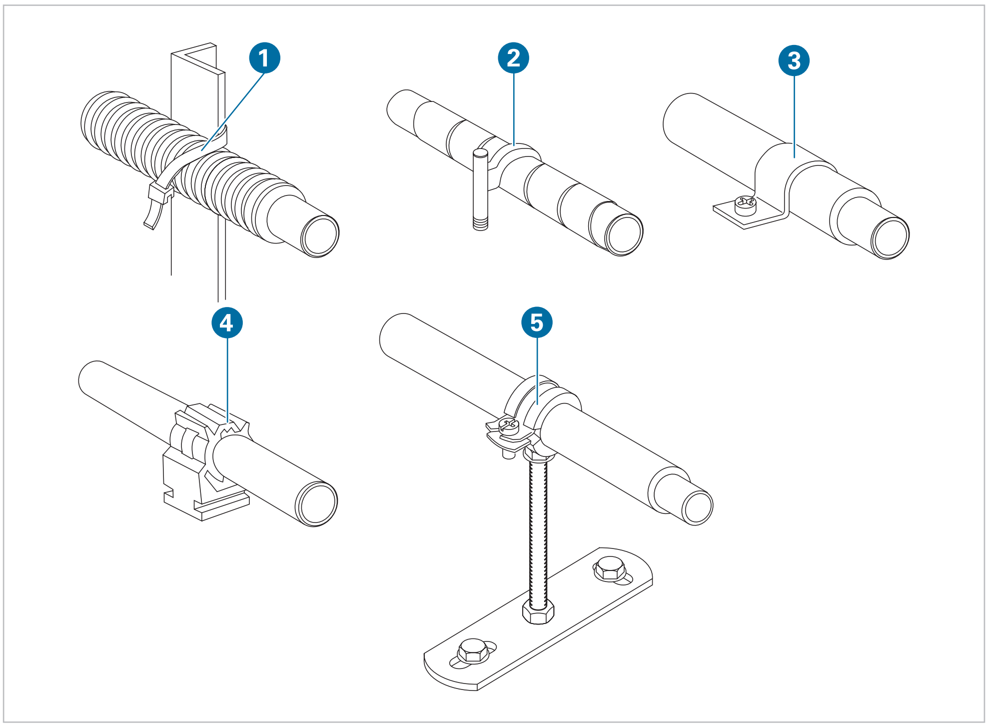
☑ Compliance with the general requirements for installing pipes on concrete ceilings is mandatory.

8 Attachment

Pipeline attachment
General information:
➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [13] 'Installation and attachment'

8.1 Attachment components

iFIT installations can be installed using attachment components from our systems or with commercially available fasteners.



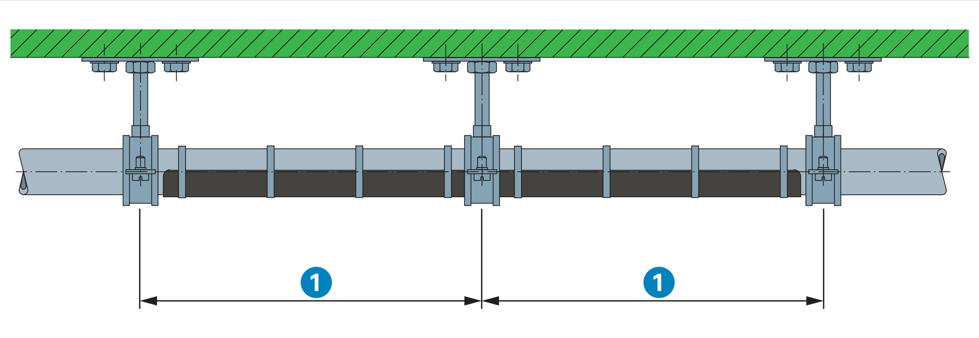
TV.44
Pipe attachments
1 Pipe binders
2 Dowel hooks
3 Pipe clip
4 Pipe clips
5 Pipe clips

8.2 Attachment using pipe clips

In general, iFIT pipelines **do not** require pipe saddles or protective conduits. However, when **PB pipes** are installed in **plain view**, it is recommended to use them.

> **NOTE! Damaged pipes due to excessive mounting distances!**
> Excessive spacing between the attachments can lead to deformation and weakening of the material as well as vibrations (formation of noise).

☑ Mounting distances BA must be maintained.
☑ Observe the change in length and allow for appropriate expansion compensation.



TV.45
Mounting distances (BA)
1 Mounting distance

TV.46
Mounting distances (recommended)

Pipe, Dimension		BA [m]			
		without pipe saddle		with pipe saddle	
d	DN	Multilayer composite pipe	PB pipe	Multilayer composite pipe	PB pipe
16	12	1.00	0.50	2.00	1.50
20	15/16	1.00	0.50	2.00	1.50
25	20	1.50	0.50	2.00	1.50
32	26	2.00	1.00	3.00	2.00

If installed flush, as in-wall installation and on concrete ceiling

When installing d16 to d25 iFIT multilayer composite pipes:
☑ A mounting distance of 80 cm must be maintained.
☑ Observe the change in length and allow for appropriate expansion compensation.

Stabilisation at increased mechanical loads

If an increase in mechanical stress must be expected in an installation zone or if the specified mounting distances (BA) cannot be maintained, it is recommend stabilising the pipes in additionally using iFIT multilayer composite pipes. For this purpose, commercial pipe saddles, protective conduit, etc. can be used.

Attachment when installing “pipe-in-pipe”

> **NOTE! Noise emissions due to pressure surges!**
> Pressure surges on quick-action fittings can cause noise emissions.
> → When using a “**pipe-to-pipe**” **installation** made of iFIT PB pipelines, appropriate precautions must be taken.

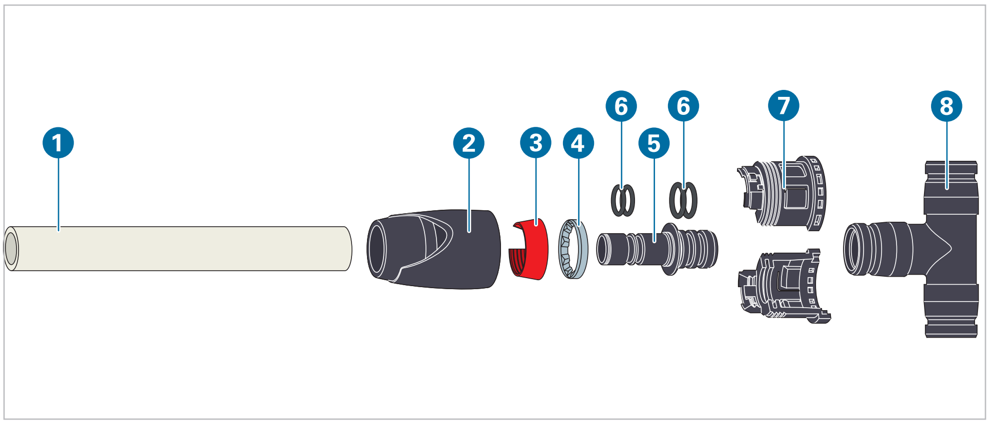
9 Connection

Jointing technology
General information:
➨ Part III 'The basics', Section 'Materials and jointing technology'

9.1 Push-fit

An iFIT tool is used for the processing and it is done manually. The iFIT push-fit guarantees a secure, fast and detachable connection. The modules are reusable. The adaptors can only be used once and must be disposed of afterwards. This also applies to adaptors if the clicking action was not completed.

An iFIT push-fit consists of several components:



GV.25
iFIT push-fit

1. Pipe (PB or multilayer composite pipe)

Adaptor

2. Adaptor housing
3. Clamping ring
4. Toothed ring
5. Insert
6. O-rings (EPDM)
7. Half shells
8. Module made of PPSU or low-lead, dezincification-resistant brass

The iFIT adaptor is plugged into a chamfered pipe end. The push-fit is then closed by clicking the module into the adaptor.

Inadmissible system connections

NOTE! Damage due to inadmissible system connections!

→ **Do not** connect iFIT system components with non-system components. Also, do **not** connect iFIT system components with INSTAFLEX-HWS components (e.g. HWS sleeves).

→ **Do not** penetrate iFIT system components through walls.

PB pipes from the INSTAFLEX assortment are **not** compatible.

→ When using iFIT, **only** PB pipes from the iFIT assortment.

V

10 Assembly

The **multilayer composite pipe** below is used to exemplify the assembly for pipes d16 to d32. The processing of PB pipes is analogous to the multilayer composite pipe. iFIT pipes can **not** be connected to JRG Sanipex fittings.

☑ Compliance with the tool's operating instruction is mandatory.
☑ Ensure the assembly tools are working properly.

10.1 Assembly of pipe and adaptor

WARNING! Risk of injury due to incorrect operation of the shears.
In the event of improper operation, there is an inherent risk of injury in the area of the pipe cutter's stops.
→ Use tools only as shown in the operating instructions.

WARNING! The sharp toothed ring of the iFIT-adaptor presents a risk of injury.
Inside the iFIT adaptor is the toothed ring.
→ When assembling the adaptor, do not reach into the iFIT adaptor with your fingers.

NOTE! Leaks in the pipe and water damage due to cutting to the incorrect length!
→ Make sure that the end of the pipe is straight and is perfectly circular.

The individual steps are illustrated on the next page.

Mounting the pipe and adaptor

Cutting the pipe

① → Cut the pipe at a right angle (90°) using a pipe cutter.
→ Visually inspect the end of the pipe.
- OK: correct / NO: wrong

☑ Pipe is cut at a right angle.

② → Chamfer and calibrate pipe end with chamfering tool.
→ Visually inspect the chamfering.
☑ Pipes are not deformed.
☑ After 1 to 2 revolutions of the tool, the circumferential chamfer must indicate > 1 mm.
→ Remove any adhering chips, even inside the pipe.

NOTE! Leaks due to improper assembly.
For pipes d16 × 2.0, d20 × 2.0, d25 × 2.5, d32 × 3.0 the following applies: **x** ≥ 1.0 mm
→ When chamfering, ensure that the chamfer dimension does not drop below the value **x**.
→ If the value **x** is too small: Check the tool.

Mounting the adaptor to the pipe

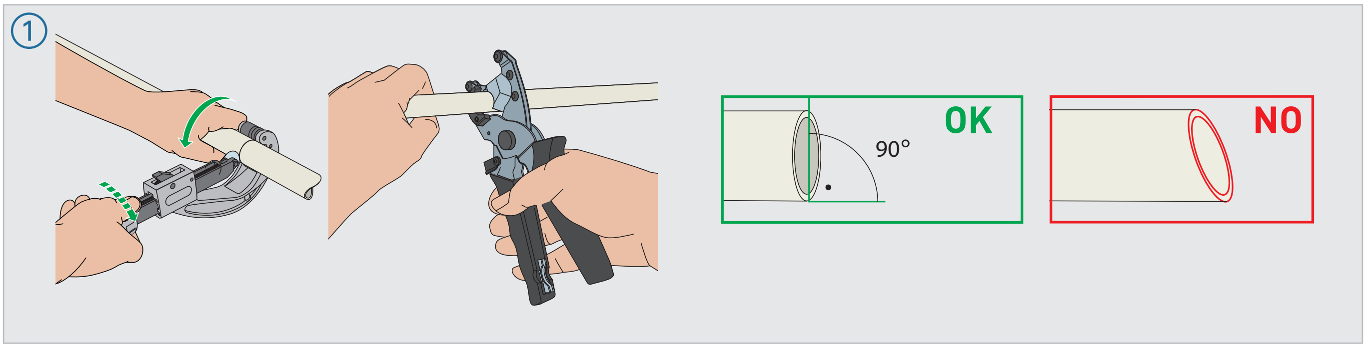
The adaptors are individually packed.
→ Do not open the adaptor packaging until immediately before use.
→ Remove the adaptor.

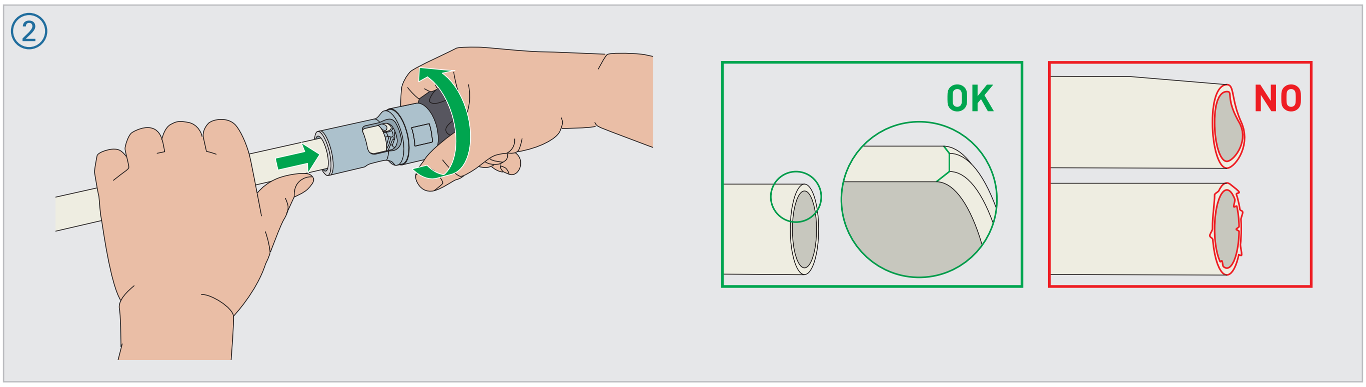
③ → Slide the adaptor onto the pipe end as far as it will go.
→ Make sure that the inspection window is completely filled by the pipe.

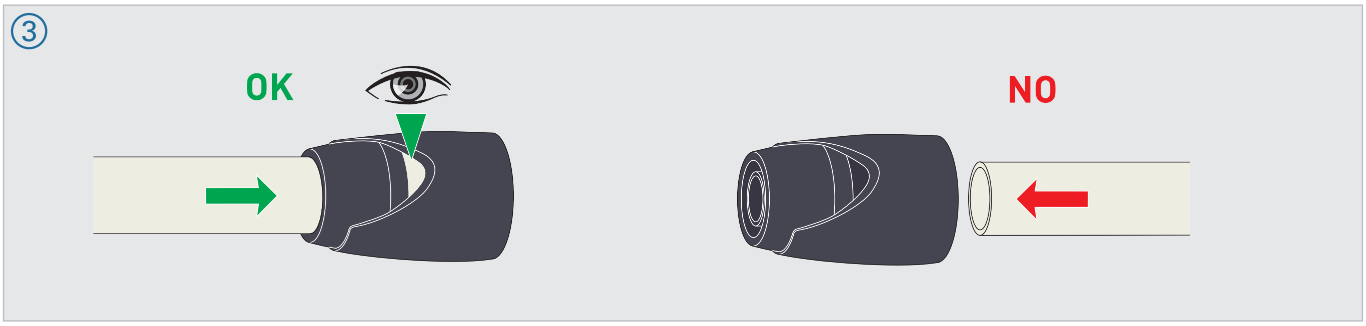
④ → Insert the module into the adaptor and push it in until a click is audible (audible check).
↳ The module is now fixed to the pipe.

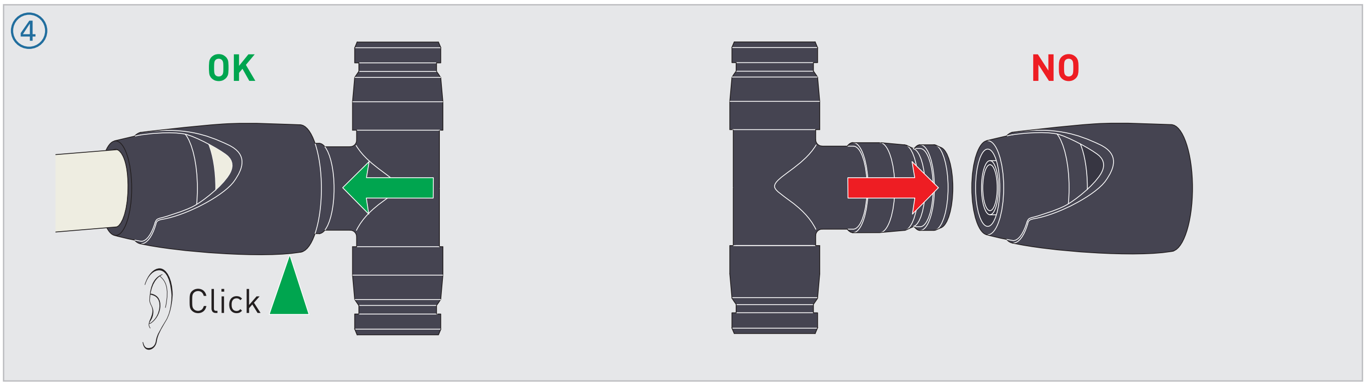
⑤ → Pull the pipe back to check the connection for completeness.
☑ When pulling the pipe back, the adaptor and module may slide apart up to **5 mm**.
Due to the dynamic holding mechanism, the pipe moves back slightly during operation or during the pressure test. Technically, this is not a defect of the assembly.

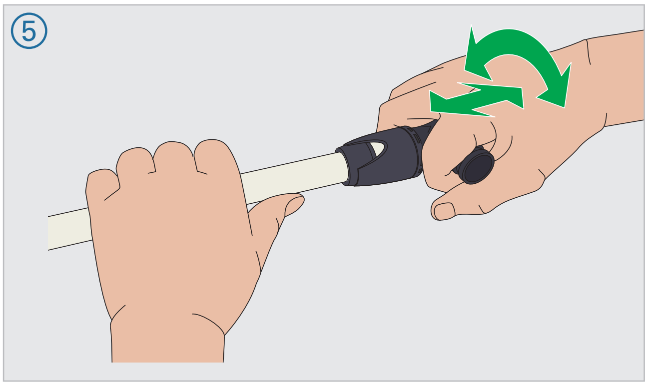
Assembly – Assembling the pipe and adaptor











10.2 Assembly of the pipe contour module

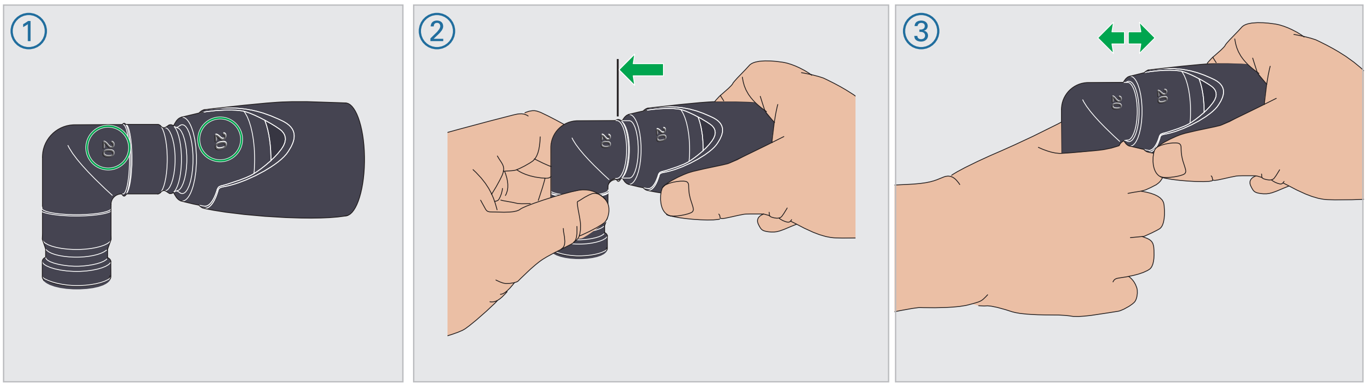
Mounting the adaptor to the pipe contour module

① → Make sure the dimension of the pipe contour module and adaptors are identical.
→ Insert a suitable adaptor onto the pipe contour of the module.

② → Insert the adaptor as far as it will go.

③ → Pull the pipe back to check the push-fit.
When pulling the pipe back, the adaptor and pipe contour module may slide back up to 5 mm. From a technical point of view is not a disadvantage.

Assembly – Assembling the adaptor to the pipe contour module



10.3 Disassembly of the push-fit

NOTE! Loss of warranty if the adaptors are open!
If **adaptors** were opened, e.g. during disassembly, all warranty claims will become null and void.
→ Do not use an opened **adaptor** anymore.

NOTE! When loosening the connection, the adaptor will be destroyed.
Disconnecting is possible, however, the adaptor will be destroyed.
→ For the next assembly: Use a **new adaptor**.

Removing the push-fit

① → Use a pipe wrench to secure the collar of the half shells.
→ Use a second pipe wrench to loosen the adaptor housing, rotating it counterclockwise.
↳ This will destroy the **housing**. Do not use the housing again.

② → Completely remove the adaptor housing.

③ → Remove the pipe from the insert.
→ Remove the adaptor housing, back-up ring and toothed ring from the pipe.

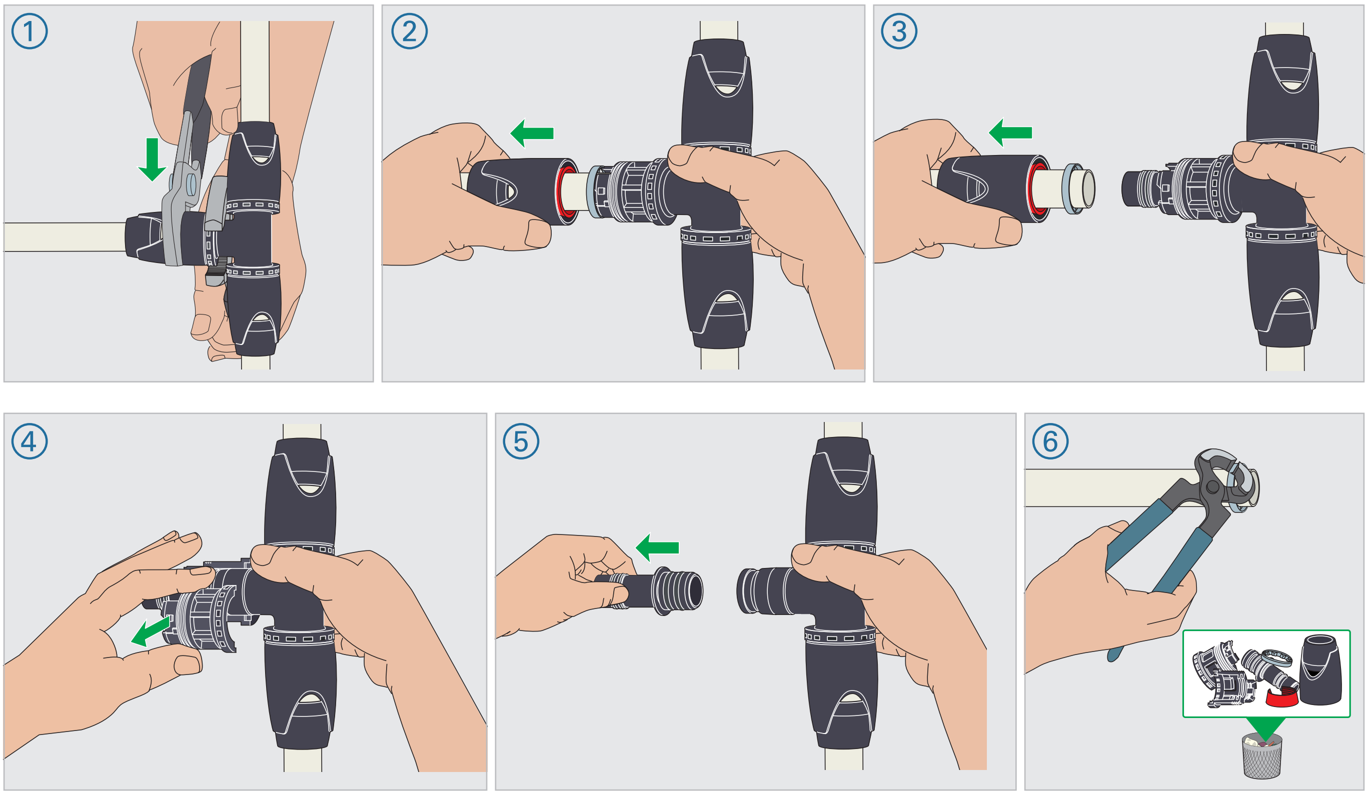
④ → Remove half shells of the adaptor from the insert of the module.

⑤ → Pull the insert of the adaptor out of the module.

⑥ → Loosen the clamping ring by squeezing it lightly with pliers and remove the ring from the pipe.
→ Dispose of all parts of the disassembled adaptor properly.

The **module** can be used again.
The pipe end must be shortened 6 mm (which corresponds to the insertion depth of the toothed ring) and calibrated again.

Removing the push-fit



11 Bending

11.1 Bending methods

Manual bending using a die

iFIT pipes can be bent by hand without the use of bending tools.

Hydraulic cylinders or bending springs

Commercially available hydraulic cylinders can be used, considering the following aspects:

☑ The shape of the bending gauge must correspond with the outside diameter of the iFIT pipe.
☑ Do not use internal bending springs.
☑ Ensure the bending radius is not less then 3.5 · d.

11.2 Manual bending using a die

11.2.1 iFIT PB pipe

iFIT PB pipes can be bent by hand without the use of bending tools.

In general, iFIT PB pipes can be installed with a bending radius of $\geq 8d_a$.

☑ Compliance with minimum bending radii listed to the table is mandatory.

TV.47
Minimum bending radii of the iFIT PB pipe

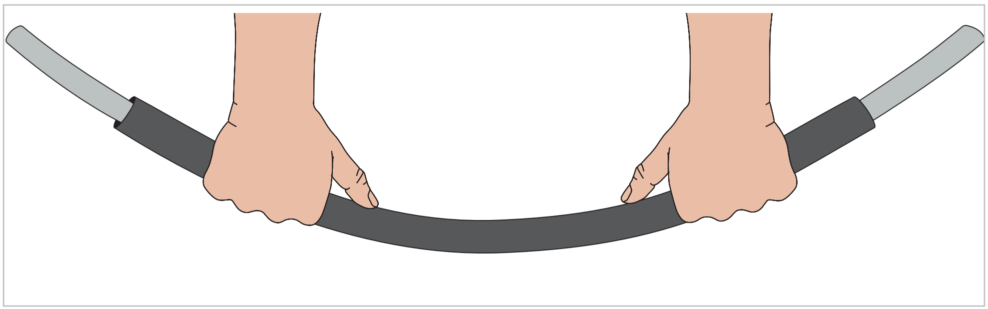
Designation	PB pipe		
Nominal width DN [mm]	12	15	20
Outside diameter d_a [mm]	16	20	25
Bending radius R, interchangeable: 8 · d_a [mm]	128	160	200

! **NOTE! Risk of damaging the pipes due to improper bending!**

→ Ensure the pipes do not kink when bending them.

11.2.2 iFIT multilayer composite pipe

iFIT multilayer composite pipes can be bent by hand without the use of bending tools.
For each dimension, however, an **outside pipe bending tool** is also available as an aid. iFIT multi-layer composite pipes can be easily shaped into the desired angle with the outside pipe bending tool.



GV.26
Bending the iFIT multilayer composite pipe

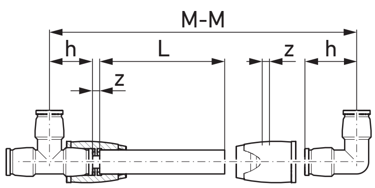
TV.48
Minimum bending radii of the iFIT multilayer composite pipe

Designation	Multilayer composite pipe (PE-RT / Al / PE)			
Nominal width DN	12	16	20	25
Outside diameter d_a [mm]	16	20	25	32
Bending radius R				
Bending radius R, with bending spring: 5 · da [mm]	80	100	200	-
Bending radius R, with tool: 3.5 · d_a [mm]	56	70	98	112

NOTE! Risk of damaging the pipes due to improper bending!
→ Ensure the pipes do not kink when bending them.
→ Do not use internal bending springs.

12 Fittings – Combinations – Dimensions

The exact dimensions of the centre-to-centre distances of the fittings are shown in the delivery program.

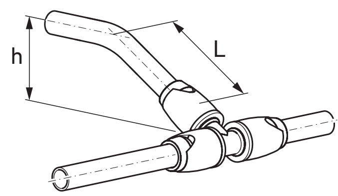


GV.27
Dimensions – Centre-centre spacings

M–M Dimension centre/centre

Pipe, Dimension	M–M [mm]	h (T90) [mm]	z Adaptor 1 [mm]	z Adaptor 2 [mm]	h 90° angle	Pipe dimension L [mm]	Recommended min. pipe length [mm]
d16	500	31	5.0	5.0	36	423	60
d20	500	31	5.0	5.0	36	423	60
d25	500	45	8.0	8.0	54	385	70
d32	500	45	8.0	8.0	54	385	80

90° elbow/pipe bend

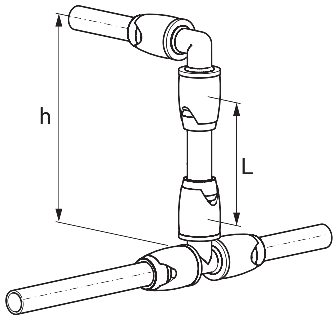


Change of position	Dimension d	16	20	25	32
	DN	12	16	20	26
	[mm]	65	85	105	160
h [mm]	M–M [mm]	Pipe dimension L [mm]			
80	113	71	–	–	–
90	127	85	85	–	–
100	141	100	100	–	–
110	156	114	114	–	–
120	170	128	128	108	–
130	184	142	142	122	–
140	198	156	156	136	–
150	212	170	170	150	–
160	226	184	184	164	164
170	240	199	199	178	178
180	255	213	213	193	193
190	269	227	227	207	207
200	283	241	241	221	221
210	297	255	255	235	235
220	311	269	269	249	249

M–M Dimension centre/centre

90° elbow / fitting

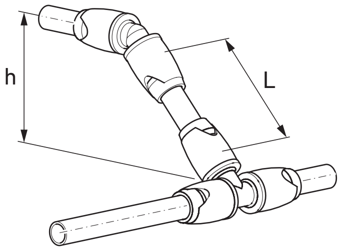
Change of position h_{min}	Dimension d	16	20	25	32
	DN	12	16	20	26
	[mm]	65	85	105	160
h [mm]	M–M [mm]	Pipe dimension L [mm]			
210	210	127	127	–	–
220	220	137	137	–	–
230	230	147	147	–	–
240	240	157	157	–	–
250	250	167	167	126	126
260	260	177	177	136	136
270	270	187	187	146	146
280	280	197	197	156	156
290	290	207	207	166	166
300	300	217	217	176	176
310	310	227	227	186	186
320	320	237	237	196	196
330	330	247	247	206	206
340	340	257	257	216	216
350	350	267	267	226	226



M–M Dimension centre/centre

45° elbow / fitting

Change of position h_{min}	Dimension d	25	32
	DN	20	26
	[mm]	170	170
h [mm]	M–M [mm]	Pipe dimension L [mm]	
170	240	130	130
180	255	145	145
190	269	159	159
200	283	173	173
210	297	187	187
220	311	201	201
230	325	215	215
240	339	229	229
250	354	244	244
260	368	258	258
270	382	272	272
280	396	286	286
290	410	300	300
300	424	314	314
310	438	328	328



M–M Dimension centre/centre

13 Maintenance and Repair

13.1 Replacing the pipe

NOTE! Odour and taste might be adversely affect due to lubricants and anti-friction agents!

→ Do not use lubricants or anti-friction agents for replacement purposes.

The individual steps are illustrated on the next page.

Maintenance and Repair – Replacing the pipe

Remove the existing pipe

① → Close shut-off valves upstream of distributor.
→ Disassemble discharge fitting.

② → Loosen the pipe end of the defective pipe from the distributor. (➨ Chapter [10.3])
→ Use a pipe draw coupling to connect the new pipe to the pipe that must be replaced.
- When doing so, observe the direction of rotation of the thread.

③ → Open the wall and expose the pipeline.

④ → Remove the box foot.

⑤ → Remove the iFIT connection according to the instructions. (➨ Chapter [10.3])

⑥ → Replace by simultaneously pulling on the pipe to be replaced and pushing the new pipe.
If the pipe can not be replaced by striking and pulling it:
→ Pull out the old pipe.
→ Use a nylon string or wire rope and pull in the new pipe with the pipe draw coupling.

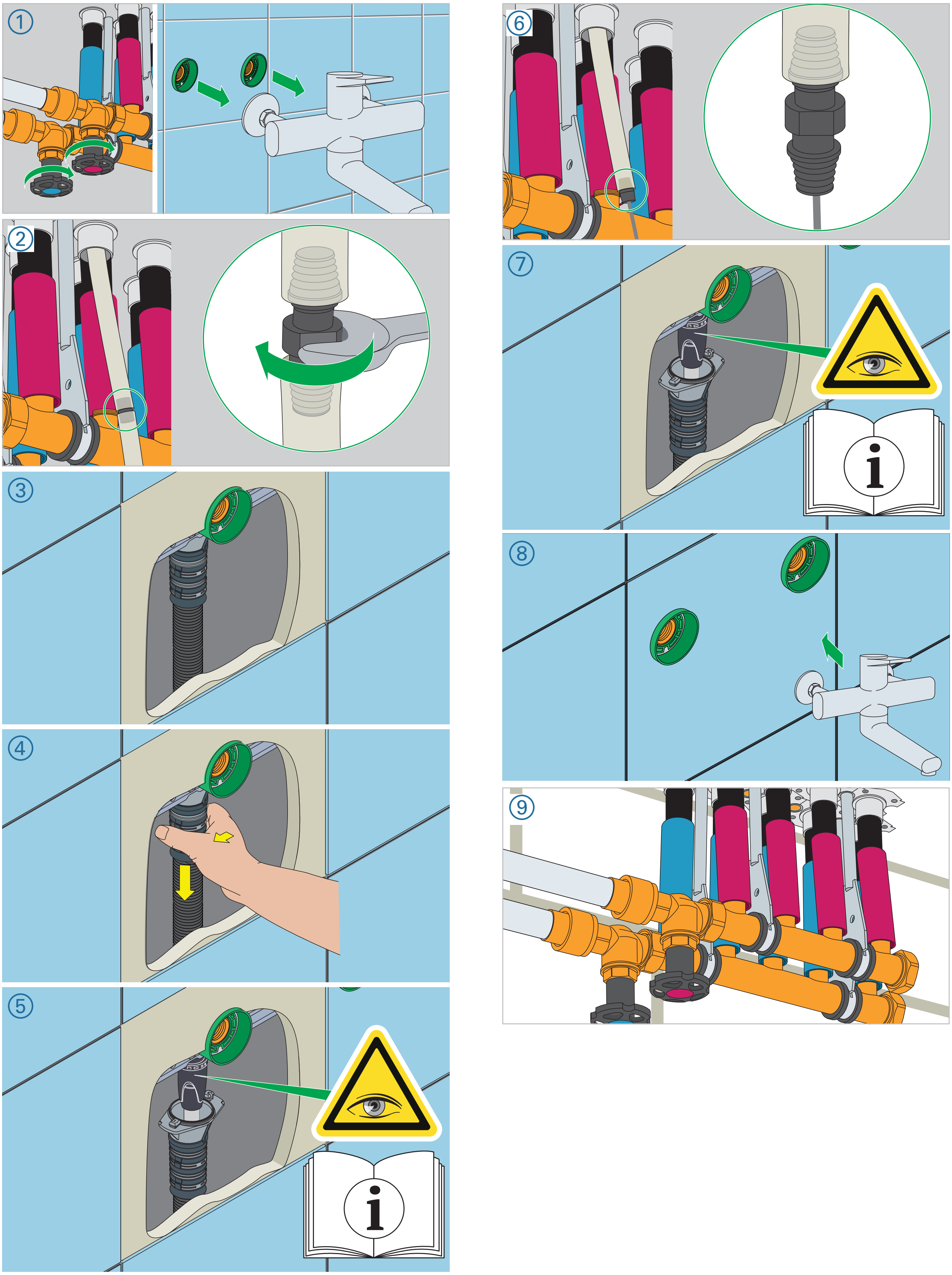
Install new pipe

⑦ → Attach adaptors on both sides of the new pipe. (➨ Chapter [10.3])
→ Mount the iFIT connection to the box.

⑧ → Close the wall.
→ Install discharge fitting.

⑨ → Connect the pipe end to the distributor.
→ Open shut-off valves upstream of distributor.
→ Check for leaks.

Maintenance and Repair – Replacing the pipe



Build

iLITE

V

iLITE

Overview

This chapter contains basic information about the iLITE system.

Additional technical and sales information

- For more information on the use and connection of other system components, piping and controls and instruments, see the chapters applicable to the appropriate systems.
- More technical information about this system and ordering information can be found on the GF website and in the sales catalogue.

1 System overview

1.1 System description

iLITE is an installation system consisting of PE-RT multilayer composite pipes, cross-linked PE-X pipes and fittings. The fittings are made of polyphenylsulfone (PPSU) and UBA compliant brass. All materials are benign, hygienically clean and comply with the applicable legal requirements. The fittings are permanently pressed onto the pipe with the pre-assembled sleeve.

The iLITE system is characterised by its high corrosion resistance. When pushed onto the fitting, the design of the cone-shaped insert simultaneously expands the pipes, thus ensuring excellent flow rates, meaning low pressure losses in the system. The sleeves are already preassembled on the rib-reinforced fittings and, using a tool, are crimped in one step. This reduces assembly times and any tool changes.

iLITE	Description
Pipe dimension	d16, d20, d26, d32
Application area	Cold and hot water, HVAC, greywater
Installation	Surface-and flush-mounted pipes throughout the building
Pipes	Crosslinked polyethylene pipes, PE-RT / Al / PE-RT multi-layer composite pipes
Fittings and system parts	Brass and plastic (PPSU)
Method	Sleeve connector method

1.2 Approvals and quality assurance

The iLITE system is subject to constant inspection by internal and external bodies. These inspections range from quality assurance during production to ISO certification for environmental and process safety. The iLITE system meets the requirements for the most important applications in the building technology and is subject to constant monitoring by the licensing offices for drinking water and heating installations on land and sea.

System approvals
General information:
➨ Annex A , Section 'Approvals'
Up-to-date information on system approvals is available from Technical Support.

1.3 Scope and application areas

The installation system iLITE is intended for the following applications:
- Drinking water installations in the cold and hot water area
- Heating and air conditioning installations (only with diffusion-proof pipe)
- Grey water installations (rainwater and the like)

iLITE is particularly suitable for connecting pipelines in single and multi-family dwellings as well as plumbing and heating installations in large-scale buildings.

Potential equalisation

The installation of the system is not a conductive metallic pipework. The installation cannot be used as a grounding conductor for electrical installations.

☑ The installation must **not** be used for equipotential bonding purposes and must **not** be used as an earth connection.

§ **Responsibility for equipotential bonding**
The installer of the electrical system is responsible for the correct implementation of the equipotential bonding.

DHW heaters

It is feasible to connect the system to **water heaters** without a metallic connection. In this case, restrictions do not apply if the water temperatures never exceed 70°C.

The use in conjunction with **flow DHW heaters** is permitted. However, only the manufacturer of the device is authorised to approve the use of the tankless water heaters.

☑ Compliance with the manufacturer's instructions for the devices is mandatory.

Protection of piping materials and connections

☑ If using flow DHW heater: Only use **thermostats** or **safety temperature limiter**, which ensure that the water temperature of 95°C is not exceeded at any point or at any time – not even when reheating.

☑ When using hydraulically controlled devices: Ensure that the **automatic switch-off** does not permit any pressures above 10 bar, even in case of the reheat effect.

Recommendation
If the temperature cannot be kept below 95°C or in older hydraulically controlled, electrically or gas-fired instantaneous water heaters, where the temperatures cannot be reliably maintained below 95°C, the following shall apply:

☑ A metallic connection with a length of at least 1.0 m shall be provided.

1.4 Properties and requirements

Service life limitation applicable to the installation
The water quality (pH value), the water constituents, as well as the operating conditions can have a direct influence on the service life of the installation, especially if chlorinated waters are being used.

1.4.1 Materials

Materials Polyethylene (PE-X, PE-RT), PPSU and brass
Detail information:
➨ Part III 'The basics', Section 'Materials and jointing technology'

1.4.2 Hygienic properties

Verification of the system's hygienic safety is provided. The test certificate of the German DVGW Technology Centre for Water (TZW) has proven that the plastic components comply with the KTW recommendations of the Federal Health Office in Germany and the requirements of the Federal Environmental Agency (UBA) in Germany. This also applies to other institutions in the field of building technology, for example, ACS, BS 6920 and KIWA. All plastic and metal components are continuously inspected in accordance with the recommendations mentioned above in order to ensure they meet national and international requirements, such as the DVGW worksheet W270.

1.4.3 Chemical resistance

The system exhibits a high chemical resistance to all natural drinking water substances (acc. to DIN 2000 and TrinkwV 2001), against disinfectants and cleaning agents (acc. to DVGW-Arbeitsblatt W291) and against corrosion inhibitors (acc. to DIN 1988, Part 4).

In addition to the utilisation for drinking water, the system can also be used for the liquid and gaseous media mentioned in [TV.1].

Suitability of the system
However, the suitability of the system is not limited to the defined chemical resistance mentioned above, but also depends on the use of the appropriate medium. The characteristics of the medium may be changed by the pipes and fittings.

TV.1 **Media**

Medium	Classification	Max. operating temperature [°C]	Max. operating pressure [bar]
Drinking water	Cold water	0 – 20	10
	Hot water	20 – 70*	
Heating water	–	0 – 70*,**	
Softened water	pH neutral (0°fH)	0 – 70	
Rain water	pH value >6.0	0 – 40	
Osmosis treatment***	–	0 – 70	
VE water***	desalinated	70	
Cooling water****	40 Vol.% ethylene glycol, Antifrogen®, ethyl alcohol	–25 – 40**	
	25 Vol.% propylene glycol	–10 – 40**	
	Saline solutions	–20 – 40**	
Disinfectant solution*****	ready for use	40	

* Short term peak temperature of 95°C during max. 150 h/a
** Only permissible with oxygen diffusion-tight pipes
*** Brass and red bronze fittings release small amounts of metal ions into osmosis-treated water. If ion-free water is desired, additional treatment at the tap is required.
**** Higher concentrations must be requested.
***** Concentrations must be requested.

Requests concerning resistance in special cases
If the system must be used for applications or concentrations exceeding the values in the table, the resistance of the materials etc. must be checked and approved by GF JRG. The following information is required in advance for testing and approval:

- Product and safety data sheet of the medium
- Operating temperature and pressure
- Concentration, exposure time, frequency and flow rate of the medium (even a sample, if required)

The use of the system for **medical gases** is **not** recommended.
Medical gases include gases that meet the requirements of the European Pharmacopoeia or which are anaesthetic gases, medical oxygen or medical carbonic acids. All of the above are approved according to the drug regulations as finished medicinal products.

1.4.4 Fire protection

Fire protection
General information on fire protection:
➨ Part IV 'Plan', Section 'Insulation, Fire protection'

Fire protection
Up-to-date information on fire protection for the system, including information on solutions, applications and product properties, can be found in the brochure **"Planungshilfe Rohrabschottung" (Planning aid pipe sealant).**

§ **Country-specific regulations**
Fire protection may be regulated differently in each countries by laws, directives, ordinances, standards, regulations and bulletins.
☑ Compliance with the local fire protection regulations is mandatory.

Fire protection - solutions with iLITE

Solutions for fire protection with iLITE
Solutions and products for fire protection with iLITE can be found here:
➨ Chapter [6] 'Fire protection'

1.4.5 Soundproofing

The basics

Water pipes do not generate any noise if the nominal pipe dimension, design, fastening method and operation are correct. There are no test regulations specified in standards or other directives to determine or assess the noise behaviour in drinking water systems. Plastic piping systems exhibit advantages over metal pipe systems due to their corrosion resistance and flexibility.
By default, drinking water systems are designed so that the volumetric flow is 2 m/s for distribution lines (standard value, which is and may only be exceeded for certain line sections) and max. 4 m/s for discharge lines is maintained. These are flow velocities at which the inherent noise of the pipelines comparted to the noise generated by the fittings or other ambient noise is not noticeable. However, the noises resonating from sanitary equipment and fittings are being transmitted. Therefore, sound insulation – which absorbs the structure-borne noise reverberating from the building – must be added to the system components.

iLITE

The iLITE installation system is compliant with the requirement of DIN 4109 and SIA 181 (6.2006). However, this implies that the installation must be carried out according to the recognised rules of technology and the assembly instructions.

V

1.4.6 Insulation

Insulation
General information on insulation:
➨ Part IV 'Plan', Section 'Insulation, Fire protection'

Country-specific regulations
The insulation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.
☑ When it comes to insulation methods, compliance with the applicable rules and regulations is mandatory.

The basics

Insulation recommendations
If local specifications do not apply, the following instructions shall be considered as minimum requirements. A protective wrapping shall be wrapped around the pipelines, a thin insulating hose or a protective conduit shall be used.
For most systems, a **pre-insulated** design (e.g. with 6 mm thick insulation) is available.

☑ Piping systems must always be insulated in order to prevent heat loss and/or heat absorption.
- Cold water pipeline: In order to prevent condensation, DHW heating and sound transmission
- Hot water, circulation and heating pipes: To reduce heat loss, absorb expansion and prevent sound transmission

☑ Select the insulation or sheathing according to the respective field of application.
☑ Ensure that the insulation does not cause corrosion to the piping materials.

Soundproofing
☑ The soundproofing may be subject to special requirements. Ensure that these potential prerequisites are considered in the design of the insulation.

Hygiene
Applying insulation to cold water pipes, for example, in order to prevent them from heating can improve the hygiene and help reduce the risk of legionella.

Planning fundamentals
The EnEV (German Energy Saving Ordinance) or DIN 1988 in Germany are available in the current version with comprehensive, detailed and practice-oriented documents. They are equally valid for new constructions, renovations and modernisations

Insulation according to EnEV 2017

Insulation according to EnEV 2017
Solutions and products for insulation according to EnEV can be found here:
➨ Chapter [5] 'Insulation according to EnEV 2017'

1.4.7 Protecting the installation

System components installed flush with the wall or walled in

Concealed pipelines that are not easily accessible, e.g. concealed inside the wall, in a pipe shaft, in a wall slot or in the concrete floor:

☑ Fittings and pipes must be insulated with a suitable material in order to absorb thermally induced changes in length, to prevent the transmission of sound, to preclude the formation of condensation, heat emission, heat loss or heating of the medium and other influences caused by building materials.

☑ Piping system and building structure must be separated from each other, for example, by using protective conduits made of PE, wrappings, insulating hoses or half shells with and without sheathing or a combination thereof.

☑ All system components must be protected from direct contact with oils, greases, solvents, solvent-based adhesives (adhesive tapes), foams, bitumen (also bituminous membranes). Furthermore, the components must not contact building materials such as screed, concrete, mortar or plaster.

Protection against environmental influences and building materials

Special measures apply to the following rooms:

- permanently or periodically wet rooms
  - Slaughterhouses, butcher shops (pressure washer)
  - Carwash
  - Tiled shower stalls, spa areas
  - Commercial kitchens
  - Rooms with risk of external water ingress
  - Swimming pools, saunas
- Areas subject to offensive gases or aggressive environments
  - Stables (ammonia)
  - Dairy factories/cheese dairies (nitric acid)
  - Swimming pools/swimming pool centres (chlorine, hydrochloric acid)
- Areas subject to uncontrollable environmental influences

Due to the moisture permeating the building materials and the resulting permanent wetness (e.g. in public showers and baths or commercial wet rooms), it is possible for an aggressive environment to form around the pipe.

☑ Appropriate precautions must be taken to protect the installation, e.g. by using the following measures:
  - Use of suitable anti-corrosion tapes (e.g. supplied by KEBU, Gyso or DENSO)
  - Wrapping the pipe with heat-shrinkable materials

☑ Ensure that pipes and fittings are dry when mounting.

Protection from UV radiation

☑ Appropriate precautions must be taken in order to prevent the installation from permanent exposure to UV rays.

When using the pipe-in-pipe system with protective conduit, this will ensure sufficient UV protection.
Sheathing with insulating material can assume the function of UV protection.

☑ Pipes and fittings must be shielded from direct sunlight and UV radiation.

☑ During transport and storage: Pipes and fittings must be covered after they have been removed from the original packing.

Protection against aggressive waters

Recommendation

☑ In areas with particularly aggressive waters: Installations must be easily accessible.

☑ Distribution lines in the single tap system (pipe-in-pipe) must be designed and installed such in order to ensure system components can be replaced at any time without damaging the building's structure.

1.4.8 Disinfection procedure

Disinfection
General information on common disinfection procedures:
➨ Part VI 'Operate', Chapter [4] 'Disinfection'
Information on the hygiene concept used at GF:
➨ Part II 'Plan – Build – Operate', Chapter [4] 'Disinfection'

Chlorine dioxide
The use of chlorine dioxide for chemical disinfection can severely limit the lifetime of the entire drinking water installation. Before implementation, the conditions must be recorded on site.

The water quality (pH value), the water constituents, as well as the operating conditions can have a direct influence on the service life of the installation, especially if chlorinated waters are being used.

1.5 Safe application and processing

☑ Only use the product as intended and in accordance with the defined areas of application and usage.
☑ Check compatibility of medium and material.
☑ Do not use the product if it is damaged or defective. Damaged product must be removed immediately.
☑ Use only approved accessories.
☑ Only trained personnel shall be permitted to assemble the product and accessories.
☑ All personnel shall be instructed on all applicable issues of local occupational safety and environmental regulations, in particular for pressurised piping. These instructions must be held on a regular basis.
☑ Compliance with the valid standards for drinking water and grey water installations as well as compliance with the regulations of the system manufacturer is mandatory.
☑ Compliance with the local water supply regulation is mandatory.
☑ Make sure that the piping system is installed correctly and inspected regularly.
☑ All installations must comply with the instructions specified in the technical documentation of the product.
☑ Compliance with the operating, maintenance and assembly instructions of the tools is mandatory.
☑ Tools must be used as intended and must not be applied for other purposes.
☑ When assembling the iLITE installation system, only iLITE assembly tools must be used.

1.5.1 Transport and storage

For hygienic reasons, all openings in pipes, fittings, controls and instruments must be closed until final assembly.
☑ Ensure to protect the product against external force (shock, impact, vibration, etc.) during transport.
☑ Transport and/or store the product in unopened original packing.
☑ Protect the product from dust, dirt, moisture, heat and UV radiation.
☑ Ensure that the product is not damaged by mechanical or thermal influences.
☑ Before proceeding with the assembly, inspect the product for damage that may have occurred during the transport.

1.5.2 Installation and assembly

The iLITE System is suitable for the following types of installation:
- Surface or flush-mounted installations
- Installation in shafts and channels, on ceilings and on floors
- Installation in-wall, element, wood and lightweight constructions
- Installation in concrete (in the pipe-in-pipe system, with PE-X pipes)

1.5.3 Acceptance and putting into operation

§ **Country-specific regulations**

Acceptance and putting into operation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.

☑ When it comes to acceptance and putting into operation, compliance with the applicable rules and regulations is mandatory.

Acceptance, pressure test, flushing and putting into operation

General information and master copies of the test reports:

➨ Part V 'Build', Section 'Putting into operation'

1.5.4 Operation, maintenance, servicing, repair and decommissioning

☑ To ensure trouble-free operation: Check installation and all control and safety fittings regularly.

Risk of injury due to pressure or explosion!

If the system is not completely depressurised, media may escape uncontrolled from the installation.

☑ Before removal, maintenance, disassembly: Pipeline must be completely depressurised.

☑ If harmful, combustible or explosive media is used: Completely empty and flush the pipeline before disassembling it. Look for potential residues.

☑ Use appropriate measures to ensure the medium is collected properly.

Risk of injury due to media harmful to health and the environment!

Risk of personal injury or environmental damage due to uncontrolled escape of hazardous media.

☑ During maintenance, servicing, repair and decommissioning, prescribed protective clothing must be worn.

☑ Compliance with the media safety data sheets is mandatory.

☑ Collect leaking media and dispose of according to local regulations.

Risk of injury due to the use of unsuitable spare parts!

Damage to the installation and risk of injury.

☑ Only use replacement parts from the current product range during the installation and repairs.

1.5.5 Disposal

The entire iLITE product range is made from environmentally friendly and recyclable materials.

§ **Country-specific regulations**

Disposal and recycling may be regulated differently in each country by laws, ordinances, standards, regulations, and bulletins.

☑ When disposing of or recycling the product, the individual components and the packaging, compliance with the local regulations is mandatory.

☑ Before disposing of individual materials, they must be separated according to their recyclability, and whether these materials are considered normal waste or special waste.

2 System components

The iLITE installation system consists of cross-linked polyethylene pipes, multi-layer composite pipes (PE-RT) and fittings made of PPSU or brass.

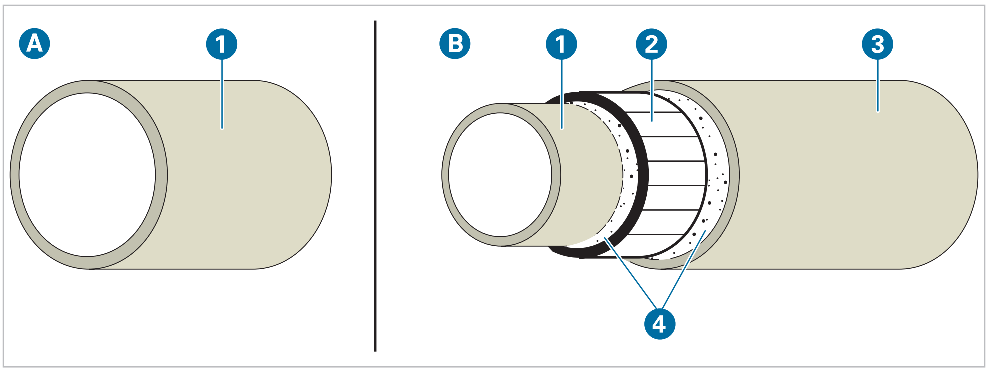
2.1 iLITE pipes

The **iLITE multilayer composite pipes** consist of several layers. These multilayer composite pipes are available pre-cut, in coils and in various designs (e.g. with insulation or in a protective conduit). Inside, there is a hygienically perfect, medium-conveying layer of heat-resistant polyethylene (PE-RT). The outer layer, which protects the pipe from mechanical stress, is also made of PE-RT. Between the outer layer and the pipe is an aluminium support conduit, butt-welded longitudinally. A bonding agents, also based on PE, permanently joins the other two layers. In addition, the aluminium layer eliminates the otherwise negatively perceived longitudinal expansion properties and short mounting distances in plastic pipes and makes the pipe resistant to bending. In addition, the pipe is thereby oxygen diffusion-tight.

The **100% plastic pipe** from the iLITE assortment, which are available pre-cut and in coils as well as in various designs (e.g. with protective conduit), are made of homogeneous polyethylene (PE-X). In addition to its flexibility, it stands above all else and is characterised by the hygienic properties of the base material.

2.1.1 Pipe construction and pipe labelling

The pipes for the iLITE system are designed as follows.

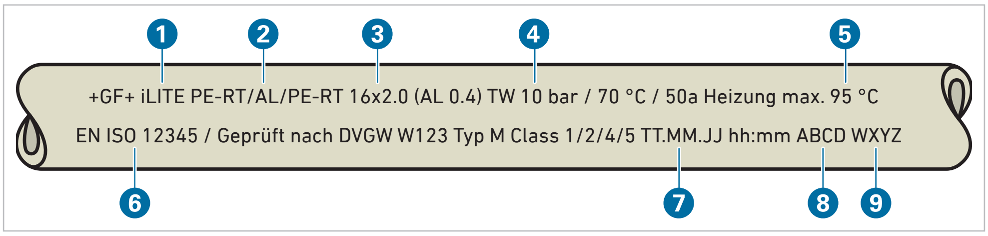


GV.1
Pipe design

A **100% plastic pipe**
1 Polyethylene (PE-X)

B **Multilayer composite pipe**
1 Inliner (PE-RT)
2 Aluminium pipe
3 Outer coating (PE-RT)
4 Bonding agent

The pipes are marked as follows.



GV.2
Pipe marking

	Labelling (example)	Meaning
1	+GF+ iLITE	Product: Company name and system name
2	PE-RT / AL / PE-RT	Layer structure / material code
3	16x2.0 (AL 0.4)	Dimension: Outside diameter x wall thickness
4	10 bar / 70°C / 50a	Medium: Operating temperature/max. operating pressure
5	max. 95°C	Heater: max. temperature
6	EN 123.. / DVGW W123..	Standard, application classes
7	DD.MM.YY hh:mm	Production data (date, time)
8	ABCD	Production site
9	WXYZ	Order number

2.1.2 Technical Data

iLITE

Feature	Pipe	Polyethylene (PE-X)	Multilayer composite pipe (PE-RT / Al / PE-RT)
Conditions in continuous operation		70°C, 10 bar (50 years)	
Max. operating temperature [°C]		95 (briefly)	
Max. operating pressure [bar]		10	
Surface roughness k [mm]		0.007	
Material constant C		12	33
Coefficient of thermal expansion [mm/(m·K)]		0.180	0.024
Thermal conductivity [W/(m·K)]		0.32	0.43
Density [kg/dm³]		~0.94	~0.95
Processing temperature [°C]		up to –10	up to –20
Fire code		IV.2 (acc. to VKF)	
Building material class		B2 (DW 4102 / E (DW 13501-1)	

	Pipe	Polyethylene (PE-X)		Multilayer composite pipe (PE-RT / Al / PE-RT)			
Feature	**Dimension**	d16	d20	d16	d20	d26	d32
Nominal width DN		12	15	12	16	20	25
Outside diameter d_a [mm]		16	20	16	20	26	32
Wall thickness [mm]		2.2	2.8	2	2.5	3.0	3.0
Internal diameter d_i [mm]		11.6	14.4	12	15	20	26
Weight [g/m]		0.089	0.142	0.129	0.202	0.296	0.365
Cross section inside A [cm²]		1.06	1.63	1.13	1.77	3.14	5.31
Volume [l/m]		0.11	0.16	0.113	0.177	0.314	0.531
Fire load [MJ/m]		4.30	6.72	3.36	4.54	7.42	8.23

	Pipe	Polyethylene (PE-X)		Multilayer composite pipe (PE-RT / Al / PE-RT)			
Bending radius	**Dimension**	d16	d20	d16	d20	d26	d32
Bending radius R, interchangeable: 8 · da [mm]		128	160	–	–	–	–
Bending radius R, not interchangable: 5 · da [mm]		80	100	–	–	–	–
Bending radius R, manually: 5 · da [mm]		–	–	80	100	–	–
Bending radius R, with tool: 3.5 · d_a [mm]		–	–	56	70	91	112

	Pipe	Polyethylene (PE-X)		Multilayer composite pipe (PE-RT / Al / PE-RT)			
Mounting distance	**Dimension**	d16	d20	d16	d20	d26	d32
Mounting distances [mm]		1.0	1.0	1.0	1.0	1.5	2.0
Assembly with pipe saddles		1.5	1.5	1.5	1.5	2.0	2.5

Protective conduits

Feature	Value
Density [kg/dm³]	~0.95
Tensile strength [N/mm²]	~25
Temperature resistance [°C]	100
Melt flow index	MFI 190/5: 0.4 g / 10 min
Elongation at break [%]	600
Thermal conductivity [W/(m K)]	0.45

	Pipe	Polyethylene (PE-X)		Multilayer composite pipe (PE-RT / Al / PE-RT)			
Feature	**Dimension**	d16	d20	d16	d20	d26	d32
Outside diameter d_a [mm]		18	25	18	25	–	–
Internal diameter d_i [mm]		14.6	20	14.6	20	–	–

V

2.2 Fittings

2.2.1 PPSU fittings

iLITE plastic fittings are made of the high-performance plastic polyphenylsulfone (PPSU). This material, which is known for its low susceptibility to cracking and excellent resistance to hot water, has proven to be well-suited for fittings in building technology and is characterised above all by excellent corrosion resistance and low incrustation. The extremely rugged design, that is to say, the special impact resistance and impact strength are just as natural as the excellent resistance to hydrolysis and chemicals – even at high temperatures. In addition to the absolutely benign hygienic and physiological properties, this is another reason why PPSU is also used in the medical sector.

The sleeves – which are pre-assembled onto the fitting – are made of glass-fibre reinforced polyamide (PA-GF30) and have an integrated inspection window.

2.2.2 PPSU special fittings

In contrast to the iLITE fittings, which are pressed with a tool, the new PPSU special fittings can be plugged directly onto another iLITE fitting by hand and secured with the sliding sleeve. The special fittings can be opened again at any time with the release pliers, removed and then reused.

2.2.3 Brass fittings

All iLITE threaded fittings are made of UBA compliant and low lead brass. The fittings are available as standard line (CW617N) and in a product line made of dezincification-resistant brass (CW 725R). In terms of corrosion and chemical resistance, all afore-mentioned fittings have properties similar to those of fittings made of PPSU.

The sleeves – which are pre-assembled onto the fitting – are made of glass fibre reinforced polyamide (PA-GF30) and have an integrated inspection window.

The fitting nipples of all metal fittings are provided with a transport protection (plastic protection caps) when they leave the factory. There is another X-ring (spacer) on the fitting as protection against contact corrosion.

3 Tools

A special tool is used when working with iLITE and, depending on the tube dimension, a different pair of jaws is used for correct and safe iLITE compression.

☑ Compliance with the tool's operating instruction is mandatory.

⚠ **Material damage and risk of injury when using unsuitable tools or non-original spare parts.**
- → Only use tools available from the current product range.
- → Tools must be used compliant with the operating instructions.
- → Only use replacement parts from the current product range.

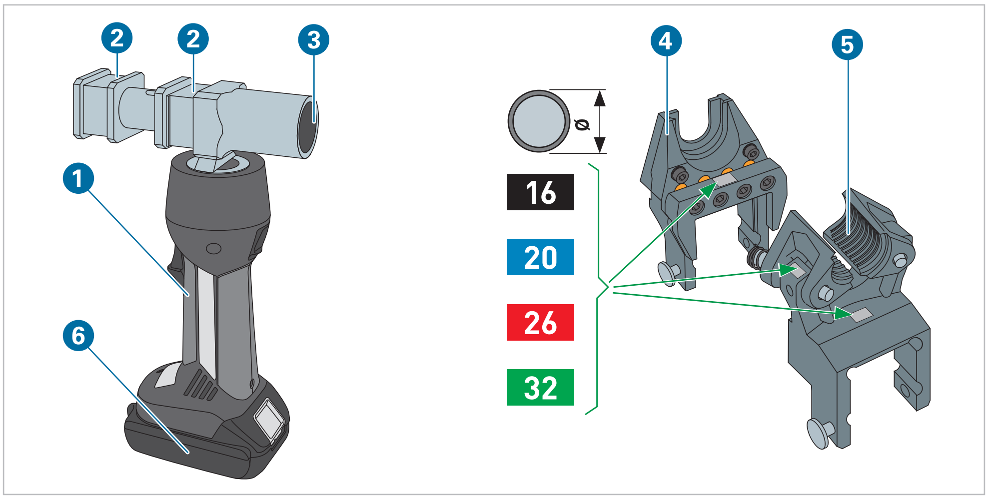
Care, testing and maintenance of tools

A flawlessly functioning tool is a basic prerequisite for a permanently sealed connection.

⚠ **Risk of injury and material damage due to poor care, incorrect testing and faulty maintenance.**
- → Tools must be maintained as specified in the operating instructions and their operation must be inspected regularly, at least once a year.
- → Do not oil the tool piston and forks. Clean only with compressed air or a brush.

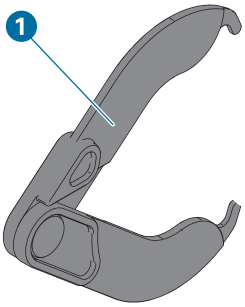
3.1 Assembly tools (d16 – d32)

3.1.1 Tool for PPSU fittings



GV.3
Assembly tool
1. Power tool
2. Jaw support
3. Optical control
4. Fitting support
5. Pipe clamp
6. Makita battery

3.1.2 Pliers for PPSU special fittings



GV.4
Assembly tool
1. Pliers

V

4 Dimensioning

Simplified calculation method
Basic information, examples and sample tables for simplified calculation:
➨ Part IV 'Plan', Section 'Drinking water installation'

The product-specific data for the simplified calculation and the calculation method are available in this chapter.

4.1 Loading units

The loading unit (LU – formerly abbreviated BW) designates the flow rate provided at the connection point upstream of the tap as a function of the intended use and the duration of use. The loading unit does not correspond to the withdrawal flow from the respective product specification.

A loading unit LU is equal to a flow of 0.1 l/s.

4.1.1 Controls and instruments and equipment

Usage Connections DN15 (½")	Volume flow Q_A per connection [l/s]	 [l/min]	LU per port
Wash-hand basin, washing trough, vanity unit, bidet, cistern, vending machine, hairdresser, household dishwasher	0.1	6	1
Sink, utility sink, taps for balcony and terrace, washing trough, shower, standing and wall spout, household washing machine	0.2	12	2
Urinal flushing (automatic), bathtub	0.3	18	3
Tap for the garden or garage	0.5	30	5

TV.2
Loading units according to intended purpose
Source: SVGW Guidelines W3 Edition 2013

Intended use Connections DN15 (½")	Volume flow per connection Q_A [l/s]	 Q_{min} [l/s]	LU per port
Hand basin, washbasin, bidet, cistern	0.1	0.1	1
Household kitchen sink, household washing machine, dishwasher, sink, shower head	0.2	0.15	2
Urinal flush valve	0.3	0.15	3
Bathtub drain	0.4	0.3	4
Tap for the garden or garage	0.5	0.4	5
Commercial kitchen sink (DN20), Commercial bath spout	0.8	0.8	8
Flush valve (DN20)	1.5	1.0	15

TV.3
Loading units according to intended purpose
Source: EN 806-3:2006 (D)
Q_A Flow rate at the tapping fitting
Q_{min} Minimum flow rate at the tapping valve

4.1.2 iLITE multilayer composite pipes

Designation	Dimension					
Total LU	3	4	5	10	20	55
Largest single value LU	–	–	4	5	8	–
$d_a \times s$ [mm]		16 × 2.0		20 × 2.5	26 × 3	32 × 3
d_i [mm]		12		15	20	26
Length of pipeline, recommended [m]	9	5	4	–	–	–
Controls and instruments		½		½	¾	1

TV.4
Loading units for iLITE multi-layer composite pipes PE-RT/Al/PE-RT

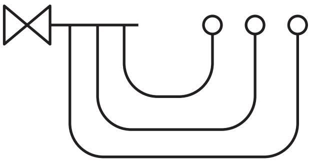
4.1.3 Installation with individual supply lines

Group of equipment/distribution at floor level
→ A velocity of max. 4 m/s must be maintained.

Directional change with pipe bend

Max. developed length [m]	5		10		15	
Residential water meter	without	with	without	with	without	with
Loading unit (LU)	[$d_a \times s$]					
1	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2
2	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2	20 × 2.5
3	16 × 2	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5
4	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	–
5	20 × 2.5	no counter	20 × 2.5	no counter	20 × 2.5	no counter
Pipe $d_a \times s$ [mm]	16 × 2	20 × 2.5				
Pipe d_i [mm]	12.0	15.0				
Instrument	½"	½"				

TV.5
Loading units (LU) applicable to multilayer composite pipe PE-RT / AI / PE-RT



Straight-seat shut-off valve ¾ "and distributor ¾" are taken into account in the calculation model.

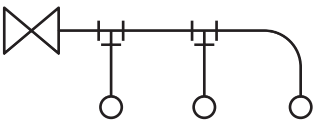
4.1.4 Installation with tees

Group of equipment/distribution at floor level
→ A velocity of max. 3 m/s must be maintained.

Directional change with pipe bend

Max. developed length [m]	5		10		15	
Residential water meter	without	with	without	with	without	with
Loading unit (LU)	[$d_a \times s$]					
1	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2
2	16 × 2	16 × 2	16 × 2	20 × 2.5	20 × 2.5	20 × 2.5
3	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	26 × 3
4	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	26 × 3
5	20 × 2.5	26 × 3	26 × 3	26 × 3	26 × 3	26 × 3
6	26 × 3	26 × 3	26 × 3	26 × 3	26 × 3	32 × 3
8	26 × 3	26 × 3	26 × 3	26 × 3	26 × 3	32 × 3
10	26 × 3	26 × 3	26 × 3	32 × 3	32 × 3	32 × 3
12	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3
15	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3
Pipe $d_a \times s$ [mm]	16 × 2	20 × 2.5	26 × 3	32 × 3		
Pipe d_i [mm]	12.0	15.0	20.0	26.0		
Instrument	½"	½"	¾"	1"		

TV.6
Loading units (LU) applicable to multilayer composite pipe PE-RT / AI / PE-RT



Pressure losses and discharge times

If using tee installations:
→ Calculate the discharge times and pressure losses.

For systems with individual tap locations:
→ The maximum length of 12 m of the pipe must not be exceeded.

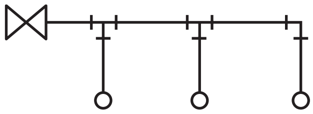
4.1.5 Installation with tees

Group of equipment/distribution at floor level
→ A velocity of max. 3 m/s must be maintained.

Directional change with fittings

Max. developed length [m]	5		10		15	
Residential water meter	without	with	without	with	without	with
Loading unit (LU)	[$d_a \times s$]					
1	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2	16 × 2
2	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5	20 × 2.5
3	26 × 3	26 × 3	26 × 3	26 × 3	26 × 3	26 × 3
4	26 × 3	26 × 3	26 × 3	26 × 3	26 × 3	26 × 3
5	26 × 3	26 × 3	26 × 3	26 × 3	26 × 3	26 × 3
6	26 × 3	26 × 3	26 × 3	26 × 3	26 × 3	32 × 3
8	26 × 3	26 × 3	26 × 3	26 × 3	26 × 3	32 × 3
10	26 × 3	26 × 3	26 × 3	32 × 3	32 × 3	32 × 3
12	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3
15	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3	32 × 3
Pipe $d_a \times s$ [mm]	16 × 2	20 × 2.5	26 × 3	32 × 3		
Pipe d_i [mm]	12.0	15.0	20.0	26.0		
Instrument	½"	½"	¾"	1"		

TV.7
Loading units (LU) applicable to multilayer composite pipe PE-RT / AI / PE-RT



Source: SVGW Sa 02/2014; SVGW Certificate No.: 0406-4834

Pressure losses and discharge times

If using tee installations:
→ Calculate the discharge times and pressure losses.

For systems with individual tap locations:
→ The maximum length of 12 m of the pipe must not be exceeded.

4.2 Pressure losses for pipes

4.2.1 The basics

TV.8
Flow velocities

Designation	Value [m/s]	
	SVGW W3*	EN 806-3:2006**
Discharge pipeline	max. 4.0	4.0
Groups of equipment	max. 3.0	–
Pipelines on individual floor levels	max. 3.0	2.0
Distribution pipelines	max. 2.0	2.0

* recommended (acc. to SVGW - Swiss Gas and Wate Industry Association Guideline W3/2013)
** The values given are based on the following flow velocities:
Collective feed lines, risers, floor lines: max. 2.0 m/s
Single feeders: max. 4.0 m/s

4.2.2 Pressure losses for iLITE multilayer composite pipes

A loading unit LU is equal to a flow of 0.1 l/s.

TV.9
Pressure losses for iLITE multilayer composite pipes

LU 1 up to LU 5

Pipe, Dimension	Pressure loss [hPa/m pipe (= mbar/m)]					
	LU	1	2	3	4	5
	[l/s]	0.1	0.2	0.3	0.4	0.5
d16		11.4	30.4	62.2	104.5	–
d20		3.9	10.4	21.4	35.7	66.0
d26		–	–	5.3	8.9	16.6
d32		–	–	–	–	4.7

V

4.2.3 Pressure losses at 10°C

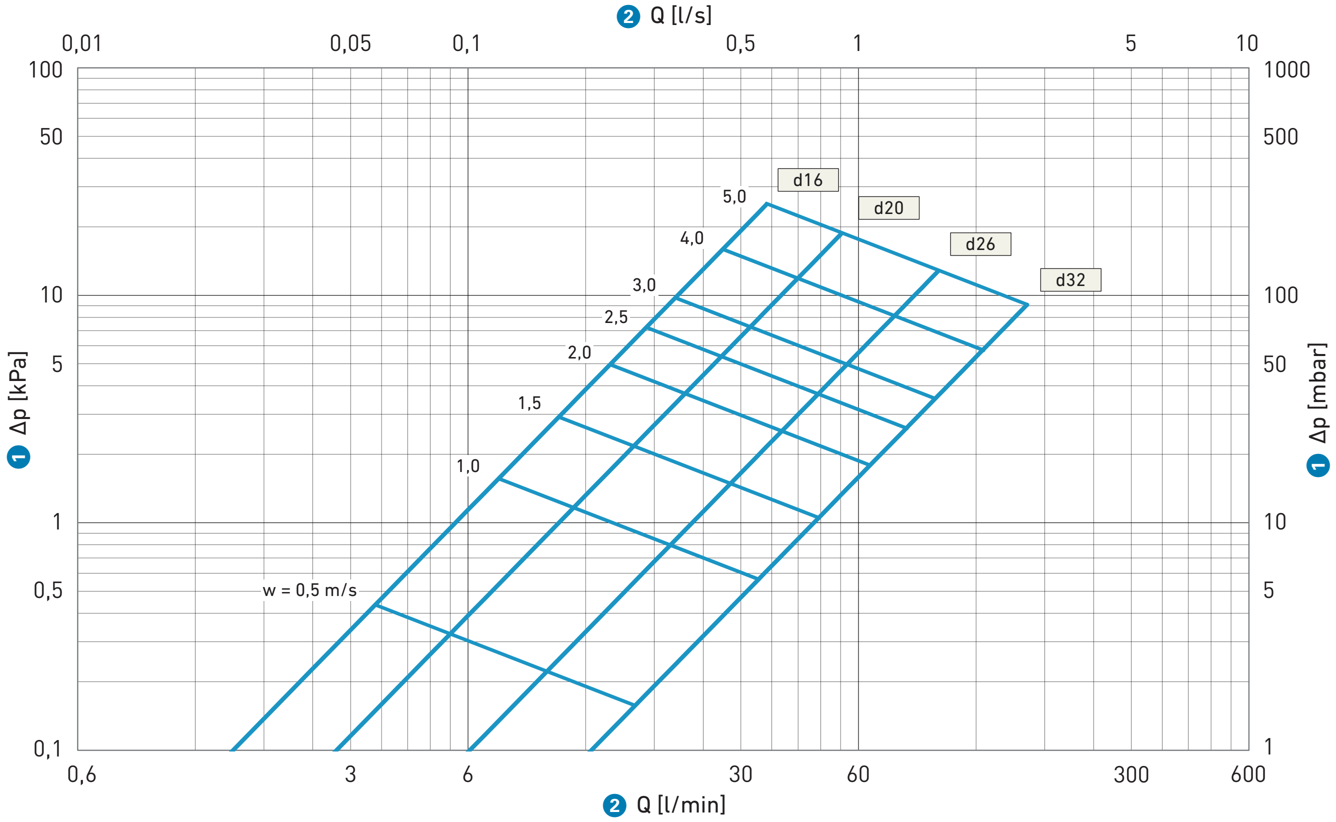
TV.10
Design fundamentals

iLITE multilayer composite pipes

Designation	Value
Dimension	d16 – d32
Density ρ (water)	999.70 kg/m³
Water temperature	10°C
Surface roughness k (inner pipe)	0.007 mm
Viscosity	0.00131 Pa · s

Pipe friction pressure drop as a function of the volumetric flow

The diagram and the tables show the pipe friction pressure drop R and the calculated flow velocity v as a function of the volumetric flow Q.



1 Pressure loss
2 Volumetric flow rate

Pressure losses at 10°C

TV.11 **Pipe friction pressure drop, flow velocity, peak flow**

d	16		20		26		32	
DN	12		15		20		25	
Q [l/s]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
0.01	0.1	0.2	–	–	–	–	–	–
0.02	0.2	0.7	0.1	0.2	–	–	–	–
0.03	0.3	1.4	0.2	0.5	–	–	–	–
0.04	0.4	2.3	0.2	0.8	0.1	0.2	–	–
0.05	0.4	3.4	0.3	1.2	0.2	0.3	–	–
0.06	0.5	4.7	0.3	1.6	0.2	0.4	–	–
0.07	0.6	6.1	0.4	2.1	0.2	0.5	–	–
0.08	0.7	7.7	0.5	2.6	0.3	0.7	–	–
0.09	0.8	9.5	0.5	3.2	0.3	0.8	0.2	0.2
0.10	0.9	11.4	0.6	3.9	0.3	1.0	0.2	0.3
0.15	1.3	23.3	0.8	8.0	0.5	2.0	0.3	0.6
0.20	1.8	38.5	1.1	13.2	0.6	3.3	0.4	0.9
0.25	2.2	57.0	1.4	19.5	0.8	4.9	0.5	1.4
0.30	2.7	78.5	1.7	26.9	1.0	6.8	0.6	1.9
0.35	3.1	102.9	2.0	35.3	1.1	8.9	0.7	2.5
0.40	3.5	130.1	2.3	44.6	1.3	11.2	0.8	3.2
0.45	4.0	160.0	2.5	54.8	1.4	13.8	0.8	3.9
0.50	4.4	192.6	2.8	66.0	1.6	16.6	0.9	4.7
0.55	4.9	227.6	3.1	78.0	1.8	19.6	1.0	5.6
0.58	5.1	249.9	3.3	85.6	1.8	21.5	1.1	6.1
0.65	–	–	3.7	104.6	2.1	26.3	1.2	7.5
0.70	–	–	4.0	119.1	2.2	29.9	1.3	8.5
0.75	–	–	4.2	134.4	2.4	33.8	1.4	9.6
0.80	–	–	4.5	150.5	2.5	37.8	1.5	10.7
0.85	–	–	4.8	167.5	2.7	42.1	1.6	11.9
0.90	–	–	5.1	185.1	2.9	46.5	1.7	13.2
0.95	–	–	–	–	3.0	51.2	1.8	14.5
1.00	–	–	–	–	3.2	56.0	1.9	15.9
1.05	–	–	–	–	3.3	61.0	2.0	17.3
1.10	–	–	–	–	3.5	66.2	2.1	18.8
1.15	–	–	–	–	3.7	71.5	2.2	20.3
1.20	–	–	–	–	3.8	77.1	2.3	21.9
1.25	–	–	–	–	4.0	82.8	2.4	23.5
1.30	–	–	–	–	4.1	88.7	2.4	25.2
1.35	–	–	–	–	4.3	94.8	2.5	26.9
1.40	–	–	–	–	4.5	101.1	2.6	28.7
1.45	–	–	–	–	4.6	107.5	2.7	30.5
1.50	–	–	–	–	4.8	114.1	2.8	32.4
1.55	–	–	–	–	4.9	120.8	2.9	34.3
1.60	–	–	–	–	5.1	127.8	3.0	36.3
1.65	–	–	–	–	–	–	3.1	38.3
1.70	–	–	–	–	–	–	3.2	40.3
1.75	–	–	–	–	–	–	3.3	42.4
1.80	–	–	–	–	–	–	3.4	44.6
1.85	–	–	–	–	–	–	3.5	46.8
1.90	–	–	–	–	–	–	3.6	49.0
1.95	–	–	–	–	–	–	3.7	51.3

d	16		20		26		32	
DN	12		15		20		25	
Q [l/s]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
2.00	–	–	–	–	–	–	3.8	53.6
2.05	–	–	–	–	–	–	3.9	56.0
2.10	–	–	–	–	–	–	4.0	58.4
2.20	–	–	–	–	–	–	4.1	63.4
2.30	–	–	–	–	–	–	4.3	68.6
2.40	–	–	–	–	–	–	4.5	73.9
2.50	–	–	–	–	–	–	4.7	79.4
2.60	–	–	–	–	–	–	4.9	85.0
2.70	–	–	–	–	–	–	5.1	90.8

4.2.4 Pressure losses at 60°C

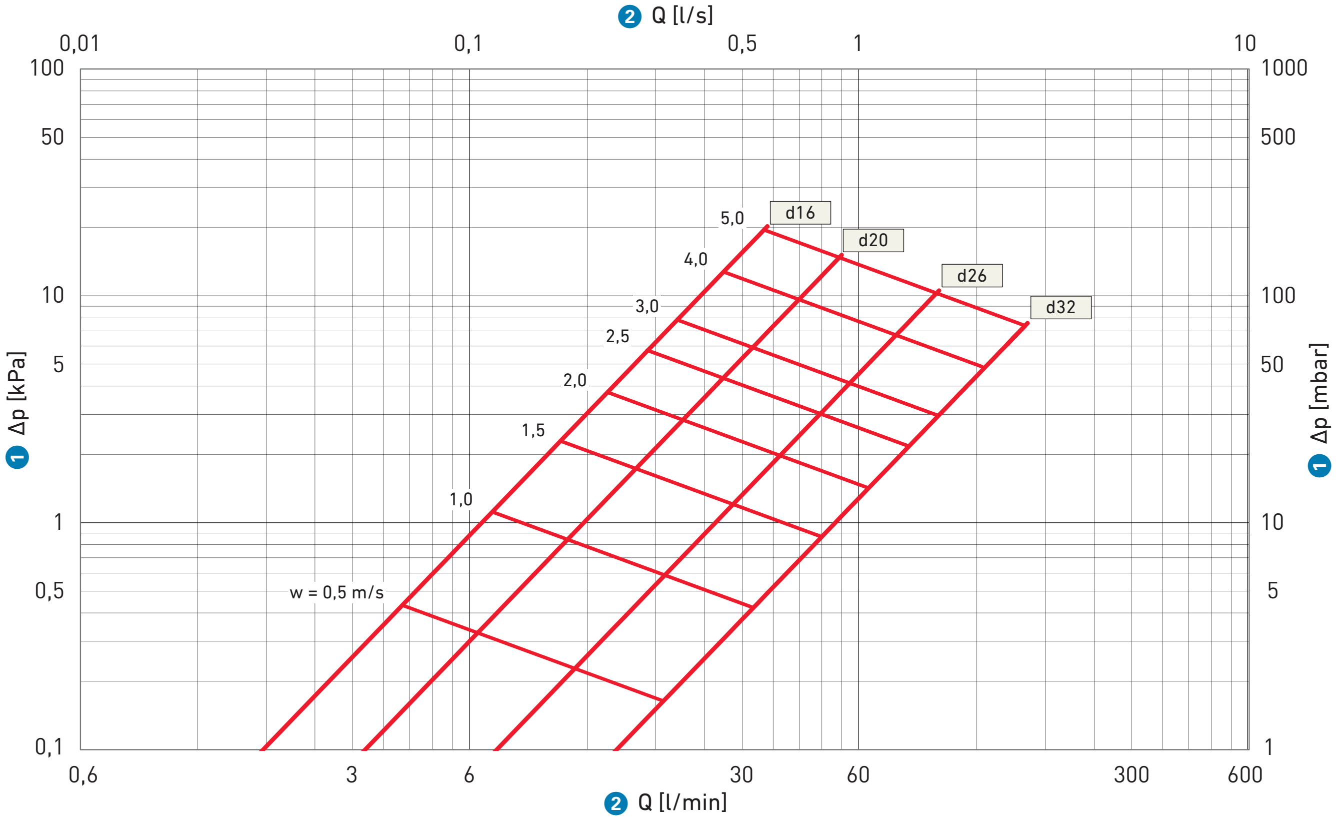
iLITE multilayer composite pipes

Designation	Value
Dimension	d16 – d32
Density ρ (water)	983.20 kg/m³
Water temperature	60°C
Surface roughness k (inner pipe)	0.007 mm
Viscosity	0.000476 Pa · s

TV.12
Design fundamentals

Pipe friction pressure drop as a function of the volumetric flow

The diagram and the tables show the pipe friction pressure drop R and the calculated flow velocity v as a function of the volumetric flow Q.



1 Pressure loss
2 Volumetric flow rate

Pressure losses at 60°C

TV.13 **Pipe friction pressure drop, flow velocity, peak flow**

d	16		20		26		32	
DN	12		15		20		25	
Q [l/s]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
0.01	0.1	0.1	–	–	–	–	–	–
0.02	0.2	0.5	0.1	0.2	–	–	–	–
0.03	0.3	1.0	0.2	0.4	–	–	–	–
0.04	0.4	1.7	0.2	0.6	0.1	0.1	–	–
0.05	0.4	2.6	0.3	0.9	0.2	0.2	–	–
0.06	0.5	3.6	0.3	1.2	0.2	0.3	–	–
0.07	0.6	4.7	0.4	1.6	0.2	0.4	–	–
0.08	0.7	5.9	0.5	2.0	0.3	0.5	–	–
0.09	0.8	7.3	0.5	2.5	0.3	0.6	0.2	0.2
0.10	0.9	8.8	0.6	3.0	0.3	0.8	0.2	0.2
0.15	1.3	18.2	0.8	6.2	0.5	1.6	0.3	0.4
0.20	1.8	30.4	1.1	10.4	0.6	2.6	0.4	0.7
0.25	2.2	45.2	1.4	15.4	0.8	3.9	0.5	1.1
0.30	2.7	62.6	1.7	21.4	1.0	5.3	0.6	1.5
0.35	3.1	82.4	2.0	28.1	1.1	7.0	0.7	2.0
0.40	3.5	104.5	2.3	35.7	1.3	8.9	0.8	2.5
0.45	4.0	128.9	2.5	44.0	1.4	11.0	0.8	3.1
0.50	4.4	155.5	2.8	53.1	1.6	13.3	0.9	3.8
0.55	4.9	184.3	3.1	62.9	1.8	15.8	1.0	4.5
0.58	5.1	202.6	3.3	69.2	1.8	17.3	1.1	4.9
0.65	–	–	3.7	84.8	2.1	21.2	1.2	6.0
0.70	–	–	4.0	96.7	2.2	24.2	1.3	6.8
0.75	–	–	4.2	109.4	2.4	27.4	1.4	7.7
0.80	–	–	4.5	122.7	2.5	30.7	1.5	8.7
0.85	–	–	4.8	136.7	2.7	34.2	1.6	9.7
0.90	–	–	5.1	151.4	2.9	37.9	1.7	10.7
0.95	–	–	–	–	3.0	41.7	1.8	11.8
1.00	–	–	–	–	3.2	45.7	1.9	12.9
1.05	–	–	–	–	3.3	49.9	2.0	14.1
1.10	–	–	–	–	3.5	54.2	2.1	15.3
1.15	–	–	–	–	3.7	58.6	2.2	16.6
1.20	–	–	–	–	3.8	63.3	2.3	17.9
1.25	–	–	–	–	4.0	68.0	2.4	19.2
1.30	–	–	–	–	4.1	73.0	2.4	20.6
1.35	–	–	–	–	4.3	78.0	2.5	22.1
1.40	–	–	–	–	4.5	83.3	2.6	23.5
1.45	–	–	–	–	4.6	88.6	2.7	25.1
1.50	–	–	–	–	4.8	94.2	2.8	26.6
1.55	–	–	–	–	4.9	99.8	2.9	28.2
1.60	–	–	–	–	5.1	105.6	3.0	29.9
1.65	–	–	–	–	–	–	3.1	31.5
1.70	–	–	–	–	–	–	3.2	33.3
1.75	–	–	–	–	–	–	3.3	35.0
1.80	–	–	–	–	–	–	3.4	36.8
1.85	–	–	–	–	–	–	3.5	38.7
1.90	–	–	–	–	–	–	3.6	40.6
1.95	–	–	–	–	–	–	3.7	42.5

d	16		20		26		32	
DN	12		15		20		25	
Q [l/s]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]	v [m/s]	R [hPa/m]
2.00	–	–	–	–	–	–	3.8	44.4
2.05	–	–	–	–	–	–	3.9	46.4
2.10	–	–	–	–	–	–	4.0	48.5
2.20	–	–	–	–	–	–	4.1	52.7
2.30	–	–	–	–	–	–	4.3	57.0
2.40	–	–	–	–	–	–	4.5	61.5
2.50	–	–	–	–	–	–	4.7	66.1
2.60	–	–	–	–	–	–	4.9	70.9
2.70	–	–	–	–	–	–	5.1	75.9

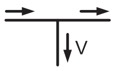
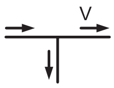
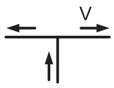
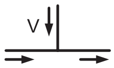
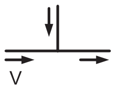
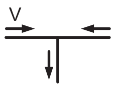
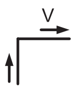
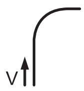
4.3 Pressure losses for system parts

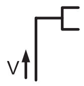
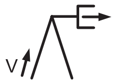
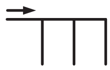
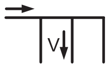
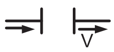
The ζ values and the equivalent lengths of the pipelines were determined in accordance with the specifications of the SVGW (SV EN 1267).

> **Loading unit and ζ value**
> A loading unit **LU** is equal to a flow of 0.1 l/s.
> The ζ value for w = 2 m/s, as shown in the table.

4.3.1 Simplified representation for 1 loading unit (LU)

TV.14 **Pressure losses in iLITE system parts**

No.	JRG code	Designation	Abbreviations	Symbol[a]	Dimension DN/d	ζ value	Equivalent length of pipeline [m]
1	E650, E652	Tee branch Flow separation	TA[b]		12/16	3.7	1.35
					15/20	3.8	1.65
					20/26	3.3	–
					25/32	3.2	–
2	E650, E652	Tee passage Flow separation	TD[b]		12/16	0.9	0.35
					15/20	0.8	0.35
					20/26	0.7	–
					25/32	0.7	–
3	E650, E652	Tee counter current Flow separation	TG[b]		12/16	3.5	1.80
					15/20	3.6	1.55
					20/26	3.7	–
					25/32	3.8	–
4	E650, E652	Tee branch Flow merging	TVA[b]		12/16	7.0	2.55
					15/20	7.1	3.05
					20/26	5.4	–
					25/32	4.7	–
5	E650, E652	Tee passage Flow merging	TVD[b]		12/16	11.7	4.25
					15/20	11.8	5.05
					20/26	8.9	–
					25/32	7.8	–
6	E650, E652	Tee counter current Flow merging	TVG[b]		12/16	8.2	3.00
					15/20	8.3	3.55
					20/26	6.2	–
					25/32	5.5	–
7_A	E670	90° angle	W90		12/16	3.4	1.25
					15/20	3.4	1.45
					20/26	3.0	–
					25/32	3.0	–
7_B	–	Pipe/bend 90°	(B90)		12/16	0.2	0.10
					15/20	0.2	0.10
					20/26	0.2	0.20
					25/32	0.2	0.20
(8_A)	–	45° angle	W45		12/16	–	–
					15/20	–	–
					20/26	–	–
					25/32	–	–
8_B	–	Pipe/bend 45°	(B45)		12/16	0.1	0.05
					15/20	0.1	0.10
					20/26	0.1	0.10
					25/32	0.1	0.10
9	E735, E730	Reduction	RED		12/16	–	–
					15/20	0.8	0.40
					20/26	1.0	–
					25/32	1.0	–

No.	JRG code	Designation	Abbreviations	Symbol[a]	Dimension DN/d	ζ value	Equivalent length of pipeline [m]
10	E610, E615	Wall mounting bracket	WS		12/16	2.3	0.85
					15/20	2.8	1.20
					20/26	–	–
					25/32	–	–
(11)	E616	Double wall mounting bracket Transfer	WSD		12/16	2.0	0.75
					15/20	2.7	1.15
					20/26	–	–
					25/32	–	–
(12)	E616	Double wall mounting bracket Pipe branch	WSA		12/16	2.2	0.85
					15/20	4.3	1.90
					20/26	–	–
					25/32	–	–
13_{A}	E640, E645	Distributor Transfer	STV_{D}		12/16	0.5	–
					15/20	0.6	–
					20/26	–	–
					25/32	–	–
13_{B}	E640, E645	Distributor Pipe branch	STV_{A}		12/16	3.8	1.40
					15/20	1.9	0.85
					20/26	–	–
					25/32	–	–
14	E690	Coupling Socket	K		12/16	0.4	0.15
					15/20	0.4	0.20
					20/26	0.3	–
					25/32	0.3	–

a The formula symbol v for flow velocity indicates the location of the relevant reference velocity in the fitting and connecting piece.
b When using reduced T-pieces, the resistance value of the equal T-piece with the smallest dimension of the reduced T-piece is used to calculate the flow path.
General information: The loss coefficient ζ is assigned to the volumetric flow (partial flow), which is marked with the graphic symbol "V".

V

4.4 Discharge times

The discharge times indicate the time elapsed until a temperature of 40°C is reached at the tap (in accordance with SIA 385/2, 2015 edition) and signal the beginning of usability. These discharge times apply to fully opened taps set to maximum "hot". In the interests of economical water and energy consumption, these discharge times should not be set too high.

In order to keep the discharge losses within economically justifiable limits and at the same time to meet the comfort requirements of the hot water user, the requirements defined in [TV.15] for discharge periods apply.* The measurement itself is carried out with the fitting installed at the installation site.

If it is not possible to choose a distribution system that conveys the hot water from the hot water storage tank to the tap within a reasonable time (discharge time), a circulation pipeline or auxiliary heating system must be planned and installed, or the arrangement of the sanitary equipment and riser zones must be optimised.

TV.15
Requirements – Discharge times
* Excerpt from SIA 385/1

Sanitary fixtures	Discharge time t [s]	
	without keeping warm (e.g. without circulation)	with keeping warm (e.g. with circulation)
Vanity unit, wash-hand basin, bidet, showers, bathtubs, sink (kitchen), utility sink	15	10

According to EN 806-2 also applies to the intended operation:

- Drinking water, cold: Max. 30 s after full opening of a tapping point:
  - Temperature must not exceed 25 °C.
- Drinking water, hot: Max. 30 s after full opening of a tapping point:
  - Temperature must be min. 55 °C.

According to VDI 6003 the following values result for different sanitary objects:

TV.16
Discharge times – Requirements
* Excerpt from VDI 6003 (requirement levels = comfort criteria)

Sanitary fixtures	Useful temperature [°C]	Discharge time t [s]*		
		Requirement level		
		I	II	III
Vanity unit	40	60	18	10
Shower	42	~26	10	7
Bathtub	45	~26	12	9
Flushing	50	60	18	10
Bidet	40	–	15	15
Whirlpool / Large tub	50	–	10	10

Factors influencing the output times include the following

TV.17 **Factors for output times**

Desired comfort	(criteria)
Floor plan	Distance to sanitary objects, grouping
Number of strings supplying the apartment	
Planning, construction and operation • Compliant with regulations (according to TRWI) or not	• with or without circulation system • Running time of the circulation pump. If the circulation pump is switched off, the distribution lines for domestic hot water will inevitably cool down. Fixed discharge times are then no longer to be observed. • Correct sizing of the circulation system, based on the product-specific resistance coefficients of the piping system.
Floor installation type	• Distribution with single supply line • Tee installation • Pipeline in series • Ring pipeline
Supply type hot water	• Individual supply line • Group supply: decentralized or centralized in apartments • Central supply: Storage system or storage charging system

Calculation

Calculating the discharge time
➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [12] 'Dimensioning'

The discharge times must be matched to the pipe dimension, length of the pipeline and the volume flows. Especially when using energy-saving mixers (flow restrictors), the effective volumetric flow must always be determined and converted (acc. to SIA 385/2, Issue 2015, Annex G), because the reduced volumetric flow results in a longer discharge time.

The calculation is based on the standard SIA 385/1, which contains the fundamental principles and requirements for domestic hot water systems. The calculation is also based on the standard SIA 385/2, which describes the hot water demand, the overall requirements and the design, such as the calculation of the discharge times.

Discharge times for iLITE multilayer composite pipes

The table does not consider fittings but only pipes.

- Input variables: Outside diameter d, wall thickness s_w
- Calculated quantities: [l/m], max. length of pipeline [m], discharge times [s/m]

TV.18 **Discharge times and lengths – iLITE multilayer composite pipes**

Pipe, Dimension				max. feasible duration of the discharge times [s] of						Discharge time [s] for each 1 m length of pipeline		
			[s]	15			10			Cold phase + warm-up phase		
			[l/s_w]	0.1	0.2	0.3	0.1	0.2	0.3	0.1	0.2	0.3
DN	d	s_w	[l/m]	max. length of pipeline [mm]						[s]		
12	16	2.0	0.113	6.6	13.2	19.8	4.4	8.8	13.2	2.3	1.1	0.8
15	20	2.5	0.177	4.2	8.4	12.7	2.8	5.6	8.4	3.5	1.8	1.2
20	26	3.0	0.314	2.3	4.7	7.1	1.5	3.1	4.7	6.3	3.1	2.1
25	32	3.0	0.531	1.4	2.8	4.2	0.9	1.8	2.8	10.6	5.3	3.5

4.5 Change of length and compensation for expansion

Due to heat and depending on the material, pipelines expand to varying degrees. Even if the temperatures of the medium (e.g. drinking water) exceeds room temperature, this causes a thermal expansion and must be taken into account in the design of the installation.

How to calculate the change in length
In order to calculate the change in length, product and material-specific values are required:
➨ Technical data for system, Chapter [2.1]

This thermally induced change in length can be compensated during the installation and mounting of the pipe. Suitable measures are:

- Directional changes of the pipeline
- Providing expansion space
- Installation of expansion joints
- Setting the fixed points and floating points

The bending and torsional forces occurring during the operation of a pipeline are safely absorbed, taking into account the above-mentioned measures. The following parameters have a significant influence on the expansion compensation:

- Material
- Structural conditions
- Operating conditions

Minor changes in length of the pipelines, especially if using smaller dimensions, can be compensated for by the elasticity of the piping system or with a corresponding insulation.

For larger piping systems, the changes in length must be absorbed by the **expansion joints**: Insulations, flexible pipe legs and U-shaped expansion loops compensate for the thermally induced change in length. The required measures for GF's plastic piping systems are – depending on the type of installation:

TV.19
Measures for the expansion compensation for plastic pipelines made by GF

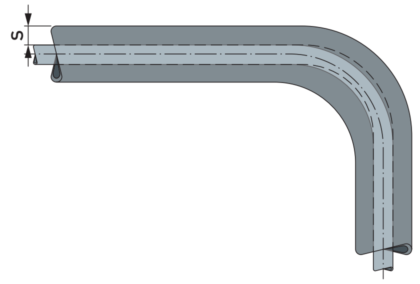
Medium	Cold water	Hot water/circulation/heater	
Dimension	d16 – d110	d16 – d26	d32 – d110
Length of pipeline L ≤12 m	If using insulated pipelines, compensation for the change in length does **not** require floating points and fixed points		
Length of pipeline L ≥12 m	If using insulated pipelines, compensation for the change in length does **not** require floating points and fixed points		Compensation for the change in length requires floating points and fixed points

4.5.1 Compensation for the change in length by using insulation

When having to compensate for the change in length due to the insulation, the minimum insulation thickness **s** must be at least 1.5 times the length change. From the calculated amounts of the change in length, the insulation thickness per meter of straight pipeline length is calculated according to the following formula:

$$s = 1.5 \cdot \Delta l$$

s Insulation thickness, min.
Δl Change in length



Installations with temperatures up to 60°C (ΔT = 50 K), a change in length Δl of 1.3 mm must be taken into account for each meter of straight pipe. This equals to an insulation thickness of 2.0 mm per meter of straight pipe length.

Insulation
General information on insulation:
➨ Part IV 'Plan', Section 'Insulation, Fire protection'
Information about insulation when installing riser pipes:
➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [13] 'Installation and attachment'

V

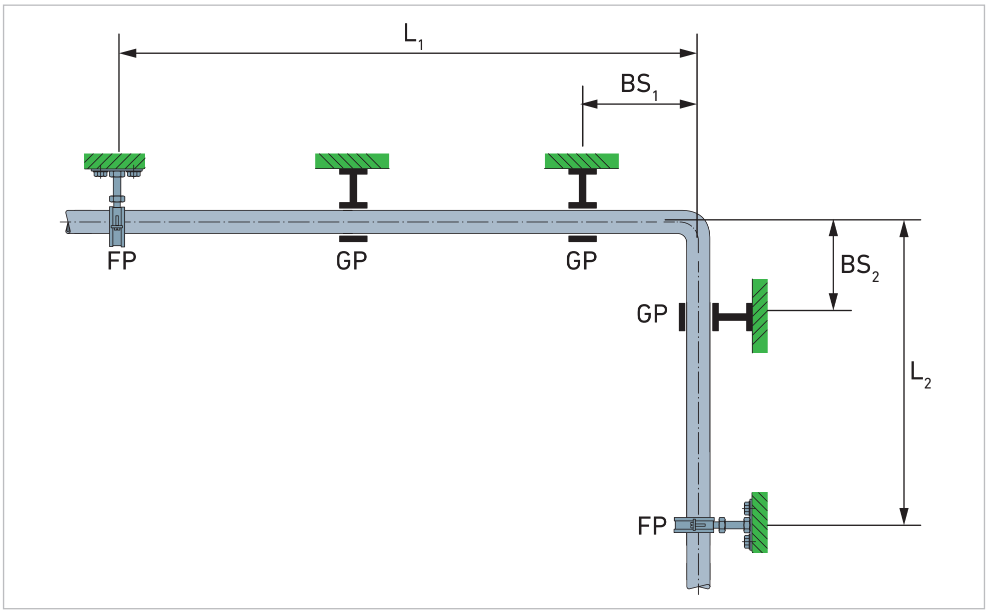
4.5.2 Compensation for the change in length by using expansion joints

Flexible pipe legs and **U-shaped expansion loops** are used as **expansion joints**. In order to ensure the function of the 2D expansion loop, **fixed points** and **floating points** (with sliding pipe clips) are installed.

Fixed points can be created at a suitable location along the pipeline, using a commercially available, custom-fit fixed point clips or a system-specific solution (e.g. fixed point clip in combination with a fixed-point pipe clip of the system used).

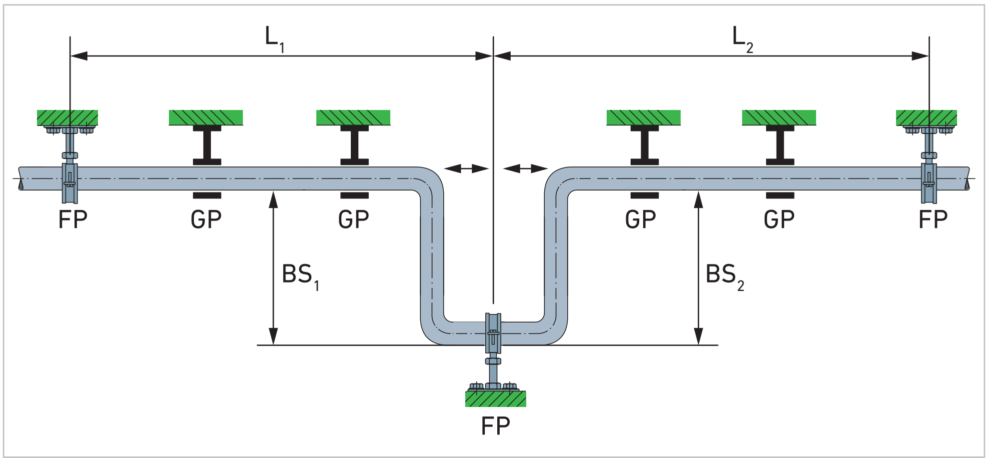
The **pipe clip** must assume the shape of the pipe and, when tightening the clip, the actual pipe diameter must not be constrict by more than 0.5 mm.

Examples – Basic design of a flexible pipe leg and U-shaped expansion loop



GV.5
Flexible pipe leg

FP Fixed point
GP Floating point (with sliding pipe clip)
BS Flexible pipe leg
L Pipe length between fixed point and deflection



GV.6
U-shaped expansion loop

FP Fixed point
GP Floating point (with sliding pipe clip)
BS Flexible pipe leg
L Pipe length between fixed point and deflection

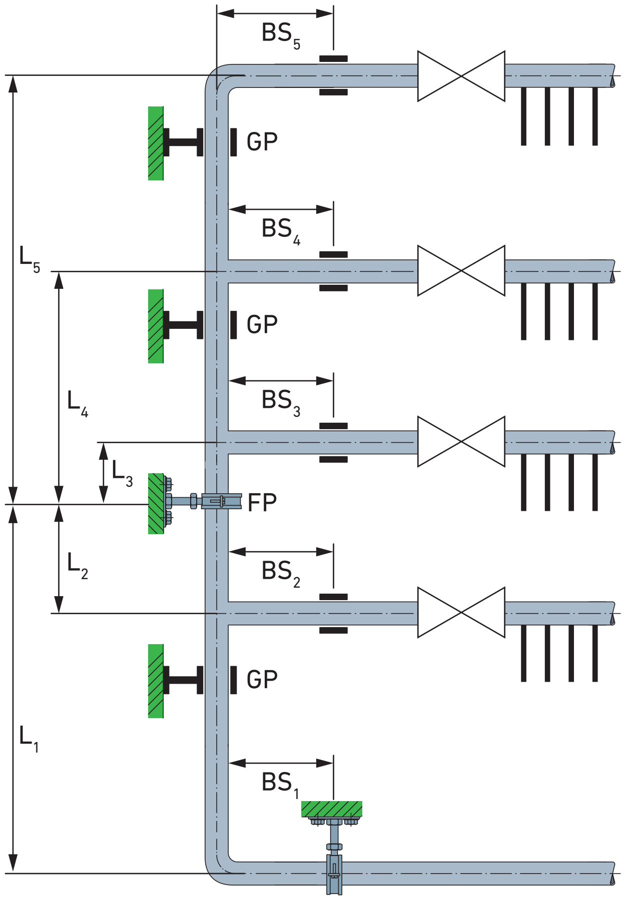
4.5.3 Fixed points and floating points when using riser pipes

If riser pipes are leading up to several storeys and accordingly have multiple fixed points (FP), the change in length between the individual fixed points must be absorbed by the flexible pipe leg (BS). The sliding pipe clamp mounted to the horizontal pipe affects the **vertical** expansion of the pipe similar to a fixed point (FP).

Examples – Basic design of fixed points (FP) and floating points (GP)

TV.20 **Spacing of fixed points and floating points in a riser pipe**

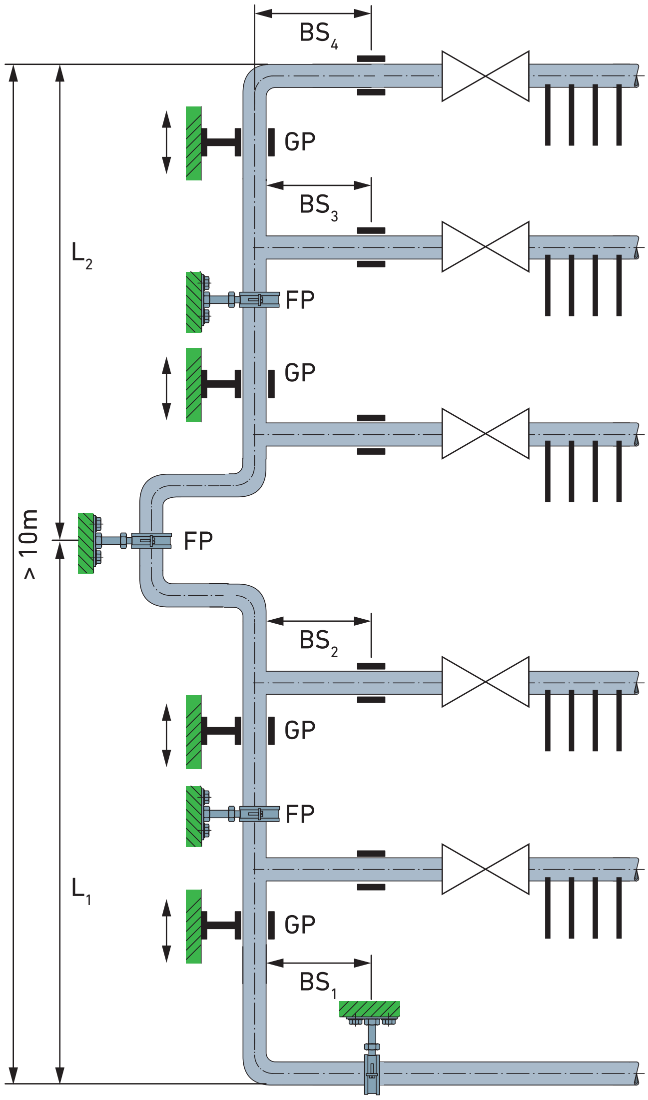
Riser pipe up to a height of 10 m



Up to a **riser pipe height of 5 m,** neither a U-shaped expansion loop nor a fixed point shall be installed along the riser pipe.

Up to a **riser pipe height of 10 m,** a U-shaped expansion loop can be omitted. In the middle of the riser pipe, however, a fixed point (FP) must be installed.

Riser pipe starting at a height of 10 m



Starting at a **riser pipe height of 10 m,** a U-shaped expansion loop with fixed points (FP) must be installed at intervals of 10 m.

L_{1-5}	Pipe length between fixed point and deflection
FP	Fixed point
BS_{1-5}	Flexible pipe leg
GP	Floating point (with sliding pipe clip)

4.5.4 How to calculate the change in length

The **change in length of a pipeline** and the corresponding design of the flexible pipe leg and U-shaped expansion loop also depend on the material used. When calculating the change in length, this must be taken into account by using corresponding material-dependent parameters.

The **calculation of the length of the flexible pipe leg** depends on the design of the flexible pipe leg:

- If using a **flexible pipe leg** in order to compensate for an extension, or if a branch line is used, the length of the flexible pipe leg must be calculated.
- If a **U-shaped expansion loop** is used to compensate for the expansion, the length of both flexible pipe legs that form the U-shaped expansion loop must be calculated.

Material constant and coefficient of thermal expansion
In order to calculate the change in length, product and material-specific values arerequired:
➨ Technical data for system, Chapter [2.1]

How to calculate the change in length

The thermally induced **change in length** Δl of pipes is calculated (in non-resisting installations) from the **temperature difference** ΔT and the **pipe length** L, using the following formula:

$$\Delta l = \alpha \cdot L \cdot \Delta T$$

Symbol	Meaning	Unit	Remark
L	Length of pipeline	[m]	–
α	Linear coefficient of thermal expansion	[mm/(m·K)]	product-/material-specific
Δl	Change in length	[mm]	–
ΔT	Temperature difference	[K]	–

Example on how to calculate a multilayer composite pipe (PE-RT / Al / PE-RT)

The length of the pipeline is 5 m. The thermally induced change of length of this pipe section must be absorbed by a flexible pipe leg. The difference between the installation temperature and the maximum operating temperature is 50 K.

Multilayer composite pipe, Dimension	d32
Length of pipeline L	5 m
Linear coefficient of thermal expansion α	0.024 mm/(m·K)
Temperature difference ΔT	50 K (20°C – 70°C)

How to calculate the change in length

$$\Delta l = \alpha \cdot L \cdot \Delta T$$

$$\Delta l = 0.024\ [mm/(m \cdot K)] \cdot 5\ [m] \cdot 50\ [K]$$

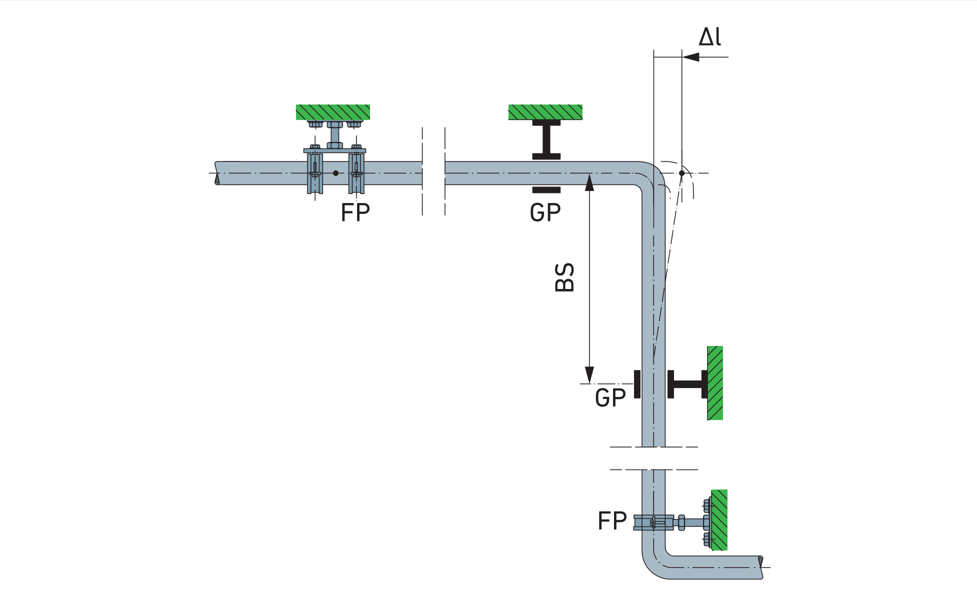
$$\Delta l = 6.0\ mm$$

4.5.5 Calculation of the flexible pipe leg

Calculation of the length of the flexible pipe leg

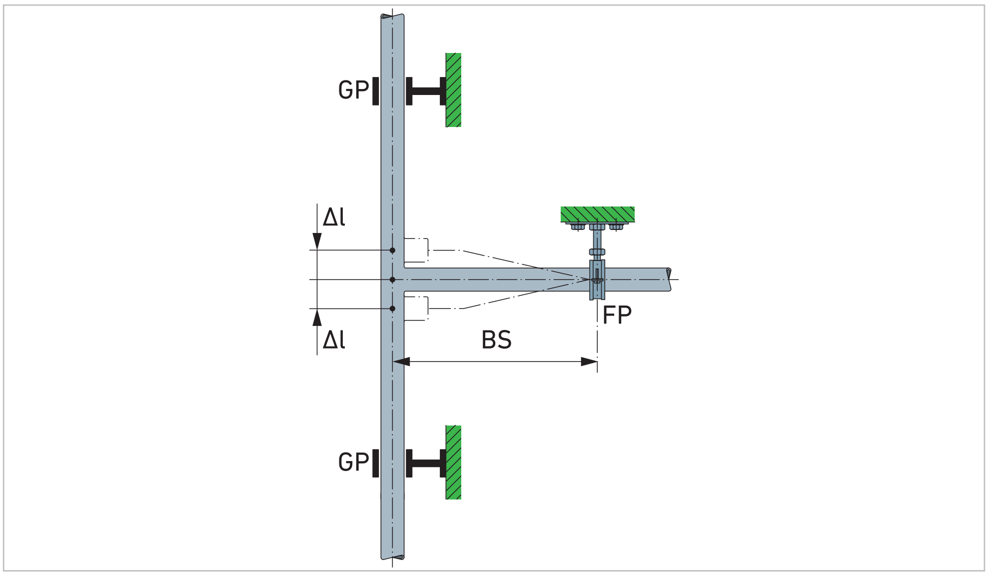
Due to the thermally induced change in length **Δl** , a pipeline shifts a pipe bend by a value **Δl**.
This change must be absorbed by a flexible pipe leg with a length equal to BS.

Length of flexible pipe leg



GV.7
Length of flexible pipe leg
GP Floating point
FP Fixed point
BS Length of flexible pipe leg

Length of flexible pipe leg intended to use for the branch line



GV.8
Length of flexible pipe leg
GP Floating point
FP Fixed point
BS Length of flexible pipe leg

The **length of the flexible pipe leg** BS is calculated from the **change in length** Δl and the **outside diameter** d of the pipe, using the following formula:

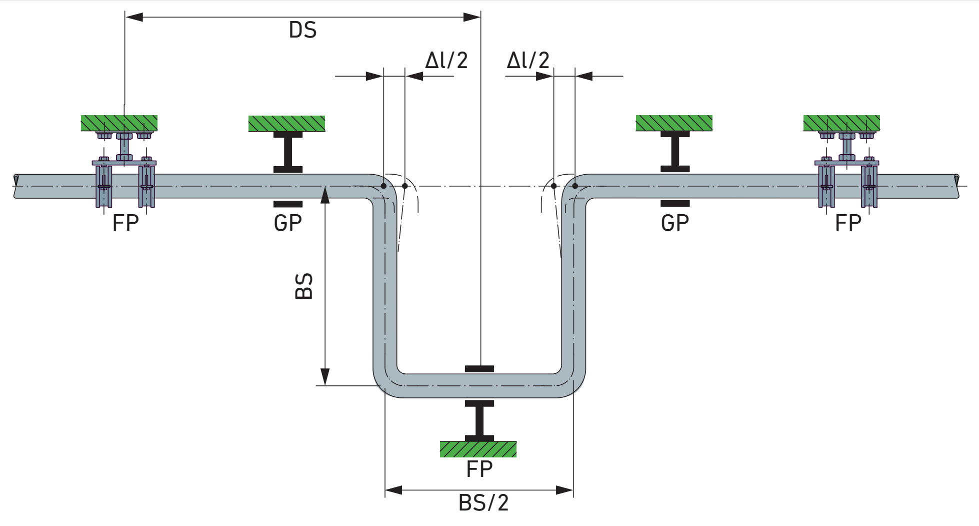
$$BS = C \cdot \sqrt{d \cdot \Delta l}$$

Symbol	Meaning	Unit	Remark
BS	Length of flexible pipe leg	[mm]	–
d	Outside diameter of pipe	[mm]	–
Δl	Change in length	[mm]	–
C	Material constant	–	product/material-specific

Calculation of the length of the flexible pipe leg in a U-shaped expansion loop

Due to the thermally induced change in length **Δl** , a pipe displaces a U-shaped expansion loop at both bends by half the value **Δl**. This change must be absorbed by the two flexible pipe legs **BS**.

Length of the U-shaped expansion loop



GV.9
Length of the U-shaped expansion loop

GP Floating point
FP Fixed point
BS Length of flexible pipe leg
DS Length of the 2D expansion loop

Example on how to calculate a multilayer composite pipe (PE-RT / Al / PE-RT)

The length of the pipeline is 5 m. The thermally induced change of length of this pipe section must be absorbed by a flexible pipe leg. The difference between the installation temperature and the maximum operating temperature is 50 K.

Multilayer composite pipe, Dimension	d32
Material constant C	33
Change in length Δl	6.0 mm

Calculation of the length of the flexible pipe leg

$$BS = C \cdot \sqrt{d \cdot \Delta l}$$

$$BS = 33 \cdot \sqrt{(32\ \text{mm} \cdot 6.0\ \text{mm})}$$

$$BS = 457\ \text{mm}$$

In order to simplify the determination of the required length of the flexible pipe leg, a material-specific diagram can also be used to determine the length of the flexible pipe leg.

When comparing this result with the result of a metal pipe – which has the same dimension – the size of a flexible pipe leg made of metal will be significantly larger. The explanation for this is the much higher material constant C for metal pipes than the material constant C for a plastic pipe.

4.6 Diagrams – Change in length and length of flexible pipe leg

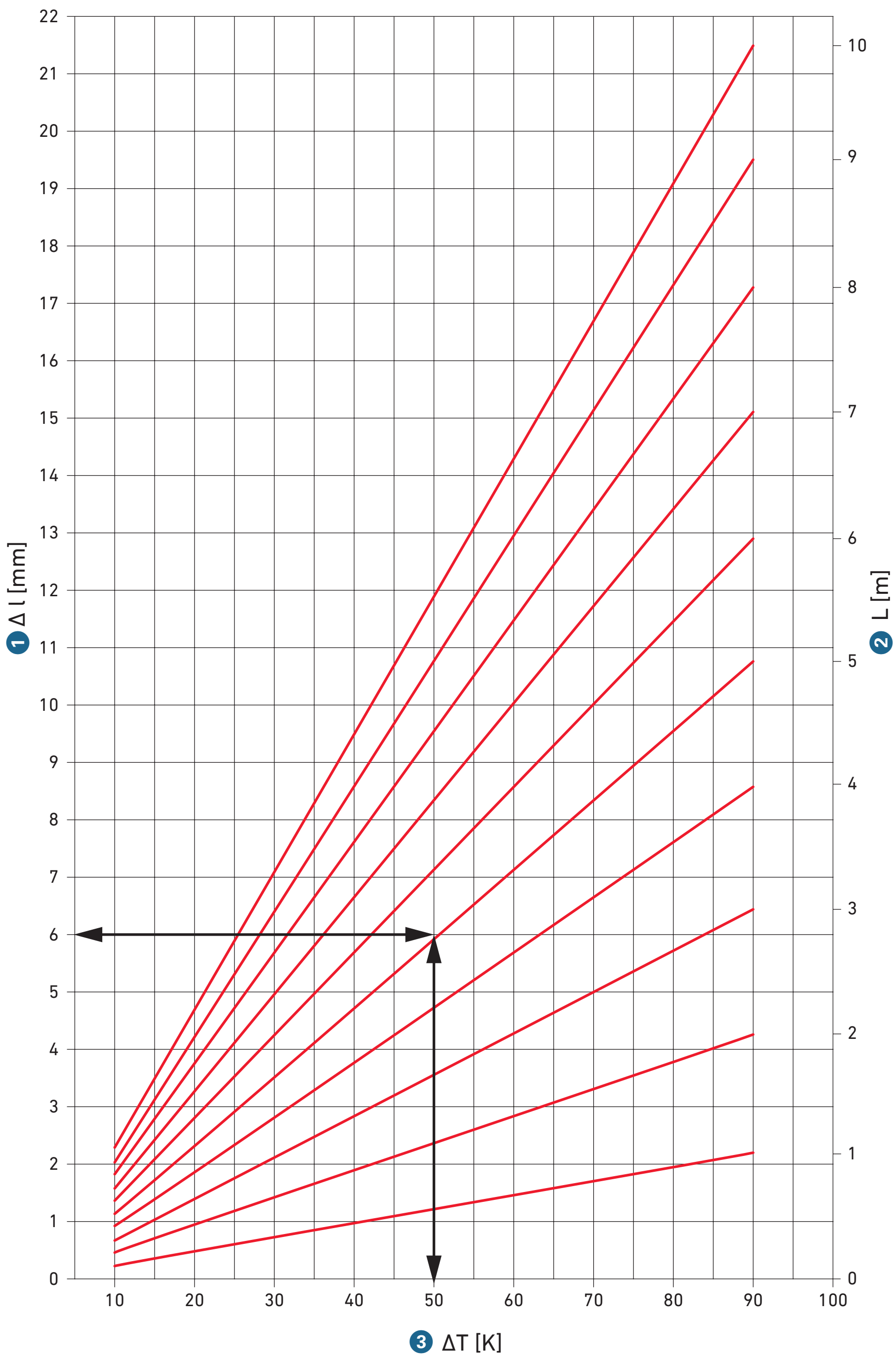
4.6.1 Change in length

The diagram shows the linear expansion of iLITE multilayer composite pipes
as a function of temperature and length of the pipe during resistance-free laying.

How to read the table

Multilayer composite pipe, Dimension	d32
Length of pipeline L	5.0 m
Temperature difference ΔT	50 K (20°C – 70°C)
Change in length Δl	6.0 mm

Δl = 6.0 mm



GV.10
Change in length - iLITE multilayer composite pipes

1. Change in length
2. Length of pipeline
3. Temperature difference

TV.21 **Thermally induced change of length**

Length of pipeline [m]		Temperature difference ΔT [K]								
		10	20	30	40	50 ▼	60	70	80	90
		Change in length [mm]								
1		0.24	0.48	0.72	0.96	1.2	1.44	1.68	1.92	2.16
2		0.48	0.96	1.44	1.92	2.4	2.88	3.36	3.84	4.32
3		0.72	1.44	2.16	2.88	3.6	4.32	5.04	5.76	6.48
4		0.96	1.92	2.88	3.84	4.8	5.76	6.72	7.68	8.64
5	▶	1.2	2.4	3.6	4.8	**6.0**	7.2	8.4	9.6	10.8
6		1.44	2.88	4.32	5.76	7.2	8.64	10.08	11.52	12.96
7		1.68	3.36	5.04	6.72	8.4	10.08	11.76	13.44	15.12
8		1.92	3.84	5.76	7.68	9.6	11.52	13.44	15.36	17.28
9		2.16	4.32	6.48	8.64	10.8	12.96	15.12	17.28	19.44
10		2.4	4.8	7.2	9.6	12	14.4	16.8	19.2	21.6
15		3.6	7.20	10.80	14.4	18	21.6	25.2	28.8	32.4
20		4.8	9.6	14.4	19.2	24	28.8	33.6	38.4	43.2

▶ Example for L = 5 m: ΔT = 50 K)

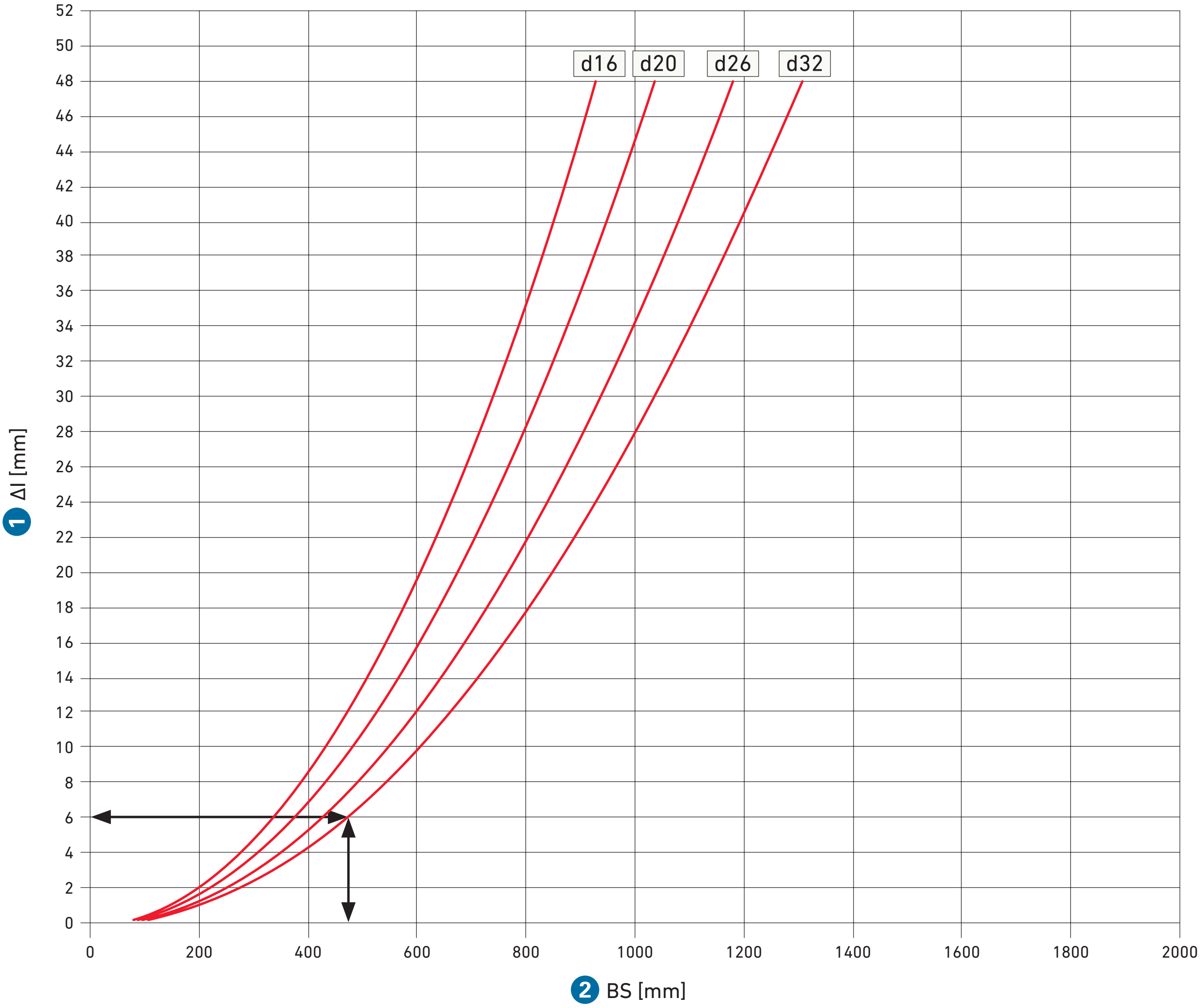
4.6.2 Length of flexible pipe leg

The length of the flexible pipe leg is derived from the pipe's change in length:

How to read the table

Multilayer composite pipe, Dimension	d32
Material constant C	33
Change in length Δl	6.0 mm

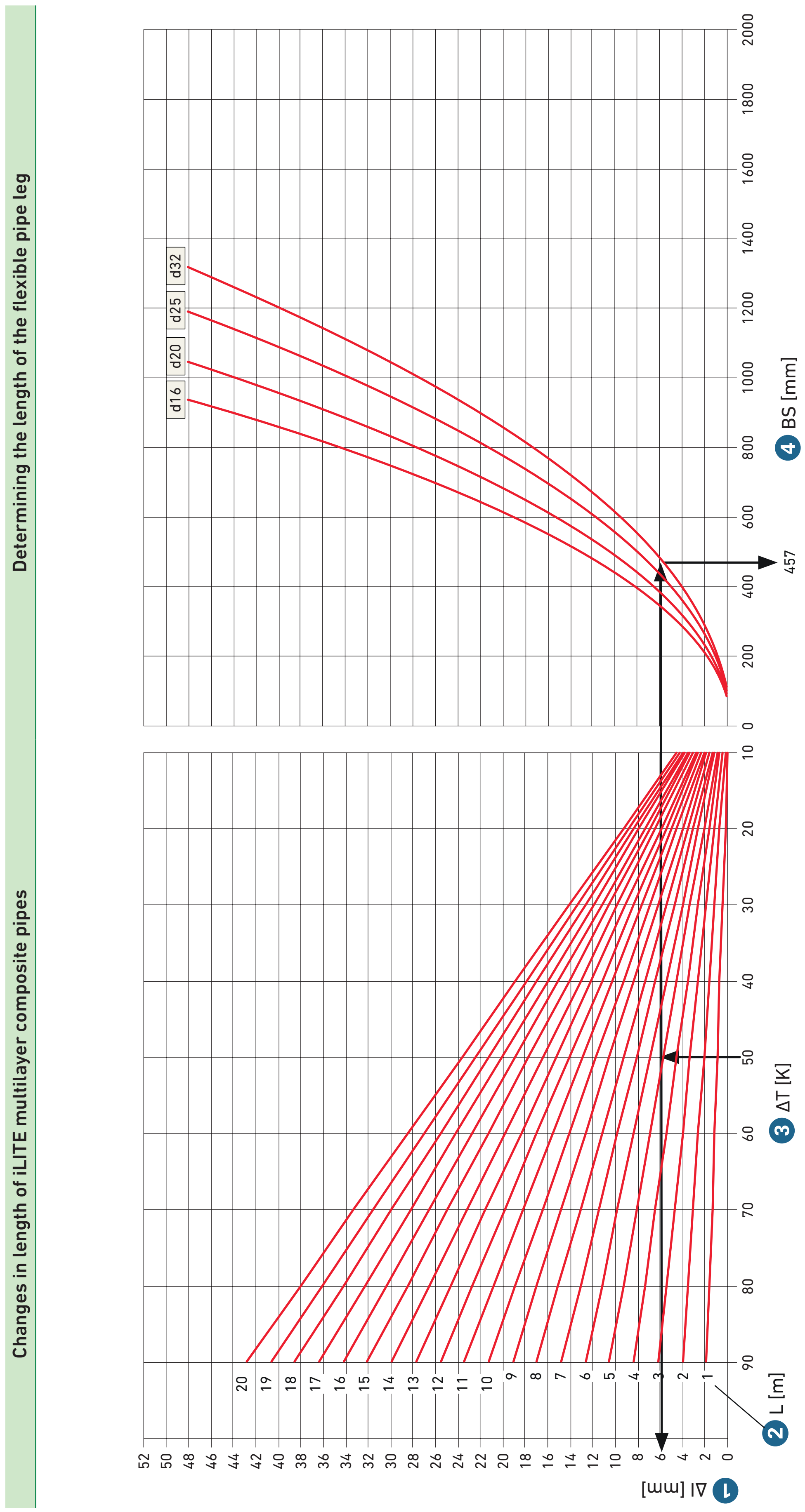
BS = 457 mm



GV.11
Length of flexible pipe leg
1 Change in length of the pipe
2 Length of flexible pipe leg

Graphic determination of the length of flexible pipe leg

The length of the flexible pipe leg can be determined with the two combined diagrams.



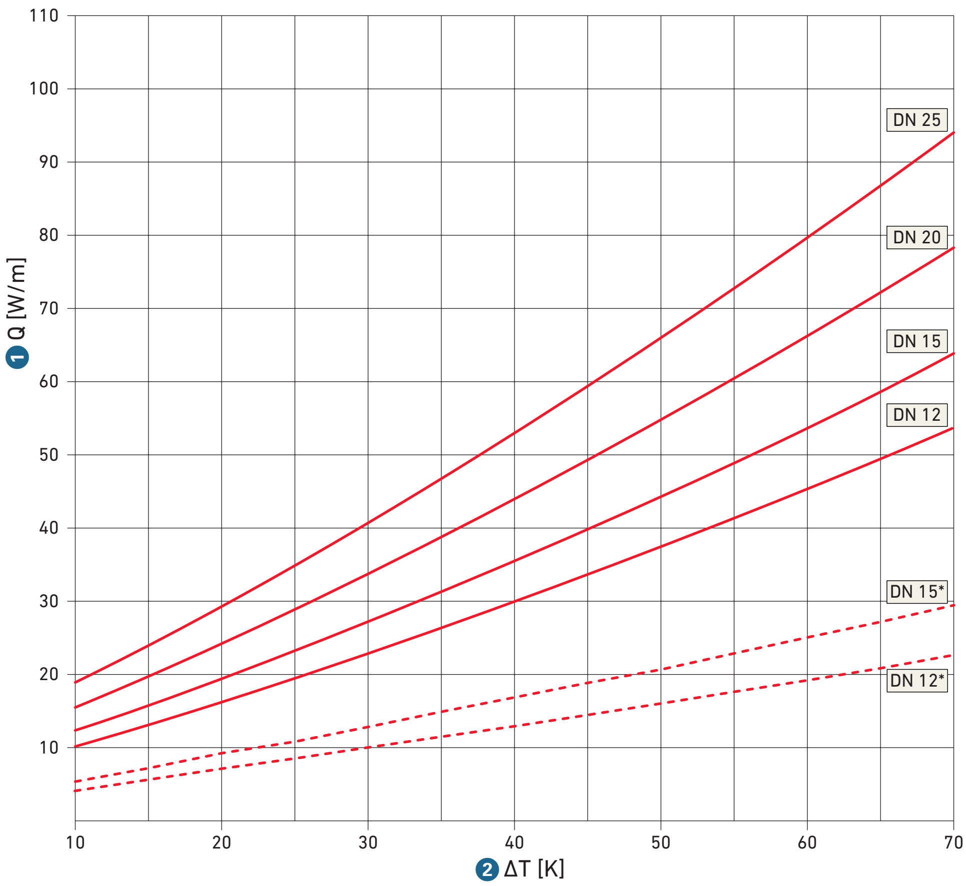
How to use the diagram

1. Read off temperature difference ❸.
2. Select the length of pipeline ❷.
3. Read change of length ❶.
4. Read off the pipe dimension.
5. Read length of the flexible pipe leg ❹.

❶ Change in length
❷ Length of pipeline
❸ Temperature difference
❹ Length of flexible pipe leg

4.7 Heat emission and insulation

iLITE multilayer composite pipe, with/without PE protective conduit

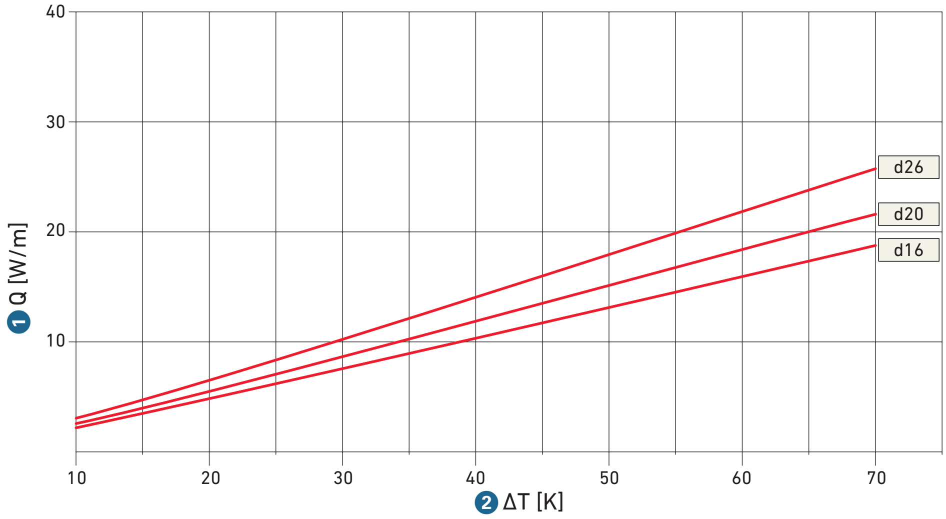


GV.12
Heat dissipation - iLITE multilayer composite pipe, with/without PE protective tube

1. Heat emission
2. Temperature difference

* inside the protective conduit

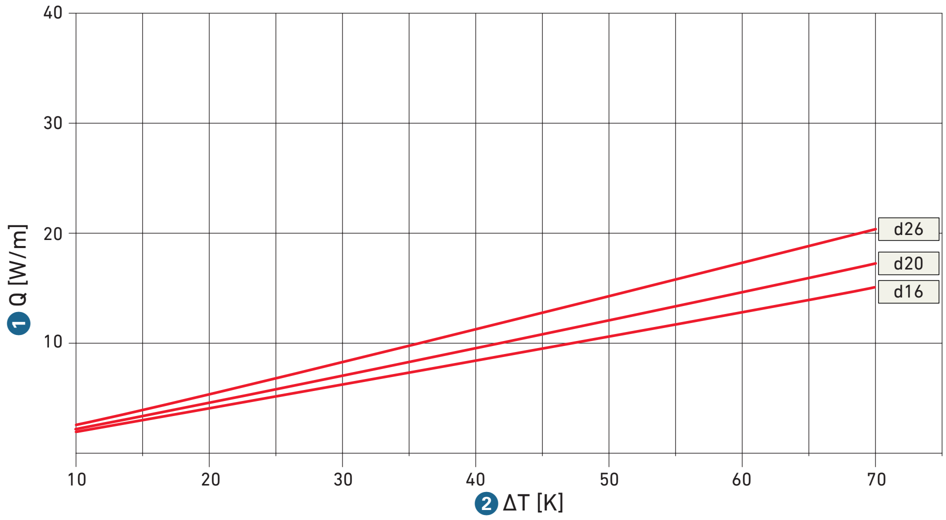
iLITE multilayer composite pipe, pre-insulated, 6 mm



GV.13
Heat emission – iLITE multilayer composite pipe, pre-insulated, 6 mm

Graph showing a 6 mm insulation with WLG 035
1. Heat emission
2. Temperature difference

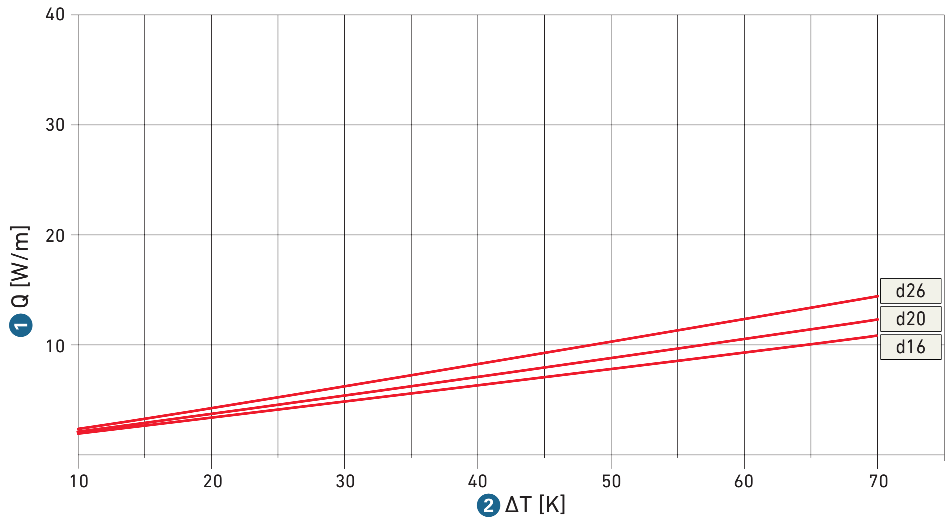
iLITE multilayer composite pipe, pre-insulated, 10 mm



GV.14
Heat emission – iLITE multilayer composite pipe, pre-insulated, 10 mm

Graph showing a 10 mm insulation with WLG 035
1. Heat emission
2. Temperature difference

iLITE multilayer composite pipe, pre-insulated, 20 mm



GV.15
Heat emission – iLITE multilayer composite pipe, pre-insulated, 20 mm

Graph showing a 20 mm insulation with WLG 035
1. Heat emission
2. Temperature difference

5 Insulation according to EnEV 2017

Insulation

General information on insulation:

➡ Part IV 'Plan', Section 'Insulation, Fire protection'

§ **Country-specific regulations**

The insulation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.

☑ When it comes to insulation methods, compliance with the applicable rules and regulations is mandatory.

The Energy Saving Ordinance (EnEV) requires limiting the heat output of heat distribution and hot water pipes. It replaces the previous Heating Installations Ordinance (HeizAnlV) and the Thermal Insulation Ordinance (WSchVO). The EnEV has been valid in **Germany** for building applications or submitted building notices since 01.02.2002, the current, revised version is the EnEV 2017. For new construction and modernization of heat distribution and hot water pipes and their fittings in buildings, these insulation regulations must be observed.

5.1 Insulation requirements of the EnEV 2017

The requirements are defined in table [TV.22] defined:

- Heating pipes and their fittings: according to lines 1 to 2
- Hot water pipes and fittings: according to lines 1 to 5
- Refrigerant distribution/chilled water lines: according to line 8

TV.22 **Insulation requirement of the EnEV 2017, Table 1**

Minimum insulation requirement	Rows	Type of pipes and fittings	Minimum thickness of the insulation layer [mm]*.
100%	1	Inner diameter d_i 22 mm	20
100%	2	Inner diameter$_{di}$ over 22 mm to 35 mm	30
100%	3	Inner diameter$_{di}$ over 35 mm to 100 mm	= Internal diameter
100%	4	Inner diameter d_i over 100 mm	100
50%	5	Lines and fittings according to lines 1 to 4 In wall and ceiling penetrations, in the intersection area of lines, at line connection points, at central line network distributors	50% of the requirements of lines 1 to 4
50%	6	Heat distribution lines according to lines 1 to 4, which were installed after January 31, 2002 in building components between heated rooms of different users	50% of the requirements of lines 1 to 4
6 mm	7	Lines according to line 6 in the floor structure	6
6 mm	8	Refrigeration distribution and chilled water piping and fittings of room air conditioning and air conditioning refrigeration systems.	6

Source: EnEV 2017, Table 1, Annex 5 (to Section 10 (2), Section 14 (5) and Section 15 (4))
* related to a thermal conductivity of λ = 0.035 W/(m K)

V

Supplementary information

1.

In cases of §10 par. 2 and §14 par. 5:

→ comply with the requirements of lines ❶ to ❼, unless otherwise specified in other provisions of the EnEV 2017.

In cases of §15 par. 4:

→ comply with the requirements of line ❽, unless otherwise specified in other provisions of the EnEV 2017.

If in cases of §14 par. 5 heat distribution and hot water pipes border on outside air:

→ Insulate these pipes with twice the minimum thickness according to lines ❶ to ❹⚡

2.

In cases of §14 par. 5:

→ [TV.22] **not** apply insofar as heat distribution lines according to lines ❶to❹ are located in heated rooms or in building components between heated rooms of a user and their heat output can be influenced by exposed shut-off devices.

In cases of §10 par. 2 and §14 par. 5:

→ Data in table [TV.22] do not apply to hot water pipes up to 3 liters, which are neither included in the circulation circuit nor equipped with electric trace heating and are located in heated rooms (stubs).

Although there are no legal requirements here, insulation should be used for reasons of corrosion protection, to prevent cracking and flowing noises, to insulate structure-borne noise and to reduce the thermal load.

3.

For materials with thermal conductivities other than 0.035 W/(m K):

→ Convert minimum thicknesses of insulation layers accordingly. For conversion and thermal conductivity, use the calculation methods and values contained in the recognized rules of technology.

Proof must be provided by the manufacturer.

4.

For heat distribution and hot water pipes as well as cold distribution and cold water pipes:

The minimum thicknesses of the insulation layers according to [TV.22] may be reduced if an equivalent limitation of heat dissipation or heat absorption is also ensured with other pipe insulation arrangements and taking into account the insulating effect of the pipe walls.

5.1.1 Minimum thickness of insulation layers

The minimum thickness of the insulation layers, which are based on the inner diameter di, are related to a thermal conductivity of λ = 0.035 W/(m K) (WLG 035) (see in the following tables: red highlights). The following tables show the minimum insulation thicknesses for different thermal conductivities λ.

TV.23 **Minimum thickness of the insulation layer for pipes with 100% requirement** ([TV.22], **line 1-4**)

Thermal conductivity λ [W/(m K)]	16 x 2.25 12	20 x 2.50 15	26 x 3.00 20	32 x 3.00 25	40 x 3.50 32
0,025	11	11	12	17	18
0,030	15	15	16	23	24
0,035	**20**	**20**	**20**	**30**	**30**
0,040	26	26	25	38	38
0,050	44	41	39	59	57

TV.24 **Minimum thickness of the insulation layer for pipes with 50% requirement** ([TV.22], **line 5-6**)

Thermal conductivity λ [W/(m K)]	16 x 2.25 12	20 x 2.50 15	26 x 3.00 20	32 x 3.00 25	40 x 3.50 32
0,025	6	6	6	6	6
0,030	8	8	8	12	12
0,035	10	10	10	15	15
0,040	13	13	12	18	18
0,050	20	19	18	27	27

5.2 Insulation of drinking water pipes (cold)

Insulation of drinking water pipes (cold) is not covered by the EnEV 2017 covered. If there is no risk of legionella due to heating of the cold water, the insulation requirements according to DIN 1988-200 Table 8.

Insulation of drinking water pipes (cold)
➨ Part IV 'Plan', Section 'Insulation, Fire protection', Chapter [1.3] 'Insulating drinking water pipes (cold)')

However, in order to minimize the risk of legionella, the insulation thicknesses according to EnEV 2017, Annex 5, Table 1 in conjunction with DVGW W 551 and DVGW W 553 are recommended. During stagnation periods, even insulation cannot provide sufficient protection against heating.

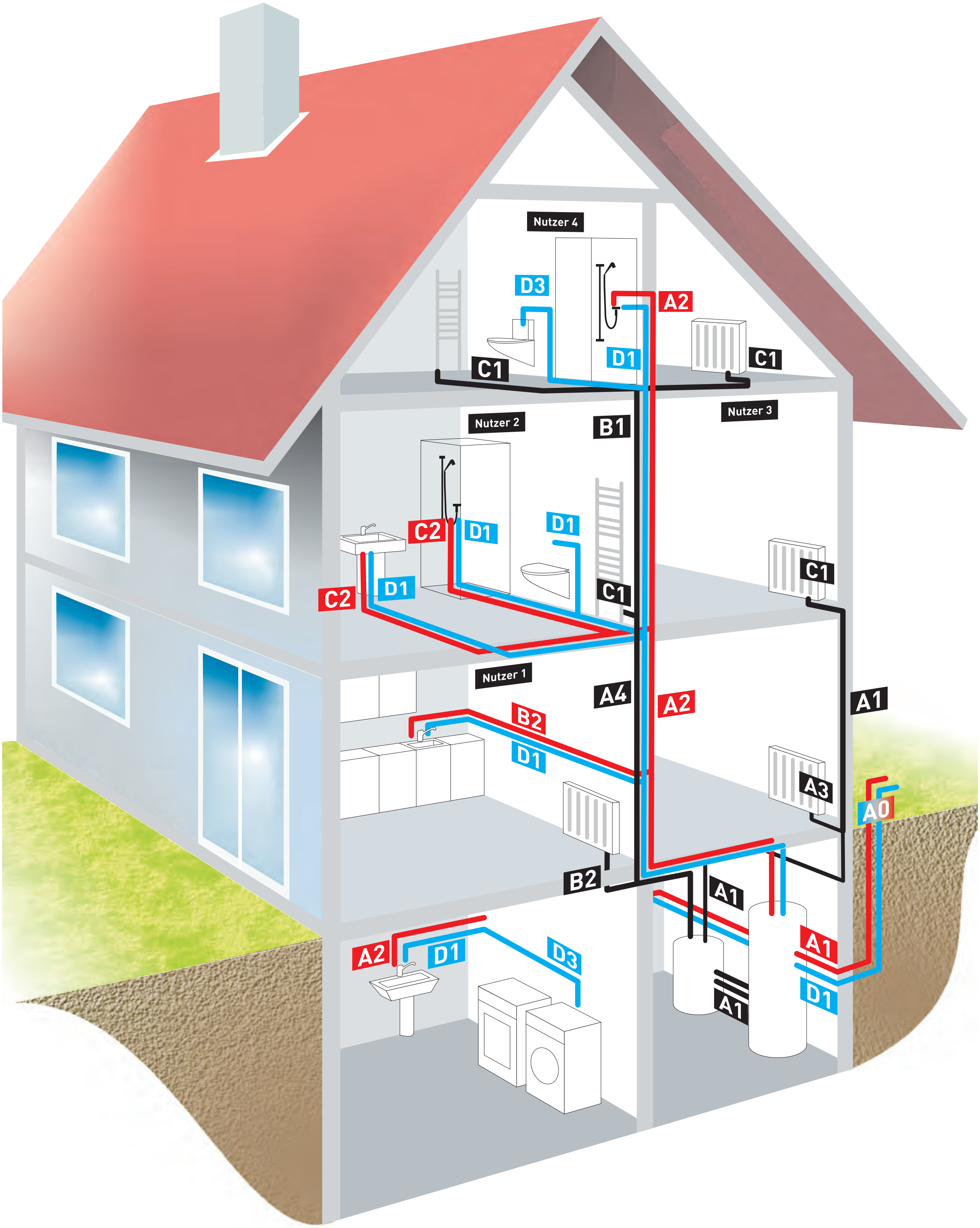
Actions:

→ Protect cold drinking water systems from inadmissible heating and, if necessary, condensation.
→ Locate cold-flowing potable water lines at a sufficient distance from heat sources. If this is not possible, insulate the pipes so that the heating does not adversely affect the drinking water's quality.

Inadequately insulated cold water pipes can also cause condensation to form on the surface of the insulation layer, and unsuitable materials can become damp through. Therefore, closed-cell or comparable materials with high water vapor diffusion resistance should be used. All joints, cuts, seams and end points must be sealed water vapor-tight.

5.3 Application

Due to these insulation regulations, heating and hot water pipes and their fittings in single-family and multi-family houses must be insulated, as shown in the following examples.



TV.25 **Heating and hot water pipes according to EnEV 2017**

Area	Installation situation pipelines	Insulation requirements [mm], for WLG 035
A0	• Heat distribution lines laid directly adjacent to the outside air	200% insulation
A1	• In exterior walls • In unheated rooms • Basement distribution pipelines	100% insulation ([TV.22], line 1 to 4)
A2	• Hot water pipes with/without circulation pipes • Circulation pipelines • Hot water pipes in basements with/without electrical trace heating	
A3	• Heating pipes in the room's floor structure intended for permanent residence of persons, against unheated rooms or ground or outside air.	
A4	• Distribution lines for the supply of several parties	
B1	• Pipes between heated rooms of different users	50% minimum insulation requirement ([TV.22], line 5 to 6)
B2	• Pipes and fittings in wall and ceiling openings • In areas where pipes are crossing • At pipe connection points • At pipe connection points • For central line network distributors	
C1	• Heating pipes in the floor structure between heated rooms of different users	6 ([TV.22], line 7 to 8)
C2	• No requirements for the minimum thickness of the insulation layer are imposed on heat distribution lines located in heated rooms or in components between heated rooms of a user and their heat emission can be influenced by exposed shut-off devices • Hot water pipes up to the inner diameter of 22 mm, which are neither included in the circulation circuit nor equipped with electric trace heating, are also exempt from these requirements	No requirement* (see "Supplementary information" in [TV.22])

* **NOTE:** This type of installation does not meet sound insulation requirements (prevention of structure-borne sound transmission). The thermal mobility of the pipeline (linear expansion) must also be ensured. Insulation is required to prevent structure-borne noise, cracking and flowing noises and the heating of other components. This is therefore recommended from a construction and economic point of view, even in this case, although the regulation text of the EnEV 2017 does not mandatorily require this.

TV.26 **Cold water pipes according to EnEV 2017**

Area	Installation situation pipelines	Insulation requirements [mm], for WLG 035
D1	• Pipes next to hot water pipes • Pipes in wall recesses next to hot water pipes • Pipes in the duct next to hot water pipes	10
D2	• Lines freely laid in heated room	6
D3	• Lines freely laid in unheated space • Pipes in the duct without hot water pipes • Lines in the wall slot, riser • Pipes on concrete ceilings	6

1. For materials with thermal conductivities other than 0.035 W/(m K):

→ Convert minimum thicknesses of insulation layers accordingly. For conversion and thermal conductivity, use the calculation methods and values contained in the recognized rules of technology.

Proof must be provided by the manufacturer.

2. Piping in areas subject to frost:

If pipelines are located in frost-prone areas, even insulation cannot provide sufficient and permanent protection against freezing during downtimes. They must be drained or otherwise protected (e.g. by trace heating). Details are regulated by the VDI guidelines VDI 2055 or VDI 2069.

3. In conjunction with DVGW W551 and DVGW W553 the insulation thicknesses according to EnEV 2017 are also recommended for **cold water pipes** to minimize the risk of legionella.

5.3.1 Application criteria applicable to pre-insulated iLITE pipes

Pipes d16 to d26 with 6 mm insulation

- Consisting of pipe and insulation
- Delivery in coils, 50 m long
- Concentric pipe insulation made of polyethylene foam with closed-cell material structure
- Insulation thickness 6 mm, WLG 035
- With durable, seamless foil coating, colour grey
- Building material class E

Suitable for cold drinking water pipes according to DIN 1988-2 (Table 9) and for central heating pipes in the floor structure between heated rooms of different users according to EnEV 2017 (Annex 5, Table 1, Line 7) as well as cold distribution and cold water pipes according to EnEV 2017 (Annex 5, Table 1, Line 8). In addition, uninterrupted impact sound insulation is necessary.

Pipes d16 to d26 with 10 mm insulation (50% EnEV)

- Consisting of pipe and insulation
- Delivery in coils, 50 m long
- Concentric pipe insulation made of polyethylene foam with closed-cell material structure
- Insulation thickness 10 mm, WLG 035
- With durable, seamless foil coating, colour grey
- Building material class E

Suitable for heating and hot water pipes with insulation requirements 50% according to EnEV 2017 (Annex 5, Table 1, Lines 5 and 6). In order to minimise the risk of legionella, the insulation thicknesses according to EnEV 2017 in conjunction with DVGW W551 and DVGW W553 are also recommended for cold water pipes. In addition, uninterrupted impact sound insulation is necessary.

Pipes d16 to d26 with 20 mm insulation (100% EnEV)

- Consisting of pipe and insulation
- Delivery in a coil, 50 m long (25 m for dimension d26)
- Concentric pipe insulation made of polyethylene foam with closed-cell material structure
- Insulation thickness 20 mm, WLG 035
- With durable, seamless foil coating, colour grey
- Building material class E

Suitable for heating and hot water pipes with insulation requirements 100% according to EnEV 2017 (Annex 5, Table 1, Line 1). In order to minimise the risk of legionella, the insulation thicknesses according to EnEV 2017 in conjunction with DVGW W551 and DVGW W553 are also recommended for cold water pipes. In addition, uninterrupted impact sound insulation is necessary.

6 Fire protection

Fire protection
See the legal requirements as they apply to fire protection (prevention of the transmission of fire and smoke to other fire compartments) in the amended state building codes and the introductory decrees of technical building regulations (ETB).
General information on fire protection:
➨ Part IV 'Plan', Section 'Insulation, Fire protection'

§ Country-specific regulations

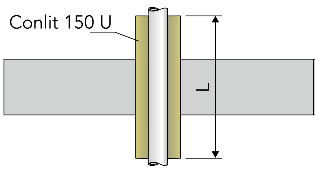
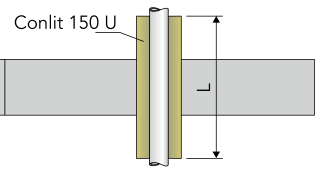
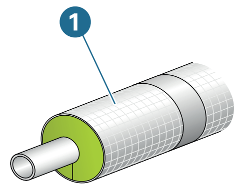
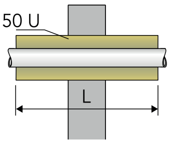
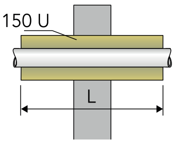
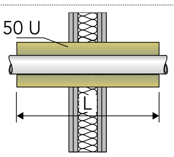
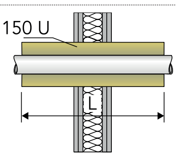
The insulation may be regulated differently in each country by laws, directives, ordinances, standards, regulations and bulletins.
☑ When it comes to insulation methods, compliance with the applicable rules and regulations is mandatory.

6.1 Implementation with Rockwool

R30 to R90 pipe penetrations for JRG installation systems with non-combustible media, e.g. drinking water, heating

Fire protection with Rockwool
For more information, see the Rockwool Planning Guide and the Rockwool website.

TV.27 **Components and implementation**

Component F 30 to F 90 Thickness [mm]	F 30	F 60 F 90	
Solid ceiling min. 150			
	L ≥ 1000 mm; WD [2]		
Solid wall min. 100			❶ ROCKWOOL 800 / Teclit PS Cold Minimum thickness: 30 mm
	L ≥ 1000 mm; WD [2]		
Lightweight partition min. 100			
	L ≥ 1000 mm; WD [2]		

Design variant according to ROCKWOOL abP P-3276/4140-MPA BS.

TV.28 **System and components**

System	Pipe dimension	Conlit 150 U		ROCKWOOL 800 [1), 2), 3)] Teclit PS Cold [1), 2), 3)]			
	Diameter, outside Da [mm]	Type [3)]	Insulation thickness [4)] s [mm]	Core drilling THK [mm]	EnEV 100%, warm, type	EnEV 50%, warm, type	DIN 1988-200, cold, type [3)]
iLITE PE-RT/Al/ PE-RT [5)]	16	16/22	22	60	18/20	18/20	18/20
	20	20/20	20	60	22/20	22/20	22/20
	26	26/17	17	60	28/20	28/20	28/20
	32	32/24	24	80	35/30	35/20	35/30

Notes and special installation conditions

1) In individual cases, the minimum insulation thickness that can be supplied is specified.

2) The insulation shell ROCKWOOL 800 or Teclit PS Cold can be used as further insulation.

3) For cold pipes, a vapor barrier must be installed according to DIN 1988-200. Therefore, only use fire protection pipe shell Conlit 150 U, insulation shell ROCKWOOL 800 or Teclit PS Cold.

4) Insulation thickness after EnEV 50% as well as according to DIN 1988-200 suitable for core drill diameter DK

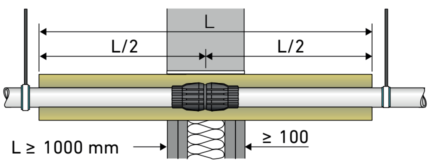
5) Sheathing (such as protective pipes or factory insulation) must be removed in the lead-through area.

All boundary conditions of the specified general building inspection test certificates (abP) must be taken into account.

R30 to R120 partitioning in solid walls, lightweight partition walls and solid ceilings

Further instructions for installing the JRG pipe connector in wall and ceiling penetrations:

➨ starting at P P-3726/4140-MPA BS, Annex 19



GV.16
Assembly of the JRG pipe connector

6.2 Implementation with Hilti

The ILITE system in combination with the Hilti fire protection bandage CFS-B is approved by the building authorities (abZ) for the following applications Z-19.53 2218 for the following applications:

- Solid ceilings, thickness: ≥150 mm
- Solid walls, thickness: ≥100 mm
- Lightweight partition walls (LTW), thickness: ≥100 mm

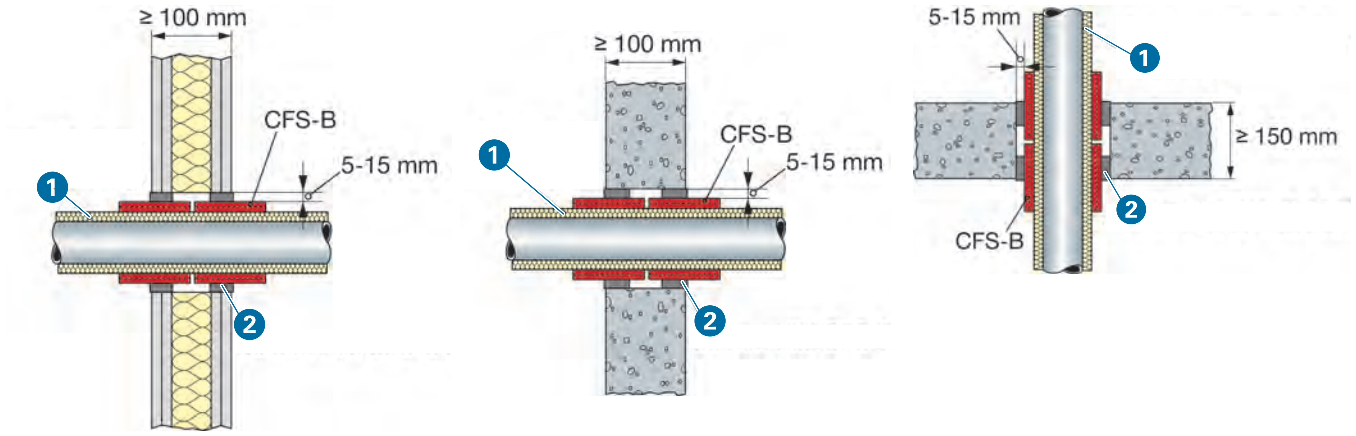
The ILITE system falls into pipe groups D and C and can therefore be installed in the following configurations.

More information
Further information can be found in the **special brochure HILTI + GF**, in the **HILTI Planning Helper** and on the HILTI website: www.hilti.de

6.2.1 Configurations with Hilti fire protection bandage CFS-B

TV.29 **Installation options and details**

Lightweight partition	Solid wall	Solid ceiling



1 Synthetic rubber insulation
2 25 mm Hilti CFS-S ACR

TV.30 **Installation options and details with Hilti fire protection bandage CFS-B - wall**

iLITE [mm]	Walls [mm]		Ceiling [mm]	Details	
	LTW, ≥100	Solid, ≥100	Solid ≥150	Pipe group	Insulation thickness [mm]
16	•	•	•	D	8–32
20	•	•	•	D	8–32
26	•	•	•	–	–
32	Lösungen mit HILTI Brandschutzstein CFS-BL P oder HILTI Brandschutzschaum CFS-F X möglich				

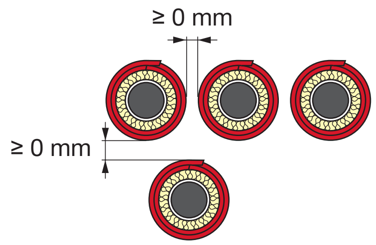
* 150 mm LTW/solid wall: min. Insulation thickness 9 mm for pipe group C
** 200 mm solid wall: min. Insulation thickness 9 mm for pipe group C

The remaining opening between the wall or ceiling and the insulated ILITE pipe must be completely filled with dimensionally stable, non-combustible building materials such as concrete, cement mortar (Hilti fire protection mortar CP636) or gypsum mortar to the thickness of the building component.

Optionally, a maximum 15 mm wide annular gap on both sides of the component may be filled to a depth of at least 25 mm with gypsum or Hilti Fire Protection Sealant CFS-S ACR.

6.2.2 Zero clearance with Hilti fire protection bandage CFS-B

ILITE pipes insulated with Hilti fire protection bandage CFS-B may be installed at zero distance from each other if they are installed in 150 mm thick solid components (wall, ceiling) or up to an outer pipe diameter of 40 mm in 100 mm thick solid components.



GV.17
Zero distance

7 Installation

Installation of pipelines

General technical information on installation types:

➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [13] 'Installation and attachment'
➨ Part V 'Build', Section 'Installation'

The iLITE System is suitable for the following types of installation:

- Surface or flush-mounted installations
- Installation in shafts and channels, on ceilings and on floors
- Installation in-wall, element, wood and lightweight constructions
- Installation in concrete (in the pipe-in-pipe system, with PE-X pipes)

7.1 Protection against environmental influences and building materials

System components flush-mounted or concealed behind a wall:

☑ In order to absorb thermally induced changes in length, to prevent the transmission of sound, to avoid the formation of condensation, to preclude heat dissipation, heat loss or to heat the medium and to protect from other building material influences, fittings or pipes must be covered with a suitable materials or they must be separated entirely from the structure of the building.

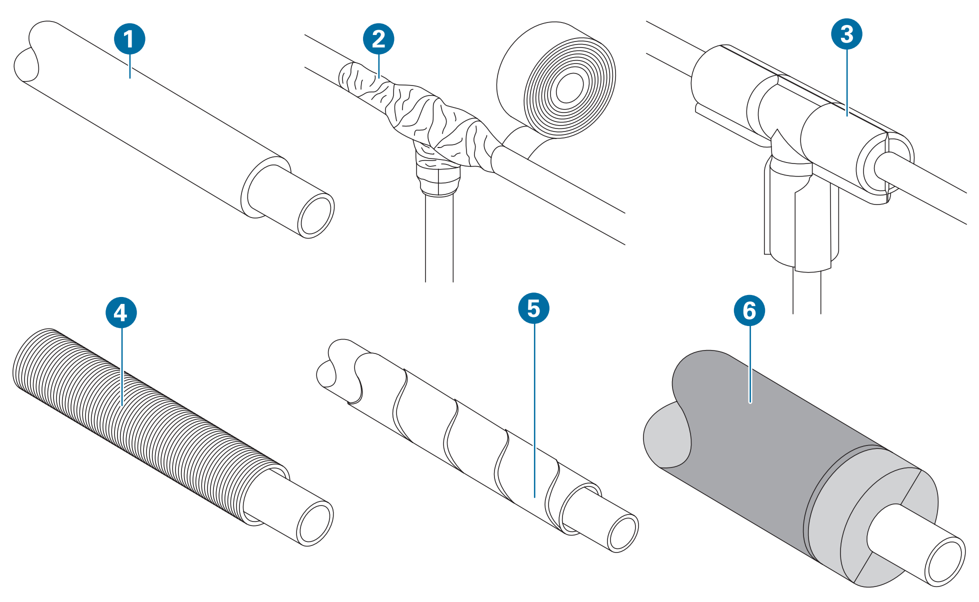
In permanently or periodically damp rooms, in areas subject to aggressive gases or other offensive environment and under uncontrollable environmental influences:

☑ Appropriate precautions must be taken to protect the installation, e.g. by using the following measures:
  - Use of suitable anti-corrosion tapes (e.g. supplied by KEBU, Gyso or DENSO)
  - Wrapping the pipe with heat-shrinkable materials

☑ Ensure that pipes and fittings are dry when mounting.

☑ All system components must be protected from direct contact with oils, greases, solvents, solvent-based adhesives (adhesive tapes), foams, bitumen (also bituminous membranes). Furthermore, the components must not contact building materials such as screed, concrete, mortar or plaster.

☑ Separating the piping system from the building structure is mandatory. In this case, protective conduits made of PE, wrappings, insulating hoses or pipe saddles with and without sheathing or a combination thereof shall be used.



GV.18
Safety measures

1. Pre-insulated pipe
2. Pipe with wrapping
3. Half shells
4. Protective conduit
5. Wrapping
6. Sheathing

V

7.2 Installation flush with wall

☑ Compliance with the general requirements for installing pipes flush with the wall.
☑ Threaded connections installed flush with the wall must be protected from moisture and contamination.

7.3 Installation in concrete ceiling

iLITE PE-X pipes inside the protective conduit may be cast in solid structures.
☑ Compliance with the general requirements for installing pipes in concrete ceilings is mandatory.
☑ Do not install or pour threaded connections or fittings into the pipe.
If the JRG iLITE installation accessories are used during the installation, the conditions can be met.

7.4 Installation in a pipe shaft, basement distributor and riser pipes

☑ Compliance with the general requirements for installing pipes is mandatory.

Change in length, bending and 2D expansion loops, fixed and floating points
☑ When installing, observe the change in the length of the pipes, the resulting flexible pipe leg and 2D expansion loop, and the required fixed points.

7.5 Installation on top of a concrete ceiling

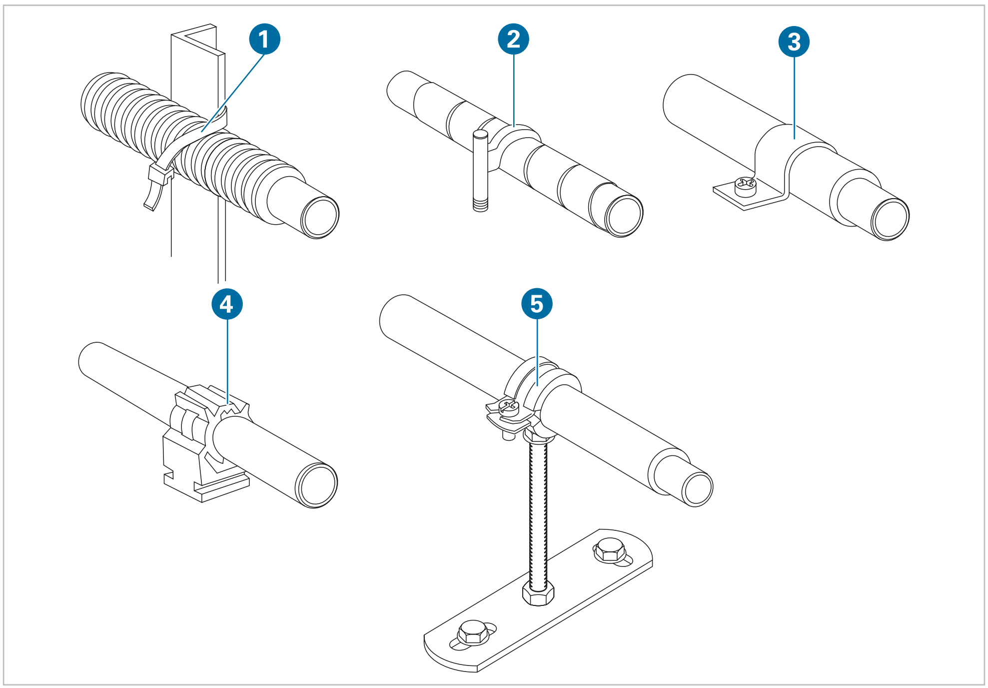
☑ Compliance with the general requirements for installing pipes on concrete ceilings is mandatory.

8 Attachment

Pipeline attachment
General information:
➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [13] 'Installation and attachment'

8.1 Attachment components

iLITE installations can be installed using attachment components from our systems or with commercially available fasteners.



GV.19
Pipe attachments

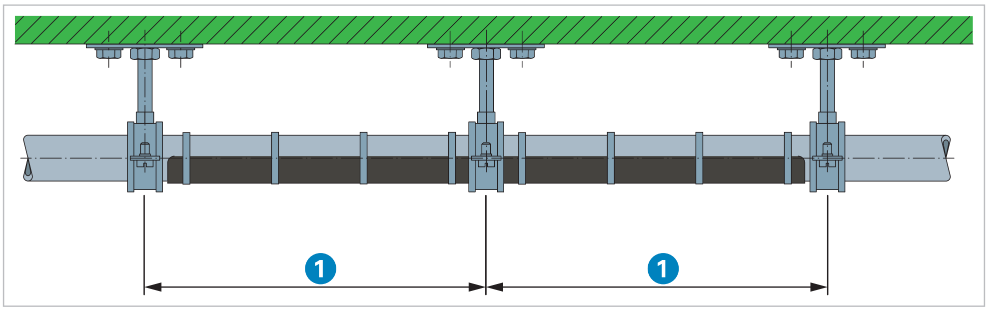
1. Pipe binders
2. Dowel hooks
3. Pipe clip
4. Pipe clips
5. Pipe clips

8.2 Attachment using pipe clips

In general, iLITE pipelines installed above ground **do not** require pipe saddles or protective conduits. When using pipe saddles, however, the mounting distances can be increased.

NOTE! Damaged pipes due to excessive mounting distances.
Excessive spacing between the attachments can lead to deformation and weakening of the material as well as vibrations (formation of noise).

☑ Mounting distances **BA** must be maintained.
☑ Observe the change in length and allow for appropriate expansion compensation.



GV.20
Mounting distances (BA)
1 Mounting distance

TV.31
Mounting distances (recommended)

Pipe, Dimension		BA [m]		
		Multilayer composite pipe		
d	DN	without pipe saddle	with pipe saddle	with **increased mechanical** load: with **additional** pipe saddle
16	12	1.00	2.00	1.00
20	15	1.00	2.00	1.00
26	20	1.50	2.00	1.50
32	25	2.00	3.00	2.00

If installed flush, as in-wall installation and on concrete ceiling

When installing iLITE pipes d16 to d26:
☑ A mounting distance of 80 cm must be maintained.
☑ Observe the change in length and allow for appropriate expansion compensation.

Stabilisation at increased mechanical loads

If an increased mechanical load in a particular installation zone must be into consideration or if the specified mounting distances (BA) are not feasible, we recommend additionally stabilising the iLITE pipelines. For this purpose, commercial pipe saddles, protective conduit, etc. can be used.

Attachment when installing “pipe-in-pipe”

NOTE! Noise emissions due to pressure surges.
Pressure surges on quick-action fittings can cause noise emissions.
→ When using a “**pipe-to-pipe**” **installation** made of iLITE pipelines, appropriate precautions must be taken.

Recommendation for mounting distance
Moreover, we recommend a maximum mounting distance of 60 cm when installing with a protective conduit (“pipe-in-pipe” installation).

☑ Ensure the pipes do not kink.

9 Connection

Jointing technology

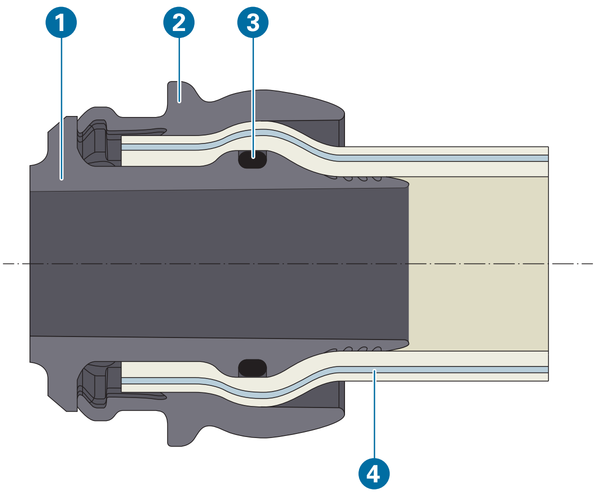
General information on jointing technology:

➨ Part III 'The basics', Section 'Materials and jointing technology'

9.1 Sliding sleeve connection

The iLITE sliding sleeve connection is a secure, flow-optimised, durable and non-detachable connection. It is pressed in the axial direction by a pre-mounted sliding sleeve and onto the fitting. This sliding sleeve is made of polyamide (PA6GF30).

An iLITE sliding sleeve connection consists of the following components:



GV.21
iLITE Sliding sleeve connection

1. Fitting (plastic or brass body)
2. Sleeve
3. O-ring
4. iLITE pipe (multilayer composite pipe or PE-X pipe

10 Assembly

☑ Compliance with the tools' instructions is mandatory.
☑ Ensure the assembly tools are working properly.

WARNING! Risk of injury due to incorrect operation.
If operating the combination shears improperly, there is a risk of injury in the area of the shear's end stops.
→ Use tools only as shown in the operating instructions.

NOTE! Leaks in the pipe and water damage due to cutting to the incorrect length!
→ Ensure the pipe end is cut straight.
→ Ensure the pipe end is not out-of-round.

10.1 Assembly – Pipes d16 – d32

The individual steps are illustrated on the next page.

Assembling the pipes (d16 – d32)

Preparing the tool

① → Select jaw set according to pipe dimension.

② → Inserting the jaws (from the side or from the top).

③ → Fit the front jaw and secure it with the knurled screw.

④ → Fit the rear jaw and secure it with the knurled screw.

⑤ → Open the rear jaw (pipe clamp unit).

Preparing the pipe

⑥ → Use a sharp pipe cutter to cut the iLITE pipe to the desired length.
→ Inspect pipe: The pipe must not be oval, it must be cut straight at a distance of at least 5 cm from the end of the pipe.
- "OK" = correct / "NO" = wrong

Mounting the fitting onto pipe

⑦ → Slide the pipe completely onto the fitting nipple.
- "OK" = correct

⑧ → Insert the fitting into the tool from above.
☑ The fitting groove must lie in the tool groove of the fitting support.

⑨ → Engaging the pipe and fitting into the jaws.
☑ Make sure the pipe and fitting are fully engaged in the jaws.
- "Click": The pipe clicks into place.

⑩ → Make sure the tool is in the zero position (visual inspection). If not: Press the reset button on the tool.
- "OK" = correct / "NO" = wrong

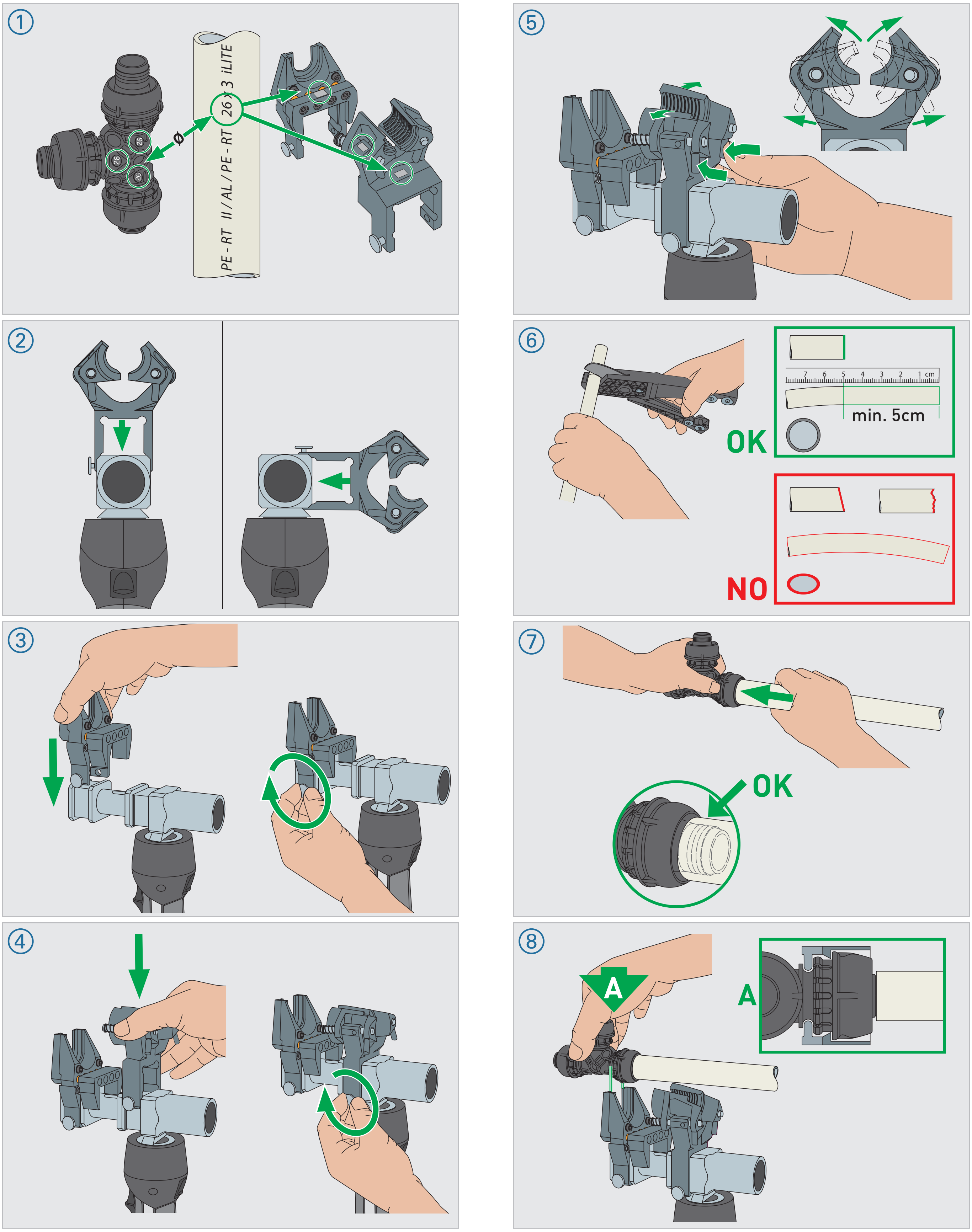
⑪ **CAUTION! Risk of injury around the working area of the tool.**
→ Careful when handling the tool.
→ Wearing safety gloves is mandatory. Keep fingers and hands outside of the working area of the tool.

⑫ → Activate the sliding process by pressing the control switch twice ("Press / Press and Hold": "Double-click and hold").
↳ The sliding forks close.

⑬ → Remove pipe with fitting after completing the sliding process.

⑭ → Visually inspect the connection through the inspection window.
☑ If the pipe is visible in the inspection window, the connection is good.
- "OK" = correct / "NO" = wrong

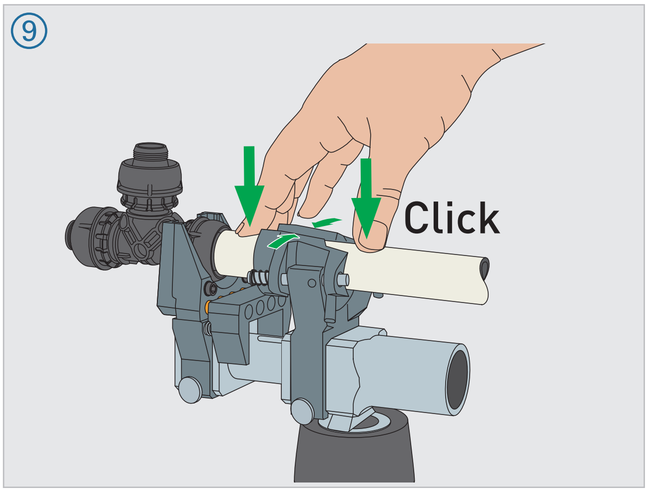
Assembly – Assembling the pipes (d16 – d32)



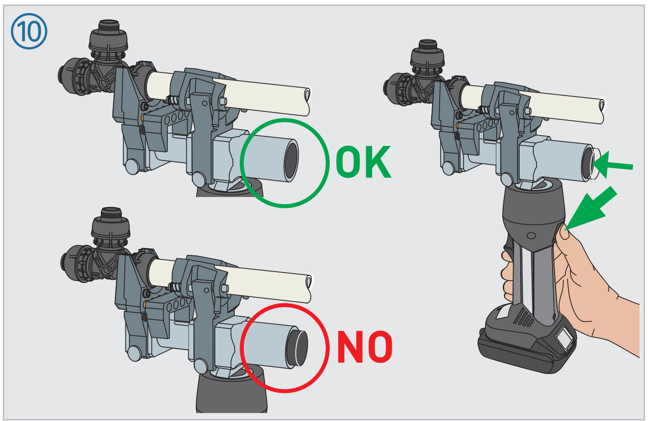
Assembling the pipes (d16 – d32) ▶▶

Assembling the pipes (d16 – d32)

⑨



⑩



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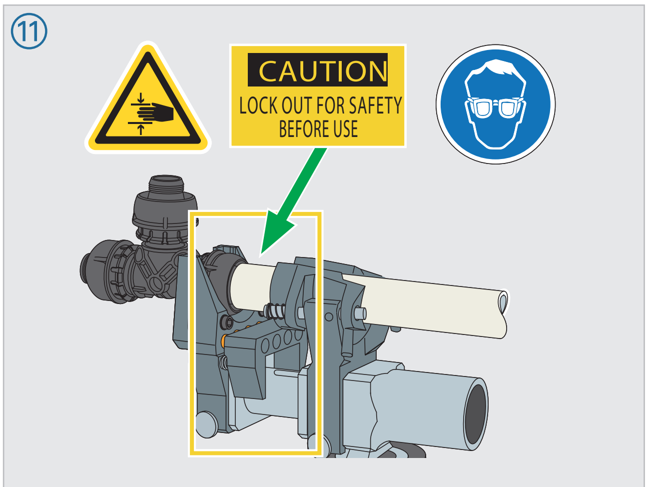

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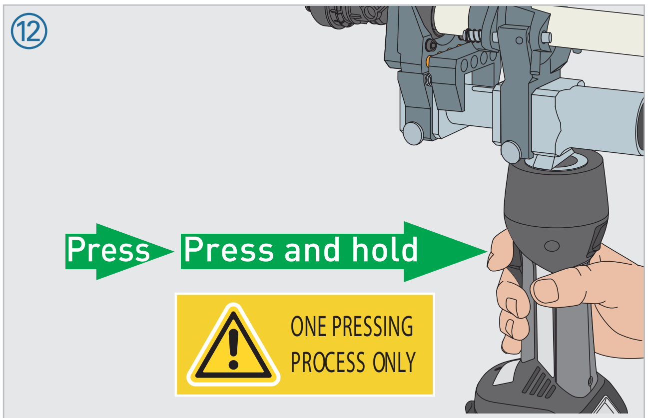

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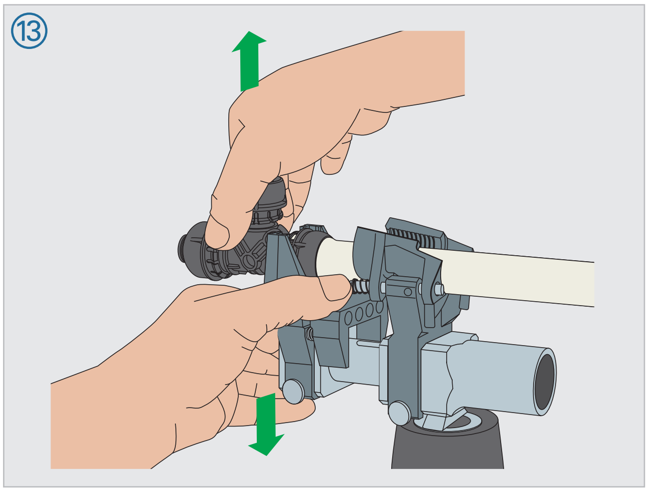
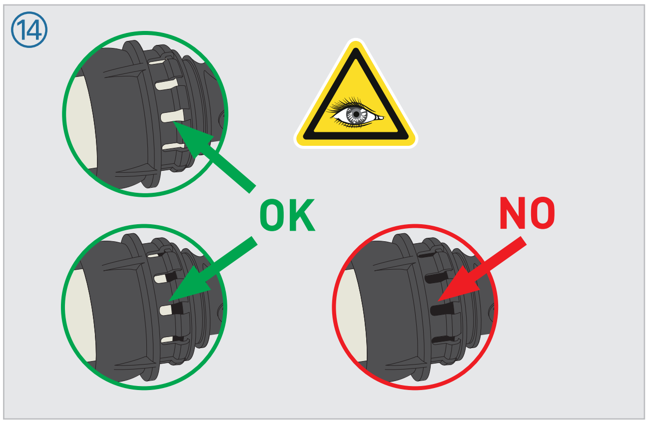


⑭



10.2 Installation/removal of the PPSU special fittings

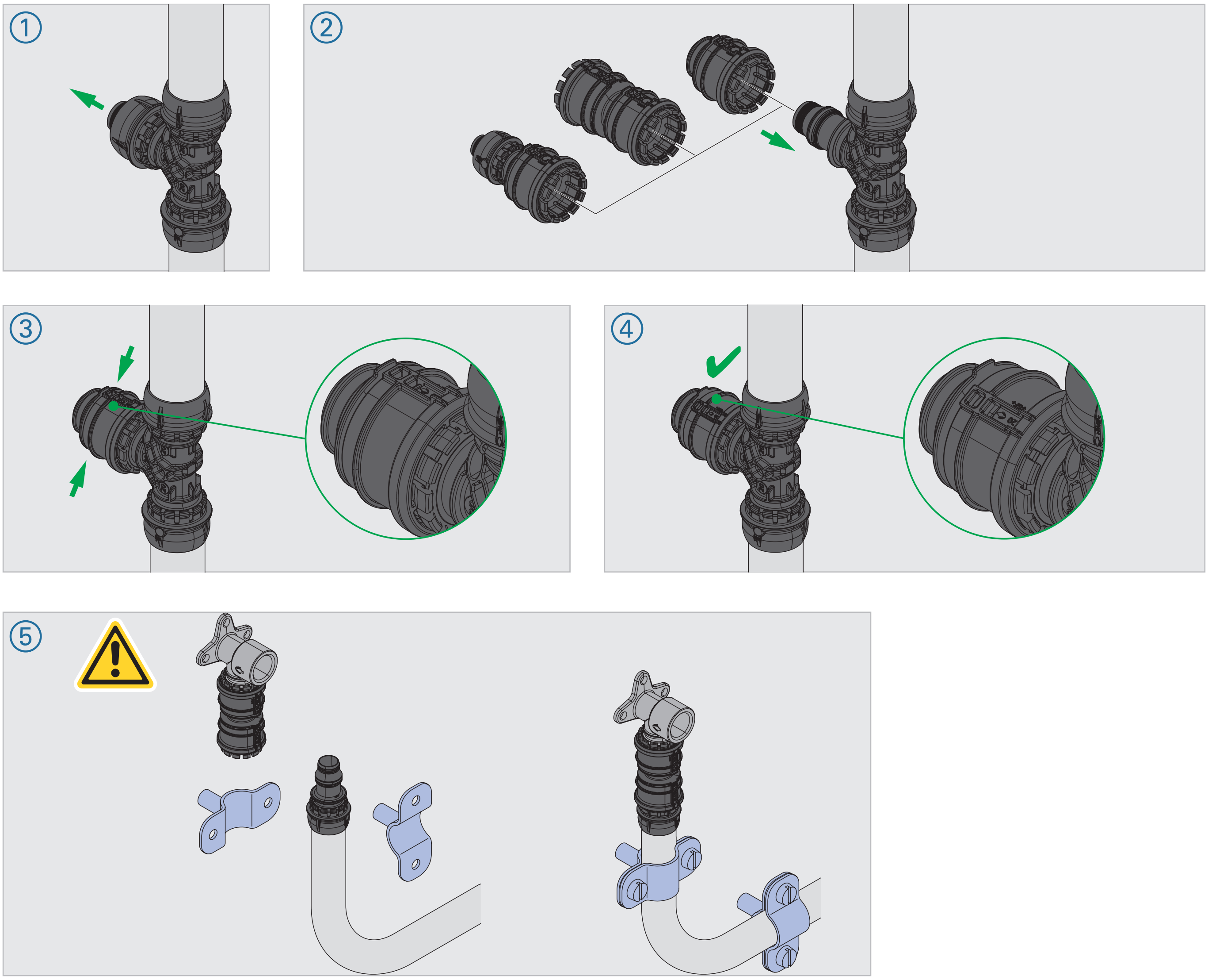
10.2.1 Installing PPSU special fittings

NOTE! Damage to pipes due to incorrect installation.
→ When fastening, ensure that the assembly is not subject to tension.

Installing PPSU special fittings

1. → Remove the sleeve from the PPSU fitting.
2. → Slip on the double socket, cap or reducer.
3. → Pull the sleeve of the PPSU special fitting backwards.
4. ↳ Sleeve engages and is locked in place.
5. → When using pipe clamps, ensure that the installation is not subject to tension.

Assembly – Installing PPSU special fittings



10.2.2 Removing PPSU special fittings

Removing PPSU special fittings

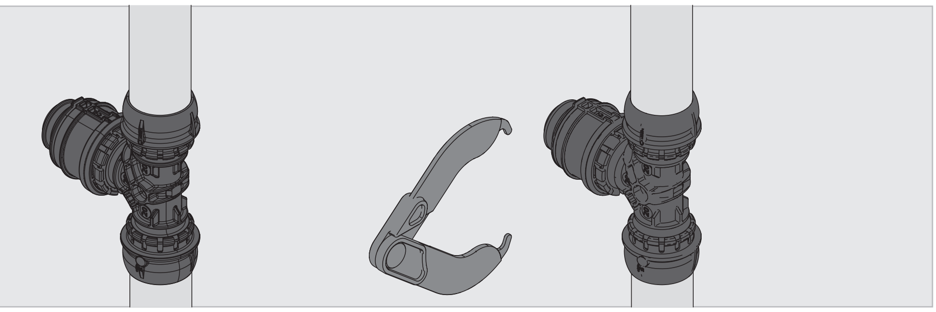
① → Place the pliers in the sleeve's opening of the PPSU special fitting.

② → Push the sleeve of the PPSU special fitting forwards.

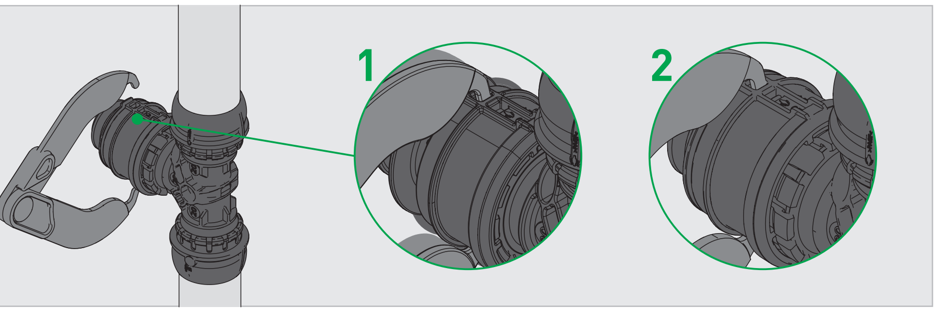
③ → Remove the PPSU special fitting from the PPSU fitting.

Removal – Removing the PPSU special fittings (d16 – d32)

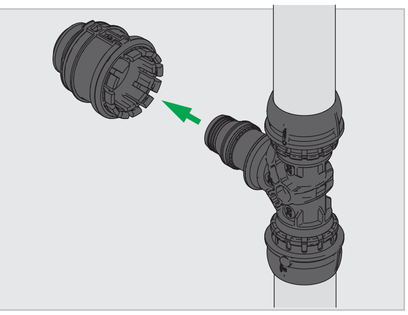
①



②



③



11 Bending

11.1 Bending methods

NOTE! Risk of damaging the pipes due to improper bending!
→ Ensure the pipes do not kink when bending them.
→ Do not use internal bending springs.
→ Only use iLITE tools.

iLITE hydraulic cylinders

iLITE hydraulic cylinders have the bending radius of 3.5 · d.

Hydraulic cylinders or bending springs

Commercially available hydraulic cylinders can be used, considering the following aspects:

☑ The shape of the bending gauge corresponds with the outside diameter of the iLITE pipe.
☑ Do not use internal bending springs.
☑ Ensure the bending radius is not less then 3.5 · d.

Dimensions d16 to d32 can be bent using a commercially available electric or hydraulic bending tool.

Dimensions for pipe bend

TV.32 **Dimensions for 30°, 45°, 60°, 90° – bending radius 3.5 · d**

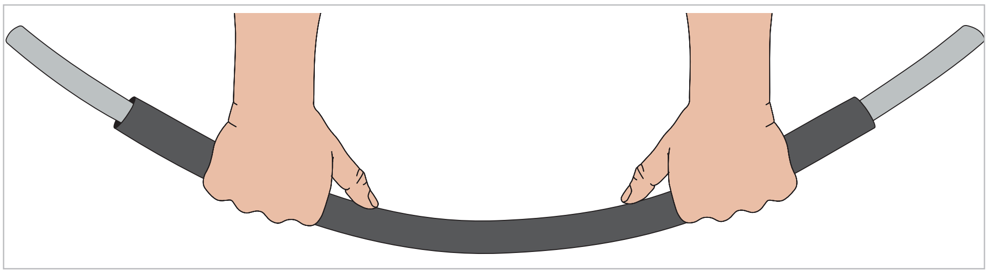
Pipe, Dimension		Bending radius [mm]	Radian BM [mm]	Hydraulic cylinder	Manual pipe bender			
				Radian BM [mm]				
d_a [mm]	DN		90°	1/6 (90°)	2/3 (90°)	1/3 (60°)	1/4 (45°)	1/6 (30°)
16	12	56	88	15	56	32	23	15
20	15	70	110	18	70	40	29	19
26	20	91	143	24	91	53	38	24
32	25	112	176	25				

Design-related dimensional deviations are taken into account.

11.2 Manual bending using a die

The **iLITE multilayer composite pipe** can be bent by hand in the dimensions d16, d20 and d26 with the JRG manual pipe bender or an outside pipe bending tool.

☑ Ensure the bending radius is not less then 5 · d.
☑ Make sure the shape of the pipe does not become oval.



GV.22
Bending an iLITE multilayer composite pipe using an outside pipe bending tool

TV.33
Minimum bending radii

Pipe, Dimension d_a [mm] × s [mm]	**Bending radius** manually [mm]	with outside pipe bending tool [mm]
16 × 2.0	$5 \cdot d_a = 80$	$2 \cdot d_a = 32$
20 × 2.5	$5 \cdot d_a = 100$	$2 \cdot d_a = 40$
26 × 3.0	$8 \cdot d_a = 208$	$4 \cdot d_a = 104$
32 × 3.0	–	$4 \cdot d_a = 128$

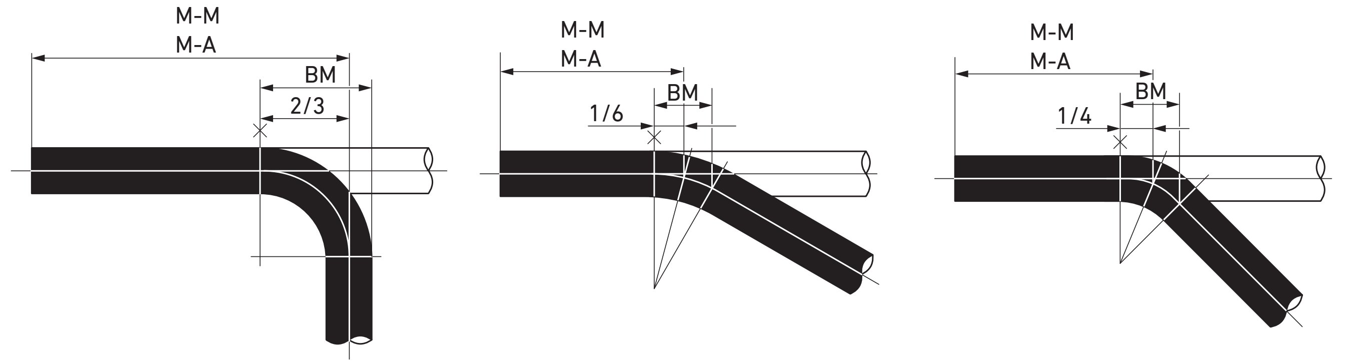
11.3 Bending, using a manual pipe bender

☑ Compliance with the tool's operating instruction is mandatory.
☑ Start of bend: **Start** of the pipe bend

Dimensions for pipe bend: ➨ Table [TV.32]

TV.34 **Start of bends at pipe bend**

90° bend	30° bend	45° bend
→ Indicate the dimension **centre/centre** (or **centre/outside**) on the straight pipe. → Measure the 2/3 radian **BM** in the direction of the start of the bend again and mark it.	→ Same procedure as above. However, measure the 1/6 radian **BM** in the direction of the start of the bend again and mark it.	→ Same procedure as above. However, measure the 1/4 radian **BM** in the direction of the start of the bend again and mark it.



M–M Dimension centre/centre
M–A Dimension centre/outside

Bend by using manual pipe bender

Determine start of bend

① → Mark the pipe bend as shown. ➨ Tab. [TV.34]

Pipe bending

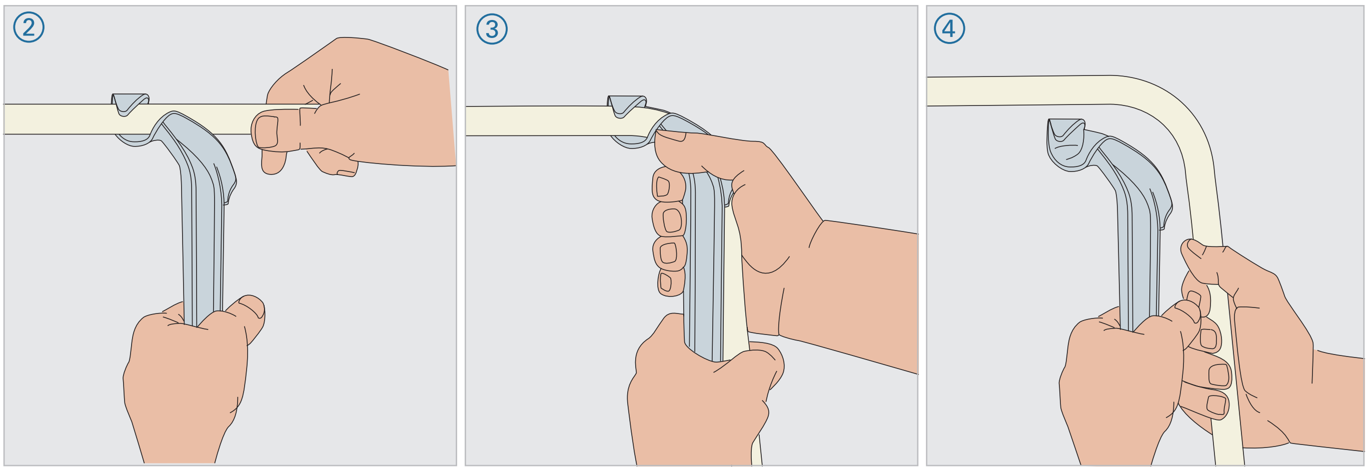
② → Insert pipe into the manual pipe bender.
- Observe start of bend.

③ → Bend the pipe.
- While doing so, guide the pipe as close as possible to the manual pipe bender.

④ → Remove the finished pipe bend from the manual pipe bender.

Bend by using manual pipe bender

① ➨ Table [TV.34]



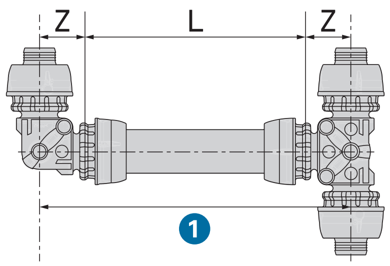
12 Fittings – Combinations – Dimensions

When using the iLITE installation system, the **z dimension method** can be used.
The specification of the centre-to-centre distance and the exact dimensions of the fittings are specified in the delivery program.

12.1 The z dimension method

z dimension method
General information about the z dimension method:
➨ Part IV 'Plan', Section 'Drinking water installation', Chapter [14] 'The z dimension method'

When using the z dimension method, efficient planning and work preparation is made easy. Based on the centre-to-centre measurement method (distance pipe axis to pipe axis) and knowing the z dimension, the exact required pipe length can be calculated.



GV.23
Dimension centre/centre
1 centre/centre
L Length of pipe

z dimension (z)

The z dimensions are calculated as the difference between the overall length minus the insertion depth. The z dimensions are listed in the delivery assortment for each fitting connection.

Pipe length (L)

The pipe length (L) is determined from the centre-centre dimension minus the z dimension of the fittings used.

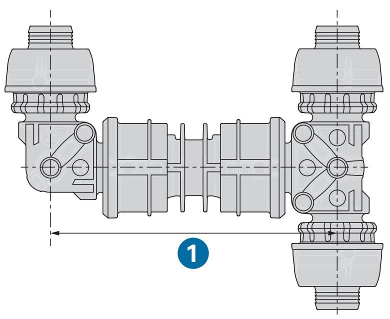
Pipe, Dimension	Pipe, minimum length L [8 mm]
d16	80
d20	95
d26	110
d32	130

TV.35
Minimum length L of the pipe between two fittings

V

Direct fitting/fitting transition thanks to special fitting (double socket)

Thanks to double sockets made of PPSU in the dimensions d16 to d32, any two fittings can also be connected directly without a pipe section.



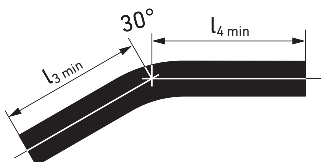
GV.24
Dimension centre/centre
1 centre/centre

12.2 Combination without fittings

Bending radius = 3.5 · d (using hydraulic cylinder)

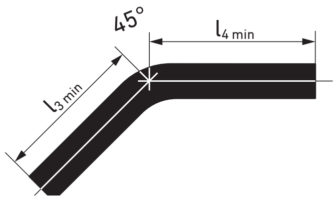
30° bend made of composite pipe

Angles α	d	16	20	26	32
	DN	12	15	20	25
			[mm]		
30 °	l_{3min}	60	65	80	102
	l_{4min}	60	65	80	102



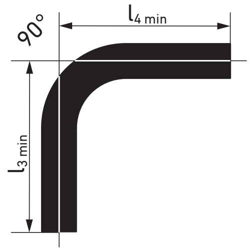
45° bend from composite pipe

Angles α	d	16	20	26	32
	DN	12	15	20	25
			[mm]		
45 °	l_{3min}	63	63	90	98
	l_{4min}	63	63	90	98



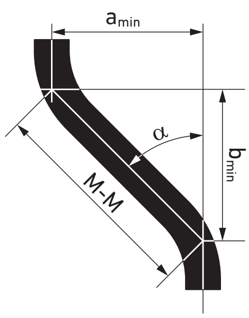
90° bend from composite pipe

Angles α	d	16	20	26	32
	DN	12	15	20	25
			[mm]		
90 °	l_{3min}	91	108	136	165
	l_{4min}	91	108	136	165



Combination of bends made of composite pipe

Angles α	d	16	20	26	32
	DN	12	15	20	25
			[mm]		
30 °	a_{min}	65	65	87	112
	b_{min}	113	113	151	194
	M-M	130	130	174	224
45 °	a_{min}	103	111	141	163
	b_{min}	103	111	141	163
	M-M	146	159	199	230
60 °	a_{min}	130	138	176	220
	b_{min}	75	80	102	127
	M-M	150	160	203	254
90 °	a_{min}	195	200	245	320
	b_{min}	16	20	26	32
	M-M	195	200	245	320



Build

JRG Valves

JRG Valves

Overview
This chapter contains basic information about the JRG valves.

Additional technical and sales information

- For more information on the use and connection of other system components, piping and controls and instruments, see the chapters applicable to the appropriate systems.
- More technical information about this system and ordering information can be found on the GF website and in the sales catalogue.

1 Overview

1.1 System description

Valves made by GF JRG are recognised as high performance valves made of corrosion-resistant gunmetal. The focus during the development and production is to meet the growing need for energy-saving technologies and increasing quality of life requirements. At the same time, the valves meet the highest requirements in terms of long-term operational and functional capability, corrosion protection and in terms of the required hygiene.

1.2 Approvals

- Current approvals are available from the technical consultant (field service/office staff) of GF.

1.3 Scope and application areas

The main applications are the distribution of hot and cold water in building technology.

- For other application areas, please contact the technical consultant (field service/office staff) of GF.

1.4 Noise behaviour of valves

Based on their noise behaviour, valves are classified in different groups.

Group of valves*	L_{ap} at 300 kPa (3.0 bar) [dB(A)]
I	≤ 20
II	$20 < L_{ap} \leq 30$
not classified	> 30

* acc. to EN ISO 3822
Starting at DN40, valves are not subject to classification.

1.5 Safe application and processing

- ☑ Only use the product as intended and in accordance with the defined areas of application and usage.
- ☑ Do not use the product if it is damaged or defective. Damaged products must be removed immediately.
- ☑ Use only approved accessories.
- ☑ Only trained personnel shall be permitted to assemble the product and accessories.
- ☑ All personnel shall be instructed on all applicable issues of local occupational safety and environmental regulations, in particular for pressurised piping. These instructions must be held on a regular basis.
- ☑ Compliance with the valid standards for drinking water and grey water installations as well as compliance with the regulations of the system manufacturer is mandatory.
- ☑ All installations must comply with the instructions specified in the technical documentation of the product.
- ☑ Compliance with the local water supply regulation is mandatory.
- ☑ In order to assemble JRG fittings in installation systems, only assembly tools approved for the system shall be used.
- ☑ Compliance with the operating, maintenance and assembly instructions is mandatory.

1.5.1 Transport and storage

- ☑ Ensure to protect the product against external force (shock, impact, vibration, etc.) during transport.
- ☑ Transport and/or store the product in unopened original packing.
- ☑ Protect the product from dust, dirt, moisture, heat and UV radiation.
- ☑ Ensure that the product is not damaged by mechanical or thermal influences.
- ☑ Inspect the product for damage that may have occurred during the transport.

1.5.2 Disposal

- ☑ Before disposing of individual materials, they must be separated according to their recyclability, and whether these materials are considered normal waste or special waste.
- ☑ When disposing of or recycling the product, the individual components and the packaging, compliance with the local regulations is mandatory.
- ☑ Compliance with country-specific regulations, standards and guidelines is mandatory.

1.6 Product groups

In this chapter, the valves are sorted according to the **JRG Code**.
In the overview on the following two pages the valves are sorted according to types and functional areas.

2 Product overview – Product sheets

Shut-off and safety group

2171	2190, 2191
	

Connection kit

8334, 8335


Taps

7015, 7016


7040	7045
	

Pressure reducer

1140	1300, 1303, 1310, 1320, 1330	1350, 1353, 1360
		

1370, 1371	1380
	

Drain valve

7301


Filter

1350, 1353, 1360	1370, 1371
	

1800	1812, 1814	1830, 1836
		

1840, 1846	1870, 1871
	

Filling valve

6303


Straight seat valve

5350, 5351, 5357, 5358, 5359	5354, 5371, 5374	5360, 5363
		

KOAX counter housing

5456


KRV lockable

5262, 5265, 5266, 5281, 5283, 5284


Ball valve

6041


V

Sampling valves

7306	7306
	

Controllers

6310


Return flow inhibitor

1610, 1611, 1612, 1614, 1615	1672
	

Flap traps

1682	1684
	

Y-type valves

5200, 5204, 5207, 5208	5211, 5213, 5220, 5221, 5222, 5225, 5227, 5228, 5229, 5234
	

Safety equipment/JRGARANT Safety valve

1025, 1028


Safety valves

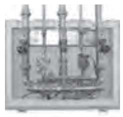
1630, 1631


Safety groups

2200, 2203, 2210	2230, 2233, 2240
	

Thermoblending valve

3000	3100, 3110
	

3400, 3410	3500, 3510, 3590
	

Concealed valves

5900, 5922, 5925	5910, 5916	5917, 5918
		 

5920, 5921	5458
	

Bypass mixing valve

5195, 5198


Distribution fittings

1511, 1521, 1531, 1541, 1542	5120	5151
		

5191	5195, 5198
	

Circulation controller – JRGUTHERM

6320	6325
	

Circulation controller – Regulating sockets

6310


JRGARANT Safety valve 1025, 1028

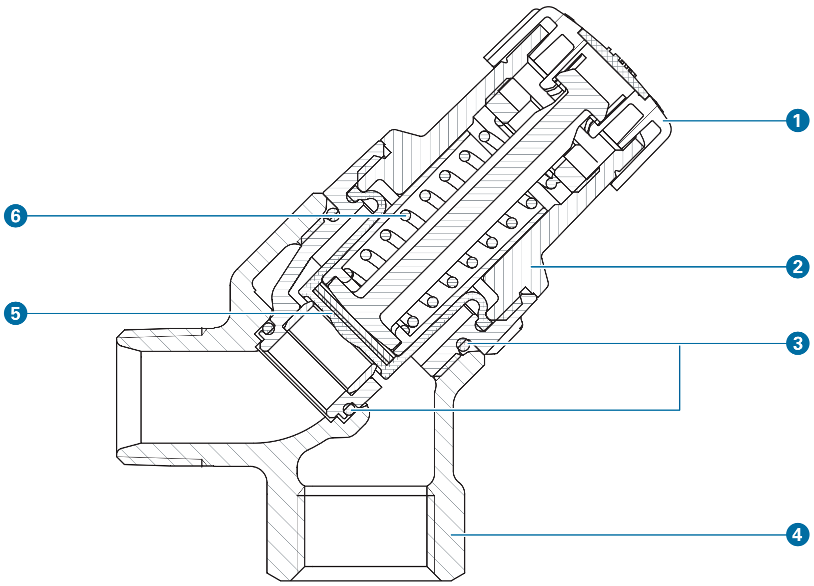
The JRGARANT safety valve protects closed-type DHW heaters against excessive pressures.

Technical Data

JRG code	Dimension	Nominal pressure PN	Factory setting [kPa (bar)]	Temperature max. [°C]	Connections
1025	GN ½" – 1" (DN15 – 25)	10	600 (6.0)	90	• Inlet: tapered external thread
1028			100 – 1000 (1.0 – 10.0)*		• Outlet: Female pipe thread

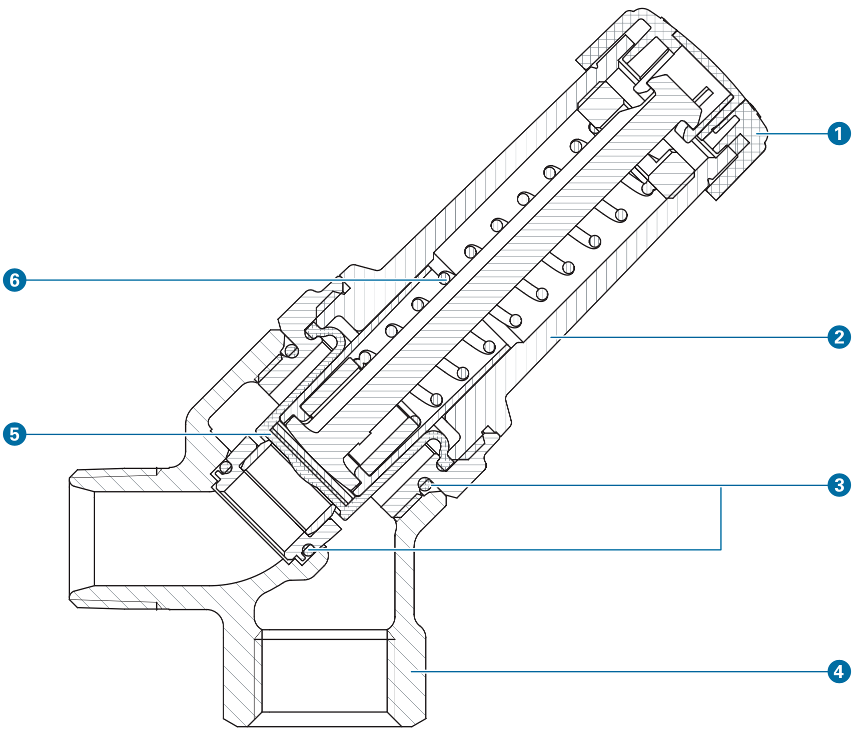
* The applicable response pressure must be specified when placing the order. A change-over on site is not possible.

1025



1. Venting nut
2. Upper part
3. O-ring
4. Valve body
5. Membrane
6. Compression spring

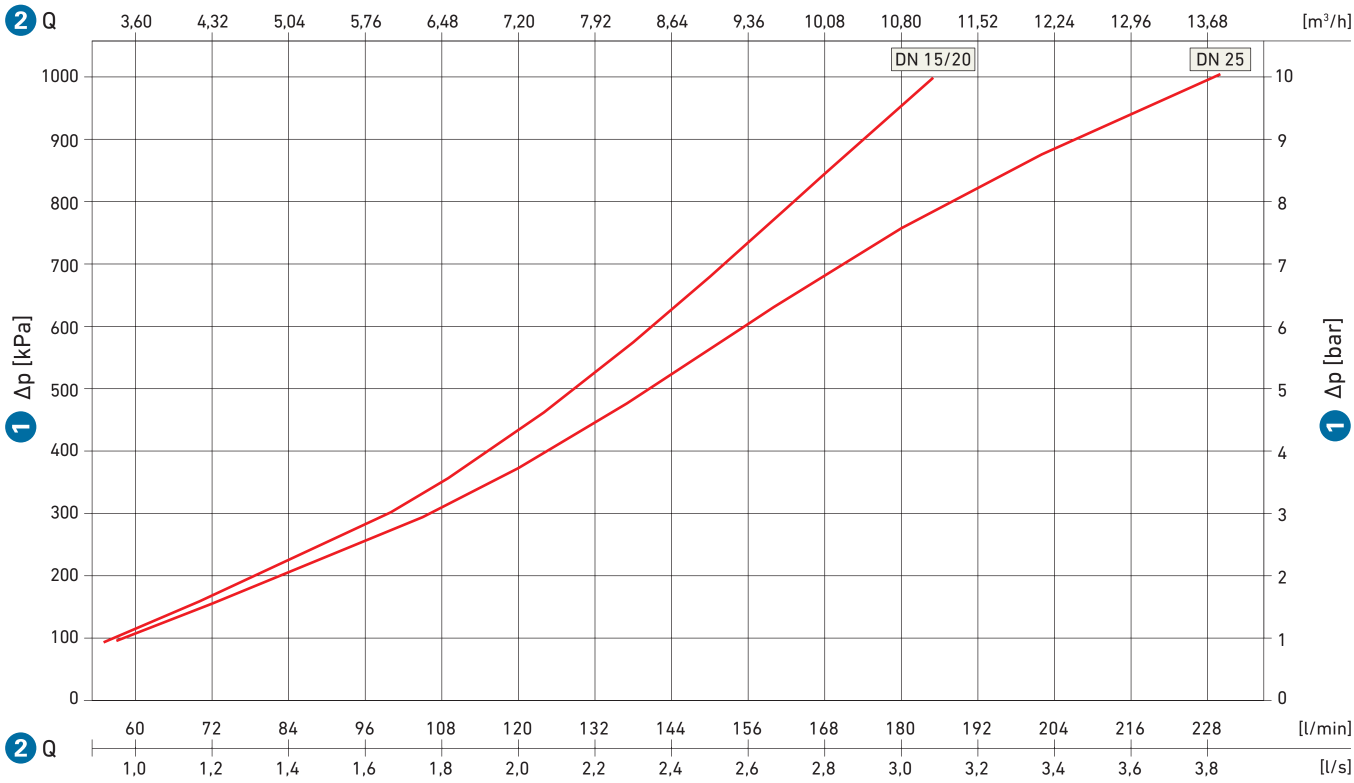
1028



V

Diagram of the drainage capacity

The drainage capacity diagram in the bleed position is used for sizing the drainage pipe.



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
1025.240 1028.240	JRGARANT Safety valve	GN ½" (DN15)	6.80	1.8
1025.320 1028.320		GN ¾" (DN20)	6.80	5.5
1025.400 1028.400		GN 1"(DN25)	7.44	11.3

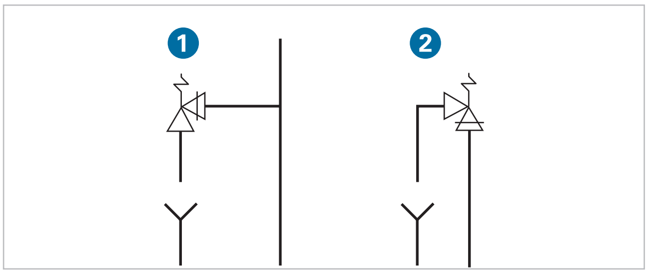
1 Pressure
2 Drainage capacity

Product description
The JRGARANT safety valve protects closed-type DHW heaters against excessive pressures.

Features and functions
When water is heated, the volume increases, resulting in a pressure increase in a closed vessel. The return flow inhibitor integrated into the supply line prevents the return of water from the DHW heater to the distribution network. The safety valve opens when the set response pressure is reached and allows the amount of water that generates the overpressure to flow off.

Mounting position and installation tips
The connecting line can be installed horizontally or vertically (increasing flow) to the safety valve.

☑ The safety valve must be easily accessible.
☑ When draining the safety valve, its discharge must be easy to see and the valve must not be obstructed. If this is not possible, the drain line must be kept as short as possible.
☑ Do not install a shut-off device between the safety valve and the DHW heater (➨ Installation examples).



GV.1 **Connection to the safety valve**

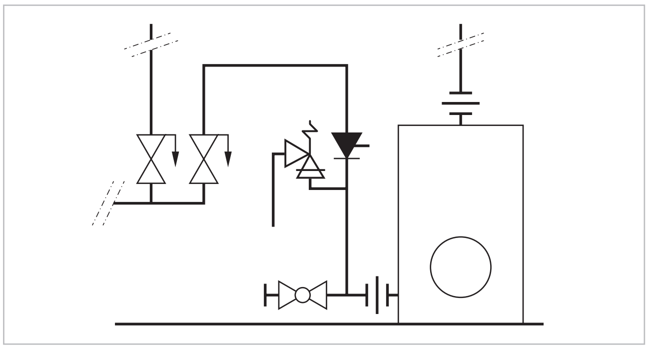
1 horizontal
2 vertical

Installation instructions
☑ During the installation, safety valves for DHW heaters, compliance with the local rules and regulations is mandatory.
☑ Do not close the drain line or spigot of the safety valve.

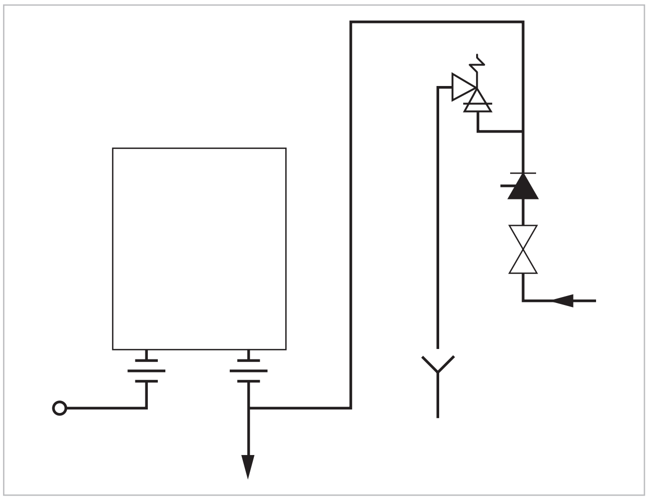
Applicable documents
- Installation instructions
- Operating and maintenance instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts
- Upper parts
- O-ring set

Installation examples


GV.2 **Connection of the floor-mounted DHW heater – Installation diagram**



GV.3 **Connection of the wall-mounted DHW heater – Installation diagram**

V

JRGURED Pressure reducer 1140

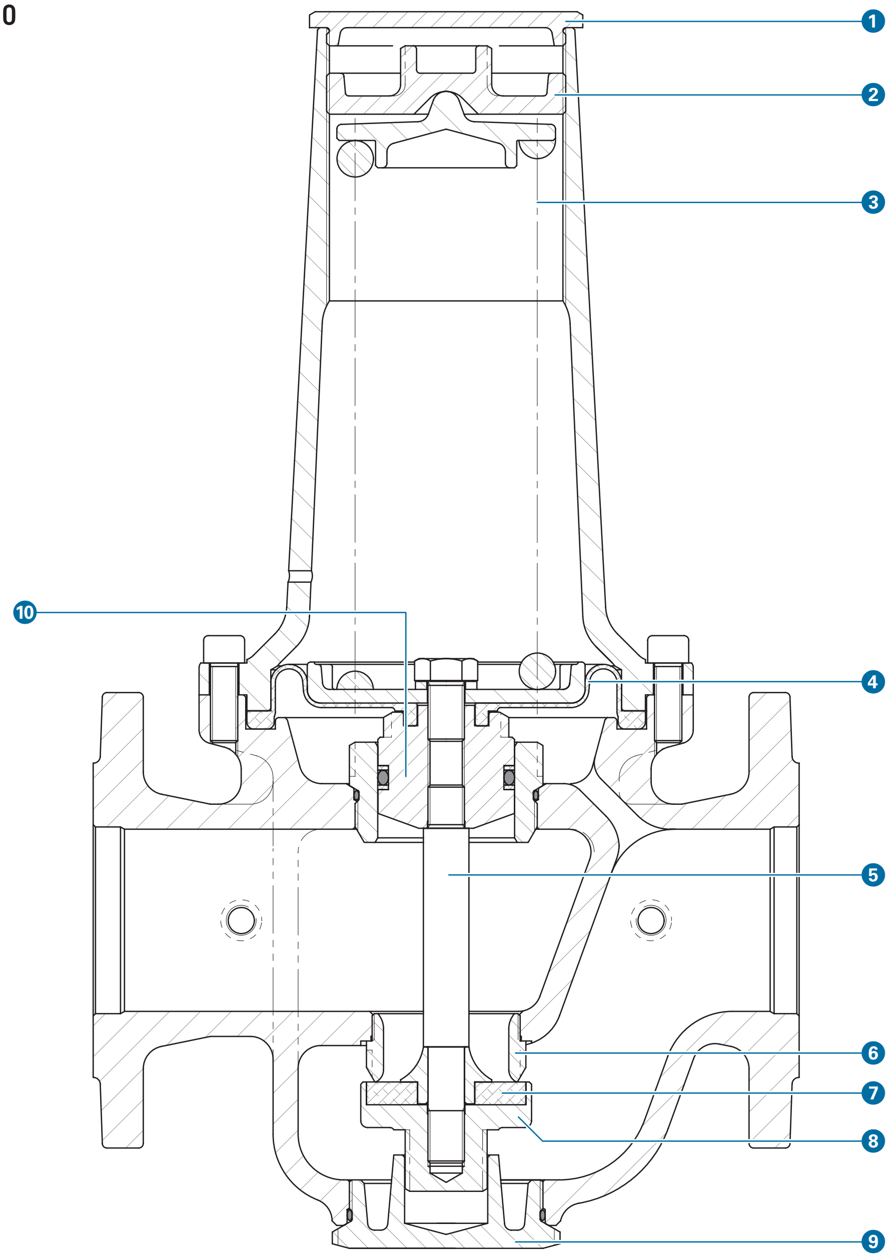
The JRGURED Pressure reducer is a balanced one-seat valve for water installations that reduces the upstream pressure to a lower, constant pressure.

Technical Data

JRG code	Dimension	Nominal pressure PN	Factory setting [kPa (bar)]	Setting range [kPa (bar)]	Temperature max. [°C]	Connections
1140	GN 2½" – 4" (DN65 – 100)	16	400 (4.0)	150 – 600 (1.5 – 6.0)*	90	Flange acc. to SN EN 1092-2

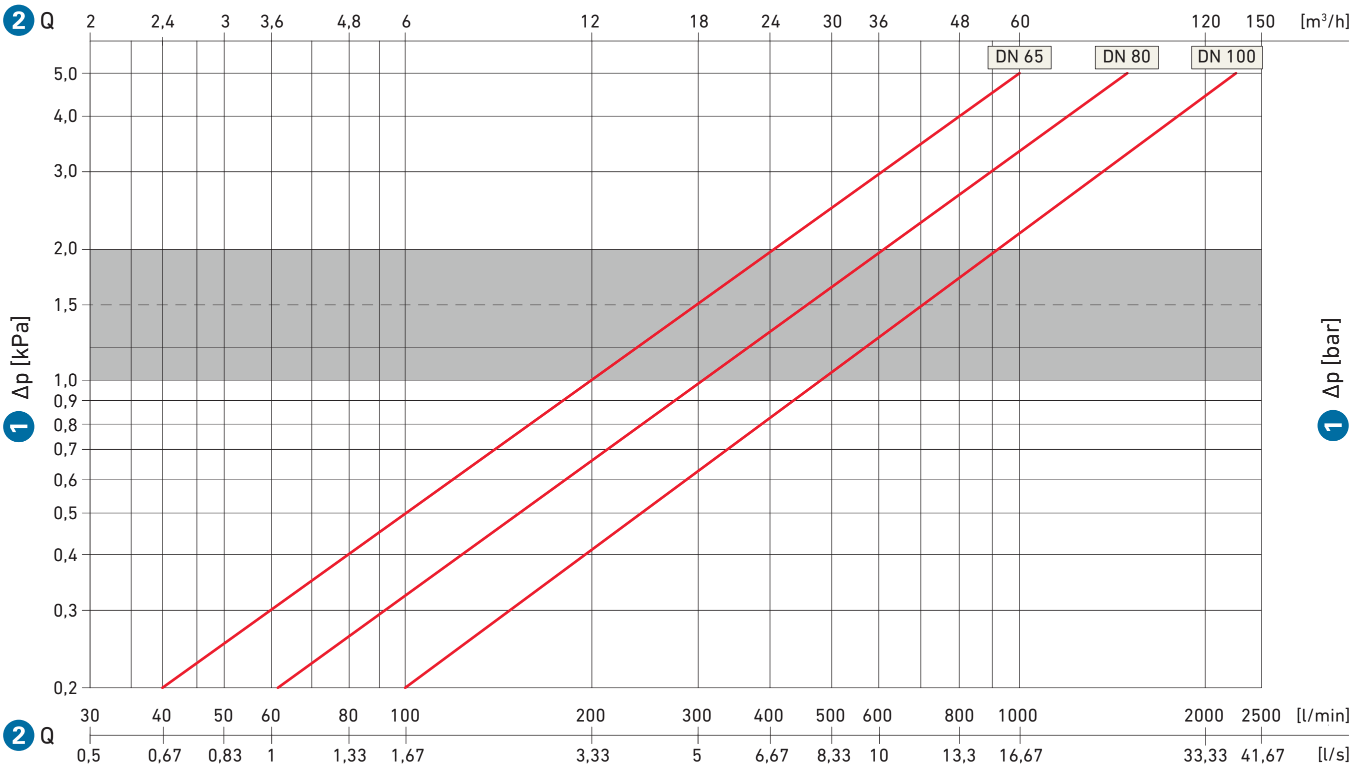
* with special compression spring: 650 – 1000 kPa (6.5 – 10.0 bar)

1140

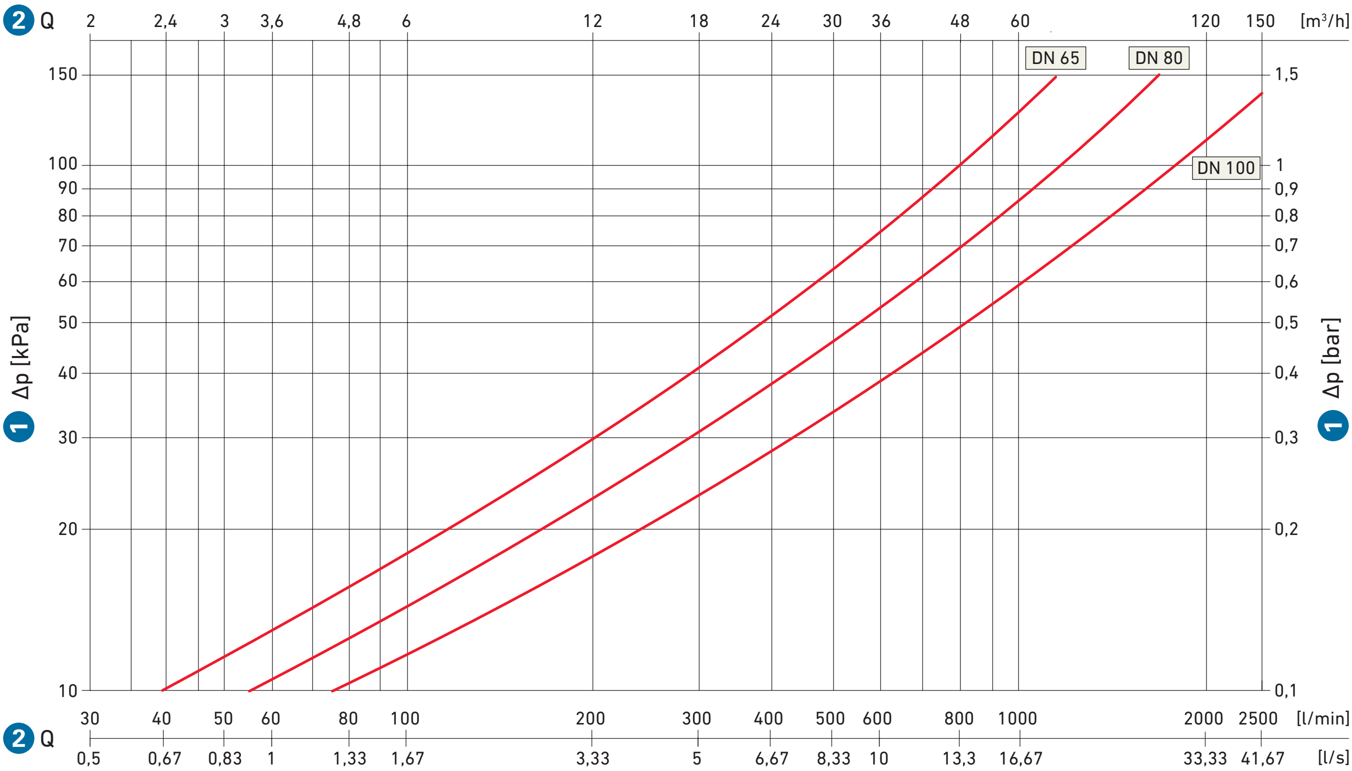


1. Upper part cover
2. Clamping nipple
3. Compression spring
4. Membrane
5. Valve rod
6. Valve seat
7. Valve seal
8. Valve poppet
9. Plug
10. Relieve piston

Performance chart – Sizing



1 Flow velocity
2 Volumetric flow rate



JRG code	Designation	Dimension
1140.065	JRGURED Pressure reducer	GN 2½" (DN65)
1140.080		GN 3" (DN80)
1140.100		GN 4" (DN100)

1 Pressure loss
2 Volumetric flow rate

V

Product description

The JRGURED Pressure reducer is a balanced one-seat valve for water installations that reduces the upstream pressure to a lower, constant pressure.

Features and functions

The upstream pressure neither opens nor closes the valve cone because the pressure against the valve cone is relieved by the acting pressure on the relief piston which acts in the opposite direction. The large-area moulded membrane serves as a control element. Here, the downstream pressure closes and the compression spring opens the control element.

Rest position if consumption is zero

When the tap is closed, the downstream pressure is the same as the adjusted setpoint (static pressure and consumption is zero). The closing force of the membrane and the valve rod connected to the membrane, acts on the valve seal and pulls the seal against the valve seat. This prevents the flow.

Flow position

If a tap is opened downstream of the reducing valve, the downstream pressure falls below the set value. As a result, the closing force of the membrane is reduced so that the compression spring can open and allow the flow between the valve seat and the valve seal. Depending on the size of the pressure drop caused by the amount of water being drawn, the compression spring opens the flow cross section more or less, and together with the membrane creates optimal flow pressure conditions.

Mounting position and installation tips

JRGURED Pressure reducers work in any mounting position.

☑ Before the assembly: Flush lines thoroughly.

☑ After the assembly: Water installations require flushing the entire pipeline system including built-in reducing valve, using the maximum tap quantity. This vents the installation.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Operation and maintenance

Pressure setting: Factory setting 400 kPa (4 bar)

Upon request, valves can also be supplied with a different factory setting: With a standard compression spring set at 150 kPa (1.5 bar) up to 600 kPa (6 bar); with a special compression spring set at 650 kPa (6.5 bar) up to 1000 kPa (10 bar). The factory setting is indicated on the top cover.

Function reversal

→ Before reversing the function, the valve must be completely depressurised.

→ After removing the upper part: Use a socket wrench, size AF36, in order to change the pressure setting within the setting range indicated in the diagram.

- Turning the clamping nipple counter-clockwise reduces the downstream pressure.
- Turning the clamping nipple clockwise increases the downstream pressure.

→ Check new pressure setting with a pressure gauge at static pressure (consumption is zero).

Maintenance

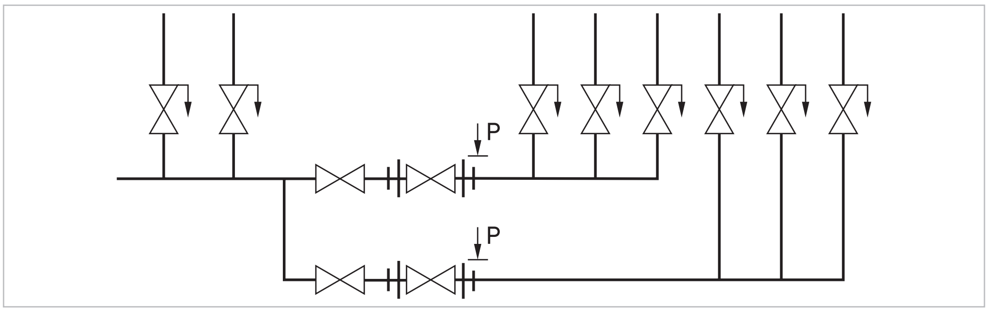
Under normal operating conditions, the JRGURED pressure reducers does not require special maintenance.

☑ Depending on the degree of contamination of the water, clean the upstream filter at certain intervals.

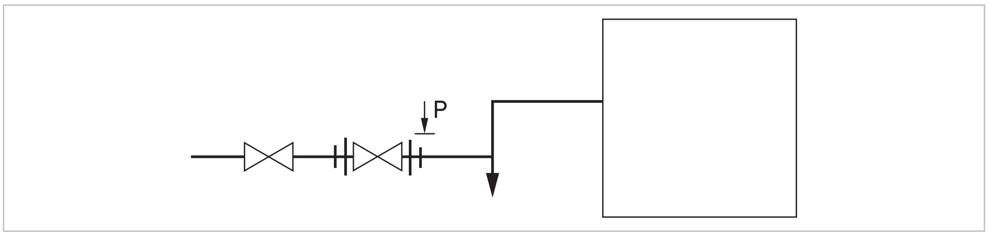
Spare parts

- none

Installation examples



GV.4
Distribution fitting for 3 pressure levels



GV.5
Equipment/machine connections with separate pressure reducing valve

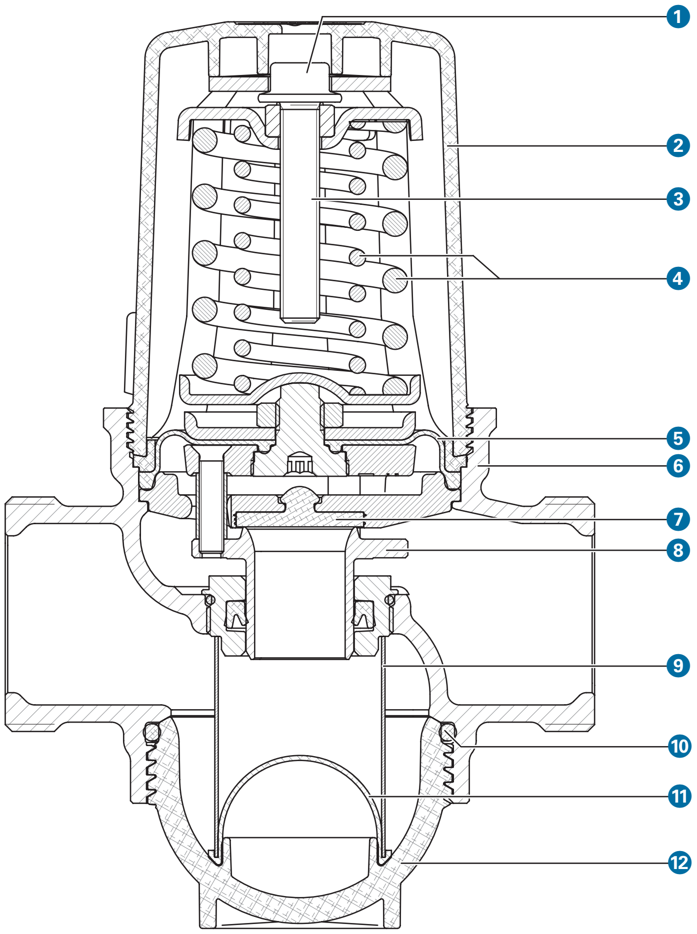
JRGURED Pressure reducer 1300 – 1330

The JRGURED pressure reducer is a compact fitting for water installations that reduces the upstream pressure to a lower, constant pressure. The fitting consists of a coarse filter and a pressure reducer. The coarse filter installed upstream of the pressure reducer retains suspended solids larger than 1000 µm.

Technical Data

JRG code	Components	Dimension	Nominal pressure PN	Factory setting [kPa (bar)]	Setting range [kPa (bar)]	Temperature max. [°C]	Connections
1300	• JRGURED • Clear filter cup • incl. threaded connectors	GN ½" – 2½" (DN15 – 65)	25	400 (4.0)	200 – 600	30	tapered external thread
1303	• JRGURED • Clear filter cup • excl. threaded connection	GN ½" – 2½" (DN15 – 65)	25	400 (4.0)	200 – 600	30	Pipe threads
1310	• JRGURED • Filter cup made of gunmetal • incl. threaded connectors	GN ½" – 2½" (DN15 – 65)	25	400 (4.0)	200 – 600	70	tapered external thread
1320	• JRGURED • Filter cup made of gunmetal • incl. threaded connectors	GN ½" – 2½" (DN15 – 65)	25	200 (2.0)	50 – 200 (0.5 – 2.0)	70	tapered external thread
1330	• JRGURED • Filter cup made of gunmetal • incl. threaded connectors	GN ½" – 2½" (DN15 – 65)	25	600 (6.0)	600 – 1000 (6.0 – 10.0)	70	tapered external thread

1303

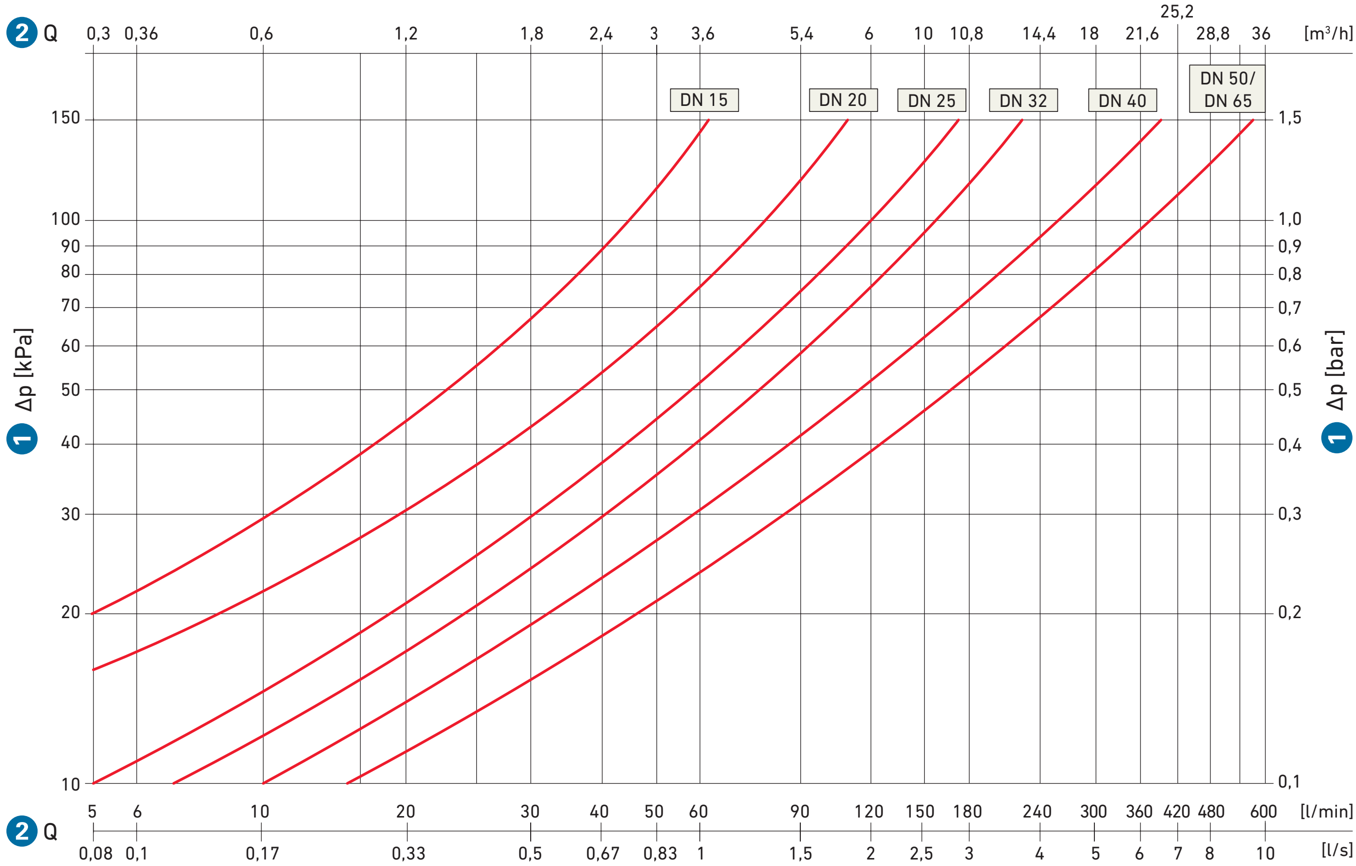


1. Pressure setting
2. Cover
3. Tensioning screw
4. Compression springs
5. Membrane
6. Housing
7. Valve seal
8. slider with seat
9. Coarse filter
10. O-ring
11. Damper membrane (DN15 – DN32)
12. Filter cup

V

Performance chart

Pressure setting: 600 / 400 kPa (6.0 / 4.0 bar)



1 Pressure loss
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN15 – 32	II

JRG code	Designation	Dimension
1300.240, 1310.240 1320.240, 1330.240		GN ½" (DN15)
1300.320, 1310.320 1320.320, 1330.320		GN ¾" (DN20)
1300.400, 1310.400 1320.400, 1330.400		GN 1" (DN25)
1300.480, 1310.480 1320.480, 1330.480	JRGURED Pressure reducer • tapered external thread	GN 1¼" (DN32)
1300.560, 1310.560 1320.560, 1330.560		GN 1½" (DN40)
1300.640, 1310.640 1320.640, 1330.640		GN 2" (DN50)
1300.720, 1310.720 1320.720, 1330.720		GN 2½" (DN65)
1303.015		GN ½" (DN15)
1303.020		GN ¾" (DN20)
1303.025		GN 1" (DN25)
1303.032	JRGURED Pressure reducer • Pipe threads	GN 1¼" (DN32)
1303.040		GN 1½" (DN40)
1303.050		GN 2" (DN50)
1303.065		GN 2½" (DN65)

Product description

The JRGURED pressure reducer is a compact fitting for water installations that reduces the upstream pressure to a lower, constant pressure. The fitting consists of a coarse filter and a pressure reducer. The coarse filter installed upstream of the pressure reducer retains suspended solids larger than 1000 µm.

Features and functions

The pressure set by the factory can be adapted to the hydraulic conditions in the object. If necessary or if there is a noticeable drop in pressure during the removal of water, the coarse filter can be cleaned.

Distribution fitting for three pressure levels (➨ [GV.6])

Central pressure reducers increase the comfort and service life of a sanitary installation and the equipment connected to it. For systems with different pressure levels, several pressure reducers with different secondary pressures must be used.

Equipment/machine connections with separate pressure reducing valve (➨ [GV.7])

If necessary, equipment or machines can be connected using a separate pressure reducer.

☑ Compliance with the regulations provided by the equipment or machine manufacturer as well as local installation regulations is mandatory.

Benefits and features

- Housing made of gunmetal
- All water-carrying parts are made of gunmetal, stainless steel or plastic
- Excellent control modes even with smallest volumes drawn from the tap
- Choice between 3 different pressure levels
- 2 variants for different temperatures
- Easy cleaning of the coarse filter
- Minimum height
- Same installation length as the predecessor JRGURED 1130

Mounting position and installation tips

The JRGURED pressure reducer works regardless of its position.

☑ Ensure to install the JRGURED pressure reducer in a place easy to access. Tension in the pipeline must be avoided.

☑ For filter maintenance purposes, a minimum clearance of 60 mm must be ensured.

☑ Install the JRGURED pressure reducer with plastic filter cup in order to ensure it is protected against intense UV radiation and aggressive environmental influences.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents

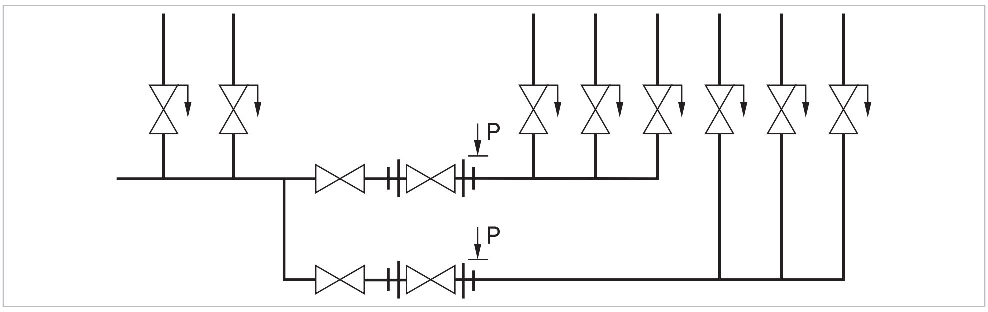
- Assembly instruction
- Operating and maintenance instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

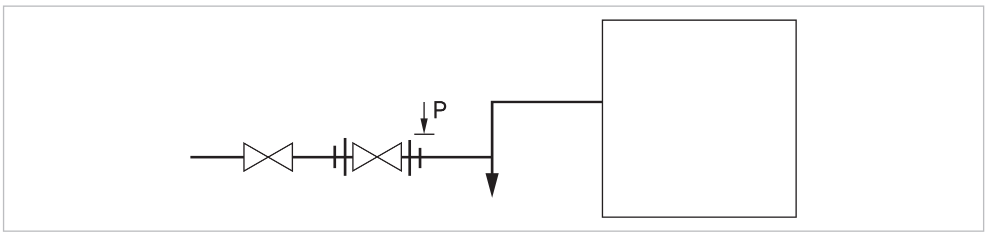
Spare parts

- Filter cup made of plastic/gunmetal
- O-ring for filter cup
- Damper membrane (GN ½" – 1¼")
- Filter insert (coarse filter)

Installation examples



GV.6
Distribution fitting for three pressure levels



GV.7
Equipment/machine connections with separate pressure reducing valve

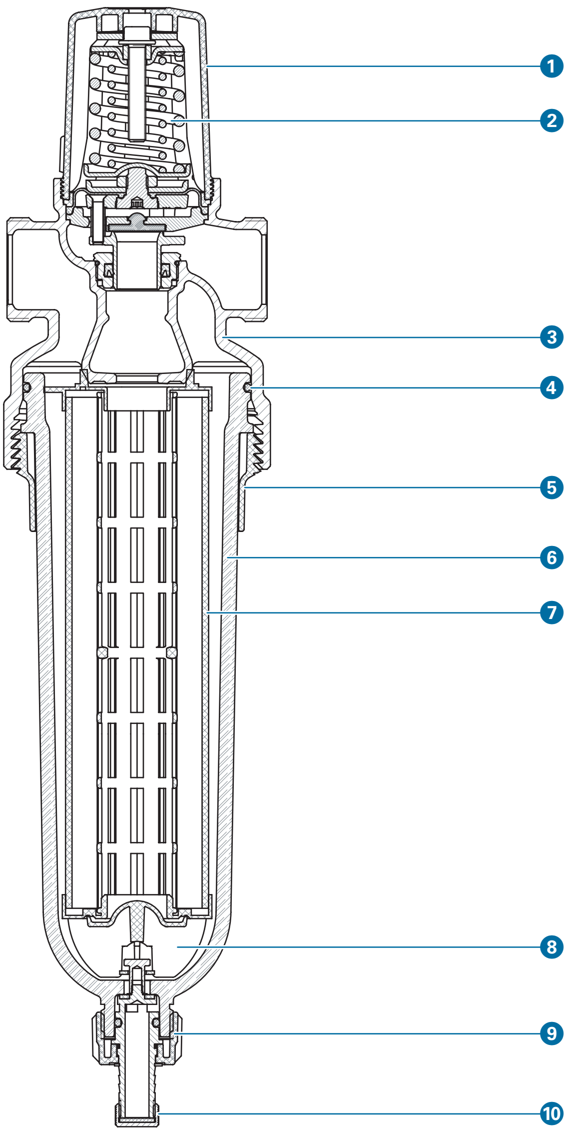
JRGURED Combi House water station 1350, 1353, 1360

The JRGURED Combi House water station is a compact combination fitting consisting of a fine filter and a pressure reducer. The pressure reducer lowers the upstream pressure to a lower, constant pressure. The fine filter installed upstream of the pressure reducer retains suspended solids larger than 100 µm.

Technical Data

JRG code	Components	Dimension	Nominal pressure PN	Factory setting [kPa (bar)]	Setting range [kPa (bar)]	Temperature max [°C]	Connections
1350	• Pressure reducer • Fine filter • Filter cup (plastic) • incl. threaded connectors	GN 1" – 2" (DN25 – 50)	16	400 (4.0)	200 – 600 (2.0 – 6.0)	30	Tapered pipe thread
1353	• Pressure reducer • Fine filter • Filter cup (plastic) • excl. threaded connections	GN 1" – 2" (DN25 – 50)	16	400 (4.0)	200 – 600 (2.0 – 6.0)	30	Pipe threads
1360	• Pressure reducer • Fine filter • Filter cup (gunmetal) • incl. threaded connectors	GN 1" – 2" (DN25 – 50)	25	400 (4.0)	200 – 600 (2.0 – 6.0)	30	Tapered pipe thread

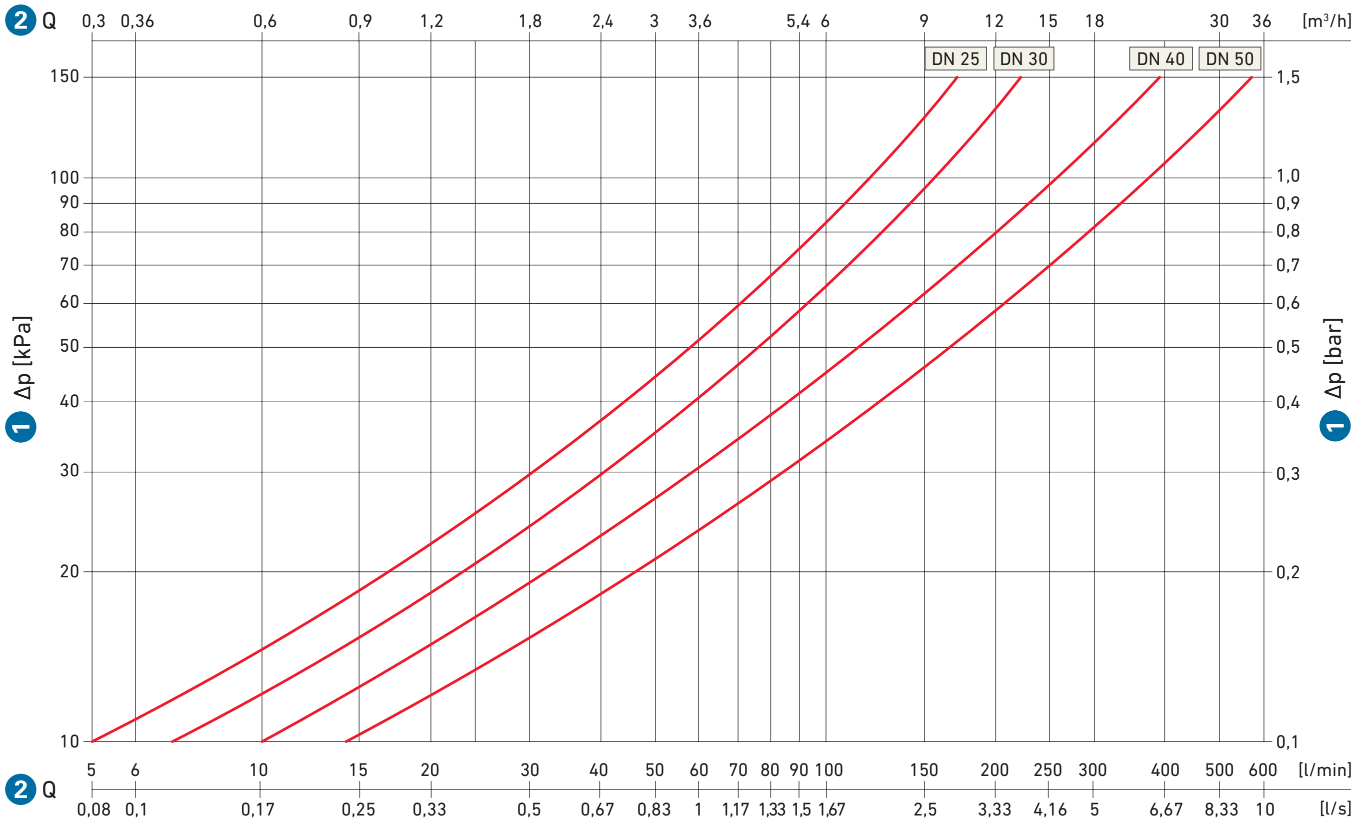
1353



1. Cover
2. Compression springs
3. Housing
4. O-ring
5. Threaded ring
6. Filter cup (clear/gunmetal)
7. Filter insert
8. Insert
9. Drain valve
10. Cap

Performance chart

Pressure setting: 400 kPa (4.0 bar)



1 Pressure loss
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN25 – 32	I

JRG code	Designation	Dimension
1350.400	JRGURED Combi House water station • tapered pipe thread	GN 1" (DN25)
1350.480		GN 1¼" (DN32)
1350.560		GN 1½" (DN40)
1350.640		GN 2" (DN50)
1353.025	JRGURED Combi House water station • pipe threads	GN 1" (DN25)
1353.032		GN 1¼" (DN32)
1353.040		GN 1½" (DN40)
1353.050		GN 2" (DN50)
1360.400	JRGURED Combi House water station • tapered pipe thread	GN 1" (DN25)
1360.480		GN 1¼" (DN32)
1360.560		GN 1½" (DN40)
1360.640		GN 2" (DN50)

V

Product description

The JRGURED Combi House water station is a compact combination fitting consisting of a fine filter and a pressure reducer. The pressure reducer lowers the upstream pressure to a lower, constant pressure. The fine filter installed upstream of the pressure reducer retains suspended solids larger than 100 µm.

Features and functions

Depending on the system, water pressures from the distribution network must be reduced to a permissible pressure with the pressure reducer.
Caused by repairs, renovations, etc., suspended solids, such as lime, rust, sand found on the public distribution network can permeate the building connection line and get into the domestic water distribution network. The fine filter retains such suspended solids and thus protects the domestic water installation.
The fine filter used in the JRGURED Combi House water station only serves to retain suspended solids from the distribution network. However, the filter does not replace a desired or necessary water treatment (softening, degermination, etc.).

Benefits and features

- Fitting enclosures made of gunmetal
- Two pressure levels are available:
  - Filter cup PN16 made of high-quality clear plastic
  - Filter cup PN25 made of gunmetal
- All water-carrying parts are made of gunmetal, stainless steel or plastic
- Easy disassembly of filter cup
- Separate threaded ring
- Filter cup with integrated drain valve
- Drain valve with hose connector
- Height of upper part kept to a minimum
- Same length as JRGURED 1130

Mounting position and installation tips

☑ Install the JRGURED Combi House water station horizontally and in a place easy to access. Tension in the pipeline must be avoided.
☑ For filter maintenance purposes, a minimum clearance of 60 mm below the filter must be ensured.
☑ The JRGURED Combi House water station with plastic filter cup must be installed in order to ensure it is protected against intense UV radiation and aggressive environmental influences.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Operation and maintenance

Changing the settings of the pressure reducing valve

If the machine operator changes the factory setting, he does so on his own responsibility (➨ “Operating and Maintenance Instruction”).

Maintenance and repairs

☑ Do not proceed with **any repairs** on the water station JRGURED Combi on your own.
☑ During maintenance of the fine filter: Compliance with the “Operating and Maintenance Instruction” is mandatory.

Applicable documents

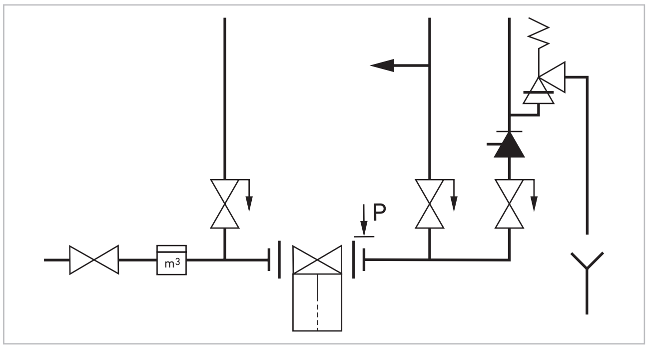
- Assembly instruction
- Operating and maintenance instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts

- Filter cup made of plastic/gunmetal
- Filter insert

Installation example



GV.8 **Installation example**

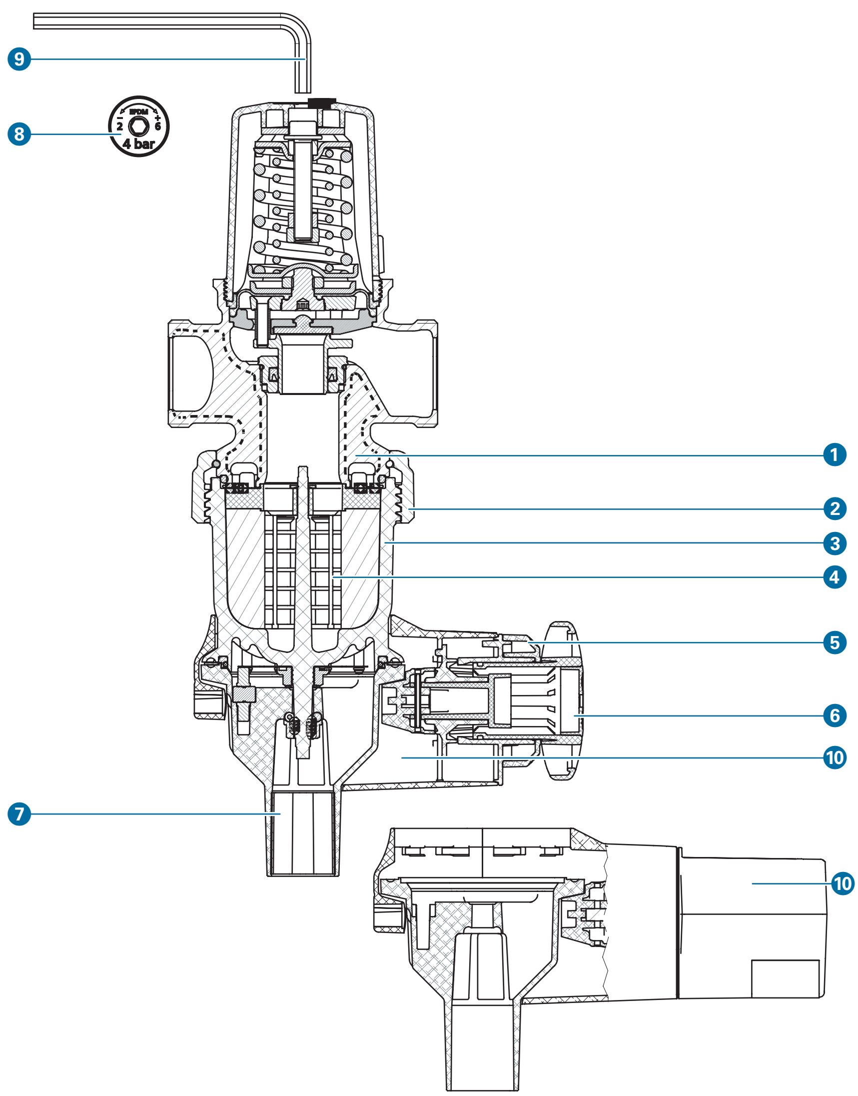
JRG CleanLine Combi House water station 1370, 1371

The JRG CleanLine Combi House water station is a combination of fittings that can be backwashed. It consists of a pressure reducer and a fine filter. The pressure reducer lowers the upstream pressure to a lower, constant pressure. The fine filter installed upstream of the pressure reducer retains suspended solids. The backwash technology offers the same filtration quality during backwashing as during normal operation.

Technical Data

JRG code	Components	Dimension	Nominal pressure PN	Factory setting [kPa (bar)]	Setting range [kPa (bar)]	Temperature max. [°C]	Connections
1370	• Pressure reducer • Backwashable fine filter	GN 1" – 1¼" (DN25 – 32)	16	400 (4.0)	200 – 600 (2.0 – 6.0)	30	Pipe threads
1371	• Pressure reducer • Backwashable fine filter • Back flushing unit						

1370

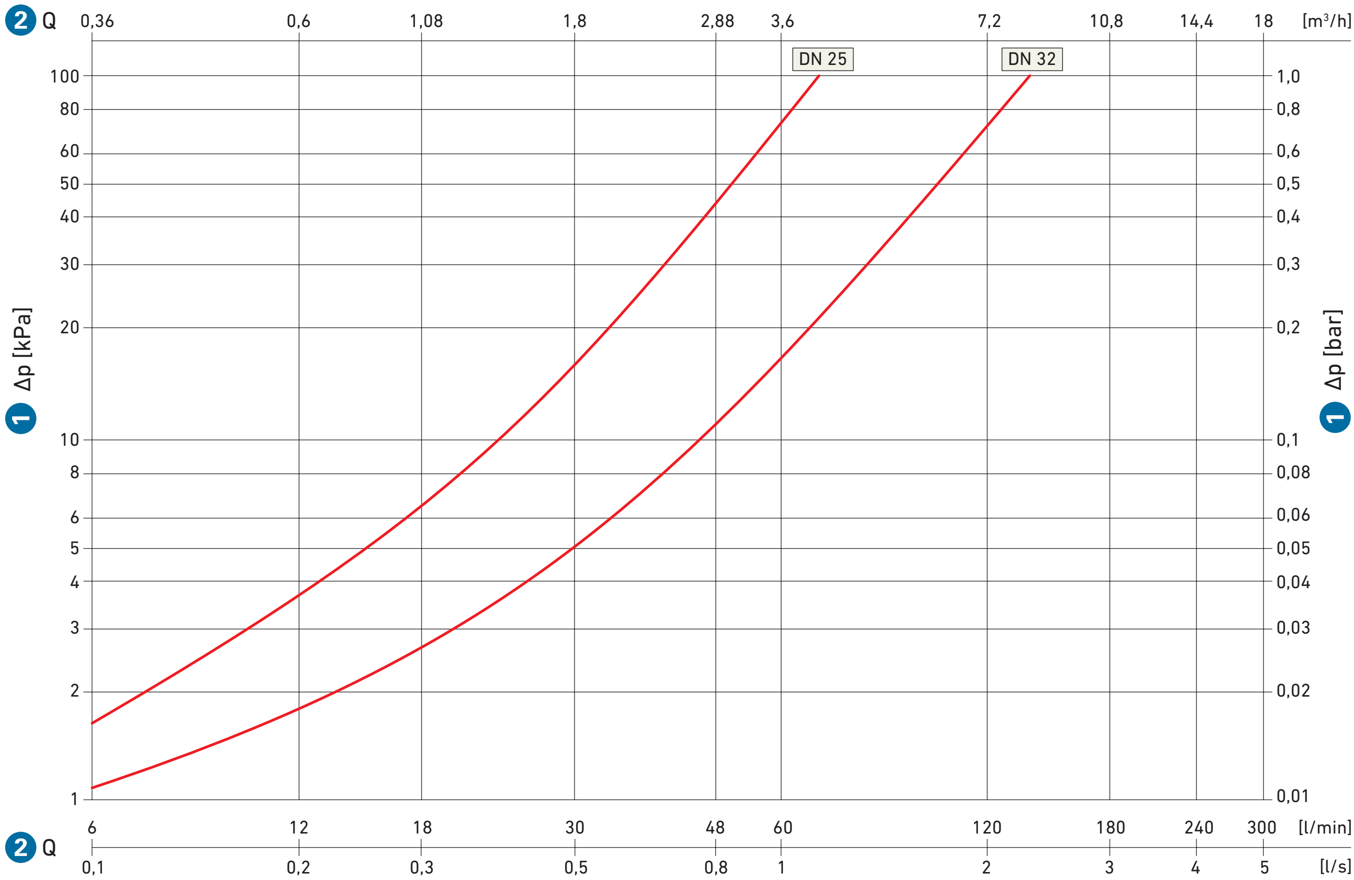


1. Housing
2. Nut
3. Filter cup
4. Filter insert
5. Months ring (scale 1 – 12) (only with JRG code 1370)
6. Manual operating mode (only with JRG code 1370)
7. Drain nozzle
8. Pressure setting
9. Socket head wrench
10. Back flushing unit (only with JRG code 1371)

V

Performance chart

Pressure setting: 600 / 400 kPa (6.0 / 4.0 bar)



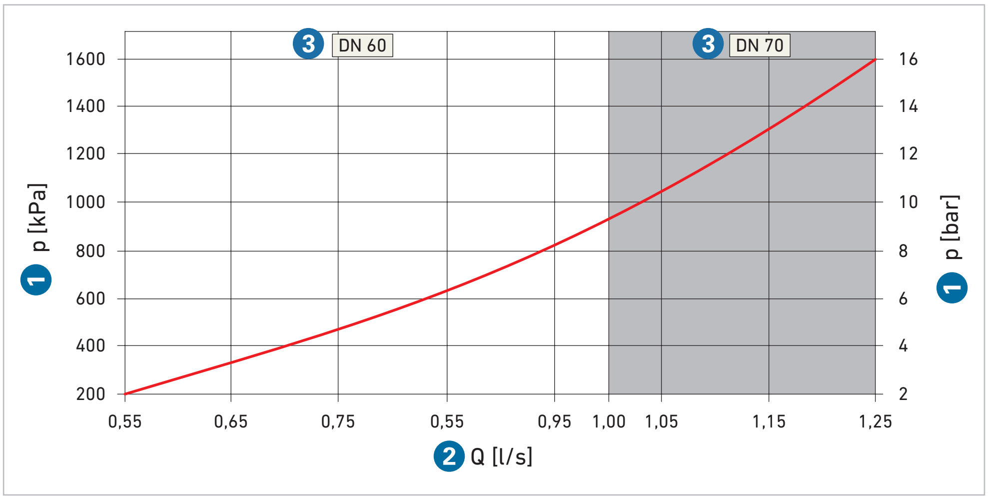
1 Pressure loss
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN25	I
DN32	II

JRG code	Designation	Dimension
1370.025 1371.025	JRG CleanLine Combi House water station	GN 1" (DN25)
1370.032 1371.032		GN 1¼" (DN32)

Flushing capacity



GV.9
Flushing capacity
1 Upstream pressure
2 Flushing capacity
3 Drainage line

Product description

The JRG CleanLine Combi House water station is a combination of fittings that can be backwashed. It consists of a pressure reducer and a fine filter. The pressure reducer lowers the upstream pressure to a lower, constant pressure. The fine filter installed upstream of the pressure reducer retains suspended solids. The backwash technology offers the same filtration quality during backwashing as during normal operation.

Features and functions

The backwashable fine filter ensures the water is filtered properly. A bypass filter has been omitted; this ensures that the entire filter surface is flushed through. The filter is partitioned into eight chambers, which are flushed one after the other during the backwashing process. During this process, the other seven chambers ensure consistent filtration quality.
For hygiene reasons, backwashing must be carried out at least every two months.
The backwashing unit ensures the backwashing of the filter insert is done automatically. The interval (7, 30 or 60 days) and the flushing time for each filter chamber (1, 3 or 6 seconds) can be set individually.
However, the fine filter does not replace any sought after or even necessary water treatment (decalcification, degermination, etc.).
Detailed information on backwashing the JRG CleanLine Combi House water station: ➨ "Operating and Maintenance instruction"

Benefits and features

- Changing the filter is not necessary
- Consistent filter quality during backwashing
- Effective backwash technology
- Minimum height
- Same length as JRGURED 1300/1130 und JRGURED Combi 1350

Mounting position and installation tips

- ☑ Install the JRG CleanLine Combi House water station and the JRG CleanLine filter in a place easy to access in a horizontal pipeline (flushing connection facing down).
- ☑ In order to remove the filter cup, a minimum clearance of 40 mm below the filter must be ensured.
- ☑ The JRG CleanLine Combi House water station and the JRG CleanLine Filter must be installed in order to ensure it is protected against intense UV radiation and aggressive environmental influences (e.g. solvent or detergent fumes etc.).

Installation instructions

- ☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.
- ☑ For installations in an aggressive environment and/or in rooms with uncontrollable environmental influences (such as solvent or cleaning agent fumes, intensive UV radiation, etc.), the fitting must be protected accordingly.

Applicable documents

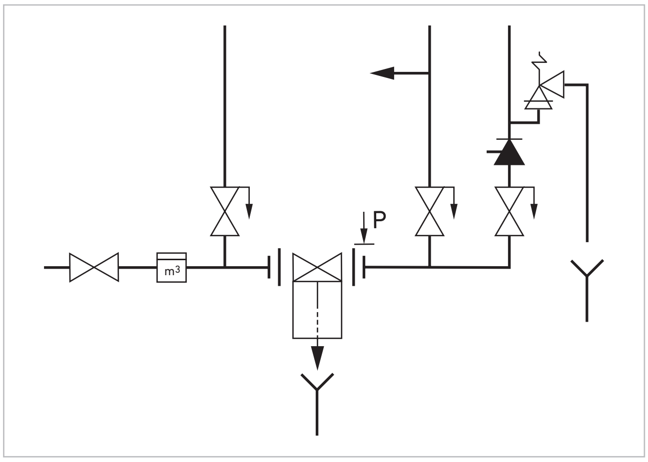
- Assembly instruction
- Operating and maintenance instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts

- Filter unit without actuator
- Back flushing unit

Installation example



GV.10 **Installation example**

V

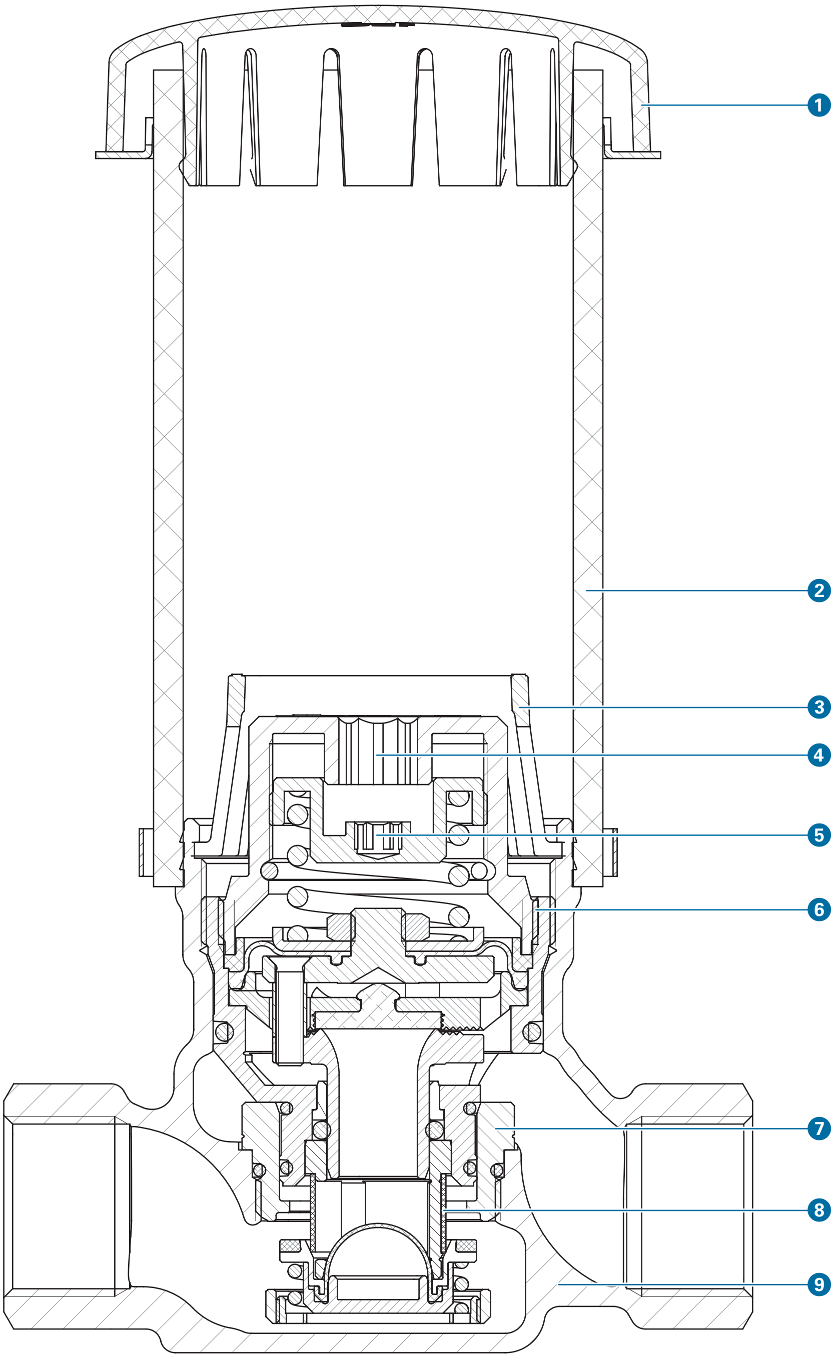
JRGURED UP Pressure reducer 1380

The JRGURED UP Pressure reducer is a compact fitting for drinking water installations consisting of a maintenance shut-off device, a coarse filter and a pressure reducer. The pressure reducer lowers the upstream pressure to a lower, constant pressure. The coarse filter retains suspended solids. The equipment was designed for the assembly inside in-wall elements.

Technical Data

JRG code	Dimension	Nominal pressure PN	Opening pressure [kPa (bar)]	Setting range [kPa (bar)]	Temperature max. [°C]	Connections
1380	GN ¾" (DN20)	16	300 (3.0)	250 – 450 (2.5 – 4.5)	70 (briefly 90)	Female thread

1380

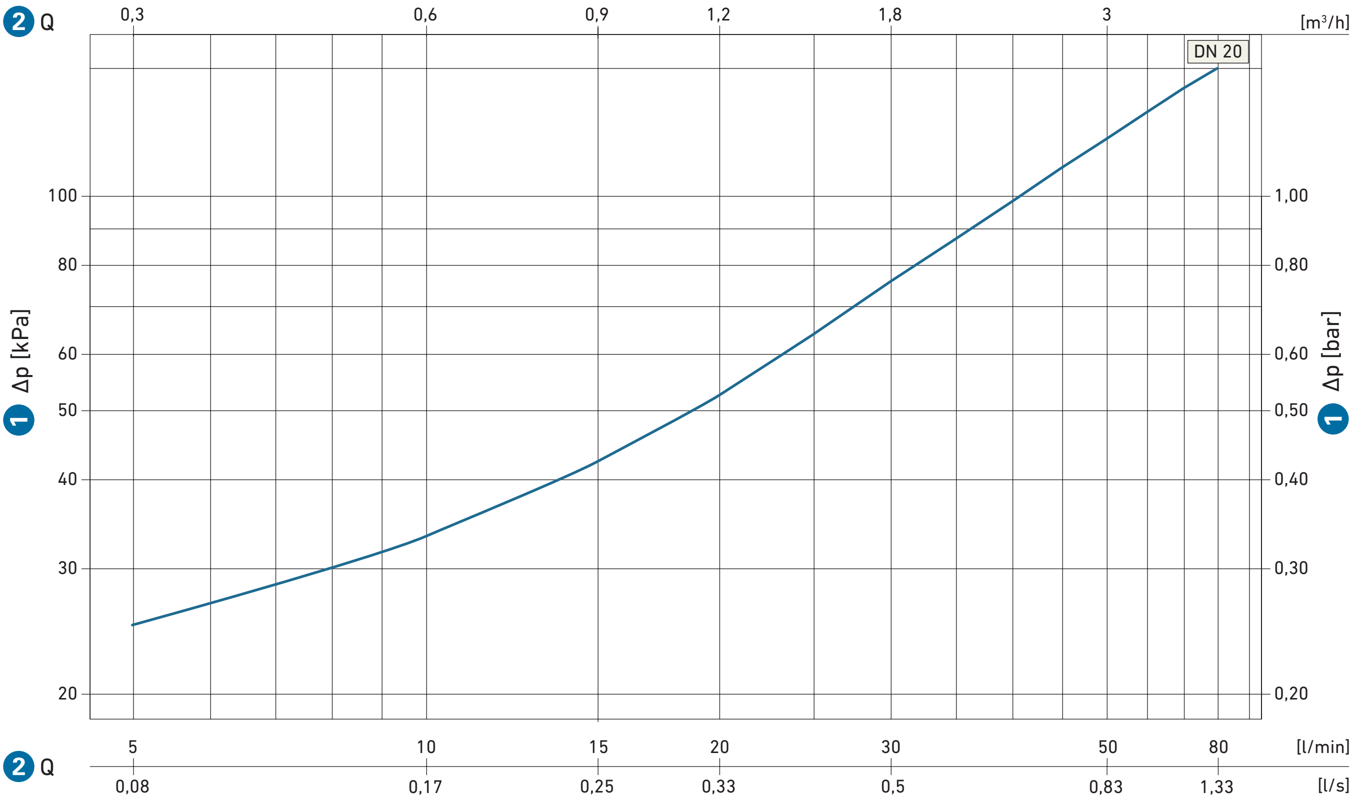


1. Rosette
2. Protective conduit
3. Safety sleeve
4. Shut-off activation (AF10)
5. Pressure setting activation (AF6)
6. JRGURED UP Cartridge
7. Shut-off unit
8. Coarse filter
9. Housing

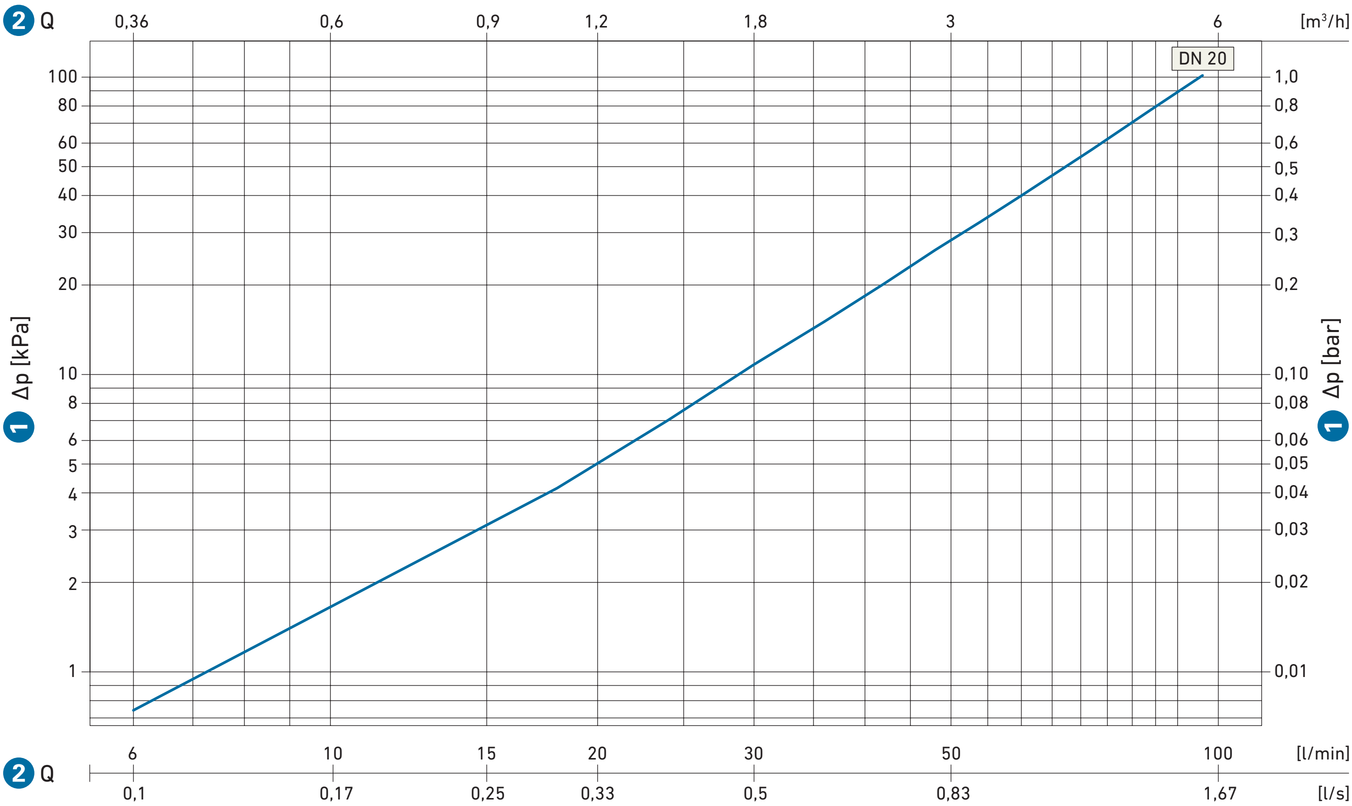
Performance chart

JRGURED UP Pressure reducer 1380, DN20 with cartridge installed

Pressure setting: 800 / 300 kPa (8.0 / 3.0 bar)



JRGURED UP Pressure reducer 1380, DN20 without cartridge, with bypass plug



Noise behaviour

Dimension	Group of valves
DN20	II

1 Pressure loss
2 Volumetric flow rate

V

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
1380.001	Pressure reducer	GN ¾" (DN20)	5.8	7.6
1380.320		GN ¾" (DN20)	–	–

Product description
The JRGURED UP Pressure reducer is a compact fitting for drinking water installations consisting of a maintenance shut-off device, a coarse filter and a pressure reducer. The pressure reducer lowers the upstream pressure to a lower, constant pressure. The coarse filter retains suspended solids. The complete equipment was designed for the assembly inside in-wall elements.

Features and functions
The JRGURED UP Pressure reducer can be installed directly on mounting rails (e.g. equipment plates for GIS profile or Duofix washbasin element).
The coarse filter installed as a standard upstream of the pressure reducer retains suspended solids larger than 1000 µm. If there is a noticeable drop in pressure during the removal of water, there is an easy way to clean the coarse filter.

Benefits and features
- Compact design
- Very small maintenance opening
- Circular maintenance opening similar to the UP straight seat valves (same design of the rosette)
- Installation depth for drywall elements Duofix / GIS optimised

Mounting position and installation tips
The JRGURED UP Pressure reducer works regardless of its position.
☑ Avoid tension when installing the valve and ensure the maintenance opening is easy to access.

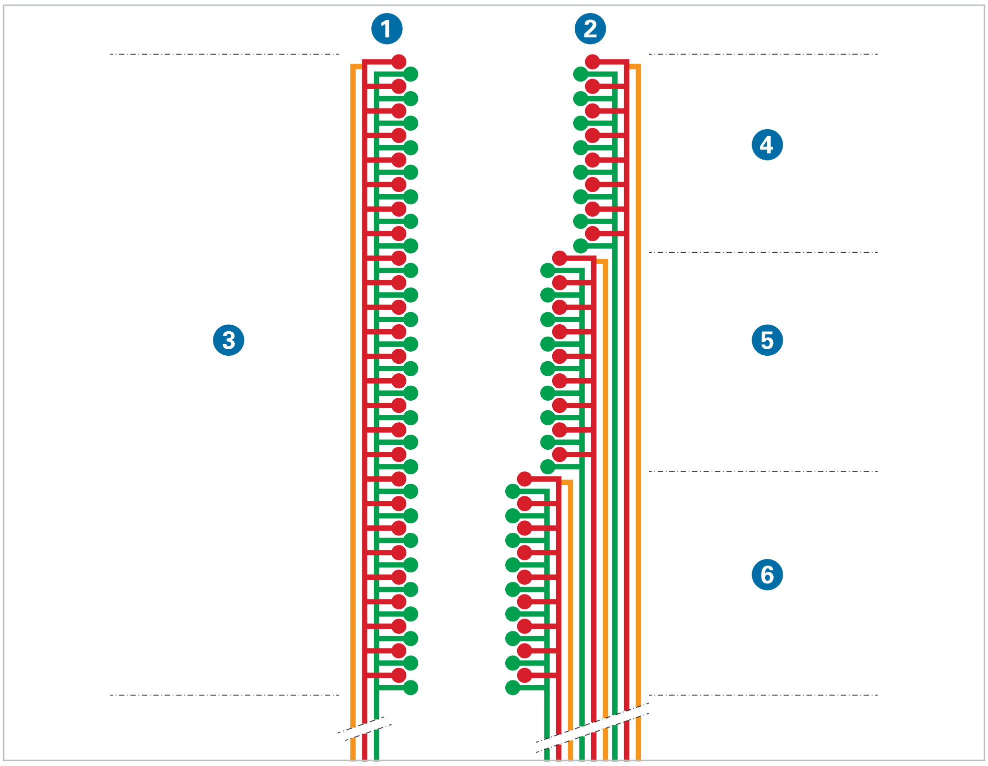
Installation instructions
☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents
- Assembly instruction
- Operating and maintenance instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts
- Shut-off unit
- JRGURED UP Cartridge
- Bypass plug
- Rosette
- Safety sleeve
- Spare parts set consisting of: Coarse filter and O-rings, suitable for the JRGURED UP Cartridge

Installation example



GV.11
Pressure levels

1. Example, using a JRGURED UP
2. conventional example
3. Pressure level 1 – pressure from the elevation system is reduced in each case upstream of the floor distribution
4. Pressure level 3 – pressure from the elevation system is not reduced
5. Pressure level 2 – pressure from the elevation system is not reduced
6. Pressure level 1 – pressure from the pipe network may be reduced

With JRGURED UP:
☑ Advantageous for smaller riser shafts and quick installation of riser pipes.

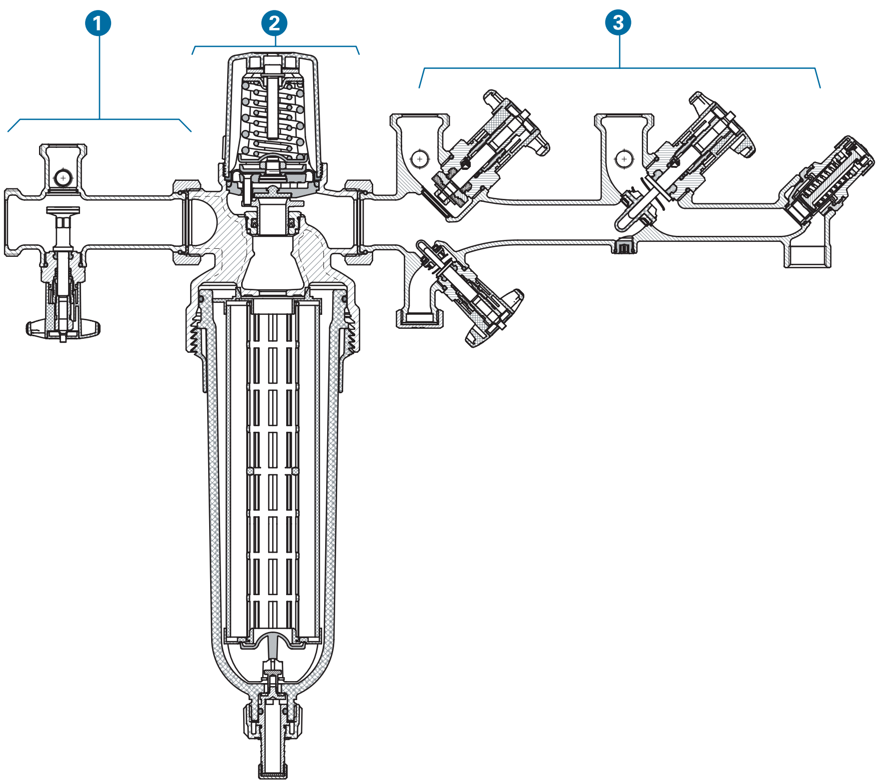
JRGUSIT Distribution fitting 1511 – 1542

The JRGUSIT Distribution fitting is equipped with all necessary components for single-family dwellings and small objects. Depending on the layout, the distribution fitting performs the required tasks of pressure reduction and distribution in the drinking water installation.

Technical Data

JRG code	Components	Dimension	Nominal pressure PN	Factory setting [kPa (bar)]	Temperature max [°C]	Connections
1511	• Distribution valve • Pressure reducer • Distribution valve	GN 1"-¾"-1"-1" (DN25-20-25-25)	16	Pressure reducer: 400 (4.0) Safety valve: 600 (6.0)	30	• Pipe threads • Drain from safety valve: Female pipe thread
1521	• Distribution valve • House water station • Distribution valve	GN 1¼"-¾"-1"-1" (DN32-20-25-25)				
1531	• Distribution valve • House water station • JRG Coral Force fitting part • Distribution valve	GN 1¼"-¾"-1"-1" (DN32-20-25-25)				
1541	• Distribution valve • House water station, can be back flushed manually • Distribution valve	GN 1"-¾"-1"-1" (DN25-20-25-25) GN 1¼"-¾"-1"-1" (DN32-20-25-25)				
1542	• Distribution valve • House water station, can be back flushed automatically • Distribution valve	GN 1"-¾"-1"-1" (DN25-20-25-25) GN 1¼"-¾"-1"-1" (DN32-20-25-25)				

1521



1. Distribution valve JRGUSIT NG
2. House water station JRGURED Combi
3. Distribution valve JRGUSIT Combi

Performance chart

Information on pressure loos

➨ refer to individual products

Product description

The JRGUSIT distribution fitting is equipped with all necessary components for single-family dwellings and small objects. The distribution valve used with JRG code 1511/1521 consists of a JRGUSIT NG Reduction valve, a JRGURED Pressure reducer, JRG code 1531-1542, a JRGURED Combi House water station or JRG CleanLine Combi House water station and a JRGUSIT Combi Reduction valve with integrated return flow inhibitor, a heating fill valve and a safety valve.

Features and functions

The distribution fitting fulfils all necessary tasks during distribution, shut-off, pressure reduction and filtration. All variants except for the JRGUSIT distribution fitting 1511 are equipped with fine filters.
The distribution fitting includes a backflow prevention unit and a overpressure protection.

Benefits and features

- High-quality and drinking water compliant materials: Gunmetal, chromium-nickel steel, EPDM etc.
- Upper part of JRG LegioStop valve without dead space and continuously smooth operation
- Valve seat made of chromium-nickel steel

Mounting position and installation tips

☑ Install distribution fitting horizontally and avoid any tension.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents

- Assembly instructions
- Operating and maintenance instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts

- Upper parts of the shut-off valves, as well as handwheels and marking signs
- Upper part of safety valve
- Filter cup and filter insert (for JRG Code 1511, 1521 and 1531)
- Filter unit (for JRG Code 1541 and 1542)
- Drain valves

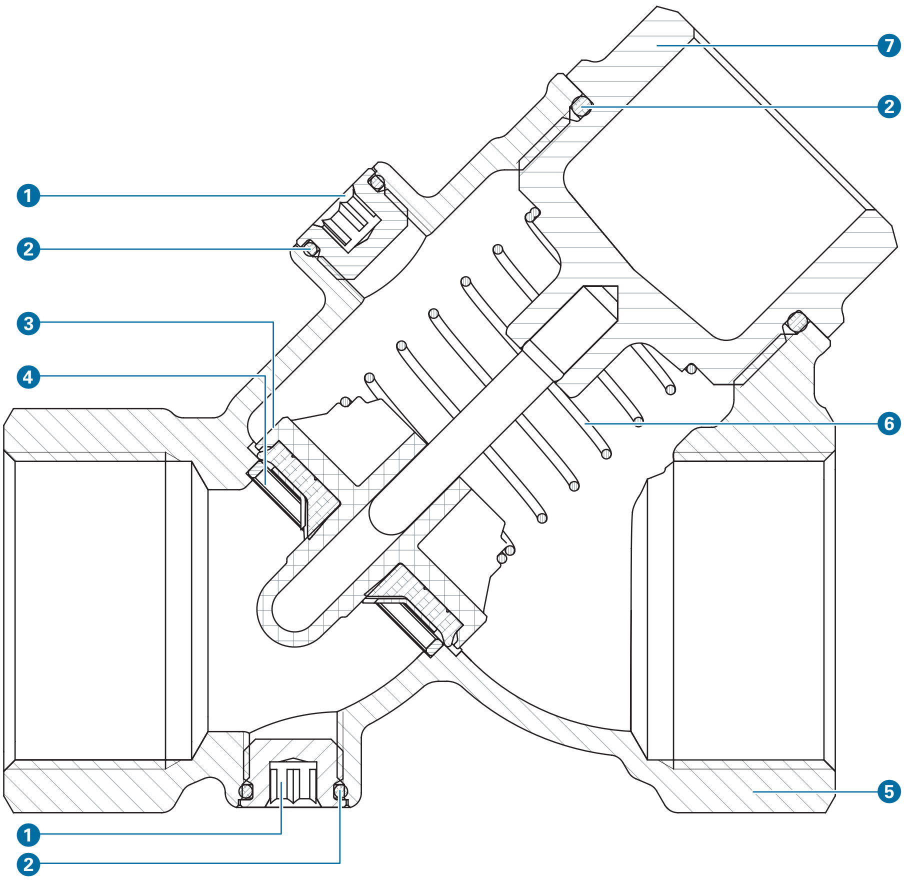
Return flow inhibitor 1610 – 1615

The return flow inhibitor, type EA, is a mechanical safety device that allows flow in one direction only. The fitting is controllable acc. to EN 13959.

Technical Data

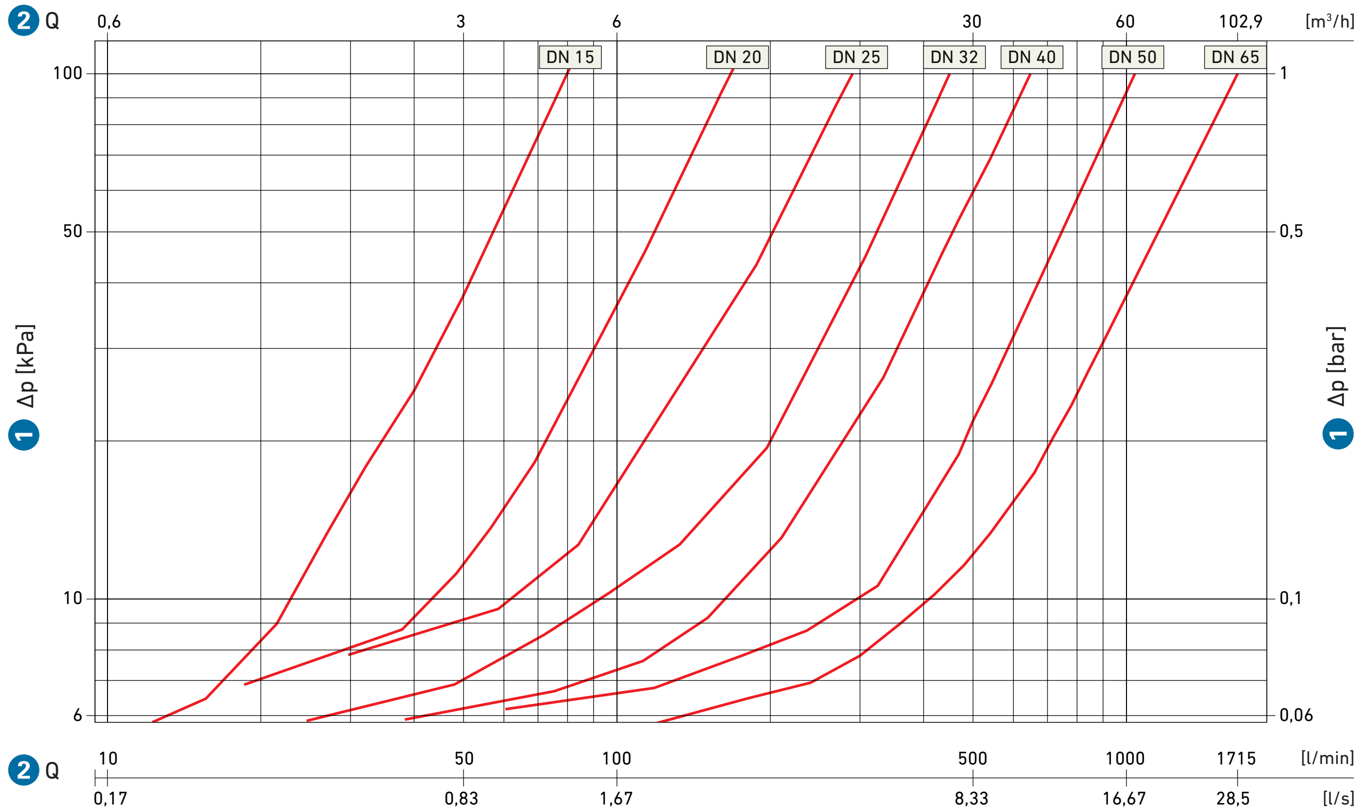
JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
1610	GN ½" – 2½" (DN15 – 65)	16	90	Female pipe thread
1611				Pipe threads
1612	d16 – d63 (DN12 – 50)	10		JRG Sanipex MT
1614	GN 1½" – 2½" (DN40 – 65)	16		Flange SN EN 1092
1615	d15 – d54 (DN12 – 50)	10		Push-fit

1610



1 Plug
2 O-ring
3 Flow body
4 Valve seat
5 Housing
6 Compression spring
7 Plug with guide

Performance chart



Noise behaviour

1 Pressure loss
2 Volumetric flow rate

Dimension	Group of valves
DN15 – 32	I

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
1610.240	Return flow inhibitor • Female pipe thread	GN ½" (DN15)	4.9	3.4
1610.320		GN ¾ (DN20)	10.1	2.5
1610.400		GN 1" (DN25	17.1	2.1
1610.480		GN 1¼" (DN32)	27.5	2.2
1610.560		GN 1½" (DN40)	38.7	2.7
1610.640		GN 2" (DN50)	63.6	2.5
1610.720		GN 2½" (DN65)	102.0	2.7
1611.015	Return flow inhibitor • Pipe threads	GN ½" (DN15)	4.9	3.4
1611.020		GN ¾ (DN20)	10.1	2.5
1611.025		GN 1" (DN25	17.1	2.1
1611.032		GN 1¼" (DN32)	27.5	2.2
1611.040		GN 1½" (DN40)	38.7	2.7
1611.050		GN 2" (DN50)	63.6	2.5
1611.065		GN 2½" (DN65)	102.0	2.7
1612.016	Return flow inhibitor • JRG Sanipex MT	d16 (DN12)	4.9	1.4
1612.020		d20 (DN15)	4.9	3.4
1612.026		d26 (DN20)	10.1	2.5
1612.032		d32 (DN25)	17.1	2.1
1612.040		d40 (DN32)	27.5	2.2
1612.050		d50 (DN40)	38.7	2.7
1612.063		d63 (DN50)	63.6	2.5

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
1614.040	Return flow inhibitor • Flange connection	GN 1½" (DN40)	38.2	2.8
1614.050		GN 2" (DN50)	62.0	2.6
1614.065		GN 2½" (DN65)	101.0	2.8
1615.015	Return flow inhibitor • Push-fit	d15 (DN12)	4.9	1.4
1615.018		d18 (DN15)	4.9	3.4
1615.022		d22 (DN20)	10.1	2.5
1615.028		d28 (DN25)	17.1	2.1
1615.035		d35 (DN32)	27.5	2.2
1615.042		d42 (DN40)	38.7	2.7
1615.054		d54 (DN50)	63.6	2.5

Product description
The return flow inhibitor, type EA, is a mechanical safety device that allows flow in one direction only. The fitting is controllable acc. to EN 13959.

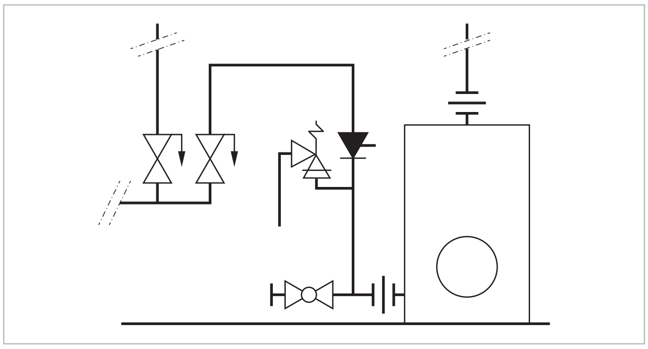
Features and functions
When water is heated, the volume increases, resulting in a pressure increase in a closed vessel. The return flow inhibitor prevents the return of water from the DHW heater into the distribution network.
The return flow inhibitor opens automatically when the pressure on the inlet side is greater than the pressure downstream of the fitting. If the pressure downstream of the fitting is higher, or there is no flow, force is applied and the fitting closes automatically.

Benefits and features
- Permanently smooth-running
- Low opening resistance and pressure loss
- Valve seat made of stainless steel

Mounting position and installation tips
The return flow inhibitor can be installed regardless of its position.
However, for inspection purposes, it is advisable to provide sufficient clearance in the area of the upper part.

Installation instructions
☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Spare parts
- Upper part of the return flow inhibitor

Installation example


GV.12 **Installation diagram**

V

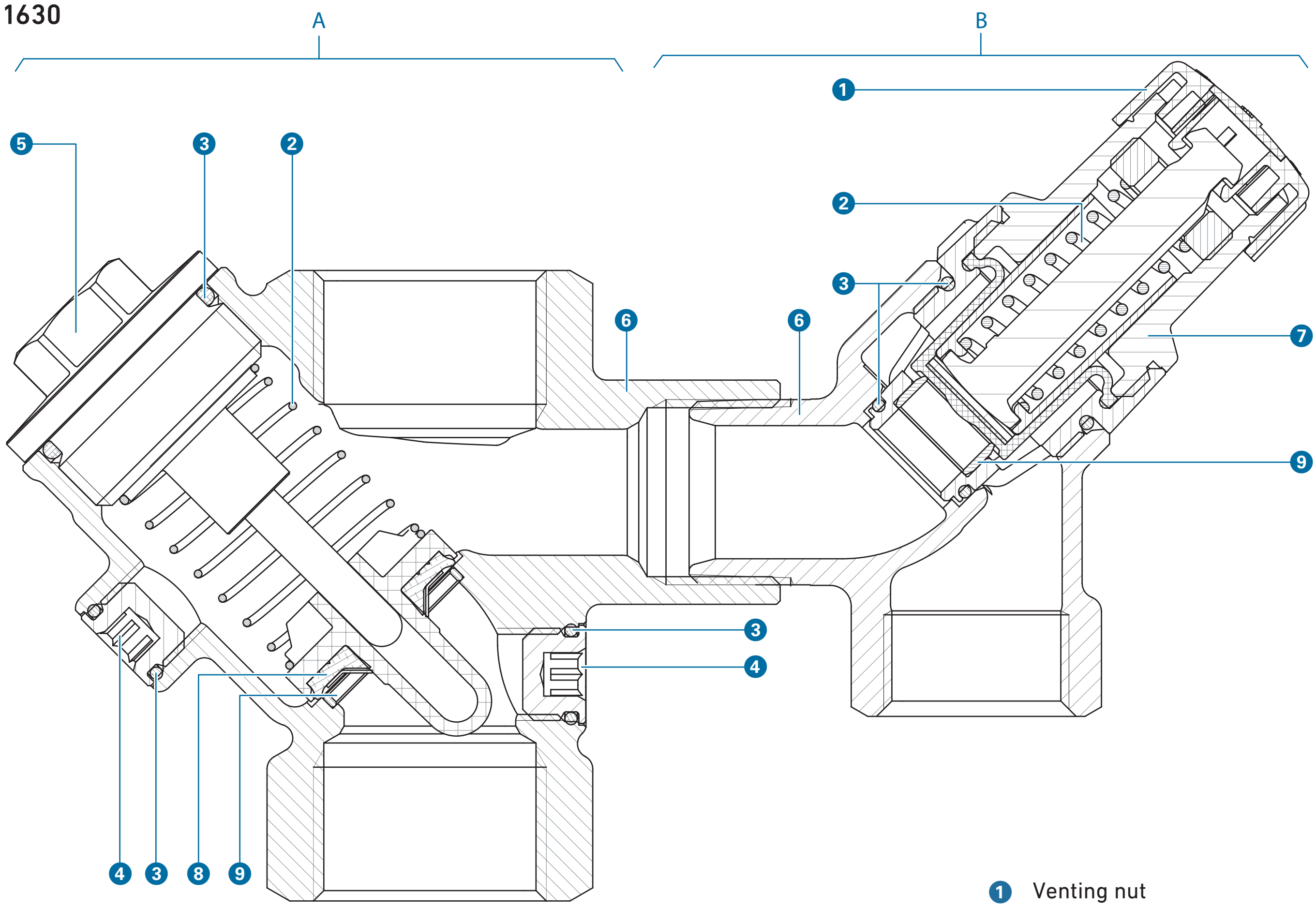
Safety group 1630, 1631

The safety group consists of the return flow inhibitor type EA and a safety valve. The return flow inhibitor, type EA, is a mechanical safety device that allows flow in one direction only. The fitting is controllable acc. to EN 13959. The JRGARANT safety valve protects closed-type DHW heaters against excessive pressures.

Technical Data

JRG code	Dimension	Nominal pressure PN	Opening pressure [kPa (bar)]	Temperature max. [°C]	Connections
1630	GN ¾" – 1¼" (DN20 – 32)	10	600 (6.0)	90	Female pipe thread
1631					Pipe threads

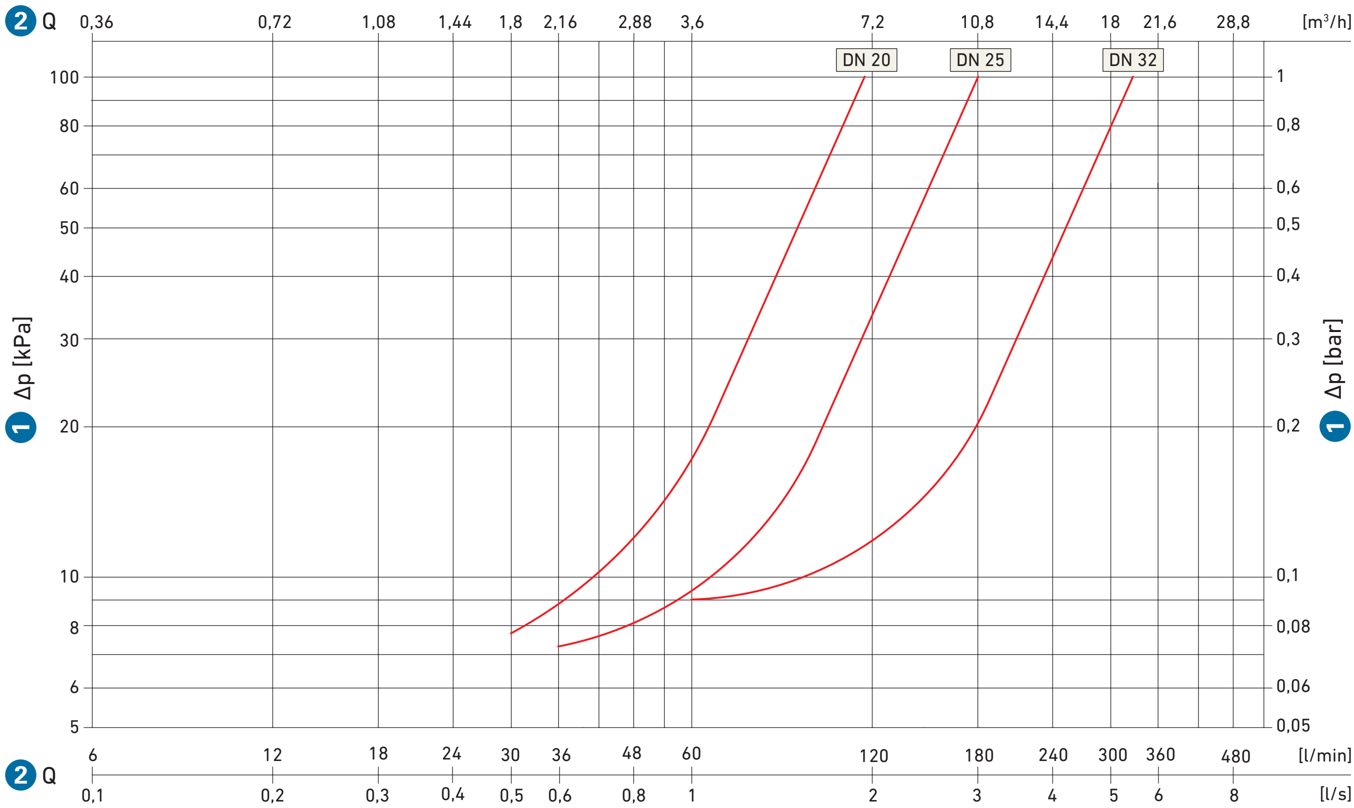
1630



1 Venting nut
2 Compression spring
3 O-ring
4 Plug
5 Plug with guide
6 Housing
7 Upper part
8 Flow body
9 Valve seat

A Return flow inhibitor
B Safety valve

Performance chart



1 Pressure loss
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN20 – 32	I

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
1630.320	Safety group • Female pipe thread	GN ¾" (DN20)	10.1	2.5
1630.400		GN 1" (DN25)	17.1	2.1
1630.480		GN 1¼" (DN32)	27.5	2.2
1631.020	Safety group • Pipe threads	GN ¾" (DN20)	10.1	2.5
1631.025		GN 1" (DN25)	17.1	2.1
1631.032		GN 1¼" (DN32)	27.5	2.2

V

Product description

The safety group consists of the return flow inhibitor type EA and a JRGARANT safety valve.
The return flow inhibitor, type EA, is a mechanical safety device that allows flow in one direction only. The fitting is controllable acc. to EN 13959.
The JRGARANT safety valve protects closed-type DHW heaters against excessive pressures.

Features and functions

When water is heated, the volume increases, resulting in a pressure increase in a closed vessel. The built-in return flow inhibitor prevents the return of water from the DHW heater into the distribution network.
The return flow inhibitor opens automatically when the pressure on the inlet side is greater than the pressure downstream of the fitting. If the pressure downstream of the fitting is higher, or there is no flow, force is applied and the fitting closes automatically.
The safety valve opens when the set response pressure is reached. The amount of water generating the excess pressure drains off.

Benefits and features

- Permanently smooth-running
- Low opening resistance and pressure loss
- Valve seat made of stainless steel

Mounting position and installation tips

The return flow inhibitor can be installed regardless of its position.
However, for inspection purposes, it is advisable to provide sufficient clearance in the area of the upper part.

☑ The safety valves must be easily accessible.
☑ When draining the safety valve, its discharge must be easy to see, or the drain line must be kept as short as possible.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.
☑ Do not close the drain line or spigot of the safety valve.

Applicable documents

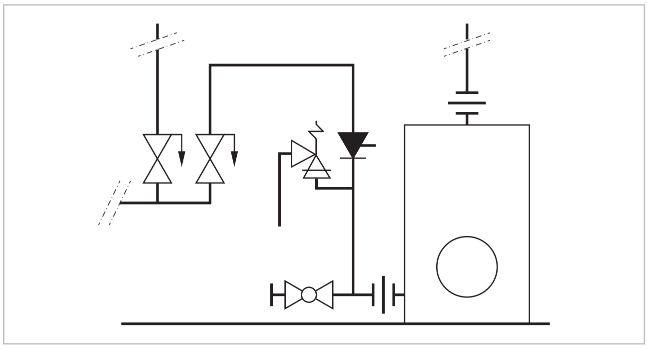
- Installation, operating and maintenance instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts

- Upper parts

Installation example



GV.13 **Installation diagram**

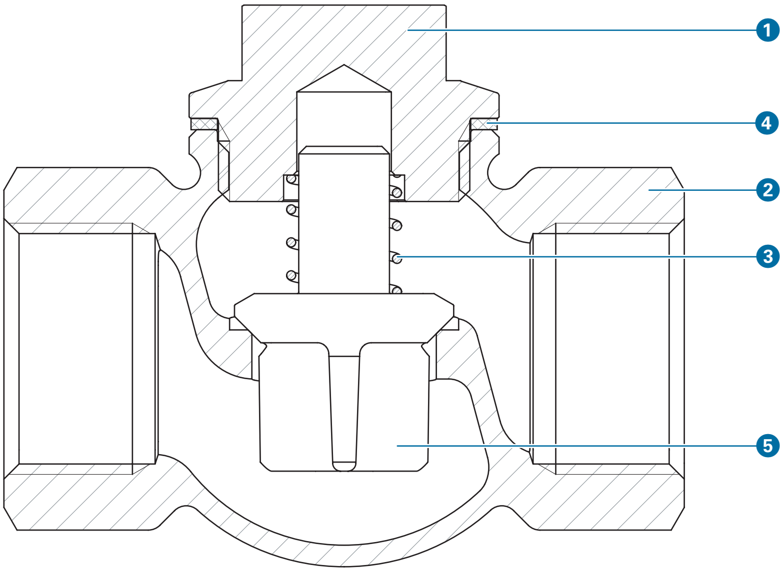
Return flow inhibitor 1672

The return flow inhibitor is a mechanical safety device (using a metal seal) that allows flow in one direction only.

Technical Data

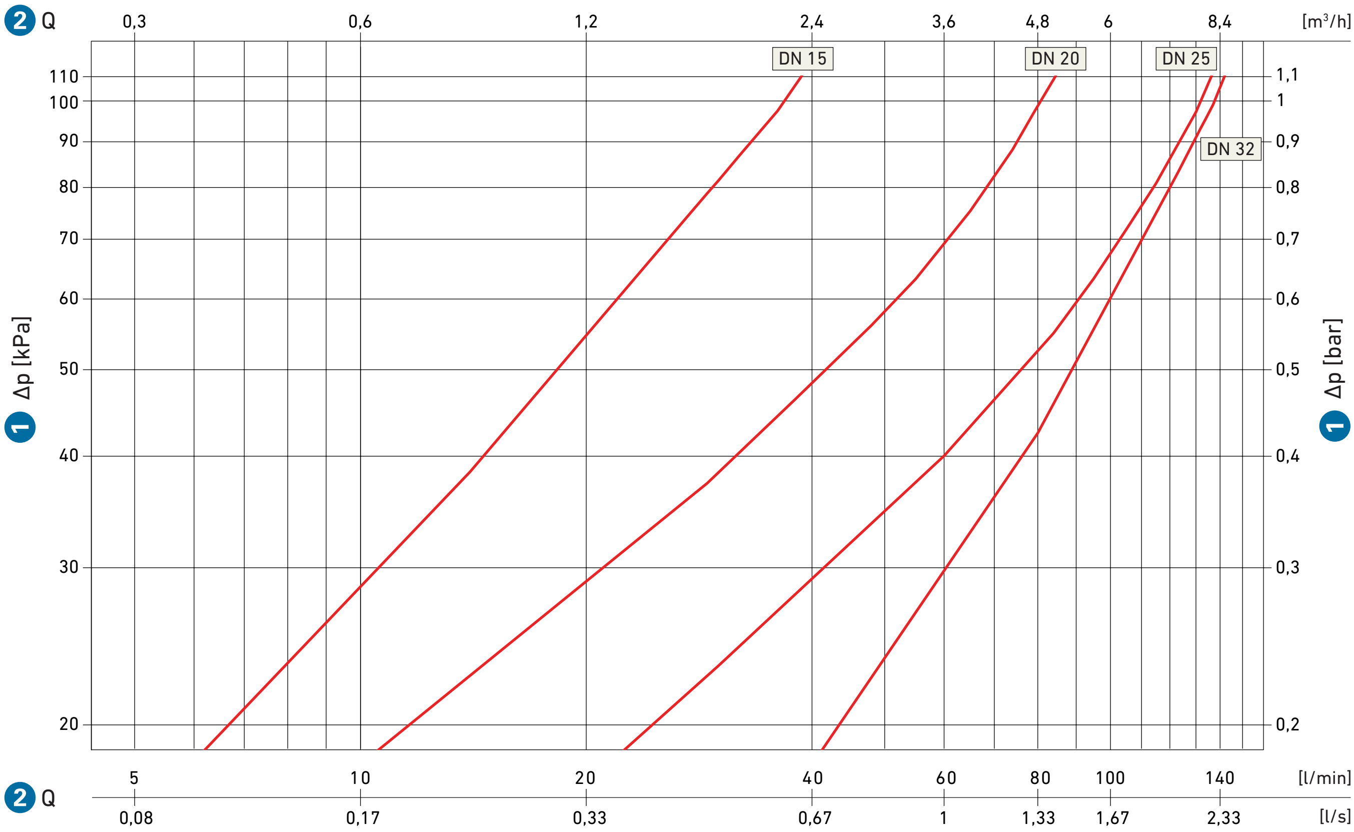
JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
1672	GN ½" – 1¼" (DN15 – 32)	16	200	Female pipe thread

1672



1. Plug with guide
2. Housing
3. Compression spring
4. Flat gasket
5. Valve poppet

Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
1672.240	Return flow inhibitor	GN ½" (DN15)	2.2	16.7
1672.320		GN ¾" (DN20)	4.8	11.1
1672.400		GN 1" (DN25)	7.8	10.3
1672.480		GN 1¼" (DN32)	8.1	25.6

1 Pressure loss
2 Volumetric flow rate

Product description

The return flow inhibitor is a mechanical safety device (using a metal seal) that allows flow in one direction only.

Features and functions

The return flow inhibitor with cone and spring opens automatically when the pressure on the inlet side is greater than the pressure downstream of the fitting. If the pressure downstream of the fitting is higher, or there is no flow, force is applied and the fitting closes automatically.

Benefits and features

- Metallic sealing
- For water, oil and steam up to 200°C

Mounting position and installation tips

The return flow inhibitor can be installed regardless of its position.
However, for inspection purposes, it is advisable to provide sufficient clearance in the area of the upper part.

Installation instructions

Since the return flow inhibitor uses a metal seal and is not fitted with a control plug, its use in drinking water installations is not permitted.

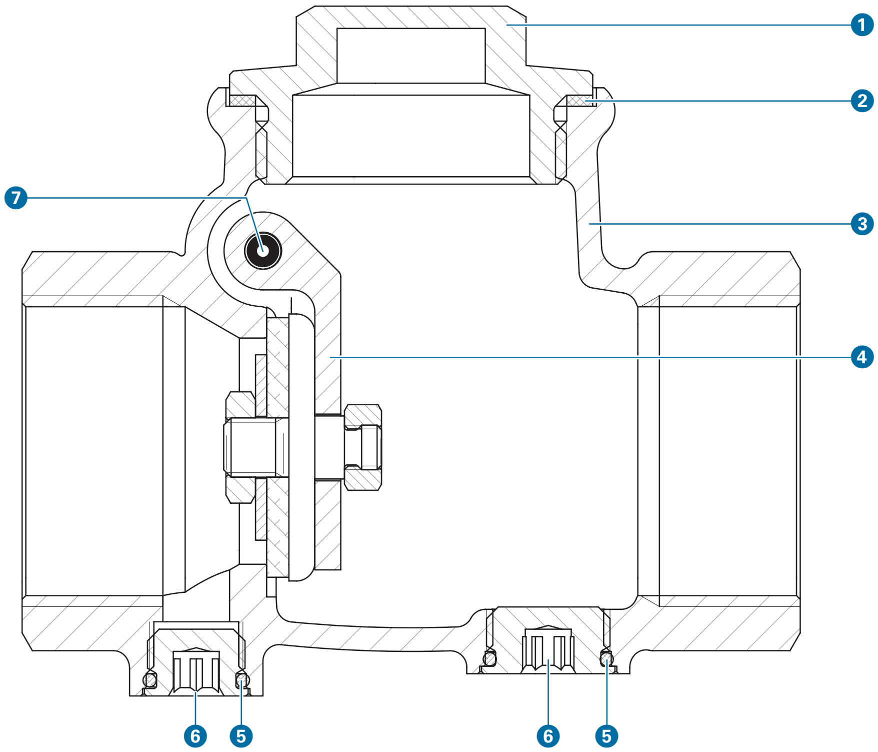
Flap trap 1682

The flap trap is a mechanical safety device that allows flow in one direction only.

Technical Data

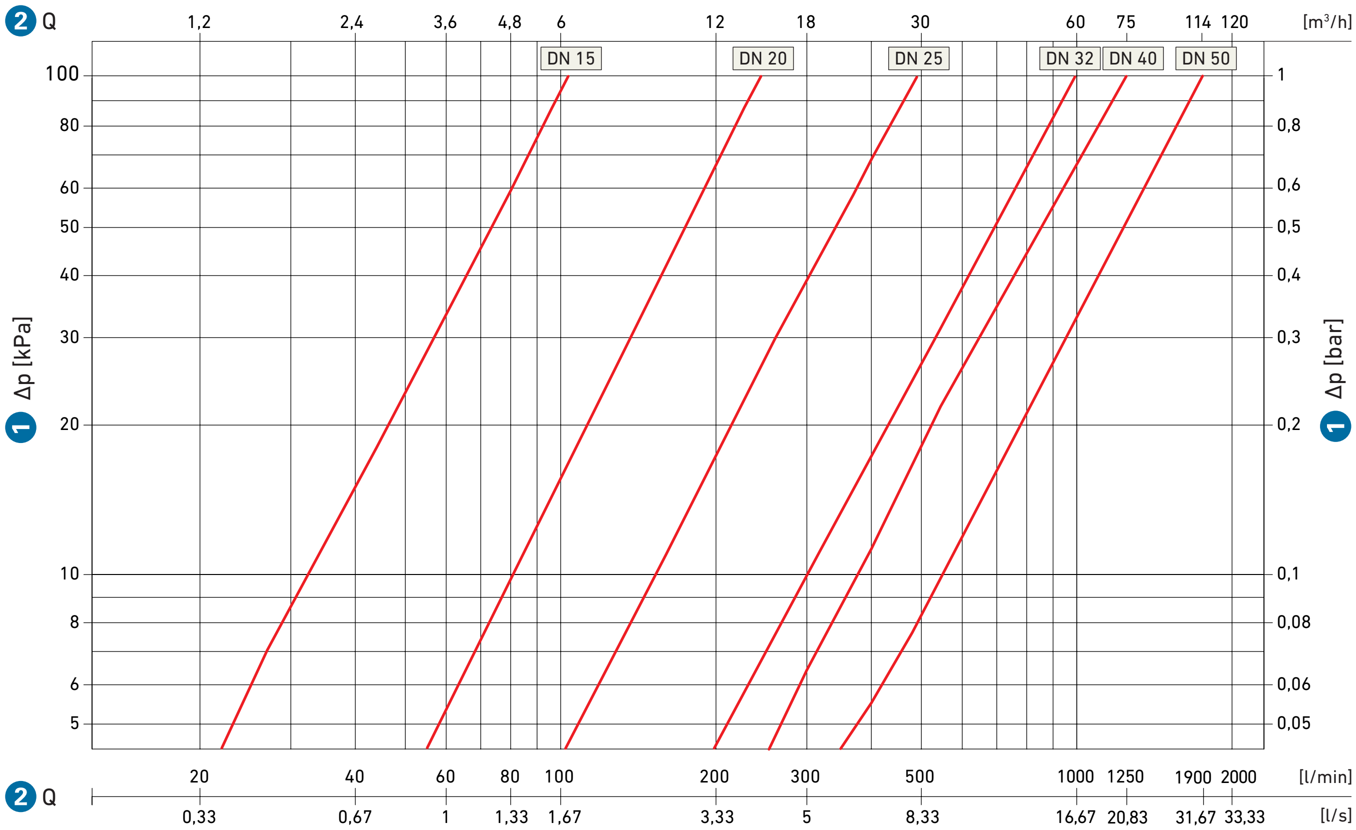
JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
1682	GN ½" – 2" (DN15 – 50)	16	90	Female pipe thread

1682



1. Plug
2. Flat gasket
3. Housing
4. Pendulum with valve disk
5. O-ring
6. Plug
7. Pendulum axle

Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
1682.240	Flap trap	GN ½" (DN15)	6.5	1.9
1682.320		GN ¾" (DN20)	15.3	1.1
1682.400		GN 1" (DN25)	29.4	0.7
1682.480		GN 1¼" (DN32)	60.0	0.5
1682.560		GN 1½" (DN40)	75.0	0.7
1682.640		GN 2" (DN50)	114.0	0.8

1 Pressure loss
2 Volumetric flow rate

Product description

The flap trap is a mechanical safety device that allows flow in one direction only.

Features and functions

The flap trap opens automatically when the flow pressure on the upstream side is higher than downstream of the fitting. If the pressure downstream of the fitting is higher, or there is no flow, force is applied and the fitting closes automatically.

Benefits and features

- Low opening pressure
- Minor pressure loss

Mounting position and installation tips

☑ Install the flap trap horizontally (top part pointing up) or vertically (flow direction from bottom to top).

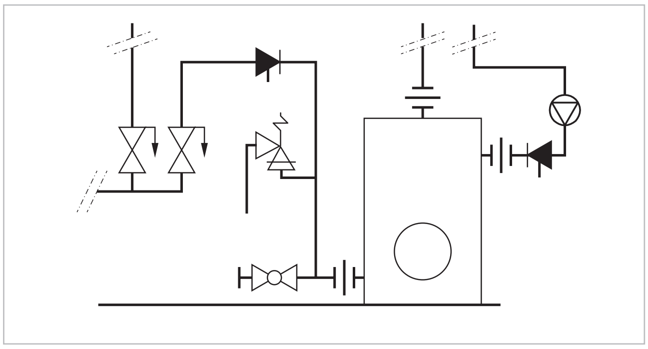
Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Spare parts

- Repair set for flap trap, consisting of:
  - Flat gasket
  - Pendulum with distributor
  - Pendulum axle with plug

Installation example



GV.14 **Installation diagram**

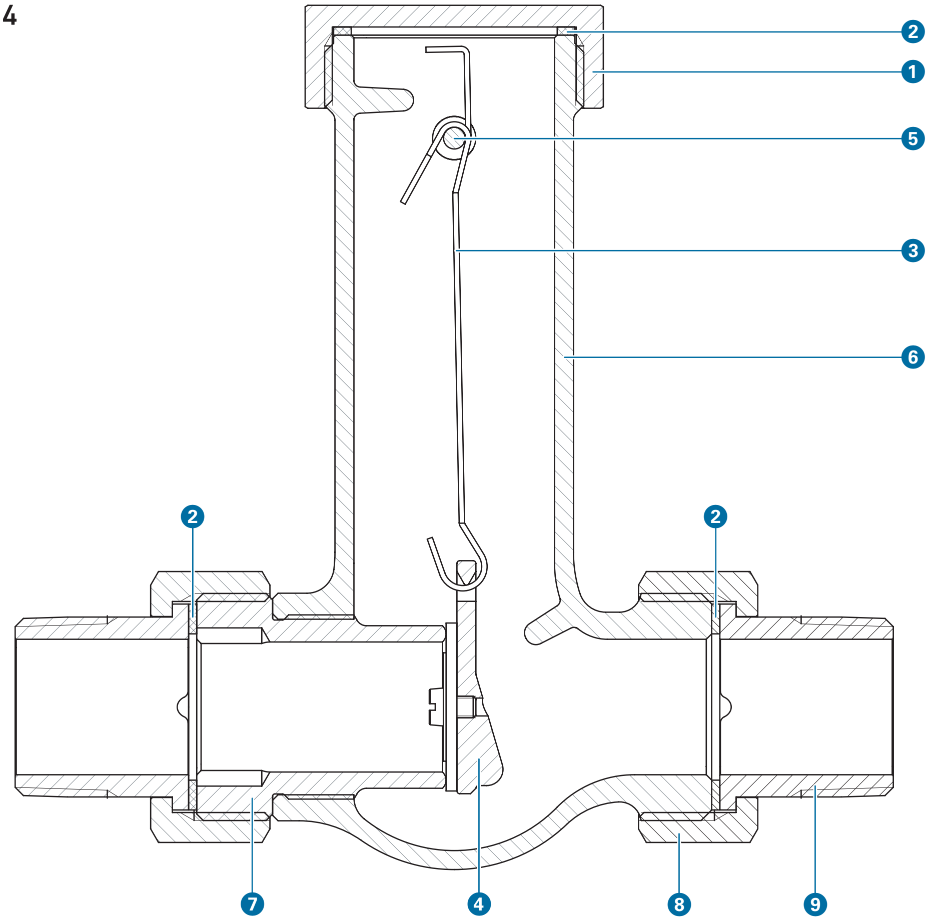
Flap trap 1684

The flap trap is a mechanical safety device that allows flow in one direction only. This type of valve is mainly used in gravity circulation systems.

Technical Data

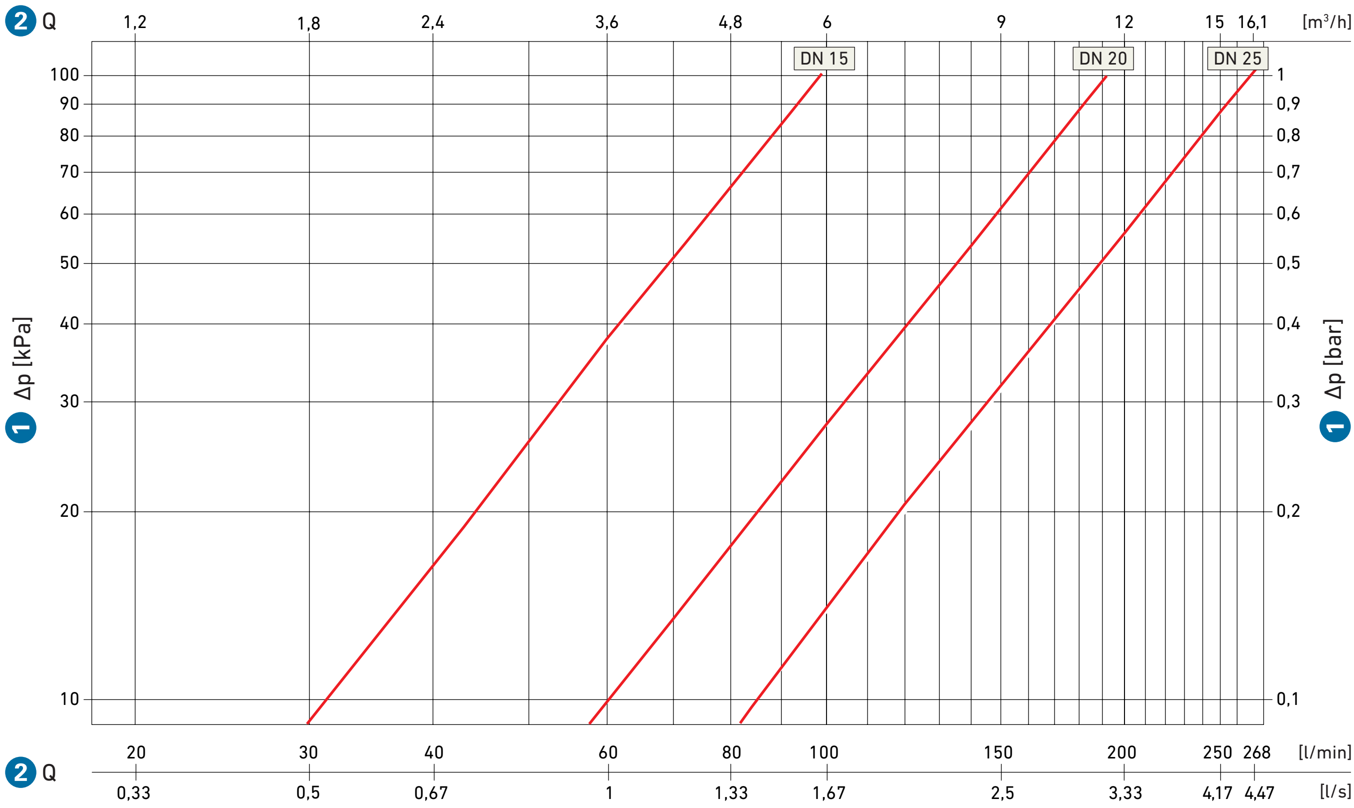
JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
1684	GN ½" – 1" (DN15 – 25)	10	90	tapered external thread

1684



1. End cap
2. Flat gasket
3. Hanger
4. Flap with seal
5. Shaft
6. Housing
7. Threaded seat
8. Raccord nut
9. Raccord spigot

Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
1684.240		GN ½" (DN15)	5.5	2.7
1684.320	Flap trap, PN10	GN ¾" (DN20)	11.8	1.9
1684.400		GN 1" (DN25)	16.8	2.2

1 Pressure loss
2 Volumetric flow rate

Product description

The flap trap is a mechanical safety device that allows flow in one direction only. This type of valve is mainly used in gravity circulation systems.

Features and functions

The flap trap opens automatically when the flow pressure on the upstream side is higher than downstream of the fitting. If the pressure downstream of the fitting is higher, or there is no flow, force is applied and the valve closes automatically.

Benefits and features

- Low opening pressure
- Minor pressure loss
- Suitable for gravity circulation systems

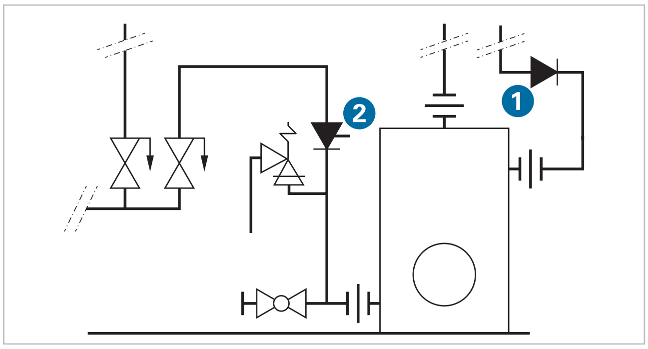
Mounting position

☑ Mount the flap trap horizontally (top part pointing up).

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Installation example



GV.15 **Installation diagram**

1 Flap trap 1684
2 Return flow inhibitor, e.g. 1610

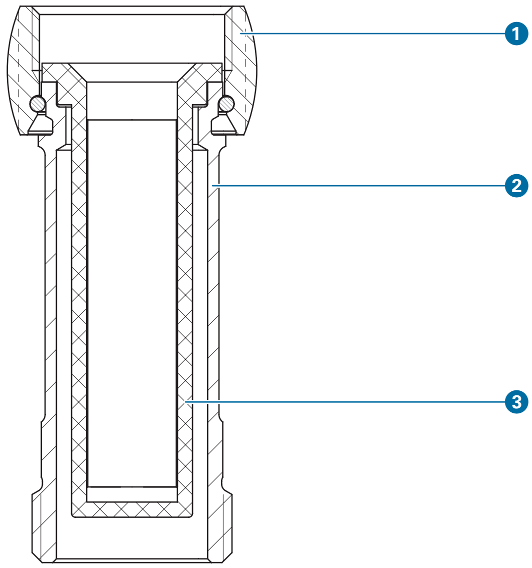
Filter 1800

The filter is installed in the water inlet of a washing machine. The filter is equipped with a fabric filter in order to prevent debris or contamination to enter into the water cycle.

Technical Data

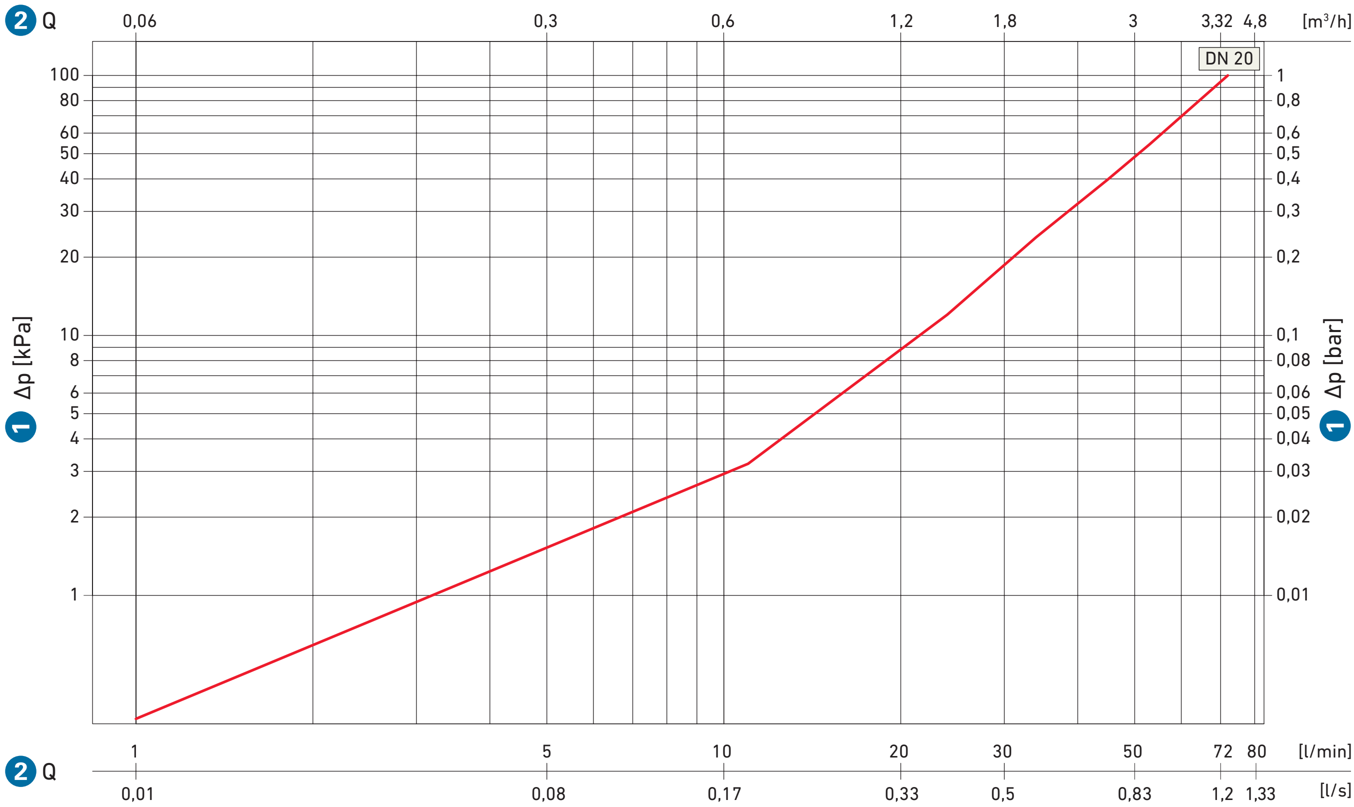
JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
1800	GN ¾" (DN20)	16	90	Inlet: loosely attached nut Outlet: External thread

1800



1. Loosely attached nut
2. Housing
3. Filter

Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
1800.320	Filter	GN ¾" (DN20)	4.2	14.5

1. Pressure loss
2. Volumetric flow rate

Product description
The filter is installed in the water inlet of a washing machine. The filter is equipped with a fabric filter in order to prevent debris or contamination to enter into the water cycle.

Features and functions
Caused by repairs, renovations, etc., suspended solids, such as lime, rust, sand can enter the connection to the washing machine. If these suspended solids are flooded into the water circulation of the washing machine, not only will this adversely affect the proper function of the machine, but also may damage the laundry.
The filter filters the water in the supply line and almost completely reduces the flooding of impurities in the water. However, the filter does not replace any sought after or even necessary water treatment (decalcification, degermination, etc.).

Benefits and features
- Suitable for water up to 90°C
- Filter insert made of plastic/stainless steel
- Filter fabric up to 335 µm

Installation instructions
☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Spare parts
- Filter insert

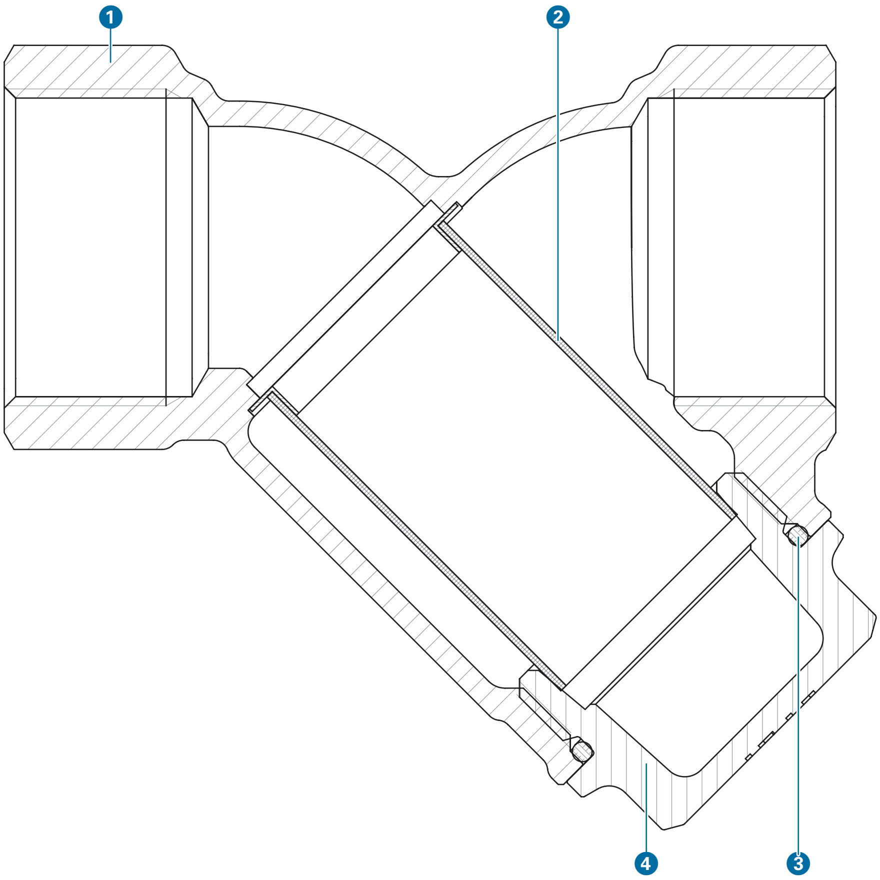
Slanted filter 1812, 1814

The slanted filter is equipped with a fabric filter, which filters out larger particles from the distribution network and thus protects the drinking water installation.

Technical Data

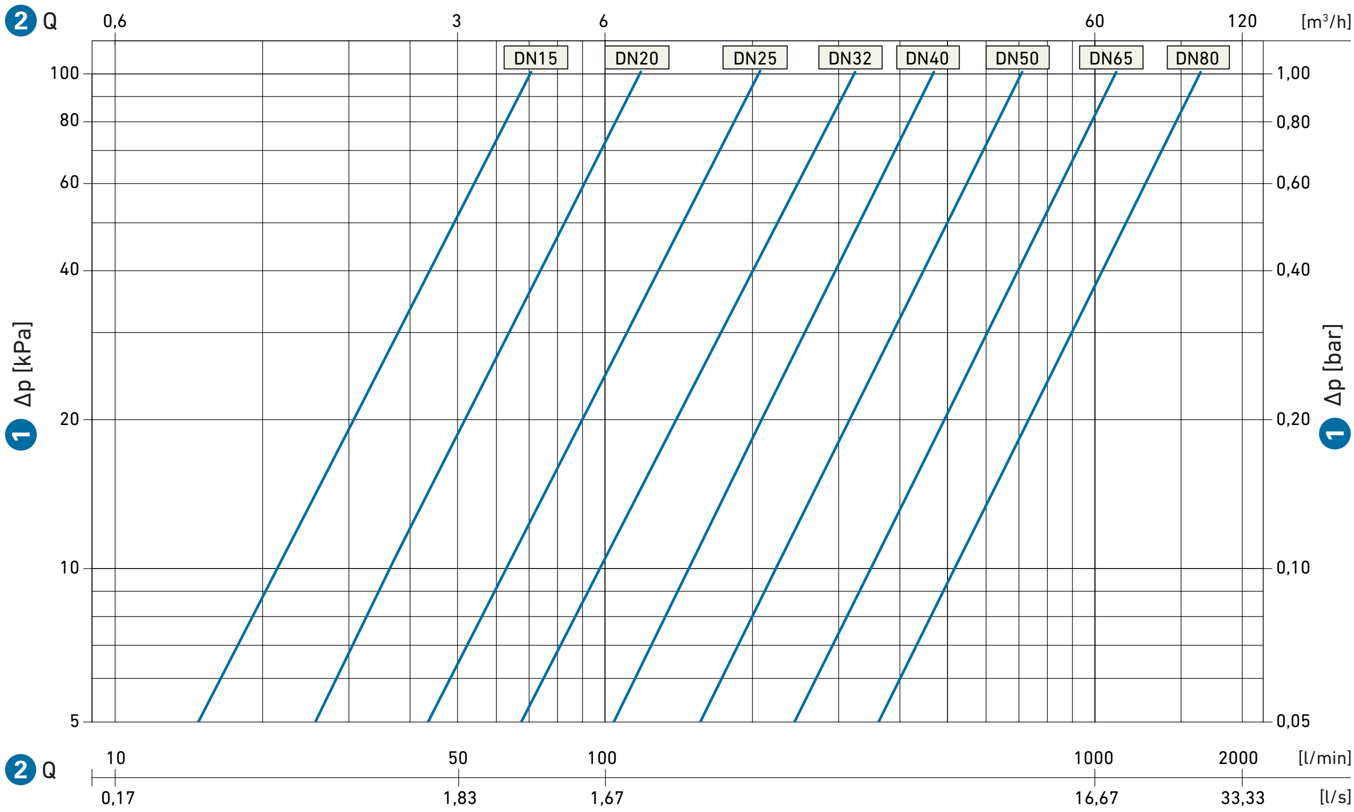
JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
1812	GN ⅜" – 3" (DN10 – 80)	16	100	Female thread
1814	GN 1½" – 3" (DN40 – 80)			Flange transfer

1810



1. Housing
2. Filter
3. O-ring
4. Cap

Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
1812.160	Slanted filter • Female thread	GN ⅜" (DN10)	3.9	1.1
1812.240		GN ½" (DN15)	4.2	4.6
1812.320		GN ¾" (DN20)	7.0	5.2
1812.400		GN 1" (DN25)	12.4	4.1
1812.480		GN 1¼" (DN32)	19.4	4.4
1812.560		GN 1½" (DN40)	27.7	5.4
1812.640		GN 2" (DN50)	39.5	6.4
1812.720		GN 2½" (DN65)	67.3	6.3
1812.800		GN 3" (DN80)	98.0	6.8
1814.040	Slanted filter • Flange transfer	GN 1½" (DN40)	27.7	5.4
1814.050		GN 2" (DN50)	39.5	6.4
1814.065		GN 2½" (DN65)	67.3	6.3
1814.080		GN 3" (DN80)	98.0	6.8

1. Pressure loss
2. Volumetric flow rate

Product description

The slanted filter is equipped with a fabric filter, which filters out larger particles from the distribution network and thus protects the drinking water installation.

Features and functions

The slanted filter has a female thread on both sides and is equipped with a large-area filter insert made of stainless steel mesh.

Benefits and features

- Suitable for water, air, oil etc. up to 100°C
- Gunmetal
- Filter insert made of stainless steel
- Filter fabric 1000 µm

Mounting position and installation tips

The slanted filter can be installed regardless of its position.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Spare parts

- Filter insert
- O-ring
- Plug

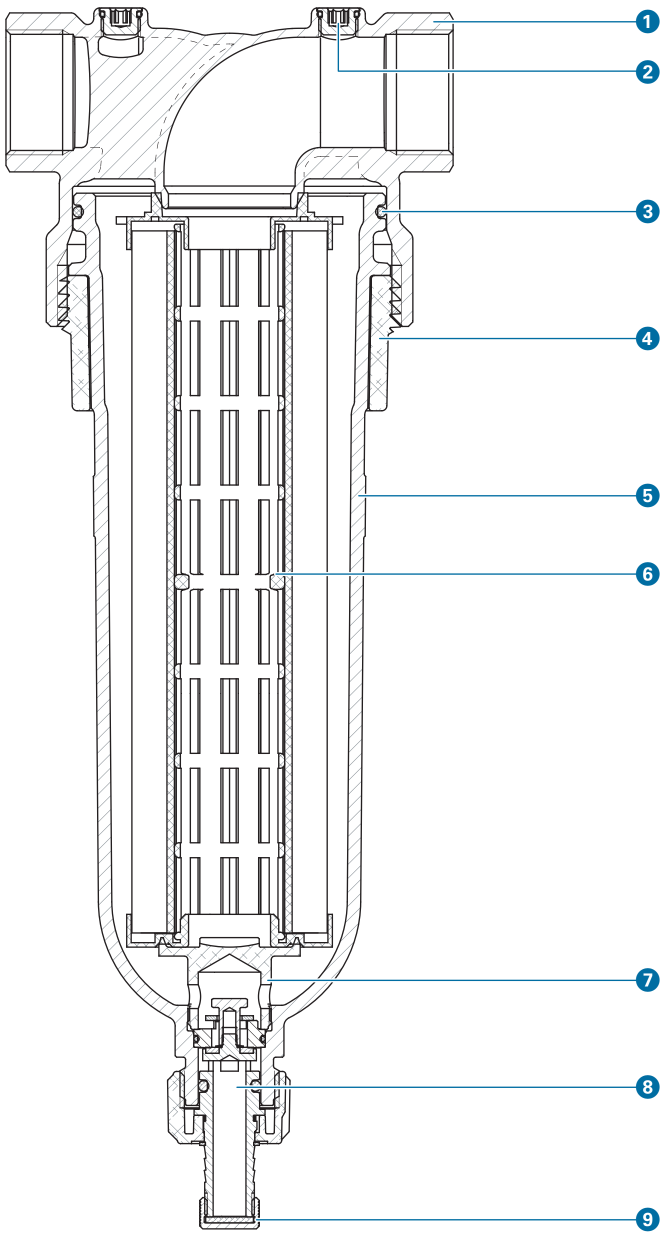
Fine filter 1830, 1836

The fine filter is the first level of protection of the installation. The fabric filter filters out particles that are present in the pipeline network and thus protects the drinking water installation.

Technical Data

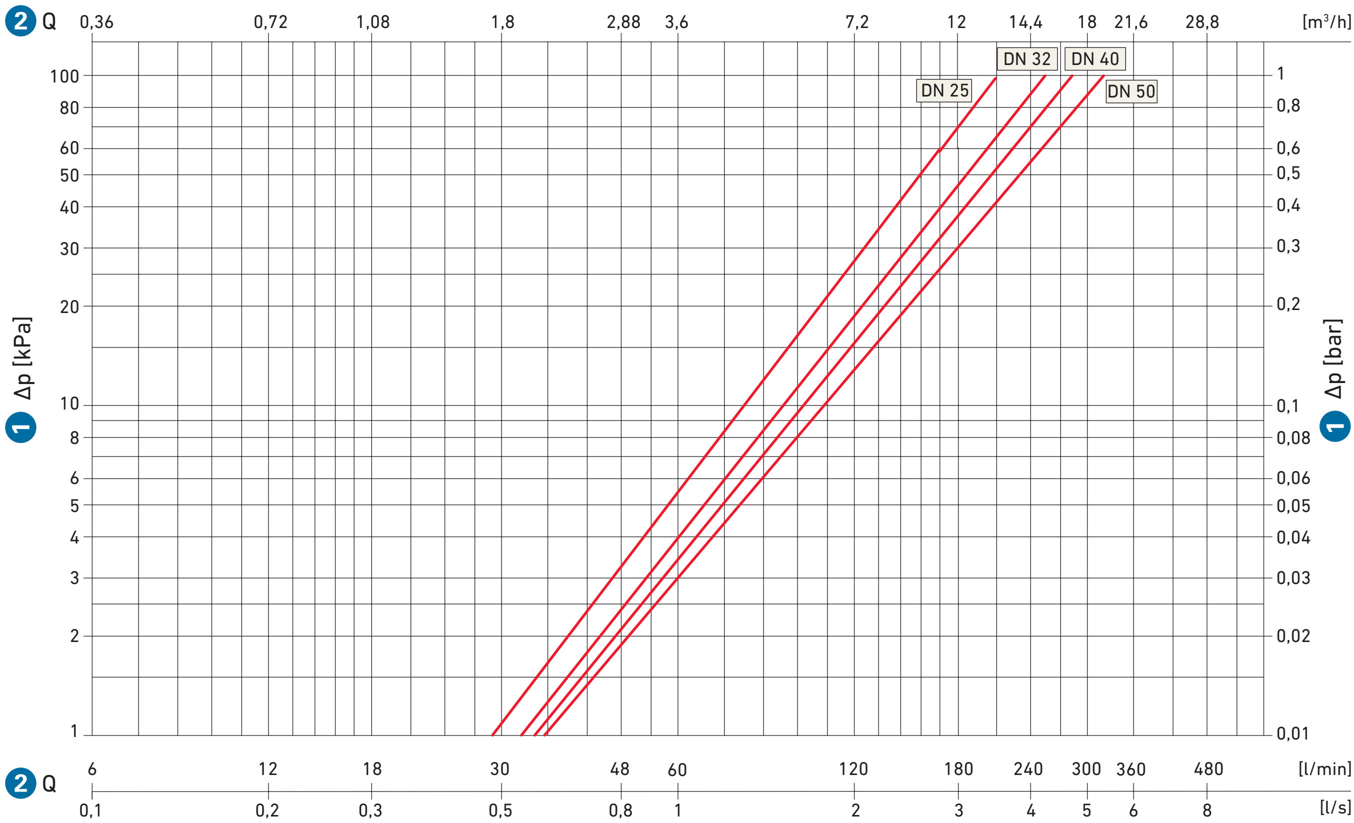
JRG code	Components	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
1830	• Fine filter • Filter cup (plastic)	GN 1" – 2" (DN25 – 50)	16	30	Female thread
1836	• Fine filter • Filter cup (gunmetal)	GN 1" – 2" (DN25 – 50)	25	with filter insert 1838: 30 with filter insert 1839: 70	Female thread

1836



1. Housing
2. Manometer adaptor socket
3. O-ring
4. Threaded ring
5. Transparent or gunmetal filter cup
6. Filter insert
7. Insert
8. Drain valve
9. Cap

Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
1830.400	Fine filter	GN 1" (DN25)	11.2	5.0
1830.480		GN 1¼" (DN32)	16.3	6.3
1830.560		GN 1½" (DN40)	17.9	12.8
1830.640		GN 2" (DN50)	19.0	27.7
1836.400	Fine filter	GN 1" (DN25)	11.2	5.0
1836.480		GN 1¼" (DN32)	16.3	6.3
1836.560		GN 1½" (DN40)	17.9	12.8
1836.640		GN 2" (DN50)	19.0	27.7

1 Pressure loss
2 Volumetric flow rate

Product description

The fine filter is the first level of protection of the installation. The fabric filter filters out particles that are present in the pipeline network and thus protects the drinking water installation.

Features and functions

Caused by repairs, renovations, etc., suspended solids, such as lime, rust, sand found on the public distribution network can permeate the building connection line and get into the domestic water distribution network. These suspended solids do not only jeopardise the function of installed fittings, such as pressure reducers, safety valves and return flow inhibitors, but also the entire in-house distribution network. A variety of types of corrosion in the pipeline system, but also malfunction of outlet fittings are due to this source: When installing a fine filter, such occurrences can be reduced or almost completely eliminated. The fine filter is intended only to filter the water. However, the fine filter does not replace any sought after or even necessary water treatment (decalcification, degermination, etc.).

Benefits and features

- Filter housing made of gunmetal
- Filter cup made of high-quality clear plastic (PN16)/ gunmetal (PN25)
- Easy disassembly of filter cup
- Separate threaded ring
- Filter cup with integrated drain valve
- Drain valve with hose connector
- Fine filters with PN16 clear cups can be mounted upstream of the pressure reducer

Mounting position and installation tips

☑ Ensure to install the filter horizontally and in a place easy to access. Tension in the pipeline must be avoided.
☑ For filter maintenance purposes, a minimum clearance of 60 mm must be ensured.
☑ The filter with plastic filter cup must be installed to ensure it is protected from intensive UV radiation and aggressive environmental influences.

Applicable documents

- Assembly instruction
- Operating and maintenance instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts

Filter insert
- Made of PES fleece, for water up to 30°C
- Suitable for JRG code 1350 – 1363, 1830 – 1846: JRG code 1838 (from 5 to 350 µm)

Filter insert, standard
- Made of PES fabric, for water up to 30°C
- Suitable for: 1350 – 1363, 1830 – 1846: JRG code 1838.100 (100 µm)

Filter insert
- Invox (V4A), for water up to 70°C
- Can be cleaned
- Suitable for JRG Code 1350 – 1363 and 1830 – 1846: JRG code 1839 (from 50 to 1000 µm)

Filter cup made of plastic, PN16
- For JRG code 1350, 1353, 1830, 1840: JRG code 1848

Filter cup made of gunmetal, PN25
- For JRG code 1360, 1363, 1836, 1846: JRG code 1849

Fine filter key
- Made of plastic, for threaded ring of filter cup 1830/1849

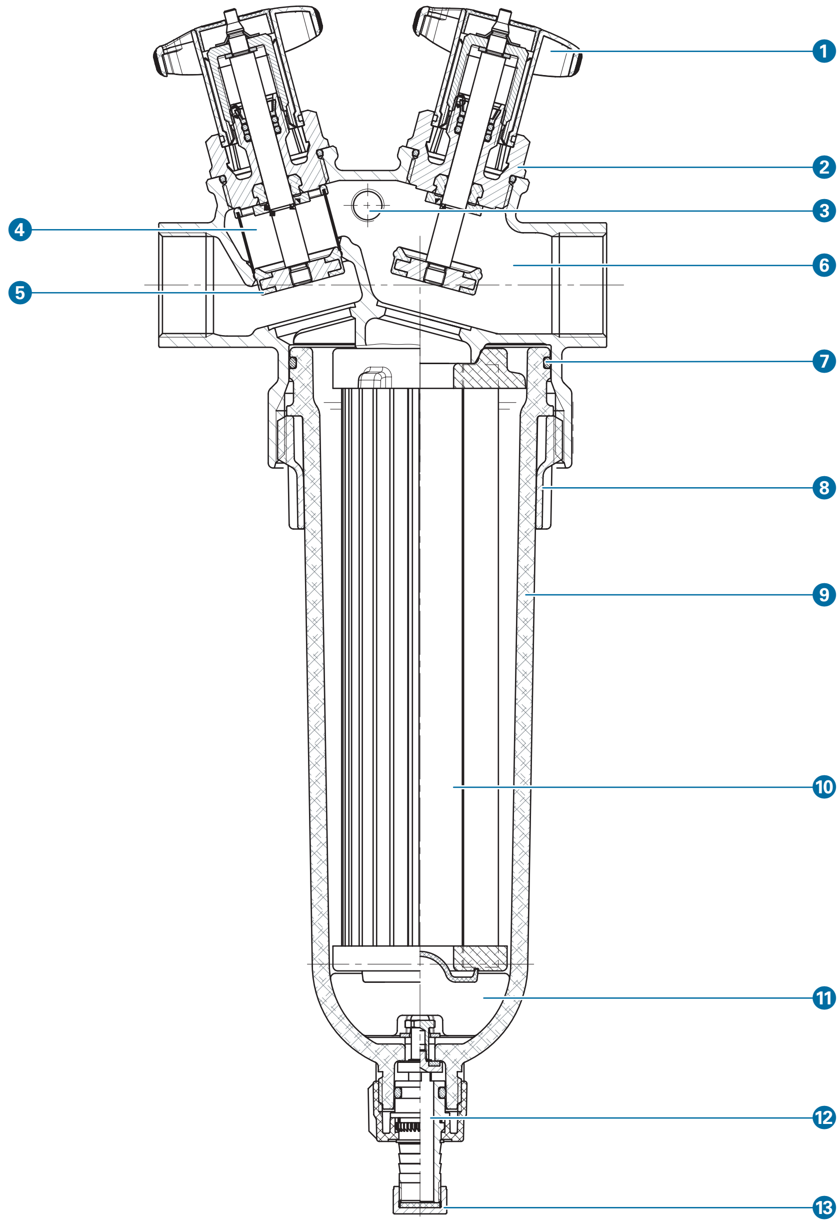
JRG LegioStop Fine filter with by-pass 1840, 1846

The JRG LegioStop fine filter is the first level of protection of the installation. The fabric filter filters out particles that are present in the pipeline network and thus protects the drinking water installation.

Technical Data

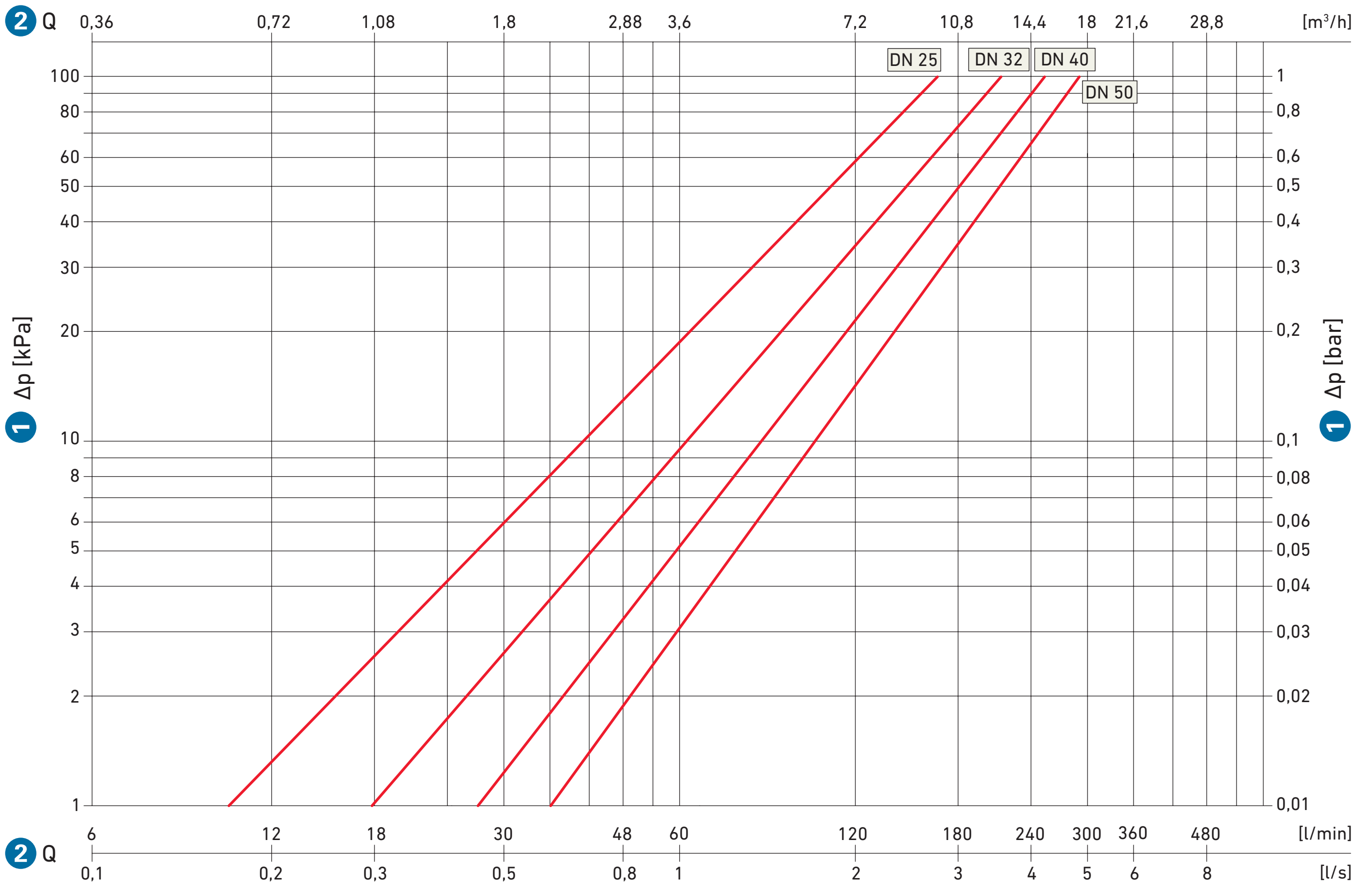
JRG code	Components	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
1840	• Fine filter with by-pass • Filter cup (plastic)	GN 1" – 2" (DN25 – 50)	16	30	Female thread
1846	• Fine filter with by-pass • Filter cup (gunmetal)	GN 1" – 2" (DN25 – 50)	25	with filter insert 1838: 30 with filter insert 1839: 70	Female thread

1840



1. Handwheel
2. Filter valves
3. Manometer adaptor socket
4. Coarse filter (bypass)
5. Valve seal
6. Filter housing
7. O-ring
8. Threaded ring
9. Transparent or gunmetal filter cup
10. Filter insert
11. Insert
12. Drain valve
13. Cap

Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
1840.400	JRG LegioStop Fine filter with by-pass	GN 1" (DN25)	8.5	8.7
1840.480		GN 1¼" (DN32)	13.0	9.9
1840.560		GN 1½" (DN40)	15.2	17.7
1840.640		GN 2" (DN50)	17.9	31.2
1846.400	JRG LegioStop Fine filter with by-pass	GN 1" (DN25)	8.5	8.7
1846.480		GN 1¼" (DN32)	13.0	9.9
1846.560		GN 1½" (DN40)	15.2	17.7
1846.640		GN 2" (DN50)	17.9	31.2

1 Pressure loss
2 Volumetric flow rate

Product description

The JRG LegioStop fine filter is the first level of protection of the installation. The fabric filter filters out particles that are present in the pipeline network and thus protects the drinking water installation.

Features and functions

Caused by repairs, renovations, etc., suspended solids, such as lime, rust, sand found on the public distribution network can permeate the building connection line and get into the domestic water distribution network. These suspended solids do not only jeopardise the function of installed fittings, such as pressure reducers, safety valves and return flow inhibitors, but also the entire in-house distribution network. A variety of types of corrosion in the pipeline system, but also malfunction of outlet fittings are due to this:
When installing a JRG LegioStop Fine filter, such occurrences can be reduced or almost completely eliminated. A bypass is integrated into the filter cartridge. This makes it easier to change the filter.
Fine filters with PN16 clear cups can be mounted upstream of the pressure reducer.

Benefits and features

- Filter housing made of gunmetal
- Bypass function
- Filter cup made of high-quality clear plastic (PN16)/ gunmetal (PN25)
- Easy disassembly of filter cup
- Separate threaded ring
- Filter cup with integrated drain valve
- Drain valve with hose connector

Mounting position and installation tips

☑ Ensure to install the filter horizontally and in a place easy to access. Tension in the pipeline must be avoided.
☑ For filter maintenance purposes, a minimum clearance of 60 mm must be ensured.
☑ The filter with plastic filter cup must be installed to ensure it is protected from intensive UV radiation and aggressive environmental influences.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents

- Assembly instruction
- Operating and maintenance instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts

- Filter cup made of plastic/gunmetal 1848/1849
- Filter insert 1839/1839
- Fine filter key

Filter insert

- Made of PES fleece, for water up to 30°C
- Suitable for JRG code 1350 – 1363, 1830 – 1846: JRG code 1838 (from 5 to 350 µm)

Filter insert, standard

- Made of PES fabric, for water up to 30°C
- Suitable for: 1350 – 1363, 1830 – 1846: JRG code 1838.100 (100 µm)

Filter insert

- Invox (V4A), for water up to 70°C
- Can be cleaned
- Suitable for JRG code 1350 – 1363, 1830 – 1846: JRG code 1839 (from 50 to 1000 µm)

Filter cup made of plastic, PN16

- For JRG code 1350, 1353, 1830, 1840: JRG code 1848

Filter cup made of gunmetal, PN25

- For JRG code 1360, 1363, 1836, 1846: JRG code 1849

Fine filter key

- Made of plastic, for threaded ring of filter cup 1830/1849

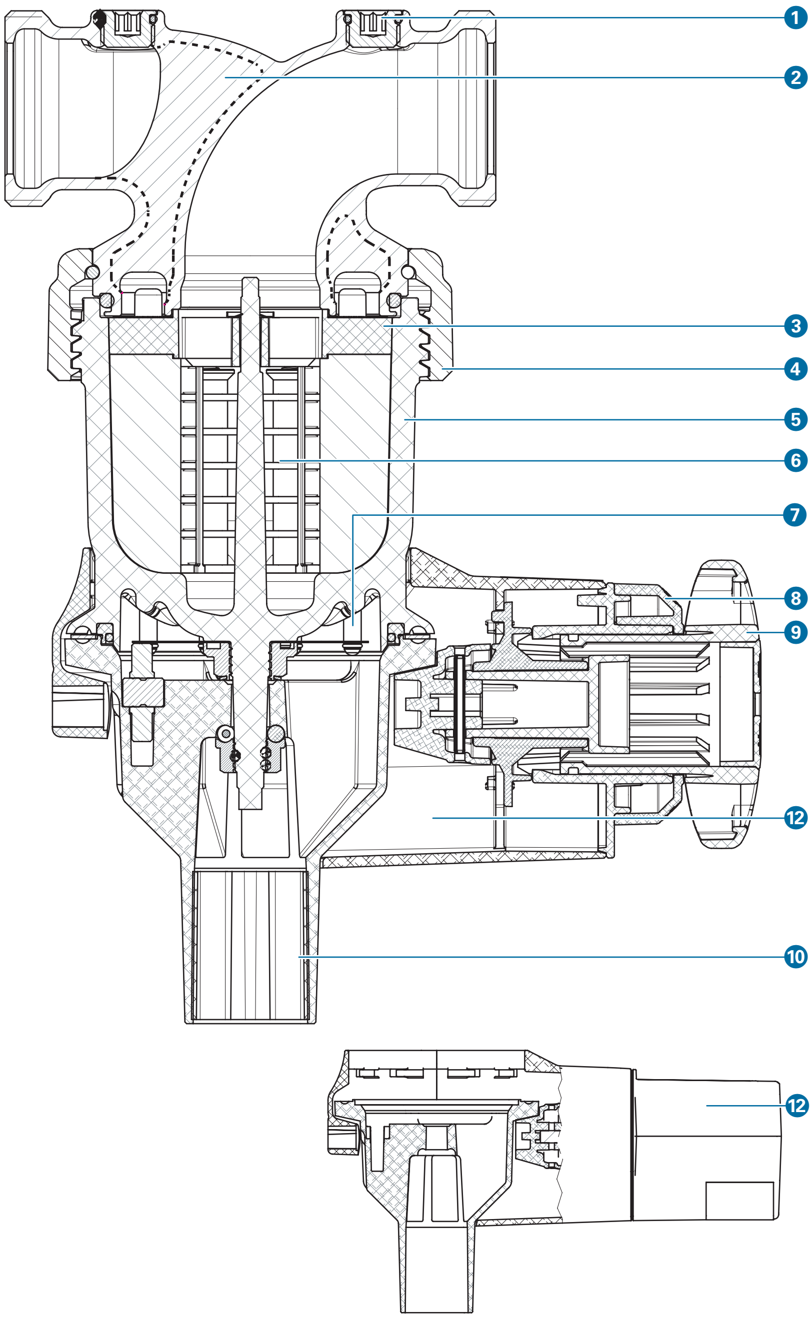
JRG CleanLine Filter 1870, 1871

The JRG CleanLine filter, which can be backwashed, is the first level of protection of the installation. The fabric filter filters out particles that are present in the pipeline network and thus protects the drinking water installation. The filter can be backwashed.

Technical Data

JRG code	Components	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
1870	Fein filter, can be backwashed	GN 1" – 1¼" (DN25 – 32)	16	30	External thread
1871	Filter, with back flushing unit				

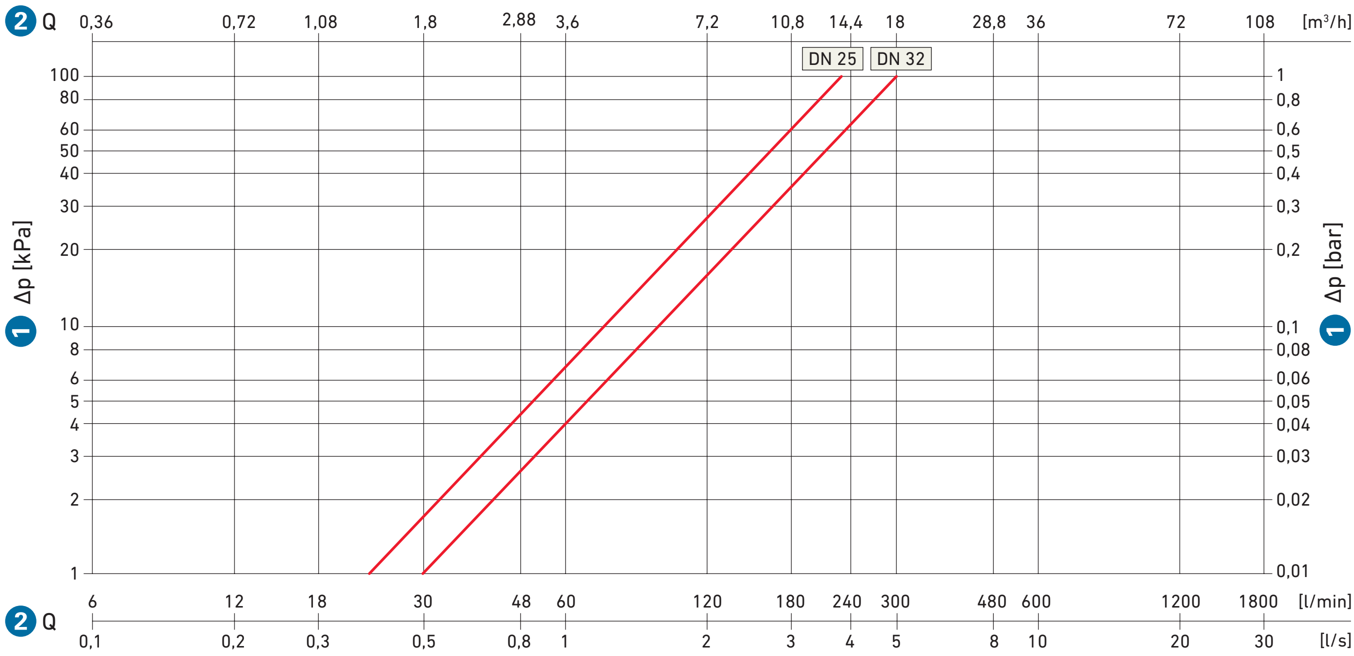
1870



1. Manometer adaptor socket/ venting screw
2. Housing
3. Coarse filter
4. Nut
5. Filter cup
6. Filter insert
7. Tappet
8. Months ring (scale 1 – 12) (only with JRG code 1370 and 1870)
9. Manual operating mode (JRG code 1370 and 1870)
10. Drain nozzle*
11. Socket head wrench (omitted for clarity)
12. Back flushing unit (only with JRG code 1371 and 1871)

* Drain for back flushing. The drain must not be used as discharge for the installation.

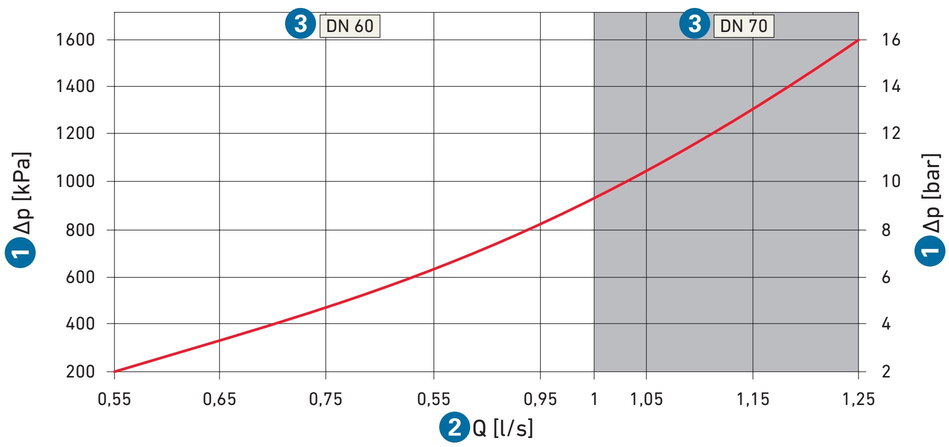
Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
1870.025	JRG CleanLine Filter	GN 1" (DN25)	14.7	2.9
1870.032		GN 1¼" (DN32)	18.3	5.0
1871.025	JRG CleanLine Filter	GN 1" (DN25)	14.7	2.9
1871.032		GN 1¼" (DN32)	18.3	5.0

1. Pressure loss
2. Volumetric flow rate

Flushing capacity



GV.16
Flushing capacity

1. Upstream pressure
2. Flushing capacity
3. Drainage line

Product description

The JRG CleanLine filter, which can be backwashed, is the first level of protection of the installation. The fabric filter filters out particles that are present in the pipeline network and thus protects the drinking water installation. The filter can be backwashed.

Features and functions

The backwash technology of the JRG CleanLine Filter offers the same filtration quality during backwashing as during normal operation. A bypass filter has been omitted in order to ensures that the entire filter surface is flushed thoroughly and at any time.
The filter is partitioned into eight chambers. These chambers are flushed one after the other during the backwashing process. During this process, the other seven chambers ensure consistent filtration quality. For hygiene reasons, backwashing must be carried out at least every two months. When using the backwashing unit, this ensures the backwashing of the filter insert is done automatically. The interval (7, 30 or 60 days) and the flushing time for each filter chamber (1, 3 or 6 seconds) can be set individually. Detailed information on backwashing the JRG CleanLine Combi and the JRG CleanLine Filters see: ➨ "Operating and Maintenance instruction"
The fine filter, which can be backwashed, is intended only to filter the water. However, the fine filter does not replace any sought after or even necessary water treatment (decalcification, degermination, etc.).

Benefits and features

- Changing the filter is not necessary
- Consistent filter quality during backwashing
- Effective backwash technology
- Minimum height
- Same length as JRGURED 1300/1130 and JRGURED Combi 1350

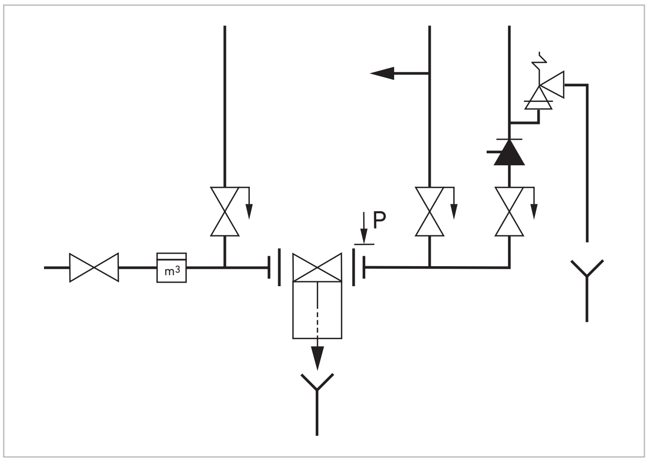
Mounting position

☑ Ensure to install the JRG CleanLine Filter horizontally (flushing connection facing down) and in a place easy to access. Tension in the pipeline must be avoided.
☑ In order to remove the filter cup, a minimum clearance of 40 mm below the filter must be ensured.
☑ JRG CleanLine Filter must be installed in order to ensure it is protected against intense UV radiation and aggressive environmental influences (e.g. solvent or detergent fumes etc.).

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.
☑ For installations in an aggressive environment and/or in rooms with uncontrollable environmental influences (such as solvent or cleaning agent fumes, intensive UV radiation, etc.): Protect the equipment using an appropriate method.

Installation example



GV.17 **Installation diagram**

Applicable documents

• Assembly instruction
• Operating and Maintenance instruction
In order to download the documents, go to www.gfps.com (D/F/I/E).

V

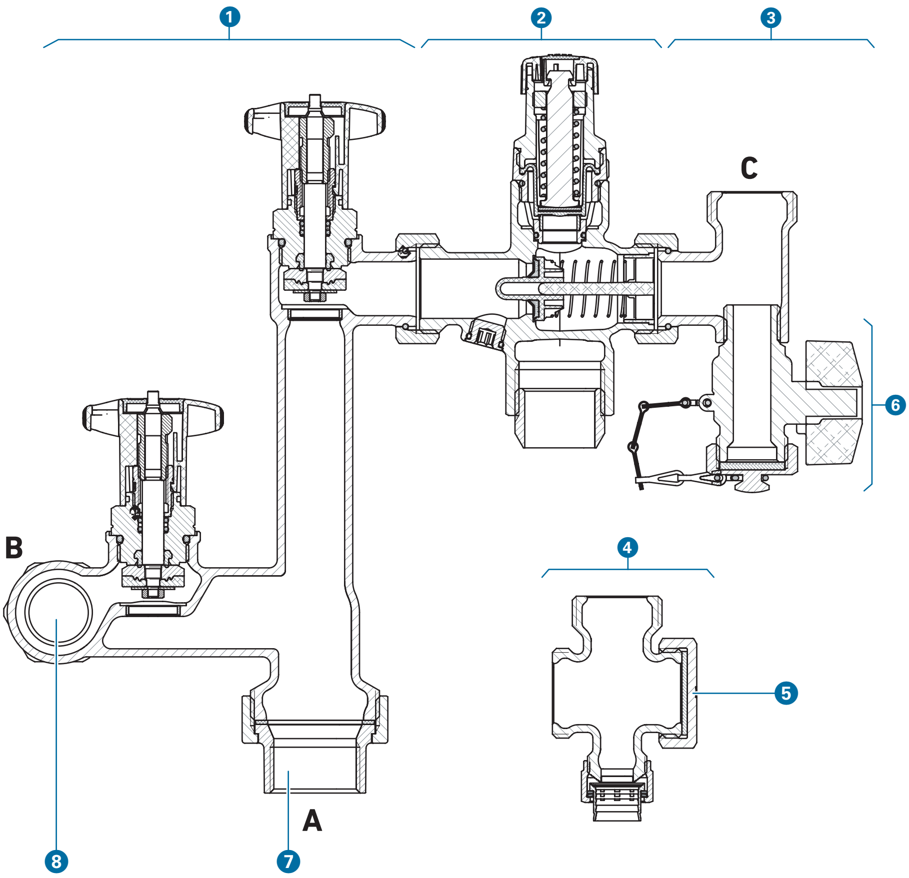
Shut-off and safety group 2171

The shut-off and safety group is a combination of fittings for cupboard-type DHW heaters of a closed design. It consists of shut-off valves for cold and hot water as well as a safety group with safety valve and back flow inhibitor, which prevents the backflow of water from the DHW heater into the distribution network.

Technical Data

JRG code	Components	Dimension	Nominal pressure PN	Opening pressure [kPa (bar)]	Temperature max. [°C]	Connections
2171	• Twin shut-off valve • Safety group • Boiler ball valve • Cross for distributor • Cap	GN 1"–¾" (DN25–20)	10	600 (6.0)	90	Pipe threads

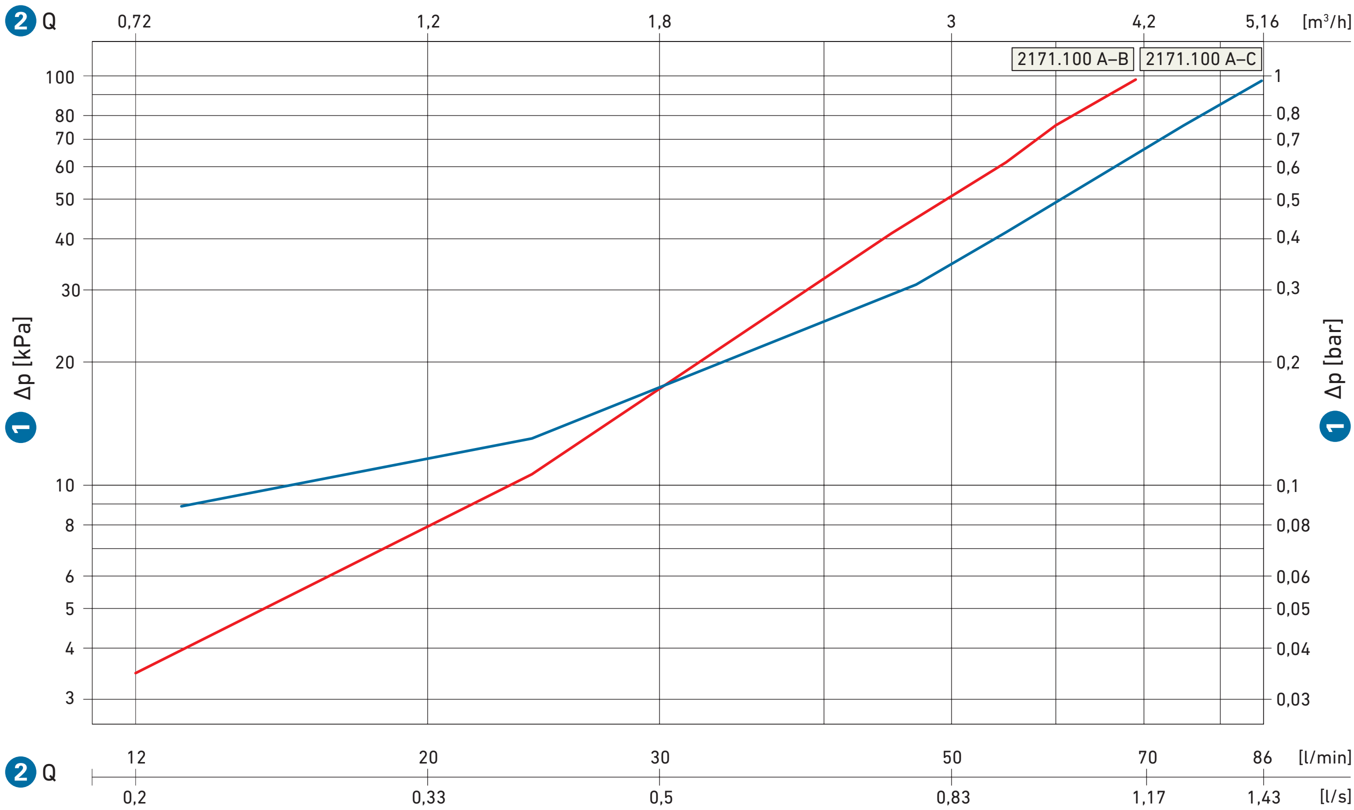
2171



1 Twin shut-off valve
2 Safety group
3 Transfer to the DHW heater
4 Cross for distributor (Hot water)
5 Cap
6 Drain valve
7 Cold water inlet
8 Cold water outlet (to the distributor)

A–B Cold water (PWC)
A–C DHW heater supply (PWH)

Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
2171.100	Shut-off and safety group, PN10 • Flow path A–B (PWC)	GN 1"–¾" (DN25–20)	5.3	22.2#
	• Flow path A–C (PWH)		3.6	19.8#

1 Pressure loss
2 Volumetric flow rate

A–B Cold water (PWC)
A–C DHW heater supply (PWH)

V

Product description

The shut-off and safety group is a combination of fittings for cupboard-type DHW heaters of a closed design. This set consists of shut-off valves for cold and hot water as well as a safety group with safety valve and return flow inhibitor, which prevent the return of water from the DHW heater to the pipeline network.

Features and functions

When using the shut-off fitting, the cold and hot water distribution can be shut off separately.
When water is heated, the volume increases, resulting in a pressure increase in a closed vessel. The return flow inhibitor prevents the return of the water from the DHW heater into the distribution network. The safety valve opens when the set response pressure is reached. The amount of water generating the excess pressure drains off.

Benefits and features

- Compact design
- Minor pressure loss
- Upper parts without dead space and continuously smooth operation
- Valve seat made of stainless steel

Mounting position and installation tips

☑ Mount the safety group horizontally with drain nozzle pointing down.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents

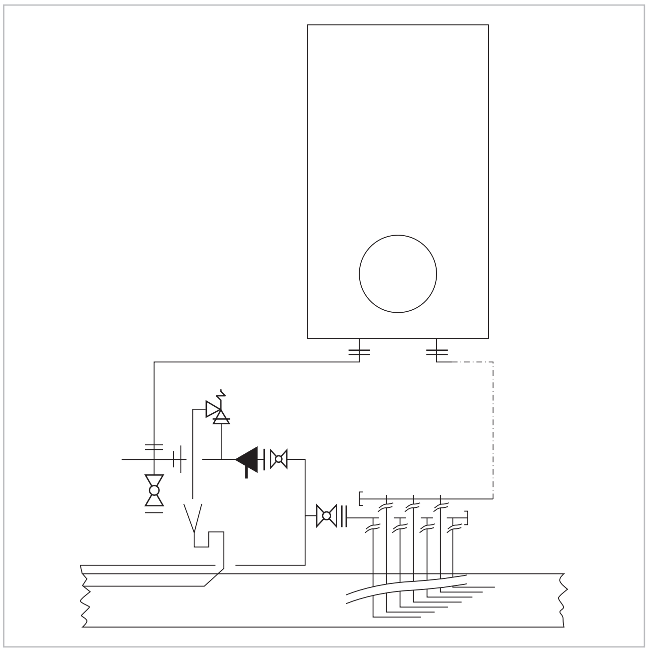
- Assembly instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts

- Upper part of JRGARANT
- Upper part of straight seat valve

Installation example



GV.18 **Installation diagram**

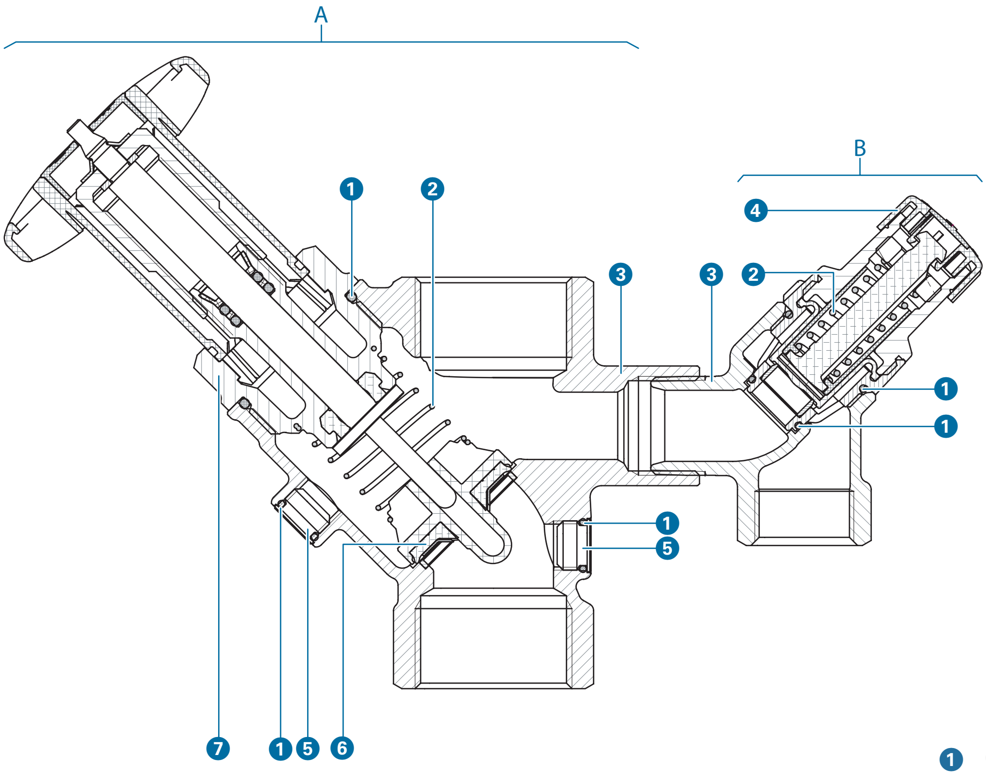
Shut-off and safety group JRG LegioStop 2190, 2191

The shut-off and safety group JRG LegioStop consists of a lockable return flow inhibitor and a safety valve. They protect the closed-type DHW heater's storage from pressure-related overloads.

Technical Data

JRG code	Components	Dimension	Nominal pressure PN	Factory setting [kPa (bar)]	Temperature max. [°C]	Connections
2190	• Return flow inhibitor, lockable • Safety valve	GN ¾" – 1¼" (DN20 – 32)	10.0	600 (6.0)	90	Female pipe thread
2191	• Return flow inhibitor, lockable • Safety valve					Pipe threads

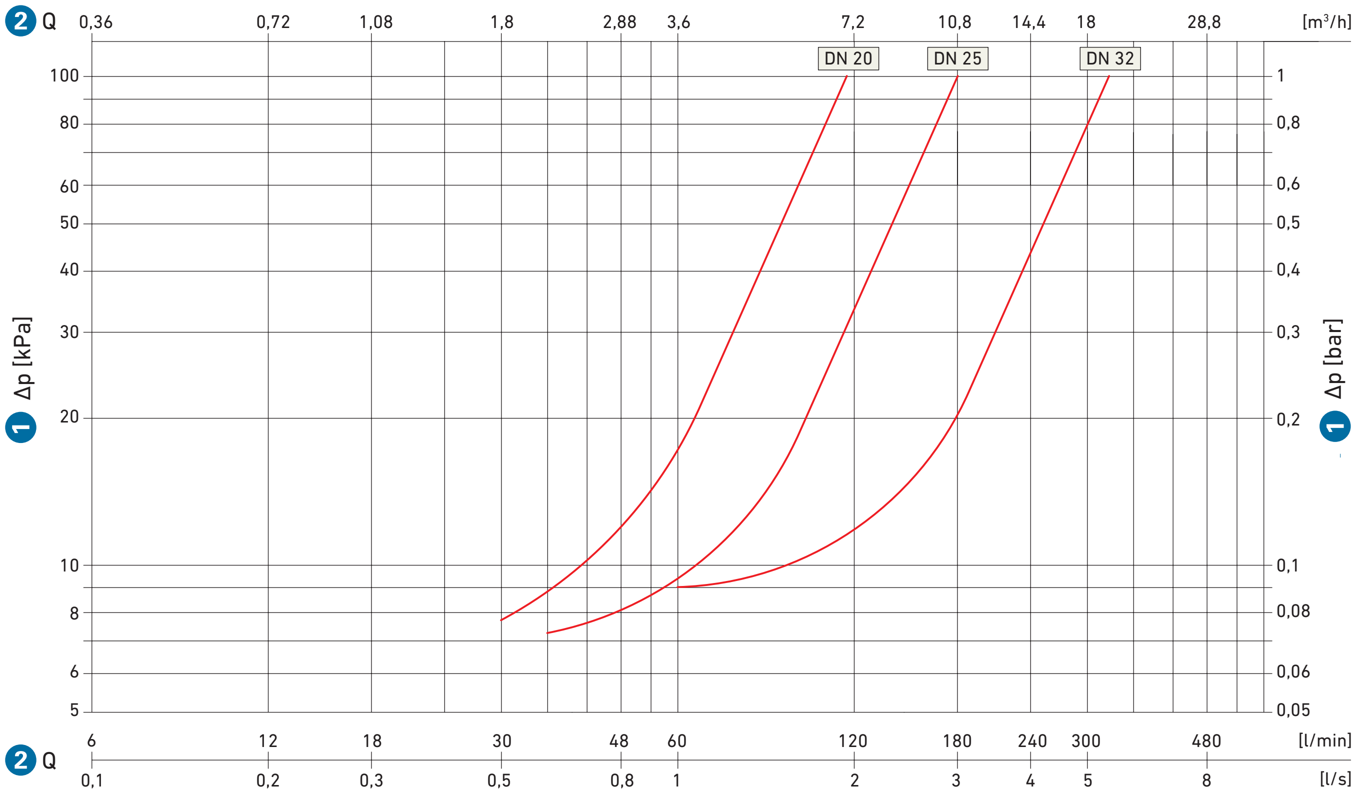
2190



1 O-ring
2 Compression spring
3 Housing
4 Venting nut
5 Plug
6 Flow body
7 Upper part

A Combined return flow inhibitor (KRV), lockable
B Safety valve

Performance chart



1 Pressure loss
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN20 – 32	I

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
2190.320	Shut-off and safety group JRG LegioStop • Female pipe thread	GN ¾" (DN20)	7.0	5.2
2190.400		GN 1" (DN25)	10.8	5.4
2190.480		GN 1¼" (DN32)	19.5	4.4
2191.020	Shut-off and safety group JRG LegioStop • Pipe threads	GN ¾" (DN20)	7.0	5.2
2191.025		GN 1" (DN25)	10.8	5.4
2191.032		GN 1¼" (DN32)	19.5	4.4

Product description

The shut-off and safety group JRG LegioStop consists of a lockable return flow inhibitor and a safety valve. They protect the closed-type DHW heater's storage from pressure-related overloads.

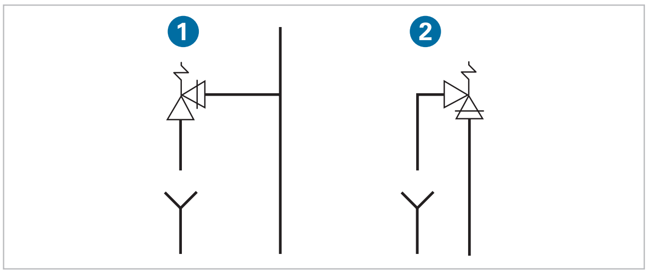
Features and functions

When water is heated, the volume increases, resulting in a pressure increase in a closed vessel. The return flow inhibitor prevents the return of the water from the DHW heater into the distribution network. The safety valve opens when the set response pressure is reached and allows the amount of water that generates the overpressure to flow off.

Mounting position and installation tips

The shut-off and safety group can be installed regardless of its position.

☑ Ensure that the pressure relief pipeline is installed vertically pointing down.



GV.19 **Mounting position**

1 horizontal
2 vertical

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

☑ Do **not** install shut-off devices between the shut-off and safety group and the DHW heater.

Applicable documents

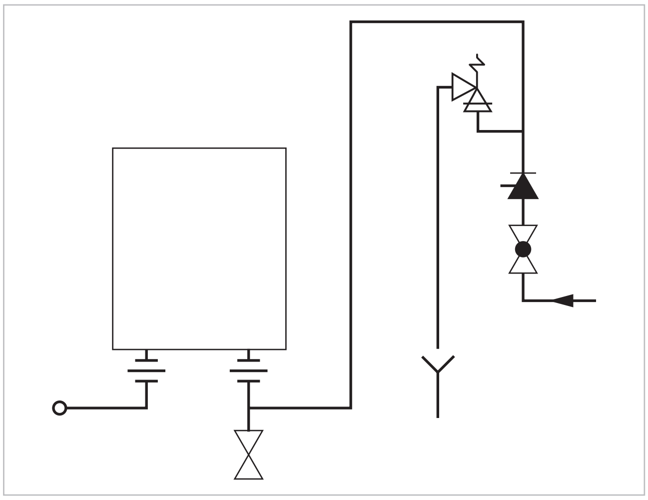
- Installation, operating and maintenance instruction (JRGARANT)

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts

- Upper parts (return flow inhibitor, lockable, and safety valve)
- O-ring set for JRGARANT

Installation example



GV.20 **Connection of a DHW heater – Installation diagram**

V

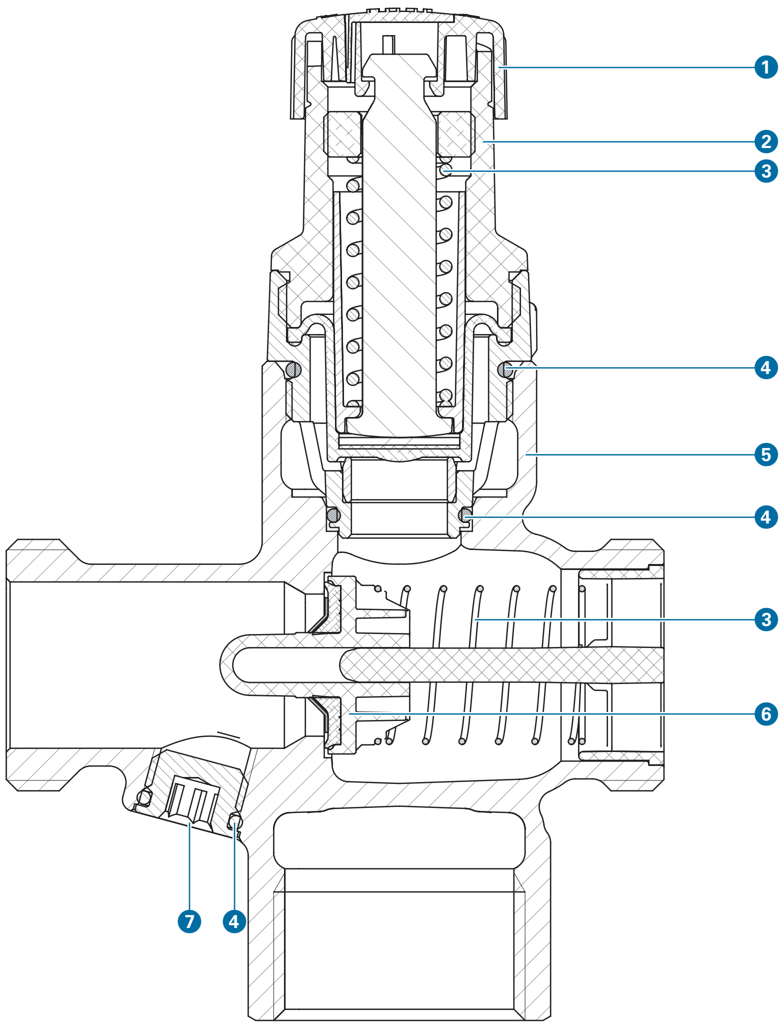
Safety group 2200, 2203, 2210

The safety group is a combined fitting. It consists of a return flow inhibitor and a safety valve. The valve protects the closed-type DHW heater's storage from pressure-related overloads.

Technical Data

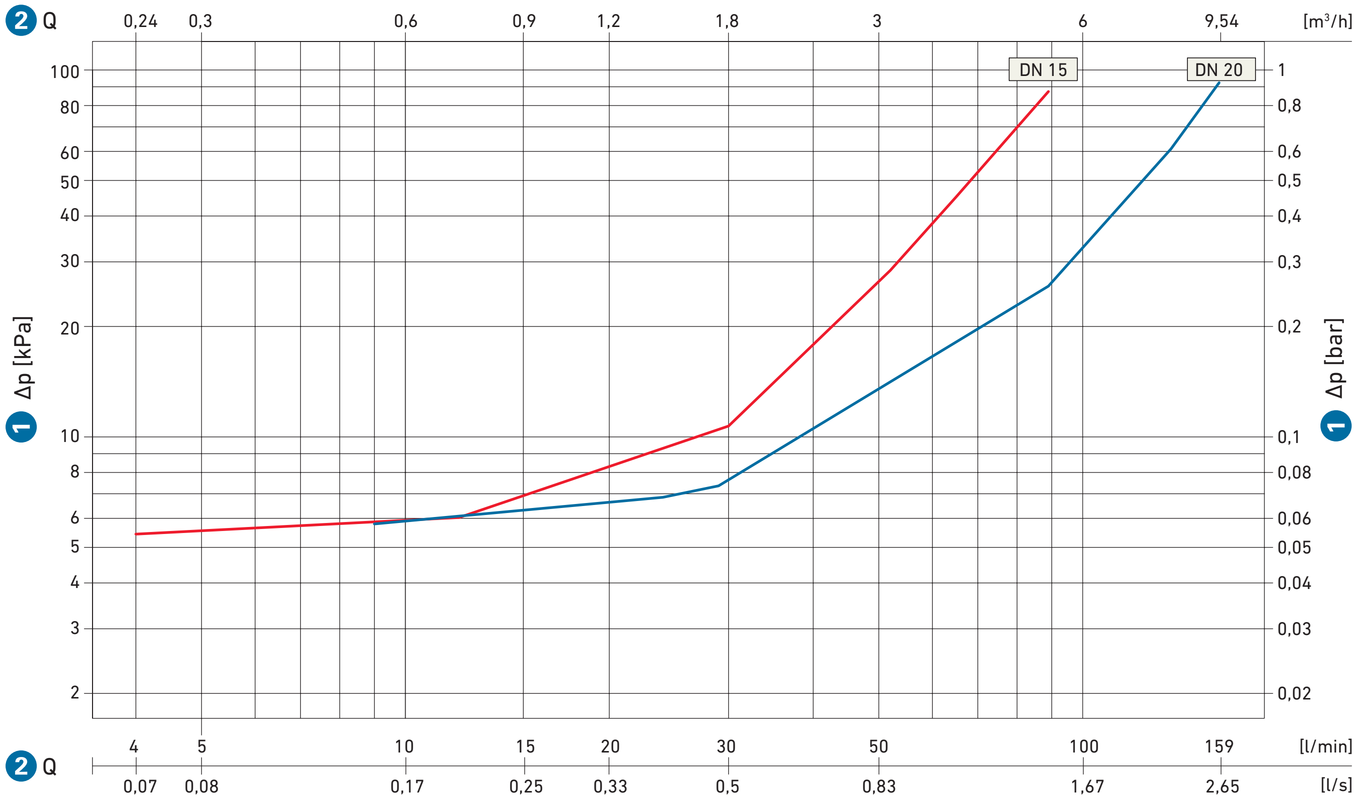
JRG code	Components	Dimension	Nominal pressure PN	Factory setting [kPa (bar)]	Temperature max. [°C]	Connections
2200	• Return flow inhibitor • Safety valve • Threaded connectors	GN ½" – ¾" (DN15 – 20)	10.0	600 (6.0)	90	Tapered external thread
2203	• Return flow inhibitor • Safety valve					Pipe threads
2210	• Return flow inhibitor • Safety valve • Pipe interrupter • Threaded connectors					Tapered external thread

2203



1. Venting nut
2. Upper part
3. Compression spring
4. O-ring
5. Housing
6. Flow body
7. Plug

Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
2200.240	Safety group, PN10 • tapered external thread	GN ½" (DN15)	5.7	2.5
2200.320		GN ¾" (DN20)	9.6	2.8
2203.240	Safety group, PN10 • Pipe threads	GN ½" (DN15)	5.7	2.5
2203.320		GN ¾" (DN20)	9.6	2.8
2210.240	Safety group, PN10 • tapered external thread	GN ½" (DN15)	5.7	2.5
2210.320		GN ¾" (DN20)	9.6	2.8

1 Pressure loss
2 Volumetric flow rate

V

Product description

The safety group is a combined fitting. It consists of a return flow inhibitor and a safety valve. The valve protects the closed-type DHW heater's storage from pressure-related overloads.

Features and functions

When water is heated, the volume increases, resulting in a pressure increase in a closed vessel.
The return flow inhibitor prevents the return of the water from the DHW heater into the distribution network.
The safety valve opens when the set response pressure is reached and allows the amount of water that generates the overpressure to flow off.

Benefits and features

- Compact design

Mounting position and installation tips

- ☑ Install the safety group horizontally.
- ☑ The safety group must be easily accessible.
- ☑ Do not install shut-off devices between the safety group and the DHW heater.
- ☑ When draining the safety group, its discharge nozzle must be easy to see, or the drain line must be kept as short as possible.

Installation instructions

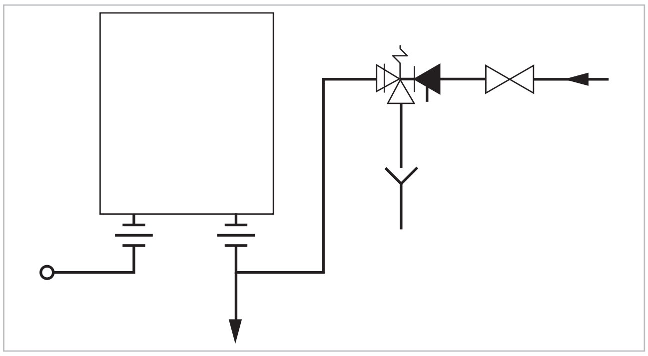
- ☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.
- ☑ Compliance with the supplementary regulations of the local water supply is mandatory.

Applicable documents

- Installation instructions
- Operating and maintenance instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Installation examples



GV.21 **Connection of a DHW heater – Installation diagram**

Spare parts

- Upper part of JRGARANT
- Return flow inhibitor insert

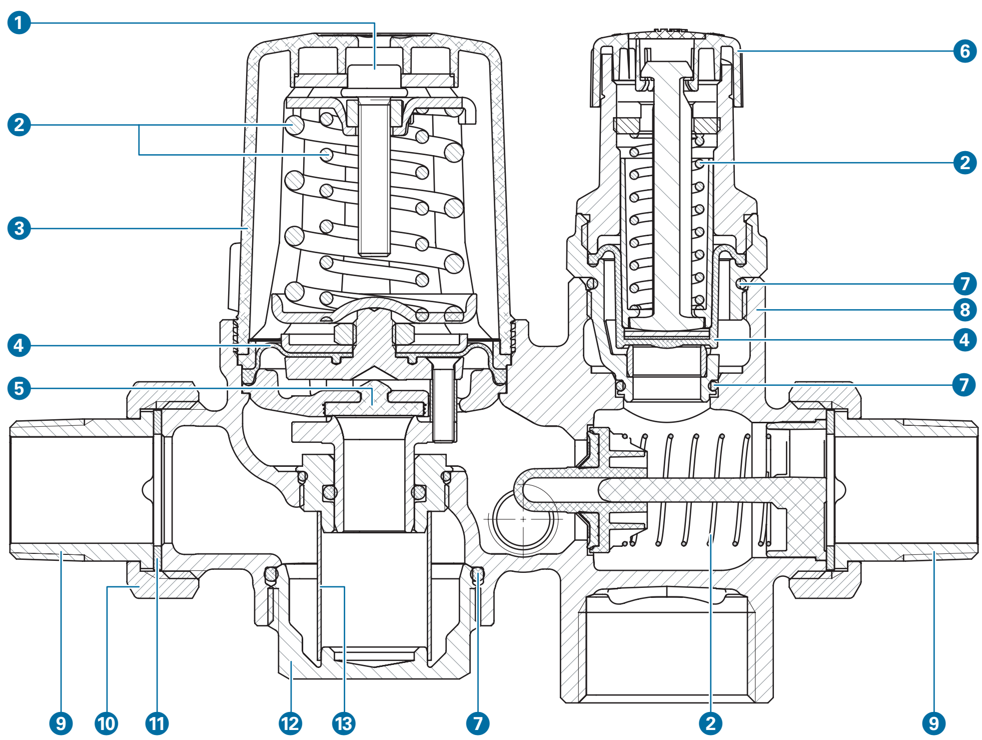
Safety group JUNIOR 2230, 2233, 2240

The safety group JUNIOR is a compact combination of valves. It consists of a pressure reducer, a return flow inhibitor and a safety valve. The valve protects the closed-type DHW heater's storage from pressure-related overloads.

Technical Data

JRG code	Components	Dimension	Nominal pressure PN	Factory setting [kPa (bar)]	Setting range [kPa (bar)]	Temperature max. [°C]	Connections
2230	• Coarse filter • Pressure reducer • Return flow inhibitor • Safety valve • Threaded connectors	GN ½" – ¾" (DN15 – 20)	16.0	DRV: 400 (4.0) SV: 600 (6.0)	DRV: 200 – 600 (2.0 – 6.0)	90	Tapered male thread/ Female pipe thread
2233	• Coarse filter • Pressure reducer • Return flow inhibitor • Safety valve						Male pipe thread/ Female pipe thread
2240	• Coarse filter • Pressure reducer • Return flow inhibitor • Safety valve • Pipe interrupter • Threaded connectors						Tapered external thread

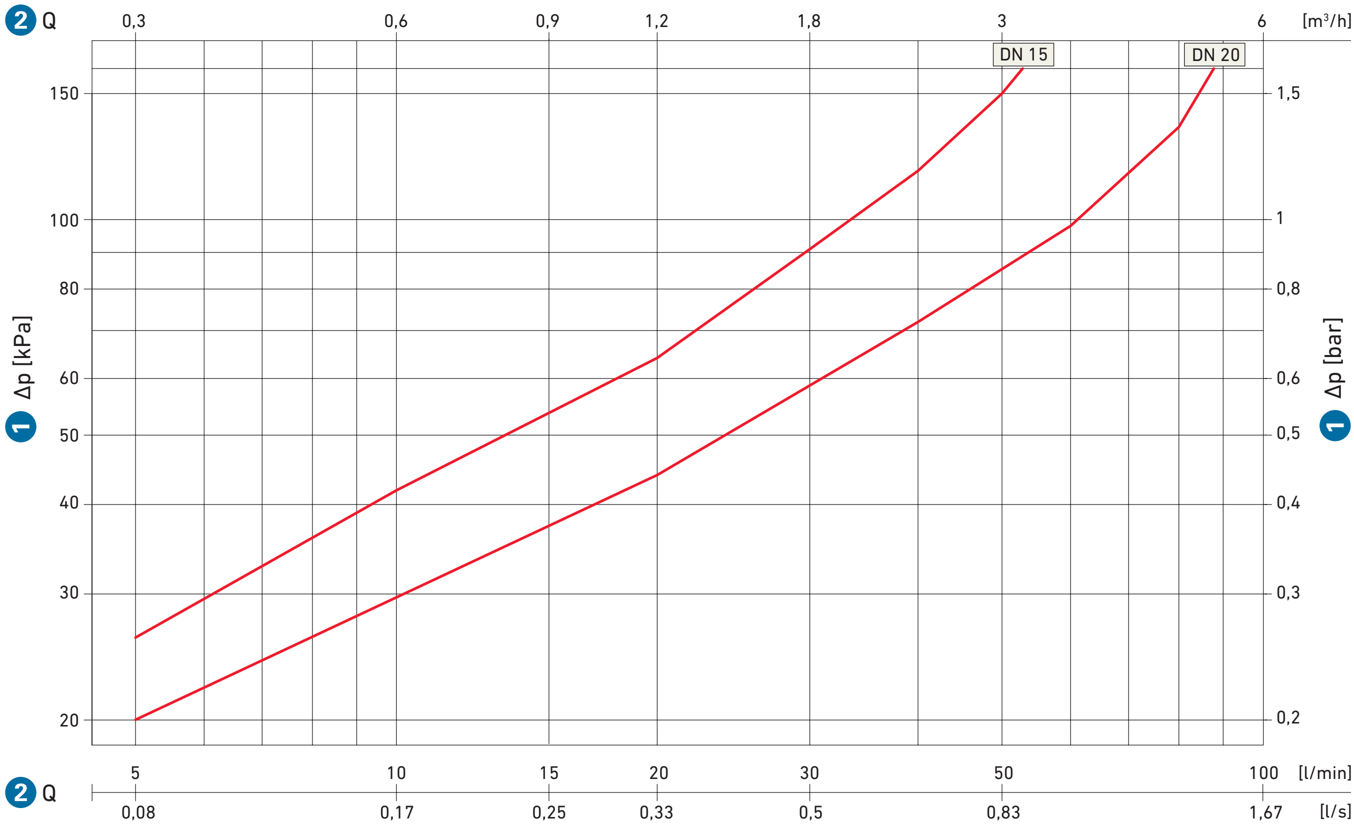
2230



1. Pressure setting
2. Compression spring
3. Cover
4. Membrane
5. Valve seal
6. Venting nut
7. O-ring
8. Housing
9. Raccord spigot
10. Raccord nut
11. Flat gasket
12. Filter cup
13. Coarse filter

Performance chart

Pressure setting: 600 / 400 kPa (6.0 / 4.0 bar)



JRG code	Designation	Dimension
2230.240	Safety group JUNIOR • Tapered male thread/ Female pipe thread	GN ½" (DN15)
2230.320		GN ¾" (DN20)
2233.015	Safety group JUNIOR • Male pipe thread/ Female pipe thread	GN ½" (DN15)
2233.020		GN ¾" (DN20)
2240.240	Safety group JUNIOR • Tapered external thread	GN ½" (DN15)
2240.320		GN ¾" (DN20)

1 Pressure loss
2 Volumetric flow rate

Product description

The safety group JUNIOR is a compact combination of valves. It consists of a pressure reducer, a return flow inhibitor and a safety valve. The valve protects the closed-type DHW heater's storage from pressure-related overloads.

Features and functions

Depending on the system, water pressures from the distribution network must be reduced to a permissible pressure.
The pressure reducer in the safety group reduces the upstream pressure to a lower, constant pressure. The filter installed upstream of the pressure reducer retains suspended solids larger than 1000 µm.
When water is heated, the volume increases, resulting in a pressure increase in a closed vessel. The return flow inhibitor prevents the return of the water from the DHW heater into the distribution network.
The safety valve opens when the set response pressure is reached and allows the amount of water that generates the overpressure to flow off.

Benefits and features

- Housing made of gunmetal
- All water-carrying parts are made of gunmetal, stainless steel or plastic
- Excellent control modes even with smallest volumes drawn from the tap
- Excellent performance indices
- Easy cleaning of the coarse filter
- Minimum height and length

Mounting position and installation tips

☑ Install the safety group horizontally near the DHW heater in the direction of the flow. Ensure it can be easily accessed.
☑ When draining the safety valve via the pipe interrupter (JRG Code 8222), its discharge must be easy to see, or the drain line must be kept as short as possible.

Installation instructions

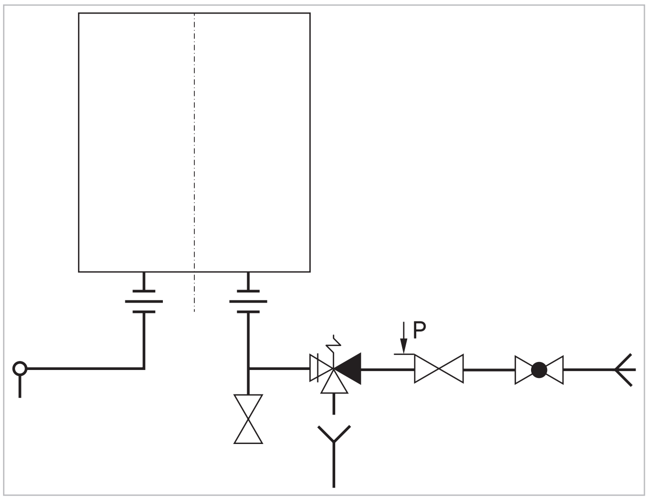
☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.
☑ Compliance with the supplementary regulations of the local water supply is mandatory.

Applicable documents

- Assembly instruction
- Operating and maintenance instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Installation example



GV.22 **Installation diagram**

Spare parts

- Coarse filter
- Return flow inhibitor insert
- Upper part of safety valve

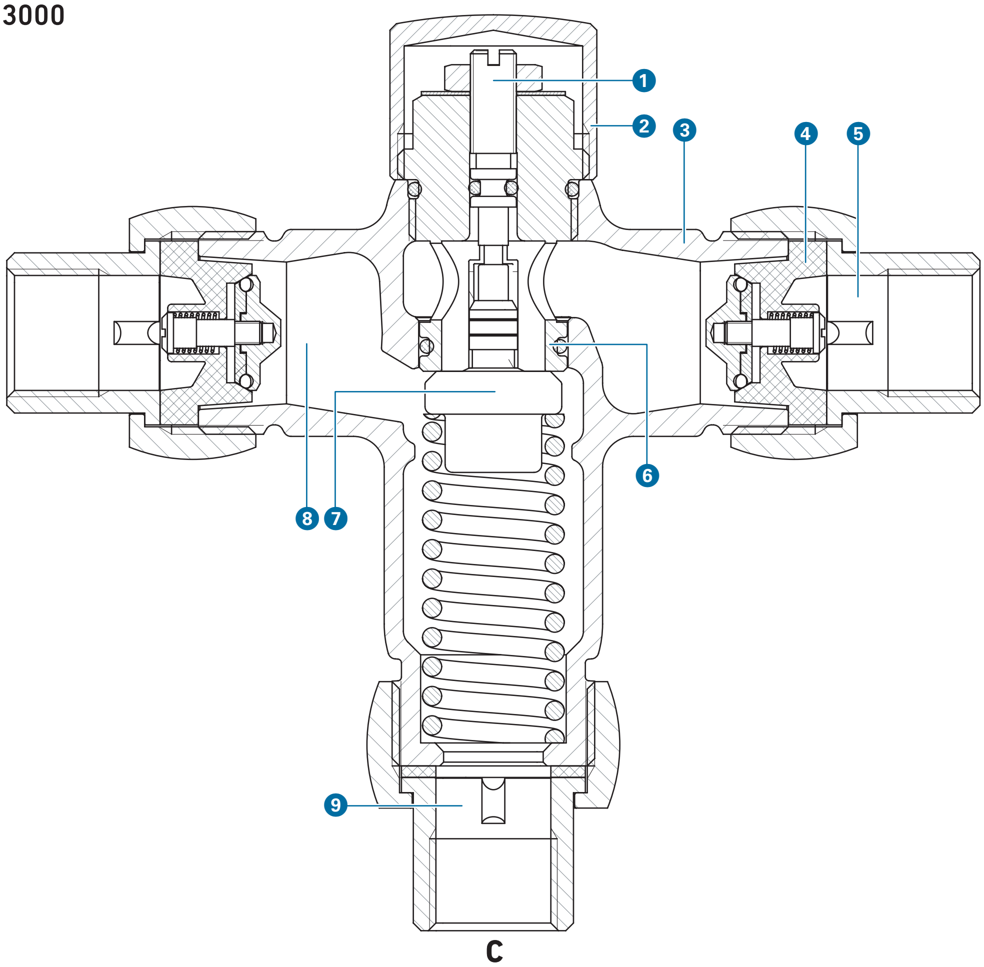
JRGUMAT Thermoblending valve 3000

The JRGUMAT Thermoblending valve is a mixing valve controlled by a thermostat. It is used wherever a constant mixing water temperature of highly controlled accuracy must be achieved. The valve mixes the hot water as required.

Technical Data

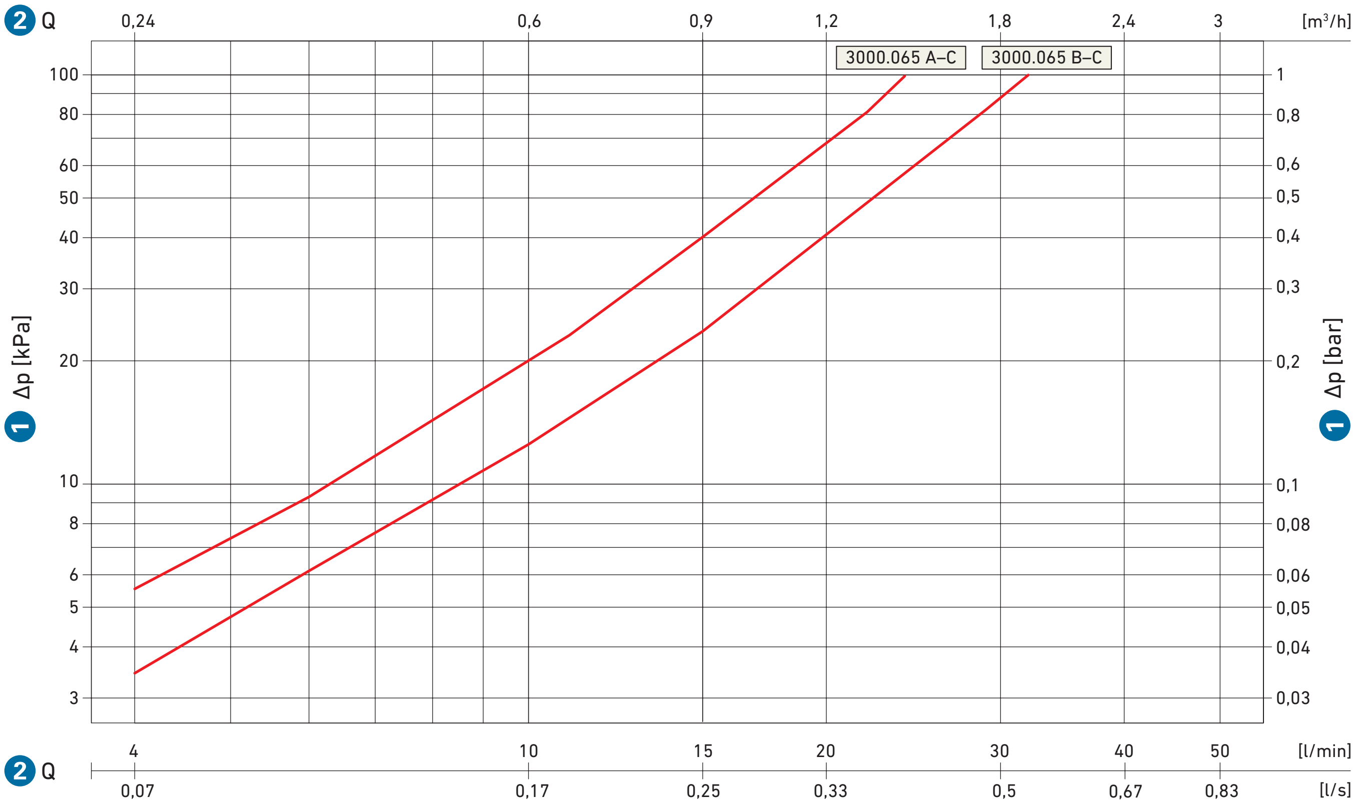
JRG code	Dimension	Nominal pressure PN	Setting range [°C]	Factory setting [°C]	Temperature max. [°C]	Connections
3000	GN ⅜" (DN10)	6	50 – 70	50 / 55 / 60 / 65	90	Female thread

3000



1. Setting screw
2. Protective cap
3. Housing
4. Return flow inhibitor
5. Cold water inlet
6. Valve spool
7. Thermostat
8. Hot water inlet
9. Mixed water

Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
3000.050 – 3000.065	JRGUMAT Thermoblending valve	GN ⅜" (DN10)	1.8	4.9

1 Pressure loss
2 Volumetric flow rate

Product description

The JRGUMAT Thermoblending valve is a mixing valve controlled by a thermostat. It is used wherever a constant mixing water temperature of highly controlled accuracy must be achieved.

Features and functions

The JRGUMAT Thermoblending valve is a proportionally regulating three-way mixer in open architecture and mixes the hot water as required.
The mixed water temperature is transferred to the thermostat. The thermostat compares the water temperature with the adjusted setpoint. If the mixed water temperature does not match the setpoint, the thermostat will change the volume. The valve spool is controlled by the pin until the mixed water temperature matches the setpoint.
The JRGUMAT Thermoblending valve cannot assume functions such as return flow prevention, shut-off or the regulation of the circulation's volume flow. Due to the design of the JRGUMAT thermostatic mixing valve, protection against excessive temperature cannot be guaranteed.

Benefits and features

- Increased comfort and equivocal safety in the hot water installation
- Supplies mixed water of constant temperature
- Saves water and energy
- Works without external energy
- Highly accurate control system from ±2 K

Mounting position and installation tips

The JRGUMAT Thermoblending valve can be installed regardless of its position. Mounting position and installation tips. To ensure proper functioning, the pressure of the hot water and cold water must be the same.

Installation instructions

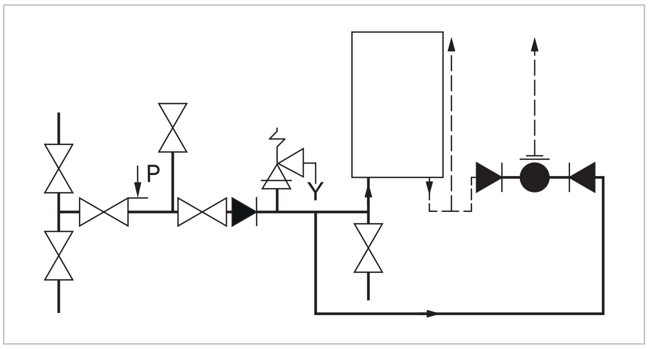
☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents

- Assembly instruction
- Operating and maintenance instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Installation example



GV.23 **Installation diagram**

V

JRGUMAT Thermoblending valve 3100, 3110

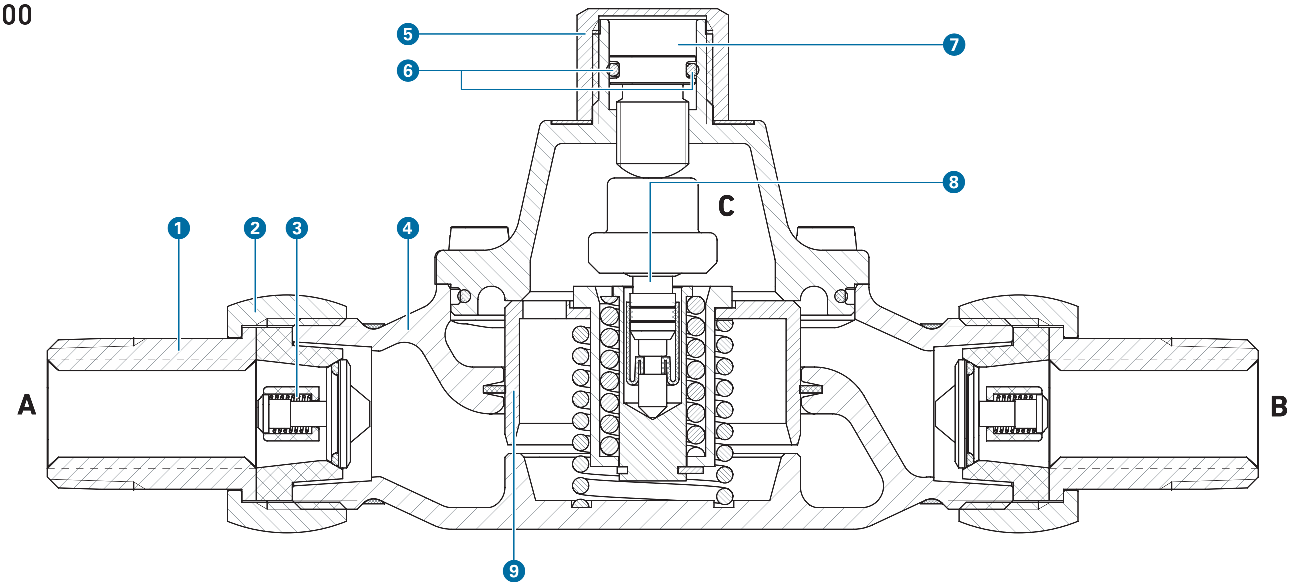
The JRGUMAT Thermoblending valve is a mixing valve controlled by a thermostat with integrated return flow inhibitor. The valve is used wherever a constant mixing water temperature of high control accuracy must be achieved.

Technical Data

JRG code	Dimension	Nominal pressure PN	Setting range [°C]	Factory setting [°C]	Temperature max. [°C]	Connections
3100	GN ½" (DN15)	10	12-25 22-30	18 26		External thread
3110	GN ½" (DN15)	10	36-40 40-44 50-65 50-65 50-65 50-65[1]	38 42 50 55 60 65[1]	70[2] 90[3]	External thread

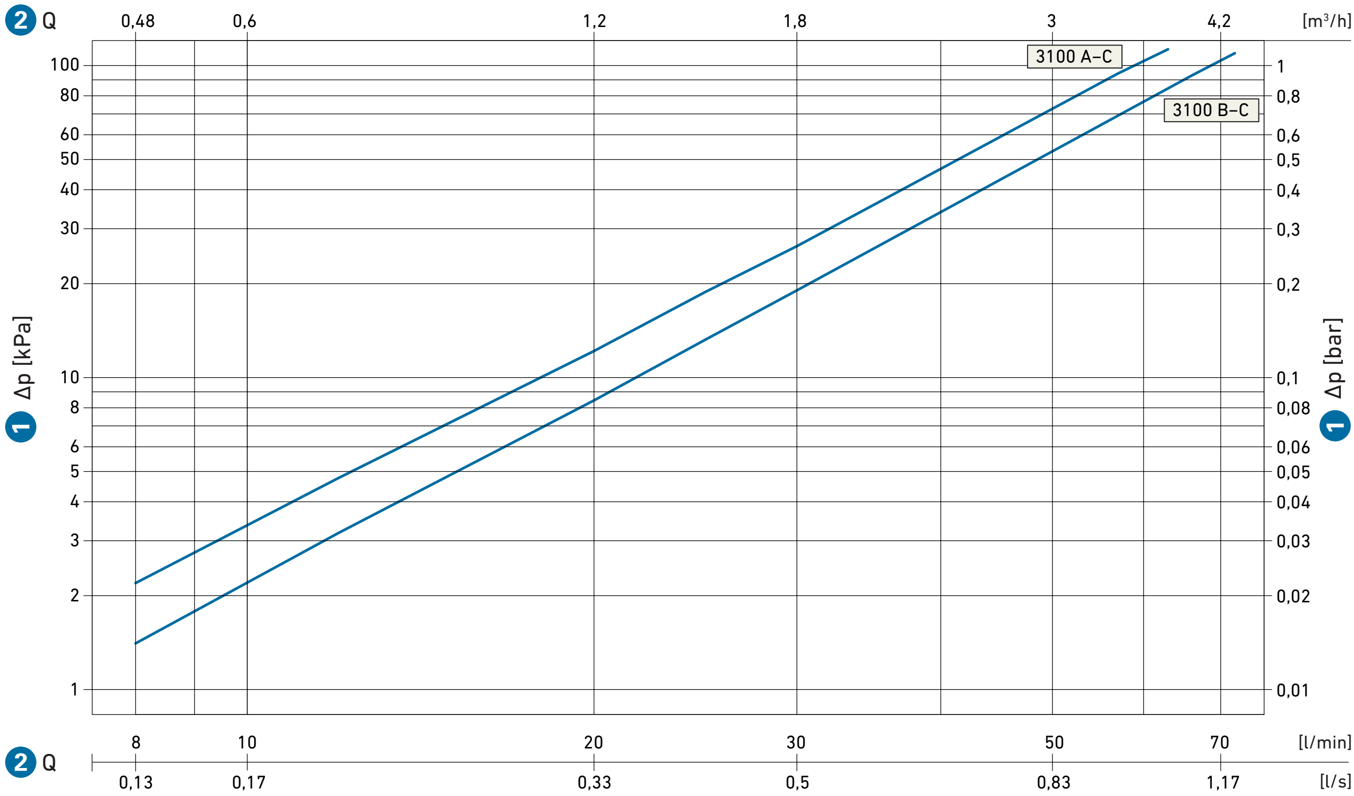
[1] only available with JRG Code 3100
[2] 70 °C to factory setting 26 °C
[3] 90 °C from factory setting 38 °C

3100



1. Threaded connector
2. Nut
3. Return flow inhibitor
4. Housing
5. Protective cap
6. O-ring
7. Setting screw
8. Thermostat
9. Regulating bushing

Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
3100.018 – 3100.065	JRGUMAT Thermoblending valve	GN ½" (DN15)	2.1	18.4
3110.018 – 3110.060	JRGUMAT Thermoblending valve	GN ½" (DN15)	2.1	18.4

1 Pressure loss
2 Volumetric flow rate

Product description

The JRGUMAT Thermoblending valve is a mixing valve controlled by a thermostat with integrated return flow inhibitor. The valve is used wherever a constant mixing water temperature of high control accuracy must be achieved.

Features and functions

The thermoblending valve is set to a certain temperature at the factory. Return flow inhibitors are installed at both water inlets.
The JRGUMAT Thermoblending valve cannot assume functions such as return flow prevention, shut-off or the regulation of the circulation's volume flow. Appropriate valves must be installed according to the installation diagram.

Benefits and features

- Increased comfort and equivocal safety in the hot water installation
- Supplies mixed water of constant temperature
- Saves water and energy
- Works without external energy
- Highly accurate control system

Mounting position and installation tips

The JRGUMAT Thermoblending valve can be installed regardless of its position. Depending on the requirements, the upper part with the mixed water outlet can be rotated 180° after removing the 4 screws.

Installation instructions

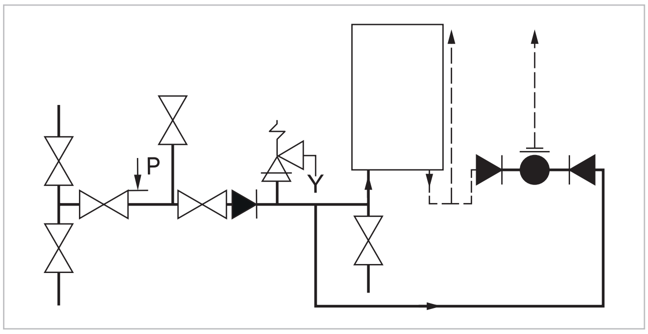
☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents

- Assembly instruction
- Operating and maintenance instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Installation example



GV.24 **Installation diagram**

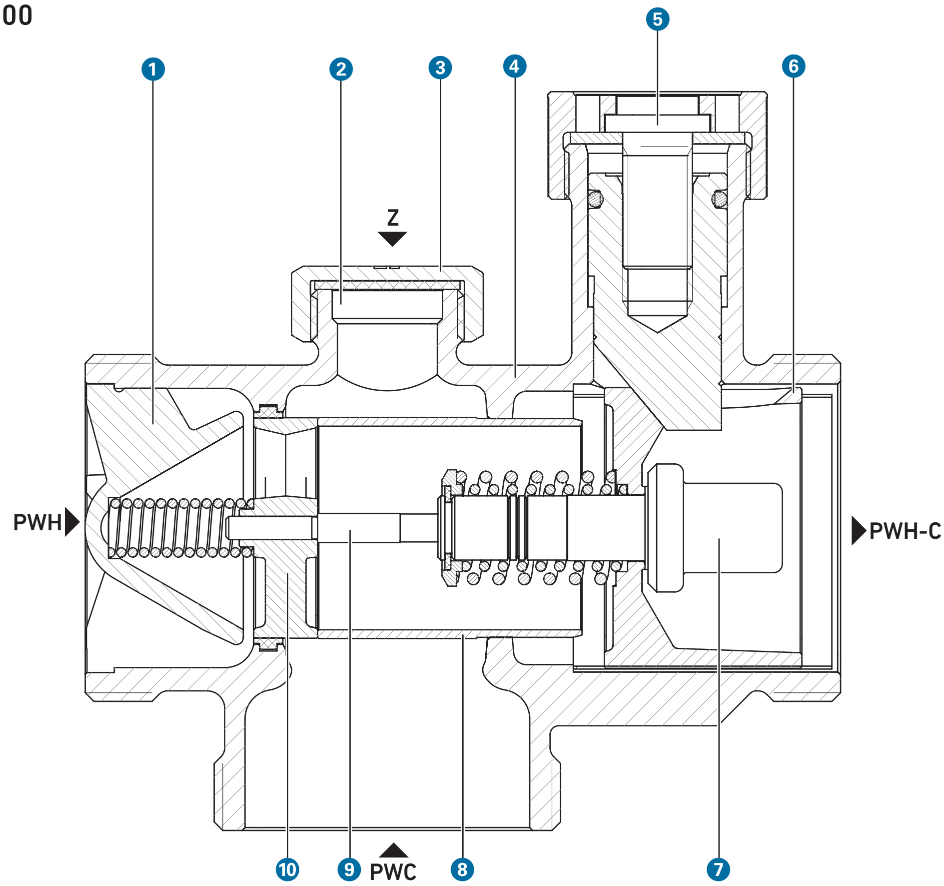
JRGUMAT Thermoblending valve 3400, 3410

The JRGUMAT Thermoblending valve is a proportionally regulating three-way mixer. It regulates the mixing water temperature without any additional energy. The valve is used wherever a constant mixing water temperature of high control accuracy must be achieved.

Technical Data

JRG code	Dimension	Nominal pressure PN	Setting range [°C]	Factory setting [°C]	Temperature max [°C]	Connections
3400	GN ½" – 2" (DN15 – 50)	10	20 – 30 30 – 45 35 – 55 45 – 65	25 40 48 55	90	External thread
3410	GN 2½" – 3" (DN65 – 80)					Flange transfer

3400



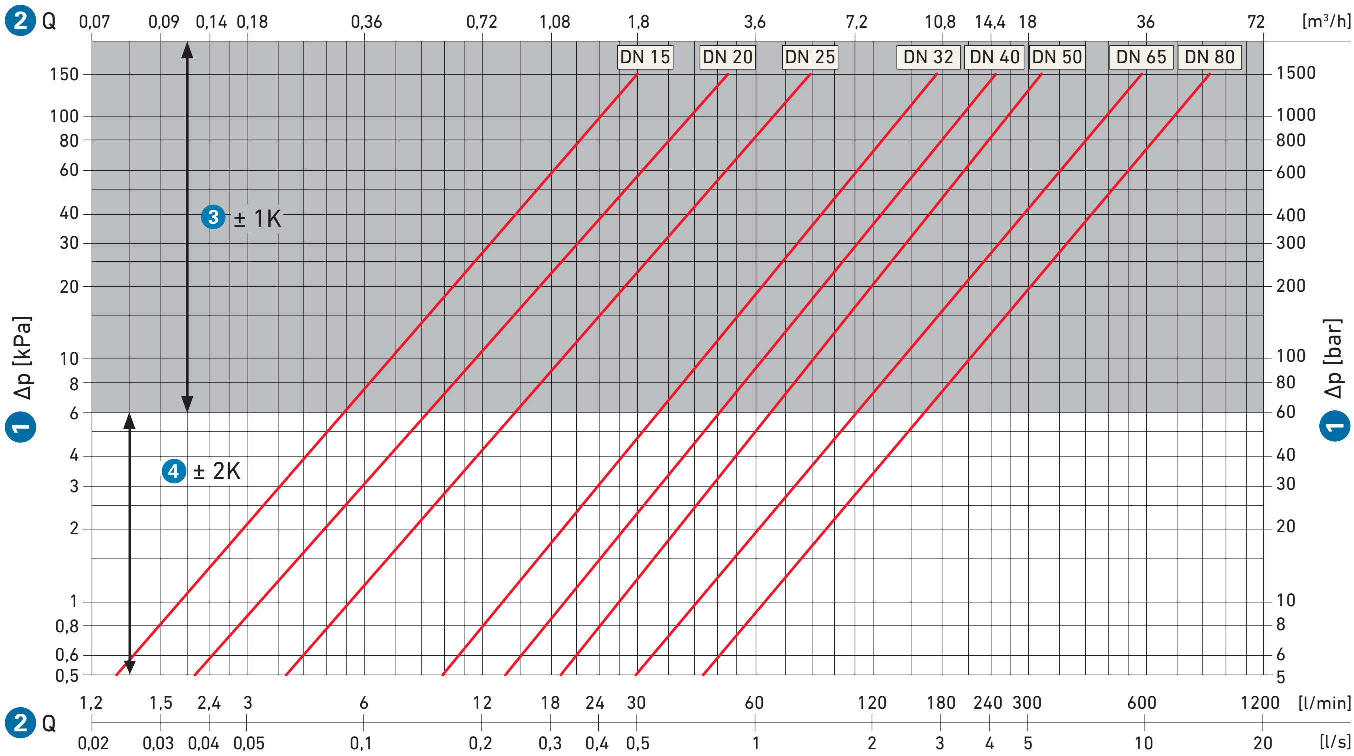
1. Hot water seat, gunmetal
2. Circulation connection
3. Cap
4. Housing, gunmetal
5. Setting screw, brass
6. Gate valve, gunmetal
7. Thermostat
8. Cold water seat, chrome nickel steel
9. Pin, chrome nickel steel
10. Valve spool, gunmetal (coated)

Z	Circulation
PWH-C	Mixed water
PWC	Cold water
PWH	Hot water

Performance chart

The pipe dimension determined during pipe sizing also applies as the nominal diameter DN for the JRGUMAT Thermoblending valve.

The relationships between volumetric flow, nominal diameter and pressure loss can be found in the nomogram. The greyed area of the nomogram indicates the optimal operating conditions.



1. Pressure loss
2. Volumetric flow rate
3. Setpoint tolerance ±1 K
4. Setpoint tolerance ±2 K

Noise behaviour

Dimension	Group of valves
DN15	I
DN20 – 32	II

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
3400.910 – 3400.916	JRGUMAT Thermoblending valve • External thread	GN ½" (DN15)	1.4	39.1
3400.920 – 3400.926		GN ¾" (DN20)	2.4	43.4
3400.930 – 3400.936		GN 1" (DN25)	4.0	40.1
3400.940 – 3400.946		GN 1¼" (DN32)	8.5	23.4
3400.950 – 3400.956		GN 1½" (DN40)	12.0	28.4
3400.960 – 3400.966		GN 2" (DN50)	15.9	39.6
3410.601 – 3410.608	JRGUMAT Thermoblending valve • Flange transfer	GN 2½" (DN65)	28.5	35.2
3410.801 – 3410.808		GN 3" (DN80)	42.0	37.2

V

Product description

The JRGUMAT Thermoblending valve is a proportionally regulating three-way mixer. It regulates the mixing water temperature without any additional energy. The valve is used wherever a constant mixing water temperature of high control accuracy must be achieved.

Features and functions

The JRGUMAT Thermoblending valve is used, among other things, as over-temperature protection in alternative energy systems such as solar systems, firewood heating, wood chip firing, pellet stoves, etc. The valve can also be used for special applications, such as a regulating device if a certain temperature must be maintained.
The mixed water temperature is transferred to the thermostat. The thermostat compares the water temperature with the adjusted setpoint. If the mixed water temperature does not match the setpoint, the thermostat will change the volume. The valve spool is controlled by the pin until the mixed water temperature matches the setpoint. The valve mixes the hot water as required. The JRGUMAT Thermoblending valve cannot assume functions such as return flow prevention, shut-off or the regulation of the circulation's volume flow.

Benefits and features

- Supplies mixed water of constant temperature
- Highly accurate control system
- Works without external energy
- Protects against scalding
- Saves water and energy
- Increases comfort and safety in the hot water installation

Mounting position and installation tips

The JRGUMAT Thermoblending valve works in any mounting position.

- ☑ Compliance with the installation regulations for the water heater circuit is mandatory. The pressure between the cold and hot water is the same.
- ☑ Install only the return flow inhibitors specified in the diagrams.
- ☑ When installing shut-off valves, only use low-pressure valves, such as y-type valves, gate valves and ball valves which will assume the shut-off function.
- ☑ Thoroughly flush the pipeline before installing the JRGUMAT Thermoblending valve.
- ☑ The hot water temperature must be at least 5K above the desired mixed water temperature.

In order to prevent the mixer from malfunctioning due to radiant heat, the mixer should be positioned at the side of the DHW heater. Ensure a minimum clearance of one meter between the DHW heater and the JRGUMAT must be maintained. If the minimum clearance cannot be maintained, a thermosiphon must be installed.

Installation instructions

- ☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents

- Assembly instructions (DE, EN, IT, NO, FR, ES)
- Help with error messages (DE, EN)
- Brochure (DE, EN, IT, FR, ES)

To download the documents, go to www.gfps.com.

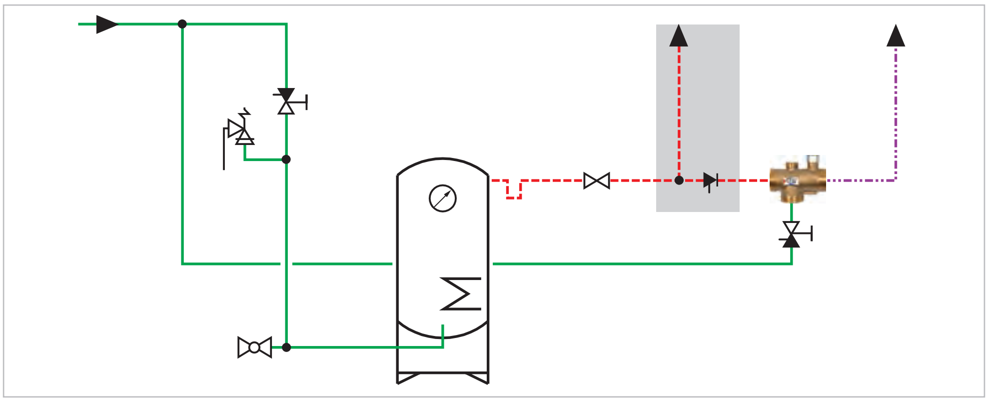
Installation examples

Notes on the installation examples	
[GV.25] to [GV.32]	The installation examples are a recommendation, without guarantee and they are not intended to be exhaustive. The installation of safety devices, equipment and valves must comply with the local standards and guidelines. However, proper planning cannot be replaced by these installation examples.
[GV.26] to [GV.29] and [GV.28]	Flow path A = To avoid overheating, regulating socket 6310 Flow path B = To cover the heat losses, JRGUTHERM 6320
[GV.29]	Thermal proportional distribution of volume flows. Control of the volumetric flows for the flow paths A and B using JRGUMAT. Size of the circulation mixer as a function of the circulation losses.
[GV.27] and [GV.28]	To ensure a thermal disinfection, each tap must be flushed. Sufficient hot water must be available for the thermal disinfection. **Caution:** During thermal disinfection, there is a risk of scalding and protection cannot be guaranteed. Thermal disinfection is only possible with the JRGUTHERM 2T circulation controller!

TV.1
Symbols

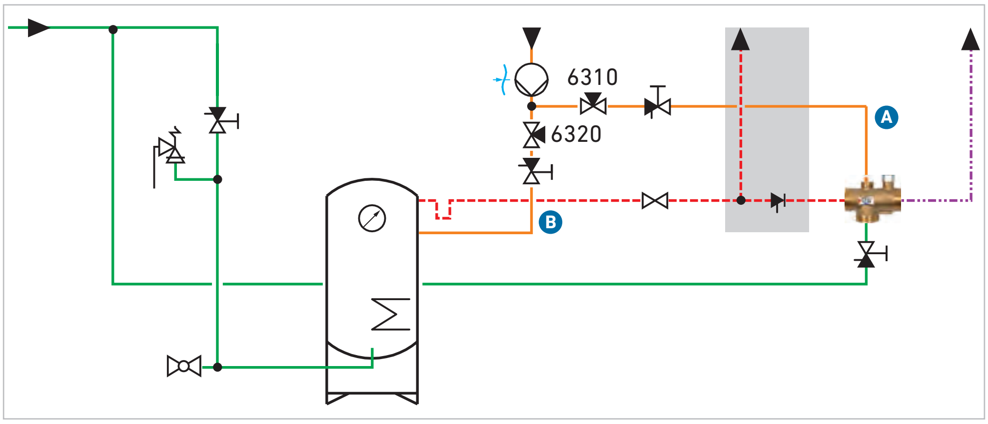
JRG code	Text	EN 806-1
–	PWC drinking water pipelines, cold	
–	PWH drinking water pipelines, hot	
–	PWH-C drinking water pipelines, hot, circulation	
–	PWH-M drinking water pipelines, hot, mixed water	
3400/3410	JRGUMAT Thermoblending valve	
5200 – 5234	Shut-off valve	
1610 – 1615	Return flow inhibitor (controllable)	
5262 – 5284	Shut-off valve with integrated return flow inhibitor (controllable)	
1025/1028	Safety valve, spring-loaded	
6310 – 6325	Circulation control valve	
–	Fluid pump with mechanical actuator	
6000 – 6012	Ball valve	
1810 – 1870	Mechanical filter	
–	Actuated by electric motor	
6410	Actuated by electric magnet	
–	Timer	
–	Speed controlled	

Mixing water installation



GV.25
Mixing water installation, option: Hot water outlet

Mixing water installation with circulation



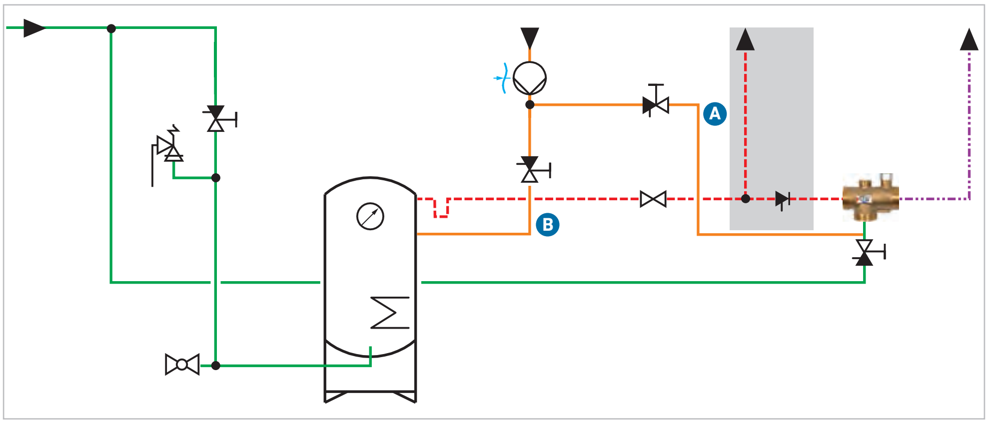
GV.26
Mixing water installation, option: Hot water outlet

- **A** Flow path to avoid overheating, regulating socket 6310
- **B** Flow path to cover the heat losses, JRGUTHERM 6320

V

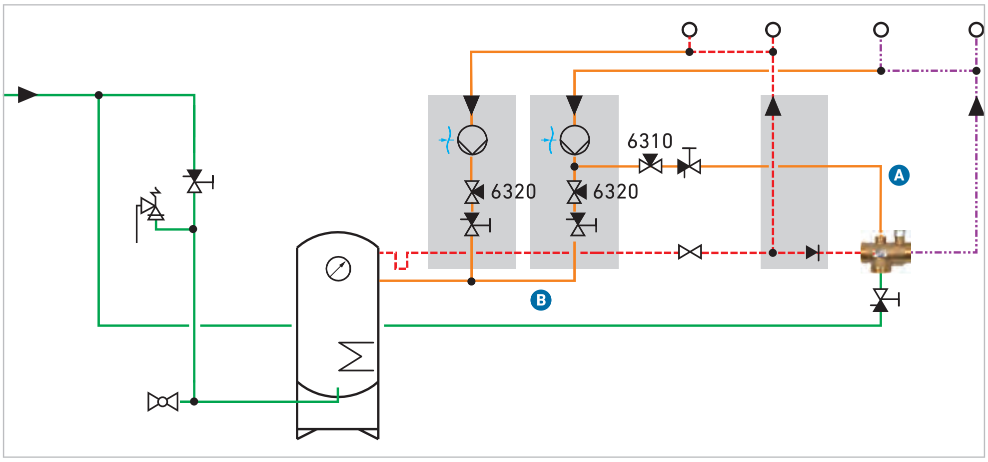
Mixing water installation with circulation

(Flow path A via the cold water inlet of the mixer)



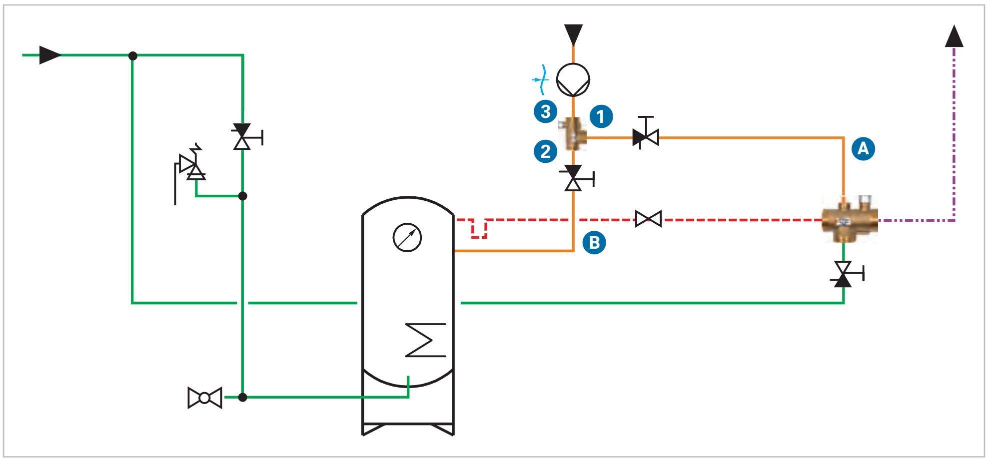
GV.27
Mixing water installation, option: Hot water outlet
- **A** Flow path to avoid overheating, regulating socket 6310
- **B** Flow path to cover the heat losses, JRGUTHERM 6320

Mixed water installation with two circulation circuits



GV.28
Mixing water installation, option: Hot water outlet with circulation
- **A** Flow path to avoid overheating, regulating socket 6310
- **B** Flow path to cover the heat losses, JRGUTHERM 6320

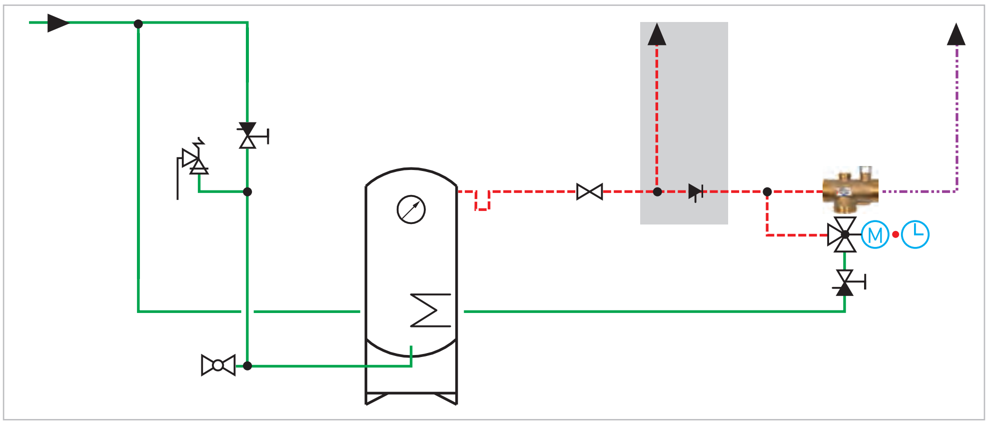
Mixing water installation with circulation line ≥¾“



GV.29 **Mixing water installation**
- **1** Cold water inlet
- **2** Hot water inlet
- **3** Mixed water outlet

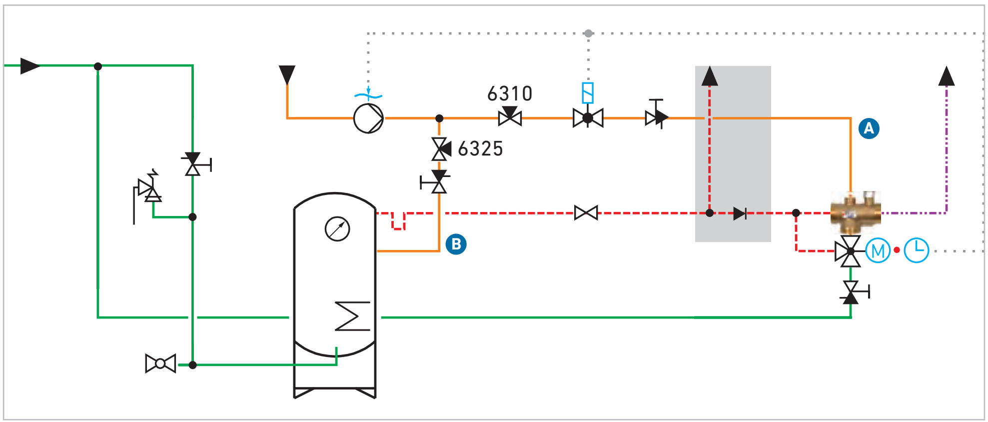
- **A** Flow path to avoid overheating, regulating socket 6310
- **B** Flow path to cover the heat losses, JRGUTHERM 6320

Mixed water installation with thermal disinfection



GV.30
Mixing water installation, option: Hot water outlet

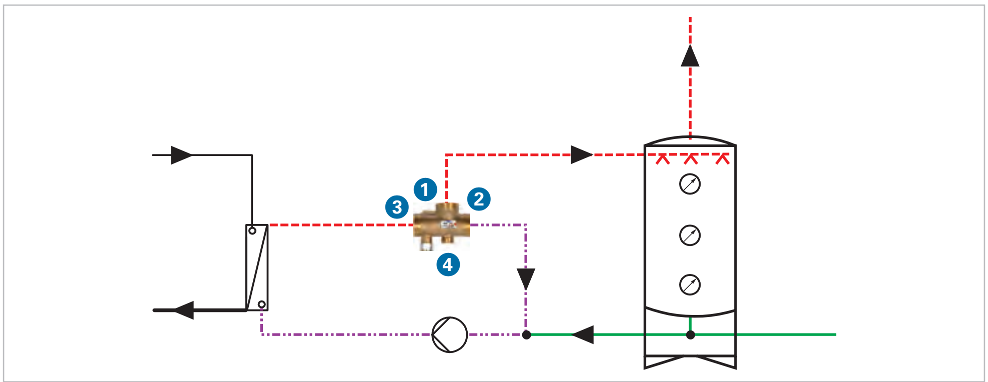
Mixed water installation with circulation and thermal disinfection



GV.31
Mixing water installation, option: Hot water outlet

- (A) Flow path to avoid overheating, regulating socket 6310
- (B) Flow path to cover the heat losses, JRGUTHERM 6320

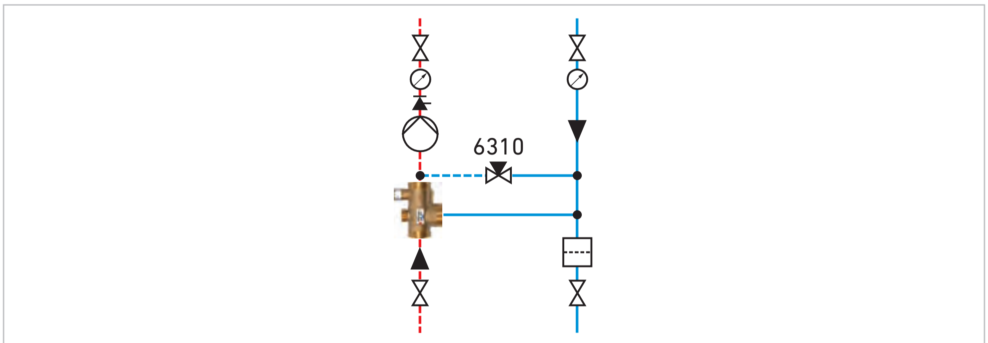
Regulation of the storage charge with JRGUMAT

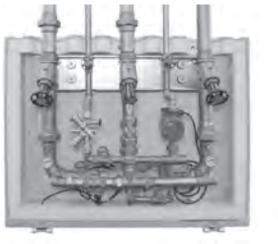


GV.32
Mixing water installation

1. Cold water inlet
2. Hot water inlet
3. Mixed water outlet
4. Circulation inlet with end cap 8325

Fixed value control with constant temperature (heating)





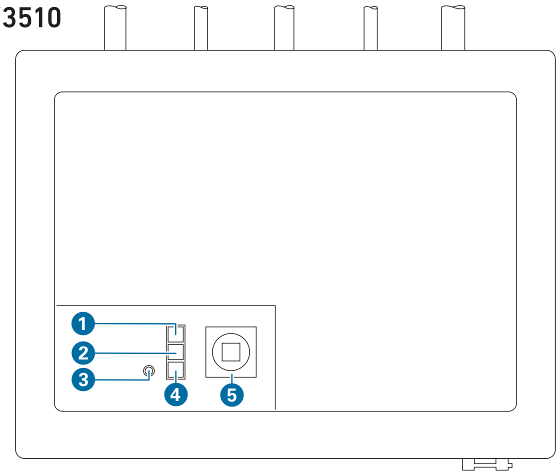
JRGUMAT Compact blending water facility 3500, 3510, 3590

The JRGUMAT Compact blending water facility is used wherever a constant mixing water temperature of high control accuracy must be achieved. The system is delivered with all necessary valves – all pipes installed, ready to use, completely insulated and inclusive control unit.

Technical Data

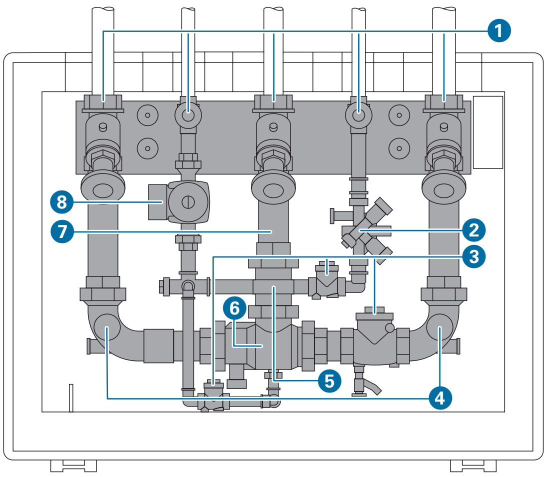
JRG code	Components	Dimension	K_{vs} value [m³/h]	Factory setting [°C]	Temperature max [°C]	Connections
3500	• without bypass control	GN 1½" – 2" (DN40 – 50)	1½": 10,8 m³/h 2": 14,0 m³/h	25 / 40 / 48 / 55		right or left
3510	• with bypass control	GN 2" (DN50)	2": 13,0 m³/h	25 / 40 / 48 / 55	90	right or left
3590	Bypass for thermal disinfection • Tee • Three-way valve with actuator • Cable and plug	GN 1½" – 2" (DN40 – 50)	-	–		-

3500/3510



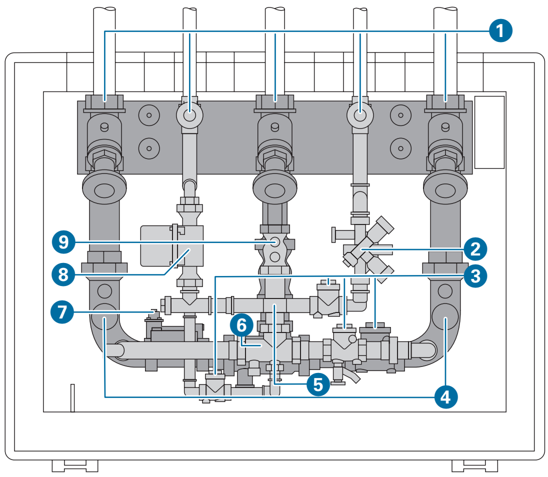
1. System switch
2. Switch
3. Fine fuse
4. Signal lamp (circulation pump)
5. 2-channel digital timer

3500



1. Shut-off valves
2. JRGUTHERM 2T
3. Flap traps
4. Thermometer
5. Mixing fitting
6. JRGUMAT Thermoblending valve
7. Return flow inhibitor
8. Circulation pump

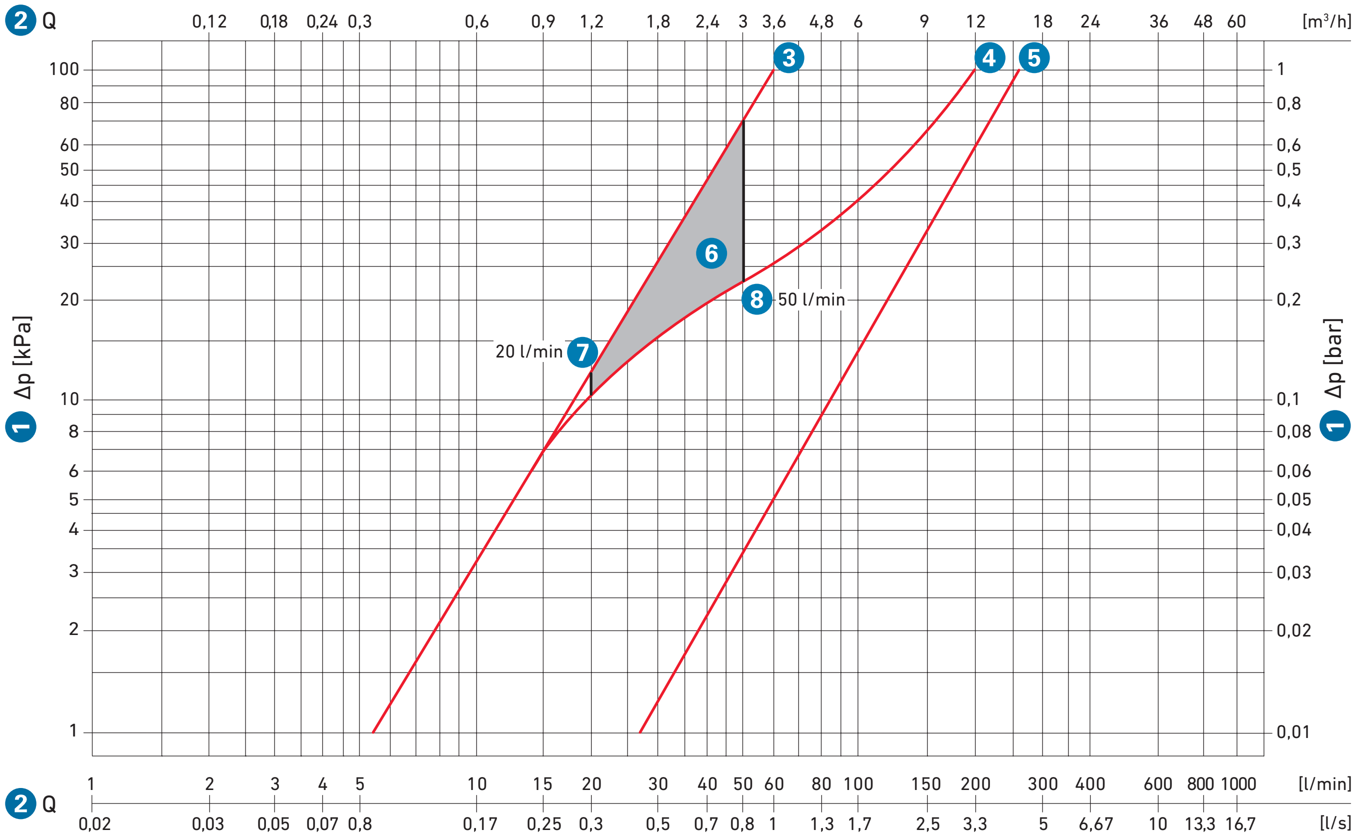
3510



1. Shut-off valves
2. JRGUTHERM 2T
3. Flap traps
4. Thermometer
5. Mixing fitting
6. JRGUMAT Thermoblending valve (2x, arranged one behind the other)
7. Differential pressure valve
8. Circulation pump
9. Return flow inhibitor

Performance chart

with control features

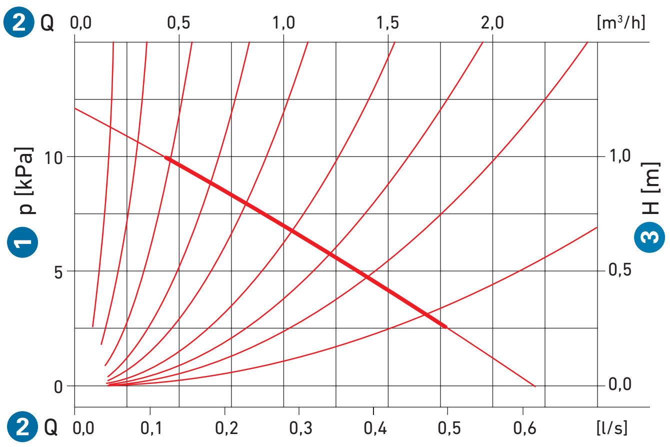


JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
3500.010	JRGUMAT Compact blending water facility • without bypass control	GN 1½" (DN40)	10.8	35.1
3500.020		GN 2" (DN50)	14.0	51.0
3510.020	JRGUMAT Compact blending water facility • with bypass control	GN 2" (DN50)	13.0	59.2
3590.560	Bypass • without bypass control	GN 1½" (DN40)	9.8	42.6
3590.640		GN 2" (DN50)	13.1	58.3

1. Pressure loss
2. Volumetric flow rate
3. only 1" mixer
4. 1"- and 1½" mixer connected in parallel
5. Compare 2" mixer 3400
6. Switching range
7. Switching point 20 l/s
8. Switching point 50 l/s

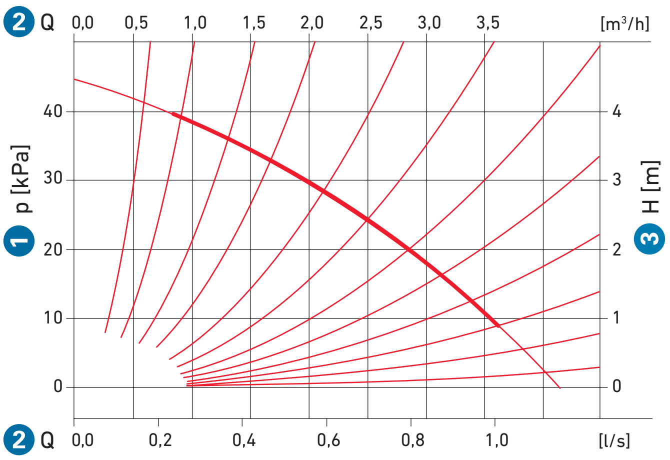
V

UP 20-15 N (Standard)



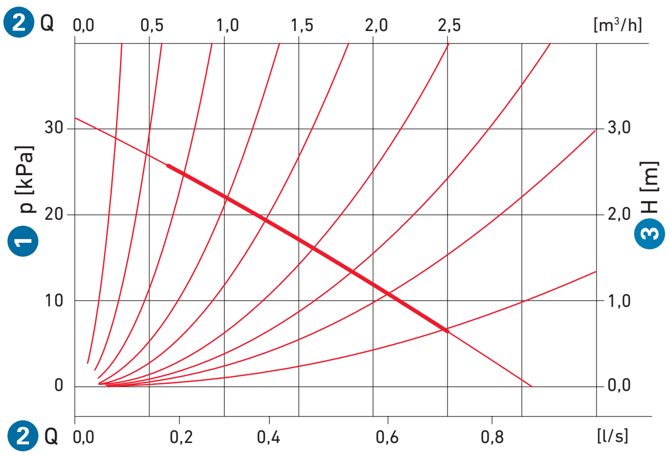
Speed level 1, P_1 [W] 65, I_n (A) 0.28

UP 20-45 N



Speed level 1, P_1 [W] 115, I_n (A) 0.50

UP 20-30 N



Speed level 1, P_1 [W] 75, I_n (A) 0.31

1 Pressure loss
2 Volumetric flow rate
3 Metres in height

Product description

The JRGUMAT Compact blending water facility is used wherever a constant mixing water temperature of high control accuracy must be achieved. The system is delivered with all necessary valves – all pipes installed, ready to use, completely insulated and inclusive control unit.

Features and functions

The JRGUMAT Thermoblending valve 3400 is the main component of the system. The system is available with or without bypass control. In systems with bypass control, 2 thermoblending valves are installed in parallel.
The system has a high control accuracy across a wide performance range. Compact blending water facility with by-pass are recommended for objects where water is drawn at very different amounts, such as in showers of sports facilities.
The circulation temperature is controlled by a separate P-controller. On the one hand, the operating time of the circulation pump and, in addition, the thermal disinfection can be set individually with the 2-channel timer.
The JRGUMAT Compact blending water facility is designed to allow a bypass (JRG Code 3590) to be added and a periodical thermal disinfection of the circulating circuit is made possible.

Benefits and features

- Supplies mixed water of constant temperature for small and large amounts of water being drawn at
- Highly accurate control system
- Compact design, small footprint
- Complete piping made of NiRo steel, valves made of gunmetal
- Sturdy heat and sound-insulated case
- Ready to use at time of delivery
- Easy planning and wall-mounting
- Fail-safe mounting
- Protects against scalding
- Saves water and energy
- Increases comfort and safety in the hot water installation
- Control system for thermal disinfection
- Optionally available: Control of the system by using the building automation

Installation tips

☑ Compliance with the installation regulations for the water heater circuit is mandatory. The pressure between the cold and hot water is the same.
☑ The hot water temperature must be at least 5K above the desired mixed water temperature.

Installation instructions

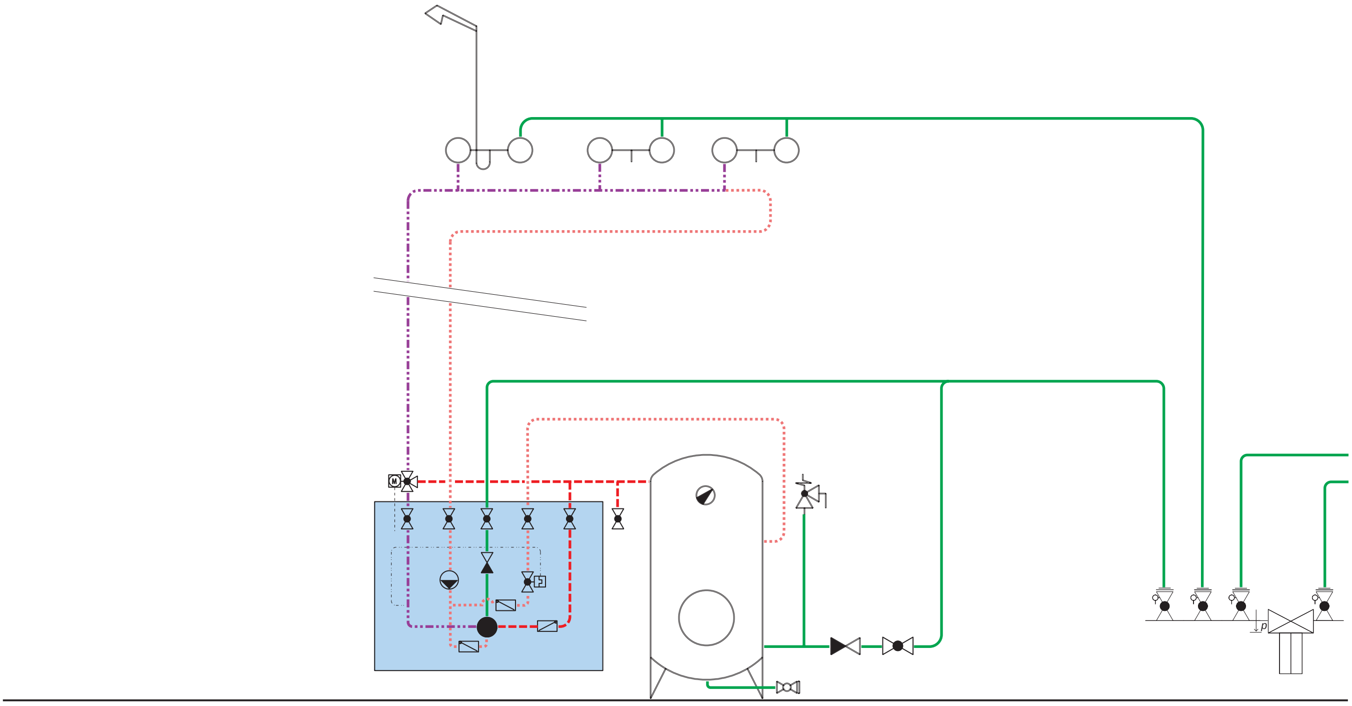
☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Spare parts

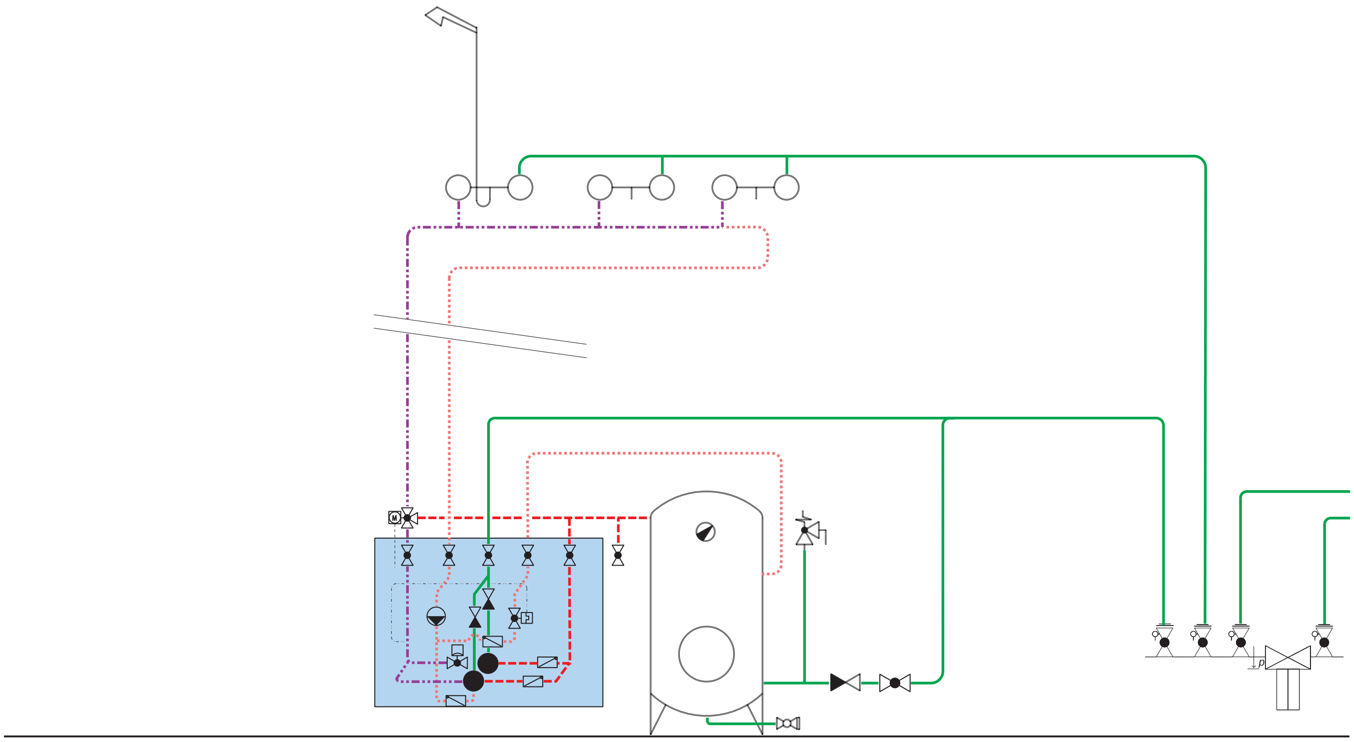
☑ If revisions to the system are required contact the GF Technical Customer Service.

Installation examples

Water blending installation with compact blending water facility 3500, without bypass control



Water blending installation with compact blending water facility 3510, with bypass control



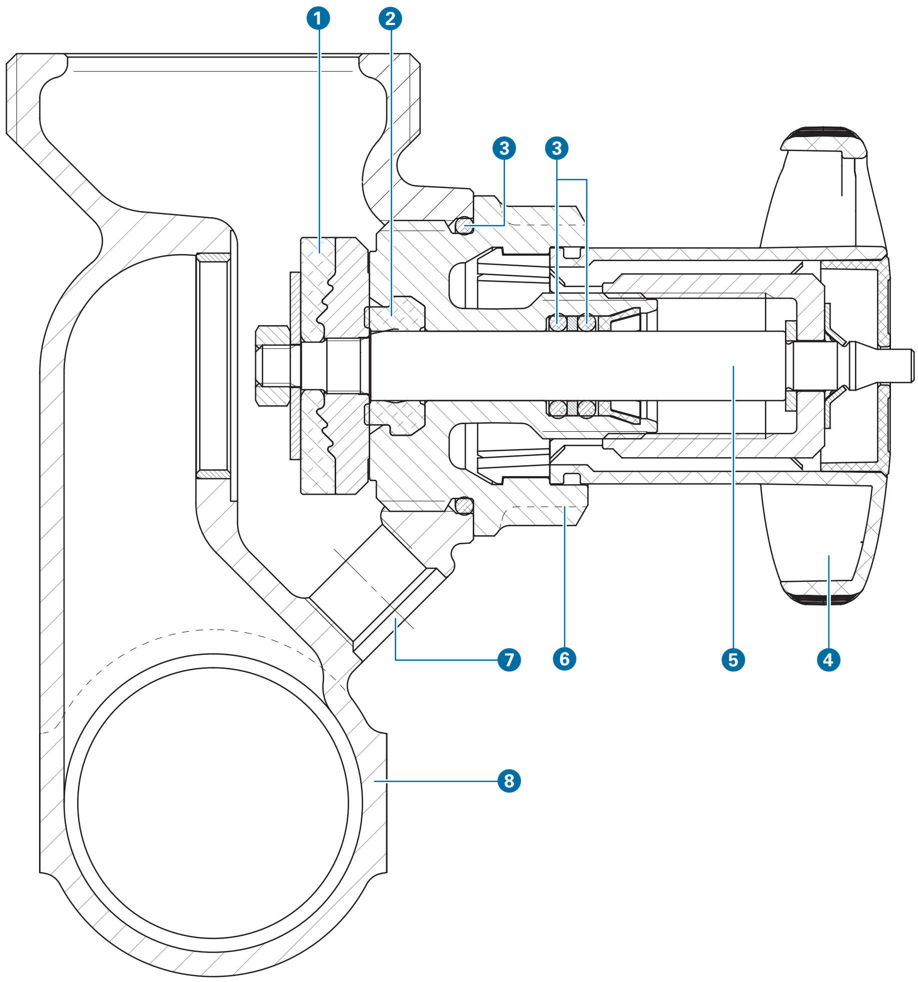
JRGUSIT Distribution valve 5120

Due to its design, the JRGUSIT Distribution valve can be used as a distributor and collector and its upper part is designed without dead space.

Technical Data

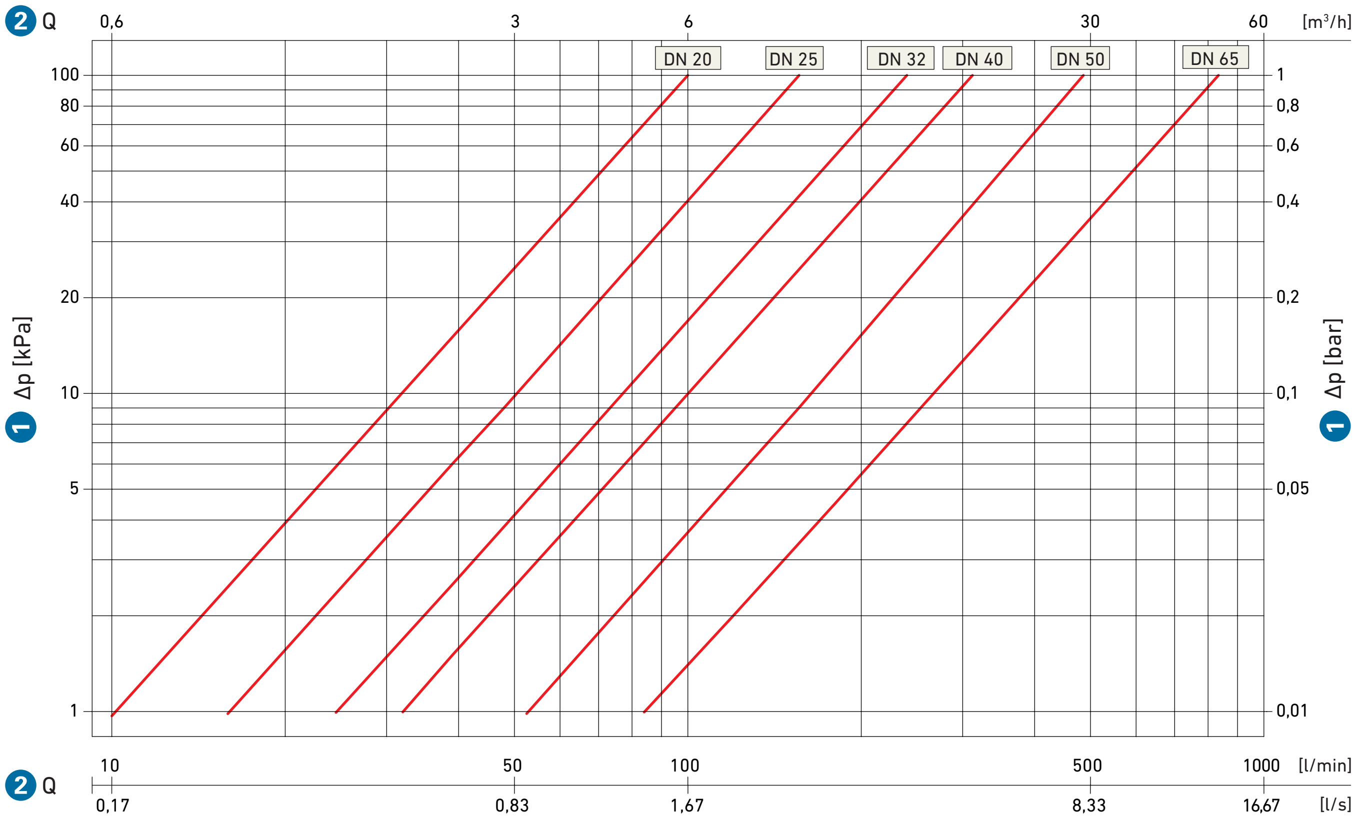
JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
5120	GN 1" – 2½" (DN25 – 65)	16	90	Stem: Female pipe thread Outlet: Pipe threads

5120



1. Valve seal
2. Backflow seal
3. O-ring
4. Handwheel
5. Valve rod
6. Upper part of valve
7. Discharge nozzle
8. Valve body

Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5120.100	JRGUSIT Distribution valve	GN 1" (DN25) – DN20	6.3	6.4
5120.110		GN 1" (DN25) – DN25	9.3	7.2
5120.200		GN 1¼" (DN32) – DN20	6.3	6.4
5120.210		GN 1¼" (DN32) – DN25	9.3	7.2
5120.220		GN 1¼" (DN32) – DN32	14.1	8.4
5120.300		GN 1½" (DN40)– DN20	6.3	6.4
5120.310		GN 1½" (DN40) – DN25	9.3	7.2
5120.320		GN 1½" (DN40) – DN32	14.1	8.4
5120.330		GN 1½" (DN40) – DN40	18.9	11.5
5120.400		GN 2" (DN50) – DN20	6.3	6.4
5120.410		GN 2" (DN50) – DN25	9.3	7.2
5120.420		GN 2" (DN50) – DN32	14.1	8.4
5120.430		GN 2" (DN50) – DN40	18.9	11.5
5120.440		GN 2" (DN50) – DN50	32.8	9.3
5120.500		GN 2½" (DN65) – DN25	9.3	7.2
5120.510		GN 2½" (DN65) – DN32	14.1	8.4
5120.520		GN 2½" (DN65) – DN40	18.9	11.5
5120.530		GN 2½" (DN65) – DN50	32.8	9.3

1. Pressure loss
2. Volumetric flow rate

Product description

Due to its design, the JRGUSIT Distribution valve can be used as a distributor and collector and its upper part is designed without dead space.

Features and functions

The natural ingredients contained in the drinking water can create encrustations in pipes and valves, but also promote the growth of biofilms (bacteria, Legionella) and corrosion. The distribution valve helps to prevent malfunctions and to meet the requirements of hygiene in the drinking water supply.

Benefits and features

- Free of dead spaces
- Permanently smooth-running
- Non-rising handwheel
- Interchangeable medium marking plate
- Valve position can be seen and felt by touch
- Valve seat made of stainless steel

Mounting position and installation tips

The JRGUSIT Distribution valve can be installed regardless of its position.

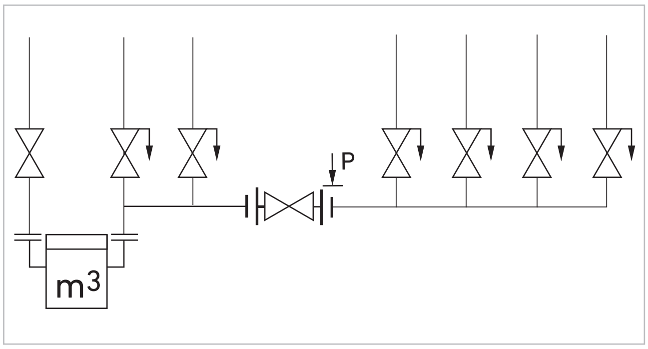
Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Spare parts

- Upper parts of straight seat valves

Installation examples



GV.33 **Installation diagram**

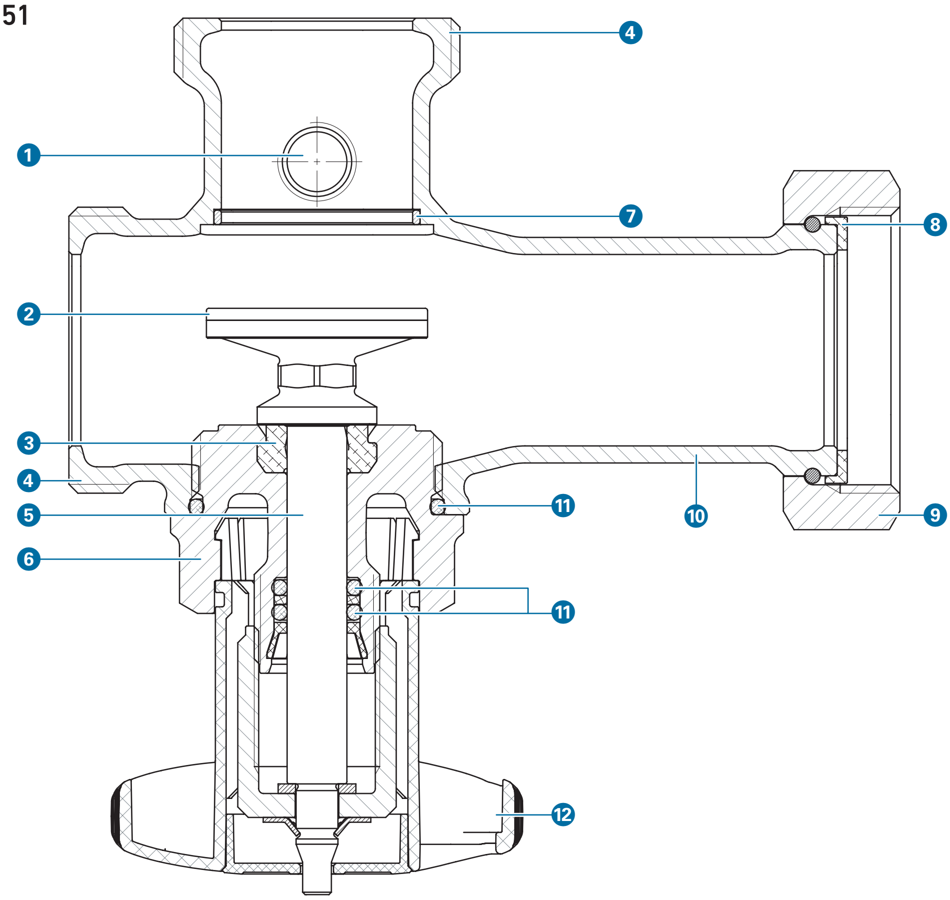
JRGUSIT NG Distribution valve 5151

The JRGUSIT NG is a distribution valve with pre-assembled screw connection in the stem and its upper part does not exhibit any dead spaces. The valve can be used as distributor and collector.

Technical Data

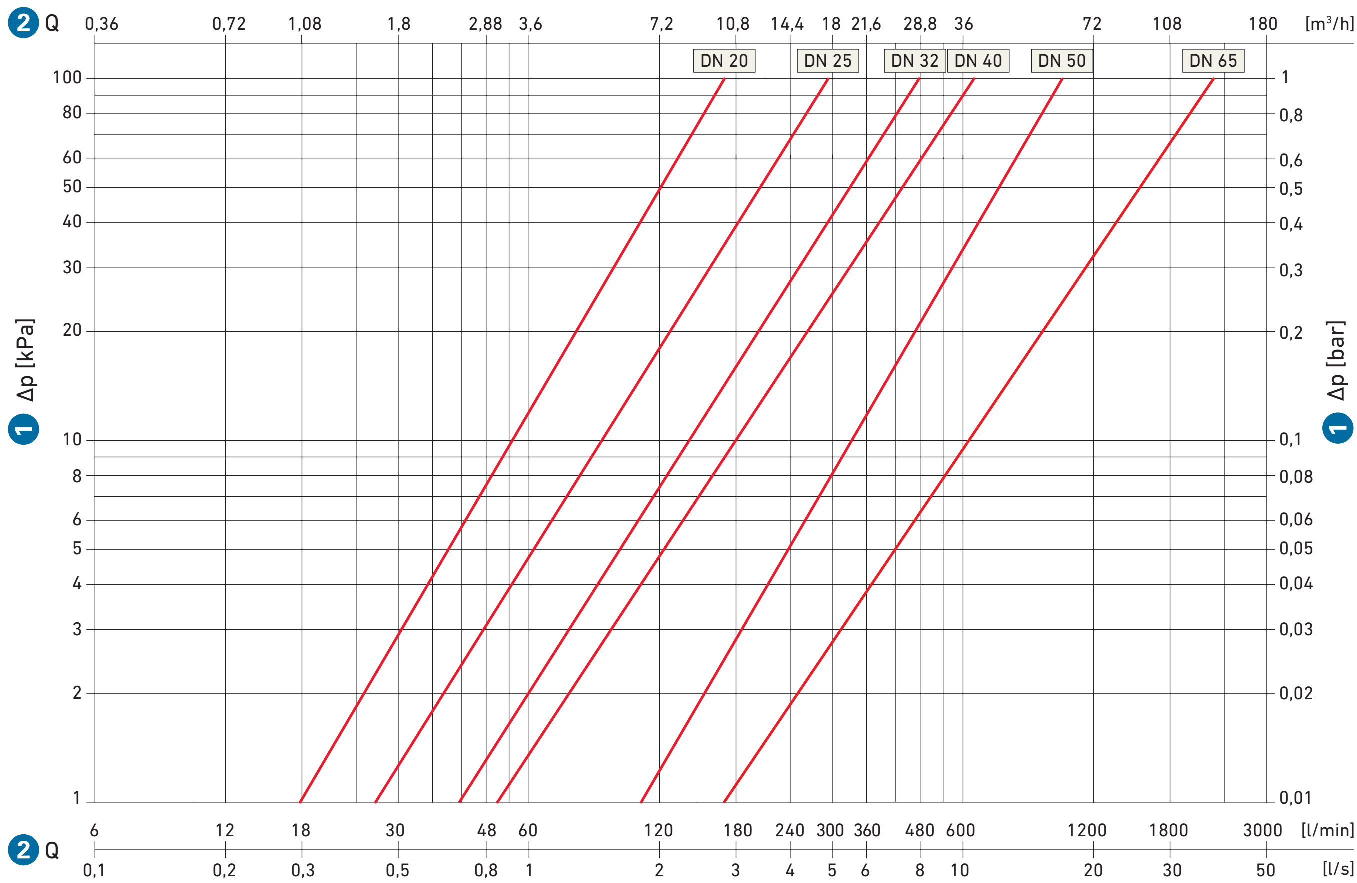
JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
5151	GN 1" – 2½" (DN25 – 65)	16	90	Stem: Female pipe thread/ male pipe thread Outlet: Pipe external thread

5151



1. Connection for drain valve (both sides, closed)
2. Valve seal
3. Backflow seal
4. External thread (BR 1)
5. Valve rod
6. Upper part
7. Valve seat made of stainless steel
8. Profile seal
9. Loosely attached nut (BR 1)
10. Valve body
11. O-ring
12. Handwheel

Performance chart



1 Pressure loss
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN20 – 32	I

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5151.100		GN 1" (DN25) – DN20	11.1	2.1
5151.110		GN 1" (DN25) – DN25	16.2	2.4
5151.200		GN 1¼" (DN32) – DN20	11.1	2.1
5151.210		GN 1¼" (DN32) – DN25	16.2	2.4
5151.220		GN 1¼" (DN32) – DN32	25.4	2.6
5151.300		GN 1½" (DN40) – DN20	11.1	2.1
5151.310		GN 1½" (DN40) – DN25	16.2	2.4
5151.320		GN 1½" (DN40) – DN32	25.4	2.6
5151.330	JRGUSIT NG Distribution valve	GN 1½" (DN40) – DN40	32.8	3.8
5151.400		GN 2" (DN50) – DN20	11.1	2.1
5151.410		GN 2" (DN50) – DN25	16.2	2.4
5151.420		GN 2" (DN50) – DN32	25.4	2.6
5151.430		GN 2" (DN50) – DN40	32.8	3.8
5151.440		GN 2" (DN50) – DN50	63.4	2.5
5151.500		GN 2½" (DN65) – DN25	16.2	2.4
5151.510		GN 2½" (DN65) – DN32	25.4	2.6
5151.520		GN 2½" (DN65) – DN40	32.8	3.8
5151.530		GN 2½" (DN65) – DN50	63.4	2.5
5151.540		GN 2½" (DN65) – DN65	82.3	4.2

Product description
The JRGUSIT NG is a distribution valve with pre-assembled screw connection in the stem and its upper part does not exhibit any dead spaces. The valve can be used as distributor and collector.

Features and functions
The distribution valve has a threaded connection on both sides for mounting a drain valve. The valve comes with plugs. The stem sizes from DN25 to DN65 enable solutions for single to multiple dwellings as well as larger properties.

Benefits and features
- Time savings due to fast assembly
- Modular system, flexible and combinable
- No sealing of the connections
- Stem and outlets - threaded version of BR 1
- Minor pressure loss at the outlet
- Upper part without dead space and continuously smooth operation
- Can be used as distributor and collector

Mounting position and installation tips
During assembly, the pre-installed screw connection eliminates the need for elaborate sealing work.
The JRGUSIT NG can be installed regardless of its position.

Installation instructions
☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Spare parts
- Upper part JRGUSIT NG
- Profile seals

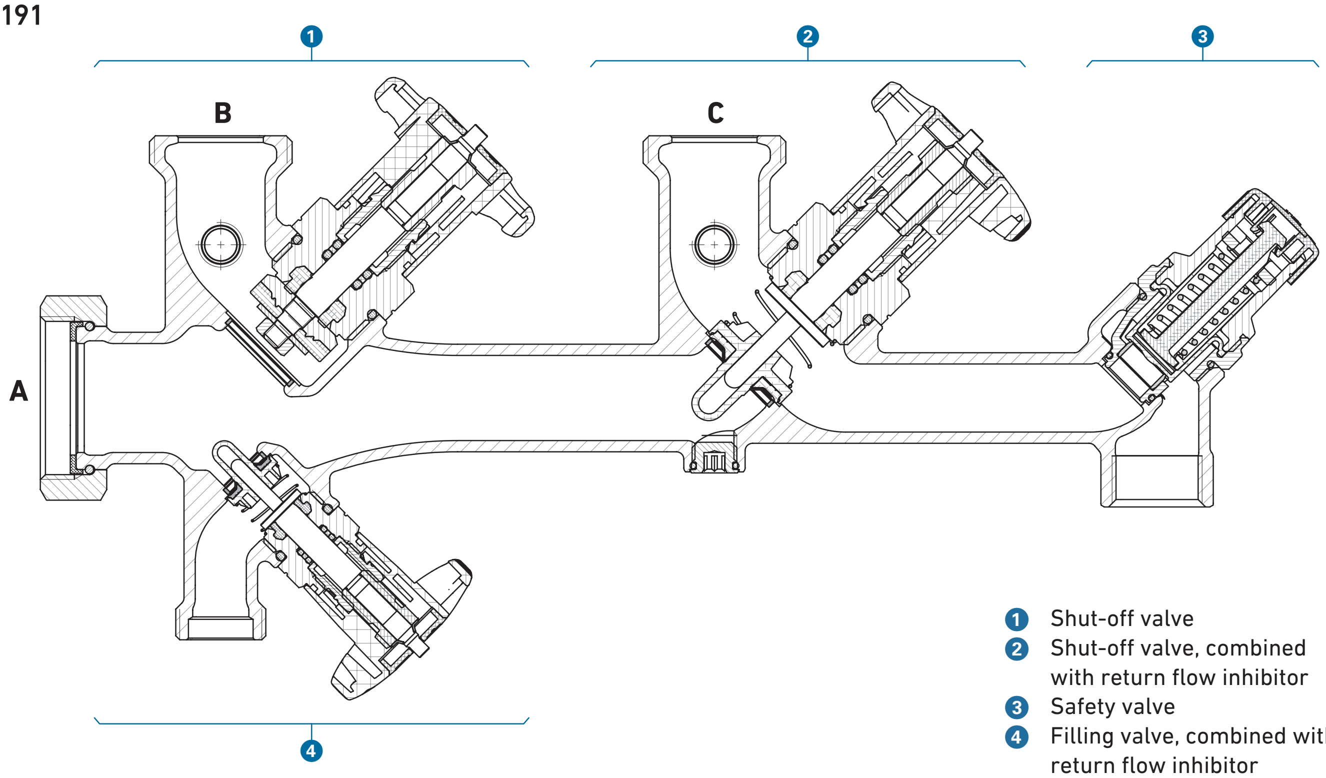
Reduction valve JRGUSIT Combi JRG LegioStop 5191

The JRGUSIT Combi Reduction valve combines different single valves in a compact unit.
The JRGUSIT Combi Reduction valve allows the distribution, shut-off and emptying the system and prevents backflow.

Technical Data

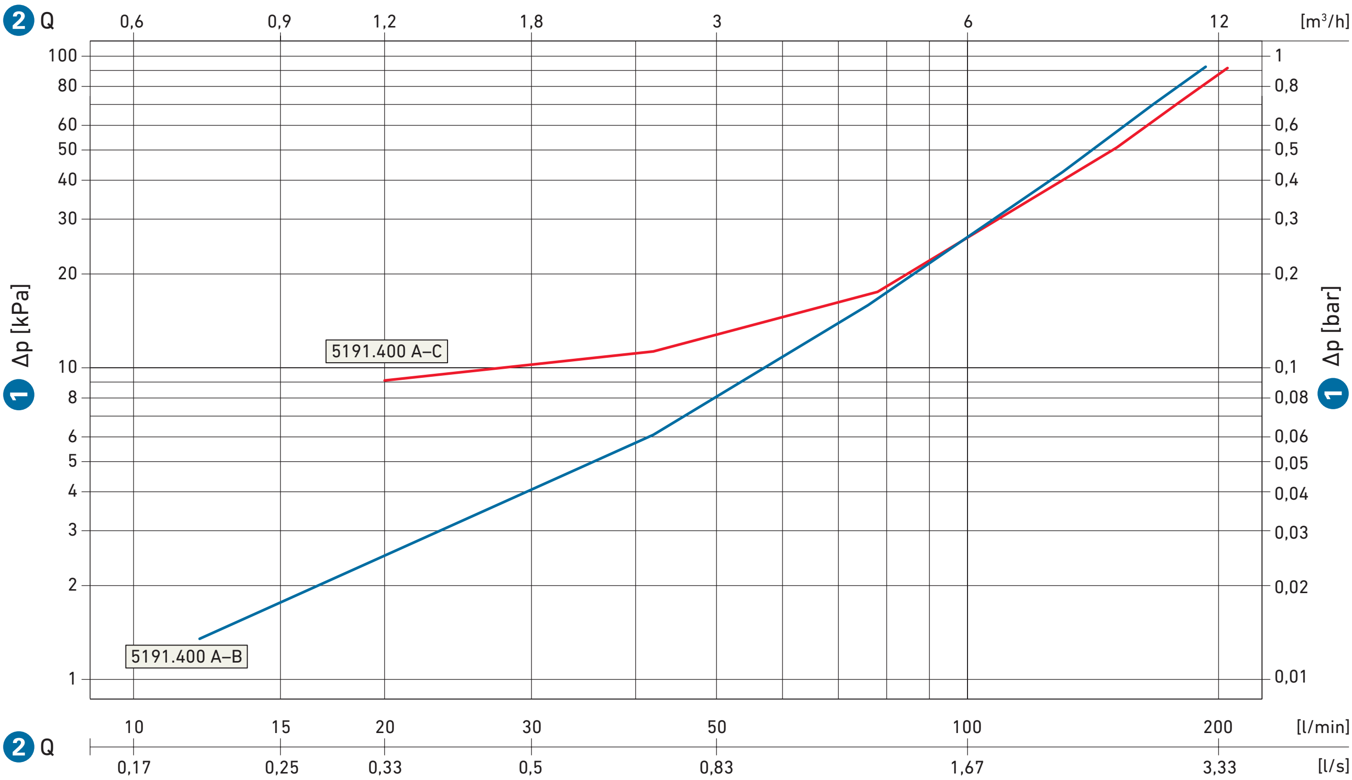
JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Factory setting [kPa (bar)]	Connections
5191	1"-1"-1" (DN25–25–25) 1¼"-1"-1" (DN32–25–25)	16	90	600 (6.0)	Inlet: Female thread Outlet: Pipe threads

5191

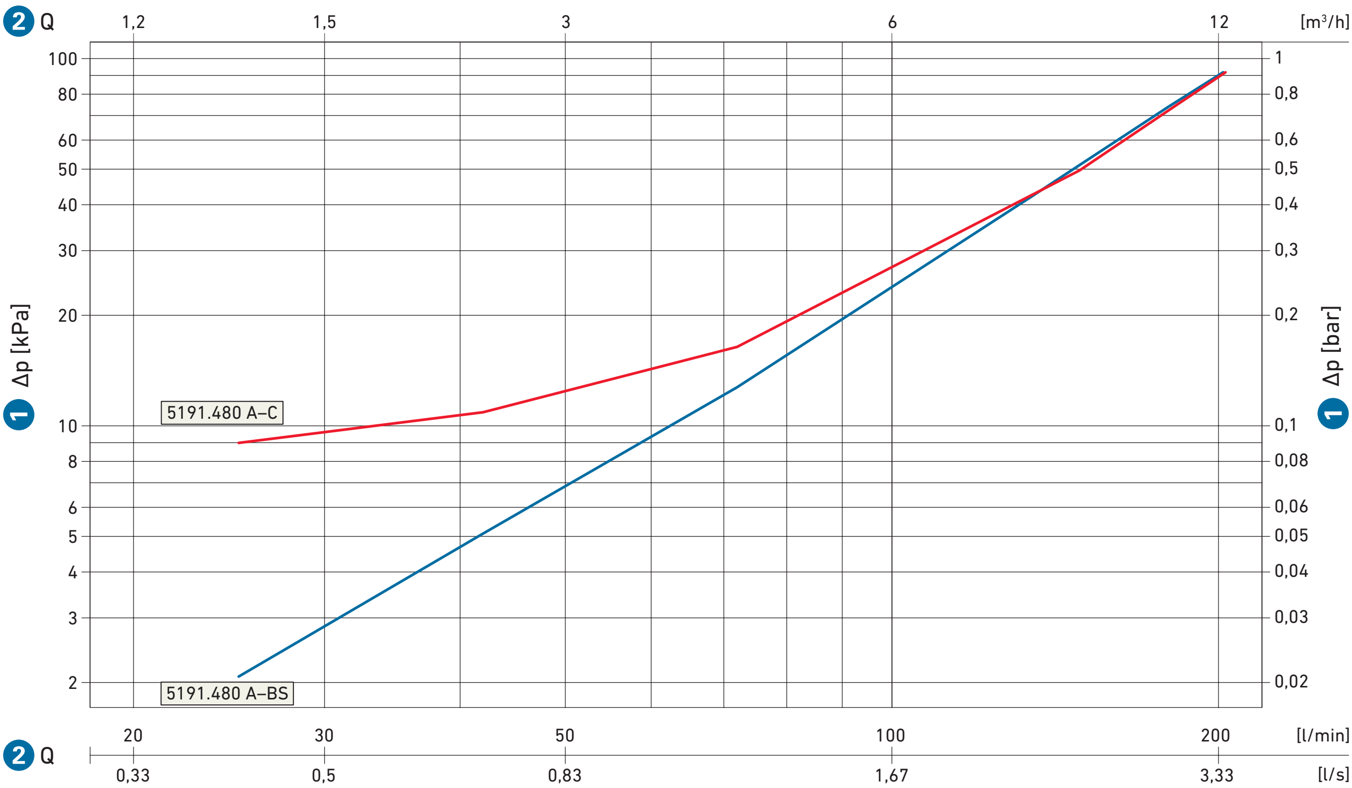


1. Shut-off valve
2. Shut-off valve, combined with return flow inhibitor
3. Safety valve
4. Filling valve, combined with return flow inhibitor

Performance chart



1 Pressure loss
2 Volumetric flow rate



1 Pressure loss
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN25–25–25	I
DN32–25–25	I

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5191.400	Distribution valve • Cold water range	GN 1" –1" –1" (DN25–25–25)	11.9	4.4
5191.400	Distribution valve • Cold water outlet to the DHW heater	GN 1" –1" –1" (DN25–25–25)	12.1	4.3
5191.480	Distribution valve • Cold water range	GN 1¼"–1" –1" (DN32–25–25)	11.9	4.4
5191.480	Distribution valve • Cold water outlet to the DHW heater	GN 1¼" –1" –1" (DN32–25–25)	12.1	4.3

Product description

The JRGUSIT Combi Reduction valve combines different single valves in a compact unit. The JRGUSIT Combi Reduction valve allows the distribution, shut-off and emptying the system and prevents backflow.

Features and functions

The valve combines various individual valves and their functions:

- Cold water outlet with y-type valve
- Cold water outlet to the DHW heater with y-type valve and return flow inhibitor
- Safety valve
- Heater filling valve with return flow inhibitor
- Drain valves
- Test and discharge plug

The fitting can be used to fill a heater. In addition, it can be used as a safety fitting for the DHW heater.

Benefits and features

- Using standard upper parts makes the device service-friendly
- Designed to ensure low pressure losses
- Clear and logical arrangement of the shut-off valves
- Connection to all pipe systems
- Time savings during assembly

Mounting position and installation tips

☑ The JRGUSIT Combi must be installed horizontally and tension must be avoided.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Spare parts

- Upper parts of shut-off and safety valve
- Hand wheels
- Drain valve
- Cap

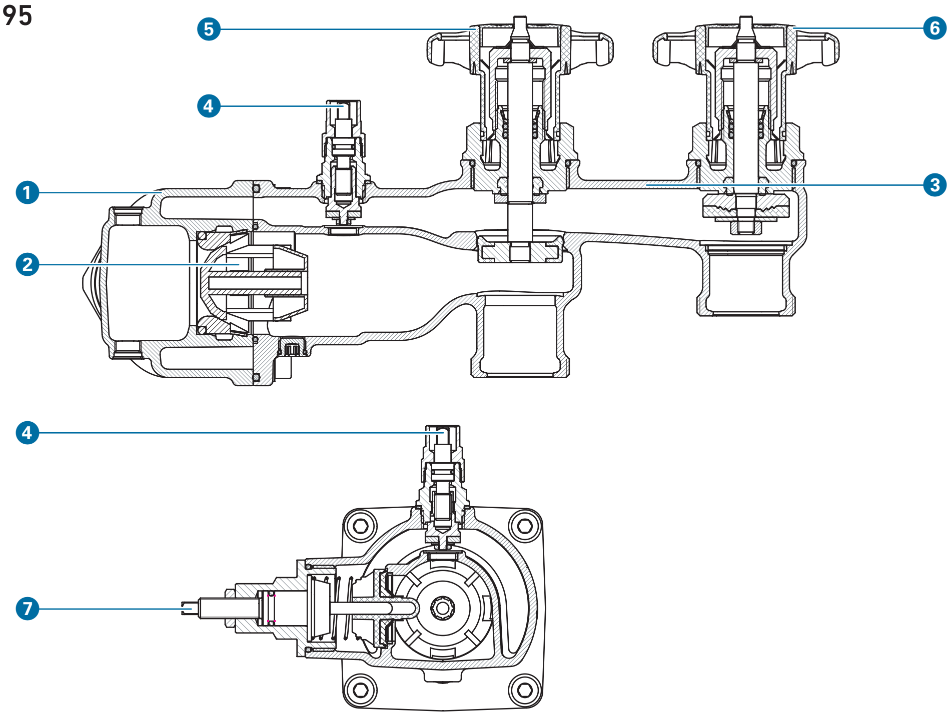
JRG Bypass mixing valve 5195, 5198

The JRG Bypass mixing valve is a compact mixing valve for drinking water installations. It consists of a return flow inhibitor as well as the reversing, shut-off and control valves for raw water admixture.

Technical Data

JRG code	Components	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
5195	• Connecting piece • Bypass • Shut-off valve • Raw water admixture • Return flow inhibitor	GN 1" – 2" (DN25 – 50)	16	65 (briefly 90)	External thread
5198	• **without** connecting piece • Bypass • Shut-off valve • Raw water admixture • Return flow inhibitor	GN 1" / 1¼" (DN25 / 32) GN 1½" / 2" (DN40 / 50)			

5195

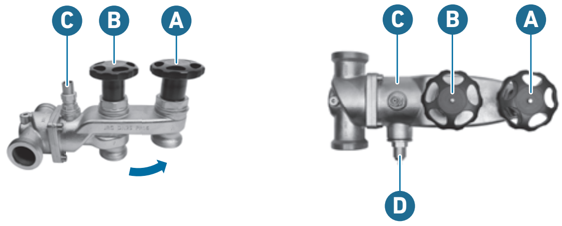


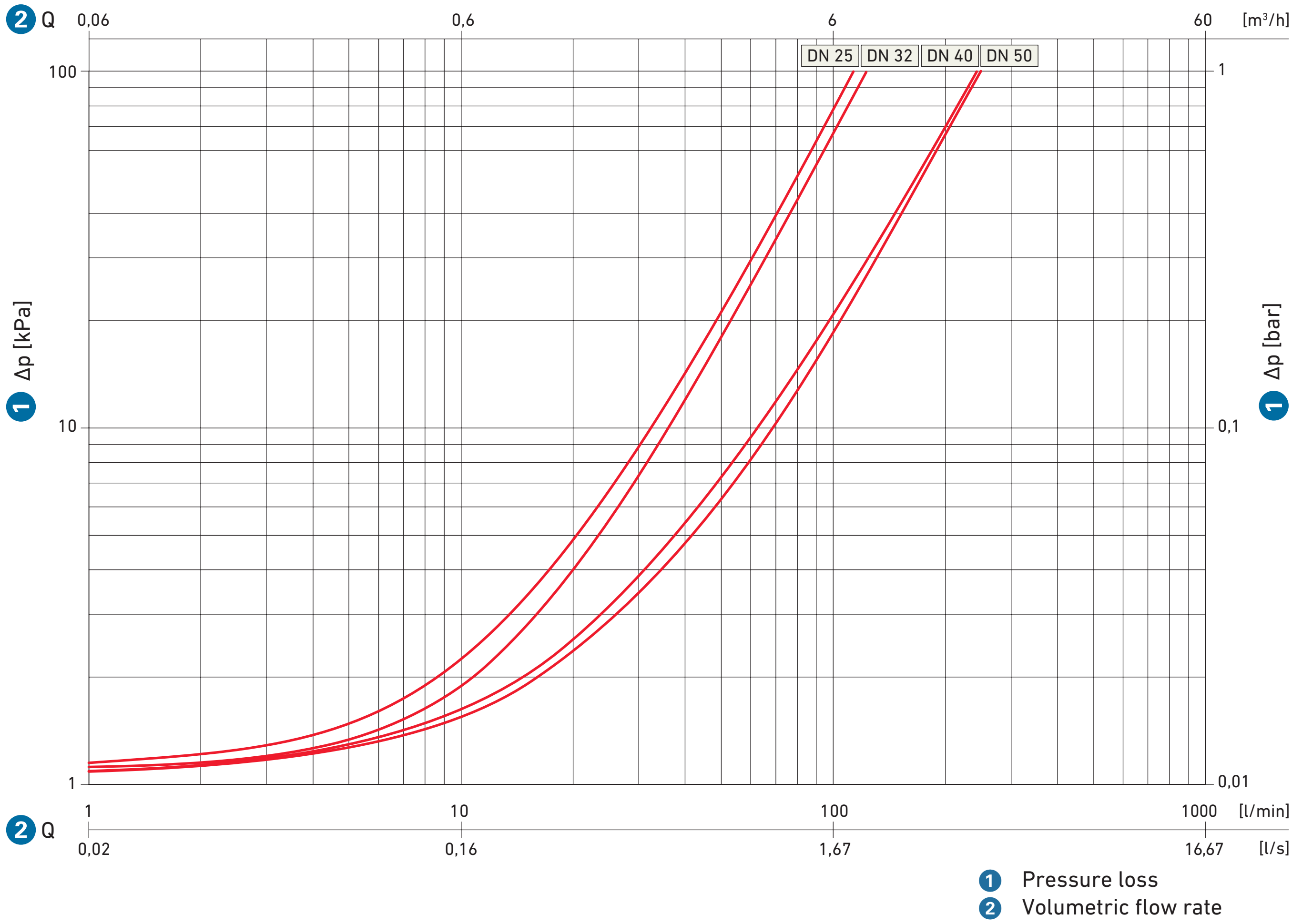
1. Connecting piece
2. Return flow inhibitor
3. Housing of bypass mixing valve
4. Raw water admixture (DN25 – DN50)
5. Reversing valve
6. Shut-off valve
7. Volume-controlled raw water admixture (DN40/DN50)

Performance chart

State 1

- Valve A/B open
- Raw water admixture valve C/D closed

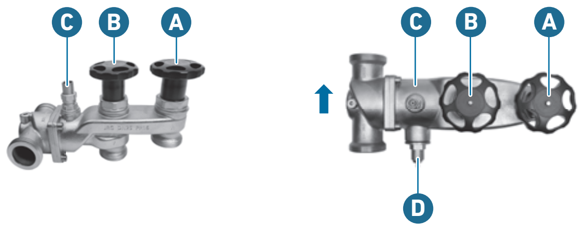


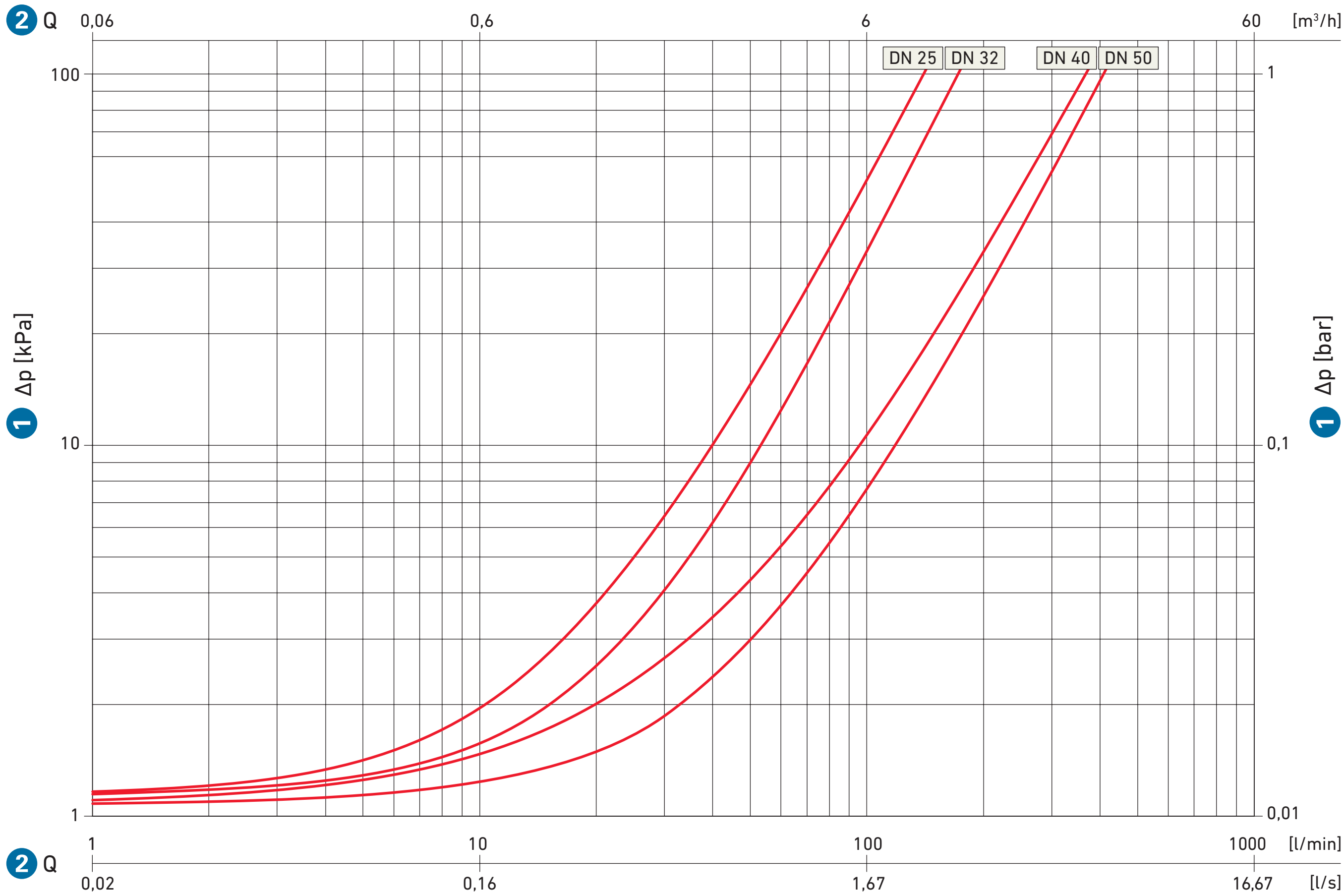


Performance chart

State 2

- Valves A/B closed
- Raw water admixture valve C/D closed





1 Pressure loss
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN25 – 32	II

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5195.025	JRG Bypass mixing valve	GN 1" (DN25)	6.3	15.7
5195.032		GN 1¼" (DN32)	7.2	32.4
5195.040		GN 1½" (DN40)	13.2	23.5
5195.050		GN 2" (DN50)	14.2	49.6

Product description

The JRG Bypass mixing valve is a compact mixing valve for drinking water installations. It consists of a return flow inhibitor as well as the reversing, shut-off and control valves for raw water admixture.

Features and functions

The volume-controlled mixing of raw water serves to feed untreated water into the network to a limited extent and thus absorb the pressure fluctuation to a certain magnitude.
This makes sense with larger volumetric flows and the associated greater pressure drop across the connected water treatment system.
Versions DN40 and DN50 have—in addition to the static admixture—a volume controlled raw water admixture.
This admixture is used for the connection of water treatment systems, such as softening systems. On the one hand, raw water can be added to the treated water and, on the other hand, if necessary, the connected water treatment system can be disconnected from the network without interrupting the supply of the downstream equipment and system components.

Benefits and features

- Maintenance tasks on the water treatment system without interrupting the distribution
- Volume-controlled raw water addition for DN40 and DN50
- Suitable for JRGUSIT NG Distribution valve
- Same installation length and connection size as JRGURED, JRGURED Combi and JRG CleanLine Combi

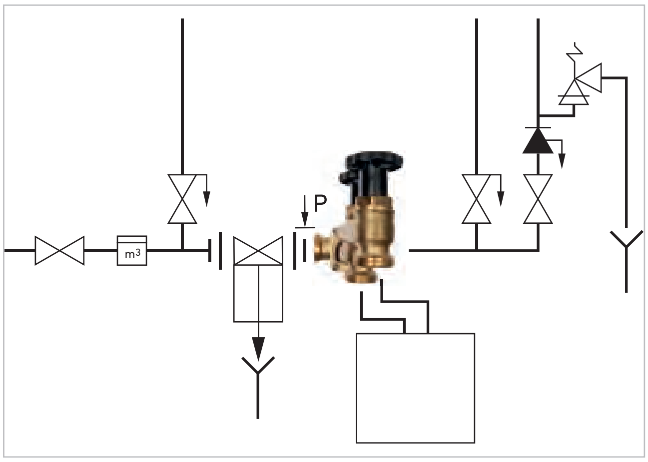
Mounting position and installation tips

The JRG Bypass mixing valve can be installed regardless of its position.

☑ When installing connecting pieces for the JRG Bypass mixing valve, tension must be avoided.

☑ All piping to/from water treatment systems must be installed without causing any tension.

Installation example



GV.34 **Installation diagram**

Installation instructions

☑ When installing the JRG Bypass mixing valve and the connected water treatment system: Compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents

- Assembly and operating instructions

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts

- Upper parts
- Return flow inhibitor
- O-ring set

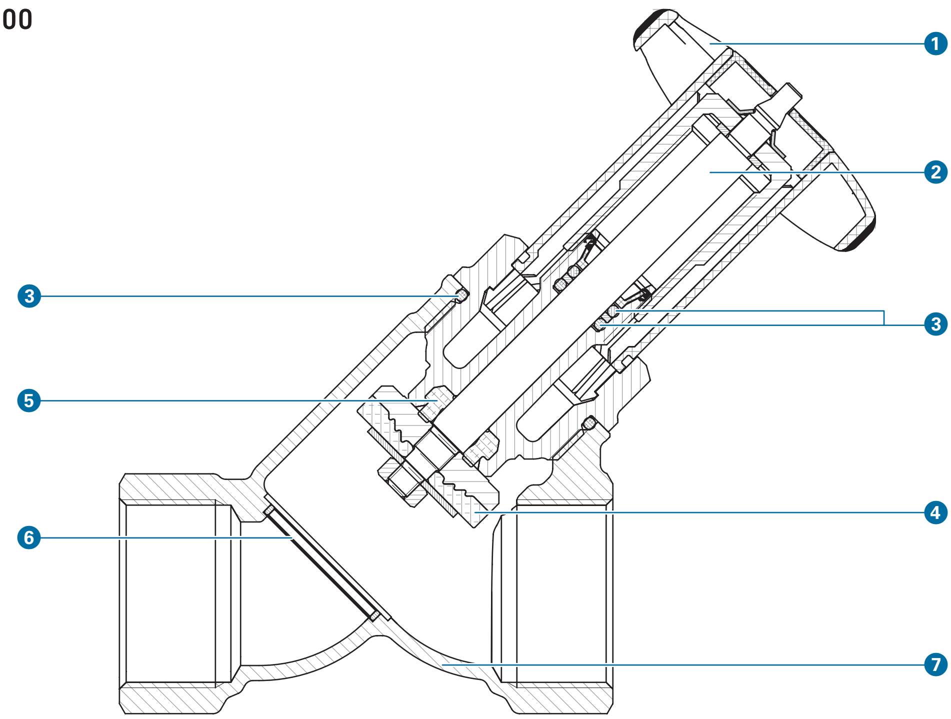
Y-type valve JRG LegioStop 5200 – 5208

The y-type valve JRG LegioStop is a shut-off valve designed without dead space.

Technical Data

JRG code	Dimension	Nominal pressure PN	Temperature max [°C]	Connections
5200	GN ½" – 3" (DN15 – 80)	16	90	Female pipe thread
5204	GN 1" – 3" (DN25 – 80)			Flange SN EN 1092
5207	d15 – d54 (DN12 – 50)			Optipress/Sanpress
5208	d15 – d88,9 (DN12 – 80)			Mapress

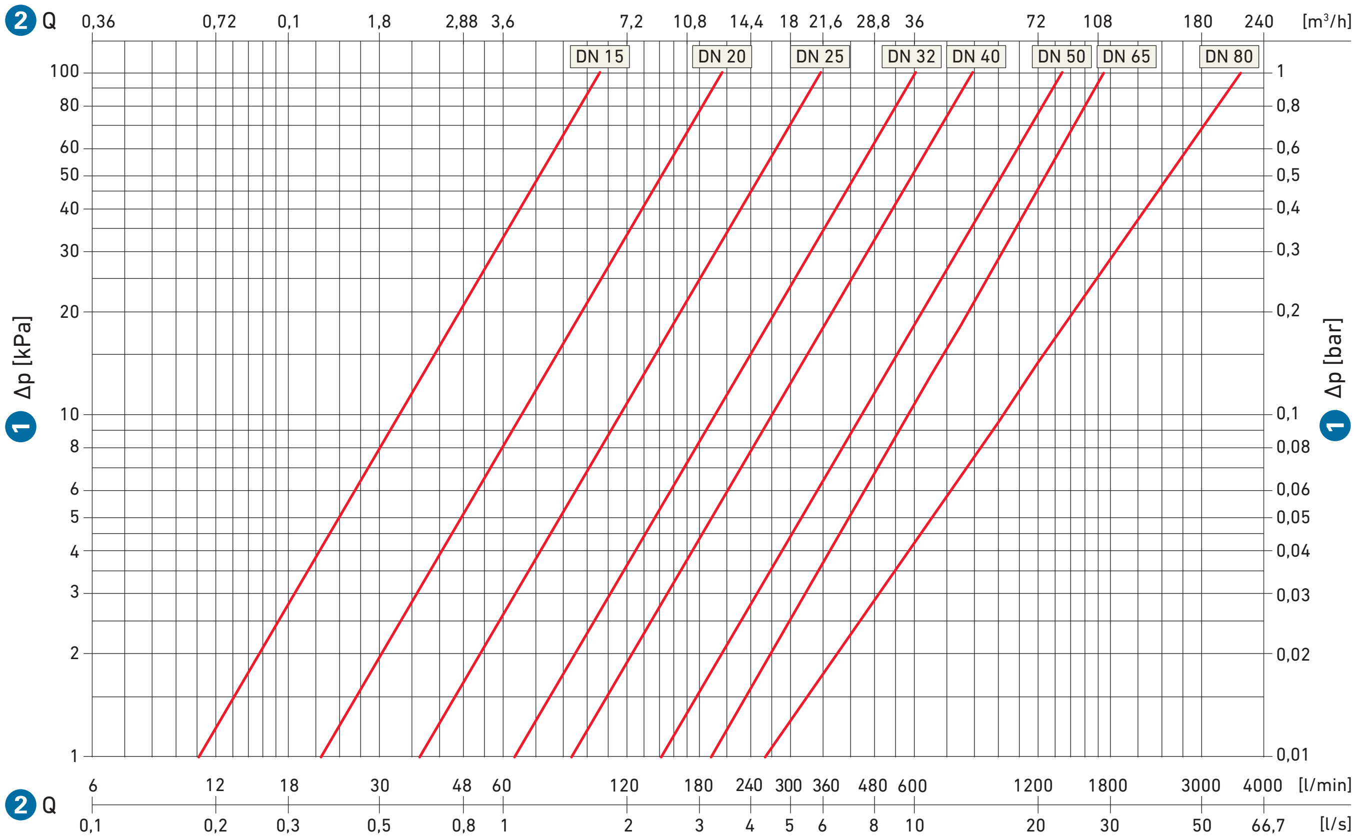
5200



1. Handwheel
2. Valve rods
3. O-ring
4. Valve seal
5. Backflow seal
6. Valve seat
7. Housing

V

Performance chart



1 Pressure loss
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN15 – 32	I

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5200.240	Y-type valve • Female pipe thread	GN ½" (DN15)	6.2	2.1
5200.320		GN ¾" (DN20)	12.3	1.7
5200.400		GN 1" (DN25)	20.5	1.5
5200.480		GN 1¼" (DN32)	34.8	1.4
5200.560		GN 1½" (DN40)	50.3	1.6
5200.640		GN 2" (DN50)	83.3	1.4
5200.720		GN 2½" (DN65)	106.0	2.5
5200.800		GN 3" (DN80)	225.3	1.3
5204.025	Y-type valve • Flange connection	GN 1" (DN25)	20.5	1.5
5204.032		GN 1¼" (DN32)	34.8	1.4
5204.040		GN 1½" (DN40)	50.3	1.6
5204.050		GN 2" (DN50)	83.3	1.4
5204.065		GN 2½" (DN65)	106.0	2.5
5204.080		GN 3" (DN80)	225.3	1.3
5207.015	Y-type valve • Optipress/Sanpress	d15 (DN12)	6.1	0.9
5207.018		d18 (DN15)	6.2	2.1
5207.022		d22 (DN20)	12.3	1.7
5207.028		d28 (DN25)	20.5	1.5
5207.035		d35 (DN32)	34.8	1.4
5207.042		d42 (DN40)	50.3	1.6
5207.054		d54 (DN50)	83.3	1.4

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5208.015	Y-type valve • Mapress	d15 (DN12)	6.1	0.9
5208.018		d18 (DN15)	6.2	2.1
5208.022		d22 (DN20)	12.3	1.7
5208.028		d28 (DN25)	20.5	1.5
5208.035		d35 (DN32)	34.8	1.4
5208.042		d42 (DN40)	50.3	1.6
5208.054		d54 (DN50)	83.3	1.4

Product description

The y-type valve JRG LegioStop is a shut-off valve designed without dead space.

Features and functions

The valve is designed without dead space and separates the medium and the mechanical parts of the valve. This helps to prevent the formation of biofilm and legionella growth. Thus, the valve meets today's hygiene requirements applicable to drinking water installations.

Benefits and features

- Separation between the medium and mechanical parts of the valve
- Honed valve rod made of chromium-nickel steel
- Backflow sealing
- Free of dead spaces
- Smooth-running
- Non-rising handwheel
- Interchangeable medium marking plate
- Valve position can be seen and felt by touch
- Upper parts compatible with earlier JRG Valve bodies and other valve bodies (DIN 3502)
- Valve seat made of stainless steel

Mounting position and installation tips

The JRG LegioStop Y-type valve can be installed regardless of its position.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Spare parts

- Upper part of JRG LegioStop
- Handwheel made of plastic (including green marker sign)
- Marker sign (available in green, red, blue and orange)

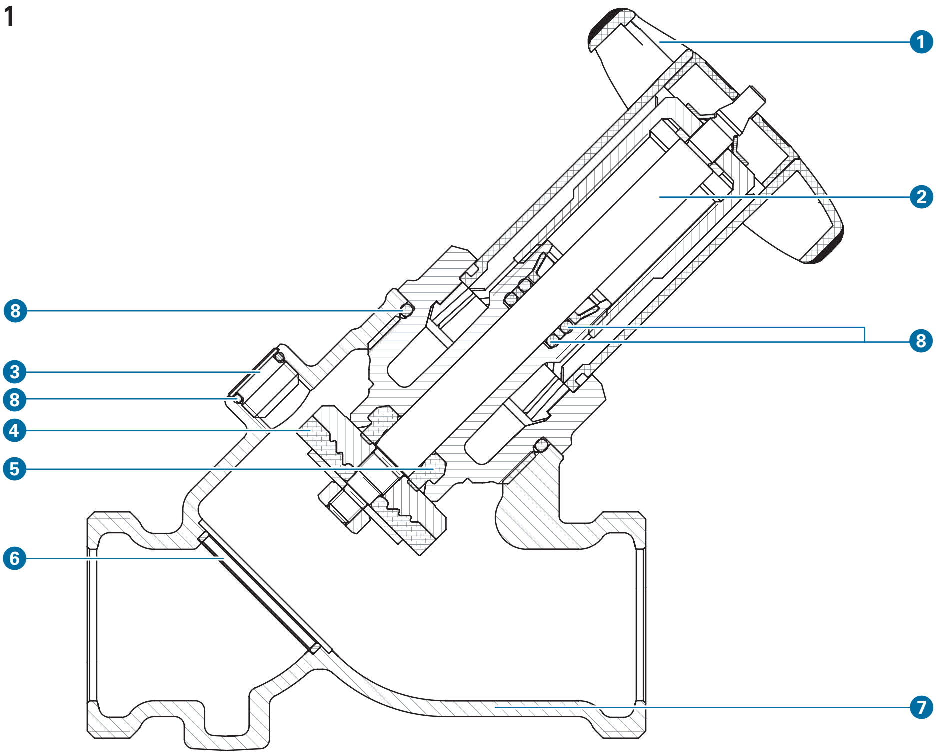
Y-type valve JRG LegioStop 5211 – 5234

The y-type valve JRG LegioStop is a shut-off valve designed without dead space.

Technical Data

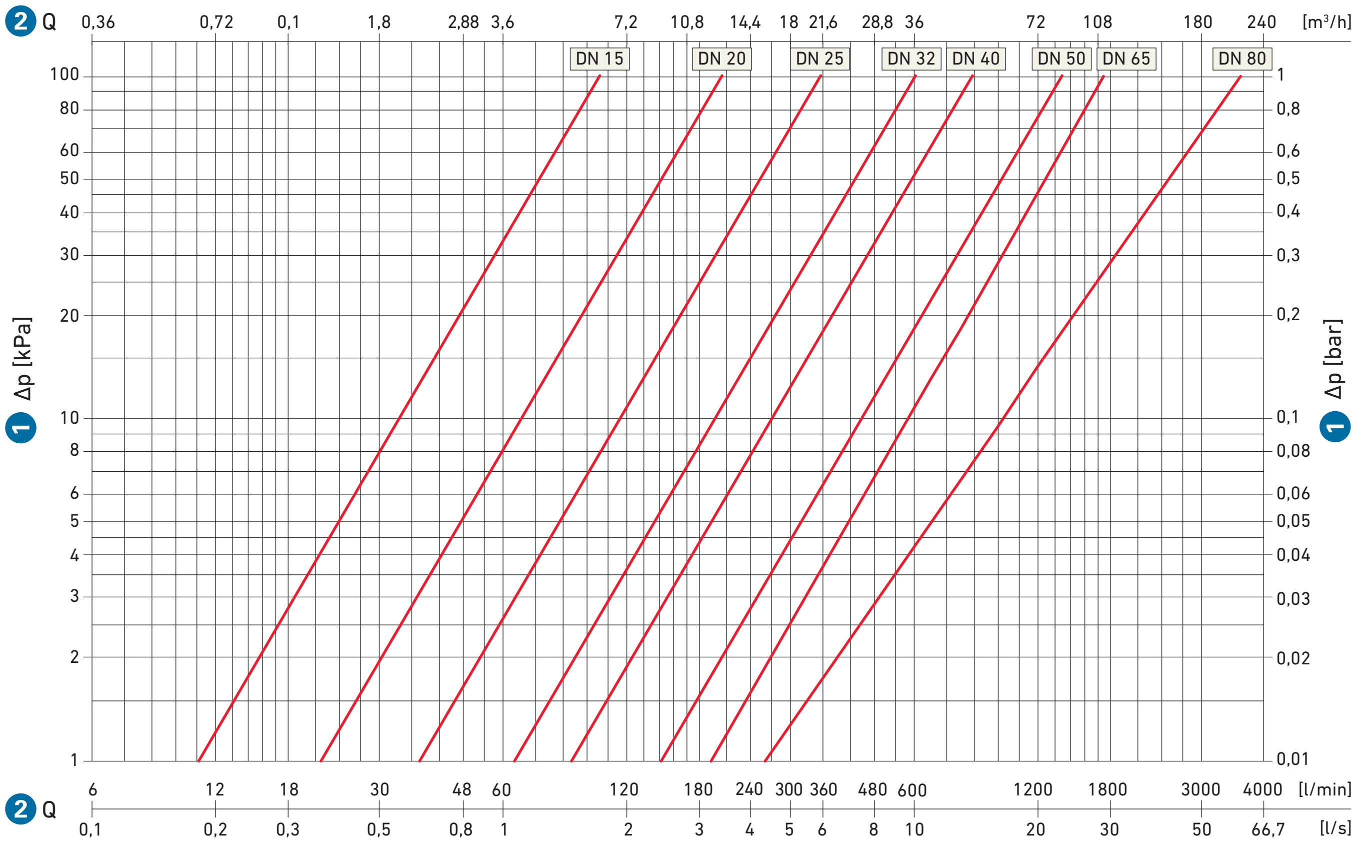
JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
5211	GN ½" – 3" (DN15 – 80)	16	90	Pipe threads
5213	d15 – d54 (DN12 – 50)			Pipe thread, Mapress threaded connection
5220	GN 1" – 3" (DN25 – 80)			Flange SN EN 1092
5221	GN ½" – 3" (DN15 – 80)			Female pipe thread
5222	d16 – d63 (DN12 – 50)			JRG Sanipex MT
5225	d15 – d54 (DN12 – 50)			Push-fit
5227	d15 – d54 (DN12 – 50)			Optipress/Sanpress
5228	d15 – d88,9 (DN12 – 80)			Mapress
5229	d16 – d63 (DN12 – 50)			Mepla
5234	d15 – d54 (DN12 – 50)			Pipe thread, Optipress/ Sanpress threaded connection

5211



1. Handwheel
2. Valve rods
3. Connection for drain valve
4. Valve seal
5. Backflow seal
6. Valve seat
7. Housing
8. O-ring

Performance chart



1 Pressure loss
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN20 – 32	I

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5211.015	Y-type valve • Pipe threads	GN ½" (DN15)	6.2	2.1
5211.020		GN ¾" (DN20)	12.3	1.7
5211.025		GN 1" (DN25)	20.5	1.5
5211.032		GN 1¼" (DN32)	34.8	1.4
5211.040		GN 1½" (DN40)	50.3	1.6
5211.050		GN 2" (DN50)	83.3	1.4
5211.065		GN 2½" (DN65)	106.0	2.5
5211.080		GN 3" (DN80)	225.3	1.3
5213.015	Y-type valve • Pipe thread, Mapress threaded connection	d15 (DN12)	6.2	0.9
5213.018		d18 (DN15)	6.2	2.1
5213.022		d22 (DN20)	12.3	1.7
5213.028		d28 (DN25)	20.5	1.5
5213.035		d35 (DN32)	34.8	1.4
5213.042		d42 (DN40)	50.3	1.6
5213.054		d54 (DN50)	83.3	1.4
5220.025	Y-type valve • Flange connection	GN 1" (DN25)	20.5	1.5
5220.032		GN 1¼" (DN32)	34.8	1.4
5220.040		GN 1½" (DN40)	50.3	1.6
5220.050		GN 2" (DN50)	83.3	1.4
5213.065		GN 2½" (DN65)	106.0	2.5
5220.080		GN 3" (DN80)	225.3	1.3

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5221.240	Y-type valve • Female pipe thread	GN ½" (DN15)	6.2	2.1
5221.320		GN ¾" (DN20)	12.3	1.7
5221.400		GN 1" (DN25)	20.5	1.5
5221.480		GN 1¼" (DN32)	34.8	1.4
5221.560		GN 1½" (40	50.3	1.6
5221.640		GN 2" (DN50)	83.3	1.4
5221.720		GN 2½" (DN65)	106.0	2.5
5221.800		GN 3" (DN80)	225.3	1.3
5222.016	Y-type valve • JRG Sanipex MT	d16 (DN12)	6.2	0.9
5222.020		d20 (DN15)	6.2	2.1
5222.026		d26 (DN20)	12.3	1.7
5222.032		d32 (DN25)	20.5	1.5
5222.040		d40 (DN32)	34.8	1.4
5222.050		d50 (DN40)	50.3	1.6
5222.063		d63 (DN50)	83.3	1.4
5225.015	Y-type valve • Push-fit	d15 (DN12)	6.2	0.9
5225.018		d18 (DN15)	6.2	2.1
5225.022		d22 (DN20)	12.3	1.7
5225.028		d28 (DN25)	20.5	1.5
5225.035		d35 (DN32)	34.8	1.4
5225.042		d42 (DN40)	50.3	1.6
5225.054		d54 (DN50)	83.3	1.4
5227.015	Y-type valve • Optipress/Sanpress	d15 (DN12)	6.2	0.9
5227.018		d18 (DN15)	6.2	2.1
5227.022		d22 (DN20)	12.3	1.7
5227.028		d28 (DN25)	20.5	1.5
5227.035		d35 (DN32)	34.8	1.4
5227.042		d42 (DN40)	50.3	1.6
5227.054		d54 (DN50)	83.3	1.4
5228.015	Y-type valve • Mapress	d15 (DN12)	6.2	0.9
5228.018		d18 (DN15)	6.2	2.1
5228.022		d22 (DN20)	12.3	1.7
5228.028		d28 (DN25)	20.5	1.5
5228.035		d35 (DN32)	34.8	1.4
5228.042		d42 (DN40)	50.3	1.6
5228.054		d54 (DN50)	83.3	1.4
5229.016	Y-type valve • Mepla	d16 (DN12)	6.2	0.9
5229.020		d20 (DN15)	6.2	2.1
5229.026		d26 (DN20)	12.3	1.7
5229.032		d32 (DN25)	20.5	1.5
5229.040		d40 (DN32)	34.8	1.4
5229.050		d50 (DN40)	50.3	1.6
5229.063		d63 (DN50)	83.3	1.4
5234.015	Y-type valve • Pipe thread, Optipress/Sanpress threaded connection	d15 (DN12)	6.2	0.9
5234.018		d18 (DN15)	6.2	2.1
5234.022		d22 (DN20)	12.3	1.7
5234.028		d28 (DN25)	20.5	1.5
5234.035		d35 (DN32)	34.8	1.4
5234.042		d42 (DN40)	50.3	1.6
5234.054		d54 (DN50)	83.3	1.4

Product description

The y-type valve JRG LegioStop is a shut-off valve designed without dead space.

Features and functions

The valve is designed without dead space and separates the medium and the mechanical parts of the valve. This helps to prevent the formation of biofilm and legionella growth. Thus, the valve meets today's hygiene requirements applicable to drinking water installations.

Benefits and features

- Separation between the medium and mechanical parts of the valve
- Honed valve rod made of chromium-nickel steel
- Backflow sealing
- Free of dead spaces
- Smooth-running
- Non-rising handwheel
- Interchangeable medium marking plate
- Valve position can be seen and felt by touch
- Upper parts compatible with earlier JRG Valve bodies and other valve bodies (DIN 3502)
- Valve seat made of stainless steel

Mounting position and installation tips

The JRG LegioStop Y-type valve can be installed regardless of its position.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Spare parts

- Upper part of JRG LegioStop
- Handwheel made of plastic (including green marker sign)
- Marker sign (available in green, red, blue and orange)
- Items of the plug connection (applicable to JRG code 5225)
- Plug

V

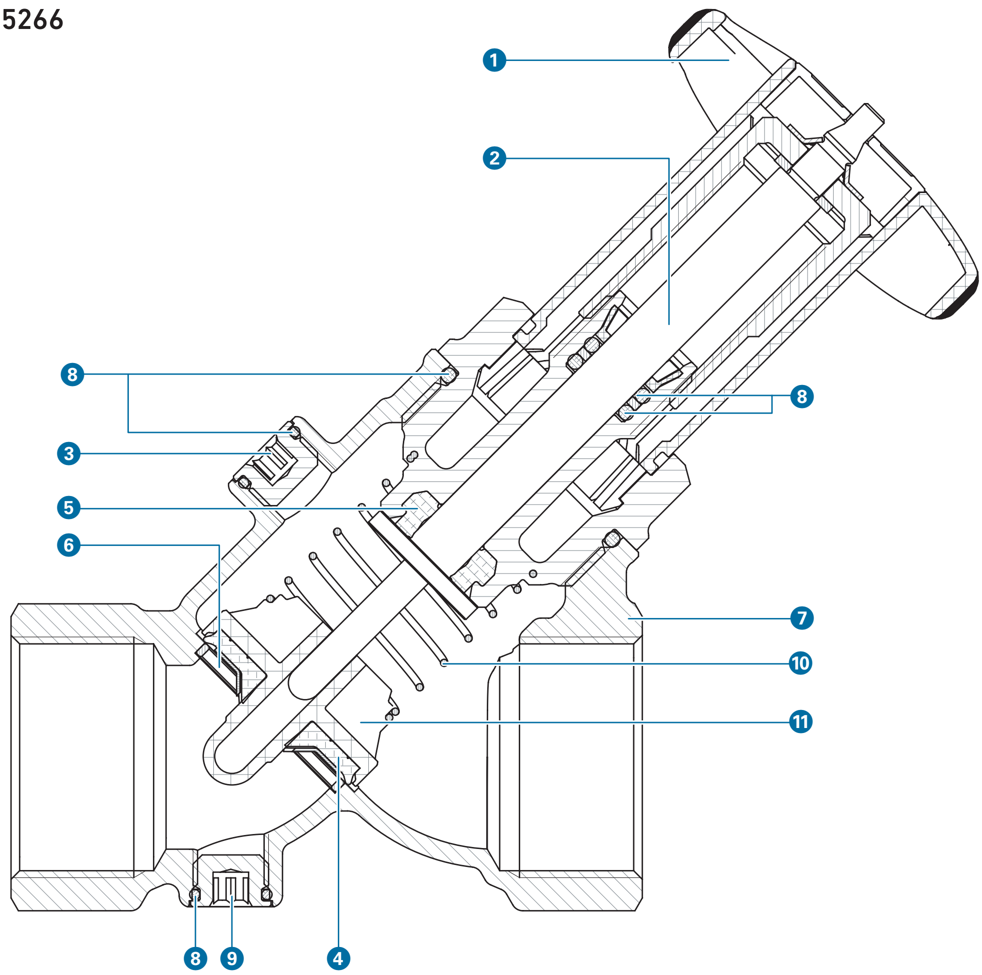
JRG LegioStop KRV lockable 5262 – 5284

The lockable JRG LegioStop KRV is a combined fitting consisting of a shut-off valve and a return flow inhibitor of type EA. The return flow inhibitor is controllable acc. to EN 13959. The mechanical safety valve allows flow in only one direction.

Technical Data

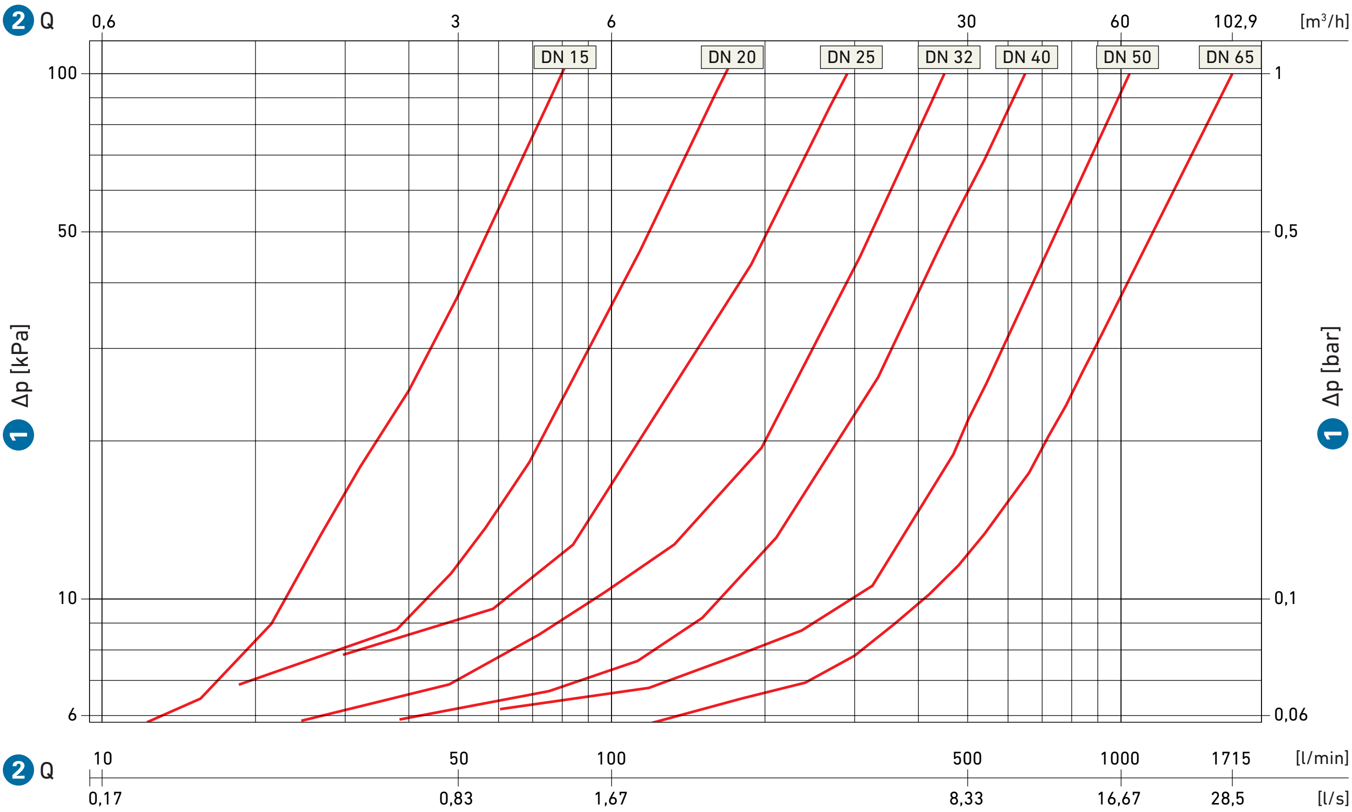
JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
5262	d16 – d63 (DN12 – 50)	10	90	JRG Sanipex MT
5265	d15 – d54 (DN12 – 50)			Push-fit
5266	GN ½" – GN 2½" (DN15 – 65)	16		Female pipe thread
5281				Pipe threads
5283	d15 – d54 (DN12 – 50)			Mapress
5284				Sanpress/Optipress

5266



1. Handwheel
2. Valve rods
3. Connection for drain valve
4. Valve seal
5. Backflow seal
6. Valve seat
7. Housing
8. O-ring
9. Test socket
10. Compression spring
11. Flow body

Performance chart



1 Pressure loss
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN15 – 32	I

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5262.016	Y-type valve • JRG Sanipex MT	d16 (DN12)	3.5	2.7
5262.020		d20 (DN15)	3.5	6.6
5262.026		d26 (DN20)	7.0	5.2
5262.032		d32 (DN25)	10.8	5.4
5262.040		d40 (DN32)	20.0	4.2
5262.050		d50 (DN40)	28.8	4.9
5262.063		d63 (DN50)	47.0	4.5
5265.015	Y-type valve • Push-fit	d15 (DN12)	3.5	2.7
5265.018		d18 (DN15)	3.5	6.6
5265.022		d22 (DN20)	7.0	5.2
5265.028		d28 (DN25)	10.8	5.4
5265.035		d35 (DN32)	20.0	4.2
5265.042		d42 (DN40)	28.8	4.9
5265.054		d54 (DN50)	47.0	4.5
5266.240	Y-type valve • Female pipe thread	GN ½" (DN15)	3.5	2.7
5266.320		GN ¾" (DN20)	3.5	6.6
5266.400		GN 1" (DN25)	7.0	5.2
5266.480		GN 1¼" (DN32)	10.8	5.4
5266.560		GN 1½" (40	20.0	4.2
5266.640		GN 2" (DN50)	28.8	4.9
5266.720		GN 2½" (DN65)	102,9	2,7

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5211.015	Y-type valve • Pipe threads	GN ½" (DN15)	3.5	6.6
5211.020		GN ¾" (DN20)	7.0	5.2
5211.025		GN 1" (DN25)	10.8	5.4
5211.032		GN 1¼" (DN32)	20.0	4.2
5211.040		GN 1½" (DN40)	28.8	4.9
5211.050		GN 2" (DN50)	47.0	4.5
5211.065		GN 2½" (DN65)	102,9	2,7
5228.015	Y-type valve • Mapress	d15 (DN12)	3.5	2.7
5228.018		d18 (DN15)	3.5	6.6
5228.022		d22 (DN20)	7.0	5.2
5228.028		d28 (DN25)	10.8	5.4
5228.035		d35 (DN32)	20.0	4.2
5228.042		d42 (DN40)	28.8	4.9
5228.054		d54 (DN50)	47.0	4.5
5227.015	Y-type valve • Sanpress/Optipress	d15 (DN12)	3.5	2.7
5227.018		d18 (DN15)	3.5	6.6
5227.022		d22 (DN20)	7.0	5.2
5227.028		d28 (DN25)	10.8	5.4
5227.035		d35 (DN32)	20.0	4.2
5227.042		d42 (DN40)	28.8	4.9
5227.054		d54 (DN50)	47.0	4.5

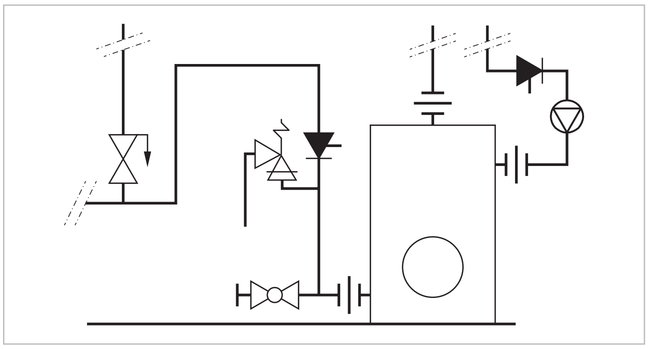
Product description
The lockable JRG LegioStop KRV is a combined fitting consisting of a shut-off valve and a return flow inhibitor of type EA.
The return flow inhibitor is controllable acc. to EN 13959.
The mechanical safety valve allows flow in only one direction.

Features and functions
When opened, the integrated return flow inhibitor automatically opens when the pressure on the inlet side is greater than the pressure downstream of the valve. If the pressure downstream of the fitting is higher, or there is no flow, force is applied and the fitting closes automatically.

Benefits and features
- Strict separation between the medium and mechanical parts of the shut-off valve
- Honed valve rod made of chromium-nickel steel
- Backflow sealing
- Free of dead spaces
- Smooth-running
- Non-rising handwheel
- Interchangeable medium marking plate
- Valve position can be seen and felt by touch
- Upper parts compatible with earlier JRG Valve bodies and other valve bodies (DIN 3502)
- Valve seat made of stainless steel
- Low opening resistance and pressure loss

Mounting position and installation tips
The lockable JRG LegioStop KRV valve can be installed regardless of its position.
However, for inspection purposes, it is advisable to provide sufficient clearance in the area of the upper part.

Installation instructions
☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Installation examples


GV.35 **Installation diagram**

Spare parts
- Upper part for KRV lockable

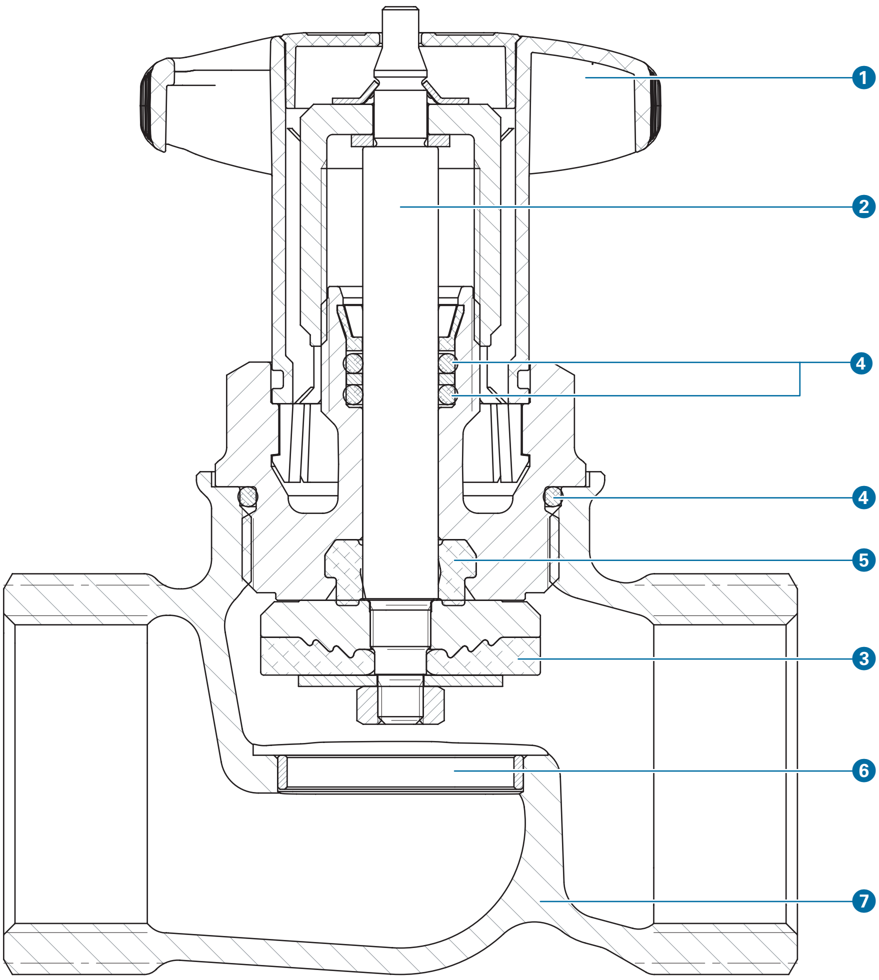
JRG LegioStop Straight seat valve 5350 – 5359

The straight seat valve JRG LegioStop is a shut-off valve designed without dead space.

Technical Data

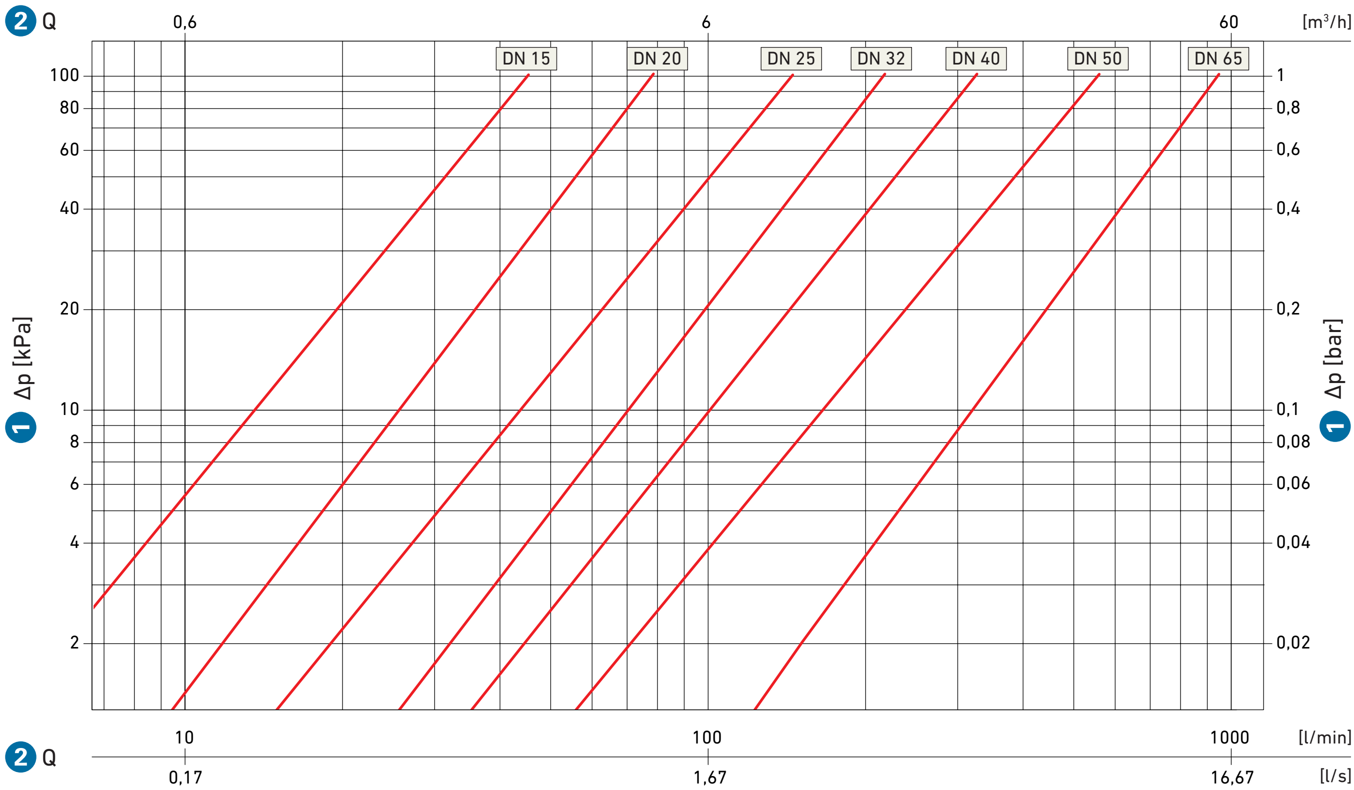
JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
5350	GN ½" – 2½" (DN15 – 65)	16	90	Female pipe thread
5351	GN 1" – 2½" (DN25 – 65)			Flange SN EN 1092
5357	d15 – d28 (DN12 – 25)			Optipress/Sanpress
5358	d15 – d28 (DN12 – 25)			Mapress
5359	d16 – d32 (DN12 – 25)			Mepla

5350



1. Handwheel
2. Valve rods
3. Valve seal
4. O-ring
5. Backflow seal
6. Valve seat
7. Housing

Performance chart



1 Pressure loss
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN20 – 32	I

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5350.240	Straight seat valve • Female pipe thread	GN ½" (DN15)	2.7	11.1
5350.320		GN ¾" (DN20)	4.8	11.1
5350.400		GN 1" (DN25)	8.2	9.3
5350.480		GN 1¼" (DN32)	13.7	8.9
5350.560		GN 1½" (DN40)	19.0	11.3
5350.640		GN 2" (DN50)	30.9	10.5
5350.720		GN 2½" (DN65)	55.3	9.3
5351.025	Straight seat valve • Flange connection	GN 1" (DN25)	8.2	9.3
5351.032		GN 1¼" (DN32)	13.7	8.9
5351.040		GN 1½" (DN40)	19.0	11.3
5351.050		GN 2" (DN50)	30.9	10.5
5351.065		GN 2½" (DN65)	55.3	9.3
5357.015	Straight seat valve • Optipress/Sanpress	d15 (DN12)	2.7	4.6
5357.018		d18 (DN15)	2.7	11.1
5357.022		d22 (DN20)	4.8	11.1
5357.028		d28 (DN25)	8.2	9.3
5358.015	Straight seat valve • Mapress	d15 (DN12)	2.7	4.6
5358.018		d18 (DN15)	2.7	11.1
5358.022		d22 (DN20)	4.8	11.1
5358.028		d28 (DN25)	8.2	9.3
5359.016	Straight seat valve • Mepla	d16 (DN12)	2.7	4.6
5359.020		d20 (DN15)	2.7	11.1
5359.026		d26 (DN20)	4.8	11.1
5359.032		d32 (DN25)	8.2	9.3

Product description

The straight seat valve JRG LegioStop is a shut-off valve designed without dead space.

Features and functions

The valve is designed without dead space and separates the medium and the mechanical parts of the valve. This helps to prevent the formation of biofilm and legionella growth. Thus, the valve meets today's hygiene requirements applicable to drinking water installations.

Benefits and features

- Strict separation between the medium and mechanical parts of the shut-off valve
- Honed valve rod made of chromium-nickel steel
- Backflow sealing
- Free of dead spaces
- Smooth-running
- Non-rising handwheel
- Interchangeable medium marking plate
- Valve position can be seen and felt by touch
- Upper parts compatible with earlier JRG Valve bodies and other valve bodies
- Valve seat made of stainless steel

Mounting position and installation tips

The straight seat valve can be installed regardless of its position.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Spare parts

- Upper part
- Handwheel
- Identification label

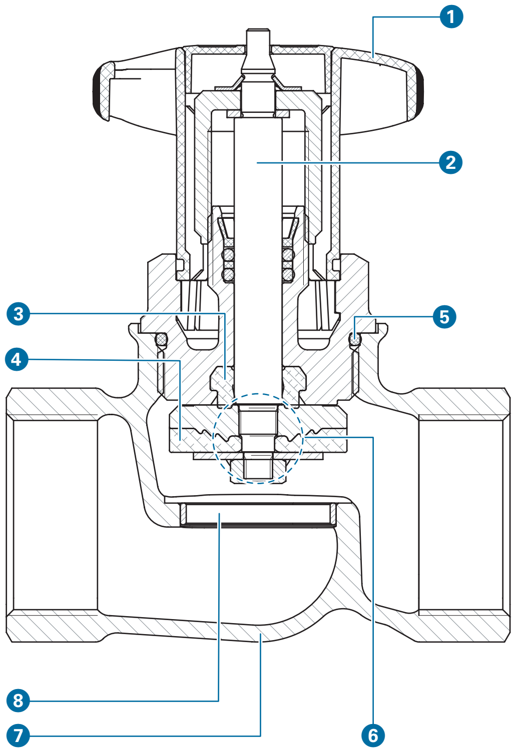
JRG LegioStop Straight seat valve 5354, 5371, 5374

The straight seat valve JRG LegioStop is a shut-off valve designed without dead space.

Technical Data

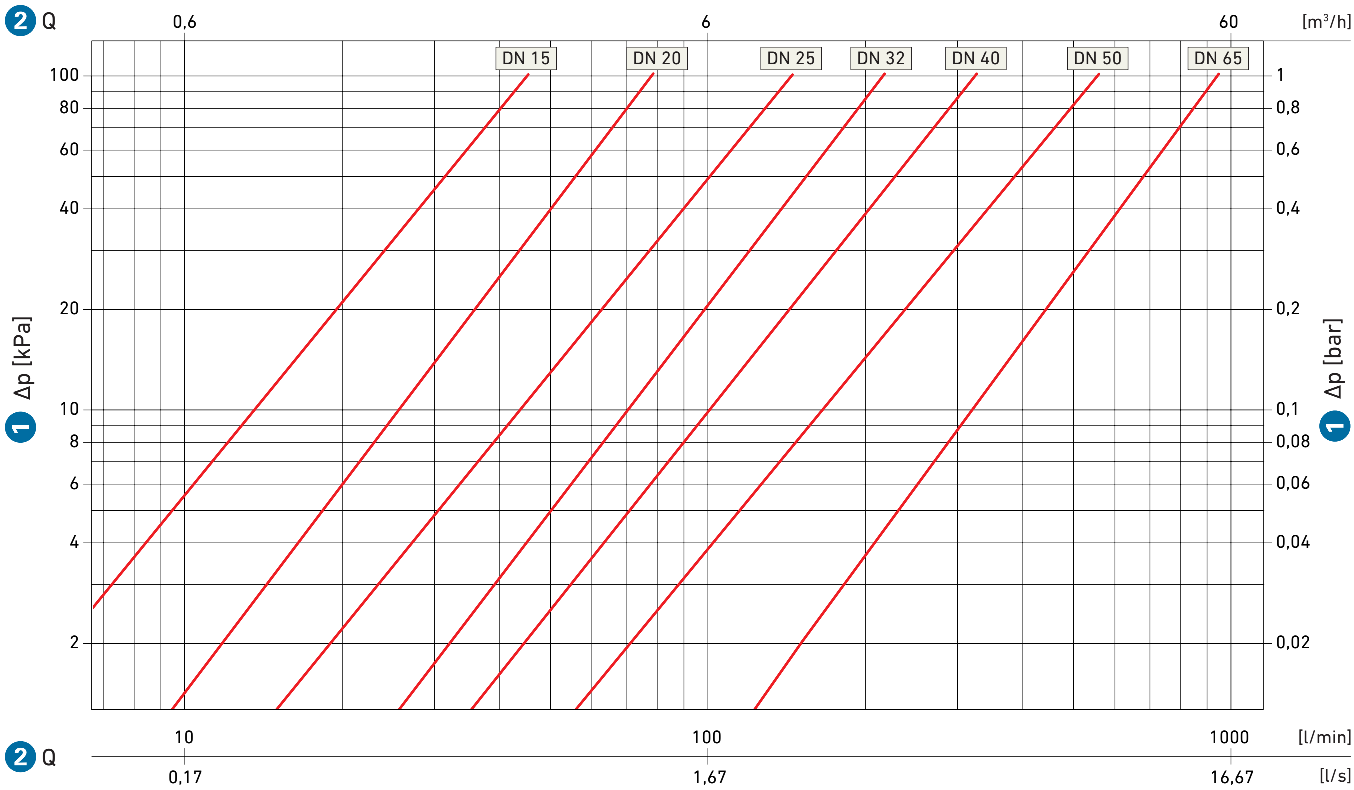
JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
5354	d16 – d32 (DN12 – 25)	10	90	JRG Sanipex MT
5371	GN ½" – 2" (DN15 – 50)	16		Female pipe thread
5374	GN 1" – 2½" (DN25 – 65)			Flange SN EN 1092

5371



1. Handwheel
2. Valve rods
3. Backflow seal
4. Valve seal
5. O-ring
6. Connection for drain valve (both sides)
7. Housing
8. Valve seat

Performance chart



❶ Pressure loss
❷ Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN15 – 32	I

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5354.016		d16 (DN12)	2.7	4.6
5354.020	Straight seat valve	d20 (DN15)	2.7	11.1
5354.026	• JRG Sanipex MT	d26 (DN20)	4.8	11.1
5354.032		d32 (DN25)	8.2	9.3
5371.240		GN ½" (DN15)	2.7	11.1
5371.320		GN ¾" (DN20)	4.8	11.1
5371.400		GN 1" (DN25)	8.2	9.3
5371.480	Straight seat valve	GN 1¼" (DN32)	13.7	8.9
5371.560	• Female pipe thread	GN 1½" (DN40)	19.0	11.3
5371.640		GN 2" (DN50)	30.9	10.5
5371.720		GN 2½" (DN65)	55.3	9.3
5374.025		GN 1" (DN25)	8.2	9.3
5374.032		GN 1¼" (DN32)	13.7	8.9
5374.040	Straight seat valve	GN 1½" (DN40)	19.0	11.3
5374.050	• Flange connection	GN 2" (DN50)	30.9	10.5
5374.065		GN 2½" (DN65)	55.3	9.3

V

Product description

The straight seat valve JRG LegioStop is a shut-off valve designed without dead space.

Features and functions

The valve is designed without dead space and separates the medium and the mechanical parts of the valve. This helps to prevent the formation of biofilm and legionella growth. Thus, the valve meets today's hygiene requirements applicable to drinking water installations.

Features and benefits

- Strict separation between the medium and mechanical parts of the shut-off valve
- Honed valve rod made of chromium-nickel steel
- Backflow sealing
- Free of dead spaces
- Smooth-running
- Non-rising handwheel
- Interchangeable medium marking plate
- Valve position can be seen and felt by touch
- Upper parts compatible with earlier JRG Valve bodies and other valve bodies (DIN 3502)
- Valve seat made of stainless steel

Mounting position and installation tips

The straight seat valve can be installed regardless of its position.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Spare parts

- Upper part
- Handwheel
- Identification label

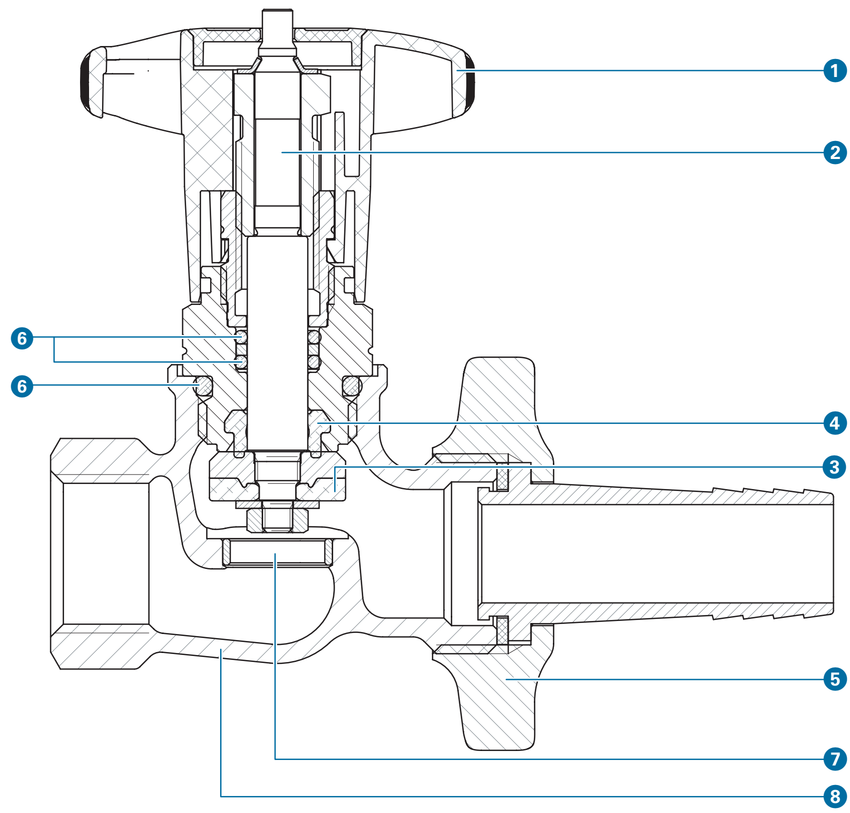
JRG LegioStop Straight seat valve with hose coupling / with cap, 5360 / 5363

The straight seat valve JRG LegioStop is a shut-off valve designed without dead space with hose coupling or end cap.

Technical Data

JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
5360	GN ½" – ¾" (DN15 – 20)	16	90	Inlet: Female pipe thread Outlet: Pipe thread with threaded hose coupling
5363				Inlet: Female pipe thread Outlet: Pipe threads with end cap

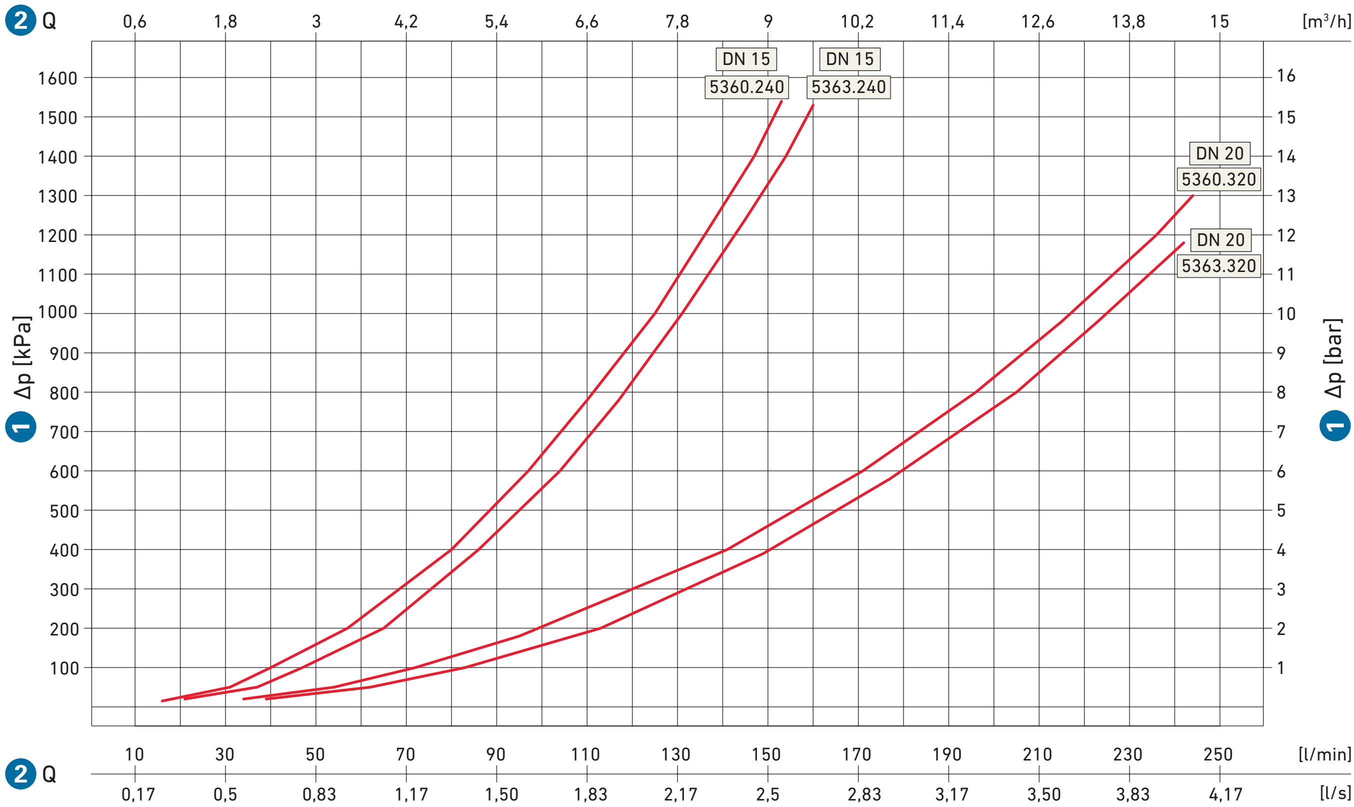
5360



1. Handwheel
2. Valve rods
3. Valve seal
4. Backflow seal
5. Hose coupling
6. O-ring
7. Valve seat
8. Housing

V

Performance chart



❶ Pressure
❷ Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN15 – 20	I

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5360.240	Straight seat valve	GN ½" (DN15)	2.7	11.1
5360.320	• with hose coupling	GN ¾" (DN20)	4.8	11.1
5363.240	Straight seat valve	GN ½" (DN15)	2.7	11.1
5363.320	• with cap	GN ¾" (DN20)	4.8	11.1

Product description

The straight seat valve JRG LegioStop is a shut-off valve designed without dead space with hose coupling or end cap.

Features and functions

The valve is designed without dead space and separates the medium and the mechanical parts of the valve. This helps to prevent the formation of biofilm and legionella growth. Thus, the valve meets today's hygiene requirements applicable to drinking water installations.

Features and benefits

- Strict separation between the medium and mechanical parts
- Honed valve rod made of chromium-nickel steel
- Backflow sealing
- Free of dead spaces
- Smooth-running
- Non-rising handwheel
- Interchangeable medium marking plate
- Valve position can be seen and felt by touch
- Valve seat made of stainless steel

Mounting position and installation tips

The straight seat valve can be installed regardless of its position.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Spare parts

- Upper part of straight seat valve

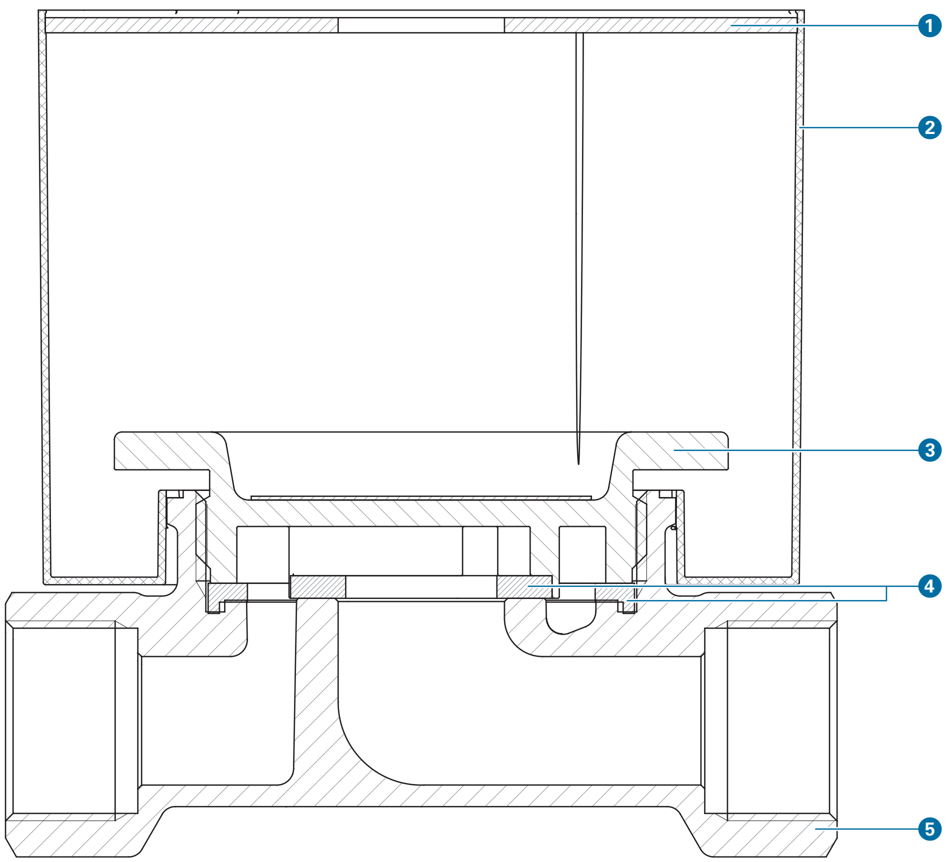
Single-pipe connector UPZ KOAX counter 5456

The single-pipe connector UPZ KOAX counter is a valve body and serves as basis for COAX counter capsules, e.g. for JRG code 5456.005.

Technical Data

JRG code	Components	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
5456	• Valve body • Blind flange • Assembly protective hood	GN ¾“ (DN20)	10	90	Female pipe thread

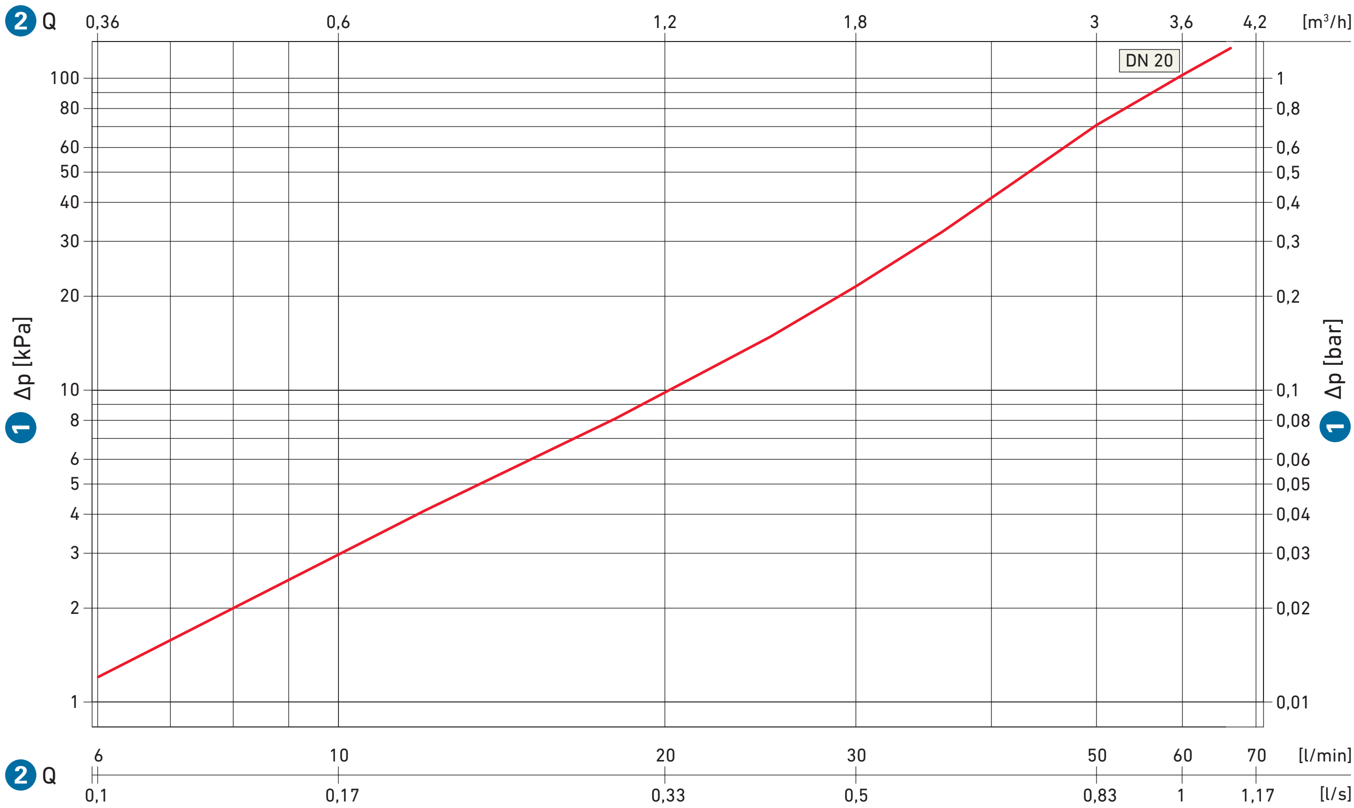
5456



1. Structure protection
2. Protective cover
3. Blind flange
4. Gaskets
5. Valve body

V

Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5456.325	Single-pipe connector UPZ KOAX counter	GN ¾" (DN20)	6.8	5.5
5456.005	Measuring capsule, PN10	DN15	3.0	9.0
5456.001	Measuring capsule	DN15	3.0	9.0

1 Pressure loss
2 Volumetric flow rate

Product description
The single-pipe connector UPZ KOAX counter is a valve body and serves as basis for COAX counter capsules, e.g. for JRG code 5456.005.

Features and functions
The single-pipe connection has a female thread and is suitable for cold and hot water up to Q_n 1.5 m³/h.

Benefits and features
- Body made of gunmetal
- Blind flange made of brass
- Gaskets made of EPDM
- Assembly protection hood suitable for 5456.005 and measuring capsule KOAX + with UP counter
- Compatible with common KOAX measuring capsules

Mounting position and installation tips
☑ Mount the single-pipe connection the UPZ KOAX counter only in such a way that the measuring capsule is installed from above or from the side.
☑ With the blind flange (16 bar) mounted, the maximum test pressure must be maintained.

Installation instructions
☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents
- Assembly instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

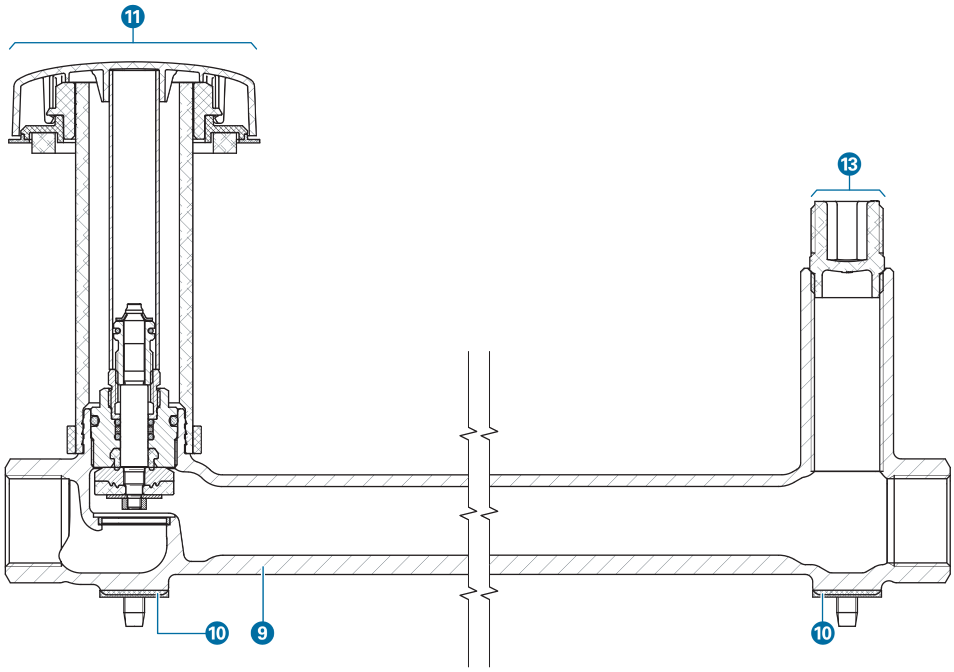
JRG LegioStop Shut-off unit 5458

The upper part of the JRG LegioStop Shut-off unit is designed with a dead space and has a connection to the vanity unit. The shut-off unit is also available with a counter connection.

Technical Data

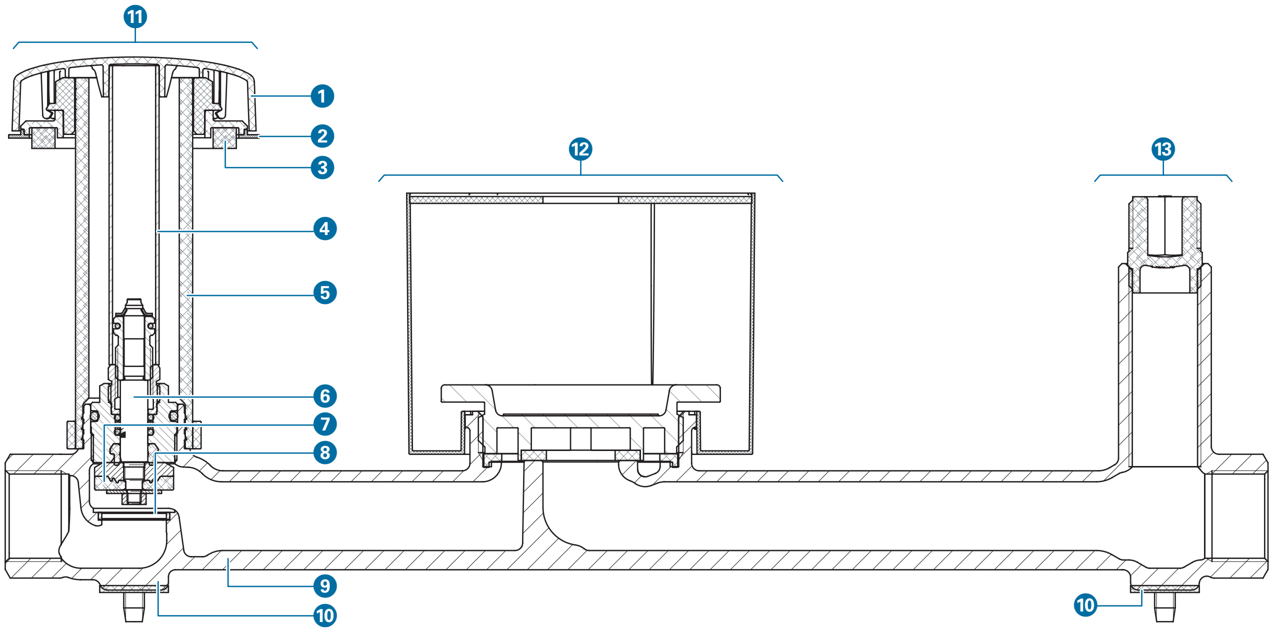
JRG code	Components	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
5458.045	• UP Straight seat valve • without counter connection • Vanity unit connection	GN¾" (DN20)	10	90	Female pipe thread
5458.055	• UP Straight seat valve • With KOAX counter connection • Vanity unit connection				

5458.045 without counter



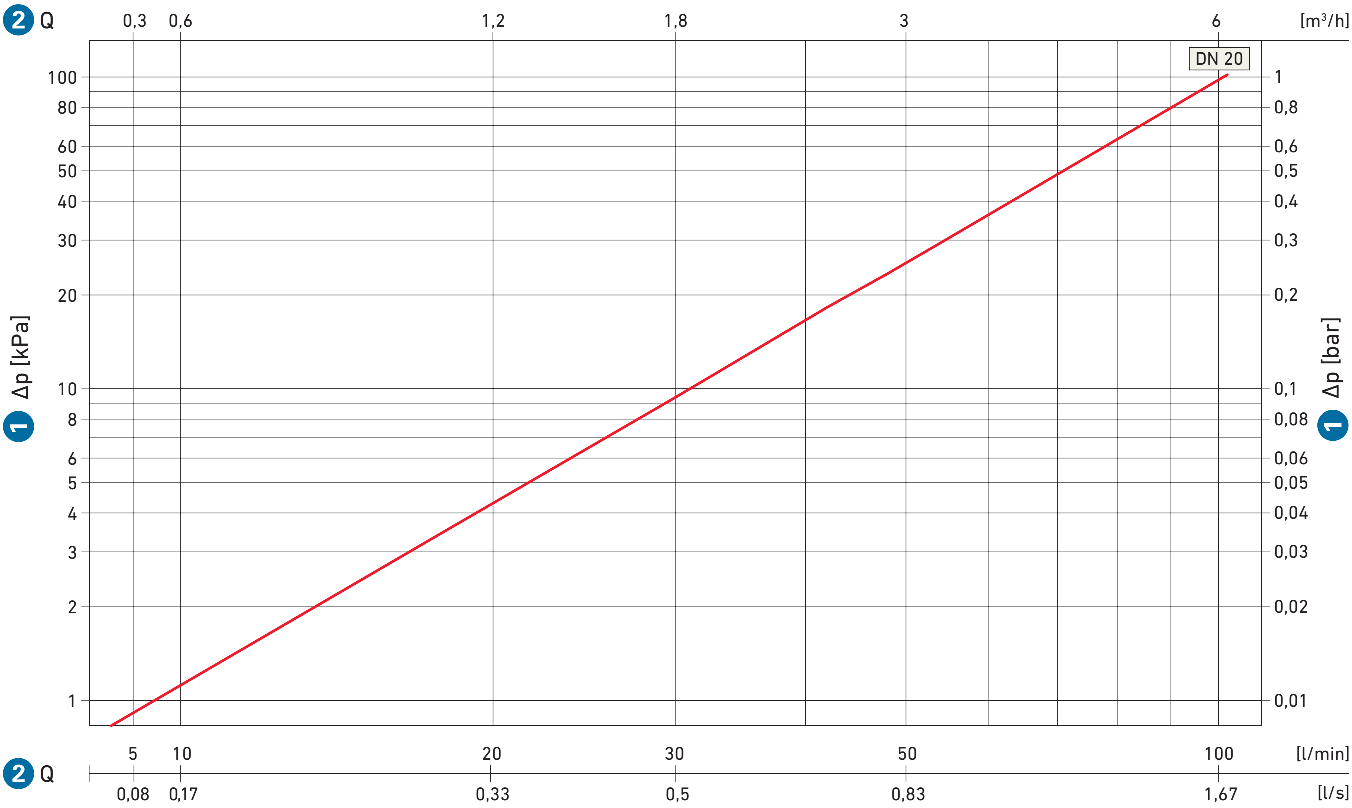
1. Handwheel/Rosette
2. Medium identification ring (blue/red)
3. Sealing ring
4. Hexagon valve rods extension
5. Protective conduit
6. Valve rod
7. Valve seals
8. Valve seat
9. Housing
10. Mounting flange
11. Concealed straight seat valves
12. KOAX Counter connection
13. Vanity unit connection

5458.055 with counter

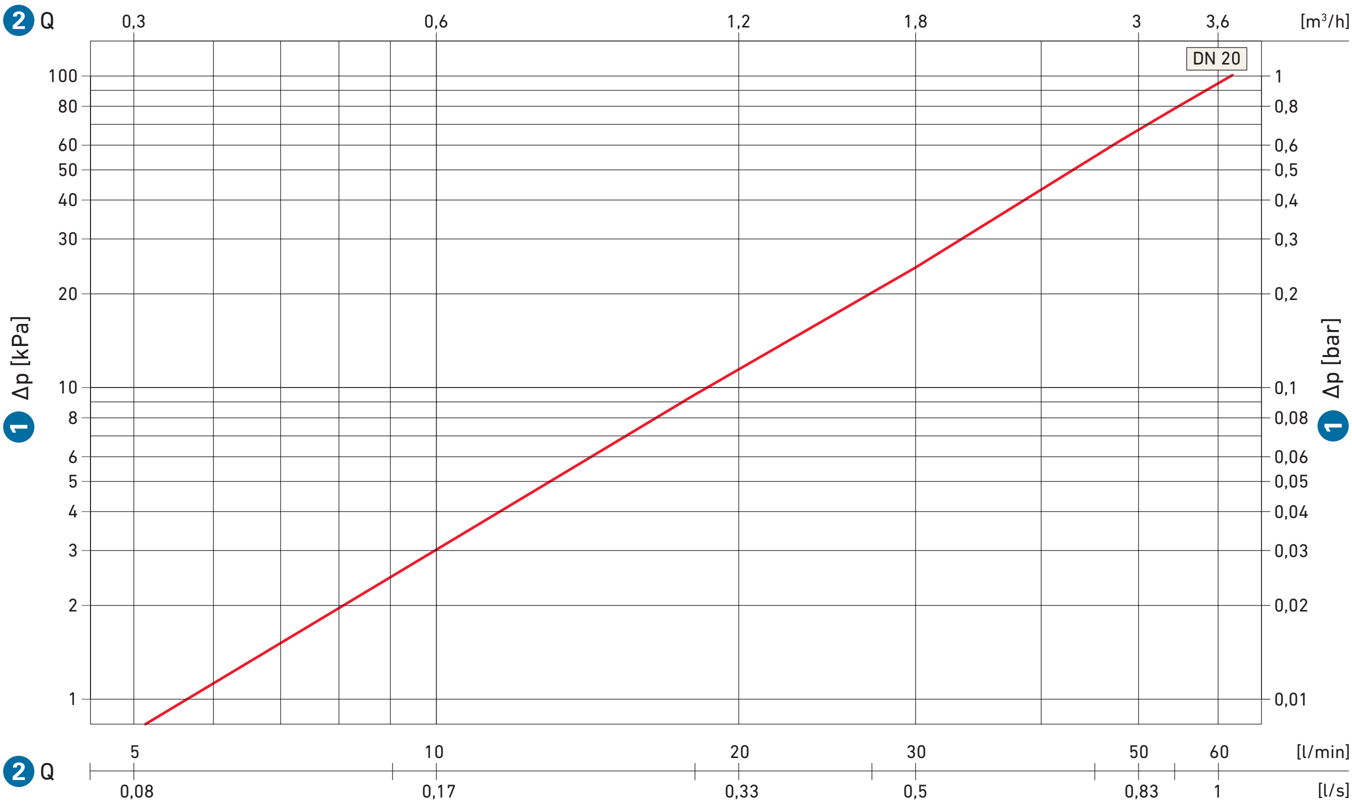


Performance chart

5458.045



5458.055



1 Pressure loss
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN20	I

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5458.045	Shut-off unit • without counter	GN ¾" (DN20)	6,1	6,9
5458.055	Shut-off unit • with counter	GN ¾" (DN20)	3,8	17,7

Product description

The upper part of the JRG LegioStop Shut-off unit is designed with a dead space and has a connection to the vanity unit. The shut-off unit is also available with a counter connection.

Features and functions

The shut-off unit is mounted inside the in-wall area using a mounting block, provided by the client. Depending on the circumstances, the units already preassembled ex factory GIS or Duofix rails can be used. When using the enclosed medium identification rings (red and blue), the respective medium can be visually identified. The chrome-plated plastic rosette can be used either as a simple cover (lock box), or the enclosed hexagonal valve rods extension can be used as a control handle in order to shut off the UP shut-off valve.

Benefits and features

Prefabricated kit

- Operating handle or rosette
- Medium identification rings (red/blue)
- Product-independent design of the rosette

Upper part

- Upper part without dead space
- Valve rod end with hexagon

Protective conduit

- Due to excess length of the hexagon, in most cases additional extensions are not necessary

Attachment

- Using the sound insulation elements to attach the product onto the rear wall or using a mounting block is possible

Mounting position and installation tips

The shut-off unit can be installed regardless of its position.

☑ The design with a counter connection (5458.055) requires the measuring capsule to be mounted from above or from the side.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents

- Assembly instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts

- Upper part
- Replacement for prefabricated kit

V

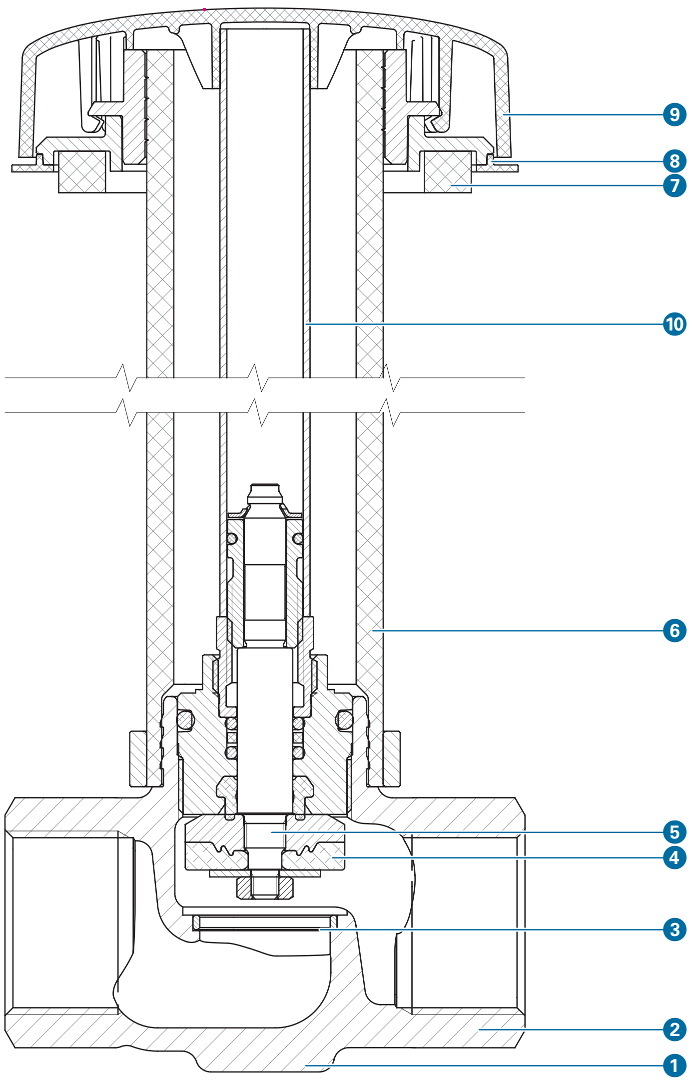
JRG LegioStop Concealed straight seat valve 5900, 5922

The design of the JRG LegioStop Concealed straight seat valve uses an upper part without any dead space.

Technical Data

JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
5900	GN ½" – 1" (DN15 – 25)	16	90	Female pipe thread
5922	d16 – d32 (DN12 – 25)	10		JRG Sanipex MT

5900

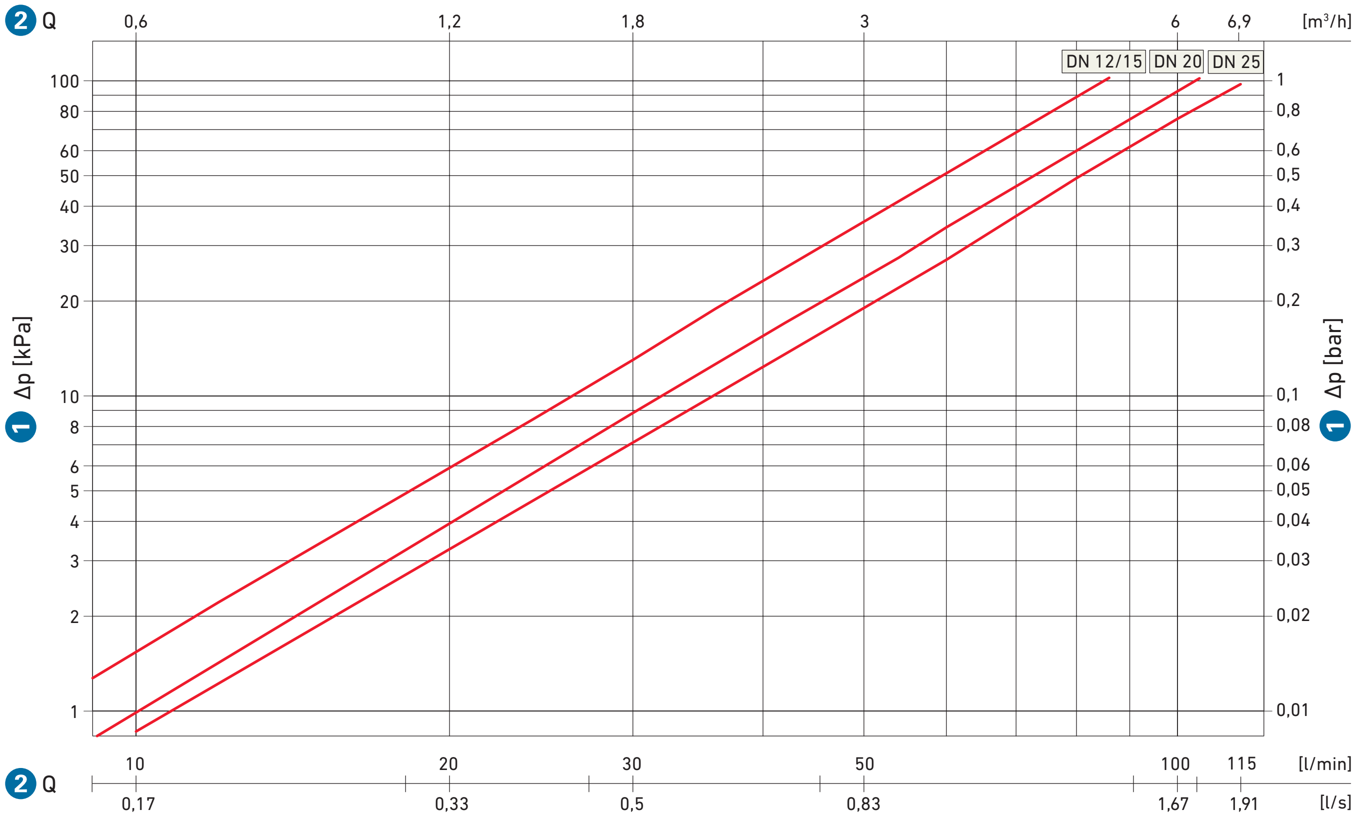


1. Mounting flange
2. Housing
3. Valve seat
4. Valve seals
5. Valve rod
6. Protective conduit

Prefabricated kit components

7. Sealing ring
8. Medium identification ring (blue/red)
9. Handwheel/Rosette
10. Hexagon valve rods extension

Performance chart



1 Pressure loss
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN12 – 20	I

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5900.240	Concealed straight seat valves • Female pipe thread	GN ½" (DN15)	5.0	3.2
5900.320		GN ¾" (DN20)	6.1	6.9
5900.400		GN 1" (DN25)	6.9	13.1
5922.016	Concealed straight seat valves • JRG Sanipex MT	d16 (DN12)	5.0	1.3
5922.020		d20 (DN15)	5.0	3.2
5922.026		d26 (DN20)	6.1	6.9
5922.032		d32 (DN25)	6.9	13.1

Product description

The design of the JRG LegioStop Concealed straight seat valve uses an upper part without any dead space.

Features and functions

The in-wall straight seat valve is mounted inside the in-wall area using a mounting block, provided by the client. Depending on the situation, the concealed shut-off valve can be secured against rotation with the cast-on flange to the rear. When using the enclosed medium identification rings (blue/red), the respective medium can be visually identified. The penetration of spray water into the building structure is prevented by the rubber seal on the end flange. The chrome-plated plastic rosette can be used either as a simple cover (lock box), or the enclosed hexagonal valve rods extension can be used as a control handle in order to shut off the UP shut-off valve.

Benefits and features

Prefabricated kit

- Operating handle or rosette
- Medium identification rings (blue/red)
- Product-independent design of the rosette
- Same rosette for all sizes

Upper part

- Upper part of all sizes designed without dead space
- Valve rod end with hexagon

Protective conduit

- Due to excess length of the hexagon, in most cases additional extensions are not necessary

Attachment

- Using the sound insulation elements to attach the product onto the rear wall or using a mounting block is possible
- Use the protective conduit to provide a twist-proof attachment

Mounting position

The concealed straight seat valve can be installed regardless of its position.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents

- Assembly instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts

- Upper part
- Prefabricated kit

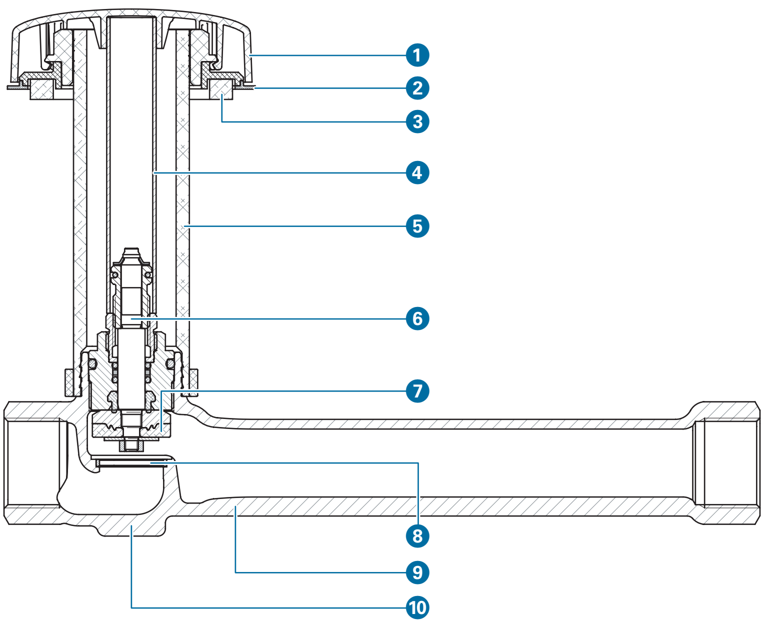
JRG LegioStop Concealed shut-off fitting 5910, 5916

The JRG LegioStop Concealed shut-off fitting uses an upper part without any dead space. The concealed shut-off fitting is also available with a KOAX counter connection.

Technical Data

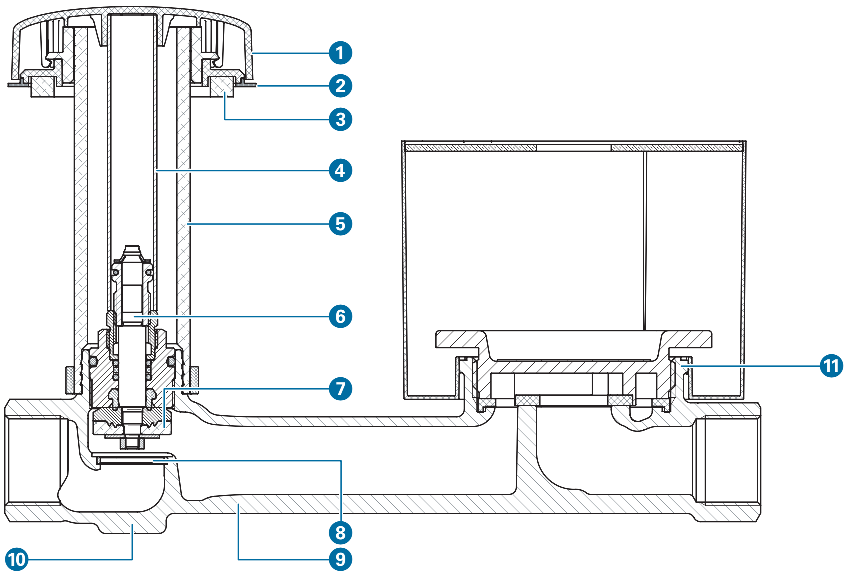
JRG code	Components	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
5910	Concealed straight seat valves • without counter connection	GN ¾" (DN20)	10	90	Female thread
5916	Concealed straight seat valves • with KOAX counter connection • without measuring capsule				

5910



1. Handwheel/Rosette
2. Medium identification ring (blue/red)
3. Sealing ring
4. Hexagon valve rods extension
5. Protective conduit
6. Valve rod
7. Valve gaskets
8. Valve seat
9. Housing
10. Mounting flange
11. KOAX counter connection

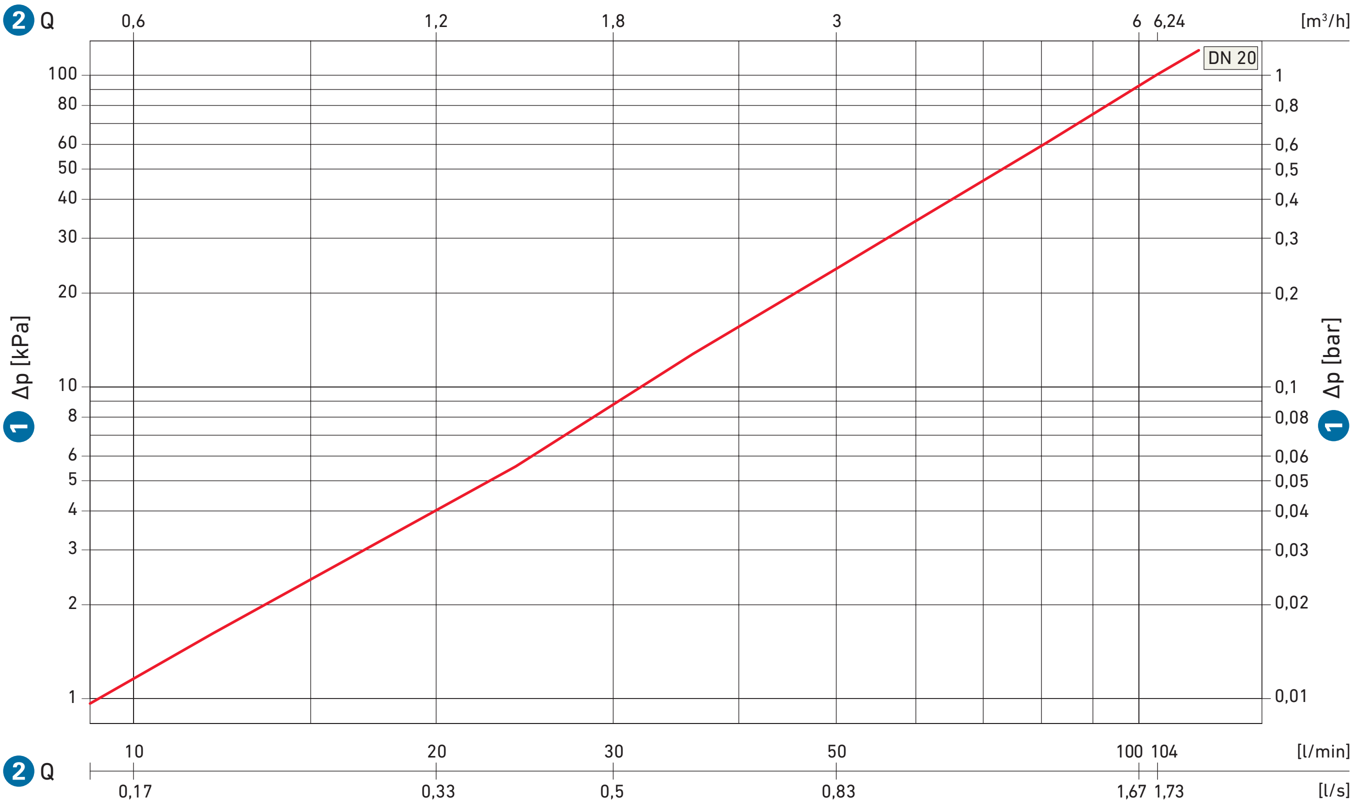
5916



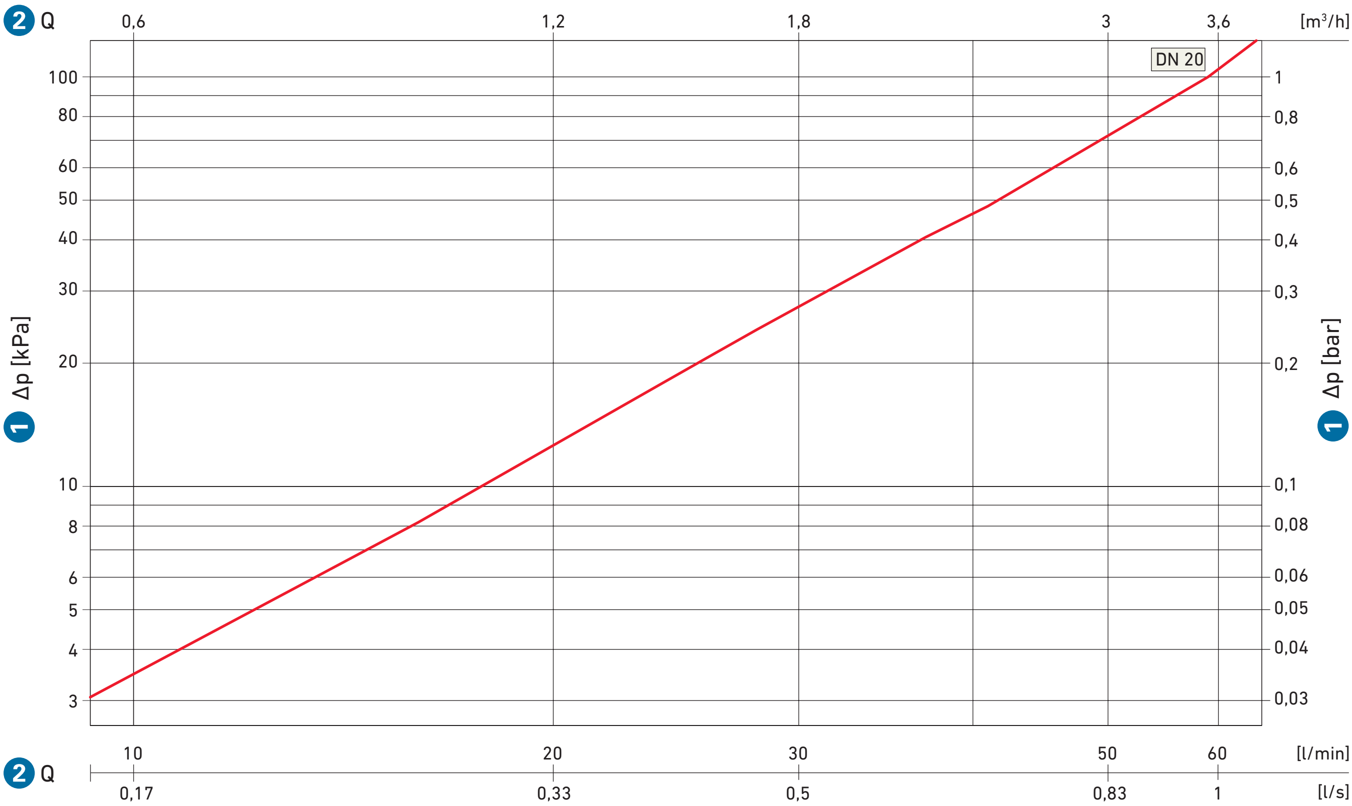
V

Performance charts

JRG LegioStop Concealed shut-off fitting 5910, without KOAX counter connection



JRG LegioStop Concealed shut-off fitting 5916, without KOAX counter connection



1 Pressure loss
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN20	I

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5910.320	Concealed shut-off fitting • without counter connection	GN ¾" (DN20)	6,2	6,7
5916.320	Concealed shut-off fitting • with KOAX counter connection, without measuring capsule	GN ¾" (DN20)	3,8	17,7

Product description

The JRG LegioStop Concealed shut-off fitting uses an upper part without any dead space. The concealed shut-off fitting is also available with a KOAX counter connection.

Features and functions

The JRG LegioStop Concealed shut-off valve is assembled inside the in-wall installation, using a mounting block, provided by the customer. Depending on the situation, the concealed shut-off valve can be secured against rotation. This an be done by using either the rear cast-on flange or using the protective conduit, which is permanently fixed to the valve. When using the enclosed medium identification rings (blue/red), the respective medium can be visually identified. The penetration of spray water into the building structure is prevented by the rubber seal on the end flange. The chrome-plated plastic rosette can be used either as a simple cover (lock box), or the enclosed hexagonal valve rods extension can be used as a control handle in order to shut off the JRG LegioStop concealed shut-off valve.

Benefits and features

- Operating handle or rosette
- Medium identification rings (blue/red)

Upper part

- Upper part without dead space
- Using the sound insulation elements to attach the product onto the rear wall or using a mounting block is possible
- Use the protective conduit to provide a twist-proof attachment

Mounting position and installation tips

The JRG LegioStop Concealed shut-off fitting can be installed regardless of its position.

☑ For version with counter connection (5916): Mount the measuring capsule so that it can only be installed from above or from the side.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents

- Assembly instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts

- Upper part
- Replacement for prefabricated kit

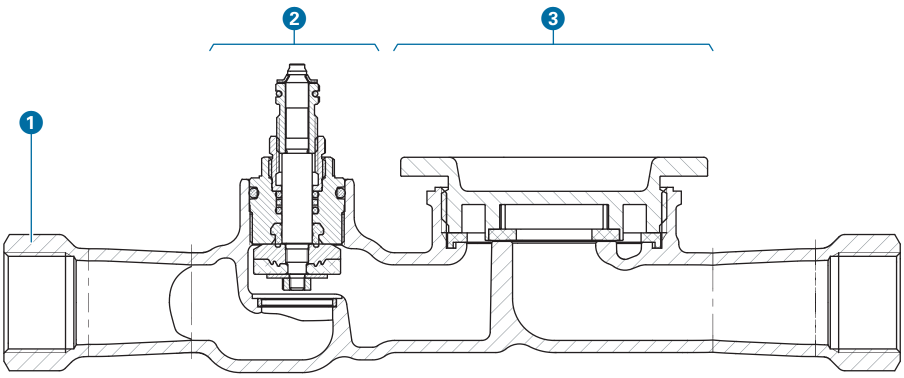
JRG UP Shut-off valve/counter unit compact 5917, JRG Connection kit 5918

The JRG UP Shut-off valve/counter unit compact and the optional JRG Connection kit are designed using JRG LegioStop technology without any dead space in the valves' upper part.

Technical Data

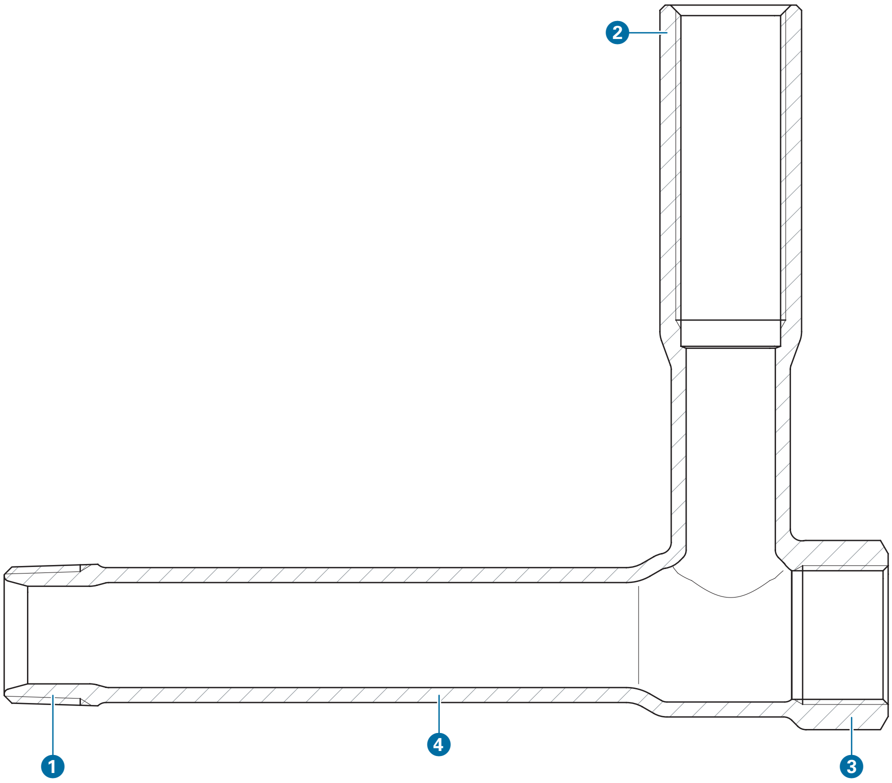
JRG code	Components	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
5917	UP shut-off/counter unit • with KOAX counter connection	GN ¾" (DN20)	10	65, briefly 90	Female pipe thread
5918	Connection kit • Vanity unit connection • Drainage pipe clamp				Tapered male thread/Female pipe thread

5917



1 Housing
2 Concealed straight seat valve
3 KOAX counter connection

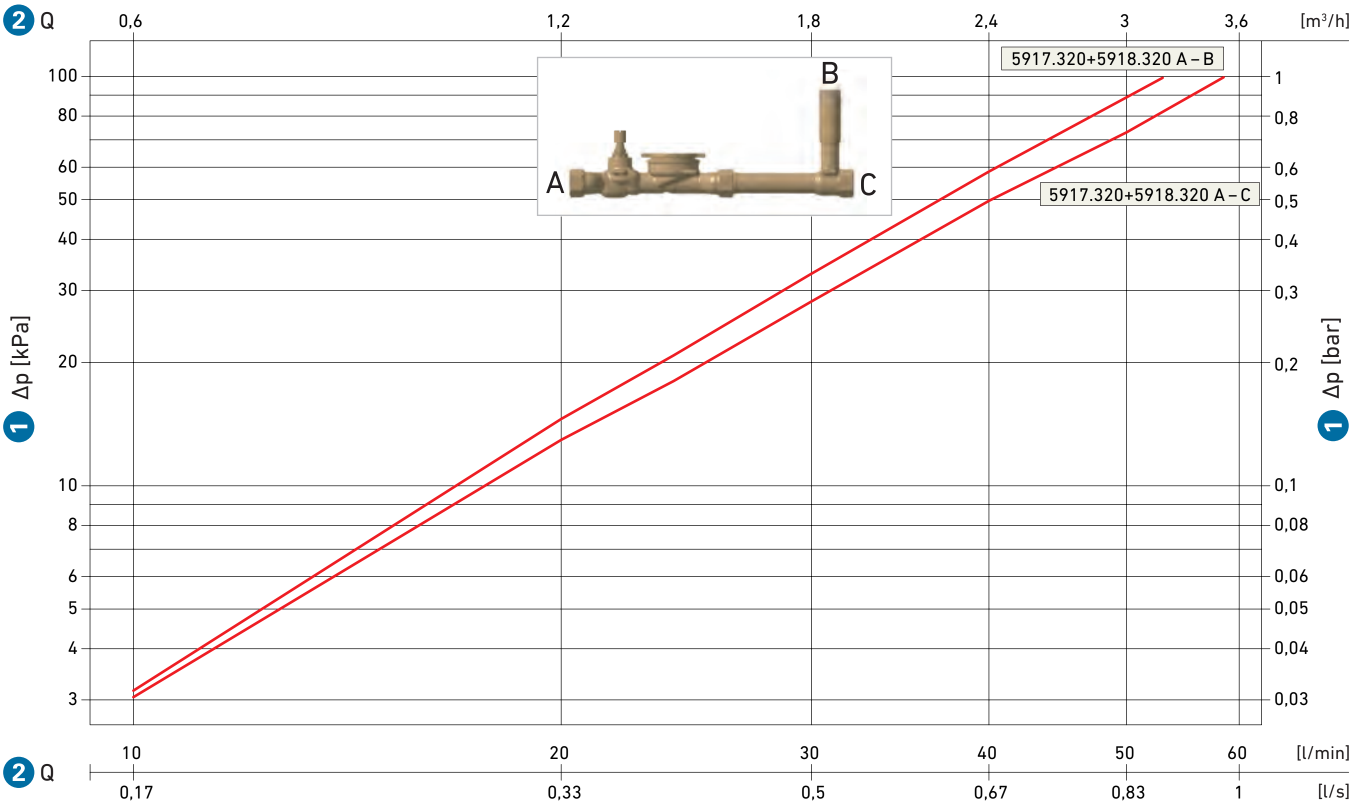
5918



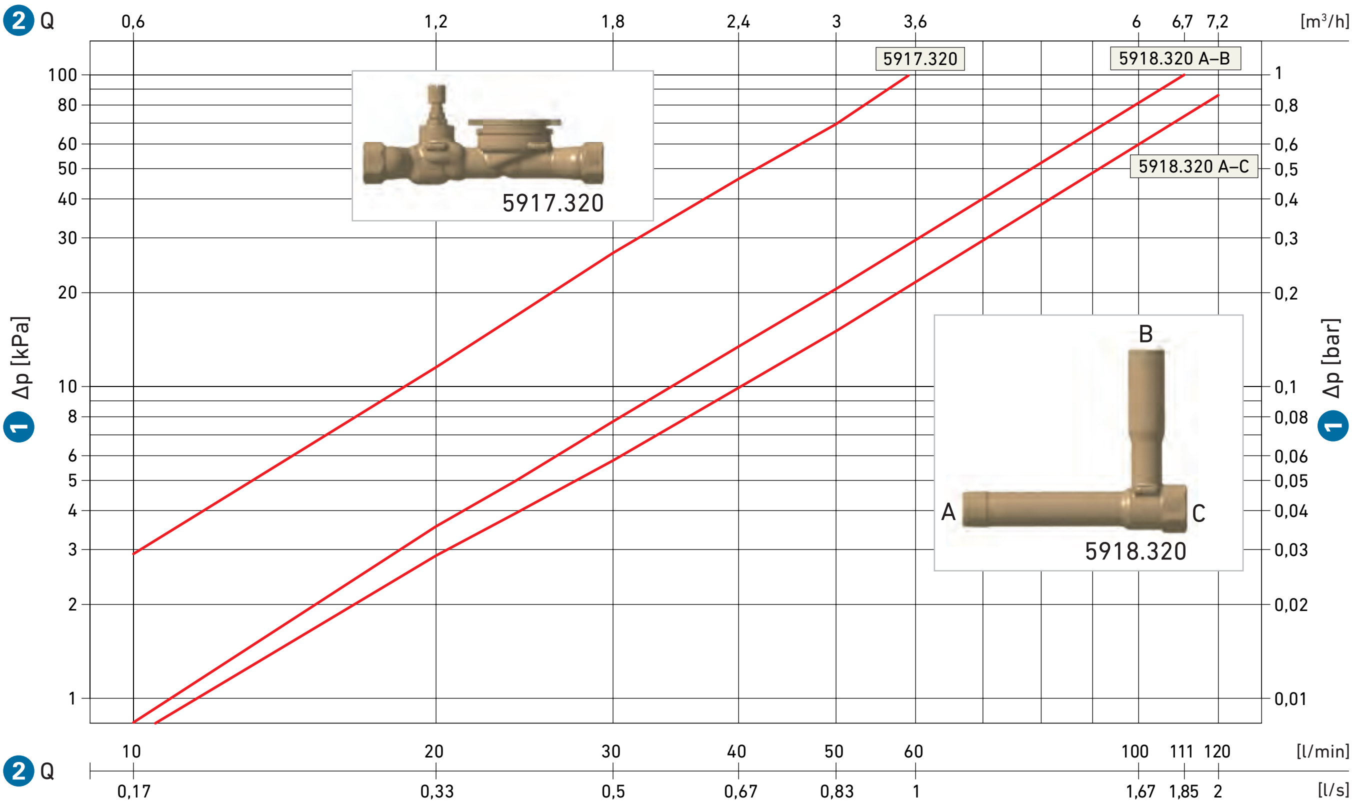
1 Connection to 5917
2 Vanity unit connection
3 Outlet
4 Housing

Performance chart

Pressure loss of the JRG UP Shut-off counter unit compact with JRG Connection kit



Pressure loss of individual components



Noise behaviour

JRG code	Dimension	Group of valves
5917.320*	DN20	I

* without measuring capsule

1 Pressure loss
2 Volumetric flow rate

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5917.320 with 5918.320	JRG UP Shut-off/counter unit compact • with JRG Connection kit • Flow path A–B	GN ¾"–½" (DN20–15)	3.2	25.0
	JRG UP Shut-off/counter unit compact • with JRG Connection kit • Flow path A–C	GN ¾" (DN20)	3.5	20.9
5917.320	JRG UP Shut-off/counter unit compact	GN ¾" (DN20)	3.5	20.9
5918.320	JRG Connection kit • Flow path A–B	GN¾"-½" (DN20–15)	6.6	5.9
	JRG Connection kit • Flow path A–C	GN ¾" (DN20)	7.5	4.6

Product description

The JRG UP Shut-off valve/counter unit compact and the optional JRG Connection kit are designed using JRG LegioStop technology without any dead space in the valves' upper part.

Features and functions

The JRG UP Shut-off valve/counter unit compact and the optional JRG Connection kit are mounted inside the front in-wall area using optional adaptors.

Benefits and features

Prefabricated kit

- Filigree cover plate
- Minimum installation dimensions and depth
- Small wall opening

Upper part

- Upper part without dead space

Attachment

- With optional adaptors for GIS, Duofix and wall mounting

Mounting position and installation tips

The concealed shut-off valves can be installed regardless of their position.

☑ Mount the measuring capsule so that it can only be installed from above or from the side.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

☑ When installing the counter, compliance with the manufacturer's instructions is mandatory.

Applicable documents

- Assembly instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts

- Upper part
- Cover plate

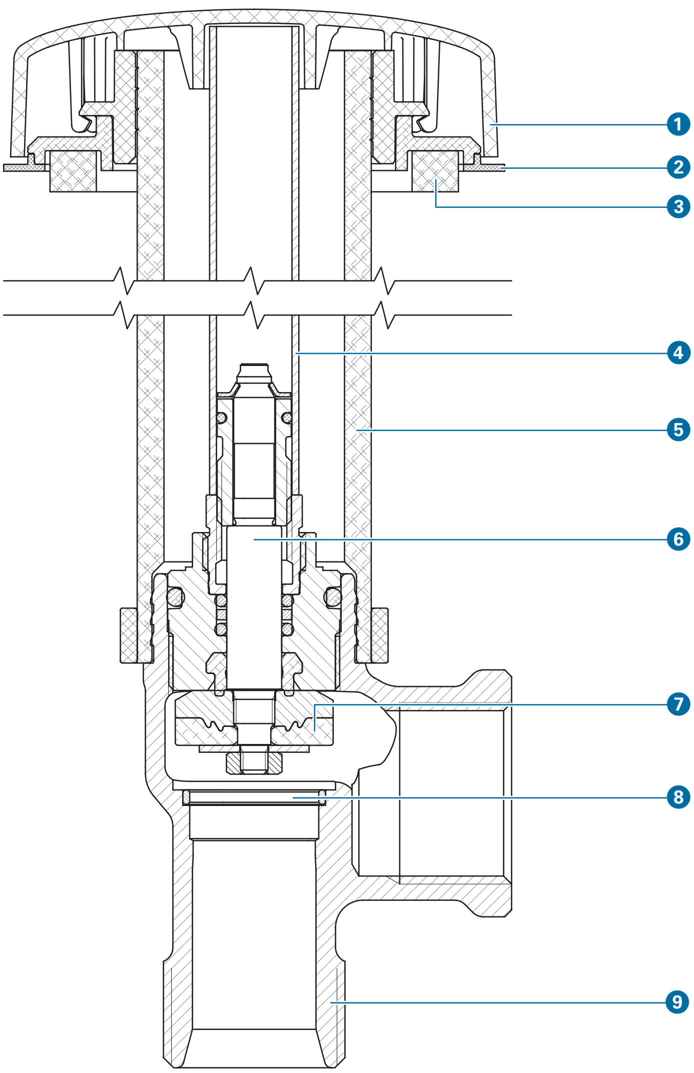
JRG LegioStop Concealed corner/straight seat valve 5920, 5921

The design of the JRG LegioStop Concealed straight seat valve uses an upper part without any dead space and is based on the tried and tested JRG LegioStop technology. The valve is used to shut off groups of equipment and residential units.

Technical Data

JRG code	Components	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
5920	• Concealed corner valve • Protective conduit • Prefabricated kit	GN ½" – ¾" (DN15 – 20)	16	90	Inlet: Tapered external thread Outlet: Female pipe thread
5921	• Concealed corner valve • without protective conduit and prefabricated kit				

5920



Prefabricated kit, components

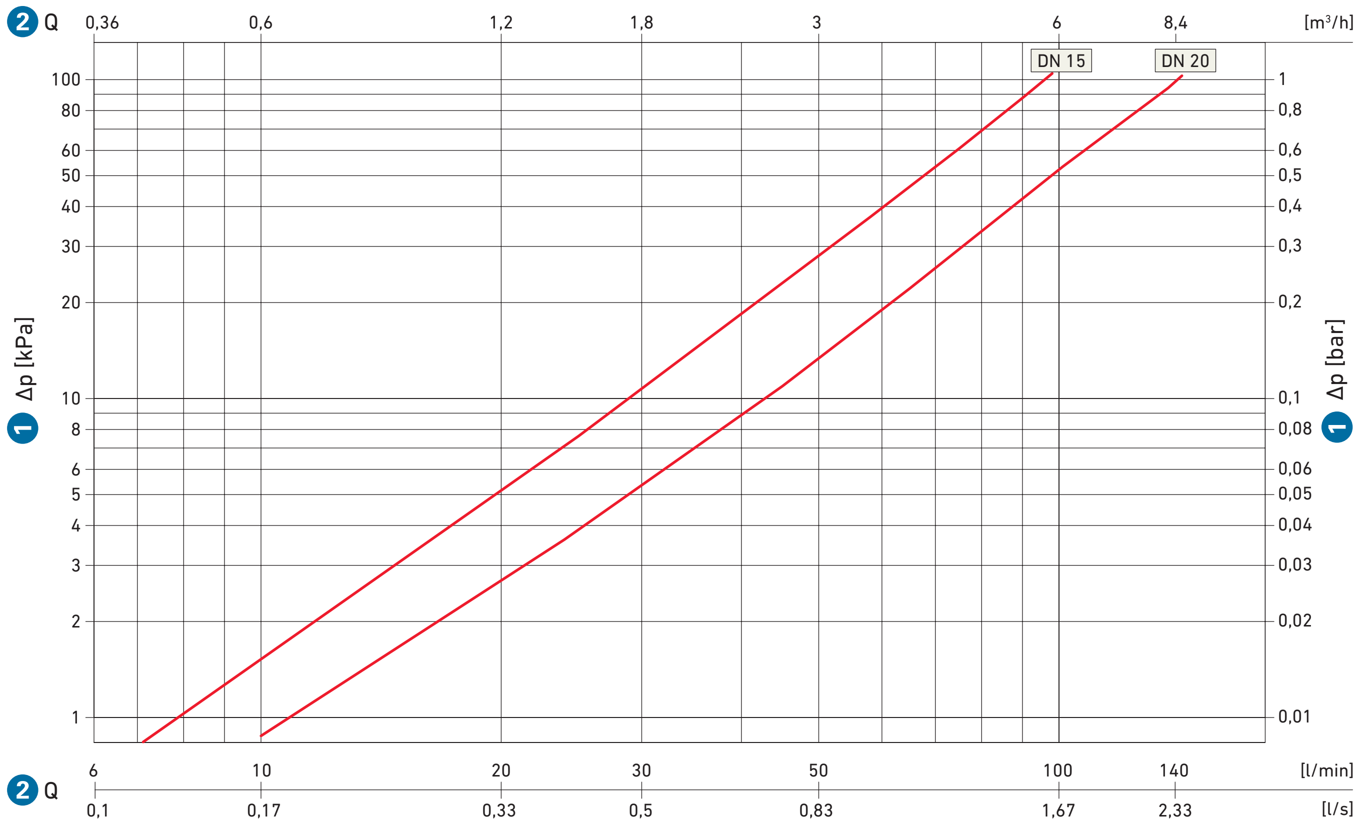
1. Handwheel/Rosette
2. Medium identification ring (blue/red)
3. Sealing ring
4. Hexagon valve rods extension

5. Protective conduit
6. Valve rod
7. Gaskets
8. Valve seat
9. Housing

V

Performance charts

JRG LegioStop Concealed corner/straight seat valve



1 Pressure loss
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN20	I

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
5920.240	JRG LegioStop Concealed corner/straight seat valve	GN ½" (DN15)	5.6	2.6
5920.320		GN ¾" (DN20)	8.4	3.6
5921.240	JRG LegioStop Concealed corner/straight seat valve	GN ½" (DN15)	5.6	2.6
5921.320		GN ¾" (DN20)	8.4	3.6

Product description

The design of the JRG LegioStop Concealed straight seat valve uses an upper part without any dead space and is based on the tried and tested JRG LegioStop technology. The valve is used to shut off groups of equipment and residential units.

Features and functions

The JRG LegioStop Concealed straight seat valve is mounted into the in-wall area. Depending on the circumstances, the concealed shut-off valve can be secured against rotation, using the protective conduit, which is firmly connected to the valve (5920). When using the enclosed (for 5920) medium identification rings (red and blue), the respective medium can be visually identified. The penetration of spray water into the building structure is prevented by the rubber seal on the end flange. The chrome-plated plastic rosette (for 5920) can be used either as a simple cover (lock box) or the enclosed hexagonal valve rods extension can be used as a control handle in order to shut off the UP shut-off valve.

Benefits and features

- Medium identification rings (blue/red) (only for 5920)
- Same rosette for all sizes (only for 5920)
- Upper part without dead space

Mounting position

The concealed corner straight seat valve can be installed regardless of its position.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents

- Assembly instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts

- Upper part
- Replacement for prefabricated kit (for 5920)

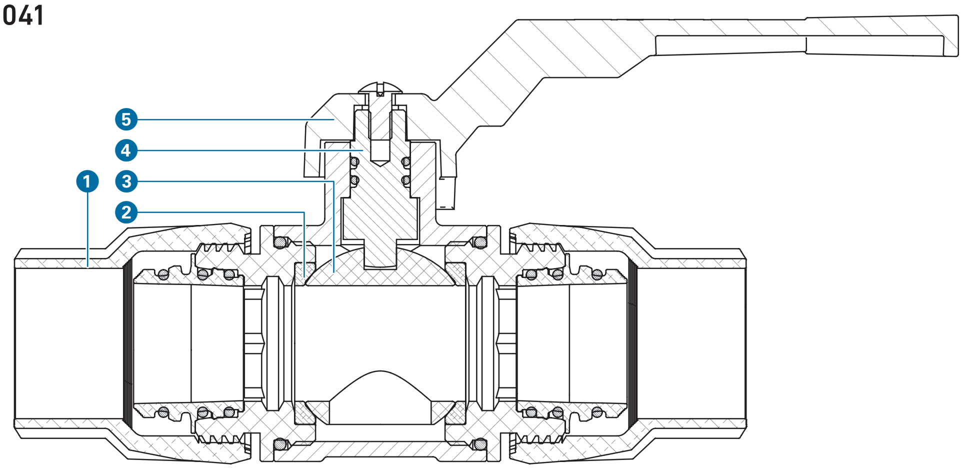
Ball valve with MT threaded connection 6041

The ball valve, made of gunmetal, is equipped with a crimp fitting for the direct transition to the JRG Sanipex MT installation system.

Technical Data

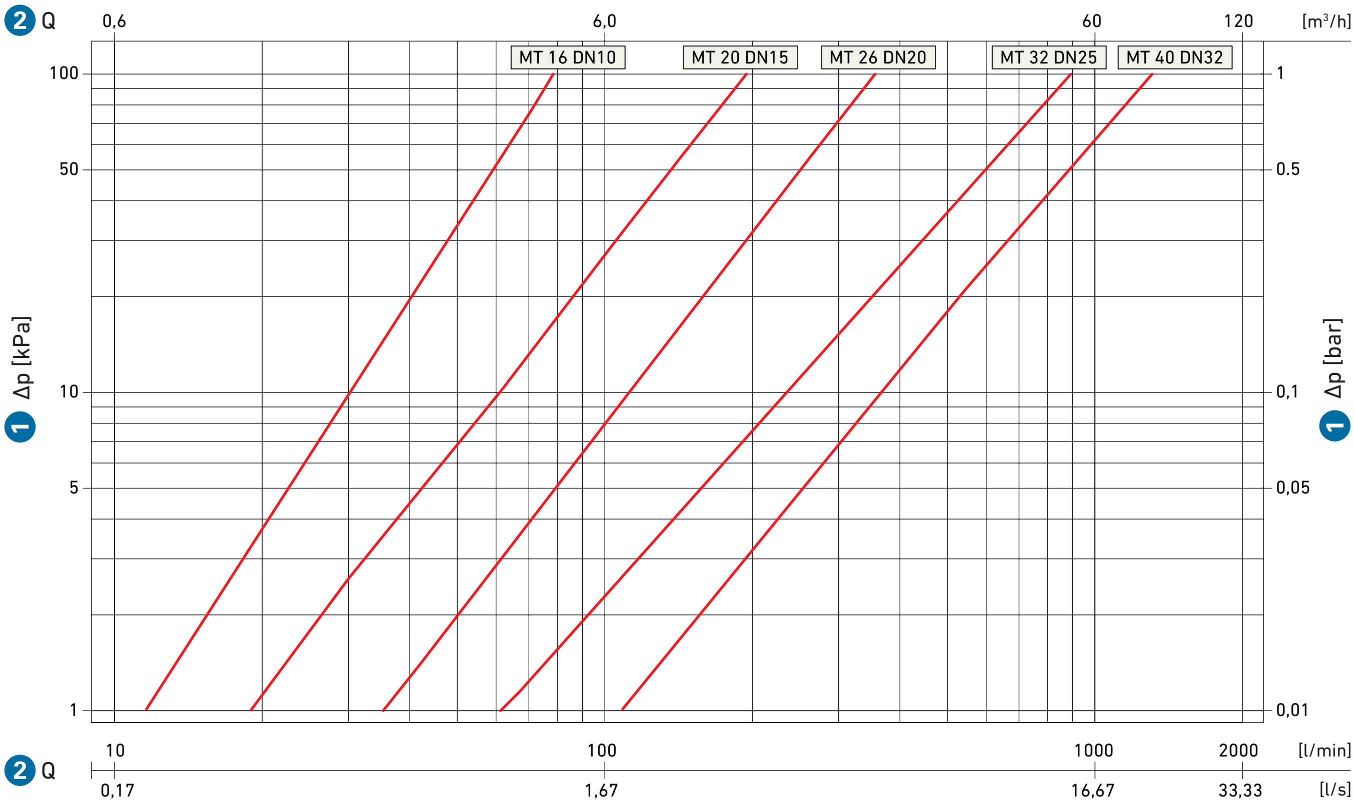
JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
6041	d16 – d40 (DN12 – 32)	10	-20 / +95	Crimped clamping connection JRG Sanipex MT

6041



1. Coupling nut JRG Sanipex MT
2. Gasket
3. Kugel
4. Spindle
5. Lever

Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
6041.016	Ball valve	d16 (DN12)	5.4	1.1
6041.020		d20 (DN15)	6.0	2.3
6041.026		d26 (DN20)	16.3	1.0
6041.032		d32 (DN25)	29.5	0.7
6041.040		d40 (DN32)	43.0	0.9

1 Pressure loss
2 Volumetric flow rate

Product description

The ball valve, made of gunmetal, is equipped with a crimp fitting for the direct transition to the JRG Sanipex MT installation system.

Features and functions

The ball valve can be used in all known applications in the field of heating and air conditioning or where compressed air and vacuum is being used.
The ball of the valve, which is completely surrounded by fluid, meets the highest hygienic requirements and all the criteria for DVGW approval in the field of drinking water. Furthermore, while the ball valve is open, only minimum pressure loss occurs.

Benefits and features

- Housing made of drinking water compliant gunmetal
- PTFE gasket
- The ball of the valve, which is completely surrounded by fluid, is made of stainless steel
- Suitable for drinking water up to 95°C

Mounting position

The ball valve can be installed regardless of its position.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Spare parts und accessories

- Spindle extension

V

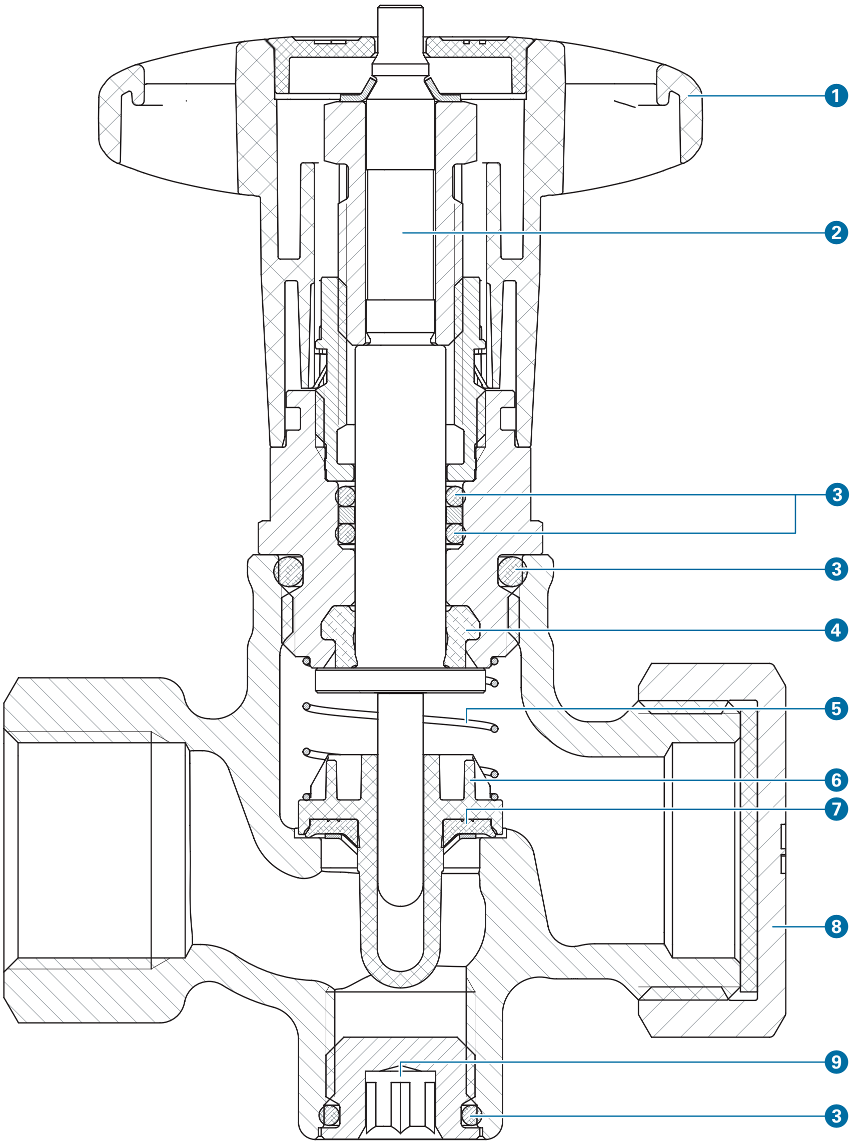
JRG LegioStop Fill valve with return flow inhibitor 6303

The JRG LegioStop filling valve, equipped with a return flow inhibitor, can be used to fill devices or installations. The return flow inhibitor is a mechanical safety device that allows flow in one direction only.

Technical Data

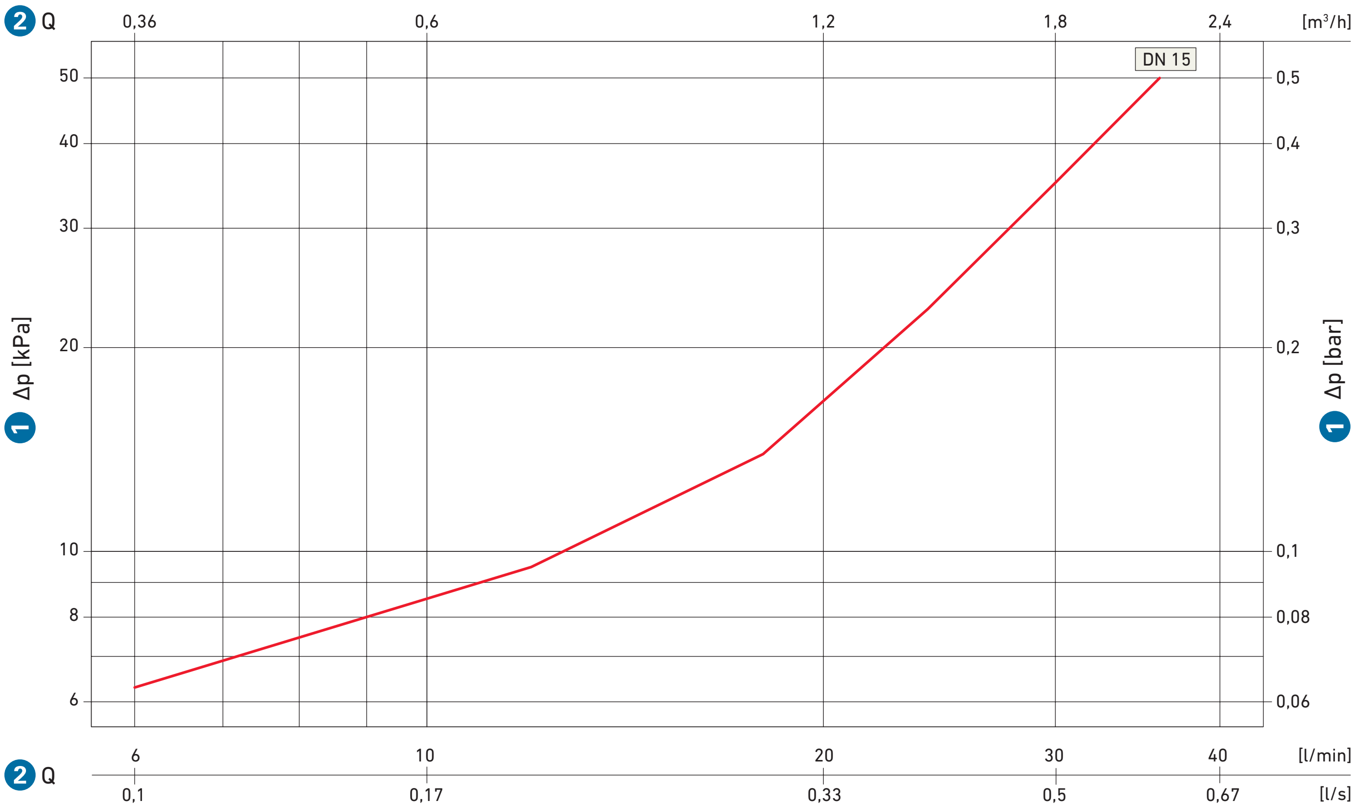
JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
6303	GN ½" (DN15)	16	90	Inlet: Female pipe thread Outlet: Pipe threads (end cap)

6303



1. Handwheel
2. Valve rod
3. O-ring
4. Backflow seal
5. Compression spring
6. Flow body
7. Valve seal
8. End cap
9. Plug

Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
6303.240	Filling valve	GN ½" (DN15)	2.4	14.1

1 Pressure loss
2 Volumetric flow rate

Product description

The JRG LegioStop filling valve, equipped with a return flow inhibitor, can be used to fill devices or installations.
The return flow inhibitor is a mechanical safety device that allows flow in one direction only.

Features and functions

The return flow inhibitor integrated into the filling valve allows the safe filling of devices or installations.

Benefits and features

- Free of dead spaces
- Permanently smooth-running
- Non-rising handwheel
- Interchangeable medium marking plate
- Valve position can be seen and felt by touch
- Valve seat made of stainless steel

Mounting position

The filling valve can be installed regardless of its position.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Spare parts

- Upper parts
- End cap

V

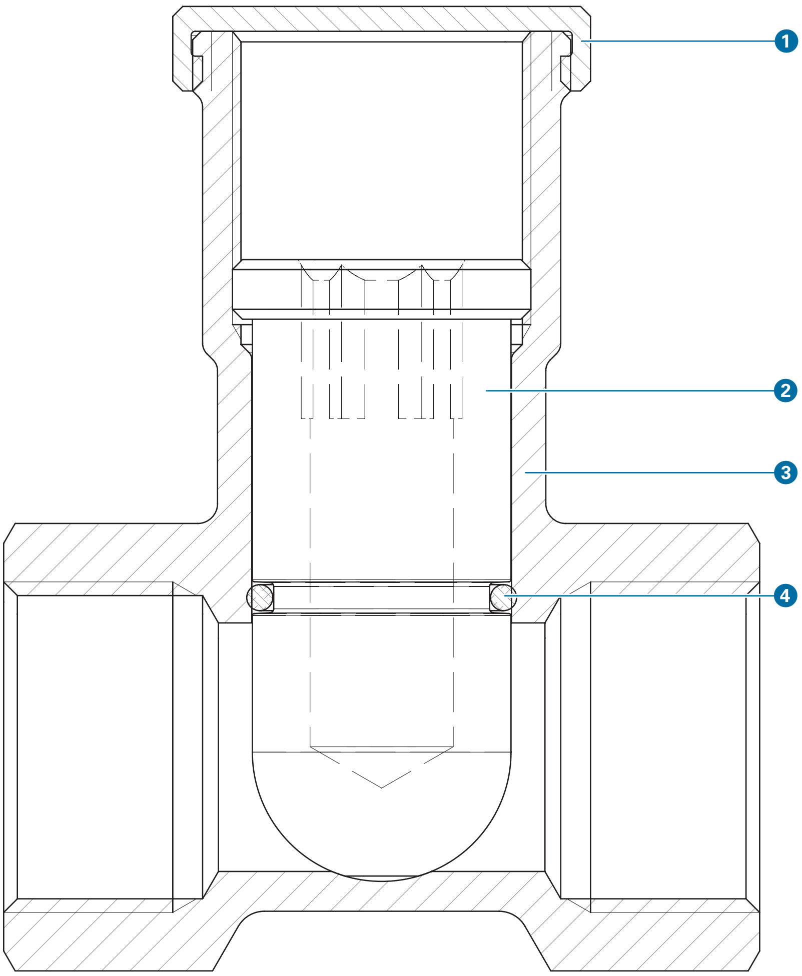
Regulating socket 6310

The regulating socket is a simple fitting for hot water circulation systems. The regulating nipple is used to change the cross section of the valve and thus the volumetric flow is changed.

Technical Data

JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
6310	GN ½" – 1¼" (DN15 – 32)	16	90	Female thread

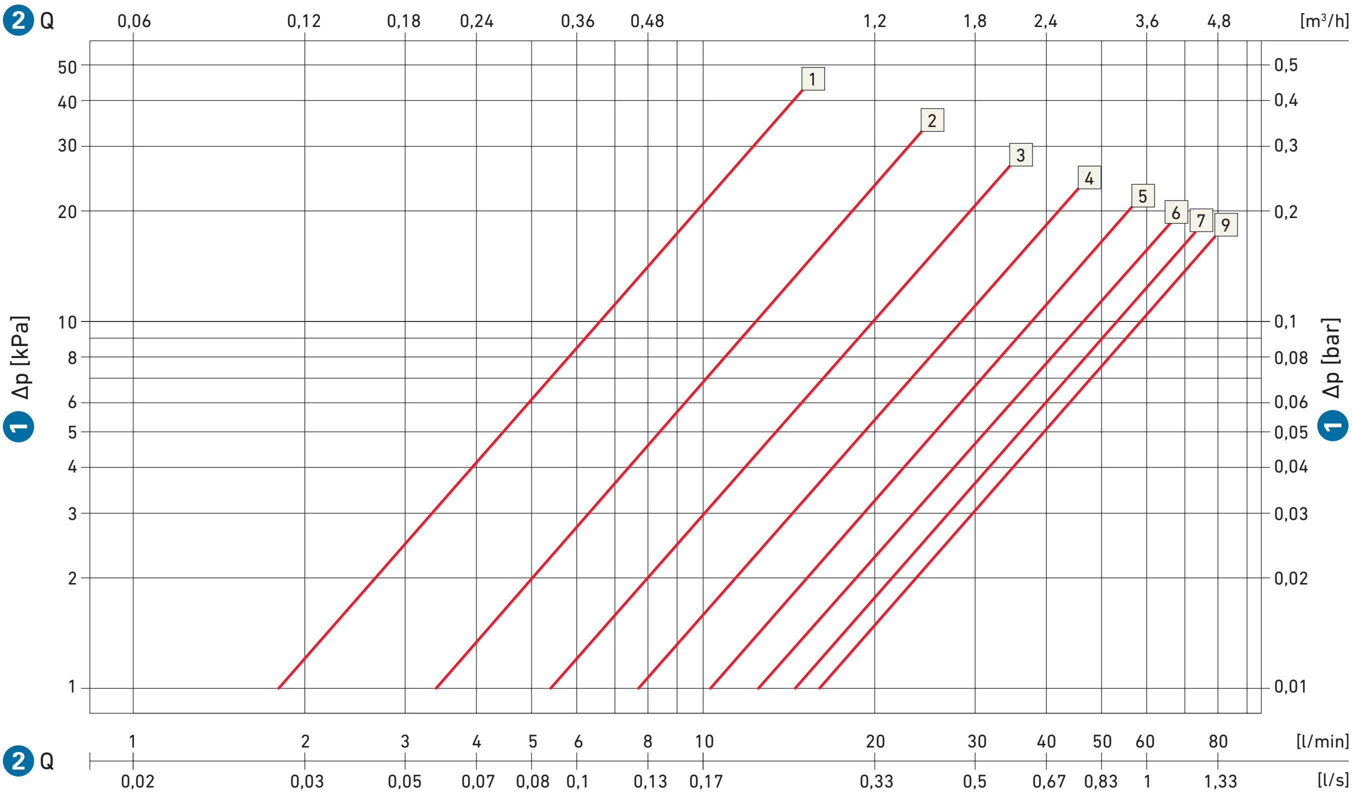
6310



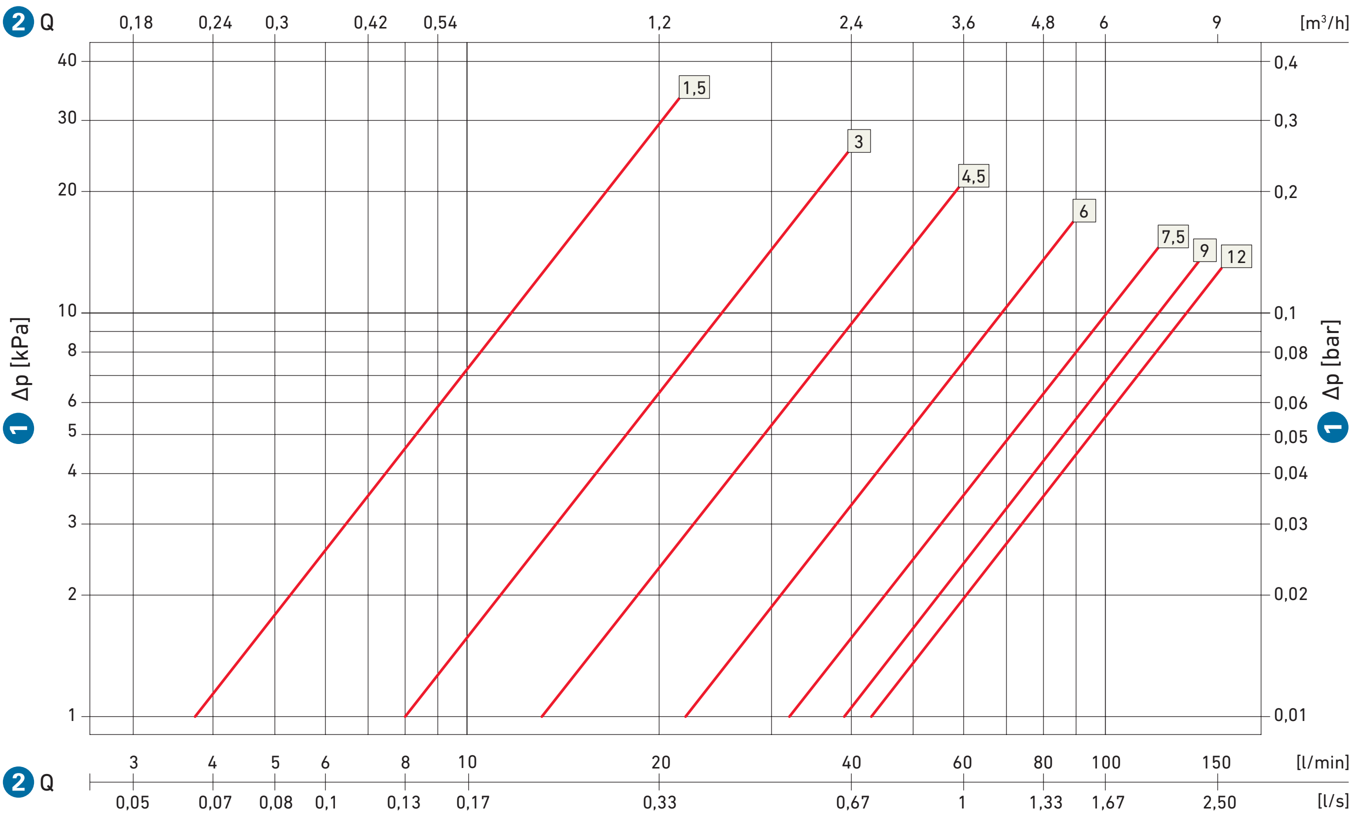
1. Sealing cover
2. Regulating nipple
3. Housing
4. O-ring

Performance charts

Regulating socket ½"



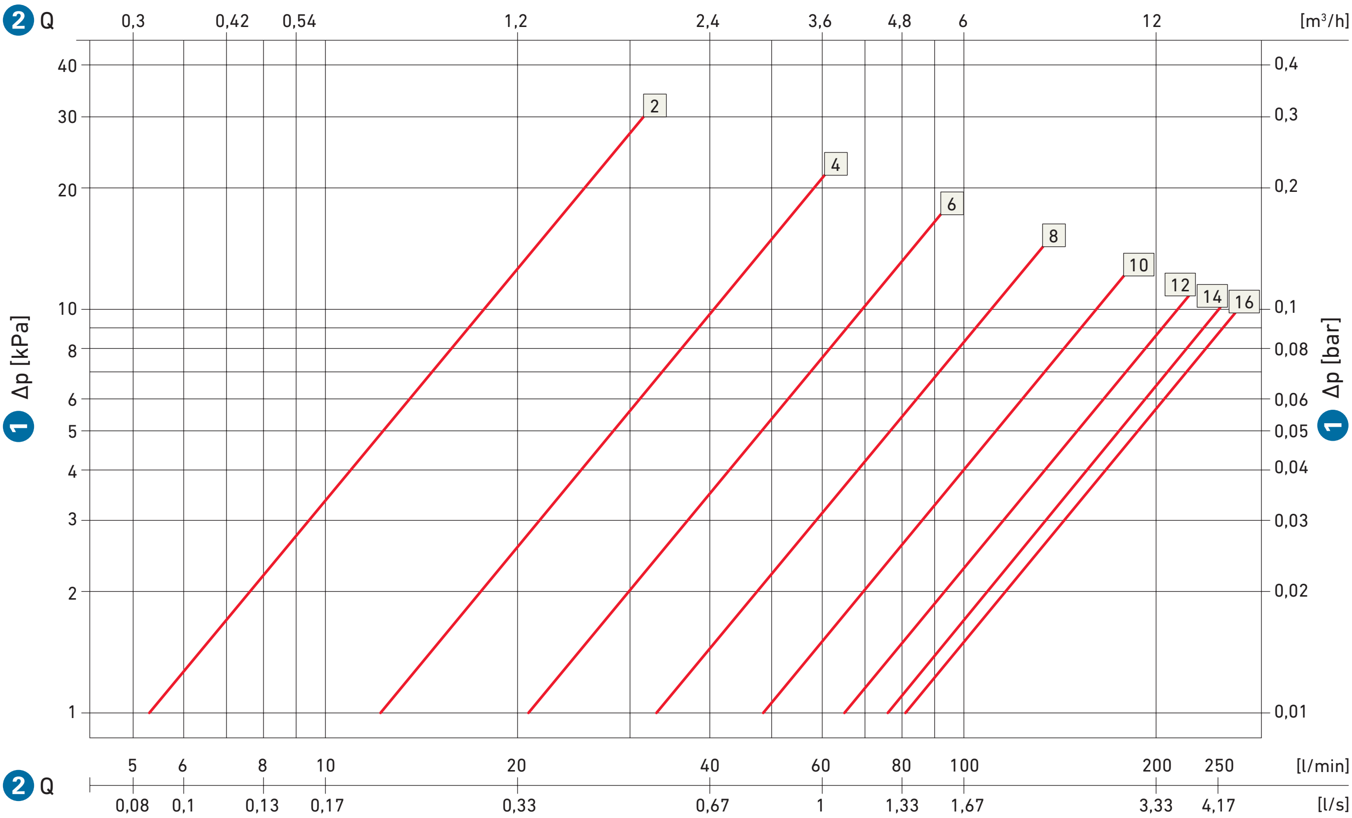
Regulating socket ¾"



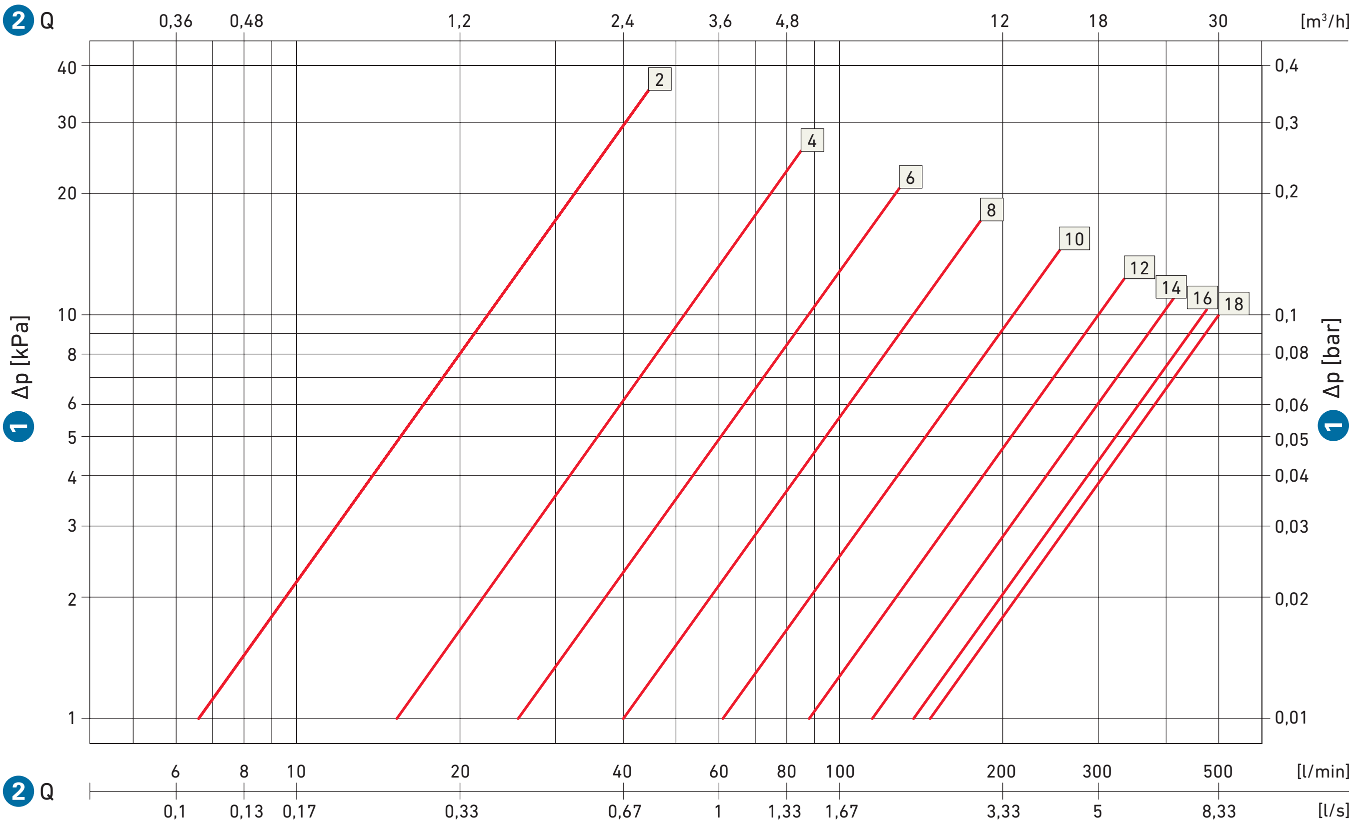
1 Pressure loss
2 Volumetric flow rate
6 Number of turns to open the device

Performance charts

Regulating socket 1"



Regulating socket 1¼"



1 Pressure loss
2 Volumetric flow rate
6 Number of turns to open the device

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
6310.240	Regulating socket	GN ½" (DN15)	11.0	0.7
6310.320		GN ¾" (DN20)	25.4	0.4
6310.400		GN 1" (DN25)	51.2	0.2
6310.480		GN 1¼" (DN32)	102.5	0.2

Product description

The regulating socket is a simple fitting for hot water circulation systems. The regulating nipple is used to change the cross section of the valve and thus the volumetric flow is changed.

Features and functions

The valve allows the constant adjustment of the flow rate by regulating the cross section of the installation.

Benefits and features

- Housing made of gunmetal
- All water-conveying parts are made of gunmetal, brass or EPDM
- Simple operation

Mounting position

The regulating socket can be mounted regardless of its position.

☑ Ensure to install the regulating socket in a place easy to access. Tension in the pipeline must be avoided.

☑ For maintenance tasks, a minimum clearance equal to the dimension “h” must be maintained.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Spare parts

- Regulating nipple with O-ring
- Sealing cover

V

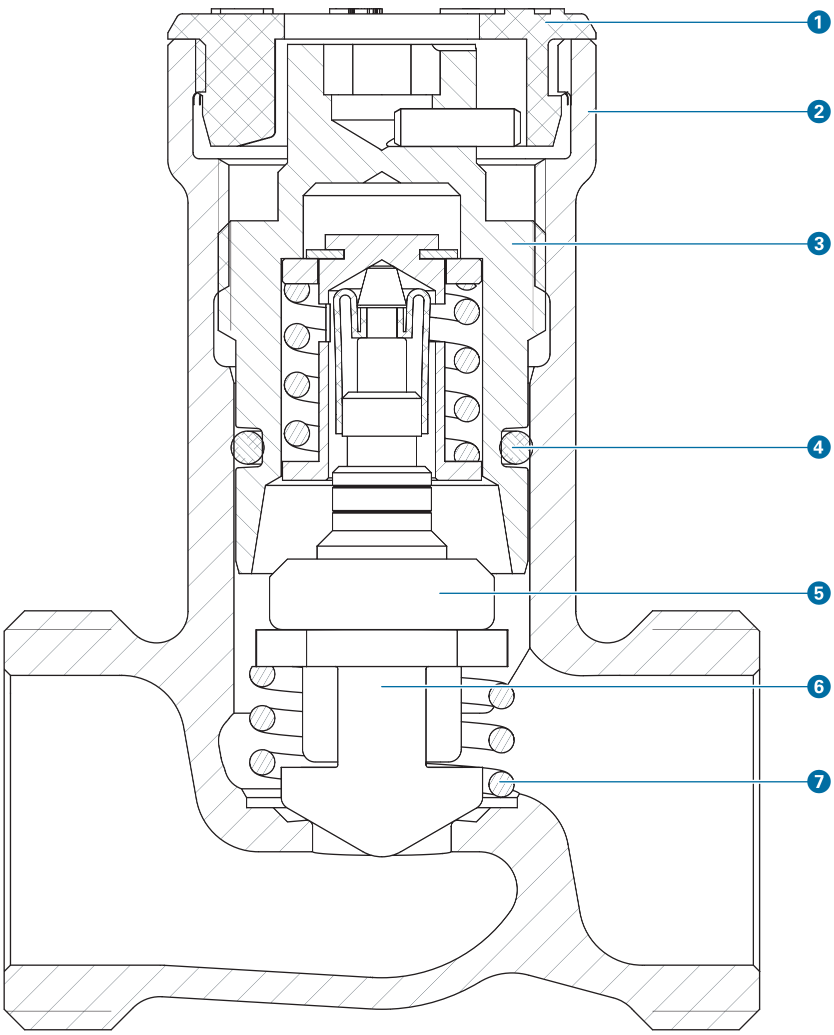
Circulation controller JRGUTHERM 6320

The thermostatic circulation controller JRGUTHERM is an automatic regulating device for hot water circuits.

Technical Data

JRG code	Dimension	Nominal pressure PN	Differential pressure max. [kPa (bar)]	Temperature max. [°C]	Connections
6320	GN ½" – ¾" (DN15 – 20)	10	40 (0.4)	ex factory: 57 max. 70	External thread

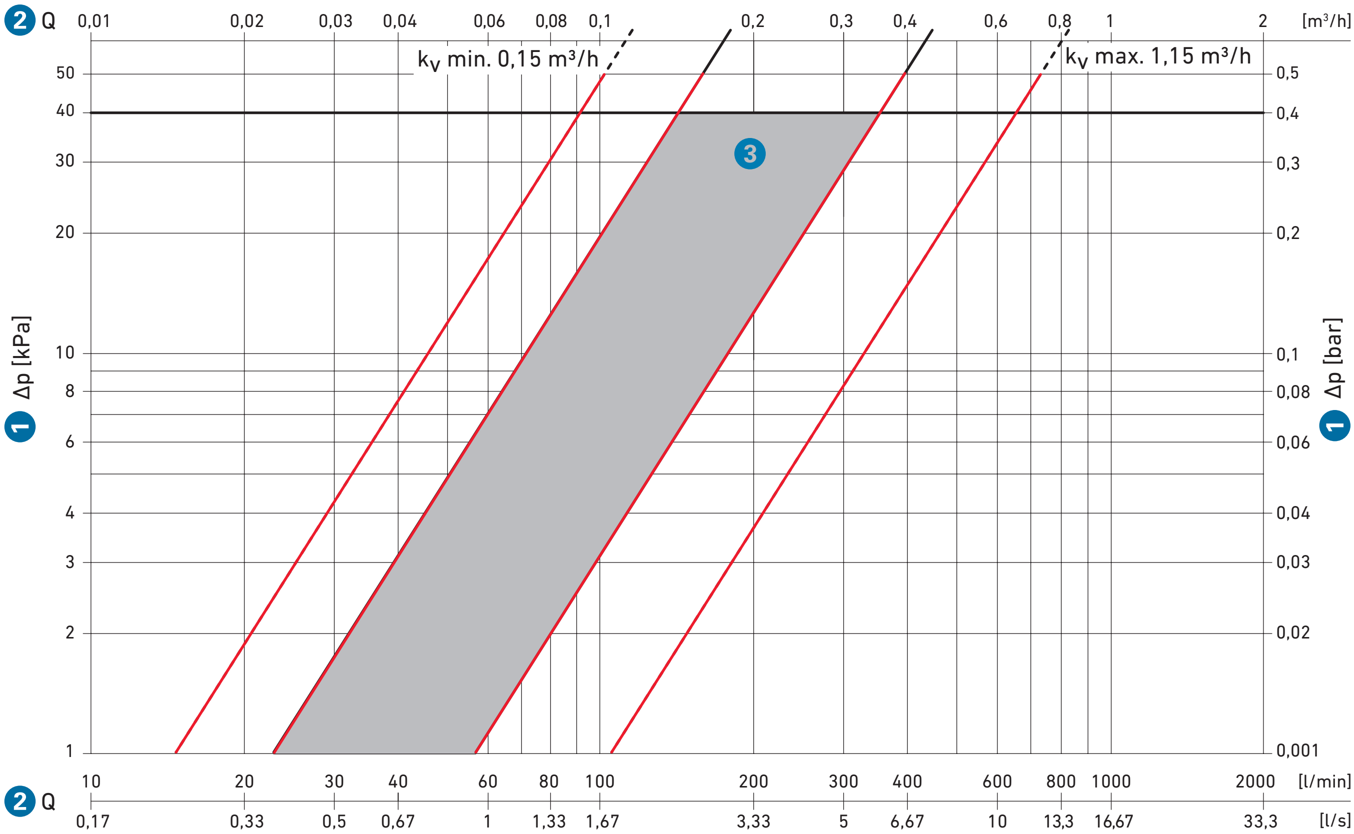
6320



1. Scale ring
2. Housing
3. Regulating bushing
4. O-ring
5. Thermostat
6. Regulator
7. Spring

Performance chart

top



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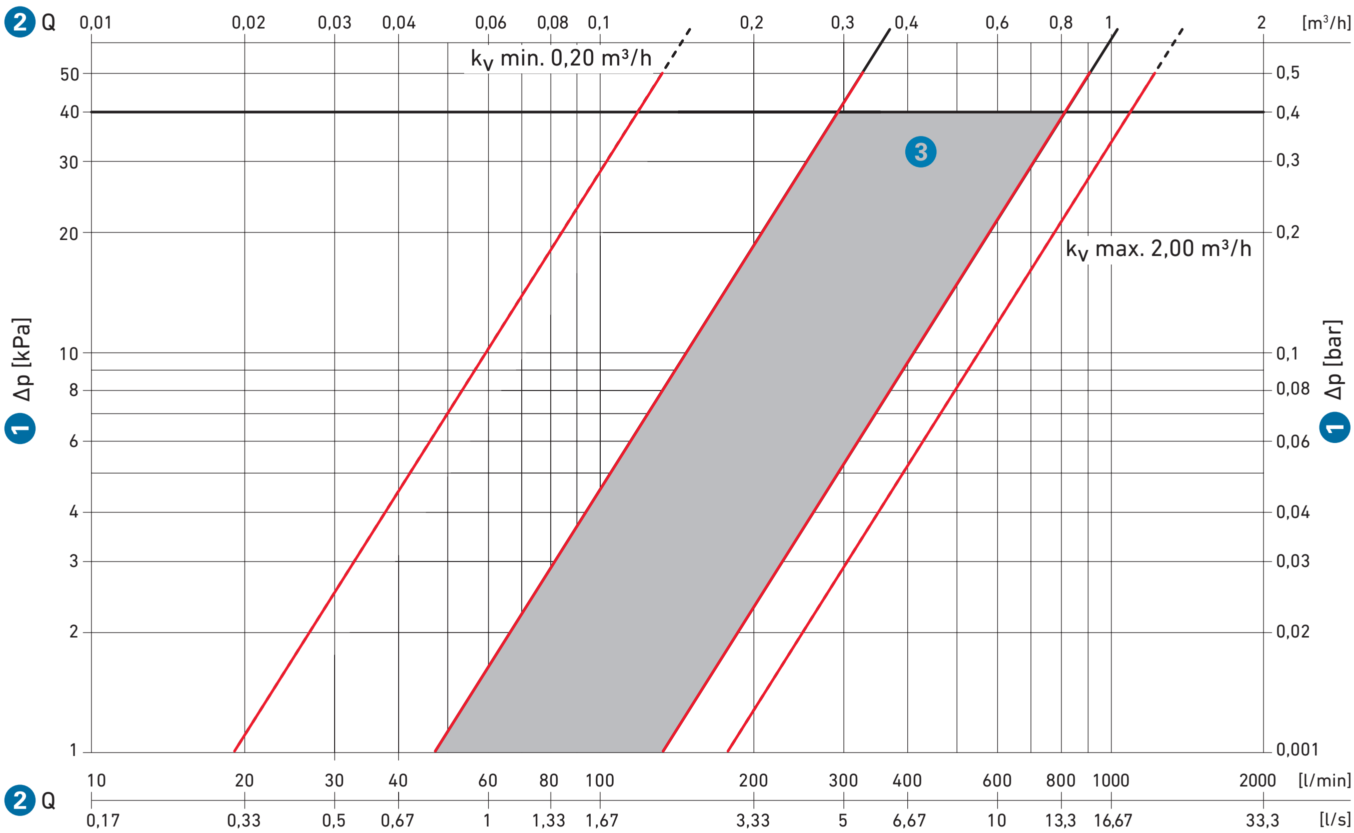


1 Pressure loss
2 Volumetric flow rate
3 optimum range

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
6320.914	Circulation controller JRGUTHERM	GN ½" (DN15)	1.15	–
6320.924		GN ¾" (DN20)	2.0	–

Product description

The thermostatic circulation controller JRGUTHERM is an automatic regulating device for hot water circuits.

Features and functions

The valve regulates the volumetric flow by using a thermostat that continuously measures the water temperature and automatically implements the hydraulic balancing. The controller is protected against excessive temperature. After the installation and adjustment, the packaging is used as thermal insulation.

☑ Do **not** use the JRGUTHERM circulation controller for gravity circulation purposes.

Features and benefits

- Simplifies the circulation calculation
- Pre-settings need not be calculated
- Maintenance-free
- Automatic regulation of the volumetric flow (hydraulic balancing)
- Shorter heating up phase after lowering the temperature
- Energy saving

Mounting position and installation tips

The circulation controller JRGUTHERM can be installed regardless its of position.
For revision purposes, we recommend installing shut-off devices (JRG Code 8339) upstream and downstream of the circulation controller.

☑ If there is a risk of medium flowing through the JRGUTHERM controller against the direction of flow: Avoid incorrect flow direction by installing suitable return flow inhibitors.

When using appropriate adaptor unions, return flow inhibitors and shut-off valves can be installed forthwith.

☑ When using thermal disinfection: Provide a bypass for the controller.

☑ Maintain a minimum distance of 1.0 m from the heat source.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents

- Assembly instruction
- Operating and maintenance instruction

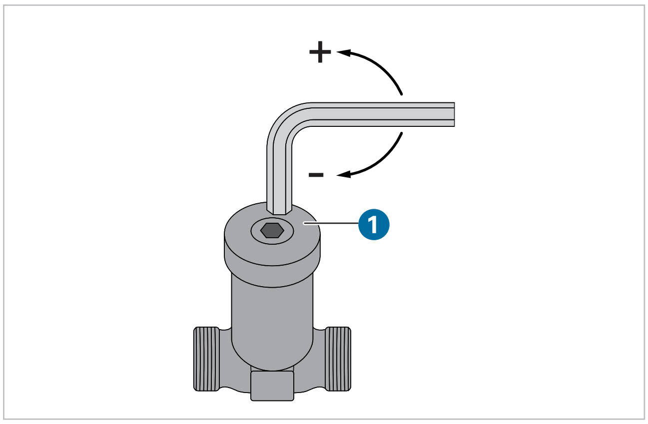
In order to download the documents, go to www.gfps.com (D/F/I/E).

Balancing the circulation controller

If the machine operator changes the factory setting, he does so on his own responsibility. The factory setting can be changed.

→ Insert a socket head wrench into the hexagon socket.
→ Turn the key clockwise in order to correct and lower the temperature.
→ Turn the key anti-clockwise in order to correct and raise the temperature.

Value on scale ① JRGUTHERM	Set value circulation [°C]
1	36
2	41
3	45
4	49
5	53
6 (Factory setting)	**57**
7	63

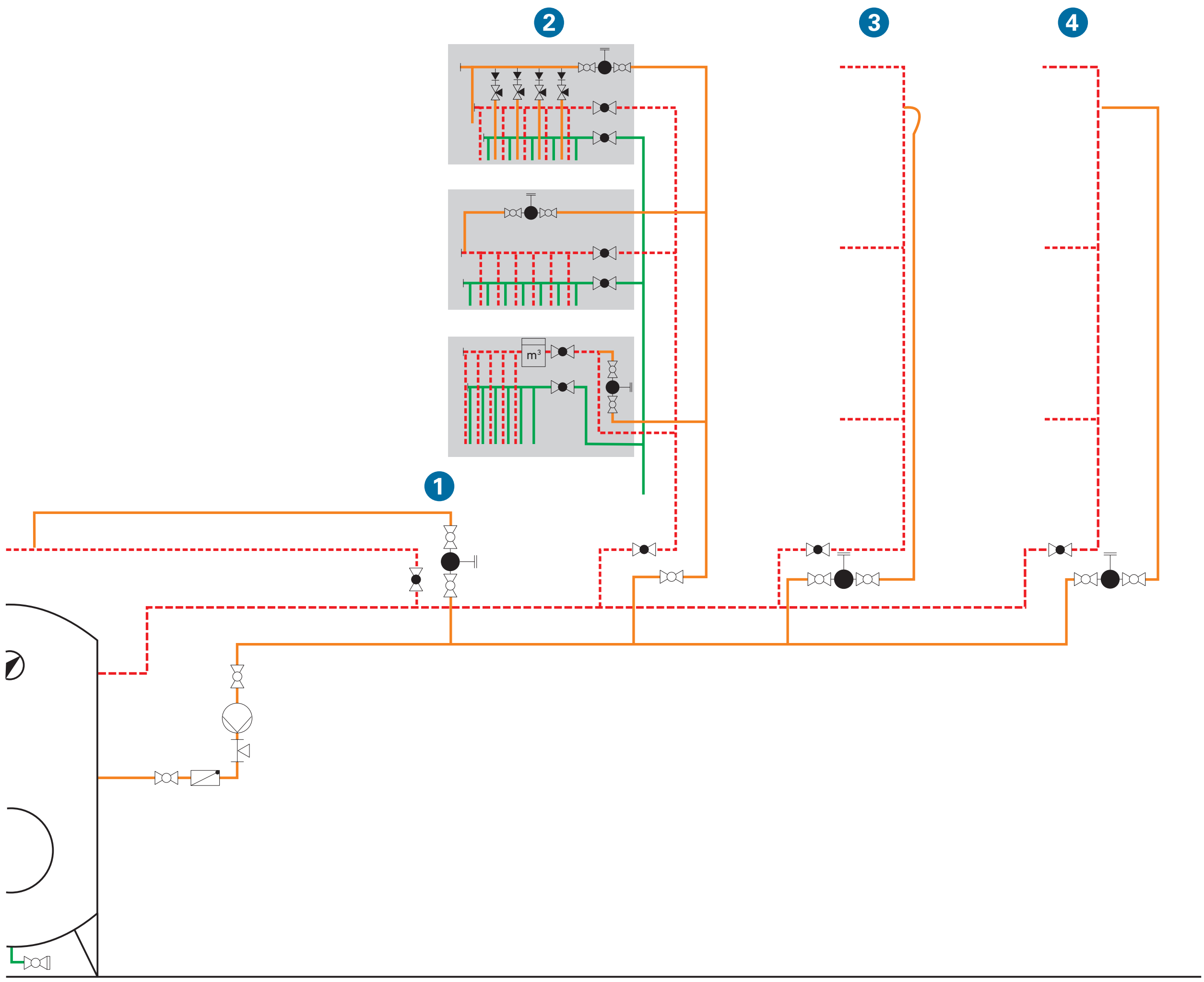


① Scale

Spare parts

- Insulation box

Installation example



DIN	Meaning	JRG code	SNEN
	PWC – TWK	–	
	PWH – TWW – WWV	–	
	PWH-C – TWZ – WW – WWR	–	
	Shut-off valve	5200 – 5034	
	Return flow inhibitor	1610 – 1615	
	Flap trap	1682	
	Regulating device	6310	
	JRGUTHERM 2T Circulation controller	6325	
	Circulation pump	–	
	Drain valve	6000 .. 6012	
	Circulation collector	–	
	Residential water meter	5450	
	Ball valve	6020/6023	

1. Single circulation
2. Upper distribution
3. Pipe to pipe
4. conventional

PWC	Cold water
PWH	Hot water
PWH-C	Circulation
TWK	Drinking water, cold
TWW	Drinking water, hot
TWZ	Drinking water, circulation
WW	Hot water
WWR	Hot water, return line
WWV	Hot water, supply line

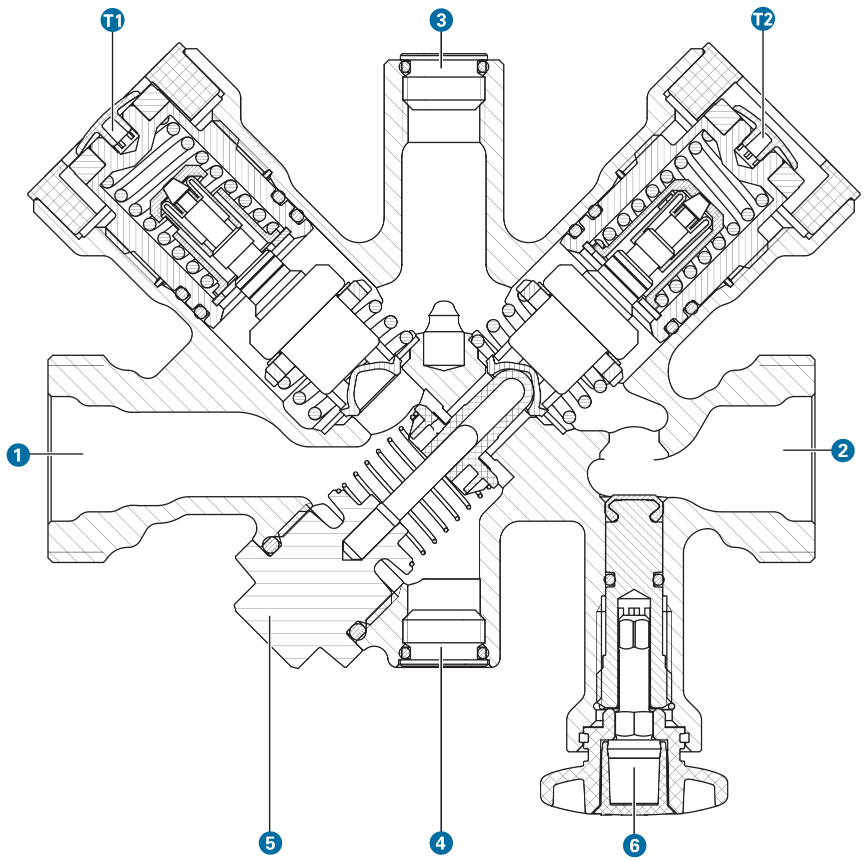
Circulation controller JRGUTHERM 2T 6325

The circulation controller JRGUTHERM 2T for hot water circuits ensures hydraulic balancing as a function of the given temperature. In addition to the standard function, the controller is used wherever a thermal disinfection of the hot water installation is required.

Technical Data

JRG code	Dimension	Nominal pressure PN	Differential pressure max. [kPa (bar)]	Setting range [°C]	Temperature max. [°C]	Connections
6325	GN ½" – ¾" (DN15 – 20)	10	40 (0.4)	T1: 35 – 60 T2: 70 – 75	90	External thread

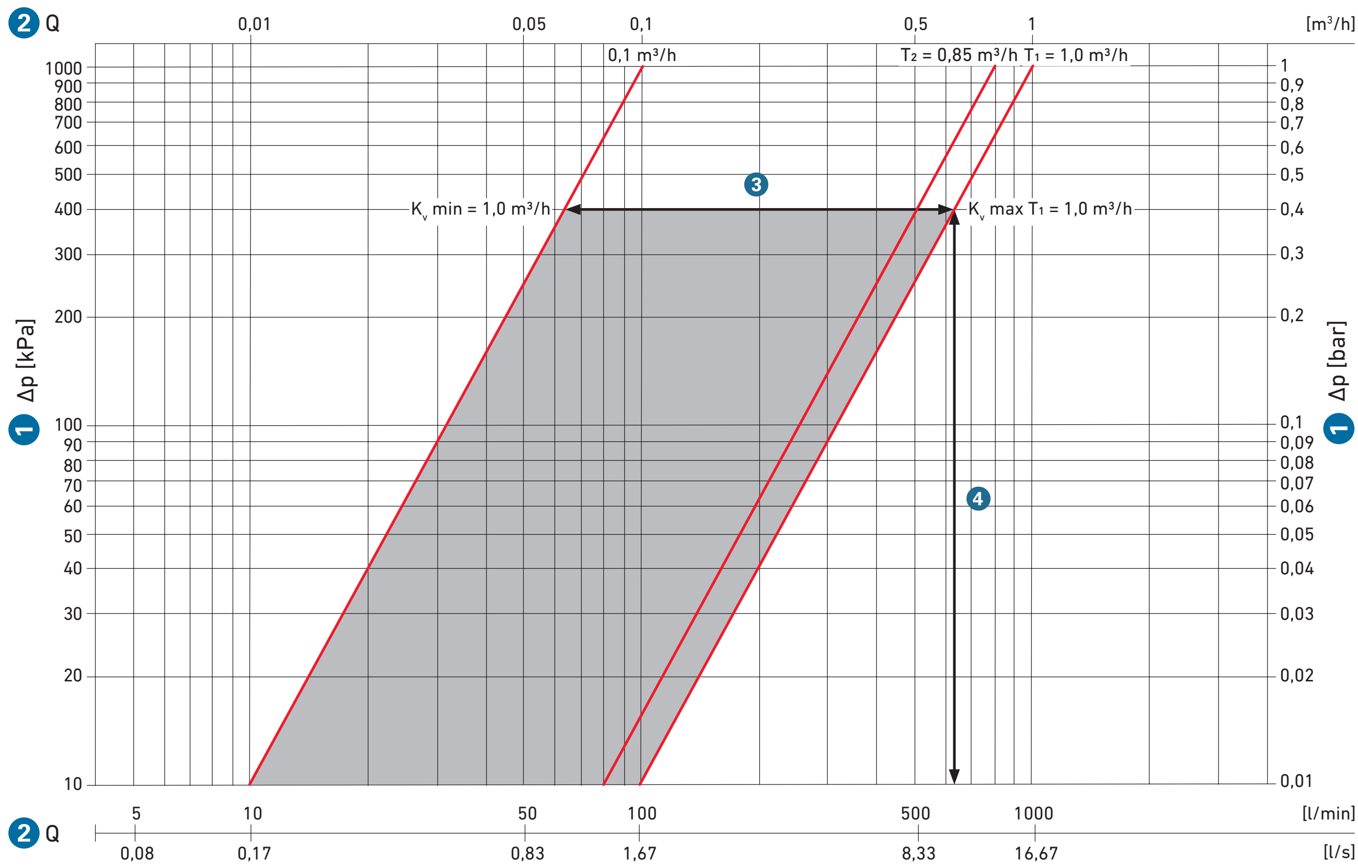
6325



1. Primary connection
2. Secondary connection
3. Connection for Thermometer/temperature sensor PT 1000
4. Connection for drain valve/ sampling valve
5. Stem for basic quantity bore hole
6. Shut-off valve

T1 Valve for hydraulic balancing
T2 Thermal disinfection valve

Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
6325.015	Circulation controller JRGUTHERM 2T	GN ½" (DN15)	1.0	–
6325.020		GN ½" (DN20)	1.0	–

1. Pressure loss
2. Circulation volumetric flow
3. K_v range T_1
4. Recommended application area

Product description

The circulation controller JRGUTHERM 2T ensures the hydraulic balancing as a function of the given temperature. In addition to the standard function, the controller is used wherever a thermal disinfection of the hot water installation is required.

Features and functions

During normal operation (T_1) and in thermal disinfection mode (T_2), the valve—which is secured against overtemperature—regulates the volumetric flows with two thermostats and implements the hydraulic balancing automatically. After the installation and adjustment, the packaging is used as thermal insulation.

☑ Do **not** use the JRGUTHERM 2T circulation controller for gravity circulation purposes.

K_v range und application area

➨ Performance chart

Even with this self-regulating circulation controller a simplified design of the system is possible. The recommended temperature difference between the DHW heater and the JRGUTHERM 2T is 2 to 5 K.

In order to select a suitable circulation pump, the flow rate of the entire system must be determined. The pressure loss of the JRGUTHERM 2T is read off the $K_v$max line of the performance diagram. The controllers in the other pipelines should be selected so that the intersection of the volumetric flow and the required pressure drop is within the design field.

Features and benefits

- Automatic hydraulic balancing, thermally controlled
- Simple circulation calculation
- Pre-settings need not be calculated
- Two temperatures, two thermostats
- Energy savings through precise adjustment
- Control via poppet valves
- Without external energy
- Basic quantity bore hole inactive during disinfection phase

Mounting position and installation tips

The circulation controller JRGUTHERM 2T can be installed regardless its of position.

☑ A JRGUTHERM 2T must be installed in all circulation circuits.

☑ Maintain a minimum distance of 1.0 m from the heat source.

☑ If there is a risk of medium flowing through the JRGUTHERM 2T controller against the direction of flow: Avoid incorrect flow direction by installing suitable return flow inhibitors.

When using appropriate adaptor unions, return flow inhibitors and shut-off valves can be installed forthwith. We recommend the installation of screw connections with return flow inhibitors (JRG Code 8208).

For revision purposes, we recommend installing shut-off devices (JRG Code 8339) upstream and downstream of the circulation controller.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents

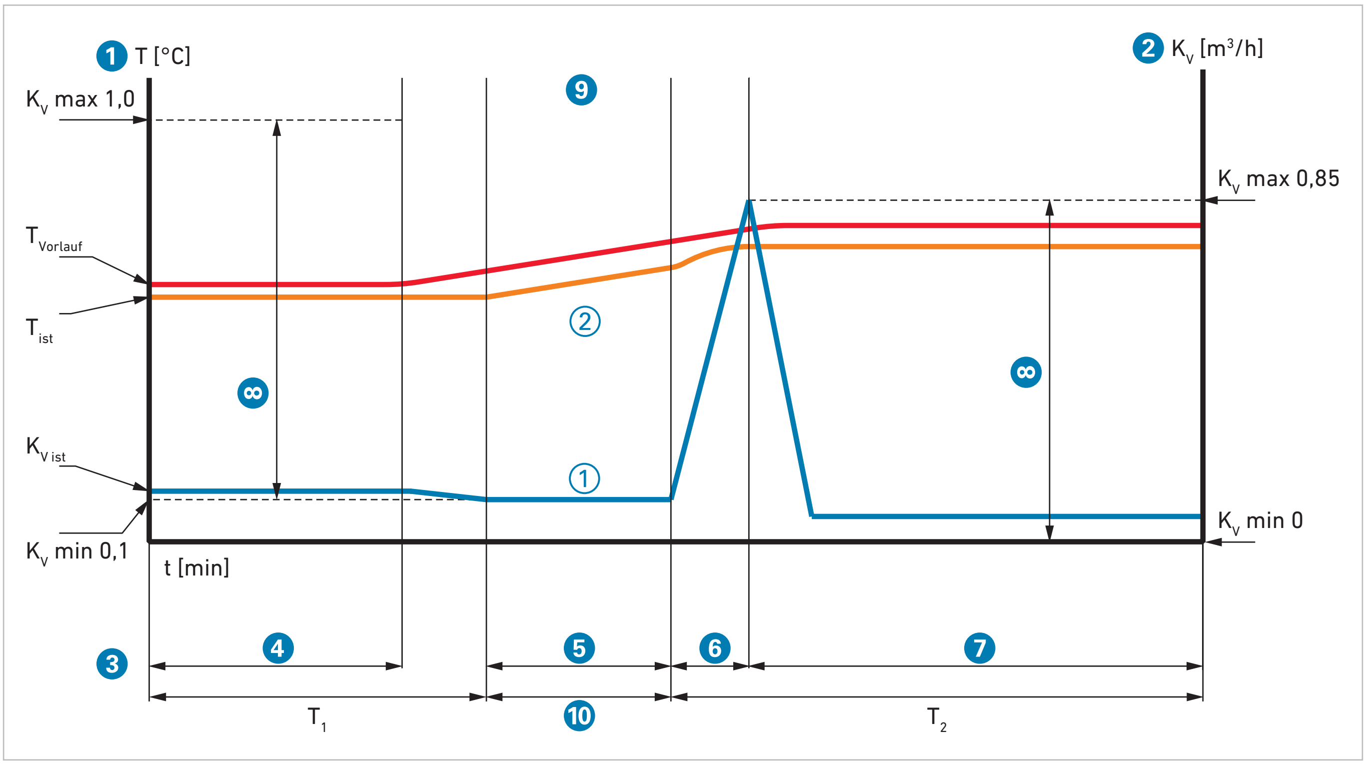
- Assembly instruction
- Operating and maintenance instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Control features

Control characteristic with factory setpoint specification:

- T_1: Hot water temperature 58°C (range: 35 to 60°C)
- T_2: Disinfection 70°C (range: 70 to 75°C)

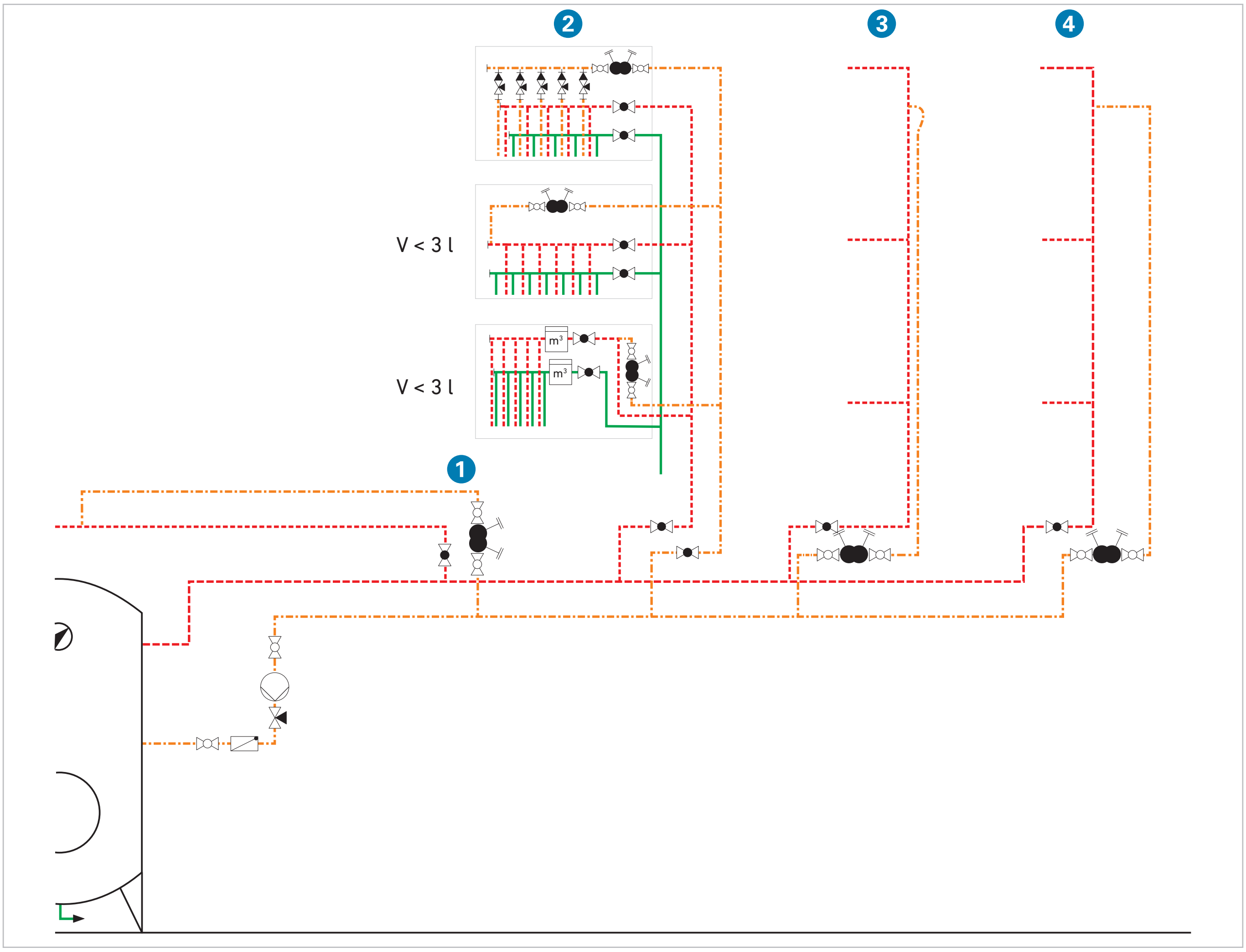


Operating phases	Description of the control features:
Phase 1	The hot water temperature is controlled. The thermostat T1 regulates the balancing temperature with the factory setting of 58°C.
Phase 2	Increasing the temperature of the hot water supply initiates the thermal disinfection of the JRGUTHERM 2T.
Phase 3	At the factory setting, the change-over is initiated at 66°C, during which the valve briefly moves to the maximum K_v value T2. The thermal disinfection starts and the balancing temperature of 70°C is set.
Phase 4	The disinfection temperature is regulated to the adjusted balancing temperature T2. The balance between the heat output and the required amount of water is adjusted to each other and thus the thermal balance is automatically controlled. The basic quantity bore hole becomes inactive and the amount of water is reduced to the necessary mass flow.

❶ Temperature
❷ Volumetric flow or pressure difference
❸ Operating phases
❹ Operating phase 1
❺ Operating phase 2
❻ Operating phase 3
❼ Operating phase 4
❽ Operating range
❾ DHW heaters
❿ Basic quantity

① K_v value
② JRGUTHERM 2T

Installation example



DIN	Text	JRG code	SNEN
	PWC – TWK, cold water		
	PWH – TWW, Hot water – WWV		
	PWH-C – TWZ, circulation WW – WWR		
	Shut-off valve	5200-34	
	Return flow inhibitor	1610-15	
	Flap trap	1682	
	Regulating device	6310	
	JRGUTHERM 2T Circulation controller	6325	
	Circulation pump		
	Drain valve	6000-12	
	Circulation collector		
	Residential water meter	5450	
	Ball valve	6020/23	

1 Single circulation
2 Upper distribution
3 Pipe to pipe
4 conventional

PWC	Cold water
PWH	Hot water
PWH-C	Circulation
TWK	Drinking water, cold
TWW	Drinking water, hot
TWZ	Drinking water, circulation
WW	Hot water
WWR	Hot water, return line
WWV	Hot water, supply line

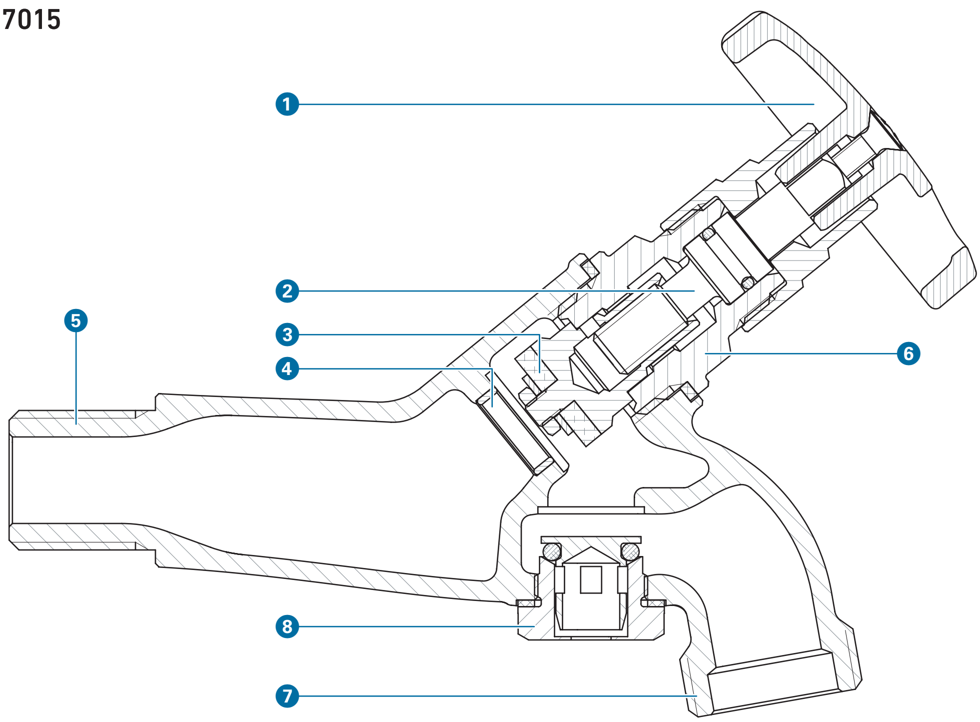
Tap 7015, 7016

The tap is a fitting to which a hose can be connected.

Technical Data

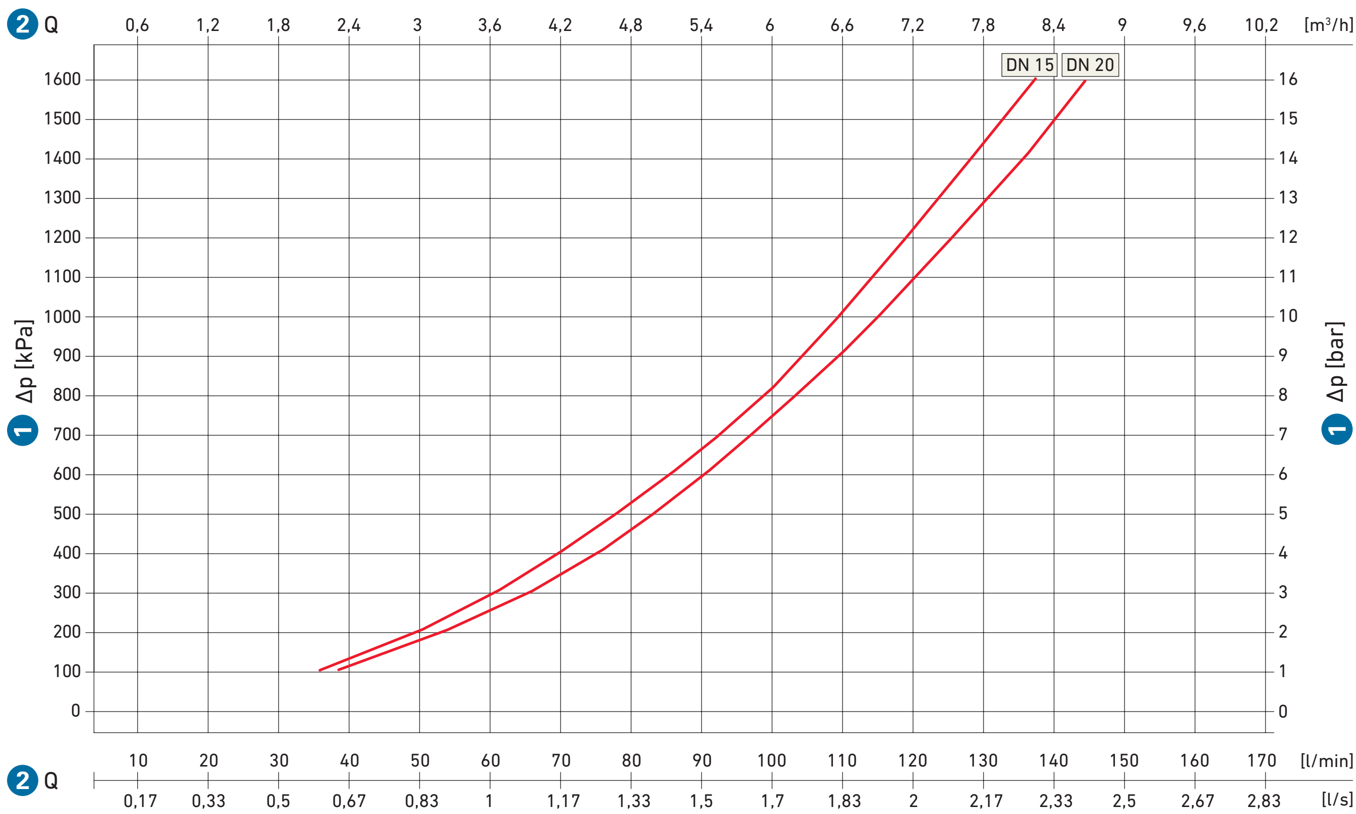
JRG code	Components	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
7015	• Pipe aerator • Tight fit • Upper part with hand wheel	GN ½" – ¾" (DN15 – 20)	16	65	Inlet: Tapered external thread Outlet: Pipe threads
7016	• Pipe aerator • Tight fit • Upper part with T-handle				

7015



1. Handwheel (7016: T-handle)
2. Valve rod
3. Valve seal
4. Valve seat
5. Valve body
6. Upper part of valve
7. Hose connection
8. Pipe aerator

Performance chart



1 Pressure
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN15	II

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
7015.240	Faucet	GN ½" (DN15)	4.3	4.4
7015.320		GN ¾" (DN20)	4.5	12.6
7016.240	Faucet	GN ½" (DN15)	4.3	4.4
7016.320		GN ¾" (DN20)	4.5	12.6

Product description

The tap is a fitting to which a hose can be connected.

Features and functions

The tap is equipped with a pipe aerator and a threaded connection for hose couplings.

Benefits and features

- Surface raw and chrome-plated
- Operation with handwheel and T-handle (socket wrench optional)
- Operation with socket wrench after disassembly of the handwheel/T-handle possible

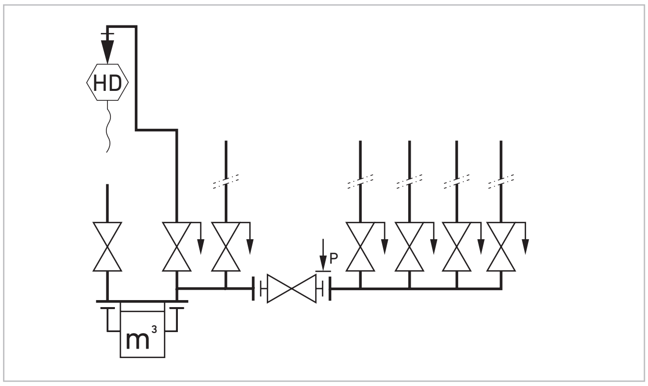
Mounting position and installation tips

The taps can be installed regardless of their position.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Installation example



GV.36 **Installation diagram**

Spare parts

- Upper parts
- Pipe aerator
- Handwheel
- T-handle
- Socket wrench

V

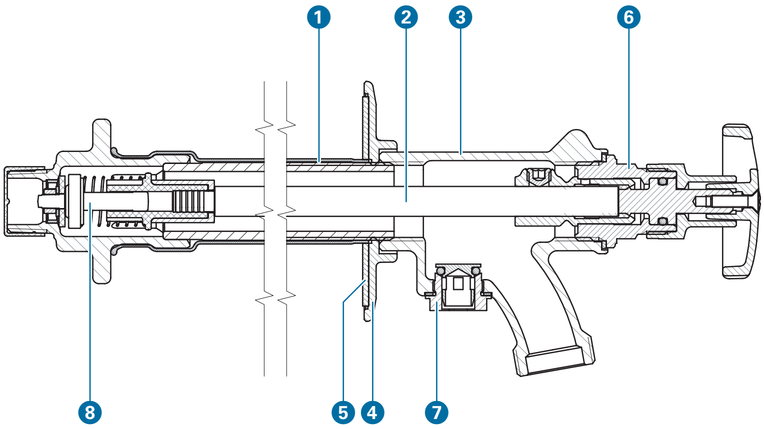
Garden valve antifrost 7040

Based on its design, the Garden antifrost valve is a discharge fitting that allows the water supply all year-round.

Technical Data

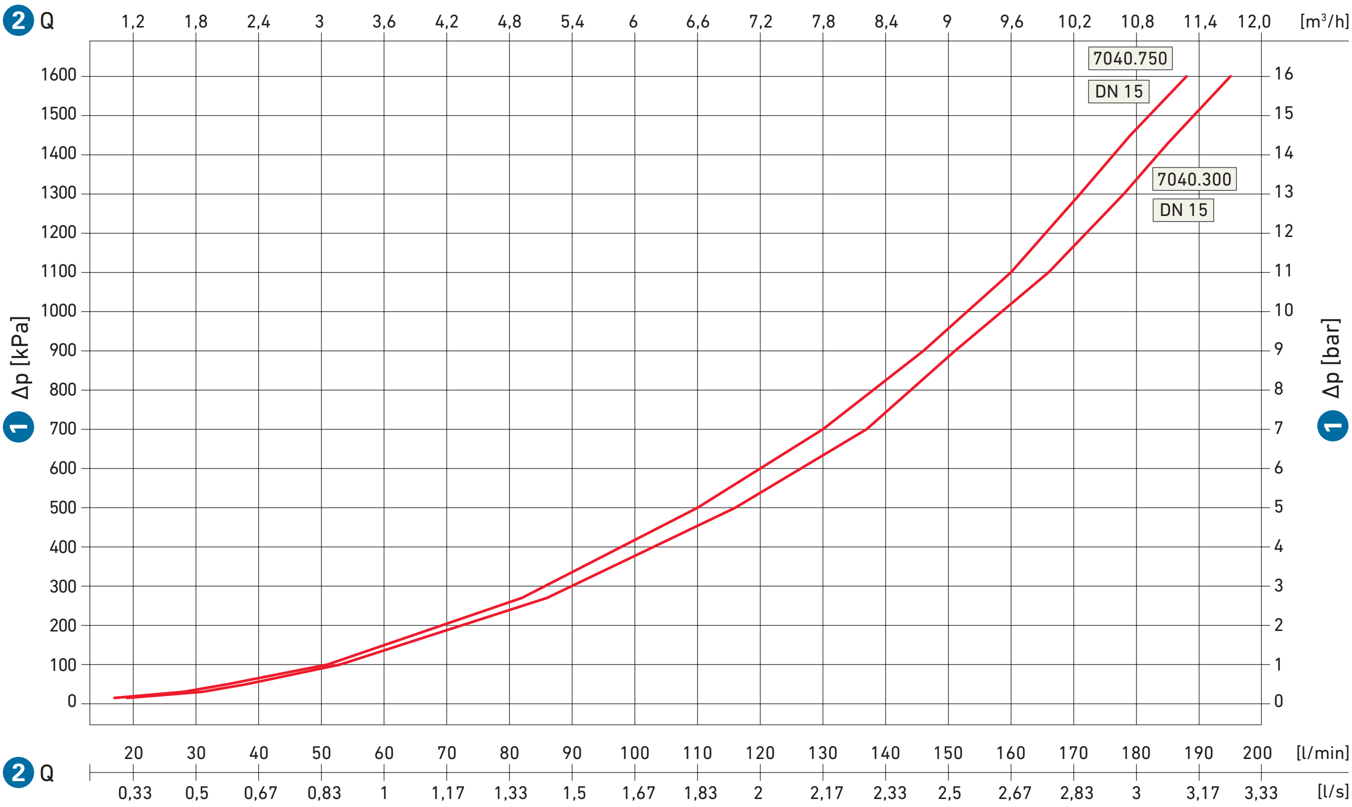
JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
7040	GN ½" (DN15)	16	90	Tapered external thread

7040



1. Connection housing with extension
2. Spindle
3. Valve body
4. Rosette
5. Soundproof ring attached to rosette
6. Upper part with operating handle
7. Pipe aerator
8. Return flow inhibitor

Performance chart



1 Pressure
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN15	I

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
7040	Garden valve antifrost	GN ½" (DN15)	6.0	2.3

Product description

Based on its design, the Garden antifrost valve is a discharge fitting that allows the water supply all year-round.

Features and functions

Since the valve seat is placed in the warm area of the building envelope, the garden valve is not prone to frost.

Features and benefits

- Handwheel made of metal, chrome-plated; also serves as a socket wrench
- UV-resistant
- Short coast-down time
- Chrome steel seat
- All parts that come in contact with the medium while the valve is closed are made of gunmetal

Mounting position and installation tips

☑ The garden valve antifrost must only be installed horizontally, with a slight slope to the outside.
- Make sure that the connection housing is in an area that is not prone to frost.

☑ If there is a risk of frost: Remove attached garden hoses to allow complete draining of the garden valve.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents

- Installation regulations, assembly and operating instructions

In order to download the documents, go to www.gfps.com (D/F/I/E).

Installation examples

Depending on the installation circumstances, the installation examples are shown in the applicable instructions.

Spare parts

- Spare parts set (plastic valve cone, spring and O-ring)
- Valve stem
- Pipe aerator
- Upper part with operating handle
- Operating handle with screw
- Rosette

V

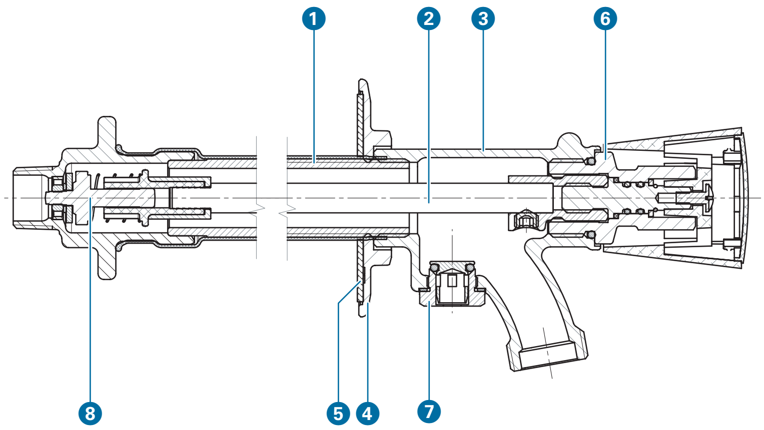
Garden valve antifrost 7045

Based on its design, the Garden antifrost valve is a discharge fitting that allows the water supply all year-round.

Technical Data

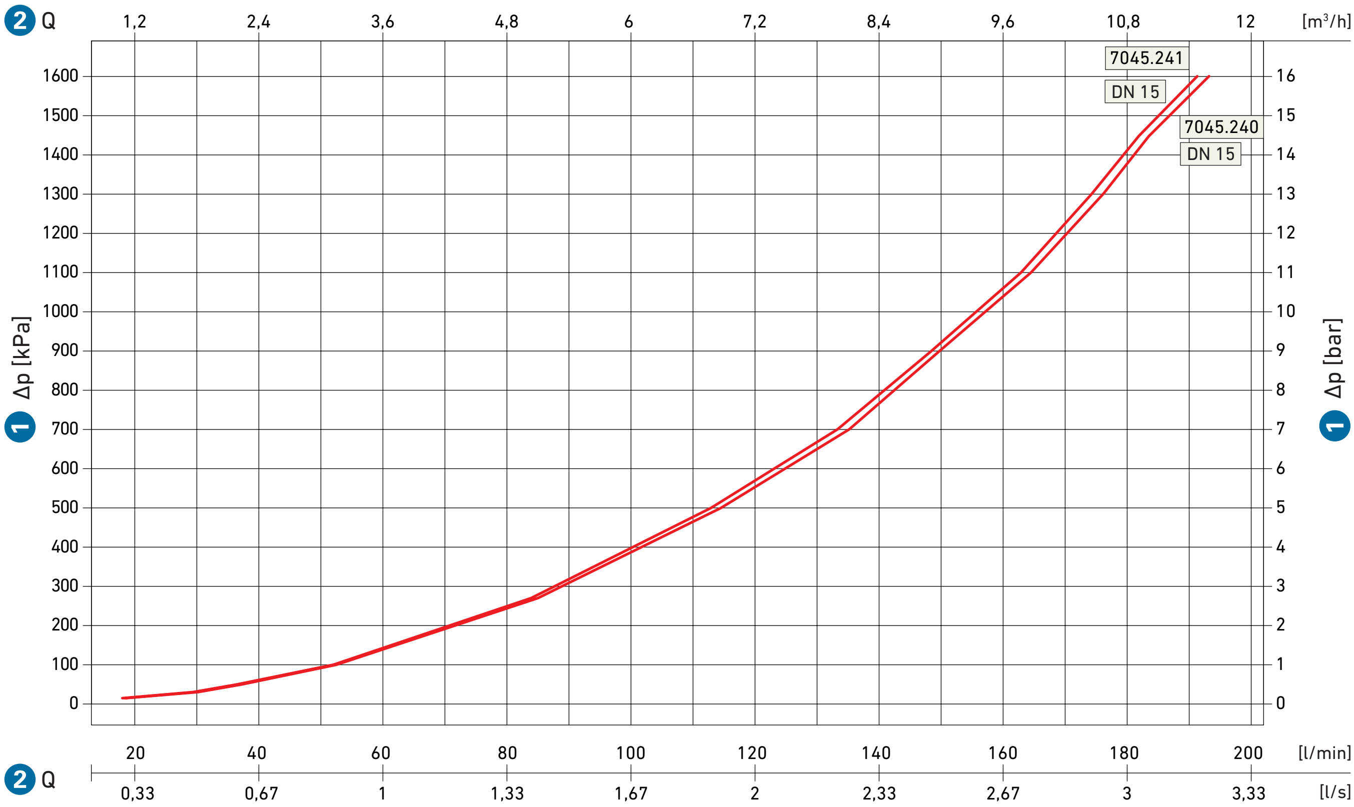
JRG code	Dimension	Nominal pressure PN	Temperature max. [°C]	Connections
7045	GN ½" – ¾" (DN15 – 20)	16	90	Tapered external thread

7045



1. Connection housing with extension
2. Spindle
3. Valve body
4. Rosette
5. Soundproof ring attached to rosette
6. Upper part with operating handle
7. Pipe aerator
8. Return flow inhibitor

Performance chart



1 Pressure
2 Volumetric flow rate

Noise behaviour

Dimension	Group of valves
DN15 – 20	I

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
7045	Garden valve antifrost	GN ½" – ¾" (DN15 – 20)	6.0	2.3

Product description

Based on its design, the Garden antifrost valve is a discharge fitting that allows the water supply all year-round.

Features and functions

Since the valve seat is placed in the warm area of the building envelope, the garden valve is not prone to frost.

Features and benefits

- UV-resistant
- Short coast-down time
- Chrome steel seat
- All parts that come in contact with the medium while the valve is closed are made of gunmetal

Mounting position and installation tips

☑ The garden valve antifrost must only be installed horizontally, with a slight slope to the outside.
  - Make sure that the connection housing is in an area that is not prone to frost.

☑ If there is a risk of frost: Remove attached garden hoses to allow complete draining of the garden valve.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Applicable documents

- Installation regulations, assembly and operating instructions

In order to download the documents, go to www.gfps.com (D/F/I/E).

Installation examples

Depending on the installation circumstances, the installation examples are shown in the applicable instructions.

Spare parts

- Spare parts set (plastic valve cone, spring and O-ring)
- Valve stem
- Pipe aerator
- Upper part with operating handle
- Operating handle with screw
- Rosette

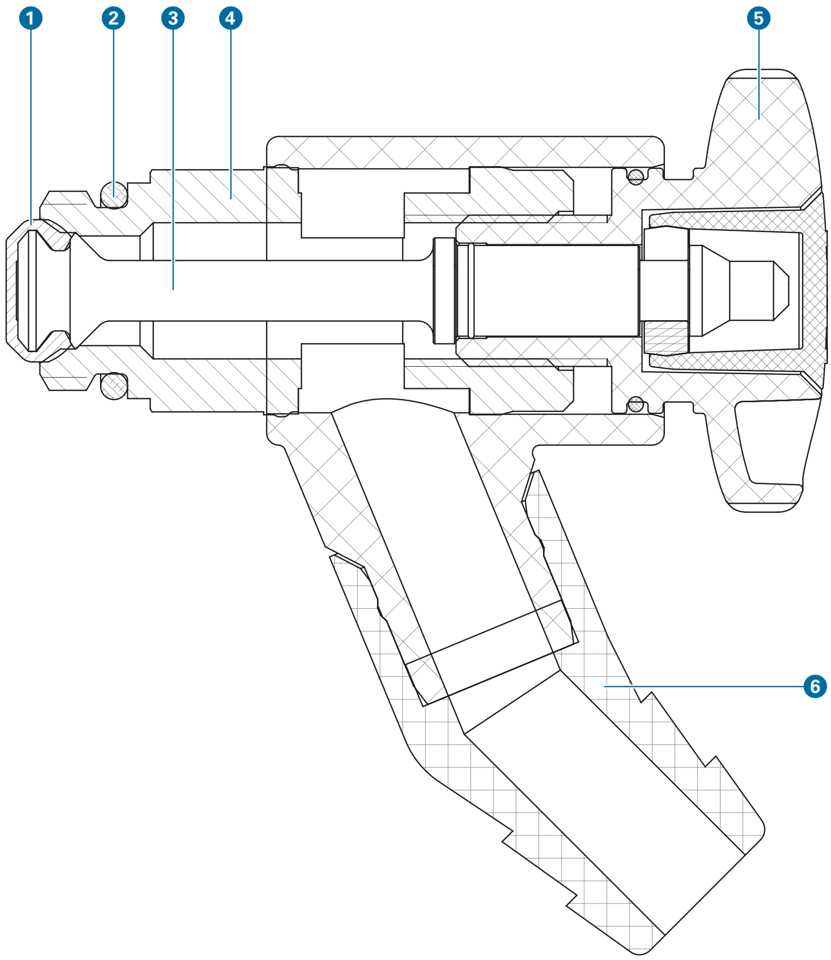
JRG LegioStop Drain valve 7301

The JRG LegioStop Drain valve can be used to empty installations.

Technical Data

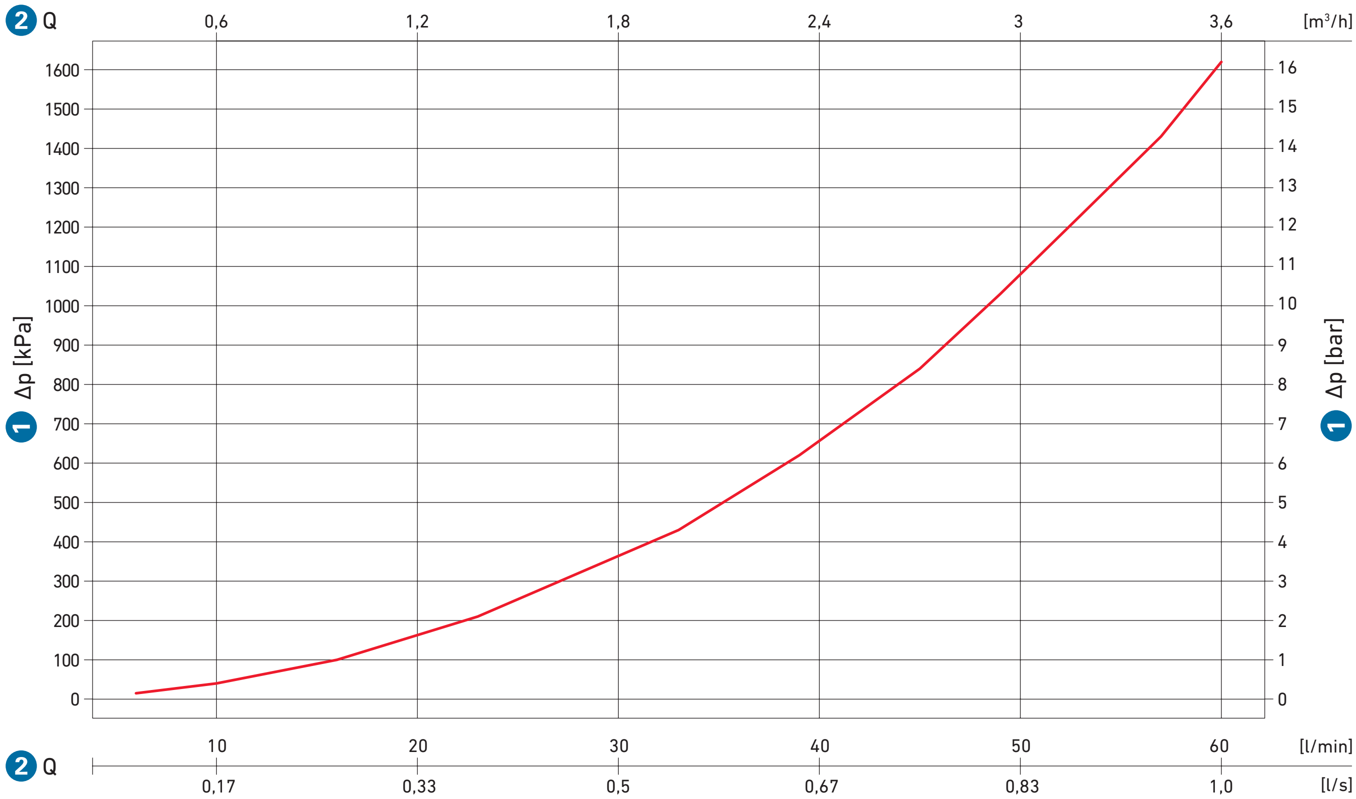
JRG code	Dimension	Nominal pressure PN	Temperature max [°C]	Connections
7301	GN ¼" – ⅜" (DN8 – 10)	16	90	Pipe threads

7301



1. Valve seal
2. O-ring
3. Valve rod
4. Housing
5. Handwheel
6. Hose connector

Performance chart



JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
7031.080	JRG LegioStop Drain valve	GN ¼" (DN8)	1.9	1.9
7031.160 7031.302		GN ⅜" (DN10)	1.9	4.4

1 Pressure
2 Volumetric flow rate

Product description

The JRG LegioStop Drain valve can be used to empty installations.

Features and functions

The valve is matched to the JRG LegioStop Y-type or straight seat valves and the JRGUSIT or JRGUSIT NG Distribution valves.

Benefits and features

- Designed without dead space
- With adjustable hose connector (90° or 45°)

Mounting position and installation tips

The JRG LegioStop Drain valve can be installed regardless of its position.

V

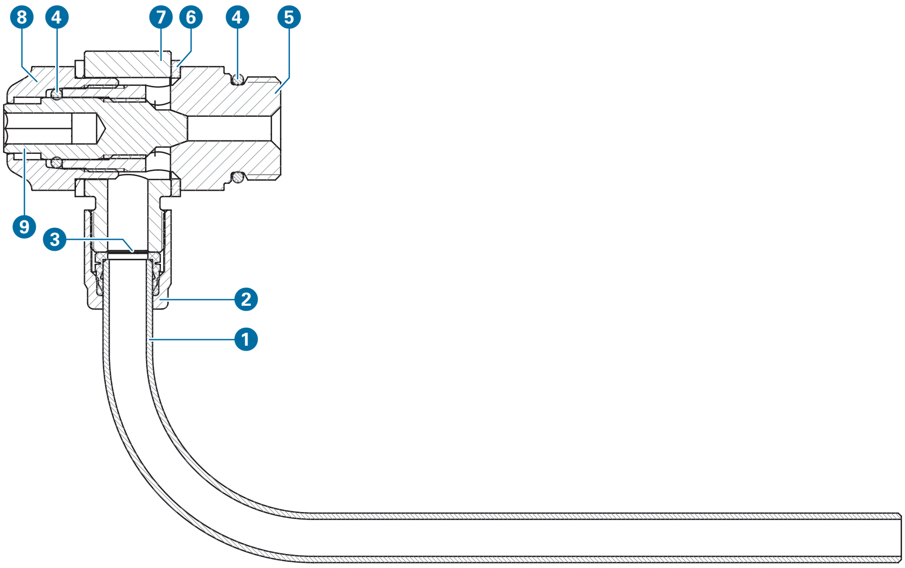
Sampling valve 7306

The sampling valve is used for the professional removal of water samples for chemical and microbiological analyses.

Technical Data

JRG code	Dimension	Nominal pressure PN	Temperature max [°C]	Connections
7306	GN ¼" – ⅜" (DN8)	16	90	External thread

7306



1. Discharge tube
2. Coupling nut
3. Compression ring
4. O-ring
5. Valve body
6. Gasket
7. Discharge housing
8. Upper part nut
9. Spindle

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
7306.080 7306.160	Sampling valve	GN ¼" – ⅜" (DN8)	0.4	53.5

Product description

The sampling valve is used for the professional removal of water samples for chemical and microbiological analyses.

Features and functions

The sampling valve is used to draw water for a drinking water analysis. Since the sampling valve uses a metal seal, it can be flame-treated. Bacteria that may be inside the valve are eradicated during the flame treatment.
For sampling, a flammable sampling pipe or a sterile plastic pipe may be used.

Benefits and features

- Metallic sealing
- Can be flame treated for disinfection purposes

Applicable documents

- Assembly, operating and maintenance instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts

- Discharge tube
- Coupling nut
- Compression ring

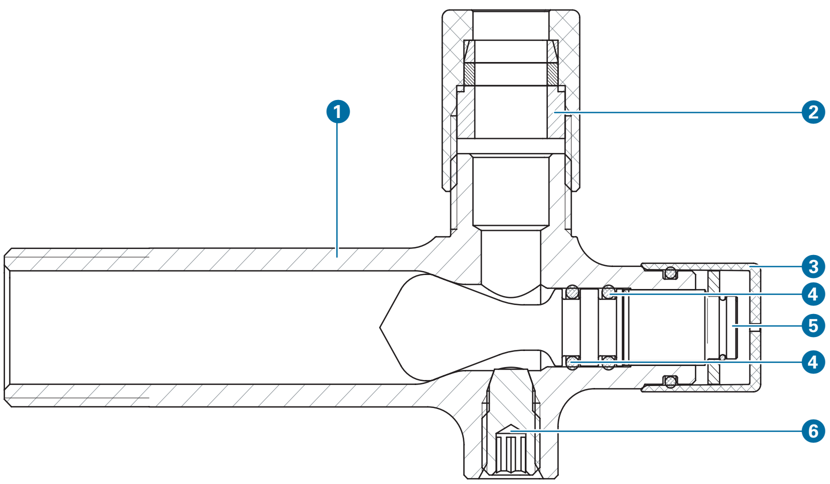
Angle valve 7306

The angle valve is used for the professional removal of water samples for chemical and microbiological analyses.

Technical Data

JRG code	Dimension	Nominal pressure PN	Temperature max [°C]	Connections
7306	GN ½" (DN15)	16	90	External thread

7306



1 Housing
2 Clamping ring
3 End cap
4 O-ring
5 Spindle
6 Plug

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
7306.240	Angle valve	GN ½" (DN15)	0.4	41.0

Product description

The angle valve is used for the professional removal of water samples for chemical and microbiological analyses.

Features and functions

The angle valve is used to tap water for a drinking water analysis. Since the sampling valve uses a metal seal, it can be flame-treated. Bacteria that may be inside the valve are eradicated during the flame treatment.
For sampling, a flammable sampling pipe or a sterile plastic pipe may be used.

Mounting position and installation tips

The angle valve is connected underneath the sink to the cold and/or hot water line.

Benefits and features

- Metallic sealing
- Can be flame treated for disinfection purposes
- Cover rosette with diameter 54 mm included

Applicable documents

- Assembly, operating and maintenance instruction

In order to download the documents, go to www.gfps.com (D/F/I/E).

Spare parts

- Discharge tube
- Coupling nut
- Compression ring

V

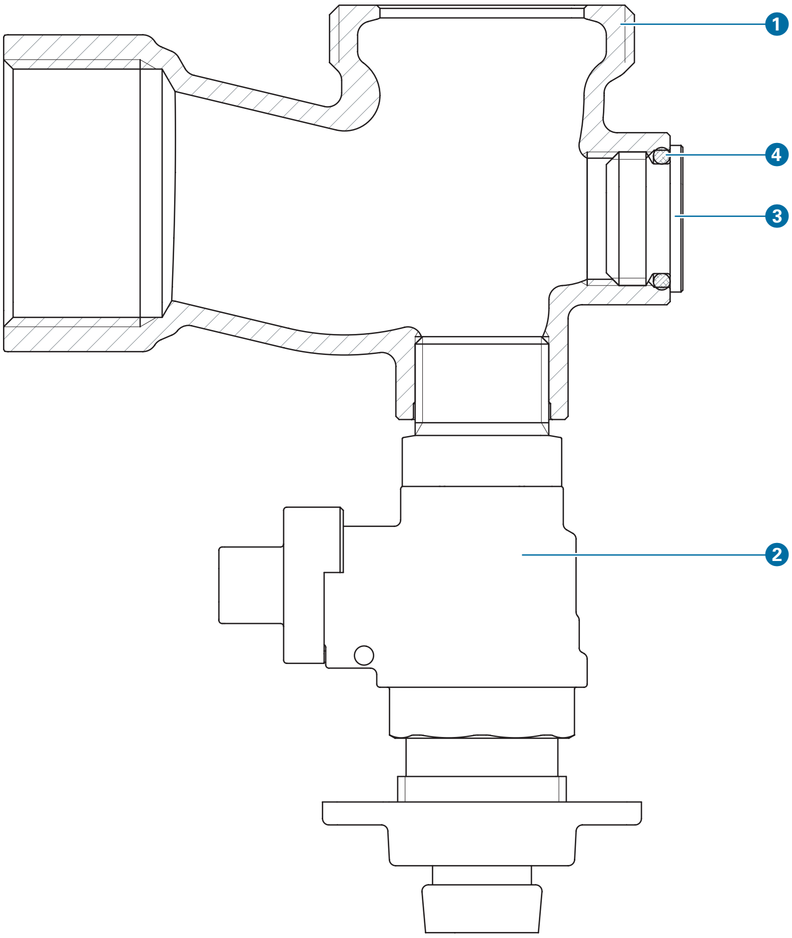
Connection kit 8334, 8335

The connection kit serves for the connection of a DHW heater or storage and additionally offers the possibility of emptying it via the boiler ball valve.

Technical Data

JRG code	Components	Dimension	Nominal pressure PN	Connections
8334	• Cross T-fitting • Boiler ball valve • Plug with O-ring	GN ¾" – 2" (DN20 – 50)	16	Female pipe thread
8335	• Cross T-fitting • Boiler ball valve • Plug with O-ring	d26 – d40 (DN20 – 32)	10	Female pipe thread/ JRG Sanipex MT

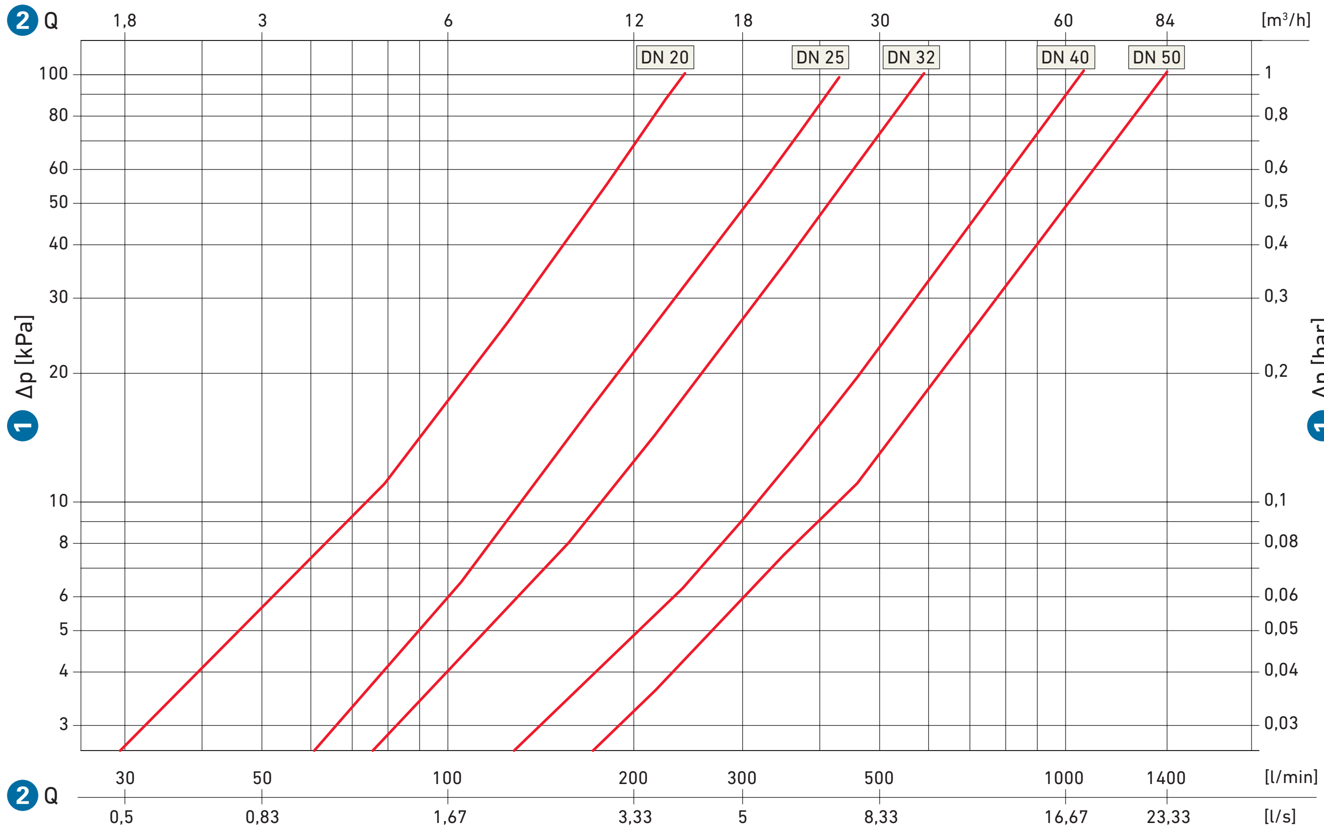
8334



1. Cross T-fitting
2. Boiler ball valve
3. Plug
4. O-ring

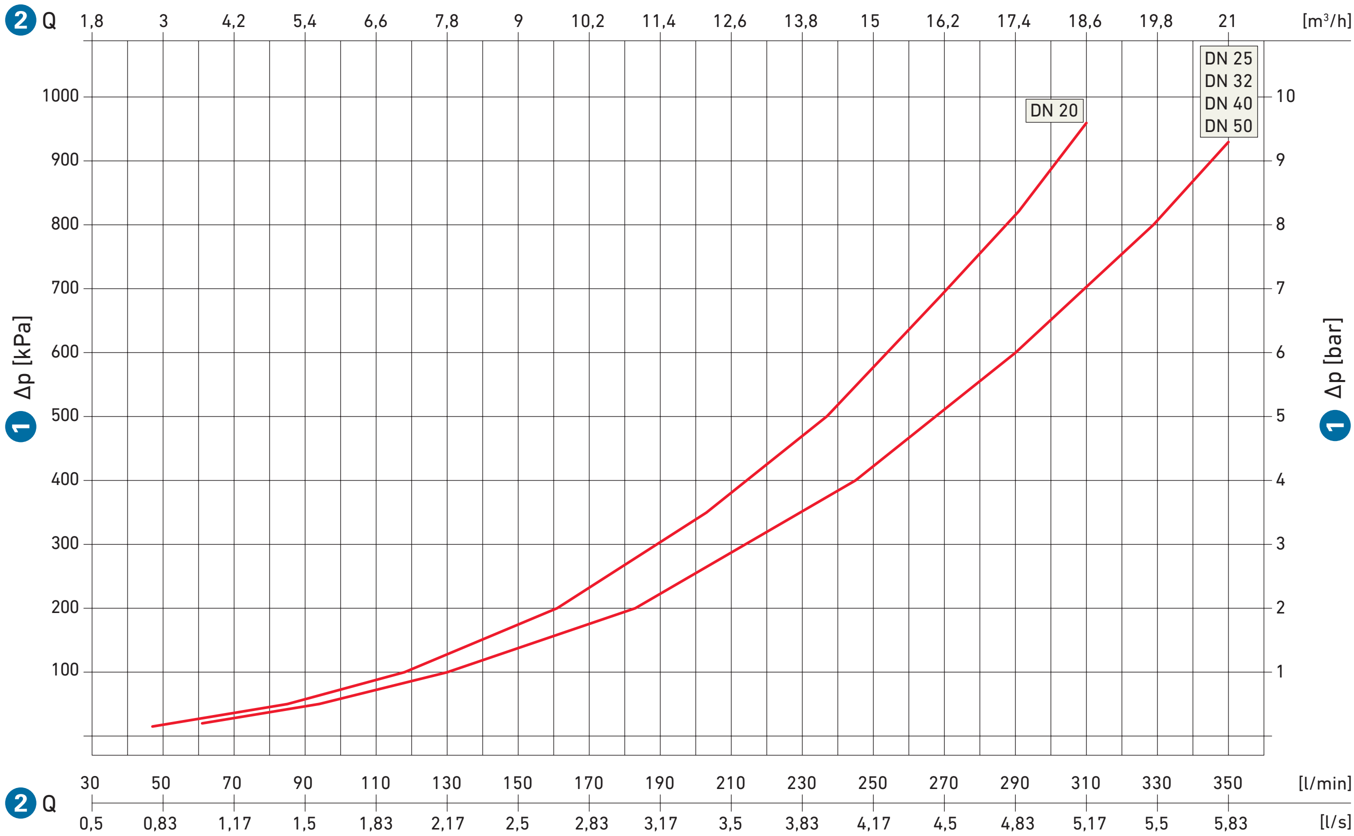
Performance chart

Connection kit



1 Pressure loss
2 Volumetric flow rate

Ball valve



1 Pressure
2 Volumetric flow rate

JRG code	Designation	Dimension	K_{vs} value [m³/h]	ζ value
8334.020	Connection kit Female pipe thread	GN ¾" (DN20)	14.5	1.2
8334.025		GN 1" (DN25)	25.8	0.9
8334.032		GN 1¼" (DN32)	35.4	1.3
8334.040		GN 1½" (DN40)	58.0	1.2
8334.050		GN 2" (DN50)	79.2	1.6
8335.026	Connection kit Female pipe thread/ JRG Sanipex MT	GN ¾" (DN20) × d26	14.5	1.2
8335.032		GN 1" (DN25) × d32	25.8	0.9
8335.040		GN 1¼" (DN32) × d40	35.4	1.3

Product description

The connection kit serves for the connection of a DHW heater or storage and additionally offers the possibility of emptying it via the boiler ball valve.

Features and functions

The DHW heaters and storage are connected with the cross T-fitting.

Benefits and features

- Compact design
- Connection of ball-type ball valve selectable

Mounting position and installation tips

The connection kit can be installed regardless of its position.

Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Spare parts

- Plug

Build

Hycleen Des

Hycleen Des

Overview
This chapter contains basic information about the Hycleen Des disinfection system.

Additional technical and sales information

- For more information on the use and connection of other system components, piping and controls and instruments, see the chapters applicable to the appropriate systems.
- More technical information about this system and ordering information can be found on the GF website and in the sales catalogue.

1 Product description

1.1 Function

The Hycleen Des system is the solution recommended by GF Piping Systems if chemical disinfection of a drinking water installation is necessary. On site, the system produces a highly active disinfectant, which is ideal for ensuring the hygiene in cold and hot water.

Hycleen Des uses electro-diaphragm analysis (ECA) technology on-site in order to produce a fresh, electro-activated disinfectant containing sodium hypochlorite (anolyte neutral) from a high-purity brine.

GV.1
Hycleen Des 5

GV.2
Hycleen Des 30

1.2 Advantages at a glance

Highly effective with controlled sustained release

This disinfectant is always freshly prepared and is characterised by the highly efficient killing of the pathogens found in drinking water such as the legionella. Even adding the smallest amounts are sufficient. After implanting the disinfectant into the drinking water, its controlled sustained release effect acts throughout the entire drinking water system. Thus, biofilms in the drinking water installation are successfully counteracted and the treated drinking water is better protected in order to prevent recontamination.

Low number of by-products

On-site production always guarantees the lowest possible concentration of undesirable degradation products such as chlorates. Furthermore, the Hycleen Des system has been designed to absolutely minimize the formation of undesirable by-products!

Safe and environmentally friendly

The disinfectant and the resources required for the production are not hazardous substances. The Anolyte Neutral disinfectant is declared as non-hazardous, that is to say, there are no increased safety requirements. In addition, there is no safety or environmental hazard due to transport, storage and handling of the disinfectant.

High material compatibility

When used correctly, the service life of products and systems by GF Building Technology is not shortened in cold and hot water. This has been proven by independent, scientific long-term tests. Such proof of the service life of pipelines and fittings in combination with chemical disinfection is almost unique in the market and offers the operator additional reliability. Many years of experience show that the Hycleen disinfection system is particularly gentle on old installation materials and is therefore ideally suited for existing properties.

Reliable and low maintenance

The Hycleen Des systems are very easy to use and require little care. The dosing method is robust, reliable and ensures a uniform disinfecting effect. In addition, the low operating costs with the Des 30 and the long service life of the system pay off in comparison to other disinfection processes.

Very minimal effect on odor and taste

In the event of a heavily contaminated system, a slight change in the taste of drinking water may occur due to the degradation of contaminants or, above all, the degradation of the Biofilm. This is detectable with a slight “pool smell”, which, however, is usually only detected by people who are very susceptible to taste. Any adverse taste and odor changes that may occur, usually disappear completely after a few weeks of dosing.

Approval and certification

The system and the disinfectant produced with this system, comply with the requirements of the EU Biocide Approval EU Nr. 528/2012 and are included in the list of approved active substances for the disinfection of drinking water. The only requirement is that high-purity salt or high-purity brine from GF Piping Systems is used as the starting material.

§ **Laws and ordinances on the use of disinfection systems**

Nationally applicable laws and ordinances may regulate the use of disinfection systems differently, for example, on the regulation of hazardous substances, or similar regulations.

The use of a disinfection system may require approval.

1.3 Hycleen Des 5

The Hycleen Des 5 system has been developed according to the Plug&Play approach. Compared to the Hycleen Des 30 system, the brine is not produced on site, but is provided in folding bag canisters of 20 liters. The ready-to-use brine is made from high-purity salt and osmosis water, ensuring the highest purity of the pH-neutral disinfectant (Anolyte Neutral).

This greatly simplifies design, installation, commissioning and operation. This approach is intended to provide the object operator with an easy-to-use and reliable disinfection technology.

Benefits

- Ideal for temporary use
- Quick installation, a water connection is not required
- No handling of hazardous substances!
- Approved for disinfection of potable water according to EU Biocide Regulation 528/2012 (product groups PT 1-5)

1.4 Hycleen Des 30

The Hycleen Des 30 system produces Anolyte Neutral from high purity salt, softened water, and electricity on-site. The system is supplied with softened potable water (< 2°dH). For this purpose, a BA system separator, an ion exchanger (pendulum system) and a 5µm fine filter must be connected upstream. The saturated brine is always provided on-site in the brine tank. The system also includes a cleaning program with Calzid-Ex, which periodically cleans the system equipment and thus ensures reliable system operation. The operation with an osmosis system is possible as a very good alternative to achieve the highest quality of disinfectant.

- High capacities
- Cost-effective disinfection
- low operating costs for long-term disinfection measures
- No handling of hazardous substances!
- Approved for disinfection of potable water according to EU Biocide Regulation 528/2012 (product groups PT 1-5)

1.5 Scope and application areas

In hygiene-critical facilities, such as hotels, retirement homes and clinics, the use of Hycleen Des system is ideal as a preventive measure to protect drinking water from microbial contamination. In the event of an acute contamination of the drinking water installation with pathogens such as legionella, the system can also be used for immediate intervention to ensure the supply of hygienic drinking water at all times. This provides time until the required rehabilitation of the drinking water installation is carried out and again a sustainable, flawless drinking water hygiene is ensured.

The gentle disinfectant **Anolyte Neutral** can be used for the disinfection of either cold or hot water. As a rule, the Anolyte Neutral is added proportionally to the cold water at the domestic water inlet. This reliable dosing strategy always guarantees a consistent concentration of disinfectants in drinking water.

1.6 Designs

The Hycleen Des systems are available in two designs:

- Hycleen Des 5 for smaller public buildings and apartment buildings
- Hycleen Des 30 for larger buildings such as hotels, clinics, and nursing homes.

TV.2
Performance data

Parameters	**Hycleen Des 5** 	Hycleen Des 30 
Production capacity	5 l/h	30 l/h
Concentration of free chlorine in the disinfectant	max 200 mg/l	max 200 mg/l
Daily water consumption at 0.3 mg/l dosing	max 20 m^3	max 300 m^3
Peak water consumption at 0.3 mg/l dosing	max 2.5 m^3/h	max 25 m^3/h
Capacity limits at 0.3 mg/l dosing	max. 13.3 m^3	max. 16600 m^3
	1 container at 20 l	25 kg salt

V

2 Installation and installation situation

The Hycleen Des is the heart of the overall system and is automatically operated with a central control system. For the installation at the house water inlet, other peripheral devices, for example, system separator, ion exchanger, fine filters, flow meter with pulse generator, dosing pump and dosing unit shall be planned and matched with the type of facility.

2.1 Hycleen Des 5 – Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Area	Condition
Room	• Volume of the air in the room: min. 10 m^3 • Room temperature: +15 °C to +22 °C • Exchange of air in the room: min. 20 m^3/h ☑ Ensure exhaust air from the Anolyte Neutral storage tank into the atmosphere.
Monitoring	Recommendation: Monitor the parameter "free chlorine" (online or manually)
Dosing	A dosing lance with a non-return valve ensures optimal mixing of the disinfectant in the drinking water.

TV.3
Hycleen Des 5 Installation instructions

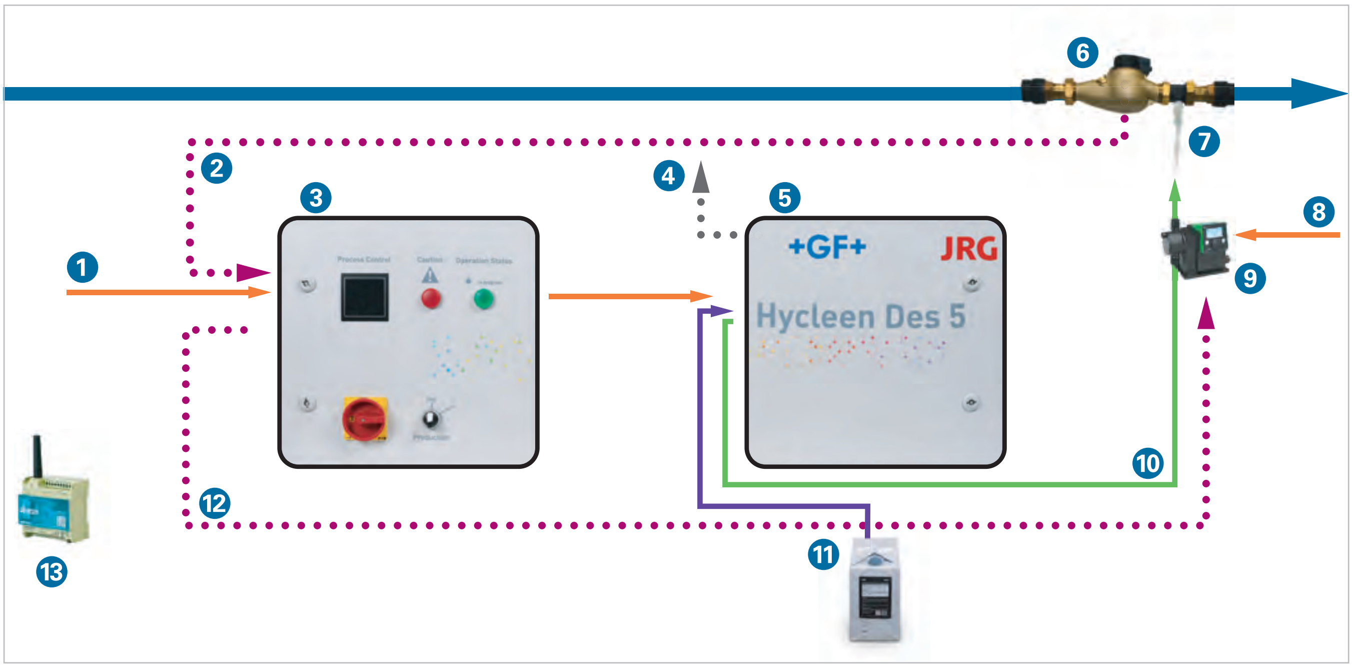
2.2 Hycleen Des 30 – Installation instructions

☑ During the installation, compliance with the locally applicable directives, regulations and standards is mandatory.

Area	Condition
Room	• Volume of the air in the room: min. 10 m^3 • Room temperature: +15 °C to +22 °C • Exchange of air in the room: min. 20 m^3/h ☑ Ensure exhaust air from the Anolyte Neutral storage tank into the atmosphere.
Water supply	• Softened drinking water, carbonate hardness <2° dH (0.36 mmoL/L) • min. flow rate 50 L/h • Flow pressure at the connection of the system: 3 to 10 bar ☑ Secure the water supply of the Hycleen Des 30 according to the recognised codes of practice (system separator type BA).
Sampling valve	to check the quality of the supply water
Lime protection sensor	optionally to protect the system from calcareous water
Monitoring	Recommendation: Monitor the parameter "free chlorine" (online or manually)
Dosing	A dosing lance with a non-return valve ensures optimal mixing of the disinfectant in the drinking water.

TV.4
Hycleen Des 30 Installation instructions

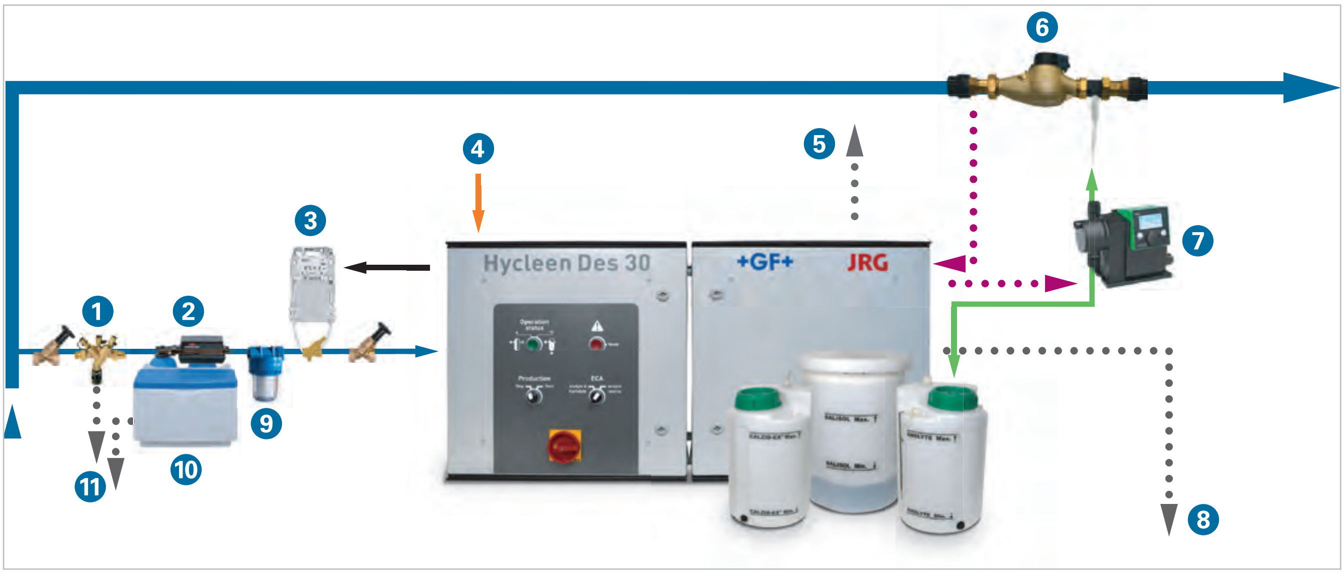
2.3 Hycleen Des 5 – System overview



1. 230 V AC voltage
2. Pulses from the water meter
3. Hycleen Des 5 Control system
4. Exhaust air
5. Hycleen Des 5 Process
6. Flow meter with pulse generator (DN32 to DN200), 1 liter pulse
7. Dosing unit with blocking and non-return valve
8. 230 V AC voltage
9. Dosng pump 12 l/h
10. Anolyte Neutral
11. Salt brine with idle monitoring
12. Pulse to dosing pump
13. option: SMS module, external antenna 5 m

GV.3
Hycleen Des 5 system design

2.4 Hycleen Des 30 – System overview



1. System separator
2. Ion exchanger
3. Hardness control unit, (optional). Use recommended in areas with very high hardness rates
4. 230 V AC voltage
5. Exhaust air
6. Flow meter with pulse generator (DN32 to DN200), 1 liter pulse
7. Dosing pump
8. Drain
9. Fine filter 5
10. Water treatment set**
11. Drain

** (recommended accessory) Provides for a perfect quality of the system's feed water and secures the drinking water installation according to the applicable requirement from the Hycleen Des 30 system.

GV.4
Hycleen Des 30 system design

3 Technical Data

3.1 Hycleen Des 5

TV.5
Hycleen Des 5 technical data

Parameters		Values
Production capacity	Possibility of producing 2 different qualities of disinfectant	5 l/h Anolyte Neutral
Free chlorine (in NaClO pursuant to EN 901)	Anolyte Neutral	<200 mg/l
Resources	Prepared brine from high purity salt and osmosis water, for the production of the disinfectant	20 l (container) (1 liter of brine makes 1 l Anolyte Neutral)
Container	Anolyte Neutral	2.5 l
Electrical connection	Power supply	230 VAC / 50 Hz
	Power consumption	max. 350 W
Maintenance	System service provided by GF Piping Systems or partner company	annually

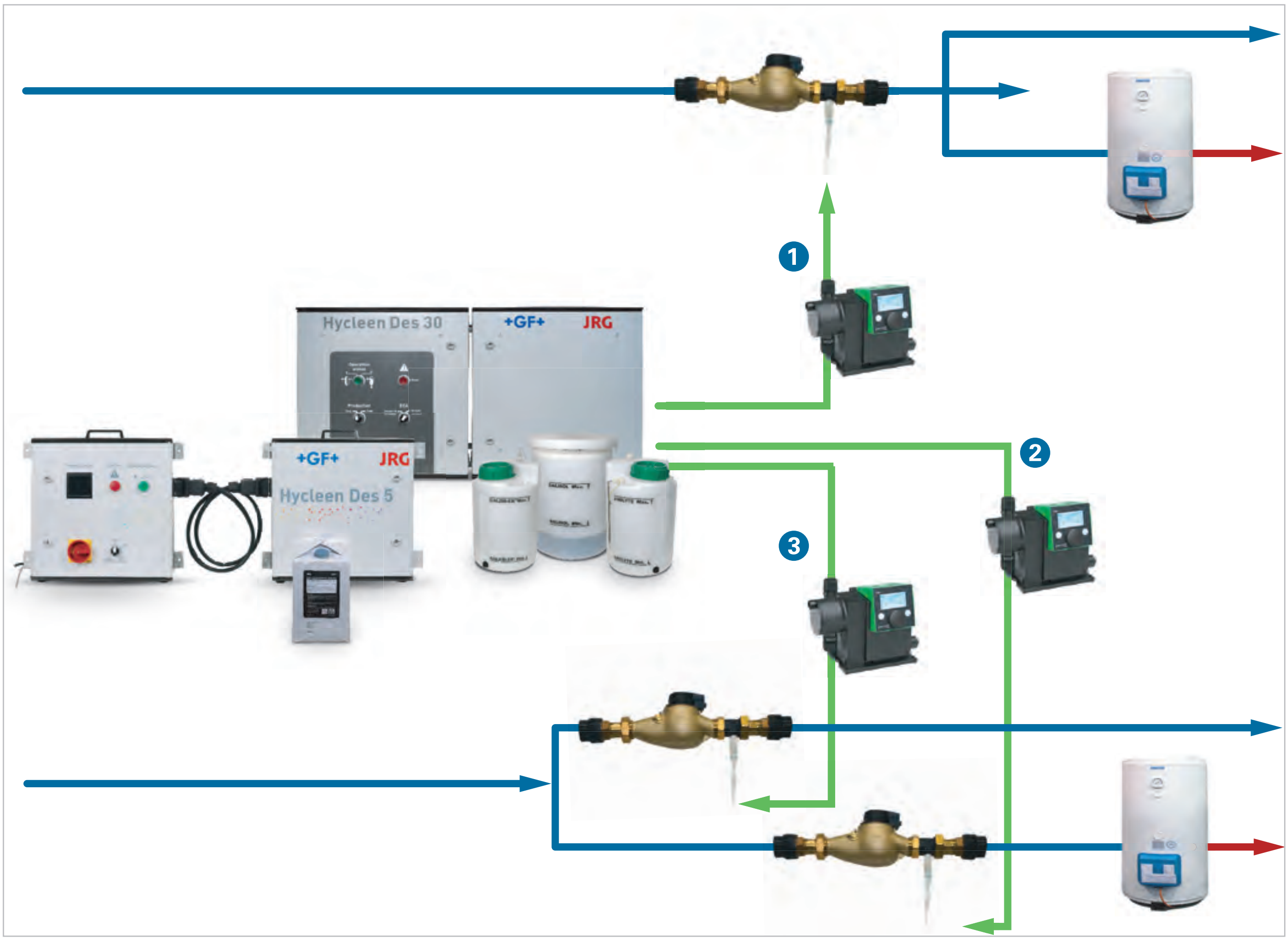
3.2 Hycleen Des 30

TV.6
Hycleen Des 30 technical data

Parameters		Values
Production capacity	Possibility of producing 2 different qualities of disinfectant	• 30 L/h Anolyte Neutral or • 20 L/h Anolyte
Free chlorine (in NaClO pursuant to EN 901)	Anolyte Neutral	<200 mg/l
Resources	For the production of the disinfectant	softened water • <2° dH, mind. 50 L/h high purity salt • Salt consumption: 0 – 2 g/l
Container (standard version)	Brine	60 l
	Cleaning supplies	100 l
	Anolyte Neutral	60 l
Electrical connection	Power supply	230 VAC / 50 Hz
	Power consumption	max. 350 W
Cleaning	Cleaning and descaling the system's inside	with Calzid-Ex (organic degradable acid)
	Cleaning cycle	always after the production of 60 L of disinfectant solution
Maintenance	System service provided by GF Piping Systems or partner company	annually

3.3 Dosage in proportion to quantity

As a rule, the Anolyte Neutral is added to the cold water at the domestic water inlet→ 1) in proportion to the quantity by means of a pulse from the contact water meter and the metering pump. As an alternative, dosing can also be made in hot water only (2) or dosing with different concentrations in cold and hot water (2 and 3). Dosing in proportion to quantity always guarantees a uniform concentration of disinfectant in the drinking water.



1 Dosing in the main supply line
2 Dosing, only hot water
3 Dosing in cold and hot water using different concentrations

GV.5
Dosage in proportion to quantity

By adding Anolyte Neutral as required, the biofilm is effectively combated. Initially, however, a large part of the disinfectant added to the drinking water is consumed by the decomposition of impurities and biofilm. The concentration of disinfectant after dosing at critical (often remote taps) must be monitored for free chlorine, for example, by using a portable meter.

At the beginning of the disinfection procedure, it is recommended to set the concentration of the disinfectant at the tap to the maximum prescribed by law. As the degradation of the biofilm continues, the consumption of the disinfectant decreases and the dosage can be reduced to a minimum level (compliance with the minimization requirement). Low consumption of disinfectant in the drinking water installation indicates a clean drinking water system.

3.4 EU Biocide Approval

The disinfectant solution containing sodium hypochlorite of the Hycleen Des system provided by Georg Fischer JRG AG fulfils the EU Biocide Approval EU Nr. 528/2012 and has been added to the list of authorized active ingredients for the disinfection of drinking water.

The Article 95 list of the European Chemicals Agency (ECHA) is publicly available.

The EU Biocide Approval offers the following advantages:

- The high effect of the disinfecting solution Anolyte against pathogens is confirmed.
- The high quality of the disinfecting solution is confirmed pursuant to ISO EN 901.
- The entire manufacturing process of the disinfecting solution with Hycleen Des is therefore completely confirmed by the ECHA and ensures the consistent quality of the disinfecting solution.

4 Application example

Drinking water – Protection against microbial germination

A hospital or a nursing home are a typical example of a facility with increased demands on drinking water hygiene. As there are many people with their immune system compromised in the building, drinking water must also be free of pathogenic bacteria such as legionella at all times.

For several years, the RoMed Clinic has been using the Hycleen Des 30 system extremely successfully in order to keep their drinking water hygienically clean. Using only one Hycleen Des 30, the entire drinking water (hot and cold water) of the hospital can be protected against microbial contamination, if necessary. The dosage inserted into the cold water at the domestic water inlet is proportional to the volume, while the system supplies three dosing points at the same time. In addition to the impeccable drinking water hygiene, it was particularly important to the RoMed Clinic that the quality of the drinking water, especially the taste, should not be adversely affected. This request was met by the Hycleen Des 30 system to the clinic's fullest satisfaction.

Especially in susceptible facilities such as clinics, the risk of pathogenic microorganisms in the water supply must be minimized. With the Hycleen Des 30 system, both the drinking water and the cooling water can be protected against microbial contamination.

Process water – Efficient and hygienically perfect cooling system

The Hycleen Des 30 system is also ideal for protecting the cooling water hygiene of evaporative cooling systems. The application Cooling Water Disinfection with the Hycleen Des 30 system runs under the name Hycleen Industrial Disinfection Process and is an environmentally friendly alternative to conventional biocides.

Bu interacting with sophisticated measuring and control engineering, the Hycleen Des 30 system meets the highest demands. The highly active, electro-activated disinfecting solution is always freshly prepared and thus it is particularly effective against legionella and it fights biofilm extremely successful. Cooling systems with up to 20 MW cooling capacity and additional water consumption of up to 40,000 m^3 drinking water per year can be disinfected with just one Hycleen Des 30 system.

The Hycleen Industrial Disinfection Process makes sure the cooling water hygiene is always sage. Compared to conventional biocides, the Hycleen Industrial Disinfection Process eliminates hazardous substances. Moreover, the input of harmful substances into the environment is significantly reduced. Furthermore, the process has other decisive advantages: high material compatibility, unbeatable operating costs and no influence on the mode of operation of the cooling tower.

Build

Hycleen Automation System

Hycleen Automation System

Overview

This chapter contains basic information about the Hycleen Automation System.

Additional technical and sales information

- For more information on the use and connection of other system components, piping and controls and instruments, see the chapters applicable to the appropriate systems.
- More technical information about this system and ordering information can be found on the GF website and in the sales catalogue.

1 System description

1.1 Functions

The Hygiene Automation System made by GF Piping Systems is a complete package for the automation of drinking water installations. Sensors and controllers integrated into the valves record the required measured values. The master assumes the control and supports a hygienically optimised drinking water installation with its applications including logging and reporting.

The master can also be connected to our remote access solution (Hycleen Connect). This feature enables remote monitoring and control of the system and provides additional alarm and analysis functions.

Benefits

Hygiene

- Contributes to the sustainable prevention of Biofilm formation and Legionella infestation through hydraulic balancing and automatic flushing

Automation

- Intelligent control system for sanitary technology via a central user interface

Monitoring and safety

- Monitoring and storage of temperature data and other critical system parameters in automatically generated reports
- Retrieving data through a building management system possible
- Connection to a higher-level building management system possible

Simplicity

- Fast installation, trouble-free wiring
- Fast start-up
- Automatic detection of type and ID of all connected controllers by the master
- Low-maintenance drinking water system

Operation

- Unambiguous and easy-to-use interface
- Bluetooth connection via smartphone or tablet possible
- Remote access, monitoring, and control of the system possible from anywhere thanks to Hycleen Connect (cloud)

Safety during operation

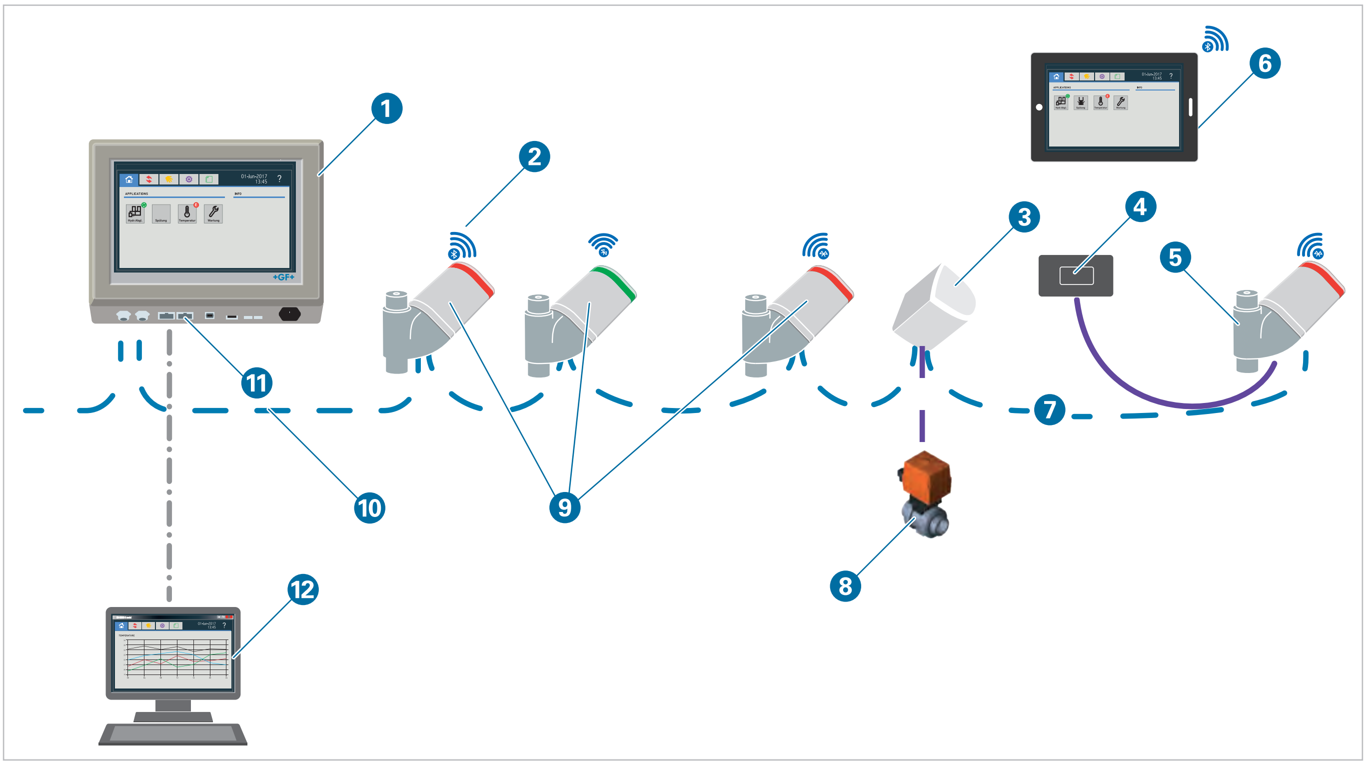
- Monitoring and logging of hygiene measures
- Secure data access by detecting approved external devices

Service

- Support during the design and putting into operation
- Data analysis and consulting during operation
- Data readout and software update

1.2 Components

Component	Functions
Hycleen Automation Master	• Central control of all Hycleen valves in the drinking water system and monitoring of flow and temperature sensors • Touchscreen with well-organised and intuitive user interface
External tablet/Smartphone	• App for mobile devices, retrieval of real-time data, Bluetooth connection
Valve	• Fast response time, integrated temperature sensor • The valve's degree of opening is always known
Connections	• Power, USB and Ethernet, 4 - 20 mA, 24/230 V relay
Controller	• Control of valves and sensors (up to 50 controllers) possible • Optional Bluetooth connection to tablet/Smartphone
Uni controller	• Universal interface for integration of sensors and control of actuators using 4 - 20 mA or relays
Additional Hycleen sensors	• Measurement and logging of temperature and flow rate • Monitoring the drainage
Activator automation application	• Connection of additional external actuators, for example, electric actuators
Building Management System Remote access via Cloud	• Integration into a building management system possible; BACnet IP and REST API are available as interfaces • Remote access via Hycleen Connect possible



GV.1
Overview of components

1. Hycleen Automation Master
2. Bluetooth connection
3. Uni controller
4. Additonal Hycleen sensor
5. Valve
6. External tablet/Smartphone
7. Up to 50 controllers
8. Actuator automation
9. Controller
10. Distribution and communication cables
11. Connections
12. Building management system/remote access via Cloud

1.3 Scope and application areas

The main applications in the building technology are:

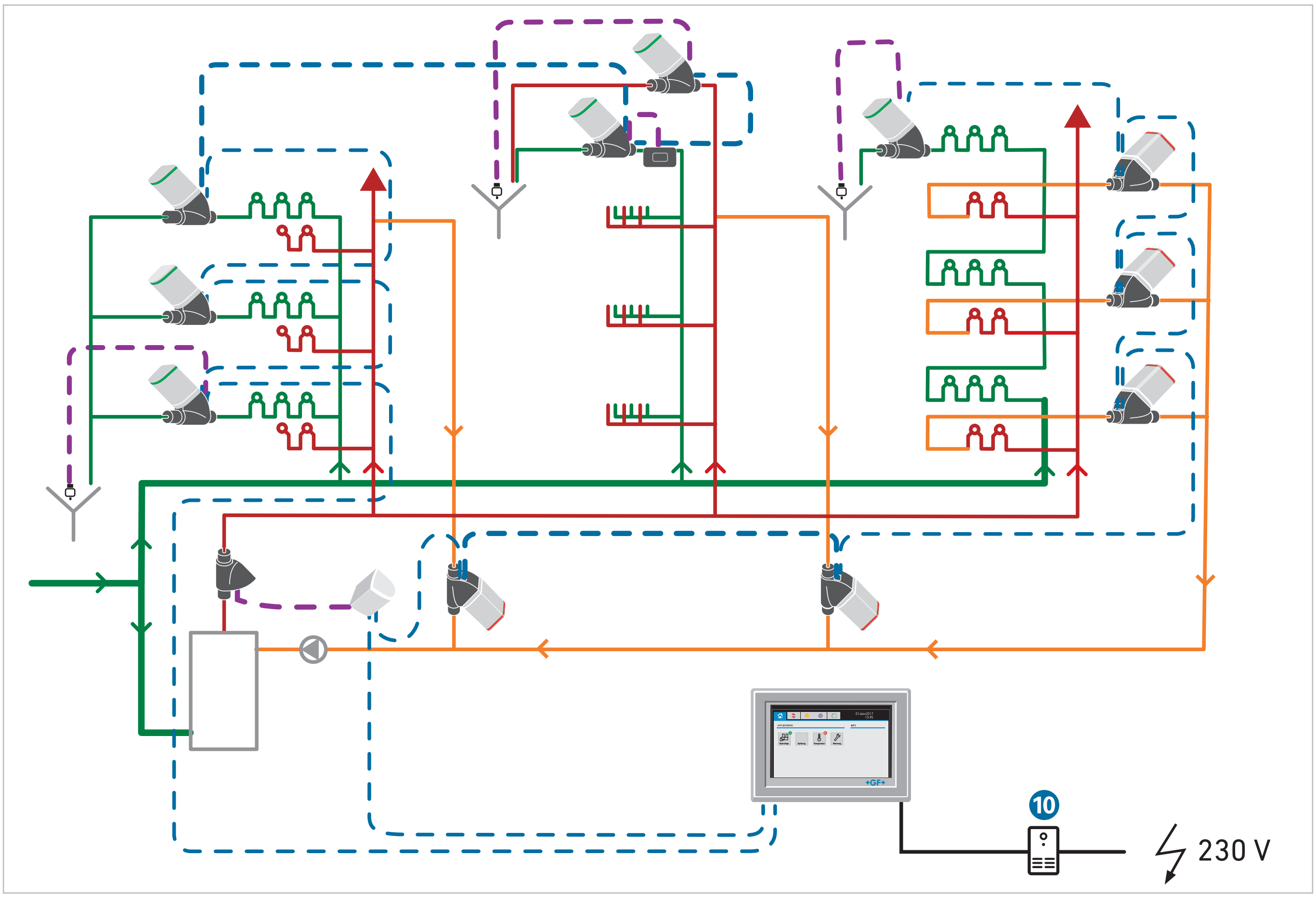
- Hydraulic balancing in the hot and cold water circulation system
- Automatic hot and cold water flushing

Monitoring and prevention require special attention in drinking water installations in hygienically sensitive buildings. But also in large properties with fluctuating water consumption (e.g. hotels) as well as in public buildings with a lot of public traffic (e.g. schools or offices), drinking water hygiene is a challenge.

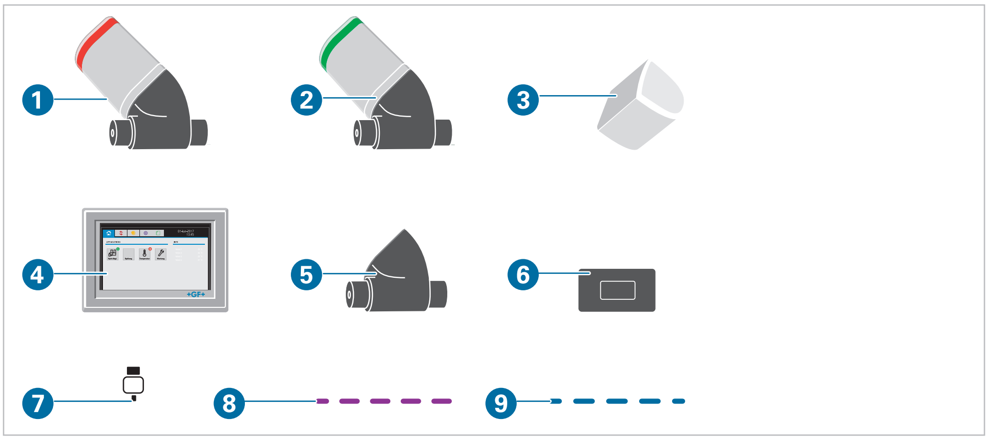
The Hycleen Automation System assists in the planning, installation, operation and maintenance of drinking water installations in large building complexes:

- Automatic hydraulic balancing for cold and hot water
- Automated flushing prevents stagnation and ensures regular exchange in the distribution of hot and cold water.
- Permanent temperature monitoring is the most important indicator for ensuring drinking water hygiene.
- Regular thermal disinfection kills existing germs.
- Continuous data logging of all measured values for complete documentation of the operating values and presentation at the monitoring station.
- Actuator control and programming

1.4 Installation diagram



System components



GV.2
Installation diagram and system components

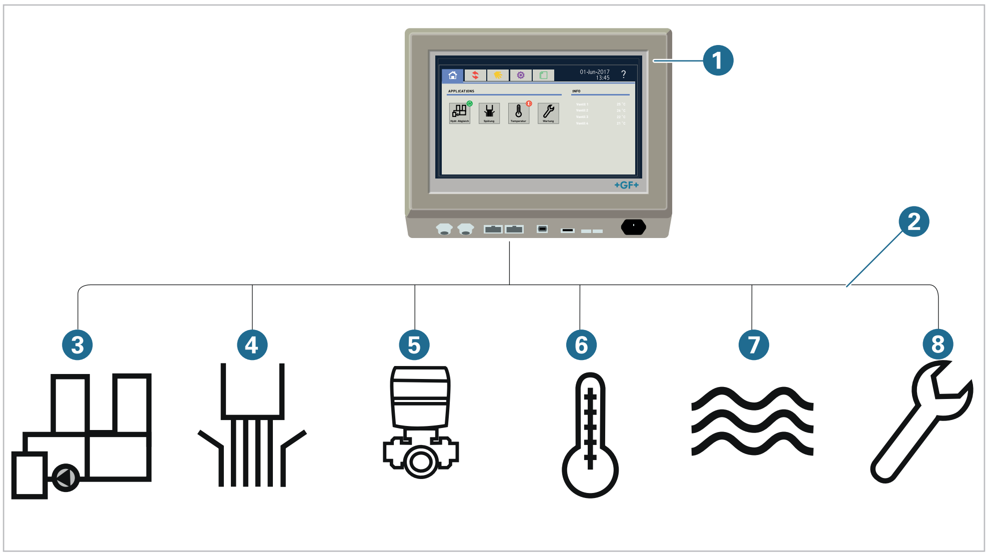
1. JRG LegioTherm 2T (valve for hydraulic balancing)
2. JRG LegioTherm K (flushing valve)
3. Uni controller
4. Hycleen Automation Master
5. T-sensor (temperature measurement)
6. Flow rate sensor
7. Drainage monitoring
8. Sensor cable
9. Power supply and communication cables
10. USVUninterruptible power supply

1.5 Functions and applications

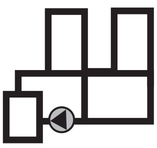
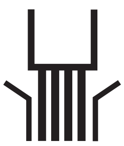
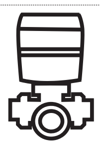
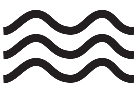
In addition to the supplied standard applications, additional applications can be freely defined in the future without any programming effort, depending on time, sensor values or external data. All programs and functions can be operated via the touchscreen on the Hycleen Automation Master. The master is connected to the controllers that regulate the individual valves and sensors. All sensors are permanently monitored and deviations are immediately reported.

Hycleen Automation Master

- One master for all applications mit inuitivem operating concept
- Customisable monitoring and reporting features with data storage



GV.3
Applications
1 Hycleen Automation Master
2 Applications

Symbol	Applications	Functions
	3 **Hydraulic balancing – Valve LegioTherm 2T**	• Hydraulic balancing for cold and hot water according to temperature or flow rate • Support for the thermal disinfection • Temperature monitoring • Leakage quantity (minimum flow rate) and maximum opening degree are adjustable
	4 **Flushing – LegioTherm K valve**	• Flushing of the cold and/or hot water system based on temperature, time or consumption • Adjustable opening degree • Turbulent flow for best possible drinking water hygiene with correct dimensioning
	5 **Actuator automation – Uni-controller/Master**	• Actuator control and programming • Time, temperature, sensors, alarms, and Hycleen applications are designated triggers
	6 **Temperature – T-sensor**	• Display of all temperatures in real time • Unambiguous graphical representation • Documentation (storage) of all valve temperatures and the external temperature sensors in the protocol
	7 **Flow rate – Flow rate sensor**	• Real-time flow rate display • Flow rate documentation
	8 **Maintenance – LegioTherm 2T valve**	• Automatic implementation of the maintenance process • Prevents valve sticking and minimises solid deposits

1.6 Hydraulic balancing

Especially in larger hot water distribution systems, for example, in hospitals, hotels or nursing homes, stagnation, rough surfaces and temperatures below 50 °C can promote the formation of biofilms and thus the propagation of legionella. Thus, sufficiently high temperatures and regular water exchange play a central role in the prevention of legionella.

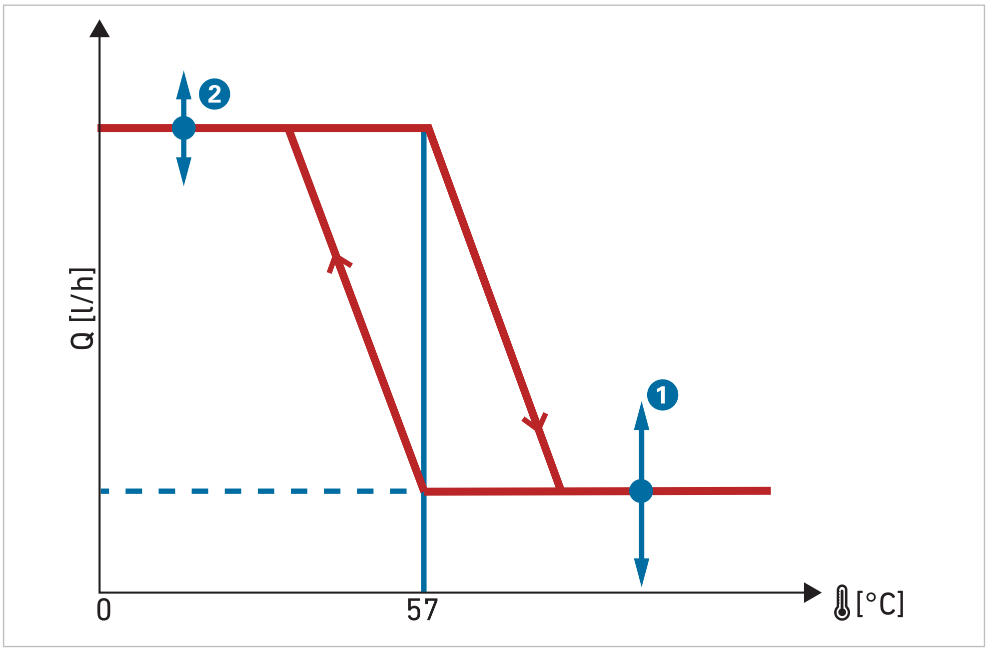
The distribution of hot water volumes in the entire pipeline network is associated with a high computational effort for the designer. In addition, the theoretical data rarely match the real conditions of installation.

The Hycleen Automation System offers several options for automated hydraulic balancing. Temperature sensors in the circulation controllers assume the installation work of the installer.

1.6.1 Hydraulic balancing according to (dynamic) temperature

The circulation controllers with temperature sensor open and close automatically and regulate the flow depending on the water temperature. If the temperature rises above the pre-programmed equalisation temperature (factory setting: 57 °C), the circulation controller closes down to the leakage quantity (minimum flow). As soon as the temperature drops below the adjustment temperature, the circulation controller opens again. Due to the permanent adjustment of all circulation controllers, a constant high water temperature of more than 55 °C is achieved, which prevents the formation of germs.

- Rapidly responds to water consumption
- Permanent temperature-controlled balancing ensures consistent water temperatures
- Temperature-controlled balancing in hot and cold water circulation is possible



GV.4
Dynamic hydraulic balancing

1 Leakage adjustable
2 Max. adjustable opening degree
Q Flow (volumetric flow rate)

1.6.2 Hydraulic balancing according to (static) temperature

Once a day, the Hycleen Automation Master checks for the ideal leakage rate for each circulation controller based on historical temperature data. This leakage rate is maintained until the next regulation phase, except when the temperature falls below the limit value. In this case, the valves open automatically once per phase.

- Optimised leakage rate of all valves
- Best possible hydraulic balancing
- Continuous adaptation to the system

1.6.3 Based on flow rate (static)

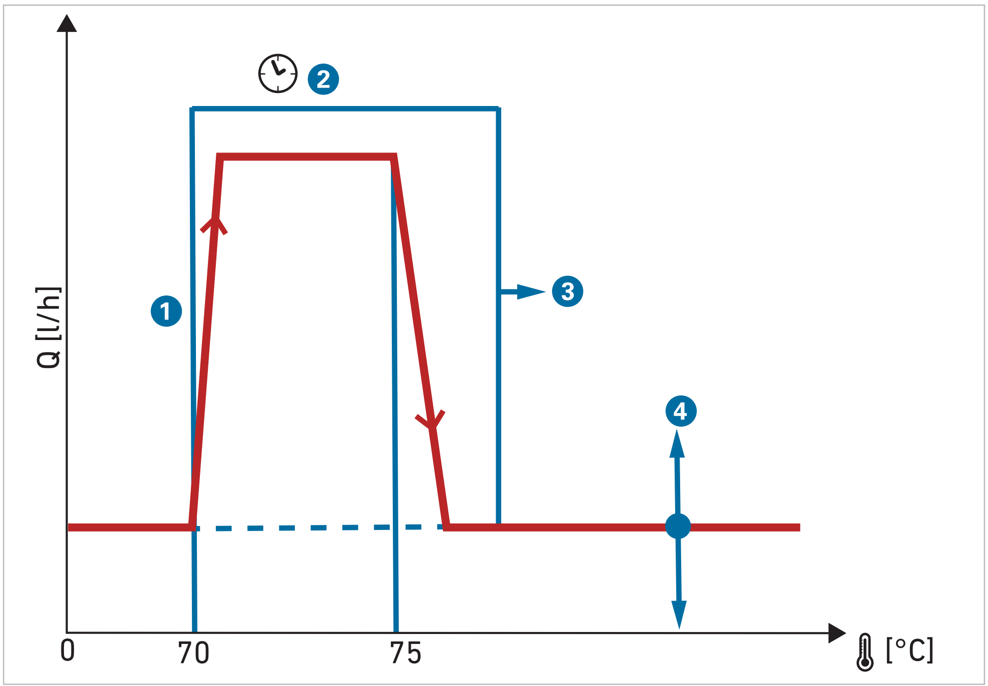
Once a day, the Hycleen Automation Master checks for the ideal leakage rate for each individual circulation controller based on historical flow rate data. The circulation controllers remain in the selected position until the next regulation phase. This function requires a flow sensor that is connected to the relevant circulation controller.

- Optimised leakage rate of all valves
- Best possible hydraulic balancing
- Continuous adaptation to the system

1.6.4 Thermal disinfection

Thermal disinfection starts automatically when the DHW heater temperature is raised above the legionella-killing, pre-set start temperature (factory setting: 70 °C), or the thermal disinfection may start at a specific, programmed time. All circulation regulators restrict the flow to the minimum quantity. The circulation controller, where the start temperature for thermal disinfection was first measured, remains open for a period of three minutes and then closes again for the leak quantity. If the balancing temperature for thermal disinfection (factory setting: 75 °C) is reached within this period of time, the circulation controller closes until the leak quantity has elapsed, before the three minutes have passed. This process is repeated on each additional circulation controller.

Even during the thermal disinfection, the hydraulic balance is maintained. After the thermal disinfection process, the system returns to normal operation with hydraulic balancing. If a temperature sensor is installed at the outlet of the DHW heater and this is intended to detect the start temperature, the Hycleen Automation Master will fully open the first valve in the system. This and the cascading opening of the valves reduce the total time for thermal disinfection process and save energy and costs compared to circulation systems where all valves are always open during thermal disinfection process.



GV.5
Thermal disinfection

1 Process start
2 3 min for each valve
3 Process start for next valve
4 Leak quantity adjustable
Q Flow (volumetric flow rate)

Safety when monitoring the limit temperature

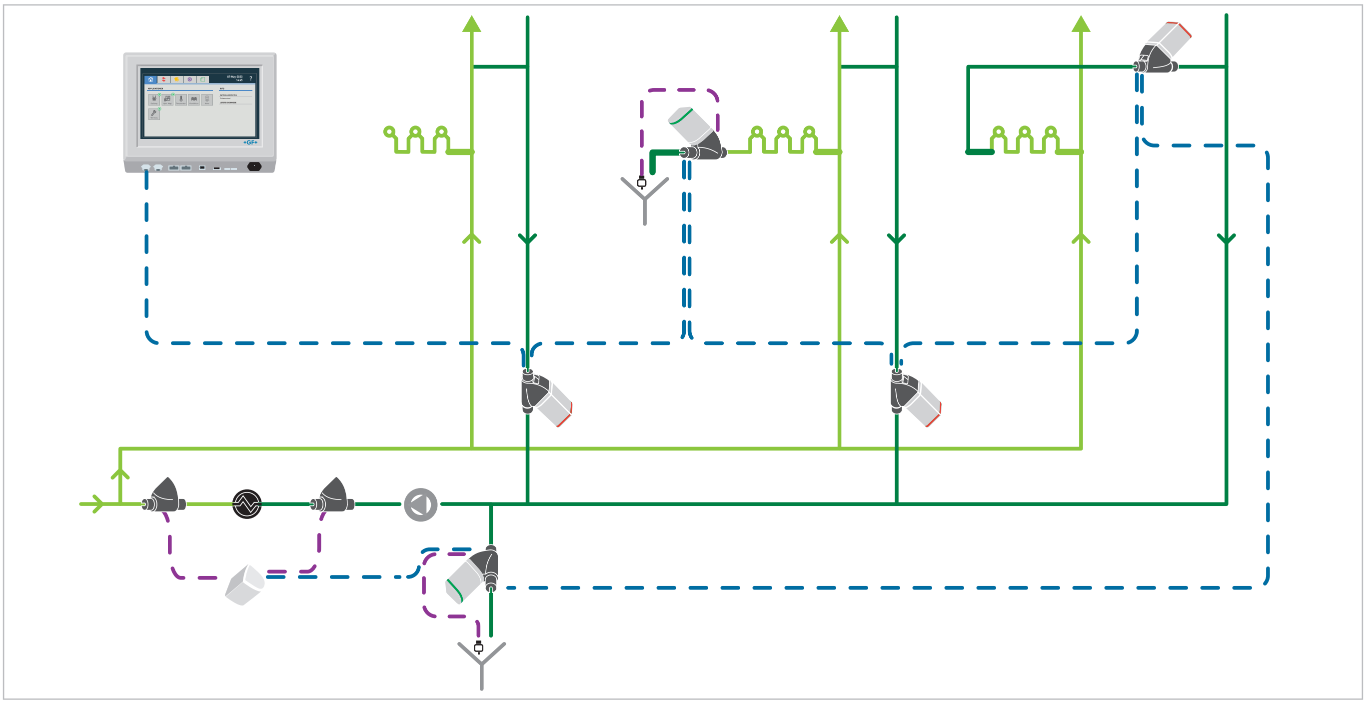
Continuous monitoring of the limit temperature and automatic maintenance increase safety. If the temperature in the drinking water system falls below a pre-set limit temperature (factory setting: 50 °C), an alarm is triggered. For static hydraulic balancing, the valve automatically opens in order to equalise the temperature drop.

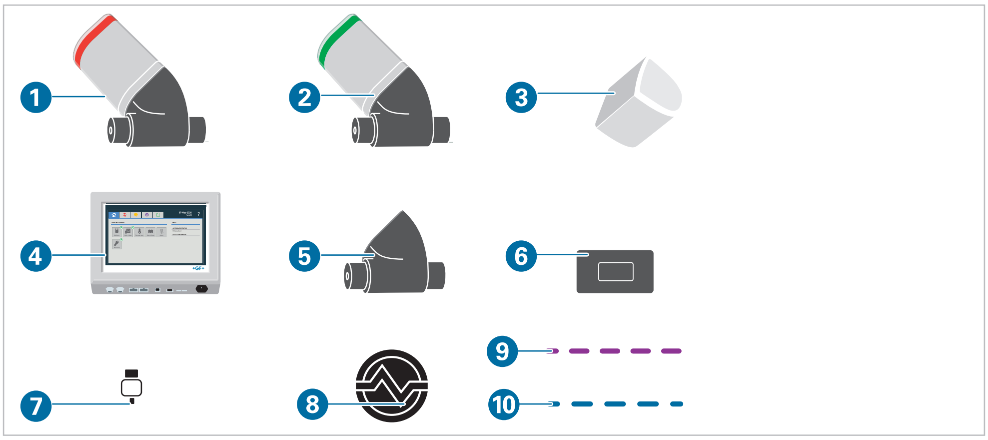
Automatic self-control for both types of hydraulic balancing (function test and cleaning process)

Once a week, a self-check is implemented on the circulation control valves, during which each valve opens and closes completely once. This method counteracts possible deterioration due to deposits in the circulation lines and in the valves. This self-check procedure of the valves is automatically stored in a separate log. Self-checking is no substitute for maintenance work in accordance with the relevant regulations.

1.6.5 Cold water circulation

Heating of the cold water to a hygiene-critical level can be caused by internal (for example hot water) as well as external heat loads (hot summer months). This problem can be solved sustainably by circulating the cold water with proper hydraulic balancing and object-specific accompanying measures, for example active cooling of the cold water or temperature or time-controlled flushing. The balancing valves for the best possible hydraulics, including temperature monitoring in the cold water circulation, and flush valves ensure a regular exchange of water.





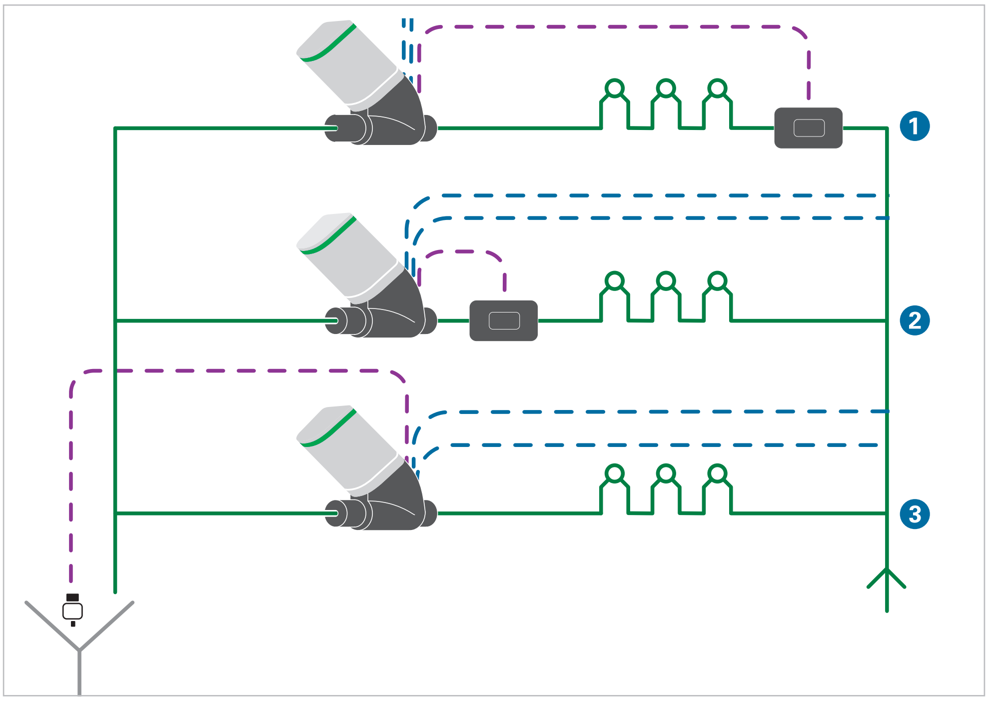
GV.6
Cold water circulation

1. LegioTherm 2T (hydraulic balancing valve)
2. Legiotherm K (flushing valve)
3. Uni controller
4. Hycleen Automation Master
5. T-sensor (temperature measurement)
6. Flow meter
7. Drainage monitoring
8. Heat exchanger / refridgeration unit
9. Sensor cable
10. Power supply and communication cables

1.7 Automatic flushing

If water stagnates over a longer period of time, bacteria can multiply in it until a dangerous concentration is reached. If the entire volume of the drinking water distribution system (cold and hot water) is replaced within three days, the bacteria are flushed out of the drinking water installation. This method counteracts a high concentration of bacteria in the long term. The Hycleen Automation system facilitates the automatic flushing of cold and hot water pipes depending on temperature, time or consumption. Every flushing process is recorded and logged.

There are several options to trigger a flush:



GV.7
Overview of flushing methods

1. Based on consumption
2. Based on time or temperature with defined rinsing volume
3. Based on time or temperature with drainage monitoring device*

* Note: The drainage monitoring module can be connected to a flush valve, to a hydraulic balancing valve, or to a Uni controller.

Temperature controlled flushing

As soon as the limit temperature of a flush valve's temperature sensor is exceeded (cold water) or drops below the setpoint (hot water), the flush valve opens. The valve closes after the pre-programmed time, based on the temperature or according to the individually defined volume per flush valve.

Time-controlled flush

All flush valves open sequentially as soon as the pre-set time is reached. The valves close after the specified flush time or after an individually defined volume per flush valve. The interval between two flush cycles can be adjusted and is flexible, so that several flushes per day are also possible.

Consumption-controlled flushing

A target water volume is defined for each flush valve, which must be exchanged in a specified time period. The Hycleen flow sensor, which is connected to the flush valve, records the effective water consumption in the time interval. After the time has elapsed, only the difference between the target and effective water consumption is flushed.. In addition, a safety flush volume can be defined that is always flushed.

- Ensuring regular water replacement with reduced water consumption

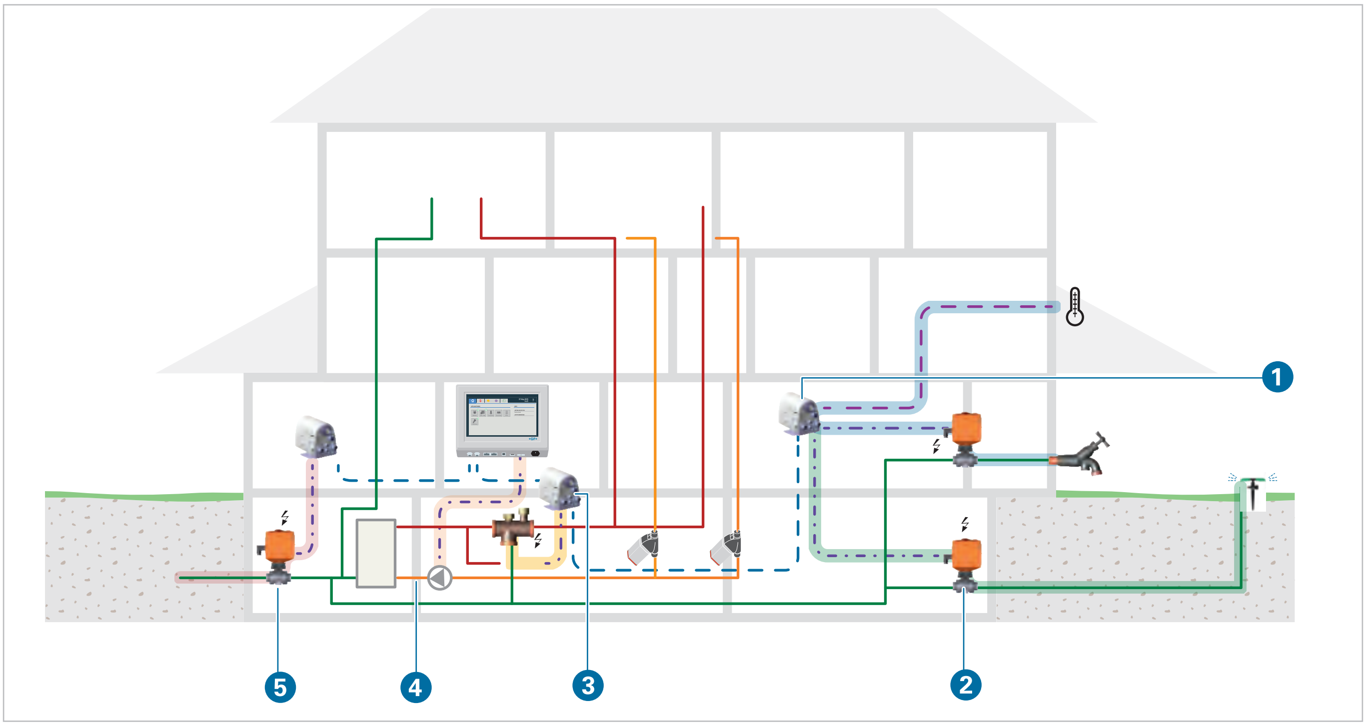
Similar to the LegioTherm 2T application, the LegioTherm K valve is fitted with a temperature sensor. The temperature is monitored and recorded by the master during the logging process.

1.8 Actuator automation

When using the Hycleen Automation Master, a relay and a uni controller, actuators, pumps and much more can be easily programmed and controlled. An automated frost protection system, the control of an electric three-way valve for thermal disinfection, the time-controlled watering of the garden: These are just a few examples in order to illustrate the benefits of the Hycleen Automation System and its many possible applications.

Example: Automation options

When using the actuator automation application, various general triggers (such as temperature, time or a 4-20 mA signal input) as well as various master-coupled triggers (for example, thermal disinfection, flushing, maintenance process or alarms) can be configured.

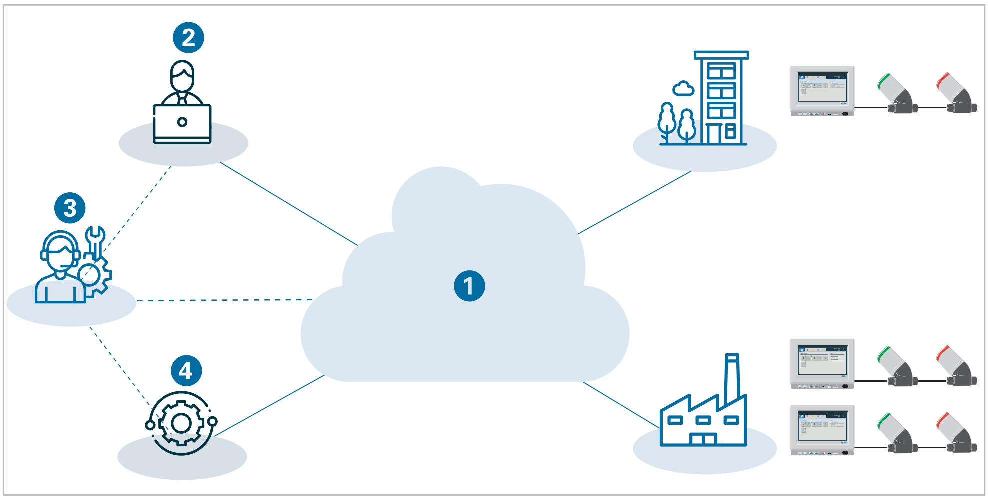


GV.8
Actuator automation

1. Automated temperature-controlled frost protection
2. Time-controlled garden irrigation
3. Thermal disinfection using the control system of an electric 3-way valve and mixer
4. Timing control of the circulation pump
5. Event-controlled shut-off of the main water supply line

1.9 Hycleen Connect

Hycleen Connect is the innovative solution for secure connection and remote access to the Hycleen Automation System from anywhere in the world. Connected drinking water installations can be conveniently controlled and monitored. The reporting and alarm functions make it easier to ensure the system's readiness and show potential for optimisation. If problems occur, a GF service technician provides support via remote access.



GV.9
Hycleen Connect

1. Hycleen Connect
2. Operating company
3. GF customer service
4. Facility Management

Benefits

Remote monitoring
- Online display of values in real time or historical data
- Easy-to-read dashboards
- Condition of the installations at a glance
- Live system overview
- Historical records & reports
- Data basis for system analysis & optimisations

Remote access
- Optimisation of the system using remote control
- Efficient system management
- Secure access to process data
- Online adjustment of all application parameters and valve settings

Alerting
- Fast respons time
- User-specific setup according to limit values or events
- Automatic messages
- Email messages
- Fewer control checks
- Reduced maintenance and operating costs

Data management
- All under one roof
- Online data storage
- Simple report creation

Asset Management
- Downloading the logs via the Cloud
- Data integrity (tamper-proof system data)
- High data security

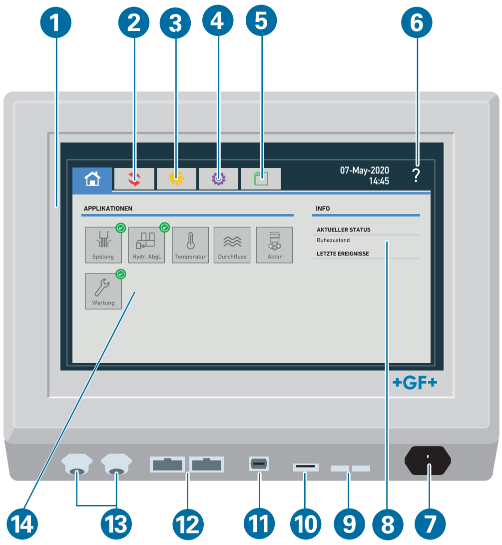
2 Components

Hycleen Automation Master 9900

The Hycleen Automation Master 9900 assumes the central control of up to 50 controllers on two cable harnesses. This enables the central control of all valves in the drinking water system via a touchscreen.

Technical Data

JRG code	Voltage [V]	Dimensions (L x W x H)
9900	230 / 36	326 × 84 × 214



1. Display
2. Running application
3. Manual operation
4. Settings
5. Reports
6. Context-sensitive help
7. Power supply
8. Display with additional indications (last event)
9. potential-free contact connection
10. USB connection
11. USV connection
12. Ethernet connection, connection for Building Management System
13. Connection for power/ communication cable
14. Applications: Hydraulic balancing, flushing, temperature, maintenance

Product description

When using the master, all connected components of the Hycleen Automation System can be regulated and controlled via its touchscreen.

Features and functions

The Hycleen Automation Master assumes the central control of up to 50 controllers on two cable harnesses. (each 500 m). All programs and functions can be intuitively operated via the touchscreen on the Hycleen Automation Master.
The master is connected to the controllers that regulate the individual valves and sensors. All sensors are permanently monitored and deviations are immediately reported.
While putting into operation, the master detects all valves and sensors in the system (with ID and type) and assigns them to the appropriate applications.
Due to predefined values, the system is immediately ready to start. However, all parameters can also be conveniently adapted to individual needs.
The customization is not only possible via the master, but also via a connection to a computer, a tablet or a smartphone.

If an uninterruptible power supply module (UPS) is connected to the master, all valves travel to a predefined, safe position in the event of a power failure.

Benefits und Features

- Central control of the Hycleen Automation System
- Using Plug & Play to put the system into operation
- Automatic logging of data
- Fast, error-free wiring
- Simple user interface
- Connection with Building Management System (GLT)
- Automatic error message
- Actuator automation

Applicable documents

- Operating and maintenance instruction

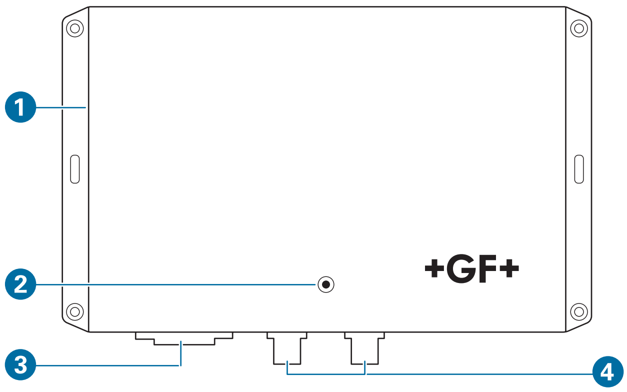
These can be downloaded via www.gfps.com (D/F/I/E/S)

Hycleen Automation Powerbox 9901

The Hycleen Automation Powerbox supplies the power to the Hycleen Automation System circulating controller, using a cable more than 300 m long.

Technical Data

JRG code	Voltage [V]	Application
9901	36	Power supply of the Hycleen Automation System



1. Powerbox
2. Operation LED
3. Power cable connection (230 V)
4. Cable connection (M12)

Product description

EMC-tested electronics in a plastic housing for powering the components of the Hycleen Automation System (conversion from 230 V AC to 36 V DC).

Features and functions

The Hycleen Automation Powerbox is used to supply power to the Hycleen Automation System if the cable length exceeds 300 m. The Hycleen Automation Powerbox converts the voltage from 230 V AC to 36 V DC. Due to the low voltage of 36 V DC and the pre-assembled cable with plug, the plumber can take care of the power supply himself.

Installation instructions

☑ Do not install the Hycleen Automation Powerbox in unvented cabinets (risk of overheating).

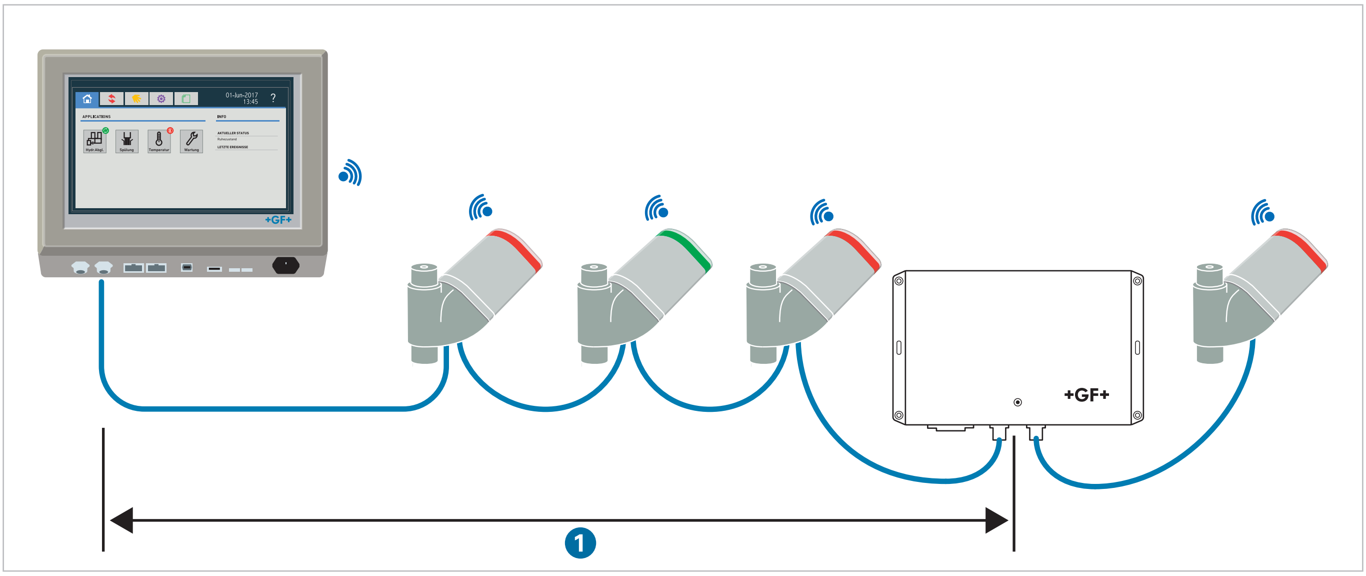
Applicable documents

• Assembly instruction

This can be downloaded via www.gfps.com (D/F/I/E/S)

Installation example

1. if cable length exceeds 300 m: Integration of the Powerbox

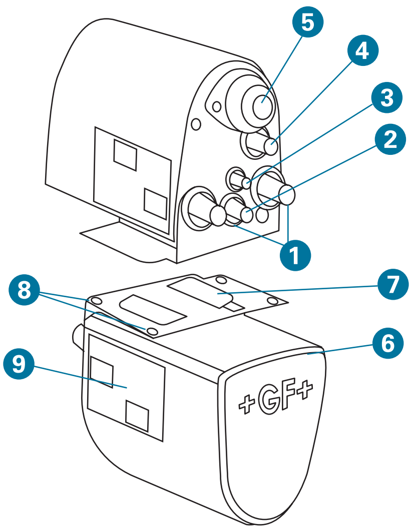


Uni controller 9902

The Uni-contoller is the plug box of the Hycleen Automation system. It can be used to connect 2 external sensors. The Uni-controller offers the option to control 2 actuators via the relay connection or the 4 - 20 mA signal using the actuator app (licence module).

Technical Data

JRG code	Temperature max. [°C]	Connections	
9920	90	1 M12 plug	• for wiring in series
		2 M8 plug	• for external sensor connection (displayed in the master as external sensor no. 2)
		3 M8 plug	• for external sensor connection (displayed in the master as external sensor no. 1)
		4 M12 plug	• for 4 - 20 mA in/out signal
		5 RD24 plug	• Relay 24 V/230 V



1. M12 plug
2. M8 plug
3. M8 plug
4. M12 plug (female)
5. RD24 plug
6. LED lighting system
7. Louvers for fastening to the pipe
8. Drill holes for wall mounting
9. Label with serial number (removable)

V

JRG code	Designation
9902.000	Uni controller

Product description

The Uni-controller facilitates the connection of 2 external sensors as well as the connection of actuators via a 24/230 V relay output and/or a 4 - 20 mA in/out signal. The Master actuator automation application is used to program the actuator.

Function

The Uni-controller is a plug box to which the sensors of the Hycleen Automation System, but also other sensors and actuators, can be connected. The actuators are controlled using relays or a 4 - 20 mA signal. Programming is done in the Actuator Automation application on the master (licence required). The Uni-controller is wired in series with the valves and allows the connection of 2 external sensors from the Hycleen Automation system range. The 4 - 20 mA In/Out connection enables the control and automation of a valve (example: from an actuator) with (or without) position feedback or a controllable 3-way valve, and much more. Thanks to the Master Actuator Automation application and the 24 V/230 V relay output, it is feasible to control a relay that itself operates an actuator, a pump, a motor or a light, and other devices.

Benefits / Features

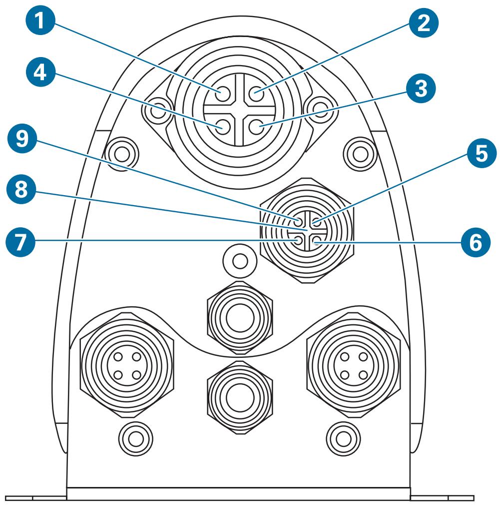
- Connection of 2 external sensors
- Relay connection for controlling the actuator
- 4 - 20 mA IN/OUT signal in order to control the actuator

Spare parts

- Controller: see GF code
- Upper part: see GF code
- Insulation: see GF code
- T-sensor PT1000: see GF code

Installation tips

Wiring diagram of relay 24 V/230 V and 4 - 20 mA In/Out (see illustration)



Relay spezifications

- Max. Impulse frequency: 360 cycles/h
- Contact
  - Type: Changeover contact (CO = Change Over)
- Low-current contact relay
  - Type: SPDT (Single Pole Double Throw switch)
  - Form: C
  - Max. rated voltage: 30 V DC or 250 V AC
  - Max. nominal current: 5 A

Relay cable (9944.005)

Pin	Colour	Designation
1	Brown	Relay contakt Relay On: Pin 1 + 2 closed Relay Off: Pin 1 + 3 closed
2	Black	Normally open contact
3	Grey	Normally closed contact
4	Yellow / green	PE

4 - 20 mA cable (9945.005)

Pin	Colour	Designation
5	Brown	24 V DC
6	Weiss	Signal output 4 - 20 mA
7	Blue	Signal input 4 - 20 mA
8	Black	GND
9	Grey	Signal output sensor type

Applicable documents

• Operating and maintenance instruction

This can be downloaded via www.gfps.com (D/F/I/E/S)

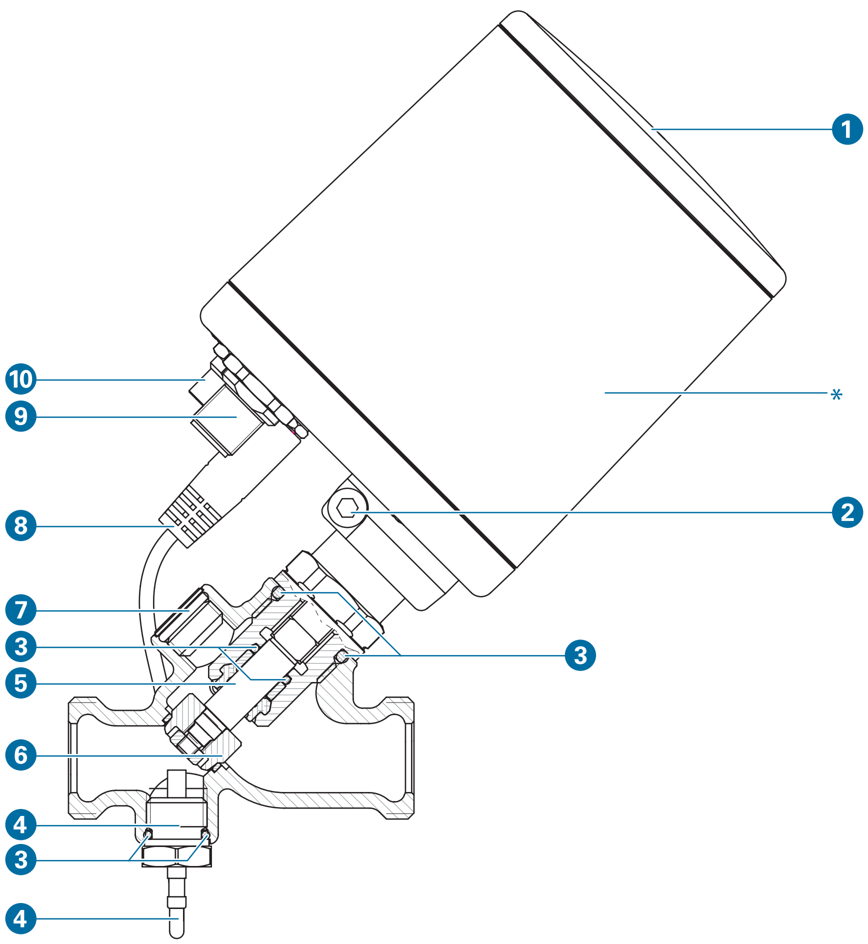
JRG LegioTherm 2T 9910

Circulation valve with controller.

The JRG LegioTherm 2T valve enables hydraulic balancing based on the temperature in circulation lines (hot or cold) with storage of data and adjustable leakage rate. Cabling with the Hycleen Automation Master enables the central control and central data management.

Technical Data

JRG code	Dimension	Nominal pressure PN	Operating mode	Factory setting [°C]	Setting range [°C]	Temperature max. [°C]	Connections
9910	DN15 – 25	10	Normal operation	57	30 – 65	90	External thread
			Thermal disinfection	75	66 – 90		



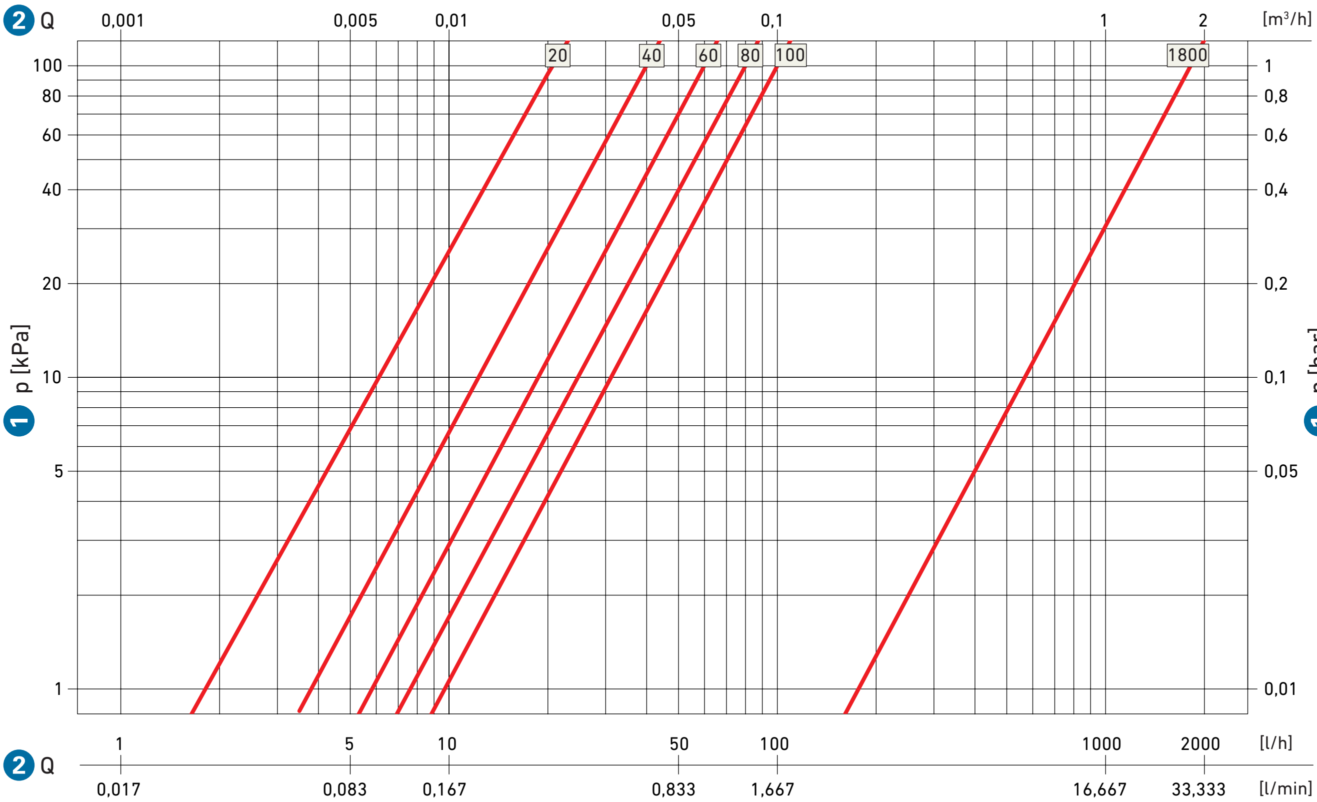
1. LED light ring
2. Screw
3. O-ring
4. Temperature sensor (PT1000)
5. Spindle
6. Cone
7. Plug
8. PT1000 plug
9. M12 plug
10. M8 plug for external sensors (4 – 20 mA)

* Controller

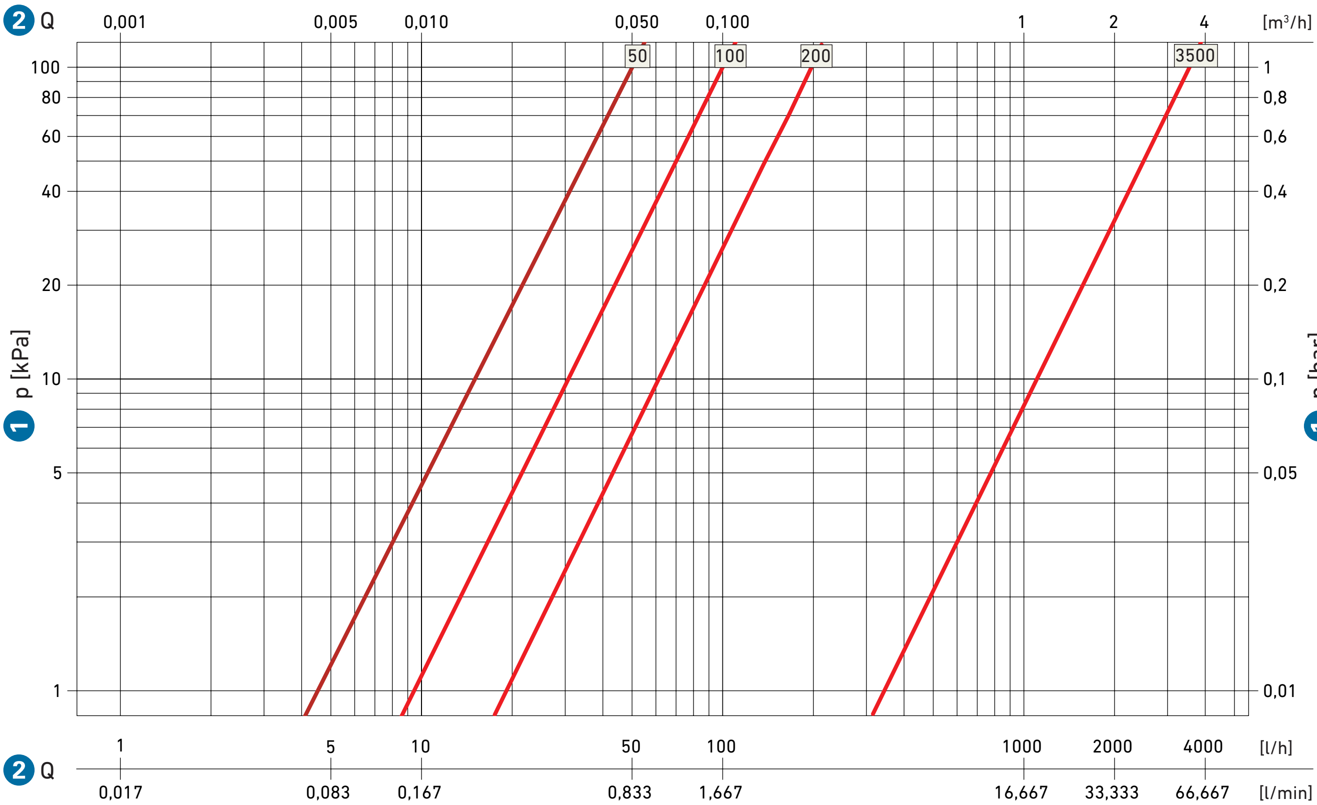
Noise class

Dimension	Noise class
DN15 – DN20	I

Pressure loss LegioTherm 2T DN15



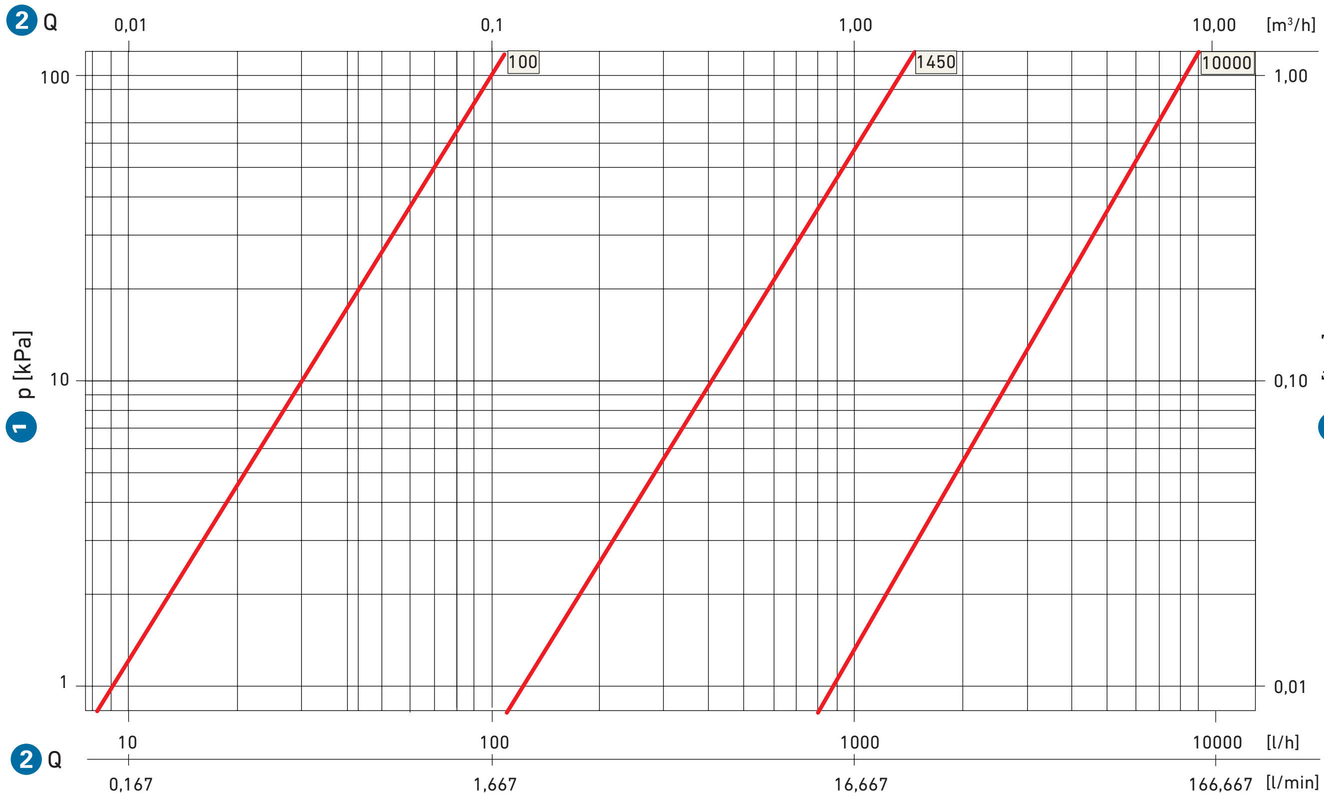
Pressure loss LegioTherm 2T DN20



JRG code	Designation	Dimension DN	K_{vs} value [m³/h]	ζ value
9910.015	LegioTherm 2T	15	1.8	6.4
9910.020		20	3.5	6.1

1 Pressure loss
2 Volumetric flow rate
20 ... 3500 [l/h]

Pressure loss LegioTherm 2T DN25



Product description

The JRG LegioTherm 2T valve of the Hycleen Automation System enables automatic hydraulic balancing with data logging and thermal disinfection capabilities.

Features and functions

In addition to the function of a circulation controller (hot or cold water), the circulation controller JRG LegioTherm 2T is used wherever a controlled, thermal disinfection of the hot water system is required (e.g. retirement and nursing homes, hospitals, etc.). The circulation controller JRG LegioTherm 2T enables the option of two calibration temperatures (normal operation/thermal disinfection).

The circulation controller JRG LegioTherm 2T regulates the volume flow, as the temperature sensor, which is completely surrounded by water, permanently measures the water temperature. The measured values are processed by the controller. If the setpoint temperature deviates, the circulation valve regulates the volumetric flow necessary for the temperature correction by opening and closing with an actuator.

Benefits und Features

- Adjustable leaks:
  minimum flow rate at the valve
- More linearity and better regulation through special cone profile
- Application: hydraulic balancing, thermal disinfection, maintenance (once a week)
- Fast, error-free wiring
- Temperature sensor PT1000 integrated in the valve and completely emerged in water
- Bluetooth connection to external tablet/smartphone can be switched on and off
- Controller incl. motor actuator with encoder; Position of the valve always known; short opening and closing time of 15 s
- Activity indicator (light ring): depending on the valve (JRG LegioTherm 2T), the colour of the light ring is red, condition of the valve
  (open/closed)

Installation tips and mounting position

The circulation controller JRG LegioTherm 2T can be installed regardless of position.

For revision purposes, we recommend installing a shut-off device (JRG code 8339) upstream and downstream of the JRG LegioTherm 2T circulation controller.

Applicable documents

• Operating and maintenance instruction

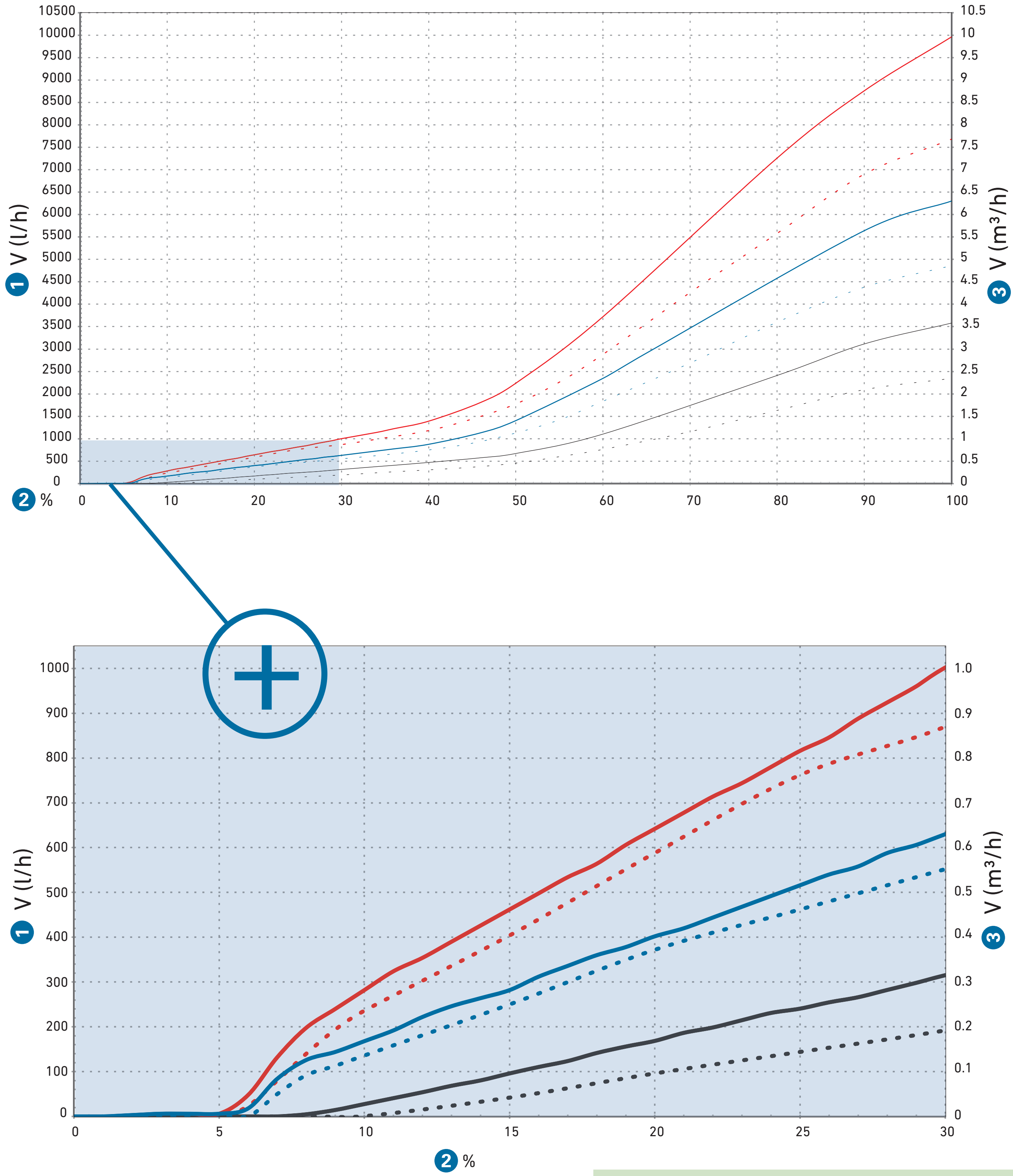
This can be downloaded via www.gfps.com (D/F/I/E/S)

Spare parts

- Controller
- Upper part
- Insulation
- Temperature sensor (PT1000)

V

Characteristic curve for valve opening degree



Colour	Designation
—— (red)	DN25 at dP = 1000 mbar
.... (red)	DN25 at dP = 400 mbar
—— (blue)	DN20 at dP = 1000 mbar
.... (blue)	DN20 at dP = 400 mbar
—— (black)	DN15 at dP = 1000 mbar
.... (black)	DN15 at dP = 400 mbar

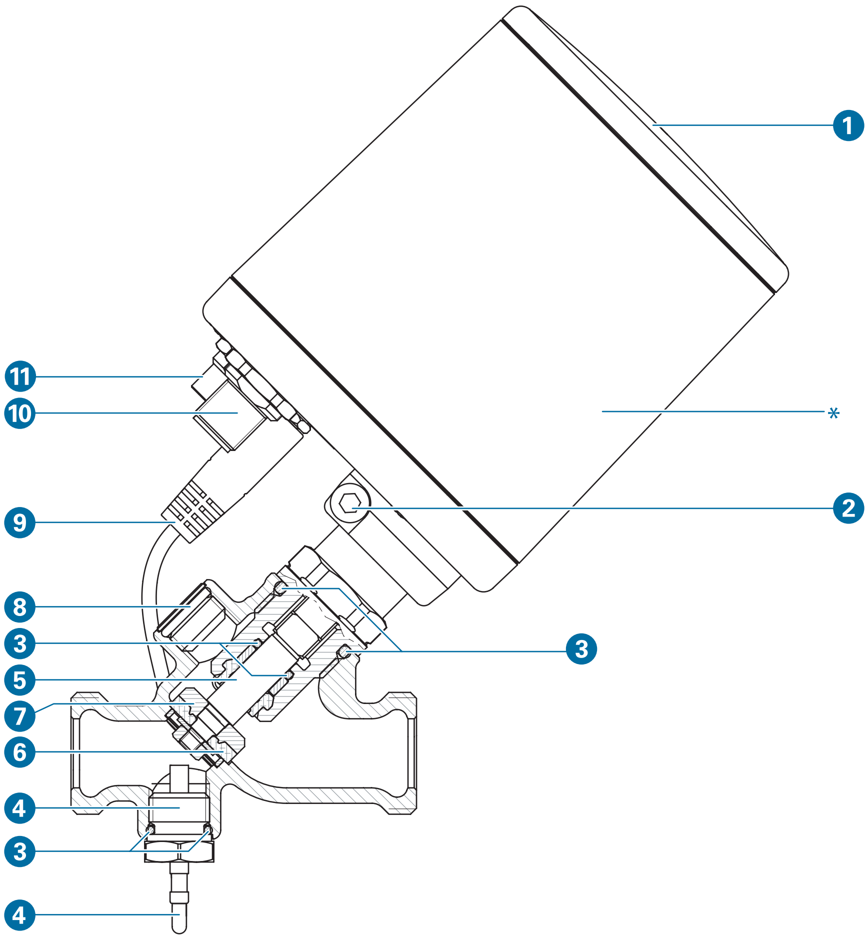
JRG LegioTherm K 9920

Flushing valve with controller

The JRG LegioTherm K valve of the Hycleen Automation System enables automatic flushing and logging of the data.

Technical Data

JRG code	Dimension	Nominal pressure PN	Operating mode	Factory setting [°C]	Setting range [°C]	Temperature max. [°C]	Connections
9920	DN15 – 20	10	Normal operation	25	2 – 90	90	External thread



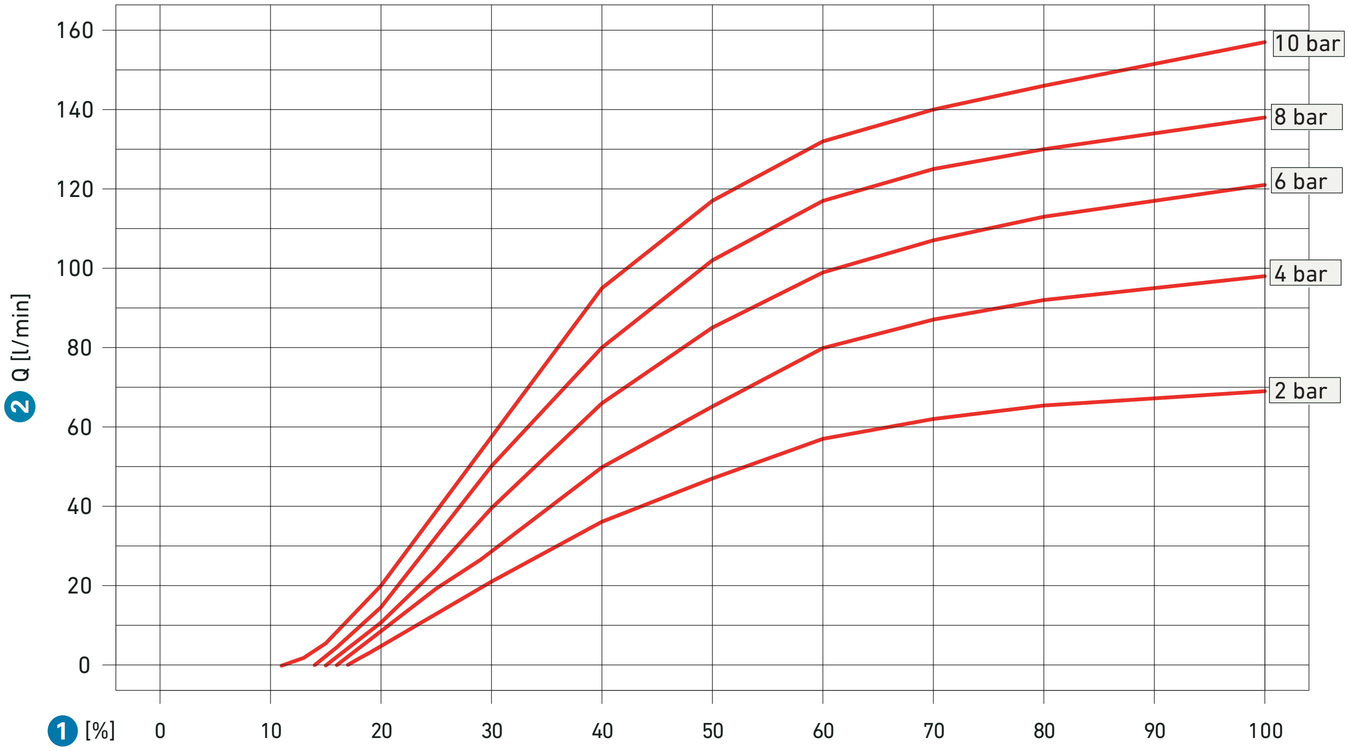
1. LED light ring
2. Screw
3. O-ring
4. Temperature sensor (PT1000)
5. Spindle
6. Gasket
7. Cone
8. Plug
9. PT1000 plug
10. M12 plug
11. M8 plug for external sensors (4 – 20 mA)

* Controller

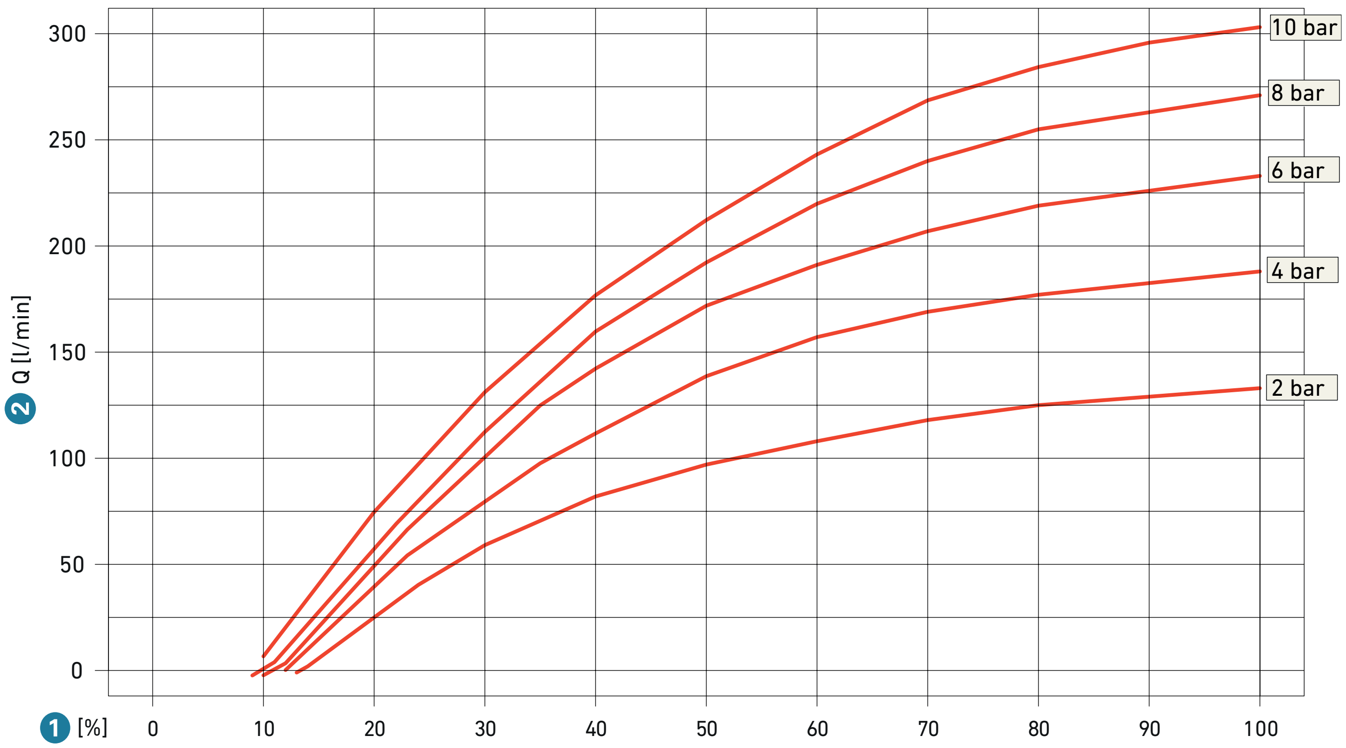
Noise class

Dimension	Noise class
DN15 – DN20	I

Flushing capacity of JRG LegioTherm K DN15



Flushing capacity of JRG LegioTherm K DN20



JRG code	Designation	Dimension DN	K_{vs} value [m³/h]	ζ value
9920.015	LegioTherm K	15	3.9	4.8
9920.020		20	7.2	4.6

1 Volumetric flow rate
2 Opening degree

Product description

The flushing valve JRG LegioTherm K of the Hycleen Automation System enables automatic flushing with logging of the data.

Features and functions

The JRG LegioTherm K is intended for flushing cold or hot water installation sections. The rinsing of individual drinking water distribution lines reduces the formation of biofilm and keeps the microbiological drinking water pollution at a low level.

The flushing processes are triggered by time or temperature control units, whereby the water temperature is monitored at the same time. Moreover, online monitoring of the temperature limit increases drinking water safety.

The valve is opened via an actuator. The valve is closed when delivered.

Benefits und Features

- Adjustable lift: Flow rate with open valve
- Application: Flushing of cold or hot water installation
- Fast, error-free wiring
- Temperature sensor PT1000 integrated in the valve and completely emerged in water
- Bluetooth connection to external tablet/smartphone can be switched on and off
- Controller incl. motor actuator with encoder; Position of the valve always known; short opening and closing time of 15 s
- Activity indicator (light ring): depending on the valve (LegioTherm K), the colour of the light ring is green, condition of the valve (open/closed)

Installation tips and mounting position

The flushing valve JRG LegioTherm K can be installed in any position. For revision purposes, we recommend installing a shut-off device (JRG code 8339) upstream of the JRG LegioTherm K circulation controller.

Discharge lines must be dimensioned for maximum flow.

Applicable documents

- Operating and maintenance instruction

These can be downloaded via www.gfps.com (D/F/I/E/S)

Spare parts

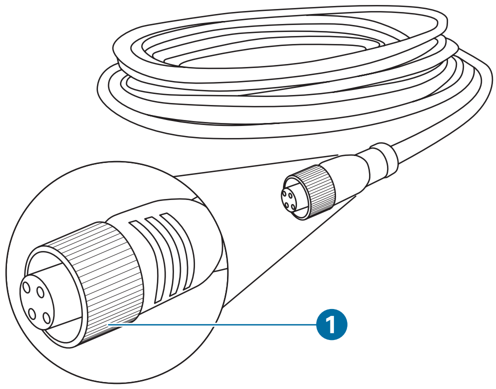
- Controller
- Upper part
- Insulation
- Temperature sensor PT1000

Hycleen Automation power supply and communication cable 9940

Cable for the serial connection of all components of the Hycleen Automation System.

Technical Data

JRG code	Dimension [m]	Connections
9940	1.5 to 50	M12



1 Plug M12

JRG code	Designation	Dimension [m]
9940.001	Hycleen Automation power supply and communication cables	1.5
9940.005		5
9940.010		10
9940.020		20
9940.050		50

Product description

The power supply and communication cable of the Hycleen Automation System makes a serial connection between all components of the Hycleen Automation System easy.

Features and functions

The cables contain 2 wires for the power supply and 2 signal lines. Both cable ends are equipped with the same female connectors and designed to prevent rotation. The M12 knurled screws provide reliable hold and secure connection even in harsh environments.

Installation tips

When connecting, make sure that the pull-out safety device is screwed on (knurled screw).

Benefits und Features

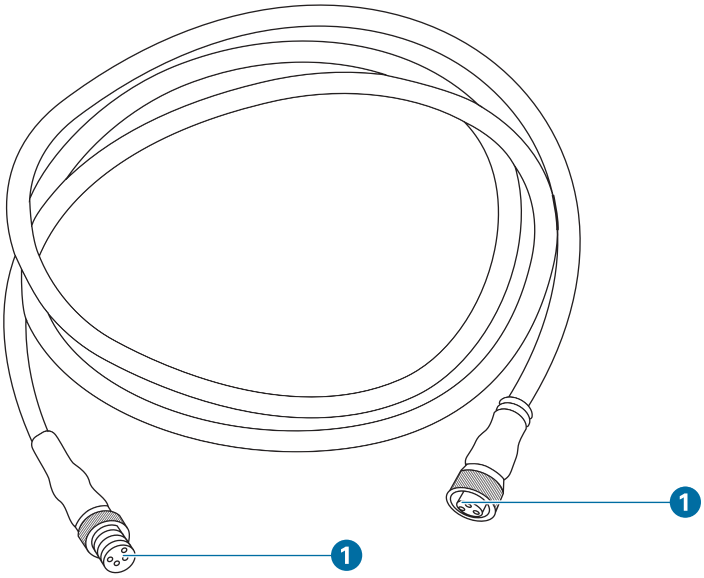
- secure connection of all components
- simple, serial connection
- anti-turn design
- Cable easily to attach due to special threaded connection

Hycleen Automation sensor cable 9943

Sensor extension cable for connecting Hycleen sensors to the Hycleen Automation system's controller.

Technical Data

JRG code	Dimension [m]	Connections
9943	5	M8



1 Plug M8

JRG code	Designation	Dimension [m]
9943.005	Cable	5

Product description

if a sensor is installed more than 5 m from the controller, the Hycleen Automation system's sensor extension cable makes it easy to connect a Hycleen sensor to the controller.

Function

The cable ends are fitted with various connectors (male/female) and are designed to be twist-proof. The M8 knurled screws provide reliable hold and secure connection even in harsh environments.

Benefits / Features

- secure connection of all components
- Sensors can be installed up to 50 m away from a controller
- anti-turn design
- Cable easily to attach due to special threaded connection

Installation tips

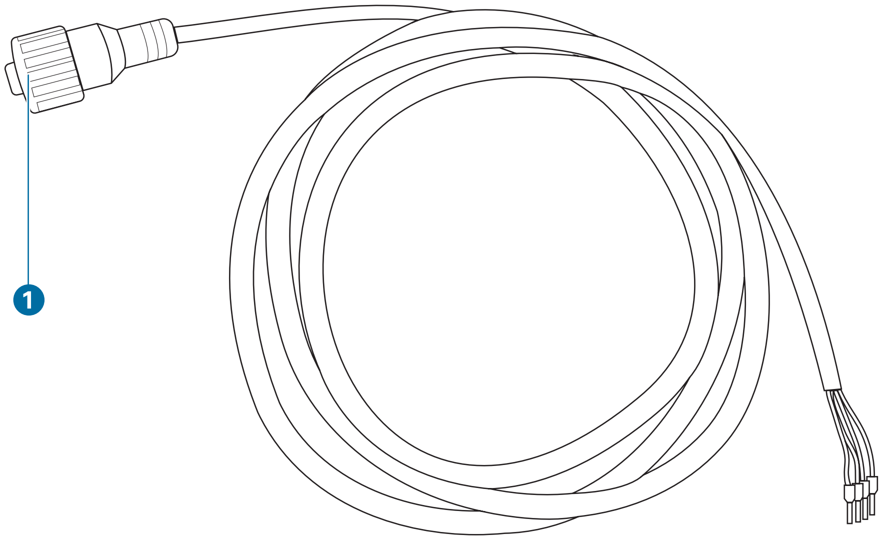
When connecting, make sure that the pull-out safety device is screwed on (knurled screw).

Hycleen Automation relay cable 9944

Cable for connecting Uni-controller relay plugs to actuators. Actuators are controlled and programmed via the master.

Technical Data

JRG code	Dimension [m]	Connections
9944	5	RD24



1 Plug RD24

JRG code	Designation	Dimension [m]
9944.005	Cable	5

Product description

The relay cable is used in order to connect an actuator to a Uni-controller. When using the actuator application on the Master (module with licence) it is possible to control the actuator by programming it in the application.

Function

The actuator can be controlled based on various triggers such as time, temperature, information from native applications on the Master, from error messages, and much more.

The actuator is not supplied with voltage via the Uni-controller, but via its own connection to the power supply.

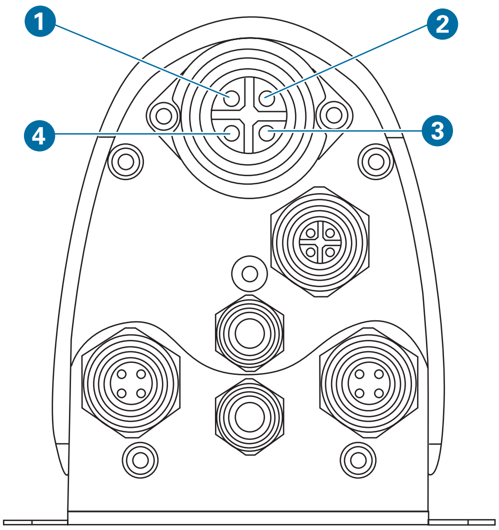
Benefits / Features

Central control of the Hycleen Automation Systems

- Automation option for actuators

Installation tips

Wiring diagram of relay (see illustration)



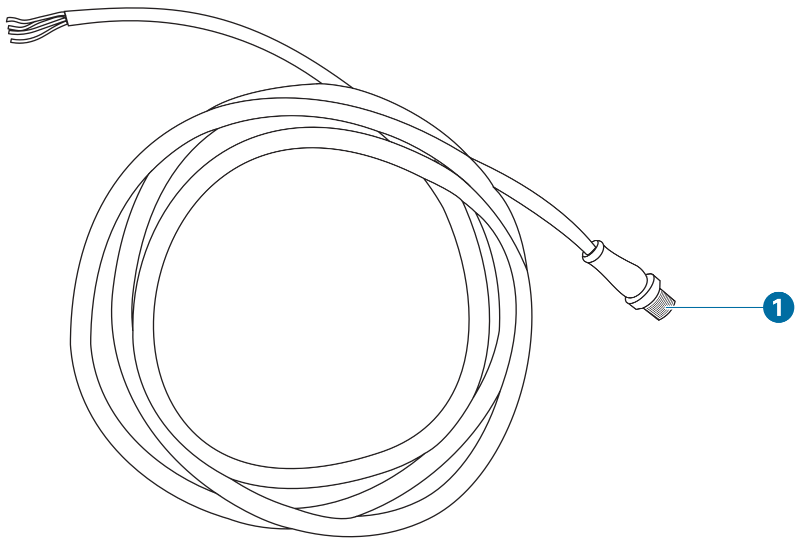
Pin	Colour	Designation
1	Brown	Relay contakt Relay On: Pin 1 + 2 closed Relay Off: Pin 1 + 3 closed
2	Black	Normally open contact
3	Grey	Normally closed contact
4	Yellow / green	PE

Hycleen Automation 4-20mA cable 9945

Extension cable for connecting Hycleen sensors to the Hycleen Automation system's controller.

Technical Data

JRG code	Dimension [m]	Connections
9945	5	M12



1 Plug M12

JRG code	Designation	Dimension [m]
9945.005	Cable	5

Product description

The 4 - 20 mA In/Out cable is used in order to connect an actuator controlled with a 4 - 20 mA signal to a Uni-controller. When using the actuator application on the Master (module with licence) it is possible to control the actuator by programming it in the application.

Function

The actuator can be controlled based on various triggers such as time, temperature, information from native applications on the Master, from error messages, and much more.

The actuator is not supplied with voltage via the Uni-controller, but via its own connection to the power supply.

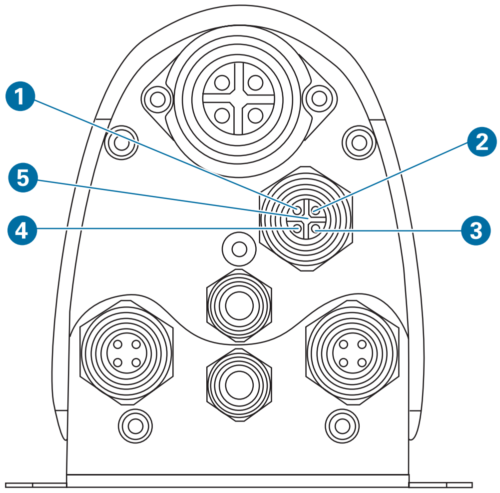
Benefits / Features

Central control of the Hycleen Automation Systems

- Automation option for actuators
- Position information

Installation tips

Wiring diagram (see illustration)



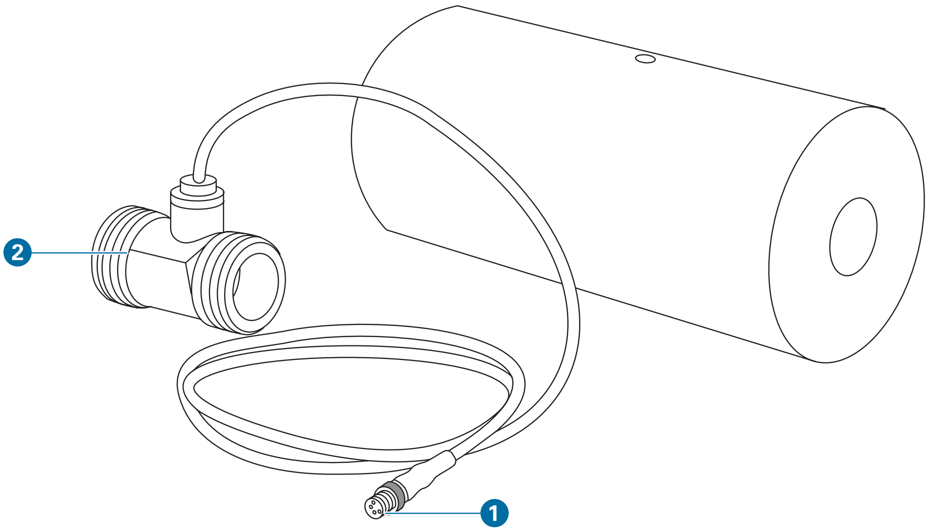
Pin	Colour	Designation
1	Brown	24 V DC
2	Weiss	Signal output 4 - 20 mA
3	Blue	Signal input 4 - 20 mA
4	Black	GND
5	Grey	Signal output sensor type

Flow rate sensor 9950

The flow sensor enables flow measurement at the desired location.

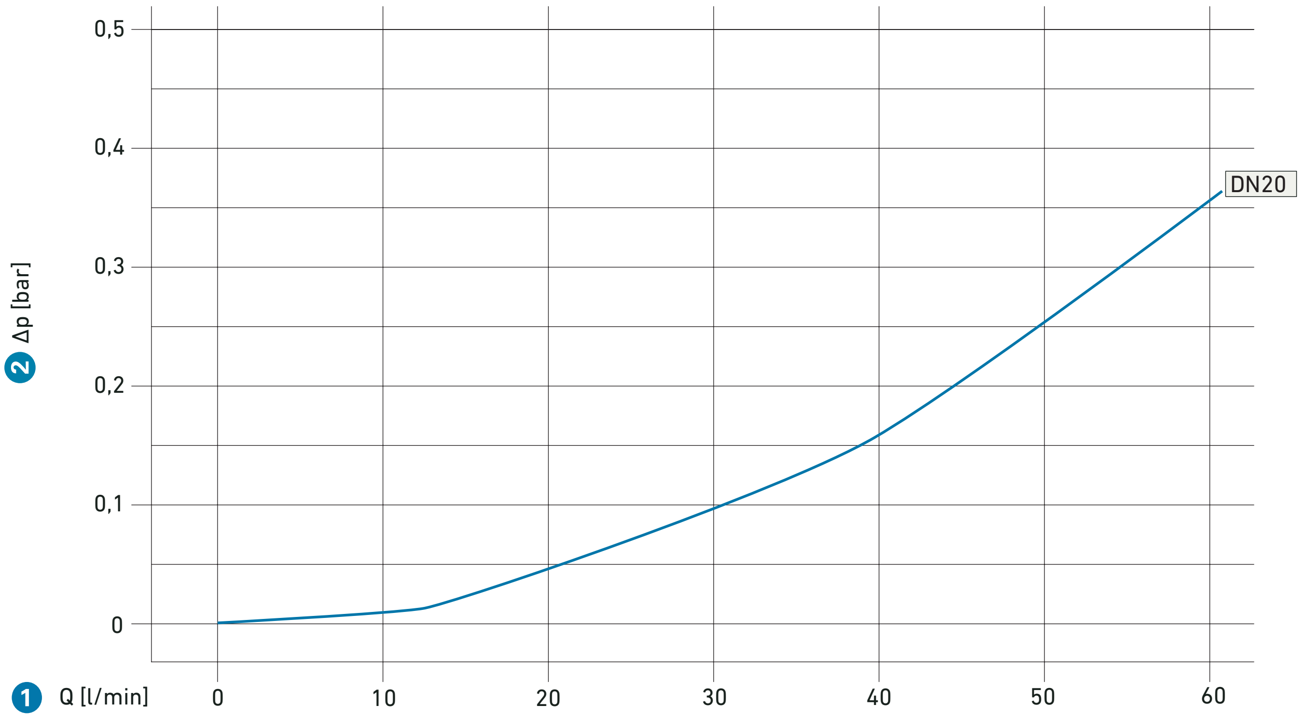
Technical Data

JRG code	Dimension	Nominal pressure	Temperature [°C]	Connections
9950	DN 20	PN 10	max. 90	M8



1 Plug M8
2 Outside thread

Flow rate sensor DN20



JRG code	Designation	Dimension
9950.020	Flow rate sensor	DN 15/20

1 Volumetric flow rate
2 Pressure loss

Product description

The Hycleen Automation flow sensor is a transducer for measuring the volume flow of liquids. The flow sensor must be connected to a LegioTherm 2T (circulation) or LegioTherm K (flushing) valve controller or a Uni-controller. The sensor can be installed up to 50 m away from the controller; however, in this case, the use of extension cables 9943.005 is manadatory. When the master is started, it is automatically recognised as an external sensor. The flow rate of the sensors (in l/h) can be read from the master.

Function

The flow sensor can be used in flush applications, in order to define a flush volume, or as a counter for the flush-after-consumption application.

Connection to any hydraulic balancing valve. This connection makes it possible to programme a hydraulic balancing feature depending on the flow rate or simply to map the flow rate in order to obtain even more information about circulation and hydraulic balancing.

Benefits / Features

- Can be used with flushing application and hydraulic balancing
- Automatic detection during initial start-up
- Automatically stored flow rate log
- Provides more information about the system,
- Helps to improve the system and solve problems

Installation tips

Mounting position

In order to achieve the highest possible measuring accuracy, a straight inlet and outlet section of the corresponding nominal width (DN) must be used. The inlet pipe should be at least 10 x DN and the outlet pipe 5 x DN long.

Installation instructions

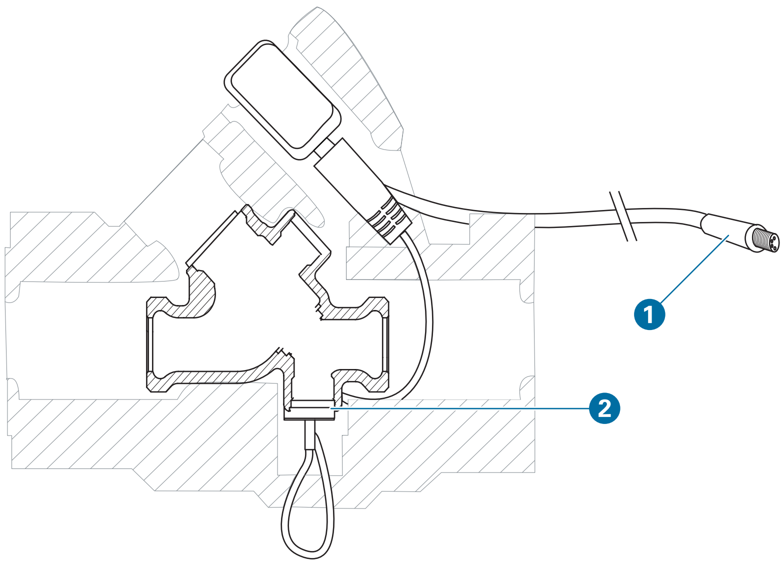
- Measuring range 1 to 60 l/min
- Accuracy ±1% of final value / ±1% of measured value
- Repeatability ±1% of measured value
- Signal output 0.8 l/min
- Bracket for Hall-effect sensor

T-sensor 9951

The T-sensor enables temperature measurement at the desired location.

Technical Data

JRG code	Dimension	Nominal pressure	Temperature [°C]	Connections
9951	DN 15/20	PN 10	max. 90	External thread M8 plug



1 M8 plug
2 External thread

JRG code	Designation	Dimension
9951.xxxx	T-sensor	DN 15/20

Product description

The T-sensor is a PT1000 temperature sensor that can be installed anywhere in the building. The T-sensor must be connected to a LegioTherm 2T (circulation) or LegioTherm K (flushing) valve controller. When using extension cables 9943.005, the sensor may also be connected to a Uni-controller and can be set up as far as 50 m from a controller.

Function

The T-sensor measures the water temperature at the desired location in the building. This temperature is displayed on the master and recorded in a log that is generated at the scheduled intervals.

Benefits / Features

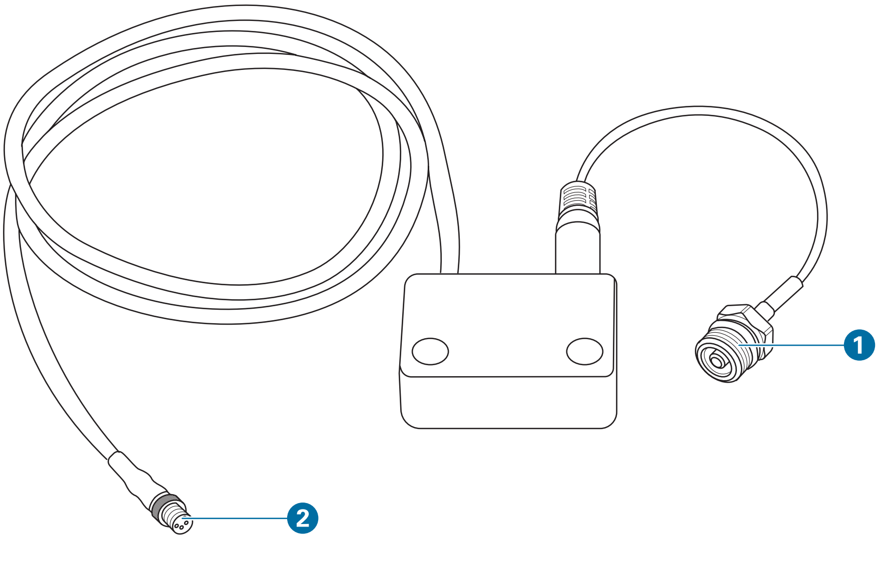
- Simple wiring
- Water temperature can be measured at any point in the network
- Temperature monitoring and automatic generation of a protocol

T-sensor 9952

The T-sensor, which is non-dimensional, enables temperature measurement at the desired location.

Technical Data

JRG code	Dimension	Nominal pressure	Temperature [°C]	Connections
9951	independent	PN 10	max. 90	External thread M8 plug



1 External thread
2 M8 plug

JRG code	Designation	Dimension
9952.000	T-sensor	Threads 1/4"

Product description

The T-sensor is a PT1000 temperature sensor that can be installed anywhere in the building. The T-sensor must be connected to a LegioTherm 2T (circulation) or LegioTherm K (flush) valve controller or to a Uni-controller. The sensor can be installed up to 50 m from a controller; however, in this case, the use of extension cables 9943.005 is manadatory.

Function

The T-sensor measures the water temperature at the desired location in the building. The temperature is displayed on the master and recorded in a log that is generated at the scheduled intervals.

Benefits / Features

- Adjustable leaks: Flow rate with closed valve
- More linearity and better regulation through special cone profile
- Application: hydraulic balancing, thermal disinfection, flushing for maintenance (once per week)
- Fast, error-free wiringAutomatic detection of input and output during initial start-up
- Temperature sensor PT1000 integrated in the valve and completely emerged in water
- Bluetooth connection to external tablet/smartphone can be switched on and off
- Controller incl. motor actuator with encoder
  - Valve position always known
  - Short opening and closing time of 15 s
- Activity display (ring of lights)
  - Colour of the light ring red depending on the valve (LegioTherm 2T)
  - Valve status (open/closed)

Installation tips

Mounting position

The circulation controller JRG LegioTherm 2T can be installed regardless of position. For revision purposes, we recommend installing a shut-off device JRG code 8339 upstream and downstream of the JRG LegioTherm 2T circulation controller.

Applicable documents

- Operating and maintenance instruction

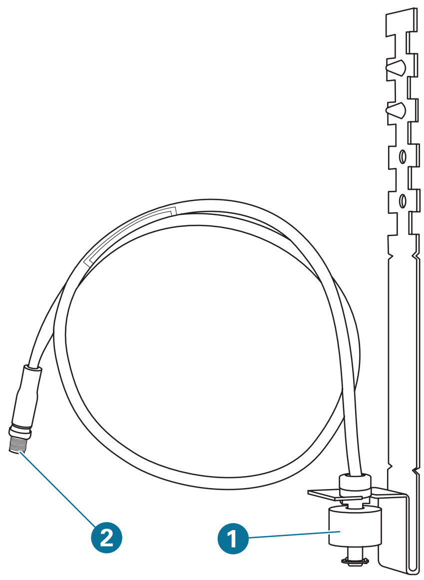
These can be downloaded via www.gfps.com (D/F/I/E/S)

Drainage monitoring 9953

The drainage monitoring feature monitors the drain and stops the flushing process if the drain is clogged.

Technical Data

JRG code	Dimension	Nominal pressure	Temperature [°C]	Connections
9953	-	PN 10	max. 90	M8 plug



1 Float switch
2 M8 plug

JRG code	Designation	Dimension
9953.000	Drainage monitoring	-

Product description

The drainage monitoring device is a sensor with a float switch that can be installed anywhere in the building's drainage system. The float switch must be connected to a LegioTherm 2T (circulation) or LegioTherm K (flushing) valve controller or a Uni-controller. The sensor can be installed up to 50 m away from the controller; however, in this case, the use of extension cables 9943.005 is manadatory.

Function

The drainage monitoring device increases safety during flushing processes. It can also be used in the actuator app as a level sensor or used as a trigger to control an actuator.

Benefits / Features

- Monitoring the drainage
- Immediately stops the flushing process if the drain is clogged
- Can be positioned anywhere in the drain pipe
- Can be installed up to 50 m away from the controller
- Fast, error-free wiring
- Automatic detection during initial start-up

Installation tips

Mounting position

The drainage monitoring device must be installed in the drain pipe. The water jet must not splash onto the float switch.

Applicable documents

• Operating and maintenance instruction

These can be downloaded via www.gfps.com (D/F/I/E/S)

Build

Malleable Cast Iron Fittings

V

Malleable Cast Iron Fittings

Overview

This chapter contains basic information about the malleable iron fitting system.

Additional technical and sales information

- For more information on the use and connection of other system components, piping and controls and instruments, see the chapters applicable to the appropriate systems.
- More technical information about this system and ordering information can be found on the GF website and in the sales catalogue.

1 Product Range

For the fittings shown in the overview below, the **figure numbers** (**Fig.**, followed by the number) are used as identifier.

Elbows

1 1a 2 2a 3 40 41 50 51 53 54 60 85 87

Angles

90 92 94 120 121 471

Tees

130 131 132 133 134 135 137 165

Cross connectors and distribution pieces

180 220 221 223

Nipples

280 281 531

Sleeves

270 271 526 529a

Plugs

290 291 294 595 596

Caps

300

Reducers

240 241 245 246 260

Locknuts

310 312

Flanges

321 326 329

Long threads

534 535 536 537

Miscellaneous

599a 901 933 933a

Threaded connectors

95 96 97 98 100 101 102 103 330 331 332 335 336 338

340 341 342 342a 344 346 350 351 356 370 371 372 373 374

375 376 378

V

1.1 Product standards

The international standard for malleable iron fittings ISO 49 and the European standard for threaded pipe fitting in malleable cast iron EN 10242 apply. Both standards are similar.

The European standard EN 10242 has been adopted by most European countries as a national edition (DIN EN 10242, ÖNORM EN 10242, SN EN 10242 etc.). At the same time, national standards (for example DIN 2950)) were withdrawn. One exception is the British standardisation. Here, the BS 143 and the BS 1256 were only partially replaced by the BS EN 10242 standard. The BS 143 and the BS 1256 standards remained in use, as they also applies to fittings made of copper alloys and continues to exist for those types of malleable iron fittings and dimensions not covered by BS EN 10242.

In EN 10242 (and in ISO 49), the various versions of malleable cast iron fittings offered by manufacturers are based on the combination of material grade and connecting thread type are grouped under what is referred to as design symbols. These design symbols are used to more easily specify the desired design of the fitting when tendered or ordered; however, they are not intended to be labelled on the product or packaging.

TV.1
Design symbols and specification

Design symbol	Type of material (acc. to EN 1562)	Tensile strength [N/mm²]	Elongation [%]	Connecting threads
A	EN-GJMW-400-5	400	5	parallel internal pipe thread Rp and external taper pipe thread R (acc. to EN 10226-1 / ISO 7-1)
	EN-GJMB-350-10	350	10	
B	EN-GJMW-350-4	350	4	
	EN-GJMB-300-6	300	6	
C*	EN-GJMW-400-5	400	5	tapered internal pipe thread (RC*) and external taper pipe thread R (acc. to EN 10226-2 / ISO 7-1)
	EN-GJMB-350-10	350	10	
D*	EN-GJMW-350-4	350	4	
	EN-GJMB-300-6	300	6	

* Not common in continental Europe or partially prohibited by national regulations.

GF exclusively manufactures malleable cast iron fittings made of decarburised annealed (white) malleable cast iron of the grade EN-GJMW-400-5 with connecting threads Rp and R. The products therefore correspond to the design symbol A.

1.2 Designations

1.2.1 Designations acc. to standard

For manufacturer-independent invitations to tender, enquiries, etc., the EN 10242 (and ISO 49) provides a syntax for the product name. The specification of the design symbol for determining the desired material and the thread design is essential.

Example

Standard designation for an angle with 2 internal threads of size ½, version galvanized, design symbol A:

Angles EN 10242 – A1 – ½ – Zn – A

❶ ❷ ❸ ❹ ❺ ❻

TV.2
Standard designation

Designation	Explanation
❶ Type of fitting	Moulded body
❷ Product standard	EN 10242 (ISO 49)
❸ Abbreviations	–
❹ Fitting size	Dimensions in inches
❺ Surface finishing	Fe = black; Zn = galvanized
❻ Design symbol	A, B, C or D; ➨ For explanation see table. [TV.1]

Size designation

The naming of the fitting types is based on the simplest possible basic types, such as: elbows, angles, tees, crosses, etc. In addition, essential features are identified. The following rules apply to the order of connection sizes:

- For fittings without special designation, the single indication of the connection size is sufficient.
- When ordering reduced fittings with 2 connections of different sizes, the connection size of the larger connection must specified first, followed by the size of the smaller connection. Exception: Fig. 92 (Connection size of the internal thread first).
- When ordering fittings with 3 or more connections (➨ Tab. [TV.3], ① and ④) - with random connections at the passage - it is sufficient to first specify the size of the passage, followed by the size specification of the branch.
- When ordering 3 different connections or parts with reduced passage, the sequence for the designation of the connections according to Table. [TV.3], ② and ③ applies.

Examples

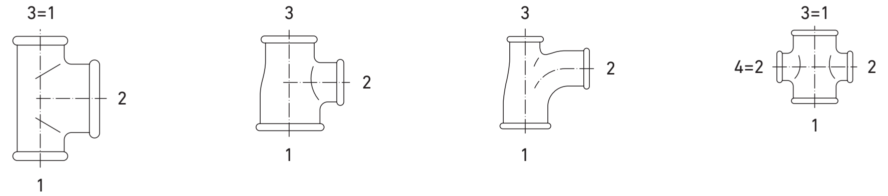
Standard designation for a tee with internal threads of size 1¼ inside the passage and ¾ in the branch, design black, design symbol A:

T EN 10242 – B1 – 1¼ × ¾ – Fe – A

The standard designation for an elbow/tee with an internal thread of size 2 and 1 ¼ in the passage and ½ at the branch, design galvanized, design symbol A:

Elbow-T EN 10242 – E1 – 2 × 1¼ × ½ – Zn – A

①	②	③	④



TV.3
Connections

1.2.2 GF designations

GF has introduced a simplified **product name** for inquiries and orders. This product name consists of the following elements:

Example

GF designation for an angle with 2 internal threads of size ½, version galvanized, design symbol A:

90 – ½ V or **770 090 204**

① ② ③ ④

TV.4
Product name

Designation		Explanation
①	Figure Number	Type of fitting
②	Fitting size	Dimensions in inches
③	Surface finishing	S = black; V = galvanised
④	GF code	9 digits

In order to avoid errors in the specification, the **9-digit GF code** ④ mentioned in the product catalogue can also be used. In both scenarios, the design symbol does not have to be provided, as GF only manufactures fittings according to design symbol A.

2 Product features

2.1 Fitting sizes

Fitting sizes are the size designations of the fittings, derived from the **thread sizes** according to EN 10226-1 and ISO 7-1.

Connection sizes of pipes, flanges or controls and instruments are designated by thread sizes or nominal diameters **DN**.

As a guideline for the relationship between fitting size and nominal diameter **DN**, the following applies:

Thread size G	⅛	¼	⅜	½	¾	1	1¼	1½	2	2½	3	4
Nominal width DN [mm]	6	8	10	15	20	25	32	40	50	65	80	100

TV.5
Fitting sizes and nominal widths

2.2 Material malleable cast iron

Additional information on the material malleable cast iron

➨ Part III 'The basics', Section 'Materials and jointing technology'

Malleable iron is an iron-carbon alloy that achieves a combination of the outstanding properties of cast iron (castability) and steel (strength and toughness properties).

The chemical composition of the melt results in excellent castability, which makes malleable iron particularly suitable for the manufacture of complex shapes and for the production of parts with very thin wall thicknesses.

When cast, malleable iron is hard, brittle and non-workable, it receives its final structure only by a subsequent heat treatment. By applying this long-term annealing treatment (= tempering), very good machinability and very good toughness properties are achieved; while at the same time sufficient high strength is attained.

Depending on the type of heat treatment, a distinction is made between two types of malleable iron. Their designation can be attributed to the respective appearance of the fractured surfaces:

Black malleable iron

Black malleable iron is annealed in an inert atmosphere (inert gas or vacuum) and has a uniform structure with a higher carbon content.

White malleable iron

White malleable iron is annealed in an oxidising atmosphere, greatly reducing the carbon content of the boundary zone.

The decarburisation of the structure is decisive for the advantages of white compared to black malleable iron:

- it is easier to galvanise (more homogeneous formation of the iron zinc alloy on the fitting's surface)
- it has a higher strength and excellent quality
- by adding heat treatment at the factory, welding and soldering can be achieved, provided certain conditions apply

Material designation	Tensile strength min. [MPa]	Elongation min. [%]	0.2 yield strength min. [MPa]
EN-GJMW-400.5	400	5	220

TV.6
GF material

measured on a specimen with 12 mm

2.3 Surface finishing

All GF malleable iron fittings are supplied in black or hot-dip galvanised finish, wetted with a preservative for the temporary prevention of flash rust.

Exceptions are items marked with the letters **ST** in the product catalogue, which are made of steel. If, for technical reasons, a galvanised version is required, these can only be offered galvanised.

Low corrosion protection when using galvanic coatings
Galvanic coatings are not suitable, as they offer much lower corrosion protection for drinking water installations.

In compliance with European and international standards, malleable cast iron fittings must be free of polycyclic aromatic hydrocarbons.

2.4 Hot dip galvanising

The term **hot dip galvanising** means the achievement of a zinc coating by immersing the prepared workpieces in a bath of molten zinc. During this process, several iron-zinc alloy phases form on the surface of the workpiece. These iron-zinc alloy phases guarantee the optimum adhesion of the pure zinc layer to the workpiece. Galvanising is a very commonly used process in order to protect iron-based materials from corrosion.

Although zinc is a relatively non-noble metal and corrodes quickly under oxygen access, it forms a very homogeneous top layer, which assumes the actual protection against corrosion.

Malleable cast iron fittings from GF are hot-dip galvanised according to EN 10242, whereby a special process technology ensures that even layer thicknesses well above the required standard value (500 g/m^2 or 70 µm on average) are achieved.

By using high-purity metallurgical zinc, continuous intake controls and zinc bath analyses, GF ensures compliance with drinking water requirements and adherence with various guidelines (for example RoHS).

2.5 Quality assurance

Malleable cast iron fittings from GF are individually tested AND compliant with existing standards. For pressure-carrying threaded fastener parts, testing is generally performed on the individual parts.

Further information on the quality assurance at GF
➨ Part I 'Introduction', chapter [2] 'GF Piping Systems'

2.6 Threads

Threads for pipes, controls and instruments, fittings and other piping parts that are mated together, comply with international and national standards. There are 2 types of threads:

TV.7
Thread types

Connecting threads	Mounting threads
Pipe thread for joints sealing inside the thread according to EN 10226-1/-2* or ISO 7-1 The applicable valid national edition of the EN 10226 replaces DIN 2999, BS 21 etc.	Pipe thread for joints not sealing inside the thread according to EN ISO 228-1

* EN 10226-2 contains the tapered internal thread **Rc**. This thread is not common in continental Europe and is not offered by GF. Therefore, further explanations regarding EN 10226-2 and the thread pairing Rc/R are omitted.

2.6.1 Connecting threads and mounting threads

Functional differences

- The pipe thread according to EN 10226-1 is sealed inside the thread, predominantly by metallic pressing (cylindrical/tapered) of the thread surfaces which are completely positive in the sealing area. Sealants improve the sealing effect.
- In contrast, the pipe thread according to EN ISO 228-1 is a purely mechanical fastening thread. When sealing parts that must be joined, soft seals (flat seals, squeeze-type gasket) metal fitting surfaces are used.

Complete designation of pipe threads

Example: Thread size 1½

TV.8
Connecting threads according to EN 10226-1

Threads	Form	Size
Internal thread (right-hand thread)	parallel	Rp 1½
External thread (right-hand thread)	tapered	R 1½

TV.9
Mounting threads acc. to EN ISO 228-1

Threads	Form	Size
Internal thread (right-hand thread)	parallel	G 1½
External thread (right-hand thread) Tolerance class A	parallel	G 1½ A
External thread (right-hand thread) Tolerance class B	parallel	G 1½ B

For its external threads according to EN ISO 228-1, GF uses exclusively tolerance class B in narrowed form (➨ Fig. [GV.1]).

Designation of left-hand threads
For designation of left-hand threads, the abbreviations LH is added to the designation.

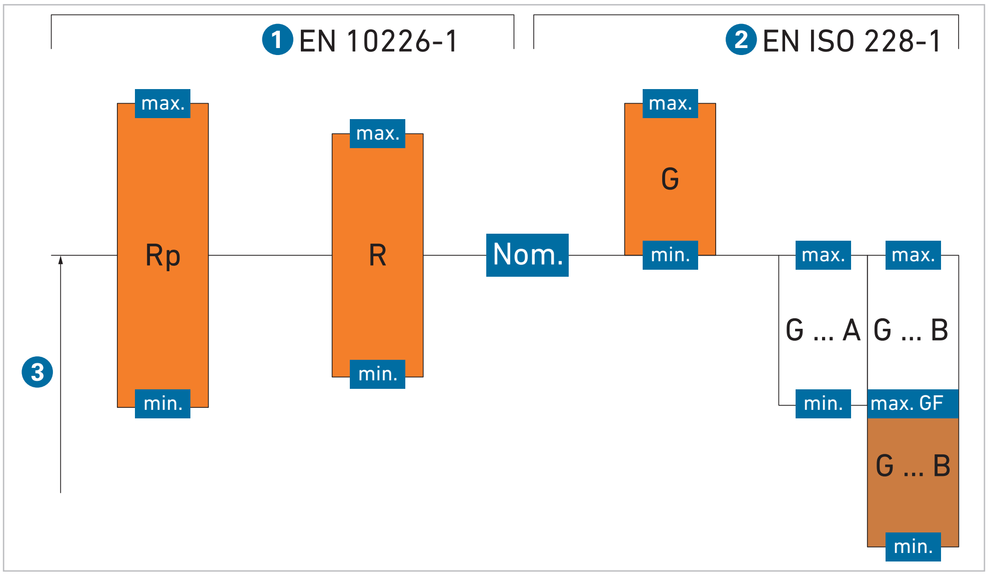
Examples

Rp 1½ – LH or **G 1½ – LH**

2.6.2 Tolerances of connection and mounting threads

Despite different standardisation, the two thread types according to EN 10226-1 and EN ISO 228-1 have the same geometric basis (flank angle, nominal diameter, pitch, etc.). In practice, both types of thread are therefore often mistaken as the other or even mixed together (combination of both). The user is quiet often confused by the fact that screwing the two thread types together succeeds in some cases, but not in other cases. This is due to the diversity of the tolerance fields for the thread diameter, the interaction of which is shown here.

GF uses the colour-coded (parts of) tolerance fields for the production of its malleable cast iron fittings.



GV.1
Tolerance positions

1 Connecting thread, sealing inside the thread
Rp Internal thread
R External thread

2 Connecting thread, not sealing inside the thread
G Internal thread
G ... A External thread, tolerance class A
G ... B External thread, tolerance class A
GF uses only the lower part of the tolerance field

3 Thread diameter
max. Size
Nom. Nominal size
min. Size

Combination of connecting threads (sealing inside the thread) with mounting threads (not sealing inside the thread)

Screwing a parallel external thread (according to EN ISO 228-1) with a parallel internal thread (according to EN 10226-1)

Due to the overlapping diameter tolerance fields (➨ Fig. [GV.1]) of G to A and G to B with Rp, connecting of the screws cannot not be guaranteed. This threaded connection can be secured if the external thread G to B is manufactured with a narrowed tolerance (lower half of G to B). Due to the lack of pressure between the metal of the two threads, this combination does not necessarily lead to a sealing connection.

For the external threads, EN ISO 228-1 does not specify a thread length and does not require a complete thread profile; this, however, increases the problem of sealing.

Screwing a tapered external thread (according to EN ISO 10226-1) with a parallel internal thread (according to EN 228-1)

In contrast to the first scenario, threading/mating the thread diameter does not present a problem. However, the EN ISO 228-1 does not specify a minimum length for the internal thread and does not require a complete thread profile. Both can lead to leakage problems and must therefore be taken into account in the product standard, which provides the G-thread.

V

2.6.3 Design and function of connecting threads (sealing inside the thread)

The standard EN 10226-1 defines thread form, dimensions, tolerances and designations per thread size. The most important dimensions of these connecting threads as well as dimensions and data of the medium and heavy threaded pipes are shown in Tab. [TV.11]. The thread profile with its most important features is illustrated in Fig. [GV.2].

Tapered external thread

When using **tapered external thread, [GV.3]** some details must be considered. As the name implies, the threads have a slight taper (conical shape) at a ratio of 1:16 (➨ Fig. [GV.4]).

The total pipe thread length consists of 3 sections (➨ Fig. [GV.3]):

- The **test length a** is defined and the tolerance is applied so that even the smallest possible internal thread diameter allows for easy mating of the fasteners. The external thread can be easily screwed in and the sparingly applied sealant is properly drawn into the connection.
- The **engagement length b** is the relevant threaded part that determines the sealing effect. The threaded length – which is fully cut into the thread root behind the measuring plane – is selected so that even the largest possible internal thread diameter allows for sufficient engagement length when using a tool. Since the thread's cone ratio is 1:16, a strong pressure between the threads leads to a permanently reliable seal.
- The **thread run-out**, which is not fully cut out at the bottom, should remain visible. If the thread is engaged too far, there is a risk that the internal thread might leak or crack on the side of the fitting (or on the control and instrument). In order to avoid backlash between the peaks of the external thread and the bottom of the internal thread in the finished bolted joint, the thread crests on the male thread of the pipe should be fully cut out over the full range of usable thread length.

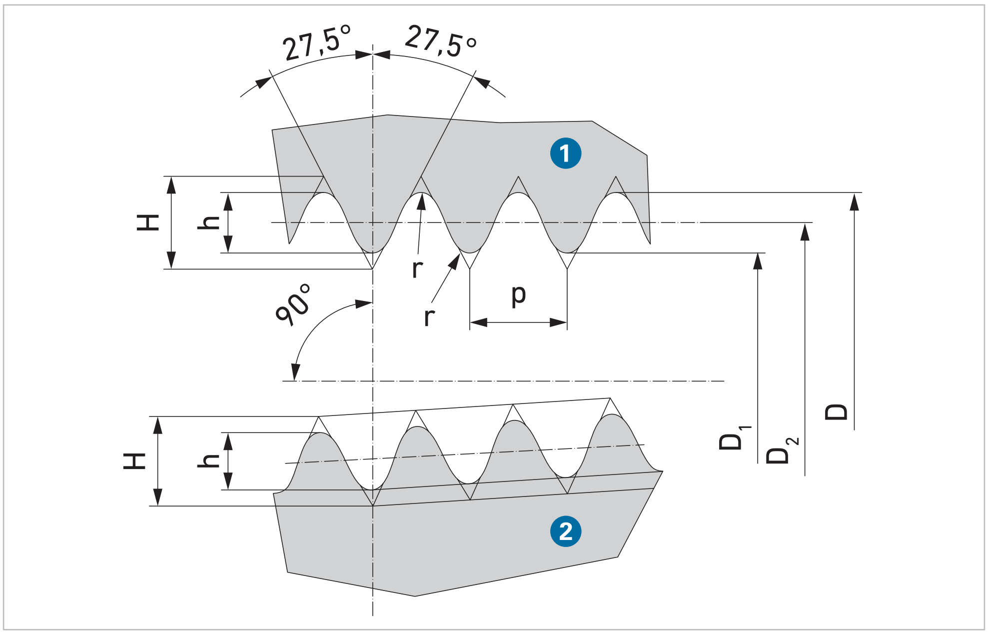
Parallel internal thread

When using the **parallel internal thread** [GV.5], it must be ensured that the usable thread length allows complete mating of the external thread until the sealing effect is achieved. This must also be ensured for the largest permissible test length of the external thread.

The different ratios of a **threaded connection** tightened manually and a connection tightened with the aid of a tool are shown in Fig. [GV.6] using the example of 1".

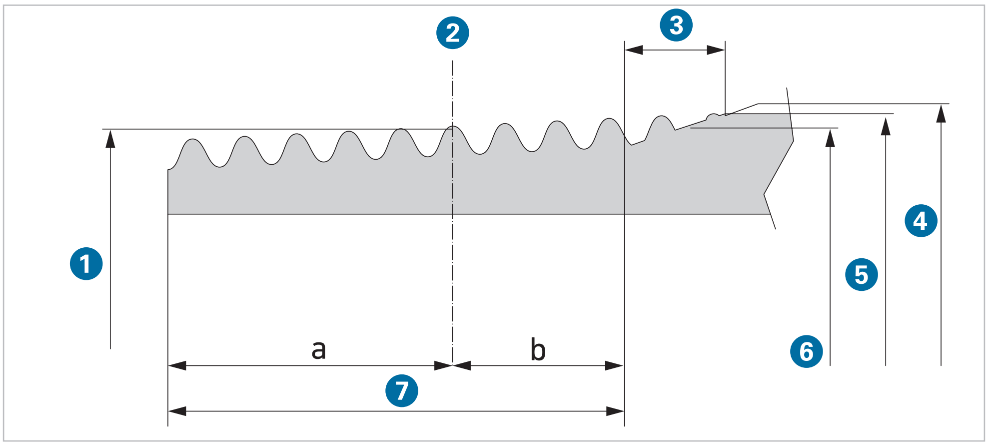
- For the manually threaded connection (➨ Fig. [GV.6] ❶), there are still 2¾ threads available on the external thread for tightening the fitting with the tool (➨ Tab. [TV.11]).
- The threaded connection bolted acc. to standard is shown in Fig. [GV.6] ❷.

In order to compensate for the outlet direction of the fitting (or the lengths of the fully assembled pipeline), the threads can be screwed in a little less or a little more. Nevertheless, the connection is perfectly tight.



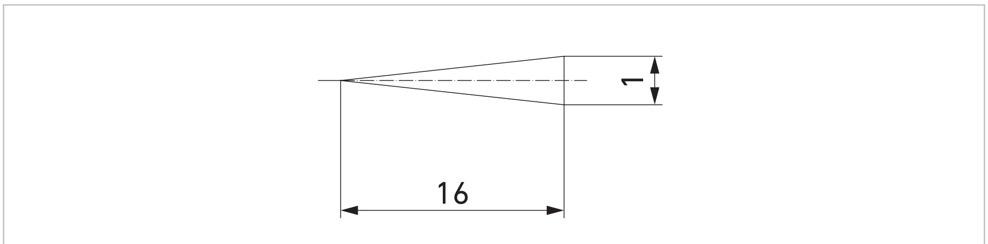
GV.2
Thread profile

- 1 Internal thread
- 2 External thread
- **p** Pitch
- **H** 0,960491 · p
- **h** 0,640327 · p
- **r** 0,137329 · p
- **D** External diameter
- **D_1** Core diameter
- **D_2** Pitch diameter



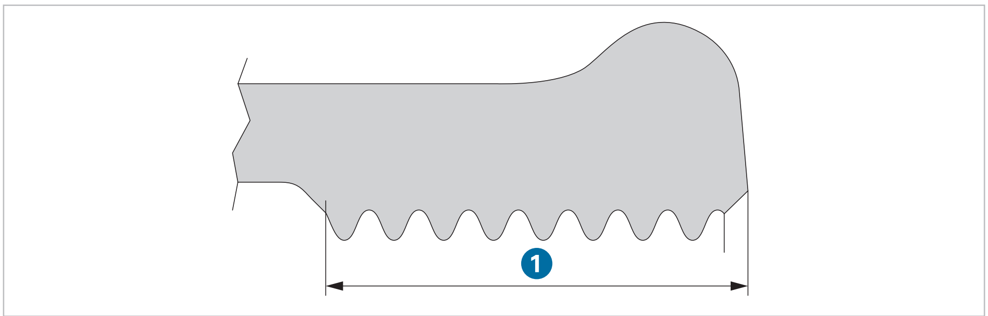
GV.3
Tapered external thread R

- 1 Thread diameter
- 2 Test plane
- 3 Thread run-out
- 4 Pipe diameter max.
- 5 Pipe diameter
- 6 Pipe diameter min.
- 7 Usable threads length
- **a** (Test length) ± tolerance
- **b** Tightening section



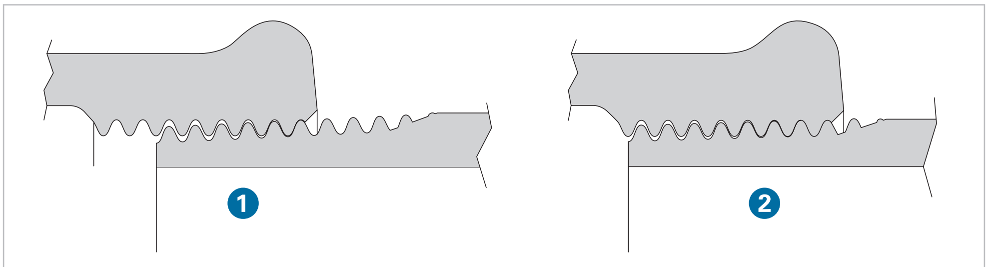
GV.4
Taper of an external thread

The thread profile is perpendicular to the pipe's axis.



GV.5
Parallel internal thread Rp

- 1 Usable threads length



GV.6
Thread connection

- 1 Tightened manual
- 2 Tightened with the aid of a tool

V

Sealing effect and sealant

The **sealing effect** in the thread is largely achieved by the fact that the internal and external threads (flank diameter) touch each other at the moment of run-up and are fit even tighter when using a tool.

In a parallel/tapered threaded connection, the **sealant** only has the task of filling in unavoidable deviations from the theoretical profile of the threads and roughness of the threaded surfaces. Therefore, only a little amount of sealant, suitable for its purpose should be used.

Tension, compression or bending stress of the connection are absorbed by the metal-to-metal contact.

√ **Ensuring the sealing effect**

In order to ensure that the desired sealing effect of the parallel/tapered connection actually occurs, the following points should be taken into consideration:

- The **thread cutter tool** must be adjusted, ensuring that the fitting can only be screwed in manually onto the unpacked thread until the tightening section remains visible with the tool (b). This ensures that even with the largest permissible internal thread diameter, the necessary sealing pressure is achieved.
- When using a tool, the end of the usable external thread (➨ Fig. [GV.3], length a + b) should not be engaged deeper than the first formed thread of the internal thread (➨ Fig. [GV.6] 2), otherwise the sealing pressure can be endangered by the incomplete thread root of the external thread outlet.

2.6.4 Thread inspection

Standardised plug thread gauges and thread ring gauges are both used to inspect connecting threads and the mounting threads.

It should be noted that when using gauges in order to inspect thread. this is considered a comparative test.

Inspection gauges for mounting threads

Thread gauges, designed as 'go' and 'no go' plug gauges or rings, are standardised in EN ISO 228-2.

Deviating from the inspecting of threads with gauges, if using thin-walled parts – according to EN ISO 228-1 – two diametrical measurements offset by 90° shall be made. Subsequently, the arithmetic mean of which shall be used to assess the dimensional accuracy (standard conformity). This is applicable to union nuts.

Inspection gauges for connecting threads

Threaded gauges, designed as thread plug gauges or rings, have been standardised according to EN 10226-3 since 2005 and are identical to the gauges according to ISO 7-2:2000.

For this test, limit gauges are used instead of 'go' and 'no go' gauges. An essential feature of these limit gauges is the display of the result of the diameter inspection by projection on the depth of thread of the gauge.

The front side of the test specimen indicates the test result at the tolerance level of the limit gauge. Details on the gauges and the test procedure are described in these two standards. In addition, an essential aspect of the gauging of internal threads is described here.

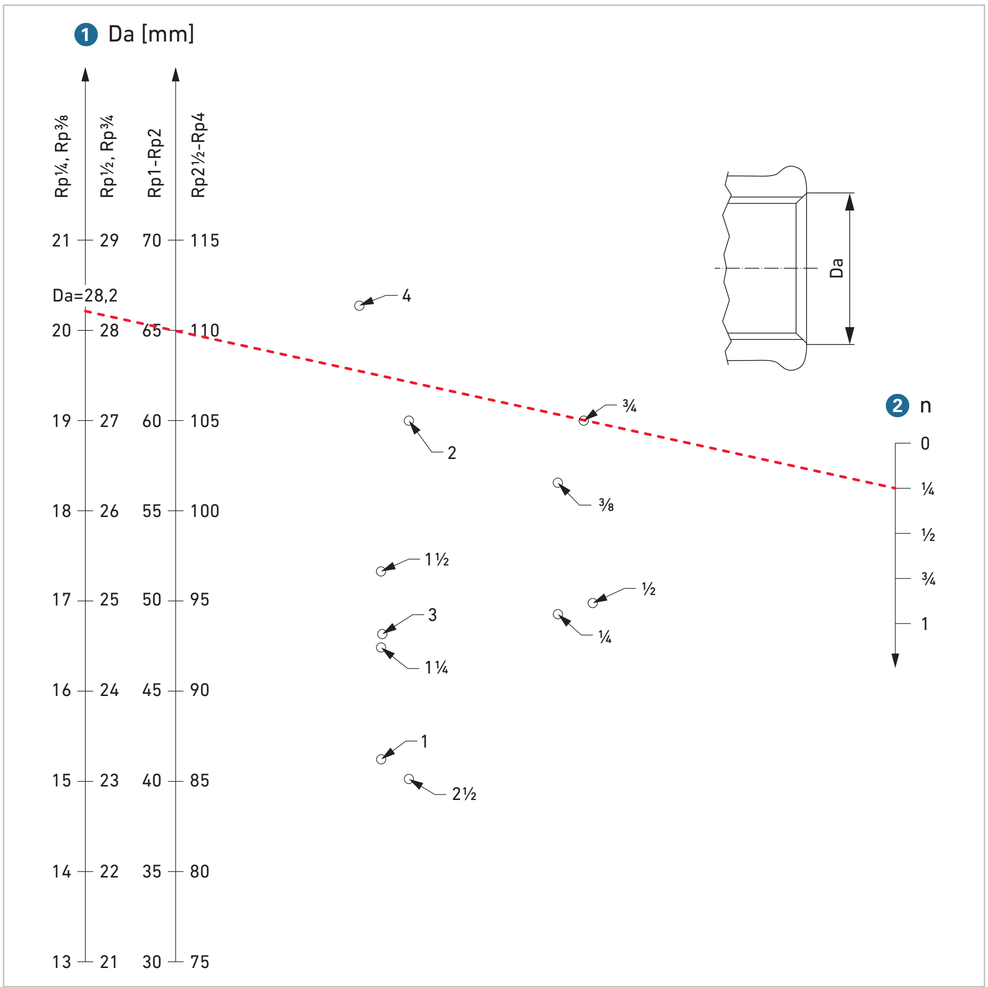
The fact that the gauging has the character of a comparative test is of particular importance for the testing of the cylindrical internal thread Rp according to EN 10226-1 in connection with the thread chamfer.

The reason for this is the missing threaded part in the chamfered area. The larger the chamfer, the wider the tapered thread plug gauge can be screwed in; that is to say, the thread diameter is greater than it actually is displayed at the tolerance level of the gauge.

The thread gauges according to EN 10226-3 and ISO 7-2 take into account a chamfer on the inside thread at the extent of ½ a thread pitch. The resulting chamfer diameters are shown in Tab. [TV.10].

In order to be able to easily correct the falsification of the gauge test result with different chamfer diameters, GF has developed a nomogram (➨ Fig. [GV.7]).

Nomogram



GV.7
Nomogram

1. Measured diameter of the thread chamfer
2. Number of correction rotations for the plug gauge

How to use the nomogram

First, the outer diameter **D_a** (➨ Fig. [GV.7]) of the thread chamfer is measured.

Subsequently, a straight line is drawn on the diagram as a function of the thread size and the measured chamfer diameter, whose point of intersection with the n axis shows the number of required correction revolutions **n**.

The measured diameter of the thread chamfer **n** corresponds to the number of correction rotations for the plug gauge.

The correction is made by turning the plug gauge back by **n** revolutions after the gauge has already been screwed in (hand-tight). The new position of the plug gauge shows the actual size of the internal thread diameter.

Example

At the angle **90 – ¾ V** a chamfer diameter of D_a = 28.2 mm is measured.

Extending the line between points D_a = 28.2 and ¾ indicates n = ¼.

Rp	¼	⅜	½	¾	1	1¼	1½	2	2½	3	4
∅D_a	14.2	17.7	22.0	27.4	34.2	42.9	48.8	60.6	76.2	88.9	114.0

* at the front of the fitting

TV.10
Chamfering nominal diameter D_a (theoretical)*

2.6.5 Pipe thread (EN 10226 / ISO 7) and threaded pipes (EN 10255 / ISO 65)

The table contains the most important dimensions.

TV.11 **Thread size and pipe thread**

Thread size G Nominal width DN		⅛ 6	¼ 8	⅜ 10	½ 15	¾ 20	1 25	1¼ 32	1½ 40	2 50	2½ 65	3 80	4 100
Pipe threads													
Gauge diameter (External thread diameter in the measuring plane)	[mm]	9.728	13.157	16.662	20.955	26.441	33.249	41.910	47.803	59.614	75.184	87.884	113.030
Pitch [mm]	[mm]	0.907	1.337	1.337	1.814	1.814	2.309	2.309	2.309	2.309	2.309	2.309	2.309
Number of threads per inch (25.4 mm)		28	19	19	14	14	11	11	11	11	11	11	11
Measured lengtha of the tapered external thread	[mm]	4.0	6.0	6.4	8.2	9.5	10.4	12.7	12.7	15.9	17.5	20.6	25.4
Tolerance for **a**	[mm]	±0.9	±1.3	±1.3	±1.8	±1.8	±2.3	±2.3	±2.3	±2.3	±3.5	±3.5	±3.5
Engagement area **b** if using a tool	[mm] Screw threads	2.5 2¾	3.7 2¾	3.7 2¾	5.0 2¾	5.0 2¾	6.4 2¾	6.4 2¾	6.4 2¾	7.5 3¼	9.2 4	9.2 4	10.4 4½
Medium thread engagement length	approx. [mm]	7.0	10.0	10.0	13.0	15.0	17.0	19.0	19.0	24.0	27.0	30.0	36.0
Threaded pipes													
External diameter	[mm]	10.2	13.5	17.2	21.3	26.9	33.7	42.4	48.3	60.3	76.1	88.9	114.3
Surface (smooth pipe)	approx. [m^2/m]	0.032	0.042	0.054	0.067	0.085	0.106	0.133	0.152	0.189	0.239	0.279	0.359
Medium series (M)													
Wall thickness	approx. [mm]	2.0	2.3	2.3	2.6	2.6	3.2	3.2	3.2	3.6	3.6	4.0	4.5
Internal diameter	approx. [mm]	6.2	8.9	12.6	16.1	21.7	27.3	36.0	41.9	53.1	68.9	80.9	105.3
Internal Cross-section	approx. [cm^2]	0.30	0.62	1.25	2.04	3.70	5.85	10.18	13.79	22.15	37.28	51.40	87.09
Content	approx. [L/m]	0.030	0.062	0.125	0.204	0.370	0.585	1.018	1.379	2.215	3.728	5.140	8.709
Pipe weight (smooth pipe, not galvanised)	approx. [kg/m]	0.40	0.64	0.84	1.21	1.56	2.41	3.10	3.56	5.03	6.42	8.36	12.20
Heavy-duty series (H)													
Wall thickness	approx. [mm]	2.6	2.9	2.9	3.2	3.2	4.0	4.0	4.0	4.5	4.5	5.0	5.4
Internal diameter	approx. [mm]	5.0	7.7	11.4	14.9	20.4	25.7	34.4	40.3	51.3	67.1	78.9	103.5
Internal Cross-section	approx. [cm^2]	0.19	0.47	1.02	1.74	3.27	5.19	9.29	12.76	20.66	35.36	48.89	84.13
Content	approx. [L/m]	0.020	0.047	0.102	0.174	0.327	0.519	0.929	1.276	2.066	3.536	4.889	8.413
Pipe weight (smooth pipe, not galvanised)	approx. [kg/m]	0.49	0.77	1.02	1.44	1.87	2.93	3.79	4.37	6.19	7.93	10.30	14.50

Details ➨ applicable standards

2.7 Tolerances

2.7.1 Length tolerances

The permissible length tolerances for standard fitting types are shown in Tab. [TV.12] and refer to the face–face dimension of straight parts (nipples, sleeves, etc.). The permissible length tolerances for fittings with directional changes (elbows, angle, Tees) refer to the face–centre dimension (axis).

For screw connections, the specified tolerance ranges above do not refer to the complete threaded connections, but to the individual parts of the screw connection.

TV.12
Length tolerance acc. to EN 10242 (ISO 49)

Dimensions (lengths) [mm]		Limit dimensions [mm]
	<30	±1.5
>30	... 50	±2.0
>50	... 75	±2.5
>75	... 100	±3.0
>100	... 150	±3.5
>150	... 200	±4.0
>200		±5.0

2.7.2 Angular tolerance

According to EN 10242 (ISO 49), the axes of the fitting's threads may deviate a maximum of 0.5° from the specified angle.

2.8 Width across the flats on cast iron fittings

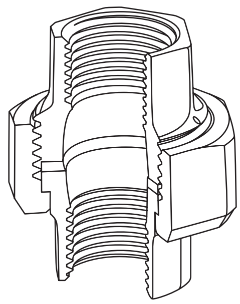
For spanner flats with a casting surface not yet machined, the dimension across flats of the spanner used is given.

2.9 Threaded connectors

2.9.1 Flat sealing threaded connectors

These fittings are delivered without sealing ring (exceptions: Fig. 350, 351, 356, 599a).
The overall lengths and z dimensions refer to the fully assembled threaded connection with one or two sealing rings of 2 or 3 mm thickness (sealing ring dimensions: ➨ Tab. [TV.16]).

The selection of the suitable sealing ring depends on the operating requirements. During the production, pressure tests are carried out exclusively on the individual parts (insert and screw-in part). Flat-sealing threaded connections can be dismantled and reassembled radially.



GV.8
Flat sealing service fitting Fig. 330

2.9.2 Flat sealing service connectors

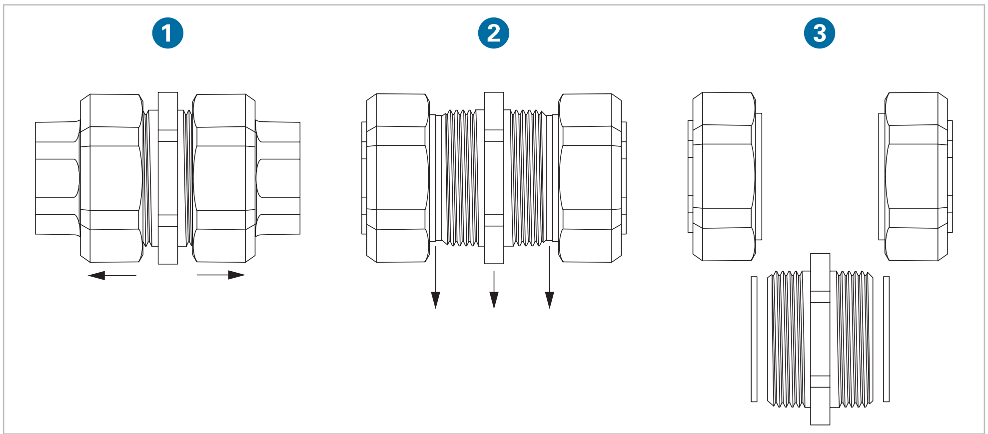
The service connector is designed for the easy removal and installation of piping components (filters, check valves, regulating or control valves, heat exchangers, etc.) of a piping system.

If the two union nuts of an installation are loosened, the screwed-in part can be removed by pulling it down (➨ Fig. [GV.9]) and thus creates the space to easily take out the following component. The screw-in part is longer than the thread length of a connection thread **R** or **Rp** (according to EN 10226-1) and, once the screw-in part has been removed, it clears the space required to be able to disassemble the following component completely.

Until now, two conventional thread connectors – before and after the component to be removed – were used for this purpose. In comparison, the shorter overall installation length of the service fitting saves space and additional time, since one less (sealing) threaded connection is required.

Good accessibility with a tool is only required in one place at the threaded service connection. Space mandatory before and after the component that needs to be removed is no longer required.

Due to the availability of numerous variants, such as internal/internal thread, internal/external thread and external/external thread, the threaded service connection can be used in all conceivable situations. The supply includes 2 sealing rings, which are suitable for the most common media (natural and liquid gases, compressed air, oils and hot water) up to 150°C/25 bar.



GV.9
Loosening a flat sealing service fitting Fig. 350

1. Loosen union nuts
2. Pull down and remove the screw-in part
3. Removed screw-in part

Thus, the threaded service connection is an ideal separation point (detachable connection) for a fixed cable installation. This type of connection can either be installed during the construction of a new system, for the purpose of subsequent service work, or retroactively for extensions of systems or for repair purposes.

2.9.3 Tapered sealing threaded connectors

When using tapered (metallic) sealing screw connections, the following aspects apply:

→ Clean sealing surfaces before use and treat the surfaces with a non-hardening lubricant, for example, thread sealing paste (for drinking water only tested according to DIN 30660).

§ **When reusing tapered sealing treads, GF cannot guarantee the tightness of these connections.**

V

2.9.4 Tapered/spherical and spherical (ball-type) sealing screw connections

- Fig. 342 and 342a offer a high-sealing effect due to their specially shaped sealing surfaces.
- Fig. 346 illustrates spherical sealing surfaces allows a stepless angle from 0 to 6°.

Application limits for Figs. 342, 342a and 346

- Fig. 342, 342a –20°C to 210°C/max. 20 bar
- Fig. 346 –20°C to 300°C/max. 20 bar

§ **Figs 342 and 342a are not suitable for drinking water installations.**

For this threaded connectors the following applies:

→ Clean sealing surfaces before use and treat the surfaces with a non-hardening lubricant.

2.9.5 Torques for metallic sealing screw connections

The following values apply to the tightening of the conical sealing screw connections Fig. 340, 341 and 344 (final assembly). These values also apply to Figs. 342, 342a, and 346.

TV.13 **Tightening torque (guidelines)**

Fitting size	⅛	¼	⅜	½	¾	1	1¼	1½	2	2½	3	4
Tightening torque [Nm]	15	20	30	50 **) 60	65 **) 80	80 **) 100	150	180	240	310	350	470
max. number of permissible rotations *)	¼	¼	¼	¼	½	½	½	½	½	½	½	½

*) maximum rotations of union nuts after manual tightening
**) deviating tightening torques for Figs. 342, 342a and 346

2.9.6 Individual threaded connectors

Most GF flat sealing fittings are also offered and delivered as individual parts.

Tapered sealing parts of threaded connections must not be exchanged or reused. Therefore, we only offer these parts in exceptional cases.

Tapered sealing inserts and screw-in parts are checked and adjusted at the factory, and are only sold as complete fittings.

§ Collar and cone dimensions on bolted components are not standardised, neither internationally nor in Europe.

They are subject to a factory standard, which can be changed for technical reasons. When replacing individual parts in conjunction with third-party components, or when reusing conical sealing parts of fittings, GF shall not be held liable should leaks occur.

3 Application technology

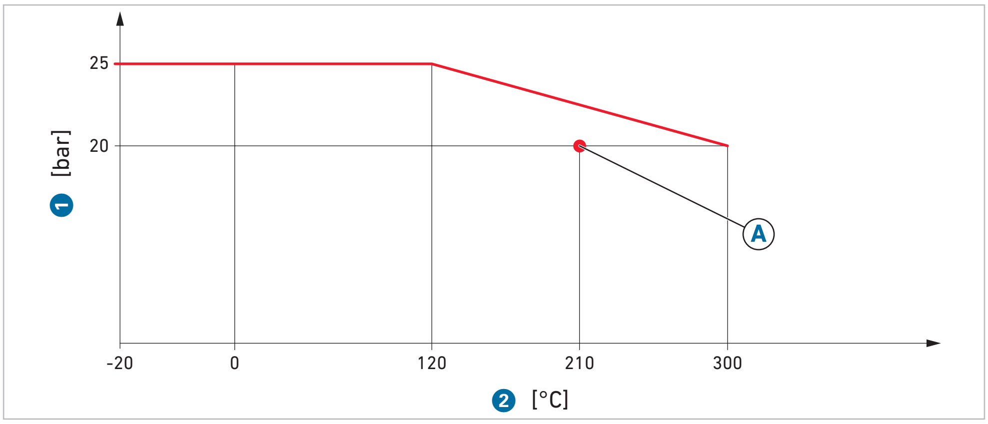
3.1 Application technology

Malleable cast iron fittings are used for the conveyance of liquids and gases up to the pressure and temperature limits specified in standard EN 10242 (ISO 49). Fittings and individual threaded fastener parts are tested for leaks item-by-item. The test pressures are above the values set in the standard. Unless otherwise specified (➨ specially pressure-tested fittings), the following operating pressures and temperatures apply to the parts of the malleable iron fittings program offered by GF.

TV.14
Operating temperatures and operating pressures

Operating temperature [°C]*	permissible operating pressure [bar]**
–20 to 120	25
>120 to 300	interpolated values
300	20

* The data refer to the temperature of the medium in continuous operation. Applications under special ambient temperatures require individual clarification.
** 1 bar = 10^5 N/m^2 = 100 kPa



GV.10
Operating temperatures and operating pressures
1 Permissible operating pressures
2 Operating temperature
A Fig. 342, Fig. 342A

Exceptions

- Fig. 342, 342a –20 to 210°C/max. 20 bar
- Fig. 346 –20 to 300°C/max. 20 bar

3.2 Standardisation and certification

GF is actively involved in international product and application-related standardisation and major national standards projects. Active handling of current and future guidelines is also very important. Examples of GF's involvement include the Pressure Equipment Directive 2014/68/EU, die Construction Products Directive No. 305/2011, the RoHS Directive 2011/65/EU or REACH.

Declarations of Conformity
Current information and Declarations of Conformity can be requested at: www.fittings.at/kontaktformular.
If required, a factory certificate according to EN 10204 can be issued for all malleable cast iron fittings.

Certification for malleable iron fittings
For essential applications, especially in the field of gas and drinking water installations, GF malleable iron fittings have been nationally certified. The articles for which the internationally valid **FM Certification** for extinguishing systems has been carried out, are listed in the **Product catalogue**.
The current status of the certificates can be viewed at: www.fittings.at/zertifikate

3.3 Installations with malleable cast iron fittings

The application limits for specific uses can be found in international, European and national regulations (for example: Standards, directives, regulations of local utility companies, etc.).

Special pressure-tested fittings

Fittings for operating pressures above 25 bar are available upon request in the dimension range from ⅜ to 3. These fittings are subjected to a separate individual test (at 100 bar test pressure) and are marked in yellow and by the letter **P**. If required, a factory certificate according to EN 10204 can be issued for all malleable cast iron fittings.

Type-tested fittings

These fittings are offered in accordance with the German VdS regulations for gas high-pressure fire extinguishing systems. Depending on the model, a **type approval test** is carried out. During this test, it is checked whether the design or shape of the respective model can withstand a bursting pressure of 300 bar.

(Note: It must be differentiated between burst pressure and permissible operating pressure).

Before delivery, these parts are also subject to a separate individual test, and are marked red and by the letter **D**. If required, a factory certificate according to EN 10204 can be issued for all malleable cast iron fittings.

The type-tested model is only offered for part of the GF range of malleable cast iron fittings. The current list of type-tested fittings is available upon request.

3.4 Potable water installation with hot dip galvanised malleable iron fittings

In addition to the steel fittings (marked with the letters **ST** in the product catalogue), galvanised parts of the GF malleable cast iron fitting range are hot-dip galvanized according to the requirements of EN 10242 (or ISO 49).

The protective coating applied by hot-dip galvanising (previously called tin plating) is composed of several iron-zinc alloy phases which are covered by a pure zinc coating. During the first phase of operation of hot-dip galvanised piping systems, the reaction with the drinking water creates a homogeneous, protective top layer. For the normal case of the positive interaction of the influencing criteria, the cover layer formation is accompanied by the physical removal of the pure zinc coating. In order to achieve this condition and to avoid corrosion damage, certain prerequisites or conditions must be met. These conditions are described in EN 12502-3.

In summary, according to this standard, compliance with the following essential criteria is mandatory:
- Material texture
- Water quality
- Operating conditions
- Design and installation of the piping system

Within the terms of the hygienic suitability in contact with drinking water, the DIN 50930 (last in the October issue of 2013) has defined additional requirements. These relate, on the one hand, to the composition of the zinc coating and, on the other hand, to the water quality. Malleable cast iron fittings and steel tubes are summarized here by the term hot-dip galvanised iron materials.

§ **Hot-dip galvanised steel pipes in cold water installations**
According to DIN 50930-6:2013-10, hot-dip galvanised steel pipes are approved for the use in cold water installations in which the drinking water meets the following requirements:
- $K_{B8.2}$ ≤0.20 mmol/L
- Neutral salt quotient S_1 <1 (according to DIN EN 12502-3)

For the unavoidable accompanying elements (% (m/m)) in the zinc coating of malleable cast iron fittings is specified:
- Pb ≤0.1%
- Bi ≤0.01%
- Cd ≤0.01%
- As ≤0.02%
- Sb ≤0.01%
- For steel pipes the following applies: Pb ≤0.05%

When using high-purity metallurgical zinc, continuous intake controls and zinc bath analyses, GF ensures compliance with drinking water requirements and adherence with various guidelines (for example RoHS).

3.5 Recyclability of disassembled fittings

If the thread pairing between fittings and threaded pipes is done properly, there is no permanent deformation due to the stress-strain ratios in our malleable cast iron fittings, which would limit or prevent reusability.

Permanent deformations (constrictions) result in external threads of pipe ends. These threads should not be reused after disassembly. For tapered (metallic) sealing threaded connectors and details of threaded connectors, the following instructions in the chapter. [2.9.3] 'Tapered sealing threaded connectors' apply.

Welding and brazing

The material used at GF **EN-GJMW-400-5** is only suitable for welding and soldering under certain conditions. The chemical analysis of this material differs from weldable materials, especially in silicon, sulphur, but also in manganese and carbon content.

Of those conditions necessary for a weldability and solderability, and an additional factory heat treatment, the requirement of a max. carbon content of 0.3% are met. Apart from the weldability and solderability, this also results in values approaching the elongation at fracture (measured on a 9 mm test rod), as required, for example, for weldable and solderable qualities.

In summary, it can be stated that the material mentioned in **EN-GJMW-400-5** can be used for welding and brazing with additional treatments. Before using this material for welded joints, however, we recommend to proceed with welding tests in order to determine if the required requirements are met. This is because, when welding (compared to soldering) due to the higher temperatures, structural changes must be expected.

In addition to these material-related measures, additional structural and procedural requirements are necessary in the event of welding or soldering.

3.6 Sealing material

3.6.1 Sealant for threaded connections

The sealant in the parallel/tapered threaded connection only has the task of filling in unavoidable deviations from the theoretical profile of the threads and roughness of the threaded surfaces. Tension, compression or bending stress of the connection are absorbed by the metal-to-metal contact.

When **sealing** threaded connections in drinking water and gas installations, only approved sealants must be used. The test of the sealant is carried out according to EN 751: Part 1 – Anaerobic jointing compounds; Part 2 – Non-hardening jointing compounds; Part 3 – Unsintered PTFE tapes.

The **alignment** of pre-fabricated installation parts sometimes makes it necessary to turn back screwed parallel/tapered threaded connections up to 45°. In order to ensure that sealants meet this requirement in countries where such handling is common, an additional requirement has been included in EN 751-2 for turning back a threaded fastener.
Such sealants require the additional **Rp** identification.

In addition to EN 751-2, the following applies to the **drinking water installation**. For example, the German DIN 30660, which stipulates – in the absence of a European guideline – requirements for the sealant with regard to drinking water hygiene. The tests of national quality brands/certificates (e.g., DVGW, ÖVGW, SVGW, etc.) generally apply to the aforementioned standard requirements.

The selection of sealant should be made according to the following criteria:

- ☑ For the **technical application area** (gas, heating, etc.): Compliance with national regulations is mandatory.
- ☑ The sealant must be adjusted to the operating conditions.

If other experience is not available, the guideline (➨ Tab. [TV.15]) can be used.

- ☑ Compliance with the application limits specified by the sealant manufacturer are mandatory.

Connections of gas lines and lines for higher pressure requirements call for special diligence.

TV.15 **Media and sealants**

Medium	Thread size	Sealant: Hemp with sealing paste	Standard PTFE sealing tape/PTFE sealing thread	Special PTFE sealing tape **	Sealant-soaked polyamide sealing cord	Anaerobic sealant	
		½ – 4	½ – 1¼	½ – 2	½ – 4	½ – 2½	3 – 4
Drinking water (up to 60°C)		●	●	●	●	●	○
System water (up to 130°C)*		●	●	●	●	●	○
Natural gas, city gas, liquefied gases		–	●	●	●	●	○
Compressed air oiled oil *** and not oiled		○	●	●	●	●	○
Steam	up to 150°C	–	●	●	○	●	○
	up to 200°C	–	–	●	–	●	○
	up to 250°C	–	–	●	–	–	–
Fuel oil, diesel oil, gasoline (max. 80°C)		●	●	●	–	●	○
Hydraulic oils (up to 200°C)		–	●	●	–	○	○

● suitable
○ conditionally suitable
– not suitable
* Fire extinguishing water and system water (drinking water fed into closed systems, for example: Water in hot water heaters, without chemical additives)
** Heavy-duty Teflon tapes (with large area-related dimensions)
*** Use oil-resistant sealing paste

TV.16 **Sealing ring dimensions**

Connecting threads Fitting size, R/Rp	Connecting thread G	Sealing ring $d_i \times d_a$ [mm]*	Thickness	Suitable for complete fittings (or regulating sleeve and plug) Fig. 95	97	100	101	330	331	332	335	336	338	350	351	356	595	599a
¼	⅝	13×20	2					●	●									
⅜	¾	17×24	2	●	●			●	●									
½	⅜	17×24	2															■
½	½	22×30	2														●	
½	1	21×30	2	●	●	●	●	●	●	●	●	●		■	■	■		
½	1⅛	24×34	2															
¾	½	21×28.5	2															■
¾	¾	27×36	2							○							●	
¾	1¼	27×38	2	●	●	●	●	●	●	●	●	●	●	■	■	■		
1	¾	26.5×34.5	2															■
1	1	34×43	2							○							●	
1	1½	32×44	2	●	●	●	●	●	●	●	●	●	●	■	■	■		
1¼	1¼	43×53	2							○								
1¼	1⅛	38×48	2															■
1¼	2	42×55	2	●	●			●	●	●	●	●	●					
1½	1¼	42×52	2															■
1½	1½	48×60	2							○								
1½	2¼	46×62	2	●	●			●	●	●	●	●						
2	1¾	54×64	3															■
2	2	61×73	3							○								
2	2¾	60×78	3	●	●			●	●	●								
2½	3½	75×97	3					●	●									
3	4	88×110	3					●	●									
4	5	115×135	3					●										

* Internal diameter × external diameter
● recommended sealing ring
○ recommended sealing ring for Fig. 373 for the centre (non-frontal) plane surface
■ sealing ring included

Available from your local dealer

TV.17
Connecting thread and sealing rings for flanges

Connecting threads R/Rp	Nominal width DN	Sealing rings $d_i \times d_a$ [mm]* Fig. 326	Fig. 329
½	15	22×43	24×51
¾	20	28×53	30×61
1	25	35×63	36×71
1¼	32	43×75	45×82
1½	40	49×85	49×92
2	50	61×95	61×107
2½	65	77×115	77×127
3	80	90×123	90×142
4	100	115×152	115×162

* Internal diameter × external diameter

Sealing rings not included.
In principle, the sealing rings are not part of the scope of supply for flat-sealing threaded connections, because the subsequent application is different and the sealing material must be selected according to the conditions of use.
The fittings Fig. 350, 351, 356 and the regulating sleeve Fig. 599a (plug with sealing ring) form an exception, since these fittings are delivered with sealing rings in the above-mentioned size.
Information on the sealing ring material on request.

3.7 Mounting distances on pipelines

TV.18
Attachment distances for steel pipes (guide lines)

Connecting thread R/Rp	Nominal width DN	Mounting distances [mm]
⅜	10	2.25
½	15	2.75
¾	20	3.00
1	25	3.50
1¼	32	3.75
1½	40	4.25
2	50	4.75
2½	65	5.50
3	80	6.00
4	100	6.00

3.8 Thermal expansion in steel pipelines

Any change in the temperature of a pipeline will result in a change in length which may cause considerable stress on the joints, fasteners, structural parts and other connected devices, controls and instruments. Although the thermal expansion of steel is low compared to other piping materials, however, it must be taken into account during planning and assembly (expansion bends, expansion joints, etc.).

When heated by 100 K (°C), 1 m of steel pipe is expands about 1.2 mm. The length changes Δl of the steel pipelines can be read from the line length l and the temperature difference ΔT from the following numbers table or calculated using the formula below. The decisive temperature difference is usually the difference between the maximum operating temperature and the installation temperature.

How to calculate the change in length

$$\Delta l\ [\mathrm{mm}] = 0.012 \cdot l\ [\mathrm{m}] \cdot \Delta T\ [\mathrm{K\ or\ °C}]$$

TV.19 **Length changes of steel pipes at temperature differences**

Pipe length l [m]	Temperature difference ΔT [K]									
	10	20	30	40	50	60	70	80	90	100
	Change of length Δl [mm]									
1	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.08	1.20
2	0.24	0.48	0.72	0.96	1.20	1.44	1.68	1.92	2.16	2.40
3	0.36	0.72	1.08	1.44	1.80	2.16	2.52	2.88	3.24	3.60
4	0.48	0.96	1.44	1.92	2.40	2.88	3.36	3.84	4.32	4.80
5	0.60	1.20	1.80	2.40	3.00	3.60	4.20	4.80	5.40	6.00
6	0.72	1.44	2.16	2.88	3.60	4.32	5.04	5.76	6.48	7.20
7	0.84	1.68	2.52	3.36	4.20	5.04	5.88	6.72	7.56	8.40
8	0.96	1.92	2.88	3.84	4.80	5.76	6.72	7.68	8.64	9.60
9	1.08	2.16	3.24	4.32	5.40	6.48	7.56	8.64	9.72	10.80
10	1.20	2.40	3.60	4.80	6.00	7.20	8.40	9.60	10.80	12.00
11	1.32	2.64	3.96	5.28	6.60	7.92	9.24	10.56	11.88	13.20
12	1.44	2.88	4.32	5.76	7.20	8.64	10.08	11.52	12.96	14.40
13	1.56	3.12	4.68	6.24	7.80	9.36	10.92	12.48	14.04	15.60
14	1.68	3.36	5.04	6.72	8.40	10.08	11.76	13.44	15.12	16.80
15	1.80	3.60	5.40	7.20	9.00	10.80	12.60	14.40	16.20	18.00
16	1.92	3.84	5.76	7.68	9.60	11.52	13.44	15.36	17.28	19.20
17	2.04	4.08	6.12	8.16	10.20	12.24	14.28	16.32	18.36	20.40
18	2.16	4.32	6.48	8.64	10.80	12.96	15.12	17.28	19.44	21.60
19	2.28	4.56	6.84	9.12	11.40	13.68	15.96	18.24	20.52	22.80
20	2.40	4.80	7.20	9.60	12.00	14.40	16.80	19.20	21.60	24.00

4 Planning of pipelines

4.1 The basics

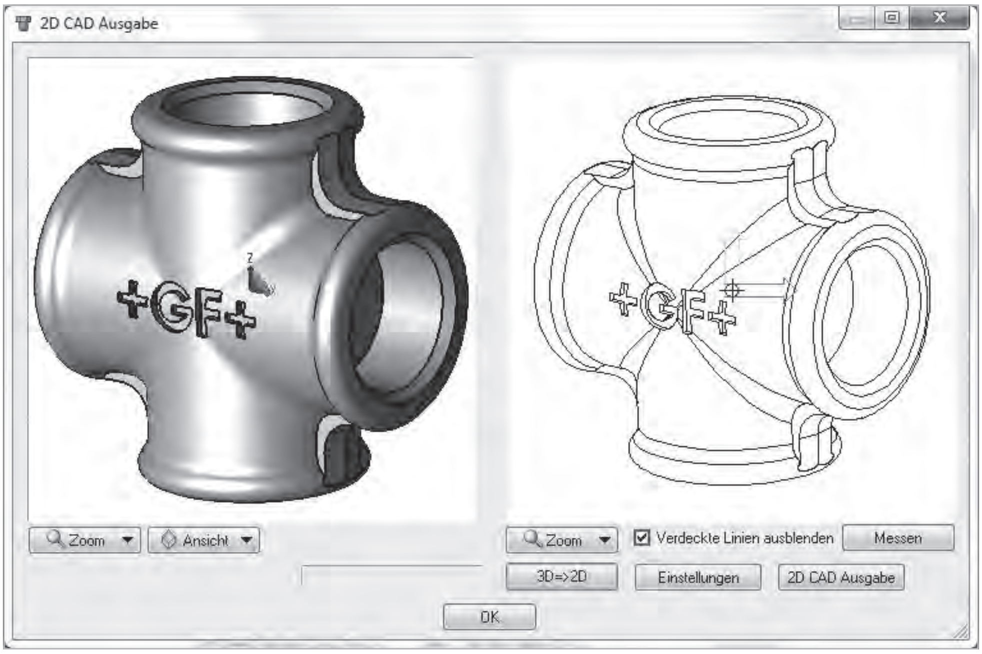
Pipeline sketches and isometric graph paper by GF

Information about the isometric graph paper by GF:

➨ Part IV 'Plan', section 'Drinking water installation', chapter [15] 'Pipeline sketches'

The most widely used planning tool by GF customers is the CAD library. This offers the possibility to export all malleable cast iron fittings of the GF product range as well as the associated standard steel pipes in common CAD formats. Moreover, the fitting geometries can be output in 2D or 3D file formats (without caching) with direct insert drivers to the common CAD applications in order to design the piping system.

The fittings are provided according to the z dimension method on the internal threads with the screw engagement depth according to EN 10242. The most important product data are linked with the fitting geometry and are transferred to the CAD system for the output of parts lists.



GV.11
Example: Surface for CAD output

CAD library

To access the CAD library, click: www.fittings.at/cad-bibliothek

More information on CAD data from GF:

➨ Part I 'Introduction', Chap. [2.1] 'Services'

4.2 z dimension method

Principles of the z dimension method

General information about the z dimension method:
➨ Part IV 'Plan', section 'Drinking water installation', chapter [14] 'The z dimension method'

4.2.1 Thread engagement length

The average thread engagement lengths of the external pipe threads (values rounded up) are according to EN 10242 (or ISO 49):

TV.20
Connection sizes and thread engagement lengths

Connection size	Medium thread engagement length [mm]
⅛	7
¼	10
⅜	10
½	13
¾	15
1	17
1¼	19
1½	19
2	24
2½	27
3	30
4	36

Note on the thread engagement lengths
The installation lengths are based on the average thread engagement lengths listed in Tab. [TV.20], which are also based on the specifications of EN 10242 (or ISO 49). In practice, it has been shown that the engagement lengths may differ from the standard values in the table, depending on the sealant used.

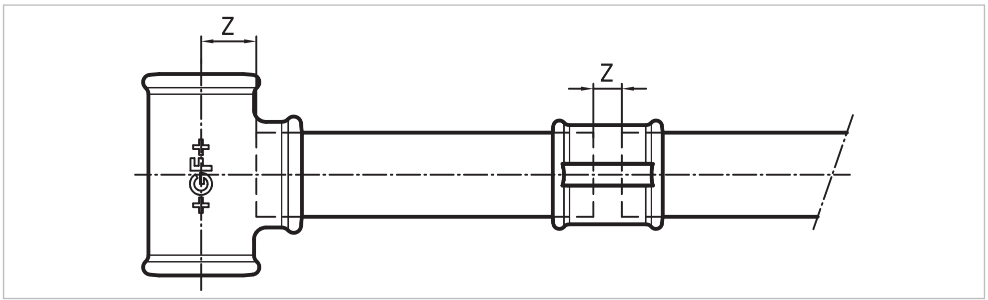
This applies especially to the larger connection sizes, where shorter engagement lengths (= larger z dimensions) occur. These may deviate from the table by up to 2 mm (and above) for 1¼ and 4 mm for 1½ threads.

It is advisable to carry out trial assembly with the specific sealant used so that appropriate corrections can be made in determining the length of the pipe and the centre-centre dimensions.

4.2.2 z dimension and measurement method for the pipe pre-fabrication

z dimension

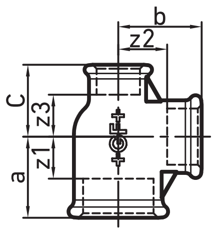
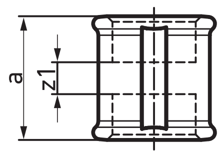
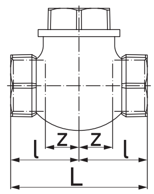
The **z dimension** – also referred to as the "laying length" – is the average distance between the installed pipe end and the axis of the fitting or the ends of two installed pipes. The z dimensions are calculated from the overall lengths minus the average length of engagement.



GV.12
z dimension

The z dimension is calculated as the difference between the **front – centre dimension** (a, b or c) and thread length of the pipe thread.

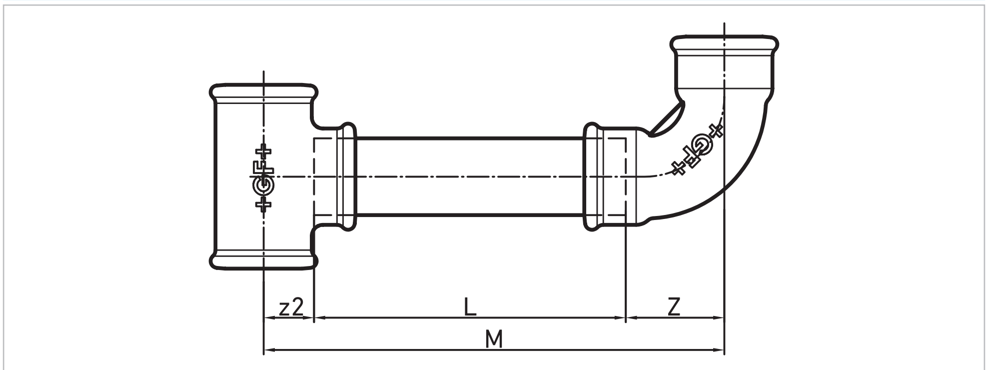
TV.21 **z dimensions**

Fittings	Sleeves	Controls and instruments
		
For fittings: for example tee no. 130, branch and passage reduced z1 = a – thread engagement length z2 = b – thread engagement length z3 = c – thread engagement length	Exception: Sleeves 270, 271 z1 = a – 2 x thread engagement length	For controls and instruments: z = l – Thread engagement length If the total length is given as L, the following applies: z = L / 2 – Thread engagement length

Measurement method

The z dimension is the "design dimension" entered by the installer. When using this dimension, the installer can easily calculate and determine the exact pipe length between fittings and/or controls and instruments. The basis for determining and applying the z dimension is the following principle:

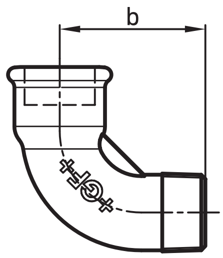
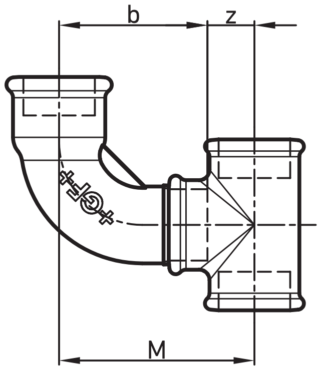
Uniform measurement	Centre – centre = M
Pipe length	L = M – (z2 + z)



GV.13
Uniform measurement

z dimension – application for fitting combinations

TV.22
z dimension for fitting combinations

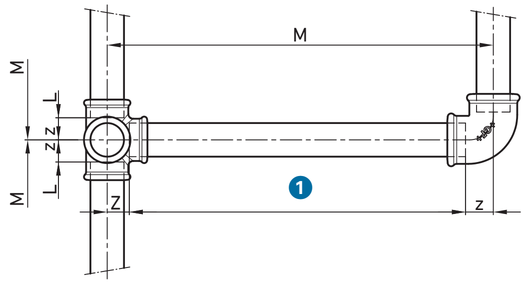
Fittings with external thread	**Fitting combinations** with internal and external thread
	
b is the dimension **centre of internal thread** to **front plane of the external thread**.	The sum of **z + b** is the distance between the axes **M**:
	M = z + b

Application example

Principle of the z dimension installation method: Uniform measurement

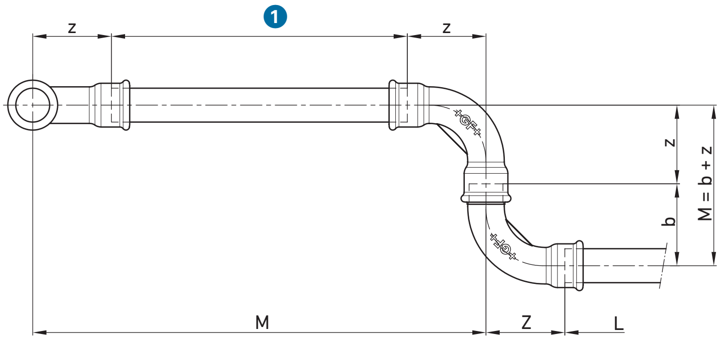
Centre – centre = M

1 pipe length L = M – (z + z)



Pipe threads lengths

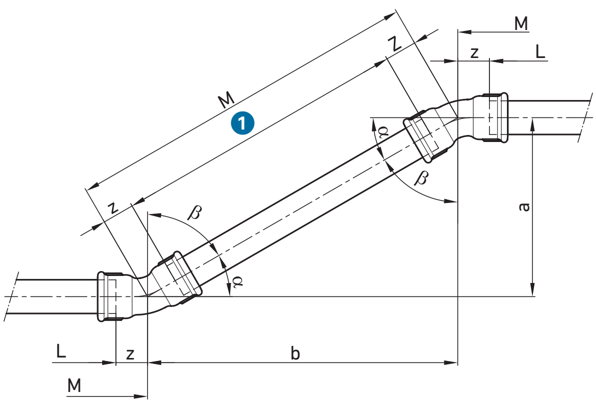
Exact pipe thread lengths results in accurate dimensions **M**.



Dimension M for pipeline parts installed oblique

The dimension **M** for oblique pipeline parts is calculated using the factor table or the numeric table.

➨ Chap. [4.2.3] 'Calculation of the length of oblique pipes'

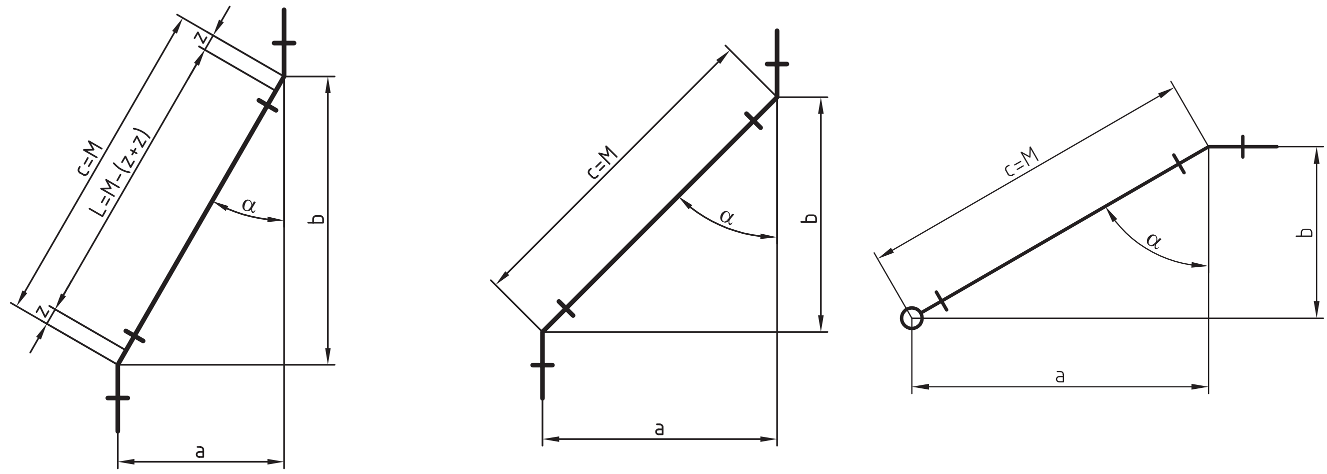


4.2.3 Calculation of the length of oblique pipes

Parts of a pipeline that deviate from the vertical or horizontal can only be laid out precisely in a few cases. Exact results are obtained by measuring and determining the remaining (triangular) side lengths at right angles.

TV.23 **Determining the lengths of the sides**

30°	45°	60°



In order to calculate the pipe lengths when using the z dimension method, the **factor table** and the **numeric table** are available.

1. Factor table

Angle-depending **factors** x **dimension a** or **b** (given)
= **Dimensions b** and **c** or **a** and **c** to be determined.

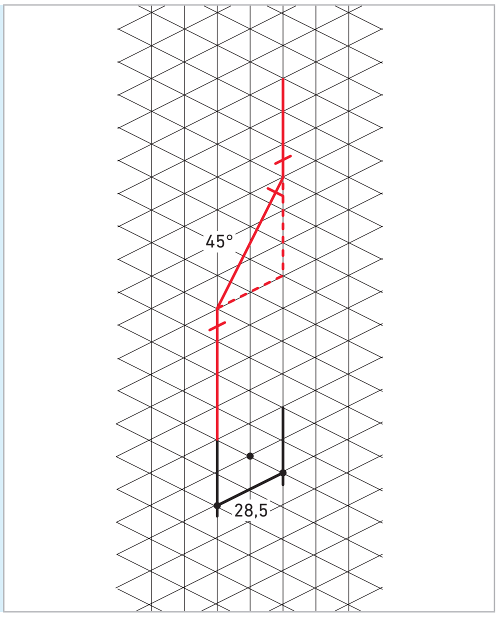
Angles		a		b	
		Factor for		Factor for	
α	**β**	b	c = M	a	c = M
75°	15°	0.268	1.035	3.732	3.864
60°	30°	0.577	1.155	1.732	2.000
45°	45°	1.000	1.414	1.000	1.414
30°	60°	1.732	2.000	0.577	1.155
15°	75°	3.732	3.864	0.268	1.035

Example

a = 28.5

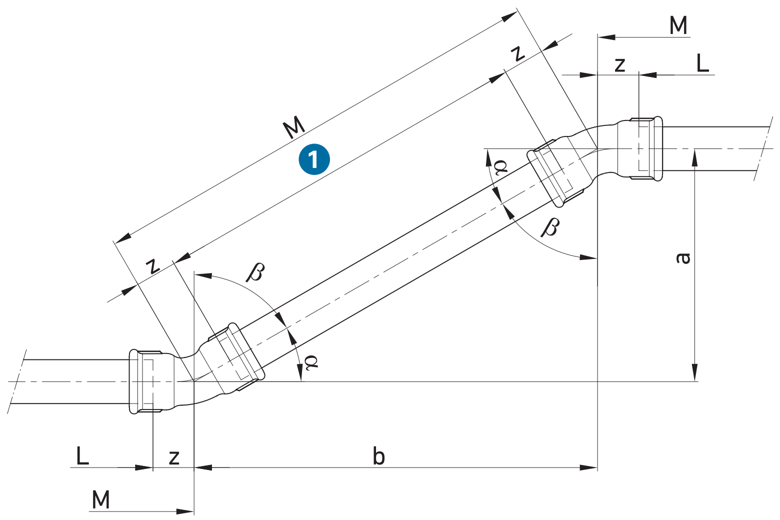
α = 45°

c = M = 28.5 x 1.414 = 40.3



GV.14
Example

2. Numerical table



GV.15
Measurements

1 Pipe length L = M – (z + z)

The required dimensions b and c can be found in the table columns underneath a, α and β.

TV.24
Dimensions of the length of oblique pipes

	α	45°		30°		15°	
	β	45°		60°		75°	
a		b [mm]	c [mm]	b [mm]	c [mm]	b [mm]	c [mm]
1		1	1.4	1.7	2	3.7	3.9
2		2	2.8	3.5	4	7.5	7.7
3		3	4.2	5.2	6	11.2	11.6
4		4	5.7	6.9	8	14.9	15.5
5		5	7.1	8.7	10	18.7	19.3
6		6	8.5	10.4	12	22.4	23.2
7		7	9.9	12.1	14	26.1	27.0
8		8	11.3	13.9	16	29.9	30.9
9		9	12.7	15.6	18	33.6	34.8
10		10	14.1	17.3	20	37.3	38.6
20		20	28.3	34.6	40	74.6	77.3
30		30	42.4	52.0	60	112.0	115.9
40		40	56.6	69.3	80	149.3	154.5
50		50	70.7	86.6	100	186.6	193.2
60		60	84.9	103.9	120	223.9	231.8
70		70	99.0	121.2	140	261.2	270.5
80		80	113.1	138.6	160	298.6	309.1
90		90	127.3	155.9	180	335.9	347.7
100		100	141.4	173.2	200	373.2	386.4
200		200	282.8	346.4	400	746.4	772.7
300		300	424.3	519.6	600	1119.6	1159.1
400		400	565.7	692.8	800	1492.8	1545.5
500		500	707.1	886.0	1000	1866.0	1931.9
600		600	848.5	1039.2	1200	2239.2	2318.2
700		700	989.9	1212.4	1400	2612.4	2704.6
800		800	1131.4	1385.6	1600	2985.6	3091.0
900		900	1272.8	1558.8	1800	3358.8	3477.3
1000		1000	1414.2	1732.1	2000	3732.1	3863.7

Example: Planes in an ascending pipe

→ Measure dimensions M, M1 and a at the construction site.
→ Use Tab. [TV.24] in order to determine remaining dimensions.

Fittings intended for use (from bottom to top)

- 1 pc. Tee Fig. 130 (1½ × ¾ × 1¼)
- 2 pcs. Elbow Fig. 51 (1¼) (30°)
- 1 pc. Tee Fig. 130 (1½ × ¾ × 1)

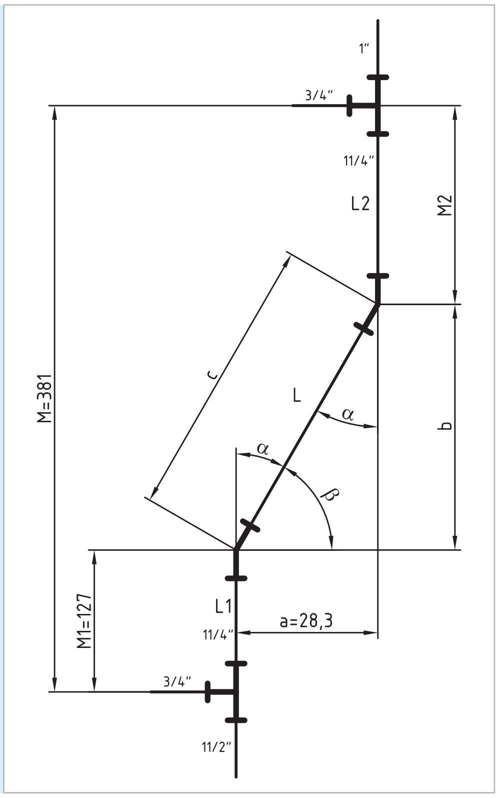
The projection “a” is: 28.3 cm = 283 mm

The value **283** consists of:

3 + 80 + 200.

The values shown in columns b and c of Tab. [TV.25] list the fractional values for the vertical distance b and the inclined length c, both of which are associated with the dimensions 3, 80 and 200.

The lengths b and c are obtained in this case by adding together the fractional values of α (= 30°) and β (= 60°).



α	70°		60°		45°		30°		15°	
β	20°		30°		45°		60°		75°	
a	b	c	b	c	b	c	b	c	b	c
3	1.1	3.2	1.7	3.5	3	4.2	5.2	6	11.2	11.6
80	29.1	85.1	46.2	92.4	80	113.1	138.6	160.0	298.6	309.1
200	72.8	212.8	115.5	230.9	200	282.8	346.4	400.0	746.4	772.7

TV.25
Excerpt from Tab. [TV.24] for the calculation example

α given angle
β applicable angle
a given dimension

a (known) [mm]	b [mm]	c [mm]
3	5.2	6
80	138.6	160
200	364.4	400
283	490.2	566
or a = 28.3 cm	b = 49.0 cm	c = 56.6 cm

TV.26
Numerical table

Determining the pipe length L

- Pipe Length L = c – (2 × z dimension of elbow no. 51 [1¼])
- z dimension elbow no. 51 = 33 mm = 3.3 cm

L = 56.6 – (2 × 3.3) = 56.6 – 6.6 = 50 cm

Determining the dimension M2

M2 = M – (M1 + b) [M1 = 127; b = 49]

M2 = 381 – (127 + 49) = 381 – 176 = 205 cm

Determining the pipe length L1

- Pipe length L1 = M1 – (Sum of the z dimensions of tee no. 130 [1½ × ¾ × 1¼] and elbow no. 51 [1¼])
- z dimension tee no. 130 (at the 1¼ outlet) = 17 mm = 1.7 cm
- z dimension elbow no. 51 = 33 mm = 3.3 cm

L1 = 127 – (1.7 + 3.3) = 127 – 5 = 122 cm

Determining the pipe length L2

- Pipe length L2 = M2 – (the sum of the z dimensions of elbow no. 51 [1¼] and tee no. 130 [1¼ × ¾ × 1])
- z dimension elbow no. 51 = 33 mm = 3.3 cm
- z dimension tee no. 130 (at the 1¼ outlet) = 17 mm = 1.7 cm

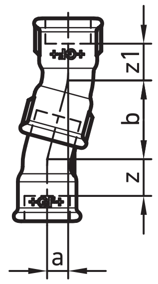
L2 = 205 – (3.3 + 1.7) = 205 – 5 = 200 cm

4.3 Combinations of malleable cast iron fittings

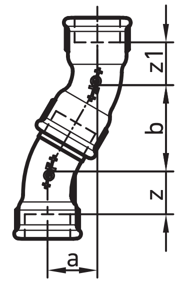
TV.27 **Combinations of malleable cast iron fittings**

R/Rp	Dimensions [mm]	15° 53/54	30° 50/51	45° 40/41	45° 120/121		90° 1/2	90° 1a/2a	90° 90/92
⅜	a			31	25	M	80	62	47
	b			31	25	z = z1	38	26	15
	z			20	10				
	z1			20	10				
½	a	9	21	37	26	M	90	77	52
	b	35	36	37	26	z = z1	42	32	15
	z	15	17	23	9				
	z1	15	17	23	9				
¾	a	11	26	45	30	M	114	85	61
	b	42	44	45	30	z = z1	54	35	18
	z	18	21	28	10				
	z1	18	21	28	10				
1	a	13	32	54	34	M	143	109	73
	b	47	55	54	34	z = z1	68	46	21
	z	20	27	34	11				
	z1	20	27	34	11				
1¼	a	16	39	70	40	M	181	133	86
	b	58	67	70	40	z = z1	86	57	26
	z	24	33	45	14				
	z1	26	33	45	14				
1½	a	16	42	76	45	M	202	151	96
	b	61	72	76	45	z = z1	97	66	31
	z	26	37	49	17				
	z1	28	37	49	17				
2	a	18	48	90	52	M	246	180	108
	b	66	83	90	52	z = z1	116	78	34
	z	27	42	57	19				
	z1	27	42	57	19				
2½	a			112	53	M	314	203	130
	b			112	53	z = z1	149	88	42
	z			72	19				
	z1			72	21				
3	a			129	60	M	365	224	146
	b			129	60	z = z1	175	97	48
	z			83	22				
	z1			83	24				
4	a			166		M	469	294	178
	b			166		z = z1	224	129	60
	z			105					
	z1			105					

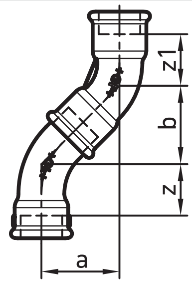
15°
53/54



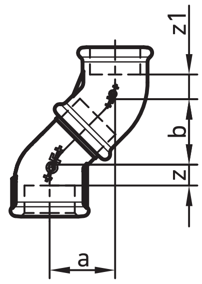
30°
50/51



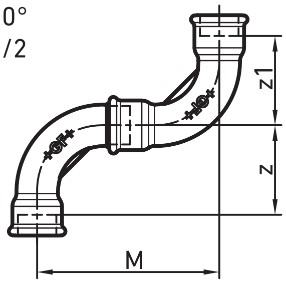
45°
40/41



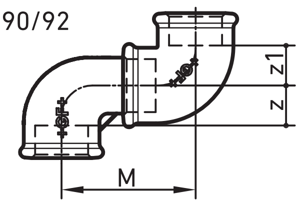
45°
120/121



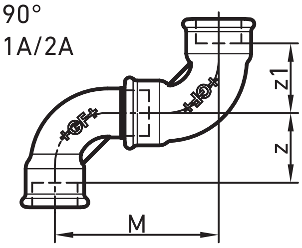
90°
1/2



90°
90/92



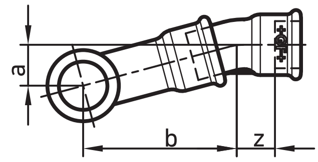
90°
1A/2A



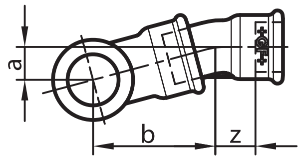
TV.28 **Combinations of malleable cast iron fittings**

R/Rp	Dimensions [mm]	15°			30°			45°		
		2/53	2a/53	90/53	2/50	2a/50	90/50	2/40	2a/40	90/40
⅜	a							44	35	28
	b							44	35	28
	z							20	20	20
½	a	16	14	9	33	28	20	51	44	32
	b	61	51	35	57	48	35	51	44	32
	z	15	15	15	17	17	17	23	23	23
¾	a	20	15	11	42	33	24	64	50	38
	b	76	58	42	73	56	42	64	50	38
	z	18	18	18	21	21	21	28	28	28
1	a	25	19	13	52	41	29	78	62	45
	b	94	72	48	90	71	49	78	62	45
	z	20	20	20	27	27	27	34	34	34
1¼	a	31	24	16	65	51	35	99	78	57
	b	116	88	58	113	87	61	99	78	57
	z	24	24	24	33	33	33	45	45	45
1½	a	34	26	17	72	56	56	110	88	63
	b	128	98	64	124	97	97	110	88	63
	z	26	26	26	37	37	37	49	49	49
2	a	41	31	19	85	66	44	132	105	74
	b	152	115	72	147	114	76	132	105	74
	z	27	27	27	42	42	42	57	57	57
2½	a	52	36	24	108	77	54	166	123	91
	b	194	135	91	186	133	94	166	123	91
	z	35	35	35	53	53	53	72	72	72
3	a				126	87	63	194	139	105
	b				218	151	108	194	139	105
	z				62	62	62	83	83	83
4	a				162	115	80	250	183	134
	b				281	198	139	250	183	134
	z				78	78	78	105	105	105

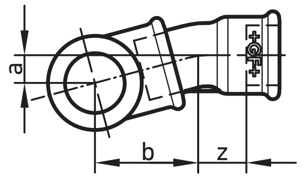
15°
2/53



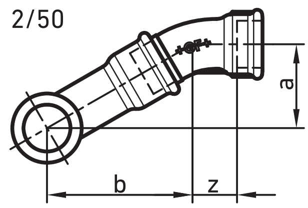
15°
2A/53



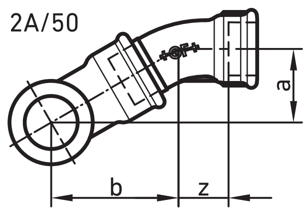
15°
90/53



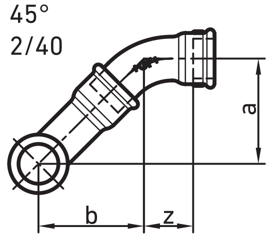
30°
2/50



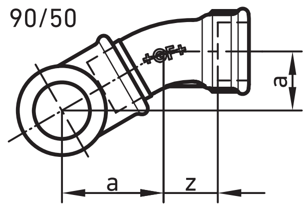
30°
2A/50



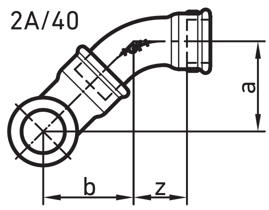
45°
2/40



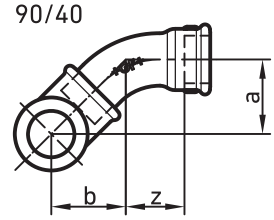
15°
90/50



45°
2A/40



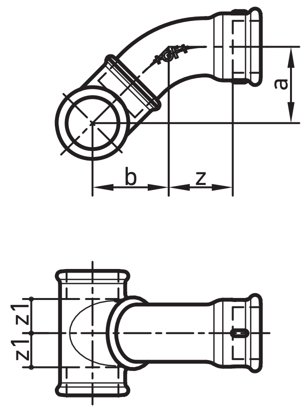
45°
90/40



TV.29 **Combinations of malleable cast iron fittings**

R/Rp	Dimensions [mm]	Pipe branch									
		⅜	½	¾	1	1¼	1½	2	2½	3	4
⅜	a=b	28									
	z1	15									
	z	20									
½	a=b	28	32								
	z1	13	15								
	z	20	23								
¾	a=b	30	34	38							
	z1	13	15	18							
	z	20	23	28							
1	a=b	33	36	40	45						
	z1	13	15	18	21						
	z	20	23	28	34						
1¼	a=b	35	39	44	50	57					
	z1	13	15	17	23	26					
	z	20	23	28	34	45					
1½	a=b	37	42	46	54	59	63				
	z1	14	17	19	20	27	31				
	z	20	23	28	34	45	49				
2	a=b		46	50	60	63	66	74			
	z1		14	16	20	24	28	34			
	z		23	28	34	45	49	57			
2½	a=b		52	57	65	69	72	79	91		
	z1		14	18	21	25	28	34	42		
	z		23	28	34	45	49	57	72		
3	a=b		57	62	65	74	78	84	95	105	
	z1		15	18	21	25	28	34	42	48	
	z		23	28	34	45	49	57	72	93	
4	a=b				74		87	93	105	115	134
	z1				20		28	34	41	48	60
	z				34		49	57	72	93	105

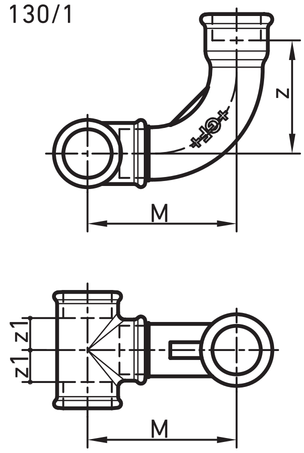
45°
130/40



TV.30 **Combinations of malleable cast iron fittings**

R/Rp	Dimensions [mm]	Pipe branch									
		⅜	½	¾	1	1¼	1½	2	2½	3	4
⅜	M	57									
	z1	15									
	z	38									
½	M	58	63								
	z1	43	15								
	z	38	42								
¾	M	60	66	78							
	z1	13	15	18							
	z	38	42	54							
1	M	64	69	81	96						
	z1	13	15	18	21						
	z	38	42	54	68						
1¼	M	68	77	86	100	121					
	z1	13	17	17	21	26					
	z	38	42	54	68	86					
1½	M	70	83	89	104	124	136				
	z1	14	14	19	23	27	31				
	z	38	42	54	68	86	97				
2	M		83	95	110	130	141	164			
	z1		14	16	20	24	28	34			
	z		42	54	68	86	97	116			
2½	M		91	104	118	138	149	179	207		
	z1		14	18	20	25	28	34	42		
	z		42	54	68	86	97	116	149		
3	M		98	111	125	146	157	179	214	238	
	z1		15	18	21	25	28	34	42	48	
	z		42	54	68	86	97	116	149	175	
4	M				138		170	192	227	252	305
	z1				20		28	34	41	48	60
	z				68		97	116	149	175	224

90°
130/1

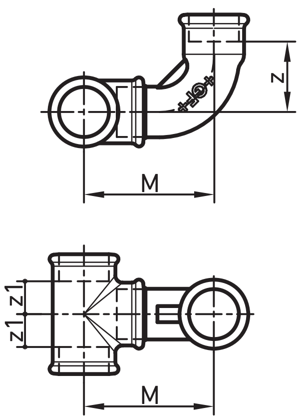


V

TV.31 **Combinations of malleable cast iron fittings**

R/Rp		Pipe branch									
		⅜	½	¾	1	1¼	1½	2	2½	3	4
⅜	M	51									
	z1	15									
	z	26									
½	M	52	60								
	z1	13	15								
	z	26	32								
¾	M	54	63	68							
	z1	13	15	18							
	z	26	32	35							
1	M	58	66	63	84						
	z1	16	15	15	21						
	z	26	32	32	46						
1¼	M	62	70	66	88	102					
	z1	13	15	15	21	26					
	z	26	32	32	46	57					
1½	M	64	74	70	92	105	116				
	z1	14	17	15	23	27	31				
	z	16	32	32	46	57	49				
2	M		80	74	98	111	121	136			
	z1		14	17	20	24	28	34			
	z		32	32	46	57	49	78			
2½	M		88	88	106	119	129	144	157		
	z1		14	14	20	25	28	34	42		
	z		32	32	46	57	49	78	88		
3	M		95	95	113	127	137	151	164	175	
	z1		15	15	21	25	28	34	42	48	
	z		32	32	46	57	49	78	88	97	
4	M				126		150	164	177	189	225
	z1				20		28	34	41	48	60
	z				46		49	78	88	97	129

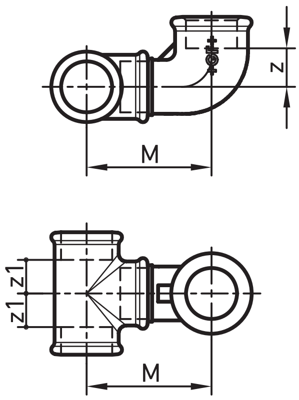
90°
130/1A



TV.32 **Combinations of malleable cast iron fittings**

R/Rp		Pipe branch									
		⅜	½	¾	1	1¼	1½	2	2½	3	4
⅜	M	47									
	z1	15									
	z	15									
½	M	48	52								
	z1	13	15								
	z	15	15								
¾	M	50	55	61							
	z1	13	15	18							
	z	15	15	18							
1	M	54	58	64	73						
	z1	13	15	18	21						
	z	15	15	18	21						
1¼	M	58	62	68	77	86					
	z1	13	15	17	21	26					
	z	15	15	18	21	26					
1½	M	60	66	72	81	89	96				
	z1	14	17	19	23	27	31				
	z	15	15	18	21	26	31				
2	M		72	78	87	95	101	108			
	z1		14	16	20	24	28	34			
	z		15	18	21	26	31	34			
2½	M		80	87	95	103	109	116	130		
	z1		14	18	20	25	28	34	42		
	z		15	18	21	26	31	34	42		
3	M		87	94	102	111	117	123	137	146	
	z1		15	18	21	25	28	34	42	48	
	z		15	18	21	26	31	34	42	48	
4	M				115		130	136	450	160	178
	z1				20		28	34	41	48	60
	z				20		31	34	42	48	60

90°
130/92



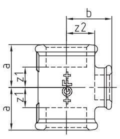
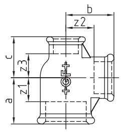
V

4.3.1 Installation aids

TV.33 **The z dimensions and overall lengths of the most common GF malleable iron fittings - random fittings**

Connection size			⅜		½		¾		1		1¼		1½		2		2½		3		4	
Medium thread engagement length			10		13		15		17		19		19		24		27		30		36	
		Fig.	z	b	z	b	z	b	z	b	z	b	z	b	z	b	z	b	z	b	z	b
Random fittings		1	38	42	42	48	54	60	68	75	86	95	97	105	116	130	149	165	175	190	224	245
		2	38	–	42	–	54	–	68	–	86	–	97	–	116	–	149	–	175	–	224	–
		1a	26	36	32	45	35	50	46	63	57	76	66	85	78	102	88	115	97	127	129	165
		2a	26	–	32	–	35	–	46	–	57	–	66	–	78	–	88	–	97	–	129	–
	45°	40	20	24	23	30	28	36	34	42	45	54	49	58	57	70	72	86	83	100	105	130
	45°	41	20	–	23	–	28	–	34	–	45	–	49	–	57	–	72	–	83	–	105	–
	30°	50	–	–	17	24	21	30	27	36	33	44	37	46	42	54	53	66	62	77	78	100
	30°	51	–	–	17	–	21	–	27	–	33	–	37	–	42	–	–	–	–	–	–	–
		85	28	–	34	–	40	–	53	–	66	–	–	–	–	–	–	–	–	–	–	–
		90	15	–	15	–	18	–	21	–	26	–	31	–	34	–	42	–	48	–	60	–
		92	15	32	15	37	18	43	21	52	26	60	31	65	34	74	42	88	48	98	60	118
	45°	120	10	–	9	–	10	–	11	–	14	–	17	–	19	–	21	–	24	–	–	–
	45°	121	10	25	9	28	10	32	11	37	14	43	17	46	19	55	19	54	22	61	–	–
		130	15	–	15	–	18	–	21	–	26	–	31	–	34	–	42	–	48	–	60	–
		180	15	–	15	–	18	–	21	–	26	–	31	–	34	–	42	–	48	–	60	–
		270	10	–	10	–	9	–	11	–	12	–	17	–	17	–	20	–	20	–	22	–
		471	15	–	15	–	18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
			a		a		a		a		a		a		a		a		a		a	
		280	38		44		47		53		57		59		68		75		83		95	

TV.34 **The z dimensions and overall lengths of the most common GF malleable iron fittings**

Fitting	Connection size	z1	z2	Fitting	Connection size	z1	z2	z3	Connection size	z1	z2	z3
130 Branch reduced 	½ – ¾	18	15	130 Branch/ passage reduced 	¾ – ½ – ½	15	18	15	1¼ – 1¼ – 1	26	26	25
	¾ – ½	15	18		¾ – ¾ – ½	18	18	18	1½ – ¾ – 1¼	19	29	17
	1 – ½	15	21		1 – ½ – ¾	15	21	18	1½ – 1–1¼	23	29	21
	1 – ¾	18	21		1 – ¾ – ¾	18	21	15	1½ – 1¼ – 1	27	29	25
	1¼ – ½	15	25		1 – ¾ – ½	18	21	18	1½ – 1¼ – 1¼	27	29	26
	1¼ – ¾	17	26		1 – 1 – ¾	21	21	21	1½ – 1½ – 1¼	31	31	29
	1¼ – 1	21	25		1¼ – ½ – 1	15	25	15				
	1½ – ½	17	29		1¼ – ¾ – 1	17	26	18				
	1½ – ¾	19	29		1¼ – 1 – ¾	21	25	21				
	1½ – 1	23	29		1¼ – 1 – 1	21	25	21				
	1½ – 1¼	27	29		1¼ – 1¼ – ¾	26	26	26				

a Dimension of front plane – front plane (overall length)
b Dimension of fitting axis – front plane of external thread
z, z1, z2, z3 z dimension

Build

PRIMOFIT

V

PRIMOFIT

Overview

This chapter contains basic information about the PRIMOFIT system.

Additional technical and sales information

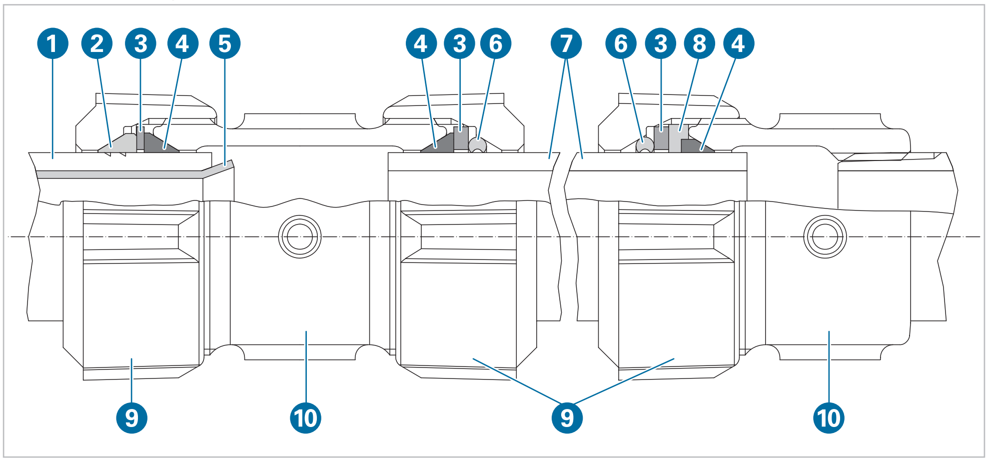
- For more information on the use and connection of other system components, piping and controls and instruments, see the chapters applicable to the appropriate systems.
- More technical information about this system and ordering information can be found on the GF website and in the sales catalogue.

1 The PRIMOFIT System

1.1 Features

- PRIMOFIT compression joints are preassembled and ready for installation, disassembly is not required
- Machining of pipe ends is kept to a minimum
- The joint cannot be pushed in and its tensile strength is high, fixing the pipe in place is not required
- Made of malleable cast iron with hot-dip galvanised and/or black finish
- Low assembly cost
- Special tools are not required
- The angular deflection of the pipe in a PRIMOFIT joint is up to 3°. This results in a permissible maximum axis deviation for two pipes connected by a PRIMOFIT compression joint of maximum 6°
- Detachable clamp connection
- Compact design - minimum space requirement
- Outer contours make shrink tubing possible
- Longitudinally electrically conductive, suitable for cathodic corrosion protection and equipotential bonding

1.2 Design



GV.1
PRIMOFIT system

1. PE pipe
2. Clamping ring for PE pipe
3. Sliding ring
4. Rubber gasket
5. Stiffener
6. Clamping ring for steel pipe
7. Steel pipe
8. Graphite ring
9. Coupling nut
10. Body of coupling

1.3 Limits of use

TV.1
Limits of use

	Gasket	Medium	Max. operating pressure [bar]	Max. operating temperature [°C]	Colour code[1]
Steel	NBR	Gas	10[2]	–20 – +60	Yellow
		Water	16	80	
		Compressed air	16	80	
		Oil	16	80	
	EPDM	Drinking water	16	35[3]	Blue
		Water	16	95	
	FKM	Fuels	10	40	Green
		Heating water/ steam	10	150[4]	
		Compressed air	16	150[4]	
	NBR + Graphite	Gas	5	–20 – +60	Red
PE	NBR	Gas	10[5]	40	Yellow
		Water	16	40	
	EPDM	Drinking water	16	35	Blue
		Water	16	40	
	FKM	Fuels	10	40	Green

1 The colour coding of the packaging labels and assembly instructions indicates the gasket material.
2 5 bar if using threaded connection
3 PRIMOFIT compression joints made of stainless steel can be in drinking water up to 95°C.
4 Since 2017, only FKM gaskets with high temperature resistance up to 150°C are being delivered. Due to intermediate inventory on the market, the previous version of FKM may still be in circulation and be used up to a max. 105°C as well. Therefore, compliance with the maximum permissible operating temperature in the assembly instructions is mandatory.
5 10 bar with PE100 / 8 bar with PE-Xa / 5 bar with threaded connections

1.4 Overview

TV.2 **Relation of compression joint dimension and pipe diameter (regardless of the compression joint) and smallest inside diameters**

Nominal width DN Compression joint dimension	10 ⅜	15 ½	20 ¾	25 1	32 1¼	40 1½	50 2	65 2½	80 3	100 4
Steel pipe Tolerance range [mm]	17.2 16.7 – 17.5	21.3 21.0 – 21.8	26.9 26.5 – 27.3	33.7 33.3 – 34.2	42.4 42.0 – 42.9	48.3 47.9 – 48.8	60.3 59.7 – 60.8	76.1 75.3 – 76.6	88.9 88.0 – 89.5	114.3 113.1 – 115.0
Welded steel tubes for pressure purposes[1] (incl. ± tolerance) [mm]	-	20.0 ±0.5	25.0 ±0.5	31.8 ±0.5	38.0 ±0.5	44.5 ±0.5	51.0 ±0.5 57.0 ±0.5 63.5 ±0.6	70.0 ±0.7	-	-
PE- u. PE-Xa pipe Tolerance range [mm]	-	20 20.0 – 20.3	25 25.0 – 25.3	32 32.0 – 32.3	40 40.0 – 40.4	50 50.0 – 50.4	63 63.0 – 63.4	-	-	-
Lead pipe [mm]	-	18.3 – 21.9	23.9 – 27.4	27.3 – 30.9 30.9 – 34.4	36.5 – 37.6 39.6 – 43.1	45.8 – 46.9 47.5 – 50.7	53.1 – 55.4 56.5 – 57.5 60.4 – 63.8	-	-	-
Min. internal diameter[2] [mm]	7.9	11.6	16.6	22.7	30.9	36.3	46.8	61.5	72.2	95.3
Thread size [inch]	⅜	½	¾	1	1¼	1½	2	2½	3	4

1 only available as seal kit. When using seal kits for steel tubes for pressure purposes, measuring 63.5 mm, a separate compression joint is needed, that is to say, the tube **cannot** be combined with standard compression joint dimension 2!
2 corresponds to the smallest inside diameter of the transition piece with external thread. For all other compression joint types, the smallest internal diameter is the inside diameter of the pipe.

1.5 Terms and abbreviations

TV.3
Terms and abbreviations

Term	Explanation
Steel	to join steel pipes
PE/PE-Xa	to join PE/PE-Xa pipe
Lead	to join lead pipes
PE dimension	Polyethylene pipe dimension
NBR	Nitrile-butadiene rubber
EPDM	Ethylene-propylene rubber
FKM	Fluorine rubber (Viton®)
HTL, German abbreviation	higher thermal load capacity
PE	Polyethylene
PE-Xa	Peroxide cross-linked polyethylene
SDR	Pipe diameter / wall thickness ratio (Standard Dimension Ratio)

2 The basics

2.1 Material

The body and coupling nut of the PRIMOFIT compression joints are made acc. to EN 10284 and prEN 10344. The material used is white malleable iron **EN-GJMW-400-5** acc. to EN 1562 and complies with the material symbol A.

TV.4
Material

Material symbol	Material grade acc. to EN 1562 approved acc. to EN 10284 / prEN 10344
A	EN-GJMW-400-5
	EN-GJMB-350-10
B	EN-GJMW-350-4
	EN-GJMB-300-6

PRIMOFIT compression joint are available in black or hot-dip galvanised design, wetted with a preservative to prevent flash rust. Hot-dip galvanizing meets the requirements of EN 10284 and prEN 10344 or DIN 50930-6 as well as the Evaluation Criteria for Metallic Materials in its currently valid version and published by the UBA (the German Environment Agency).

Deviating from these standards and version are the bodies of the PRIMOFIT compression joints that are made of 316 stainless steel (V4A). This also corresponds to the Evaluation Criteria for Metallic Materials by the UBA.

Seal material

The sealing materials NBR, EPDM, NBR + graphite (FIREJOINT) and FKM are offered to cover a wide range of applications. In order to distinguish between the sealing materials, NBR gaskets are black and FKM gaskets are green. EPDM gaskets are also black, however, they bear a blue dot as a distinguishing feature to the NBR gasket. The EPDM gasket complies with the requirements of the UBA Elastomer Guideline and is approved for drinking water applications.

All PRIMOFIT compression joints are individually packed in PE pouches together with assembly instructions. The colour coding of the individually packaged pieces indicates the gasket material.

TV.5
Seal materials

Seal materials	Colour coding
NBR	Yellow
EPDM	Blue
FKM	Green
NBR + Graphite (FIREJOINT)	Red

2.2 Connecting threads

General information

Threads for pipes, controls and instruments, fittings and other piping parts that are mated together, comply with international and national standards.

Connecting threads are pipe threads where pressure tight joints are made on the threads acc. to EN 10226-1 or ISO 7-1. The valid national edition of EN 10226 replaced by DIN 2999, BS 21, etc.

When using connecting threads acc. to EN 10226-1, the internal thread designated with the letters Rp is cylindrical. However, the outside thread designated with the letter R is tapered.

2.2.1 Design and function of connecting threads (sealing inside the thread)

The standard EN 10226-1 (ISO 7-1) defines thread form, dimensions, tolerances and designations based on the thread size. The major dimensions of these connecting threads, the weight and data of the medium- and heavy-duty threaded pipes are shown in the table. The thread profile with its most important features is illustrated in Fig. [GV.2].

Tapered external thread

When using **tapered external thread, [GV.3]** some details must be considered. As the name indicates, it is cut at a taper (cone-shaped), at a taper rate of 1:16 [GV.4].

The entire pipe thread length consists of 3 sections [GV.4]:

- The **test length a** is defined and the tolerance is applied so that even the smallest possible internal thread diameter allows for easy mating of the fasteners. The external thread can be easily screwed in and the sparingly applied sealant is properly drawn into the connection.
- The **engagement length b** is the relevant threaded part that determines the sealing effect. The threaded length—which is fully cut into the thread root behind the measuring plane—is selected so that even the largest possible internal thread diameter allows for sufficient engagement length when using a tool. Since the thread's cone ratio is 1:16, a strong pressure between the threads leads to a permanently reliable seal.
- The **thread run-out**, which is not fully cut out at the bottom, should remain visible. If the thread is engaged too far, there is a risk that the internal thread might leak or crack on the side of the fitting (or on the control and instrument). In order to avoid backlash between the peaks of the make thread and the bottom of the internal thread in the finished bolted joint, the thread crests on the male thread of the pipe should be fully cut out over the full range of usable thread length.

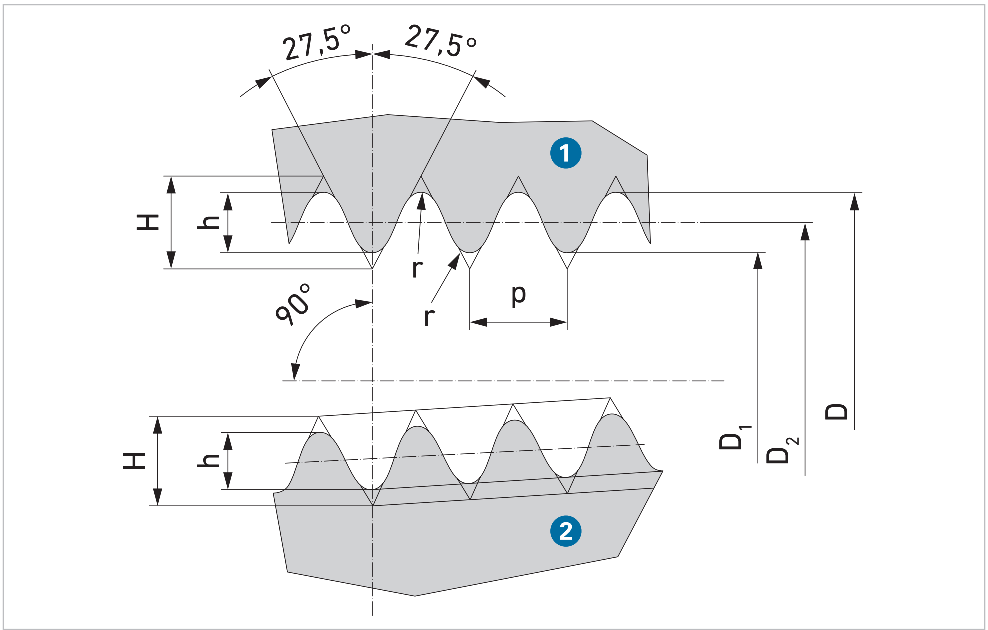
Parallel internal thread

When using the **parallel internal thread** [GV.5], it must be ensured that the usable thread length allows complete mating of the external thread until the sealing effect is achieved. This must also be ensured for the largest permissible test length of the external thread.

The different ratios of a **threaded connection** that is tightened manually and a connection tightened with the aid of a tool are shown in Fig. [GV.6] (for example: 1").

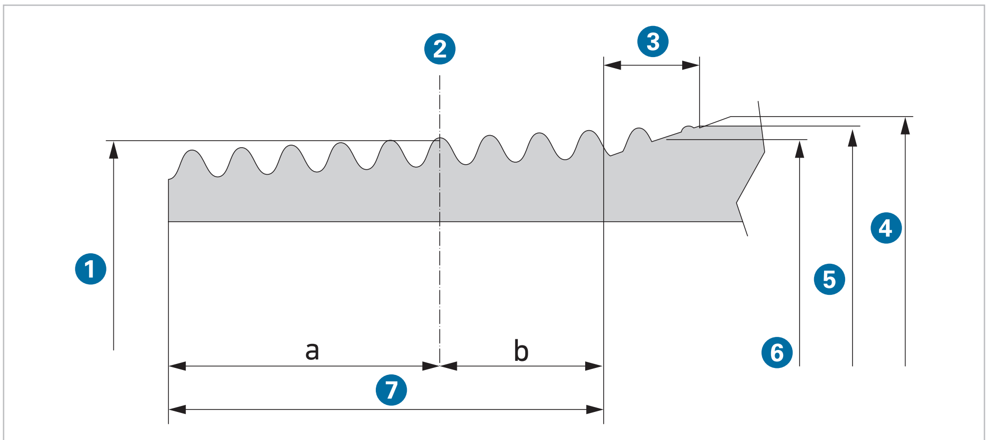
- When using a manually threaded connection ([GV.6] ➊), 2¾ threads will still be available on the make thread, allowing the use of a tool for the final tightening of the thread (➨ Tab. [TV.6]).
- The threaded connection bolted acc. to standard is shown in Fig. ([GV.6] ➋).

In order to compensate for the outlet direction of the fitting (or the lengths of the fully assembled pipeline), the threads can be screwed in a little less or a little more. Nevertheless, the connection is perfectly tight.



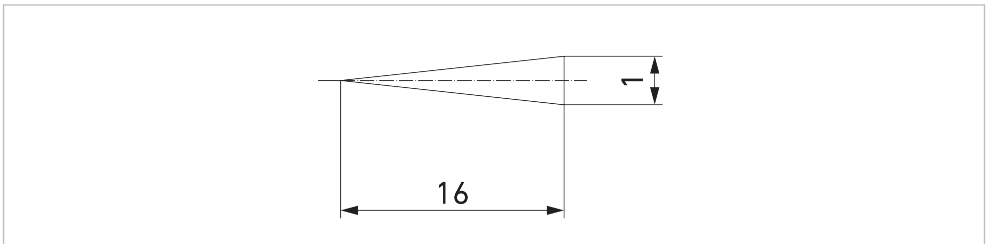
GV.2
Thread profile

- **1** Internal thread
- **2** External thread
- **p** Pitch
- **H** 0,960491 · p
- **h** 0,640327 · p
- **r** 0,137329 · p
- **D** External diameter
- **D_1** Core diameter
- **D_2** Pitch diameter



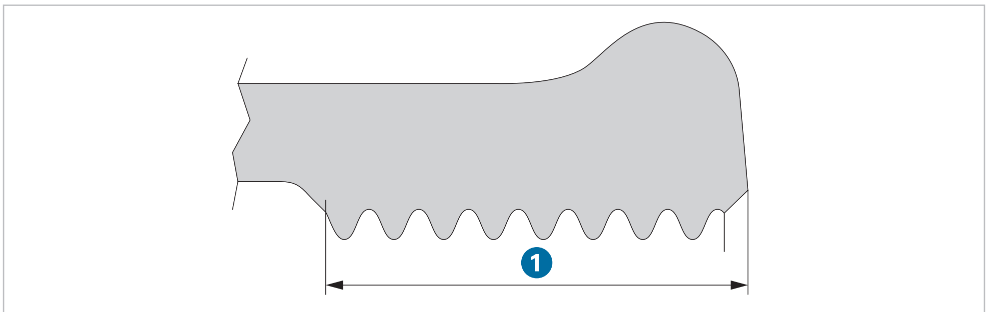
GV.3
Tapered external thread R

- **1** Thread diameter
- **2** Test plane
- **3** Thread run-out
- **4** Pipe diameter max.
- **5** Pipe diameter
- **6** Pipe diameter min.
- **7** Usable threads length
- **a** (Test length) ± tolerance
- **b** Tightening section



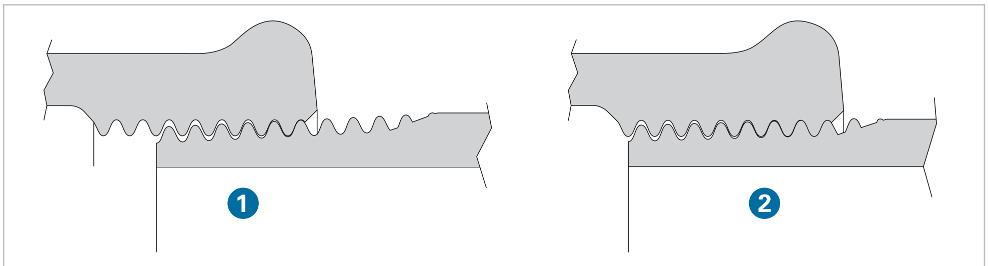
GV.4
Taper of an external thread

The thread profile is perpendicular to the pipe's axis.



GV.5
Parallel internal thread Rp

- **1** Usable threads length



GV.6
Thread connection

- **1** Tightened manual
- **2** Tightened with the aid of a tool

Sealing effect and sealant

The **sealing effect** in the thread is largely achieved by the fact that the internal and external threads (flank diameter) touch each other at the moment of run-up and are fit even tighter when using a tool.

Consequently, in a cylindrical/tapered connection, the only task of a **sealant** is to fill in unavoidable deviations from the theoretical profile of the threads and roughnesses of the threaded surfaces. Therefore, only a little amount of sealant, suitable for its purpose should be used.

Tension, compression or bending stress of the connection are absorbed by the metal-to-metal contact.

√ **Ensuring the sealing effect**

In order to ensure that the desired sealing effect of the cylindrical/tapered connection occurs, compliance with the following instructions is mandatory:

- The **thread cutting tool** must be set so that the fitting can be screwed onto the unpacked thread manually. The remaining threads can only be screwed in using an appropriate tool. This ensures that the necessary sealing pressure is obtained even in the largest permissible internal thread diameters.
- The end of the usable make thread ([GV.3], length a + b) should not be inserted deeper with the tool than the first formed thread of the internal thread ([GV.6] 2). Otherwise, the sealing pressure can be jeopardised by the incomplete thread root of the make thread's runout.

The most important dimensions of the pipe thread acc. to EN 10226-1 (ISO 7-1)

TV.6 **Pipe threads – dimensions**

Thread size **Nominal width DN**	⅜ 10	½ 15	¾ 20	1 25	1¼ 32	1½ 40	2 50	2½ 65	3 80	4 100
Pipe threads										
Gauge diameter (Thread outside diameter in the measuring plane) [mm]	16.662	20.955	26.441	33.249	41.910	47.803	59.614	75.184	87.884	113.030
Pitch [mm]	1.337	1.814	1.814	2.309	2.309	2.309	2.309	2.309	2.309	2.309
Number of threads per inch (25.4 mm)	19	14	14	11	11	11	11	11	11	11
Measuring length "a" of the tapered outside thread [mm]	6.4	8.2	9.5	10.4	12.7	12.7	15.9	17.5	20.6	25.4
Tolerance for "a"	±1.3	±1.8	±1.8	±2.3	±2.3	±2.3	±2.3	±3.5	±3.5	±3.5
Screw-in area "b" with tool [mm]	3.7	5.0	5.0	6.4	6.4	6.4	7.5	9.2	9.2	10.4
threads	2¾	2¾	2¾	2¾	2¾	2¾	3¼	4	4	4½
Medium thread engagement length [approx. mm]	10.0	13.0	15.0	17.0	19.0	19.0	24.0	27.0	30.0	36.0

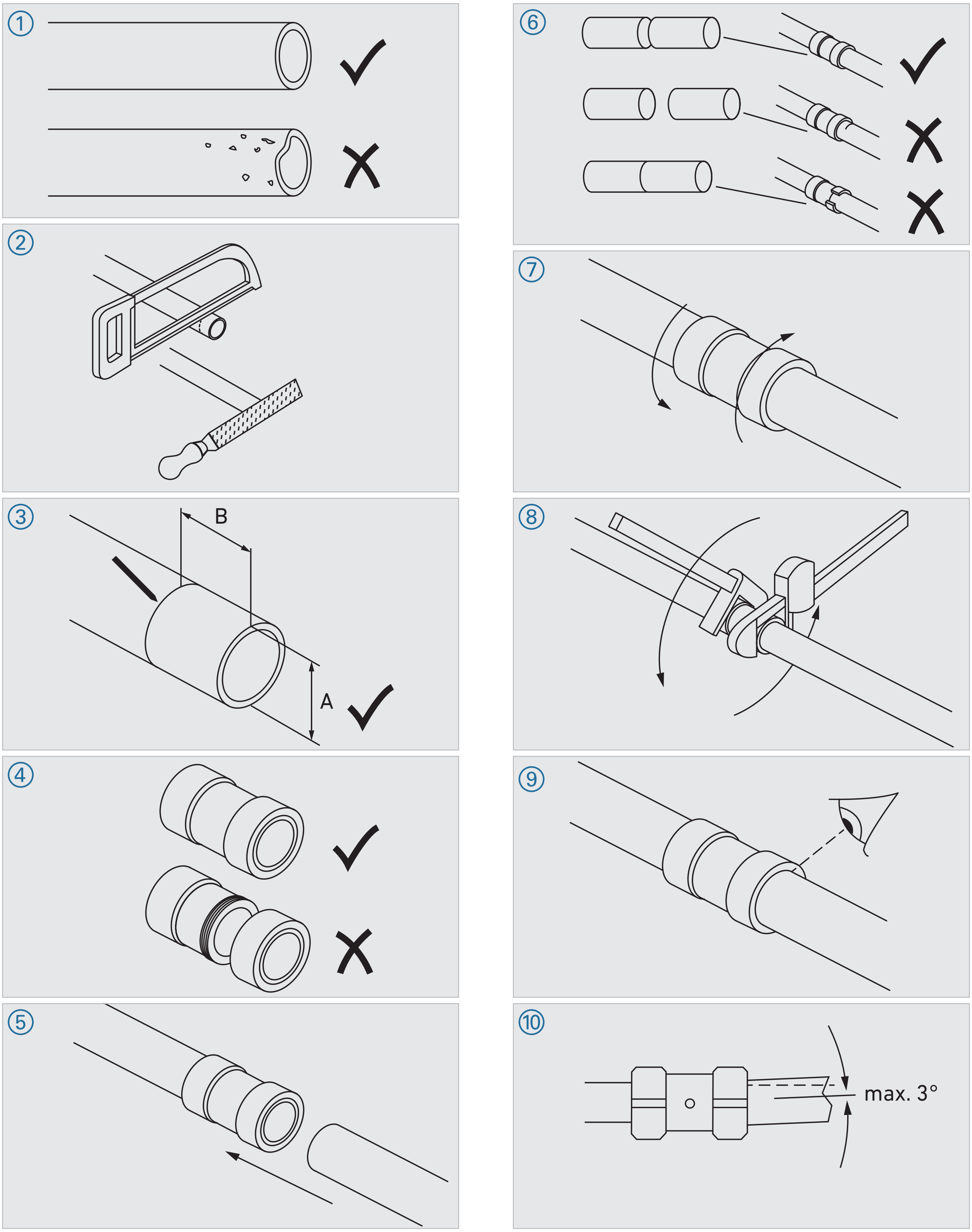
Details ➡ applicable standards

2.3 Assembly

Each PRIMOFIT compression joint comes with assembly instructions.

If required, these instructions can also be requested by e-mail: primofit.ps@georgfischer.com

The overview below illustrates the assembly:



2.3.1 Installation video

Watch our installation video to see the use of PRIMOFIT compression joints first hand. In addition to various requirements that are placed on the product, the assembly process is also explained. Moreover, different application examples can also be viewed.

Installation video
Watch the video below: https://www.fittings.at

2.3.2 Limits of use

The PRIMOFIT is a high tensile compression joint that is shear-resistant. Each connection can accommodate an angle deviation up to 3° between pipe and compression joint. Due to the modular design of the PRIMOFIT, the replacement of the seal kits (clamping, sliding ring and gasket) can also be used by the customer to convert to other types of pipe.

For the use of the PRIMOFIT compression joint in the respective application areas, consulting the relevant international, European and national regulations (e.g. standards, directives, regulations of the local utilities, etc.) is mandatory.

The selection of the appropriate seal material (NBR, EPDM, FKM or NBR + graphite) and the matching surface finish (black or hot-dip galvanised) is carried out according to the "limits of use" tables and is decisive for the suitability of the product in a specific application.

2.3.3 Pressure Equipment Directive 2014/68/EU

PRIMOFIT compression joints are not pressure equipment in the sense of the Pressure Equipment Directive and are therefore not intended for CE marking in connection with this EC Directive. PRIMOFIT compression joints are pressure equipment components that meet the operating limits requirements of EN 10284 or prEN 10344 and the Pressure Equipment Directive – within EN 10284 and prEN 10344.

PRIMOFIT must only be used for media for which the material malleable cast iron and the selected seal material are suitable. If required, GF will gladly provide test report 2.2, together with a manufacturer's declaration.

2.4 Certificate

GF operates an integrated management system, which is certified acc. to EN ISO 9001, EN ISO 14001 and BS OHSAS 18001.

Current certificates
If required, our current certificates can be requested via the following website:
www.fittings.at/kontaktformular

The suitability of the PRIMOFIT compression joints made of malleable cast iron for gas and drinking water installations has been approved and verifiable with DVGW certificates.

The current status of the certificates
In order to view the current status of the certificates and their applicable registration numbers, go to the following website:
www.fittings.at/zertifikate

2.5 Use

2.5.1 Use of PRIMOFIT compression joints under ground

If PRIMOFIT compression joints are installed in the ground, they must be permanently protected against external corrosion on-site. The corrosion protection must comply with the requirements of EN 12068 ("Cathodic protection – External organic coatings for the corrosion protection of buried or immersed steel pipelines used in conjunction with cathodic protection - Tapes and shrinkable materials"), as well as national standards and generally applicable rules or guidelines. In addition, compliance with the respective building specifications of the responsible power supply companies or engineering offices is mandatory.

The corrosion protection products used must be tested in accordance with the above mentioned regulations.

2.5.2 Use of PRIMOFIT compression joints in masonry (flush-mounted)

If PRIMOFIT compression joints are installed in masonry, they must be permanently protected against corrosion on-site. The corrosion protection must comply with the requirements of the national standards and the generally applicable regulations or pipe installation guidelines. In addition, compliance with the respective building specifications of the responsible power supply companies or engineering offices is mandatory.

2.5.3 Reuse of PRIMOFIT compression joints

When reusing the PRIMOFIT compression joints, the gasket, sliding and clamping ring must be replaced. For this purpose, sealing kits are available separately.

If mechanical damage, wear or corrosion is not visible on the body and coupling nut, these fittings can be used again.

3 Connection for steel pipes

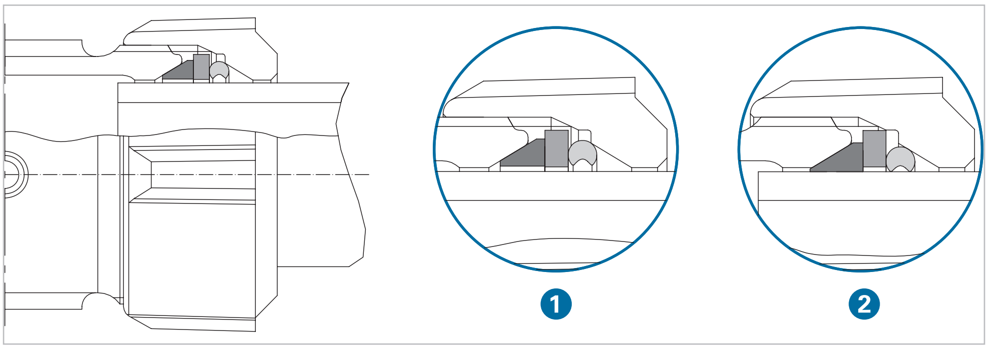
This assortment range of compression joints acc. to prEN 10344 is used—depending on the field of application—to connect black or hot-dip galvanised steel pipes according to EN 10255 and EN 10220 Series 1 with outside diameters according to ISO 65. Sealing kits are available for some dimensions of welded steel tubes for pressure purposes of series 2 and 3. The PRIMOFIT stainless steel compression joint is designed for repairs on galvanised hot water pipes that are made of hot-dip galvanised iron materials. All media-contacting materials (body and elastomer gasket) comply with the UBA regulations.

3.1 Jointing technology

In the ready-to-install, pre-assembled state of the PRIMOFIT compression joint, the internal diameters of the gasket, sliding and clamping ring are larger than the largest permissible outside diameter of the pipe. This guarantees that the pipe can be inserted without disassembly. Tightening the coupling nut has two functions:

- First, the gasket is pressed against the jointing faces of the tapered seal chamber and the pipe's surface.
- Subsequently, the clamping action of the clamping ring in order to ensure tensile and shear protection of the compression joint.

As opposed to using a coupling nut when tightening a pipe joint, in order to tighten a 4 inch diameter pipe, the screws on a flange system are used to achieve the same effect. However, the principle of sealing and clamping shown here is the same as for smaller dimensions.



GV.7
Connection for steel pipe
1 Loose connection
2 Tightened connection

3.2 Pipe specification

TV.7
Steel/EN 10255
Steel/EN 10220-R1
Steel/EN 10220-R2/3
(welded steel tubes for pressure purposes)

Steel/EN 10255 Steel/EN 10220-R1			**Steel/EN 10220-R2/3 *** (Welded steel tubes for pressure purposes)	
Dimension [inch]	D [mm]	Tolerance range [mm]	D [mm]	Tolerance range [mm]
⅜	17.2	16.7 – 17.5	–	–
½	21.3	21.0 – 21.8	20.0	19.5 – 20.5
¾	26.9	26.5 – 27.3	25.0	24.5 – 25.5
1	33.7	33.3 – 34.2	31.8	31.3 – 32.3
1¼	42.4	42.0 – 42.9	38.0	37.5 – 38.5
1½	48.3	47.9 – 48.8	44.5	44.0 – 45.0
2	60.3	59.7 – 60.8	51.0	50.5 – 51.5
			57.0	56.4 – 57.6
			63.5	62.9 – 64.1
2½	76.1	75.3 – 76.6	70.0	69.3 – 70.7
3	88.9	88.0 – 89.5	–	–
4	114.3	113.1 – 115.0	–	–

D Nominal outside diameter of steel pipe
* Sealing kits are for pipe outer diameters of series 2 and 3 are available.

3.3 PRIMOFIT compression joints, galvanised, for steel pipe

The PRIMOFIT is a high tensile compression joint that is shear-resistant. In addition, each connection can accommodate an angle deviation up to 3° between pipe and compression joint. This compression joint according to prEN 10344 is used to connect hot-dip galvanised steel pipes according to EN 10255 and EN 10220 with the standardised outside diameters according to ISO 65.

Application areas

The limits of use for specific application areas can be found in international, European or national application-related regulations (standards, directives, etc.).

TV.8
Application areas

Gasket	Medium	Max. operating pressure [bar]	Max. operating temperature [°C]
NBR	Gas[1]	10[2]	–20 – +60
	Water	16	80[3]
	Compressed air	16	80
	Oil	16	80
EPDM	Drinking water[4]	16	35
	Water	16	90[3]
FKM[5]	Fuels[6]	10	40
	Compressed air	16	150[7]

1 Natural gas and liquefied petroleum gas acc. to DVGW G260
If gas pipelines are installed indoors, we recommend the use of the FIREJOINT family of products. This type of PRIMOFIT compression joint permits a much higher thermal load (HTL).
2 5 bar if using threaded connection
3 The maximum operating temperature is derived from the limits of use of the seal material.
4 Drinking water installation: When planning and designing drinking water installations, compliance with the regulations of DIN EN 806-2 is mandatory. Essential information on corrosion prevention in hot-dip galvanised ferrous materials can be found in DIN EN 12502-3. With regard to the compliance with drinking water hygiene in Germany, the requirements of DIN 50930-6, together with the UBA Evaluation Criteria for Metallic Materials in its currently valid version apply. It approves the use of hot-dip galvanised iron materials for cold drinking water with a base capacity of KB8.2 ≤0.2 mmoL/L and neutral salt ratios S1 <1. The UBA Evaluation Criteria for Metallic Materials also regulates the requirements for the composition of the zinc coating, compliance with which is demonstrated by GF by the associated DVGW certificate. In the case of a repair or additions to an existing cold and hot water installation on a small scale, according to the UBA Evaluation Criteria for Metallic Materials, based on the experience in the previous operation of the system and the results of a drinking water hygiene analysis, exceptions are possible. In special cases, GF will be happy to advise you. Nevertheless, the general rule applies stating that in the interests of corrosion protection, 60°C should not be exceeded in continuous operation. Wherever drinking water pipes are used, only PRIMOFIT compression joints with EPDM gaskets shall be used.
5 FKM gaskets shall **not** be used in drinking water installations and for the medium gas.
6 Diesel, leaded and unleaded petrol.
7 Since 2017, only FKM gaskets with high temperature resistance up to 150°C are being delivered. Due to intermediate inventory on the market, the previous version of FKM may still be in circulation and be used up to a max. 105°C as well. Therefore, compliance with the maximum permissible operating temperature in the assembly instructions is mandatory.

Materials

The body and coupling nuts of the PRIMOFIT compression joint are made of white malleable cast iron **EN-GJMW-400-5** according to EN 1562. Sealing materials: ➨ Tab. [TV.8]. Corrosion protection by applying hot dip galvanising according to prEN 10344. When installed under ground (compression joint is exposed directly to earth, sand, etc.), the installer must apply additional corrosion protection methods (e.g. tape).

More details
Details on general product information, jointing and application methods as well as pipe specifications can be found in: ➨ Chapter [2] 'The basics'

3.4 PRIMOFIT compression joints, stainless steel, for steel pipe

The PRIMOFIT is a high tensile compression joint that is shear-resistant. In addition, each connection can accommodate an angle deviation up to 3° between pipe and compression joint.

This compression joint according is used to connect hot-dip galvanised steel pipes according to EN 10255 and EN 10220 with the standardised outside diameters according to ISO 65.

Application areas

The limits of use for specific application areas can be found in international, European or national application-related regulations (standards, directives, etc.).

Existing galvanised hot water installations without hygienic problems are present in large numbers in buildings. Based on Section 1 of the UBA Evaluation Criteria, repairs to pipes made of hot-dip galvanised iron materials are permitted under certain conditions. If these requirements are not fulfilled, the PRIMOFIT stainless steel compression joint can be used as an alternative. All materials coming in contact with drinking water (body and elastomer seal) comply with the UBA regulations.

TV.9
Application areas

Gasket	Medium	Max. operating pressure [bar]	Max. operating temperature [°C]
EPDM	Drinking water	16	95[1]

1 In conjunction with hot-dip galvanised steel pipes and in the interests of corrosion protection, 60°C should not be exceeded in continuous operation.

PRIMOFIT compression joints made of stainless steel can be combined with all sealing kits in the dimension range mentioned above.

Materials

The bodies of the PRIMOFIT compression joints are made of **316 stainless steel** (V4A) and coupling nuts are made of white malleable iron **EN-GJMW-400-5** according to EN 1562. Sealing materials: ➨ Tab. [TV.9]. When installed under ground (compression joint is exposed directly to earth, sand, etc.), the installer must apply additional corrosion protection methods (e.g. tape).

More details
Details on general product information, jointing and application methods as well as pipe specifications can be found in: ➨ Chapter [2] 'The basics'

3.5 PRIMOFIT compression joints, black, for steel pipe

The PRIMOFIT is a high tensile compression joint that is shear-resistant. In addition, each connection can accommodate an angle deviation up to 3° between pipe and compression joint.

This compression joint according to prEN 10344 is used to connect black steel pipes according to EN 10255 and EN 10220 with the standardised outside diameters according to ISO 65.

Application areas

The limits of use for specific application areas can be found in international, European or national application-related regulations (standards, directives, etc.).

TV.10
Application areas

Gasket	Medium	Max. operating pressure [bar]	Max. operating temperature [°C]
FKM[1]	Fuels[2]	10	40
	Heating water/ steam[4]	10	105/150[3]
	Compressed air	16	105/150[3]

1 FKM gaskets shall not be used in drinking water installations and for the medium gas.
2 Diesel, leaded and unleaded petrol.
3 Since 2017, only FKM gaskets with high temperature resistance up to 150°C are being delivered. Due to intermediate inventory on the market, the previous version of FKM may still be in circulation and be used up to a max. 105°C as well. Therefore, compliance with the maximum permissible operating temperature in the assembly instructions is mandatory.
4 Heating water: Heating water also includes water in ventilation and air conditioning systems. Especially when glycol-containing antifreeze is used, black fittings with FKM gaskets are recommended.

Materials

The body and coupling nuts of the PRIMOFIT compression joint are made of white malleable cast iron **EN-GJMW-400-5** according to EN 1562. The sealing material is FKM. The mechanic shall be responsible for any necessary corrosion protection. When installed under ground (compression joint is exposed directly to earth, sand, etc.), the installer must apply additional corrosion protection methods (e.g. tape).

More details
Details on general product information, jointing and application methods as well as pipe specifications can be found in: ➨ Chapter [2] 'The basics'

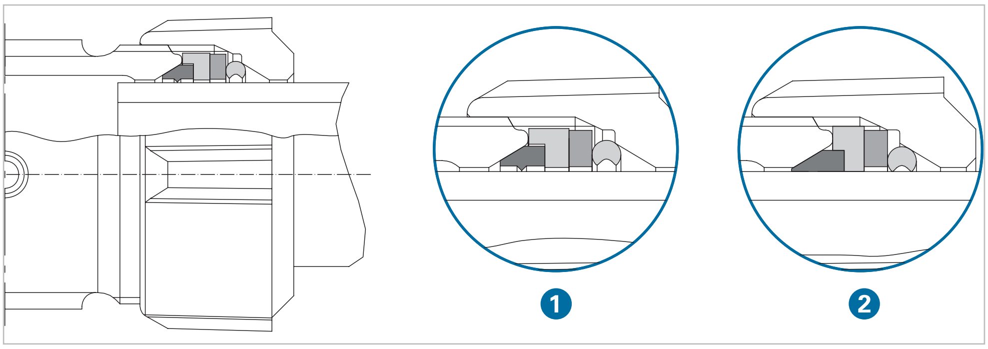
4 FIREJOINT connection for steel pipes (HTL version)

The PRIMOFIT FIREJOINT compression joint is the fire-resistant, higher thermal load (HTL) version, which is mandatory for gas pipes installed indoors according to DVGW. The compression joint is also used to connect black or hot dip galvanised steel pipes acc. to EN 10255 and EN 10220 Series 1 with an outside diameter acc. to ISO 65. The yellow passivated coupling nut makes it easy to recognise the PRIMOFIT FIREJOINT.

4.1 Jointing technology

This design is identical with the pipe connector for steel pipes, except for its different seal kit (with additional graphite ring). This fitting has been specially designed for gas installations and meets the requirements for higher thermal load (HTL) in the event of fire, as defined by standardised test methods.

An additional graphite ring maintains the tension- and shear-resistant connection, as well as the tightness during a fire. For sealing purposes in normal operation, an NBR gasket is embedded in the graphite ring.



GV.8
Connection for steel pipe (HTL version)

1 Loose connection
2 Tightened connection

4.2 Pipe specification

TV.11
Steel/ISO 65

Dimension [inch]	D [mm]	Tolerance range [mm]
½	21.3	21.0 – 21.8
¾	26.9	26.5 – 27.3
1	33.7	33.3 – 34.2
1¼	42.4	42.0 – 42.9
1½	48.3	47.9 – 48.8
2	60.3	59.7 – 60.8

D Nominal outside diameter of steel pipe

4.3 PRIMOFIT FIREJOINT compression joint, galvanised, HTL version for steel pipe

The PRIMOFIT is a high tensile compression joint that is shear-resistant; the fitting is approved for indoor gas line installations: DVGW tested at 650°C against higher thermal load (HTL version). An additional graphite ring maintains the tension- and shear-resistant connection, as well as the tightness during a fire. In addition, each connection can accommodate an angle deviation up to 3° between pipe and compression joint.

This compression joint according to prEN 10344 is used to connect hot-dip galvanised or black steel pipes according to EN 10255 and EN 10220 Series 1 with the standardised outside diameters according to ISO 65. The PRIMOFIT FIREJOINT is available with a yellow passivated coupling nut for visual differentiation from other PRIMOFIT compression joints.

Application areas

The limits of use for specific application areas can be found in international, European or national application-related regulations (standards, directives, etc.). FIREJOINT complies in particular with the regulations of DVGW TRGi and DIN 3387-1.

TV.12
Application areas

Gasket	Medium	Max. operating pressure [bar]	Max. operating temperature [°C]
NBR + Graphite	Gas[1]	5	-20 – +60

1 Natural gas and liquefied petroleum gas acc. to DVGW G 260.

When using FIREJOINT sealing kits, all PRIMOFIT compression joints can be converted into FIREJOINT compression joints.

FIREJOINT sealing kits also incorporate a yellow passivated coupling nut.

Materials

The body and coupling nuts of the PRIMOFIT compression joint are made of white malleable cast iron **EN-GJMW-400-5** according to EN 1562. The seal material is NBR with an additional graphite ring. Corrosion protection by applying hot dip galvanising according to prEN 10344. Coupling nut with additional galvanising for colour differentiation purposes.

More details
Details on general product information, jointing and application methods as well as pipe specifications can be found in: ➨ Chapter [2] 'The basics'

5 Connection for PE and PE-Xa pipes

Transition joints from the above-specified steel pipes to PE/PE-Xa pipes as well as joints from PE/PE-Xa to PE/PE-Xa pipes are offered. These compression joints are made acc. to EN 10284 and are suitable for PE-Rohre acc. to EN 12201-2 (water), as well as networked polyethylene pipes PE-Xa acc. to EN ISO 15875-2: ➨ Tab. [TV.21].

The following pipe materials are permitted to use, PE 80 (PE-MD), PE 100 (PE-HD) and PE-Xa.

Each PE/PE-Xa connection includes a stiffener. The use of stiffeners is manadatory.

When using a stiffener with the PRIMOFIT PE/PE-Xa connection, the wall thicknesses (SDR series) specified in the assortment section of the catalogue under "Dimension PE" must be taken into account when selecting the compression joint.

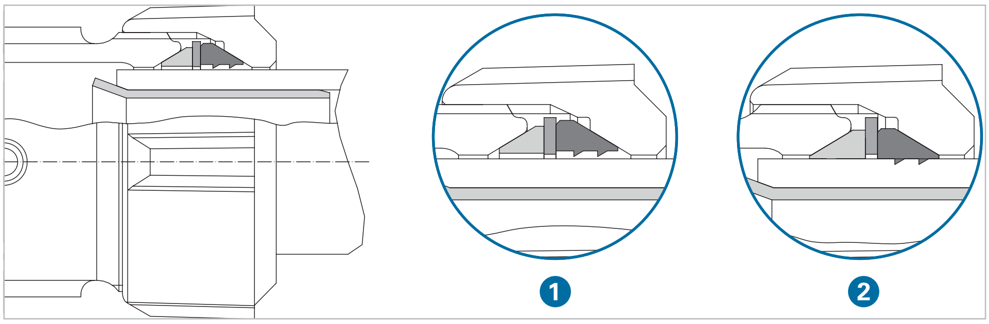
5.1 Jointing technology

The principle of the jointing method corresponds to that of the steel pipe connection. In contrast, a stiffener matching the pipe's internal diameter is required. This stiffener increases the resistance of the PE/PE-Xa pipe against the radial forces.

Gasket, sliding and clamping ring are matched to the pipe material and pipe diameter. The shape of the clamping ring for PE/PE-Xa pipes requires special attention. This rigidity of this joint is limited and tolerates only a certain deflection of the pipe when the latter is tightened.

Important information

PROMOFIT compression joint are made of stainless steel and can also be used to connect PE, PE-Xa pipes and lead pipes by using suitable PE sealing kits.



GV.9
Connection for steel pipe (HTL version)

1. Loose connection
2. Tightened connection

5.2 Pipe specification

TV.13
Pipe specification

	PE EN 12201-2/Water			**PE** EN 1555-2/Gas		**PE-Xa** DIN 16892/93 and EN ISO 15875-2	**Steel / ISO 65**	
SDR S	7.4 3.2	11 5	17.6 (17) 8.3 (8)	11 5	17.6 8.3	11 5	– –	
Da [mm]	s [mm]	s [mm]	s [mm]	s [mm]	s [mm]	s [mm]	Dimension [inch]	D [mm]
20	3.0	2.0	–	3.0	2.3	1.9	½	21.3
25	3.5	2.3	2.0 (2.0)	3.0	2.3	2.3	¾	26.9
32	4.4	3.0	2.0 (2.0)	3.0	2.3	2.9	1	33.7
40	5.5	3.7	2.3 (2.4)	3.7	2.3	3.7	1¼	42.4
50	6.9	4.6	2.9 (3.0)	4.6	2.9	4.6	1½	48.3
63	8.6	5.8	3.6 (3.8)	5.8	3.6	5.8	2	60.3

Da/s Nominal outside diameters/wall thicknesses of PE/PE-Xa pipes
D Nominal outside diameter of steel pipe

Important information on the scope of delivery

The scope of delivery includes support stiffener(s).

☑ In order to select the correct compression joint, consideration of the wall thicknesses of the PE/PE-Xa pipes (SDR series) is most important. These wall thicknesses together with the pipe diameters are indicated in the assortment table.

5.3 PRIMOFIT compression joints, galvanised, for transition from steel to PE/PE-Xa pipe

The PRIMOFIT is a high tensile compression joint that is shear-resistant. In addition, each connection can accommodate an angle deviation up to 3° between pipe and compression joint. This transition compression joint according to EN 10284 is used to connect hot-dip galvanised steel pipes according to EN 10255 with standard outside diameters according to ISO 65 with polyethylene pipes according to EN 12201-2 with PE 100 or PE 80 material, as well as with cross-linked polyethylene pipes PE-Xa according to EN ISO 15875-2.

☑ Compliance with the different wall thicknesses of the PE/PE-Xa pipes (SDR series) is mandatory.

Application areas

The limits of use for specific application areas can be found in international, European or national application-related regulations (standards, directives, etc.).

The max. permissible operating pressure in the specific application depends on the pipe specification and local regulations!

TV.14
Application areas

Gasket	Medium	Max. operating pressure [bar]	Max. operating temperature [°C]
NBR	Gas[1]	5	40
	Water	16	40
EPDM[2]	Drinking water[3]	16	35
	Water	16	40

1 LPG and natural gas acc. to DVGW G260.
Steel/PE connections are not permitted in the installation of internal gas pipelines;
2 The use of EPDM sealing kits is mandatory.
3 Drinking water installation: When planning and designing drinking water installations, compliance with the regulations of DIN EN 806-2 is mandatory. Essential information on corrosion prevention in hot-dip galvanised ferrous materials can be found in DIN EN 12502-3. With regard to the compliance with drinking water hygiene in Germany, the requirements of DIN 50930-6, together with the UBA Evaluation Criteria for Metallic Materials in its currently valid version apply. It approves the use of hot-dip galvanised iron materials for cold drinking water with a base capacity of KB8.2 ≤0.2 mmoL/L and neutral salt ratios S1 <1. The UBA Evaluation Criteria for Metallic Materials also regulates the requirements for the composition of the zinc coating, compliance with which is demonstrated by GF by the associated DVGW certificate. In the case of a repair or additions to an existing cold and hot water installation on a small scale, according to the UBA Evaluation Criteria for Metallic Materials, based on the experience in the previous operation of the system and the results of a drinking water hygiene analysis, exceptions are possible. In special cases, GF will be happy to advise you. Nevertheless, the general rule applies stating that in the interests of corrosion protection, 60°C should not be exceeded in continuous operation. Wherever drinking water pipes are used, only PRIMOFIT compression joints with EPDM gaskets shall be used.

Materials

The body and coupling nuts of the PRIMOFIT compression joint are made of white malleable cast iron **EN-GJMW-400-5** according to EN 1562. The sealing material is NBR. Use hot dip galvanising according to EN 10284 for corrosion protection purposes. When installed under ground (compression joint is exposed directly to earth, sand, etc.), the installer must apply additional corrosion protection methods (e.g. tape).

More details
Details on general product information, jointing and application methods as well as pipe specifications can be found in: ➨ Chapter [2] 'The basics'

V

5.4 PRIMOFIT compression joints, galvanised, for PE/PE-Xa pipe

The PRIMOFIT is a high tensile compression joint that is shear-resistant. In addition, each connection can accommodate an angle deviation up to 3° between pipe and compression joint. This compression joint acc. to EN 10284 is used to connect polyethylene pipes acc. to EN 12201-2 with material PE 100 or PE 80 and cross-linked polyethylene pipes PE-Xa and DIN EN ISO 15875-2.

☑ Compliance with the different wall thicknesses of the PE/PE-Xa pipes (SDR series) is mandatory.

Application areas

The limits of use for specific application areas can be found in international, European or national application-related regulations (standards, directives, etc.).

The max. permissible operating pressure in the specific application depends on the pipe specification and local regulations!

TV.15
Application areas

Gasket	Medium	Max. operating pressure [bar]	Max. operating temperature [°C]
NBR	Gas[1]	5	40
	Water	16	40
EPDM[2]	Drinking water[3]	16	35
	Water	16	40

1 LPG and natural gas acc. to DVGW G260.
Steel/PE connections are not permitted in the installation of internal gas pipelines;
2 The use of EPDM sealing kits is mandatory.
3 Drinking water installation: When planning and designing drinking water installations, compliance with the regulations of DIN EN 806-2 is mandatory. Essential information on corrosion prevention in hot-dip galvanised ferrous materials can be found in DIN EN 12502-3. With regard to the compliance with drinking water hygiene in Germany, the requirements of DIN 50930-6, together with the UBA Evaluation Criteria for Metallic Materials in its currently valid version apply. It approves the use of hot-dip galvanised iron materials for cold drinking water with a base capacity of KB8.2 ≤0.2 mmoL/L and neutral salt ratios S1 <1. The UBA Evaluation Criteria for Metallic Materials also regulates the requirements for the composition of the zinc coating, compliance with which is demonstrated by GF by the associated DVGW certificate. In the case of a repair or additions to an existing cold and hot water installation on a small scale, according to the UBA Evaluation Criteria for Metallic Materials, based on the experience in the previous operation of the system and the results of a drinking water hygiene analysis, exceptions are possible. In special cases, GF will be happy to advise you. Nevertheless, the general rule applies stating that in the interests of corrosion protection, 60°C should not be exceeded in continuous operation. Wherever drinking water pipes are used, only PRIMOFIT compression joints with EPDM gaskets shall be used.

Materials

The body and coupling nuts of the PRIMOFIT compression joint are made of white malleable cast iron **EN-GJMW-400-5** according to EN 1562. Sealing material: ➨ Tab. [TV.15]. Use hot dip galvanising according to EN 10284 for corrosion protection purposes. When installed under ground (compression joint is exposed directly to earth, sand, etc.), the installer must apply additional corrosion protection methods (e.g. tape).

More details
Details on general product information, jointing and application methods as well as pipe specifications can be found in: ➨ Chapter [2] 'The basics'

6 Connection for lead pipes

In compliance with the Directive 98/83/EC ("Quality of water intended for human consumption"), existing lead pipes must be removed from the drinking water installations. PRIMOFIT compression joints are used exclusively for repairs or additions (transitions to other systems) of existing lead pipes and allow temporary operation until the final removal of the lead pipe installation.

Since lead pipes can have different consistencies depending on the installation situation, the following instructions must be observed when installing PRIMOFIT compression joints on lead pipes:

- The surface of the lead pipe must not be damaged and dirt in the insertion area must be removed.
- The outside diameter of the lead pipe must be within the tolerances indicated on the packaging label. This diameter may also be found in the dimension chart for lead pipes
- The out-of-roundness of the lead pipe must not exceed 1 mm (= difference between minimum and maximum outside diameter)
- The insertion depth of the lead pipe and the number of revolutions required to tighten the coupling nut can be found in the assembly instructions. For lead pipes, the values of the corresponding PE pipe sizes shall be used.
  - Example: Lead pipe 30 mm, use the values for PE 32 mm: Insertion depth 32 mm ±1 mm
- After the installation, a pressure test must be carried out in accordance with national guidelines and attention must be paid to possible leaks. However, the test pressure should be at least 1.5 times the nominal pressure (1.5 × PN) or min. 10 bar (higher value should be used).

6.1 Jointing technology

The principle of the jointing method corresponds to that of the steel pipe connection. Gasket, sliding and clamping ring are matched to the pipe's material and diameter.

☑ The shape of the clamping ring for lead pipes require special attention.

6.2 Pipe specification (lead pipes)

TV.16
Pipe specification

Dimension [inch]	D [mm]
½	18.3 – 21.9
¾	23.9 – 27.4
1	27.3 – 30.9
1	30.9 – 34.4
1¼	36.5 – 37.6
1¼	39.6 – 43.1
1½	45.8 – 46.9
1½	47.5 – 50.7
2	53.1 – 55.5
2	56.5 – 57.5
2	60.4 – 63.8

D Range of the lead pipe's nominal outside diameter

6.3 PRIMOFIT compression joints, galvanised, for lead pipe

The PRIMOFIT is a high tensile compression joint that is shear-resistant. In addition, each connection can accommodate an angle deviation up to 3° between pipe and compression joint.

This compression joint is based on prEN 10344 and is used to connect pressure-bearing lead pipes with outside diameters: ➨ Tab. [TV.17].

Application areas

The limits of use for specific application areas can be found in international, European or national application-related regulations (standards, directives, etc.).

TV.17
Application areas

Gasket	Medium	Max. operating pressure [bar]	Max. operating temperature [°C]
NBR	Drinking water	10	35

In compliance with the Directive 98/83/EC Quality of water intended for human consumption, existing lead pipes must be removed from the drinking water installations. The PRIMOFIT compression joints are used exclusively for repairs or additions (transitions to other systems) of existing lead pipes and allow temporary operation until the final removal of the lead pipe installation is completed.

Materials

The body and coupling nuts of the PRIMOFIT compression joint are made of white malleable cast iron EN-GJMW-400-5 according to EN 1562. The sealing material is NBR. Corrosion protection by applying hot dip galvanising according to prEN 10344. When installed under ground (compression joint is exposed directly to earth, sand, etc.), the installer must apply additional corrosion protection methods (e.g. tape).

More details
Details on general product information, jointing and application methods as well as pipe specifications can be found in: ➨ Chapter [2] 'The basics'

Important information
→ Compliance with installation instructions is mandatory ➨ Chapter [6] 'Connection for lead pipes'

7 Pipe specification

The pipes to be used must comply with the tables below.

Summary table – Relation of compression joint dimension and pipe diameter (regardless of the compression joint) and smallest inside diameters

TV.18 **Overview – Compression joint dimension, pipe diameter, inside diameter**

Nominal width DN	10	15	20	25	32	40	50	65	80	100
Compression joint dimension	⅜	½	¾	1	1¼	1½	2	2½	3	4
Steel pipe Tolerance range [mm]	17.2 16.7 – 17.5	21.3 21.0 – 21.8	26.9 26.5 – 27.3	33.7 33.3 – 34.2	42.4 42.0 – 42.9	48.3 47.9 – 48.8	60.3 59.7 – 60.8	76.1 75.3 – 76.6	88.9 88.0 – 89.5	114.3 113.1 – 115.0
Welded steel tubes for pressure purposes* (incl. ± tolerance) [mm]	-	20.0 ±0.5	25.0 ±0.5	31.8 ±0.5	38.0 ±0.5	44.5 ±0.5	51.0 ±0.5 57.0 ±0.5 63.5 ±0.6	70.0 ±0.7	-	-
PE- u. PE-Xa pipe Tolerance range [mm]	-	20 20.0 – 20.3	25 25.0 – 25.3	32 32.0 – 32.3	40 40.0 – 40.4	50 50.0 – 50.4	63 63.0 – 63.4	-	-	-
Lead pipe [mm]	-	18.3 – 21.9	23.9 – 27.4	27.3 – 30.9 30.9 – 34.4	36.5 – 37.6 39.6 – 43.1	45.8 – 46.9 47.5 – 50.7	53.1 – 55.4 56.5 – 57.5 60.4 – 63.8	-	-	-
Min. internal diameter** [mm]	7.9	11.6	16.6	22.7	30.9	36.3	46.8	61.5	72.2	95.3
Thread size [inch]	⅜	½	¾	1	1¼	1½	2	2½	3	4

* only available as a seal kit;
if using sealing kits for steel tubes for pressure purposes, measuring 63.5 mm, a special compression joint body is required, that is to say, the latter **cannot** be combined with standard compression joints of dimension 2!

** corresponds to the smallest inside diameter of the transition piece with external thread. For all other compression joint types, the smallest internal diameter is the inside diameter of the pipe.

Steel pipes: Threaded pipes acc. to DIN EN 10255 (formerly DIN 2440, DIN 2441), welded steel tubes for pressure purpose acc. to DIN EN 10220 Series 1 (formerly DIN 2448/2458 Series 1)

i **Information on out-of-roundness shape**

Limiting deviations of the out-of-roundness margins are included in the diameter limits. By contrast, maximum out-of-roundness shape of 0.5 mm apply to FIREJOINT.

V

TV.19 **Steel pipes – Threaded pipes**

Thread size **Nominal width DN**	⅜ 10	½ 15	¾ 20	1 25	1¼ 32	1½ 40	2 50	2½ 65	3 80	4 100
Threaded pipes DIN EN 10255										
Nominal outside diameter [mm]	17.2	21.3	26.9	33.7	42.4	48.3	60.3	76.1	88.9	114.3
Surface of the smooth pipe [approx. m^2/m]	0.054	0.067	0.085	0.106	0.133	0.152	0.189	0.239	0.279	0.359
Light-weight pipe type (L2)										
Wall thickness [approx. mm]	1.8	2.0	2.3	2.6	2.6	2.9	2.9	3.2	3.2	3.6
Internal diameter [approx. mm]	13.6	17.3	22.3	28.5	37.2	42.5	54.5	69.7	82.5	107.1
Internal cross-section [approx. cm^2]	1.45	2.35	3.91	6.38	10.87	14.19	23.33	38.16	53.46	90.09
Volume [approx. L/m]	0.145	0.235	0.391	0.638	1.087	1.419	2.333	3.816	5.346	9.009
Pipe weight, of the smooth pipe, not galvanised [approx. kg/m]	0.67	0.947	1.38	1.98	2.54	3.23	4.08	5.71	6.72	9.75
Medium heavy series (M)										
Wall thickness [approx. mm]	2.3	2.6	2.6	3.2	3.2	3.2	3.6	3.6	4.0	4.5
Internal diameter [approx. mm]	12.6	16.1	21.7	27.3	36	41.9	53.1	68.9	80.9	105.3
Internal cross-section [approx. cm^2]	1.25	2.04	3.7	5.85	10.18	13.79	22.15	37.28	51.4	87.09
Volume [approx. L/m]	0.125	0.204	0.37	0.585	1.018	1.379	2.215	3.728	5.14	8.709
Pipe weight, of the smooth pipe, not galvanised [approx. kg/m]	0.839	1.21	1.56	2.41	3.1	3.56	5.03	6.42	8.36	12.2
Heavy-duty series (H)										
Wall thickness [approx. mm]	2.9	3.2	3.2	4.0	4.0	4.0	4.5	4.5	5.0	5.4
Internal diameter [approx. mm]	11.4	14.9	20.5	25.7	34.4	40.3	51.3	67.1	78.9	103.5
Internal cross-section [approx. cm^2]	1.02	1.74	3.3	5.19	9.29	12.76	20.67	35.36	48.89	84.13
Volume [approx. L/m]	0.102	0.174	0.33	0.519	0.929	1.276	2.067	3.536	4.889	8.413
Pipe weight, of the smooth pipe, not galvanised [approx. kg/m]	1.02	1.44	1.87	2.93	3.79	4.37	6.19	7.93	10.3	14.5
Welded steel tubes for pressure purposes DIN EN 10220 **Series 1***										
Outside diameter [mm]	17.2	21.3	26.9	33.7	42.4	48.3	60.3	76.1	88.9	114.3
Wall thickness [approx. mm]	1.8	2.0	2.3	2.6	2.6	2.6	2.9	2.9	3.2	3.6
Internal diameter [approx. mm]	13.6	17.3	22.3	28.5	37.2	43.1	54.5	70.3	82.5	107.1
Internal cross-section [approx. cm^2]	1.45	2.35	3.91	6.38	10.87	14.59	23.33	38.82	53.46	90.09
Volume [approx. L/m]	0.145	0.235	0.391	0.683	1.087	1.459	2.333	3.882	5.346	9.009
Pipe weight, of the smooth pipe, not galvanised [approx. kg/m]	0.684	0.952	1.4	1.99	2.55	2.93	4.11	5.24	6.76	9.83

* In addition to Series 1, there are special sealing kits for the lower pipe diameters 20, 25, 31.8, 38, 44.5, 51, 57, 63.5 and 70 mm.

Maximum operating pressure of the PE/PE-Xa pipes

TV.20
Maximum operating pressures

Pressure level, bar	EN 12201-2		DIN 8047*		EN ISO 15875-2**
Pipe specification	PE 80	PE 100	PE 80	PE 100	PE-Xa
SDR 7.4/S 3.2	20	25	16	25	-
SDR 11/S 5	12.5	16	10	16	12.5
SDR 17/S 8	8	10	6.2	10	-
SDR 17.6/S 8.3	-	-	6.0	9.6	-

* SF=1.6, 50 years, TB=20°C
** SF=1.5, 100 years, TB=50°C

Common PE/PE-Xa pipe series acc. to EN 1555-2, EN 12201-2, DIN 8074 and EN ISO 15875-2

TV.21
PE-/PE-Xa pipes series

Nominal outside diameter, D_a	20	25	32	40	50	63
SDR 7.4/S 3.2 acc. to EN 12201-2/water						
Wall thickness [approx. mm]	3.0	3.5	4.4	5.5	6.9	8.6
Internal diameter [approx. mm]	14	18	23.2	29	36.2	45.8
Internal cross-section [approx. cm^2]	1.54	2.54	4.23	6.61	10.29	16.47
Volume [approx. L/m]	0.154	0.254	0.423	0.661	1.029	1.647
Pipe weight [approx. kg/m]	0.16	0.238	0.383	0.596	0.93	1.464
SDR 7.4/S 3.2 acc. to DIN 8074						
Wall thickness [approx. mm]	2.8	3.5	4.4	5.5	6.9	8.6
Internal diameter [approx. mm]	14.4	18	23.2	29	36.2	45.8
Internal cross-section [approx. cm^2]	1.63	2.54	4.23	6.61	10.29	16.47
Volume [approx. L/m]	0.163	0.254	0.423	0.661	1.029	1.647
Pipe weight [approx. kg/m]	0.154	0.238	0.383	0.596	0.93	1.464
SDR 11/S 5 acc. to EN 1555-2/Gas						
Wall thickness [approx. mm]	3.0	3.0	3.0	3.7	4.6	5.8
Internal diameter [approx. mm]	14	19	26	32.6	40.8	51.4
Internal cross-section [approx. cm^2]	1.54	2.84	5.31	8.35	13.07	20.75
Volume [approx. L/m]	0.154	0.284	0.531	0.835	1.307	2.075
Pipe weight [approx. kg/m]	0.16	0.208	0.275	0.425	0.66	1.043
SDR 11/S 5 acc. to EN 12201-2/Water						
Wall thickness [approx. mm]	2.0	2.3	3.0	3.7	4.6	5.8
Internal diameter [approx. mm]	16	20.4	26	32.6	40.8	51.4
Internal cross-section [approx. cm^2]	2.01	3.27	5.31	8.35	13.07	20.75
Volume [approx. L/m]	0.201	0.327	0.531	0.835	1.307	2.075
Pipe weight [approx. kg/m]	0.115	0.168	0.275	0.425	0.66	1.043

Nominal outside diameter, D_a*	20	25	32	40	50	63
SDR 11/S 5 acc. to DIN 8074 / EN ISO 15875-2						
Wall thickness [approx. mm]	1.9	2.3	2.9	3.7	4.6	5.8
Internal diameter [approx. mm]	16.2	20.4	26.2	32.6	40.8	51.4
Internal cross-section [approx. cm^2]	2.06	3.27	5.39	8.35	13.07	20.75
Volume [approx. L/m]	0.206	0.327	0.539	0.835	1.307	2.075
Pipe weight [approx. kg/m]	0.112	0.171	0.272	0.425	0.66	1.043
SDR 17/S 8 acc. to EN 12201-2 /water						
Wall thickness [approx. mm]	–	–	2.0	2.4	3.0	3.8
Internal diameter [approx. mm]	–	–	28	35.2	44	55.4
Internal cross-section [approx. cm^2]	–	–	6.16	9.73	15.21	24.11
Volume [approx. L/m]	–	–	0.616	0.973	1.521	2.411
Pipe weight [approx. kg/m]	–	–	0.192	0.29	0.447	0.713
SDR 17/S 8 acc. to DIN 8074						
Wall thickness [approx. mm]	–	1.8	1.9	2.4	3.0	3.8
Internal diameter [approx. mm]	–	21.4	28.2	35.2	44	55.4
Internal cross-section [approx. cm^2]	–	3.6	6.25	9.73	15.21	24.11
Volume [approx. L/m]	–	0.36	0.625	0.973	1.521	2.411
Pipe weight [approx. kg/m]	–	0.137	0.187	0.29	0.447	0.713
SDR 17.6/S 8.3 acc. to EN 1555-2 / Gas						
Wall thickness [approx. mm]	2.3	2.3	2.3	2.3	2.9	3.6
Internal diameter [approx. mm]	15.4	20.4	27.4	35.4	44.2	55.8
Internal cross-section [approx. cm^2]	1.86	3.27	5.9	9.84	15.34	24.45
Volume [approx. L/m]	0.186	0.327	0.59	0.984	1.534	2.445
Pipe weight [approx. kg/m]	0.131	0.168	0.22	0.28	0.434	0.68
SDR 17.6/S 8.3 acc. to EN 12201-2 /water						
Wall thickness [approx. mm]	–	–	2.0	2.3	2.9	3.6
Internal diameter [approx. mm]	–	–	28	35.4	44.2	55.8
Internal cross-section [approx. cm^2]	–	–	6.16	9.84	15.34	24.45
Volume [approx. L/m]	–	–	0.616	0.984	1.534	2.445
Pipe weight [approx. kg/m]	–	–	0.192	0.28	0.434	0.68
SDR 17.6/S 8.3 acc. to DIN 8074						
Wall thickness [approx. mm]	–	–	1.8	2.3	2.9	3.6
Internal diameter [approx. mm]	–	–	28.4	35.4	44.2	55.8
Internal cross-section [approx. cm^2]	–	–	6.33	9.84	15.34	24.45
Volume [approx. L/m]	–	–	0.633	0.984	1.534	2.445
Pipe weight [approx. kg/m]	–	–	0.179	0.28	0.434	0.68

* Permitted for nominal outside diameter (D_a) 25 and 32 s = 2.0 mm if existing pipe installations <0.1 bar.

Build

COOL-FIT 2.0

V

COOL-FIT 2.0

1 General Information

COOL-FIT 2.0 is a pre-insulated piping system for the delivery of secondary refrigerants. Thanks to its insulation thickness of 20 mm, the system can be used in air-conditioning systems with secondary refrigerant temperatures above 0 °C. COOL-FIT 2.0 is based on established, impact resistant and corrosion free PE pipe and fittings. The smooth inner surface of the fluid pipe provides minimal losses of pressure. The low thermal conductivity and high quality insulation guarantee low operating cost over the entire lifespan of the system. Thanks to the 3 in 1 design – Fluid pipe / Insulation / Jacket tube – installation time is kept very short.

The system consists of pipe, fittings, valves, flexible hoses and transition fittings. All components are pre-insulated or supplied with mountable insulation shells. The COOL-FIT 2.0 tools allow for fast and safe installation of the system.

The COOL-FIT 2.0 system is a completely pre-insulated plastic piping system for secondary refrigerant circuits run with water, brine, or Glycol based solutions.

The COOL-FIT 2.0 system is suitable for use in applications like:

Comfort Cooling	Safe Cooling
• Air conditioning • Airports • Apartments • Hospitals • Industrial buildings	• Data centers • Hotels • Shopping centers • Sports center / leisure center • Universities • Bank / public institutions

2 System Specification

Specification		COOL-FIT 2.0	COOL-FIT 2.0F
Materials[1]	Pipe	PE100	PE100
	Insulation	GF-HE foam, halogen free, closed-cell	GF-HE foam, halogen free, closed-cell
	Outer jacket	Pipe HDPE	Flame retardant - GF-FR
		Fitting GF-HE	-
Size [2]		d32DN25 – d140DN125 mm	d32DN25 – d140DN125 mm
Connection techno-logy		Electrofusion	Electrofusion
Nominal pressure[3]		16 bar, SDR 11	16 bar, SDR 11
Temperature	Medium	0 °C bis +60 °C	0 °C bis +60 °C
	Environment	0 °C bis +55 °C	0 °C bis +55 °C
Insulation	Thermal conductivity $\lambda_{20°C}$ PE Inner pipe HE Foam PE jacket GF-FR jacket	 0.38 W/mK 0.022 W/mK 0.38 W/mK	 0.38 W/mK 0.022 W/mK 0.15 W/mK
	Density	≥ 70 kg/m³	≥ 70 kg/m³
	Foam cell size	max. Ø 0.5 mm	max. Ø 0.5 mm
	Nominal thickness	22 mm	22 mm
Mechanical strength (from insulation)	Axial shear strength	≥ 0.12 N/mm²	> 0,12 N/mm²
	Compressive strength	≥ 0.3 N/mm²	≥ 0.3 N/mm²
Colour	Outer jacket	Black	Black
Weight (without medium)	Pipe d32	1.12 kg/m	1.06 kg/m
	Pipe d110	5.5 kg/m	5.39 kg/m
Oxygen diffusion at ≤ 5°C	ISO 17455	≤ 0.083 mg/(m² d)	≤ 0.083 mg/(m² d)
Fire classification [4]	EN 13501-1 [4]	E	B - s2, d0

1) All three materials are firmly bonded together.

2) Bigger dimensions available via COOL-FIT 4.0 and COOL-FIT 4.0F product range

3) At 20 ° C, medium water, the specified value is valid for all system components, with the exception of the butterfly valves, PN10 applies to the nominal pressure and for flexible hoses with maximum pressure according product datasheet.

4) Additional information in chapter "Fire behavior and fire prevention measures".

Specification		COOL-FIT 2.0	COOL-FIT 2.0F
Environment	Stability	Moisture and vapor-tight	Moisture and vapor-tight
	Ozone Depletion Potential	Zero	Zero
Standards and Guidelines	EN ISO 15494	Plastic piping systems for industrial applications – polybutene (PB), polyethylene (PE) and polypropylene (PP) – specifications for components and the piping system – metric series	
	ISO 7	Threaded Joints	
	EN ISO 16135 EN ISO 16136 EN ISO 16137 EN ISO 16138	Industrial valves ... – Ball valves made of thermoplastics – Butterfly valves made of thermoplastics – Backflow protection made of thermoplastics – Diaphragm valve made of thermoplastics	
	EN ISO 16871	Plastic piping and ducting systems – Plastic pipe and fittings – Method for exposure to direct (natural) weathering	
	EN ISO 13501-1	Fire classification of construction products and building elements	
Product declarations Green buildings		BNB BN 2015 BREEAM Int 2016 DGNB 2015 DGNB 2018 LEED V3 LEED V4 WELL V1 2019	
eco-bau	(BKP 240, 244, 250)	201710.1516	201908.5715

3 Technical Details

3.1 COOL-FIT 2.0

COOL-FIT 2.0 pipe

COOL-FIT 2.0 pipes are made from PE 100. The high efficiency GF-HE hard foam insulation exhibits a thermal conductivity λ of 0.022 W/mK. The pipes are protected by a impact resistant PE jacket.

All three materials are firmly bonded in order to ensure good insulation properties and low thermal expansion or contraction for the system.

The pipes are available in 5 m lengths.

Pipe size (mm)	Inner Pipe d x e (mm)	Inner Pipe d_i (mm)	Outer jacket D x e1 (mm)	Weight empty (kg/m)	Weight with water (kg/m)	Volume (l/m)	Insulation thickness (mm)	Heat transfer coefficient (U) (W/m K)	Fire load (kWh/m)
d32/75	32 x 2.9	26.2	75 x 3	1.12	1.66	0.54	18.5	0.16	12.41
d40/90	40 x 3.7	32.6	90 x 3	1.50	2.34	0.83	22.0	0.17	16.55
d50/90	50 x 4.6	40.8	90 x 3	1.67	2.98	1.31	17.0	0.24	18.91
d63/110	63 x 5.8	51.4	110 x 3.4	2.47	4.54	2.07	20.1	0.25	27.91
d75/125	75 x 6.8	61.4	125 x 3.8	3.24	6.20	2.96	21.2	0.28	36.88
d90/140	90 x 8.2	73.6	140 x 4	4.17	8.43	4.25	21.0	0.32	47.91
d110/160	110 x 10	90.0	160 x 4	5.50	11.86	6.36	21.0	0.38	63.47
d140/200	140 x 12.7	114.6	200 x 5	8.71	19.02	10.31	25.0	0.47	100.88

d Nominal outer diameter of the PE pipe
d_i Nominal inside diameter of the pipe
D Nominal outside diameter of the outer PE jacket
e, e1 Nominal wall thickness

COOL-FIT 2.0 fittings

General

The media fitting and insulation used for COOL-FIT 2.0 fittings fulfill the same specifications as the COOL-FIT 2.0 pipe. The COOL-FIT 2.0 fittings are based on ELGEF electrofusion fittings, which have been in use successfully for years. They provide an easy and safe connection.

The pre-insulated COOL-FIT 2.0 fittings are available in two types:

Type A:

Electrofusion fitting with integrated resistance wires for direct electrofusion pipe-to-fitting connections.

90° elbow as an example

Type B:

Spigot fitting with free ends for pipe-to-fitting electrofusion with COOL-FIT 2.0 electrofusion fittings.

90° elbow as an example

Usefull functions - Fittings type A:

Fusion indicators

After welding, check whether there is wear to the fusion indicators. After the welding process, the indicator pin shows clearly that energy has been applied to the welding zone.

Sealing lip

The sealing lip can be used to check whether the insulation has been properly sealed. If they bulge after the fitting has been pushed up to the end stop on the pipe, the installation is correct. By labelling the lip end on the pipe any changes in position of the fitting can be monitored.

For direct fitting-to-fitting or fitting-to-valve connections, the sealing lip can be removed beforehand during electro-fusion fitting.

Label

The fittings have abrasion-resistant marking.

Trace code

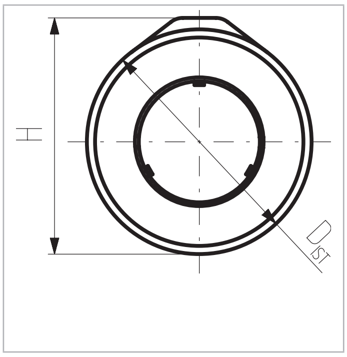
Relevant product data can be traced back to production via traceability codes.

Angle marking

By marking the ends of the fittings, connections between pipe and fittings can be optimally aligned.

All Type A fittings feature a dome surrounding the welding connectors. It tops the outer diameter of a fitting, thus increases the total height (H) of a fitting in this specific section. The outer diameter of a fitting (D_{Ist}) is slightly larger than the nominal outer diameter (D) of the system. See dimension table for Type A fittings:

d/D (mm)	D_{Ist} (mm)	H (mm)
32/75	82	87
40/90	97	99
50/90	97	105
63/110	117	123
75/125	132	139
90/140	147	154
110/160	168	177
140/200	208	208



d/D	Nominal inner- / outer diameter COOL-FIT 2.0 System
D_{Ist}	Effective outer diameter fitting Type A
H	Fitting height at welding connector section

Jointing

Pipe and Fitting

Type A fittings have integrated resistance wires, which are put under electric current during the welding operation through welding contacts on the fittings. This heats up the inside of the fitting and bonds the melting zone with the pipe.

Type B fittings feature non-insulated spigot ends. They are connected with electrofusion coupler to a pipe (see chapter below "components").

Fitting-to-fitting

Two COOL-FIT 2.0 fittings are usually connected by using a piece of COOL-FIT 2.0 pipe with free ends or a short piece of ecoFIT PE pipe and an insulation ring (e.g. ring removed with the foam removal tool). The shortest connection between two COOL-FIT 2.0 Type A fittings can be achieved by cutting off the sealing lips and using a barrel nipple and an adhesive ring for the vapor seal (see components).

Two COOL-FIT 2.0 Type B fittings can be joined using an electrofusion coupler (see components).

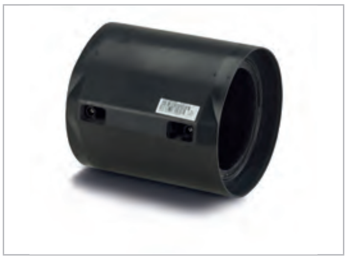
The connection of a COOL-FIT 2.0 fitting Type A and Type B is also possible.

Components

Fittings can be connected to either pipe or other fittings using the parts described below:

COOL-FIT 2.0 Electrofusion coupler

COOL-FIT 2.0 electrofusion couplers are used to connect pipe and components with free ends like type B fittings, valves and transition fittings.



COOL-FIT 2.0 Elbows 45° and 90°

(Refer to „General" chapter above)

COOL-FIT 2.0 T90 ° equal and COOL-FIT T90 ° reduced

The equal and reduced type A 90° tees have, like the coupler, resistance wires for electrofusion. The central outlets can be connected to the type A fitting, so all combinations are possible.

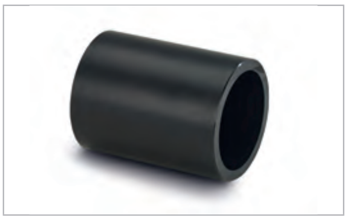
The type B fittings with free fusion spigots can be connected to all type A fittings.

COOL-FIT 2.0 reducer

The COOL-FIT 2.0 reducer can be used to reduce the flow of the starting size by up to three to four sizes (e.g. from d140 up to d63 or from d75 up to d32).

COOL-FIT 2.0 barrel nipple

COOL-FIT 2.0 barrel nipple serves as a compact direct connector for type A fittings.



Combination of T90° and Reducer

If a reduction step should be done after the branch of a T90°, either a COOL-FIT 2.0 T90° reduced, or a COOL-FIT 2.0 T90° reduced/ equal connected to a reducer should be used.

Branch \ Run	40	50	63	75	90	110	140
32	Δ	Δ	Δ	Δ	Δ	Δ	O
40		X	X	O	O	O	O
50			X	O	O	O	O
63				Δ	Δ	Δ	Δ
75					Δ	Δ	Δ
90						Δ	Δ
110							Δ

X T90°- equal + reducer
O T90°- reduced + reducer
Δ T90°- reduced

Accessories

Insulation for fusion contacts

Supplied with each fitting. Prevent formation of a cold bridge at the fusion contacts. Insulation parts can also serve as an indicator that a connection has been welded. (Install insulation after welding to show that the welding has been completed.)

Adhesive ring

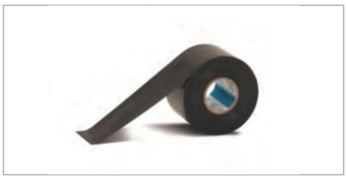
With a compact connection with a barrel nipple (fitting-to-fitting), this adhesive ring is used to ensure that the connection is water and vapor tight after the removal of the sealing lip.

Cement

For frontal bonding of the insulations of transition fittings and flexible hoses

Adhesive tape

Optional for covering hand-cut faces.



Y-Cable kit for COOL-FIT Fixpoints

Cuts the welding time by 50% and includes the required welding adapters.

Article no.: 790 156 032.

COOL-FIT 2.0 valves

COOL-FIT 2.0 valves are based on GF Standard plastic valves. The valves are supplied including GF-HE insulation shells with a protective PE jacket. The sealing faces between the shells and the valve are vapor tight by their design. No additional tape or sealant is required.

Releasable plastic bands for sizes d32DN25 – d63DN50 and metal straps with tension locks for sizes d75DN65 – d140DN125 permit the pre-insulated shells to be fitted to and removed from the valves easily, allowing easy maintenance.

The insulated ball valve in PVC-U is available in sizes d32DN25 – d90DN80, and the butterfly valve in sizes d110DN100 – d140DN125. Manual versions or such ISO 5211 interface are available. The interface is suitable for electric actuators from GF as well as for 3rd party actuators.

Interfaces:

F03 and F05 for ball valves d32DN25 – d63DN50

F07 for all ball- and butterfly valves d75DN65 – d90DN80

COOL-FIT 2.0 transition fittings, flange connectors

Transition fittings and flange connectors enable connections to different systems in either metal or plastic, such as the Georg Fischer systems iFIT or Sanipex MT. All listed components are supplied with insulation in NBR foam:

Thread type/connector/ pitch circle	Size	Material	Thread type/connector/ pitch circle
Transition fittings for metal*	d32 – d63 ½" – 2 ¾"	PE – stainless steel PE – brass	Male thread (R), Female thread (Rp), Loose union nut (G)
Transition fittings to iFIT or Sanipex MT*	d32 1"	Stainless steel Brass	iFIT, Sanipex MT
Union plastic - plastic*	d32 – d110 1" – 4 "	PE – PE, PE – ABS	Welding spigots Cementing socket
Adaptor union to metal*	d32 – d63 1" – 2 "	PE – stainless Steel	Internal thread (Rp), External thread (R)
Flange joints**	d32 – d140	PE	Bolt circle PN 10/16

* NBR foam insulation
** Insulation half shells similar to valve insulations

COOL-FIT 2.0 flex hoses

The flexible hose in EPDM with stainless stell protection permit mobile access to devices such as fancoils, compensating for expansion or contraction within the system. The tear-resistant protective tissue jacket and NBR insulation (19mm, $\lambda_{10°C} \leq 0.036$ W/mK) ensure the temperature of the cooling medium remains unchanged. Versatile connectivity options mean that system connection is ensured:
G thread (external thread + loose nut)

d (mm)	DN (mm)	Thread	Length (mm)	Max. compensation ΔL (mm)	R_{min} (min. bending radius) (mm)
20	15	½"	1000	276	119
25	20	¾"	1000	161	156
32	25	1"	1000	68	192
40	32	1 ¼"	1500	233	252
50	40	1 ½"	2000	396	312
63	50	2"	2000	233	372

COOL-FIT 2.0 Installation fittings type 313

Installation fittings are used to install various types of sensors to the system. Pressure or temperature sensors can be connected using the ½ "or ¾" Rp female thread.

The insulation is comprised of highly efficient GF-HE foam with excellent insulating capabilities.

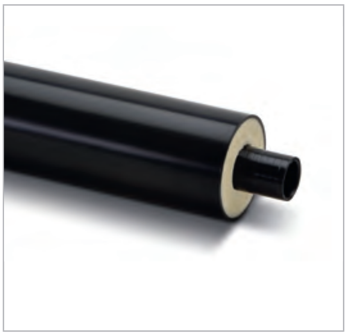
3.2 COOL-FIT 2.0F

COOL-FIT 2.0F pipe

COOL-FIT 2.0F inner pipe is made from PE100. The insulation made of highly efficient GF HE rigid foam has a thermal conductivity λ of 0.022 W/mK. The pipe is protected by the GF-FR fire retardant jacket.

All three materials are firmly bonded in order to ensure good insulation properties and low thermal expansion or contraction for the system.

The pipes are available in 5m legths and can be connected with all fittings from COOL-FIT 2.0.



Pipe size (mm)	Inner Pipe d x e (mm)	Inner Pipe d_i (mm)	Outer jacket D x e1 (mm)	Weight empty (kg/m)	Weight with water (kg/m)	Volume (l/m)	Insulation thickness (mm)	Heat transfer coefficient (U) (W/m K)	Fire load (kWh/m)
d32/75	32 x 2.9	26.2	75 x 1.8	1.06	1.60	0.54	19.7	0.16	7.54
d40/90	40 x 3.7	32.6	90 x 1.8	1.43	2.27	0.83	23.2	0.17	10.65
d50/90	50 x 4.6	40.8	90 x 1.8	1.60	2.91	1.31	18.2	0.23	13.01
d63/110	63 x 5.8	51.4	110 x 1.8	2.27	4.34	2.07	21.7	0.24	19.20
d75/125	75 x 6.8	61.4	125 x 1.8	2.88	5.84	2.96	23.2	0.26	25.29
d90/140	90 x 8.2	73.6	140 x 2.5	4.09	8.34	4.25	22.5	0.30	35.87
d110/160	110 x 10	90.0	160 x 2.5	5.39	11.76	6.36	22.5	0.36	49.65
d140/200	140 x 12.7	114.6	200 x 2.5	8.05	18.37	10.31	27.5	0.44	76.84

d — Nominal outer diameter of the PE pipe
d_i — Nominal inside diameter of the pipe
D — Nominal outside diameter of the outer PE jacket
e, e1 — Nominal wall thickness

3.3 COOL-FIT tools

Electrofusion Machines

Electrofusion machines are required to join COOL-FIT 2.0 components. The range includes dedicated and multipurpose electrofusion machines which are reliable and easy to use.

GF recommends: MSA-Series electrofusion machines.

Foam removal tool and peeling tool – manually operated

The foam removal tool is used to prepare shortened COOL-FIT 2.0 / 2.0F pipe for electrofusion. The tool removes the foam and cuts outer jacket, and also peels the surface of the inner pipe. Any oxide layer present is removed when the welding zone is treated.The tool is available in two versions:

1. for sizes d32 – d90,
2. for sizes d110 – d140.

Clamping tool

The fusion process gives rise to forces that can pull the pipe out of the coupler. Therefore it is recommended that the assembly should be fitted with COOL-FIT installation clamps. This prevents movement during the welding- and cool-down process.

The central hinge allows the use of the clamps on elbows and reducers. Depending on the length of the pipe, 2 or 4 of the glass-reinforced plastic holders can be used. The linkage is made of galvanized steel. Tension bands are included and a T-adapter is optional available.

4 Dimensioning and design

The following section describes only the COOL-FIT specific planning fundamentals. For prevailing information see general GF planning fundamentals.

4.1 General information about the dimensioning and installation of plastic piping

Plastics have different physical characteristics to metals. When designing and installing thermoplastic piping systems, this needs to be taken into account. Although PE and COOL-FIT 2.0 are very robust systems, care should be taken to avoid damage during handling and transportation.

For over 50 years, GF Piping Systems has developed and sold a variety of plastic piping systems which are subjected to very rigorous demands, such as optimized insulation properties in cooling applications. Experience has shown that plastic provides an economical and reliable alternative to metal when designers and installers take account of the recommendations in the technical documentation. In the professional production of plastic piping systems, for example, piping systems must be able to move to accommodate changes in length caused by temperature and pressure changes. To allow for these changes in length, the use of pipe holders that permit this movement is vital.

The following technical information contains the basic information needed to ensure an economical and trouble-free installation. However, this chapter does not contain all of the details. For more information, or if you have specific questions, please call your local GF Piping Systems representative. Additional information is available on the official GF Piping Systems website.

4.2 COOL-FIT 2.0 pressure-temperature diagram

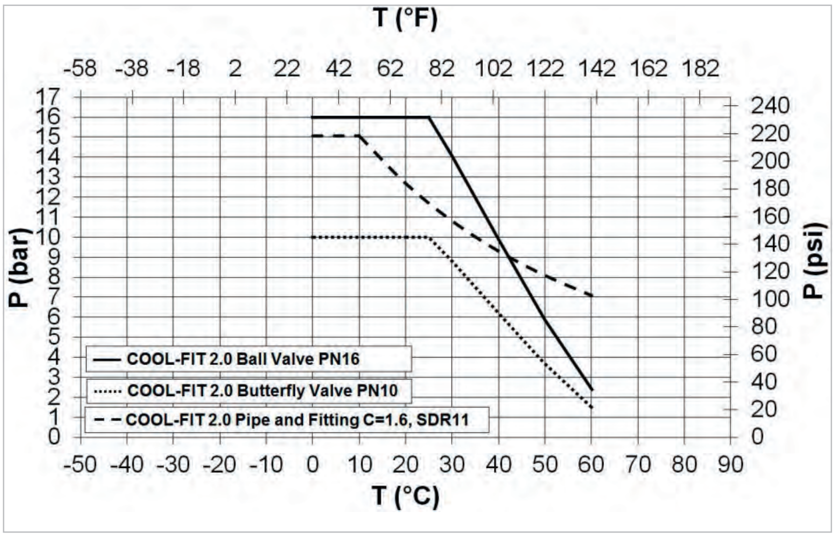
The pressure resistance for thermoplastic pipe for water is always specified at +20 °C. At higher temperatures allowance must be made for a lower maximum operating pressure.

The graph shows the maximum permissible pressure for COOL-FIT 2.0 pipe, fittings and valves at various temperatures, up to the maximum permissible media temperature of +60 °C. The table is based on an ambient temperature of +20 °C. A safety factor of 1.6 and a minimum lifespan of 25 years have been allowed for in all calculations.

The values given in this chapter apply to both COOL-FIT 2.0 and COOL-FIT 2.0F.

Pressure/temperature limits for COOL-FIT 2.0 fittings, pipe, valves – water coolant

Limits for COOL-FIT 2.0: 25-year values allowing for the safety factor (with water as the coolant).



P Allowable pressure (bar, psi)
T Temperature (°C, °F)
C Safety factor

The butterfly valves used for the COOL-FIT 2.0 system exhibit lower pressure-temperature ratings than the rest of the components. If valves are used, it is necessary to refer to the data in the diagram above.

Influence of secondary refrigerants with antifreeze additives

At ambient temperatures below 0 °C, antifreeze must be used in the water to prevent it from freezing during a plant shut-down.

COOL-FIT 2.0 is generally resistant to secondary coolants such as glycol and brines. For some secondary coolants a reduction factor is necessary depending on the type and mixing ratio. The permissible operating pressure is corrected downwards from the pressure-temperature curve for water.

Reduction factors[1]

Inorganic salt solutions	F = 1
Organic salt solutions	F = 1
Glycol solutions (max. 50 %)	F = 1.1

For the calculation, the following formula is used:

$$P_{AF} = \frac{P_W}{AF}$$

P_{AF} Permissible pressure with reduction factor
P_W Permissible pressure for water
AF Reduction factor

[1] valid for materials HD-PE, EPDM, PVC-U, metals

V

Glycol solutions

COOL-FIT 2.0 / 2.0F can be used with glycol solutions with concentrations up to 50%. The chemical resistance of COOL-FIT 2.0 systems is suitable for the following antifreeze types:

Brand name	Hersteller	Typ
Antifrogen N	Clariant	Ethylene glycol
Antifrogen L	Clariant	Propylene glycol
Showbrine Blue Showa standard EG brine	Showa Brine	Ethylene glycol
Showbrine Blue Showa trial EC brine	Showa Brine	Ethylene glycol
Tyfocor L	Tyfo	Propylene glycol
Tyfocor	Tyfo	Ethylene glycol
DOWFROST	DOW	Propylene glycol
Zytrec FC	Arteco	Propylene glycol
Zytrec LC	Arteco	Propylene glycol
Zytrec MC	Arteco	Propylene glycol
Neutrogel Neo	Climalife Dehon	Ethylene glycol
Friogel Neo	Climalife Dehon	Propylene glycol
DOWTHERM SR-1	DOW	Ethylene glycol

When using other coolants, compatibility with COOL-FIT 2.0 should be clarified with GF Piping Systems.

Example – glycol dissolved in water

For water-glycol mixture ≤ 50%, the reduction factor for the pressure-temperature diagram is 1.1. Thus, at +10 °C, with a minimum life of 25 years, the maximum allowable working pressure is reduced as follows:

$$P_{AF} = \frac{15\ \text{bar}}{1.1} = 13.6\ \text{bar}$$

Organic salt solutions

These media are usually potassium formates or potassium acetates: aqueous solutions with low viscosity at low temperatures. COOL-FIT 2.0 can be used with the media below. The manufacturer's instructions must be followed.

Brand name	Manufacturer	Type
Antifrogen KF	Clariant	Brine
Zytrec S-55	Frigol	Brine
Temper	Temper	Brine
Hycool	Addcon	Brine

For detailed information on resistance and reduction factors, see Planning Fundamentals "Material selection – Chemical resistance".

4.3 Polyethylene (PE)

The dominant material for the COOL-FIT 2.0 / 2.0F system is polyethylene (PE). As the inner pipe which comes into contact with the media is made of PE-100, its properties are of particularly high relevance.

Properties of PE (approximate)

Property	PE 100-value[1]	Unit	Testing standard
Density	0.95	g/cm^3	EN ISO 1183-1
Yield stress at 23 ° C	25	N/mm^2	EN ISO 527-1
Tensile modulus at 23 ° C	900	N/mm^2	EN ISO 527-1
Charpy notched impact strength at 23 ° C	83	kJ/m^2	EN ISO 179-1/1eA
Charpy notched impact strength at -40 ° C	13	kJ/m^2	EN ISO 179-1/1eA
Crystallite melting point	130	°C	DIN 51007
Thermal conductivity at 23 ° C	0.38	W/m K	EN 12664
Water absorption at 23 ° C	0.01 - 0.04	%	EN ISO 62
Color	9,005	-	RAL
Oxygen Index (LOI)	17.4	%	4589-1

1 Typical, measured on material characteristics, should not be used for calculations.

General information

All polymers made from hydrocarbons of the formula C_nH_{2n} are constructed with a double bond (ethylene, propylene, butene-1, isobutene) are referred to collectively as polyolefins. Among them is polyethylene (PE). It is a semi-crystalline thermoplastic. Polyethylene is probably the best known plastic. The chemical formula is: $-(CH_2-CH_2)n$. Polyethylene is an environmentally friendly hydrocarbon product. PE, like (PP), is a non-polar material. Therefore, it is insoluble and scarcely swellable in conventional solvents. PE pipe cannot therefore be adhesively bonded to fittings. Welding is the appropriate connection method for the material.

In industrial piping, high molecular weight types have resulted in medium to high density. The types are classified by their creep rupture strength into PE80 (MRS 8 MPa) and PE100 (MRS 10 MPa). The latter are also called 3rd generation types of PE, while PE80 types are primarily associated with the 2nd generation. There are barely any first generation PE types – PE63 under the modern classification – remaining on the market. Creep rupture strength has been tested by long-term tests as per ISO 1167, and calculated in accordance with ISO 9080. The most widespread in piping system construction is PE for use in underground gas and water pipe. In this area polyethylene has become the dominant material in many countries. However, the advantages of this material mean that it is also used in domestic installations and industrial piping.

Advantages of PE

- Light weight
- Excellent flexibility
- Good wear resistance (abrasion resistance)
- Corrosion resistance
- Ductile fracture properties
- High impact strength even at very low temperatures
- Very good chemical resistance
- Weldable

Mechanical properties, chemicals, weathering and abrasion resistance

Chemical resistance

Polyethylene exhibits good resistance to a wide range of media. For detailed information, please see the detailed chemical resistance list from GF Piping Systems, or contact the person responsible at GF Piping Systems directly.

Abrasion resistance

PE has excellent resistance to abrasive wear. You can therefore find PE piping systems in use in numerous applications for transporting solids and media containing solids. For many applications, PE has proven especially advantageous with metals.

Thermal properties and electrical properties

Operating limits

The application limits of the material depend on both embrittlement and softening temperatures and on the manner and method of application. Details are provided in the relevant pressure-temperature charts.

Electrical properties

Polyethylene, like most thermoplastics, is non-conductive. This means that systems in PE do not suffer from electrolytic corrosion. However, the non-conductive properties must be taken into consideration, as electrostatic charges can build up in the pipe. Polyethylene has good electrical insulation properties. The volume resistance is 3.5 x 10^{16} Ωcm, the surface resistance 101^{3} Ω. This must be taken into account in applications where there is danger of fire or explosion.

4.4 Fire behavior and fire prevention measures

Firestop classes

Classification of fire behavior

Construction materials are classified into different firestop classes depending on their fire behavior. The classification is decisive for whether specific materials may be legally used for construction in certain areas of construction projects.

European classification according to EN 13501-1

In the year 2001, the EN 13501-1 was introduced, a European classification system for construction materials. EN 13501-1 defines 6 construction material classes from A to F:

A	No contribution to the development of a fire (A1, A2)
B	Very little contribution to the development of a fire
C	Limited contribution to the development of a fire
D	Acceptable contribution to the development of a fire
E	Acceptable fire behavior
F	No performance criteria detected

In addition to the fire behavior, the European standard also rates fire side effects: smoke release (s1, s2, s3) and burning droplets (d0, d1, d2).

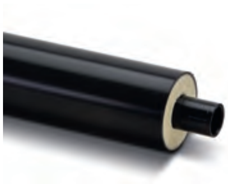
Smoke release:

s1	limited smoke release
s2	average smoke release
s3	high smoke release, or smoke release not tested

Burning droplets:

d0	no burning droplets/fall off within 600 seconds
d1	no burning droplets/fall off with an afterglow time of more than 10 seconds within 600 seconds
d2	No performance criteria detected

Fire prevention classes EN13501-1, VKF and British building codes

	COOL-FIT 2.0	COOL-FIT 2.0F	COOL-FIT 2.0/ mineral wool [2]
			
EN 13501-1	E	B – s2, d0	$A2_L$
VKF	RF3*	RF2	RF1
BS 5422:2009[1]	National Class 3	-	National Class 0

[1] Test method according to BS 476-6 and BS 476-7
[2] Type: Rockwool 800
* d32 + d140 and COOL-FIT 4.0 d >= d160mm

V

Thermal load

The thermal load corresponds to a thermal potential (energy release) related to a specific base area, fire section area in m^2, for example an escape route. The physical unit for the thermal load is energy per surface area kWh/m^2. The calculative thermal load is equivalent to the sum of the different thermal potentials of all used combustible used elements, such as pipelines. When the energy released per running meter of the pipe (kWh/m) is known, the thermal load of the pipe is calculated from the used pipe length.

d/D (mm)	32/75	40/90	50/90	63/110	75/125	90/140	110/160	140/200
Thermal load COOL-FIT 2.0 pipes (kWh/m)	12.02	15.97	18.43	29.38	36.84	46.93	62.32	99.14

d/D (mm)	32/75	40/90	50/90	63/110	75/125	90/140	110/160	140/200
Thermal load COOL-FIT 2.0F pipes (kWh/m)	7.54	10.65	13.01	19.20	25.29	35.87	49.65	76.84

Fire resistance of components

While the fire behavior characterizes individual materials, the fire resistance must be considered for entire assemblies, for example a solid wall with pipe penetrations. The fire resistance is equivalent to the amount of time in which a component maintains its function during a standard fire.

The European system allows classification according to different criteria, stating the respective fire resistance duration in minutes.

Fire resistance and classification according to the European standards

Pipe insulation systems are exposed to a standard fire according to EN 1363-3. Classification is according to EN 13501-2 and generally includes the criteria integrity (E, Étanchéité) and thermal insulation (I, Insulation).

Abbreviation	Criterion	Rating
E – Étanchéité	Flame protection or integrity	Measurement of an element's capacity of preventing the passage of gases and flames in case of fire.
I – Insulation	Insulation or thermal insulation	Measurement of the insulation capacity of an element, i.e. the duration in which the side of the element facing away from the fire does not exceed 180° C + the ambient temperature.

Firestop collars/Fire sealing

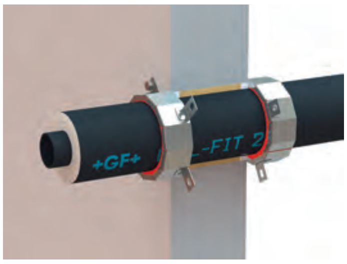
When pipes are installed through fire-rated assemblies, whose reliable functioning must not be affected, firestop collars that comply with local requirements and legislation must be used.

Hilti firestop

System description

The firestop collar (inlc.fastening hook) is made of galvanized steel sheet into which strips of intumescent material (i.e. that swells in case of fire) are inserted.

The fire retardation sealing with straight pipes is regulated in conjunction with the following products in the individual countries:



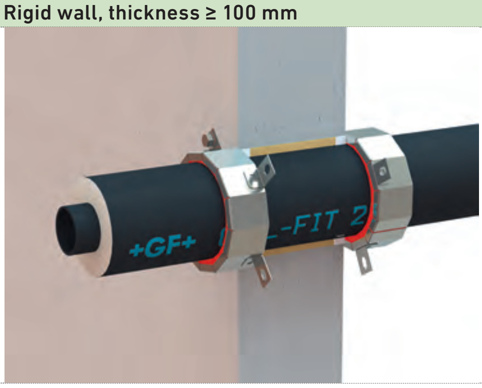
Product	Proof of applicability	Countries
Hilti firestop collar CP 644	Allgemeine Bauartgenehmigung (aBg) Z-19.53-2330	DE
Hilti firestop collar CP 644	VKF Technische Auskunft 14108	CH
Hilti firestop collar CFS-C P	ETA-10/0404	EU

The respective details of the proofs of application must be taken into account.

Additional information is available at Hilti online or from your Hilti contact person.

Hilti CP 644	Hilti CFS-C P
Info | Shop qr.hilti.com/r3069	Info | Shop qr.hilti.com/r4831

The following applications are regulated via the above proofs of application:

Rigid wall, thickness ≥ 100 mm	Rigid floor, thickness ≥ 150 mm
	

Fire-retarding sealing

COOL-FIT 2.0 pipes up to and including an outside diameter D of 200mm, can be sealed in rigid walls and rigid floors by a Hilti firestop collar.

Rigid wall ≥ 100mm solid		Product DE, CH	Product EU	Fire resistance	Mounting
d (mm)	**D (mm)**	**CP 644**	**CFS-C P**		**Number of hooks**
32	75	CP 644-75/2.5"	CFS-C P 75/2.5"	EI 120-U/C	3
40	90	CP 644-90/3"	CFS-C P 90/3"	EI 120-U/C	3
50	90	CP 644-90/3"	CFS-C P 90/3"	EI 120-U/C	3
63	110	CP 644-110/4"	CFS-C P 110/4"	EI 120-U/C	4
75	125	CP 644-125/5"	CFS-C P 125/5"	EI 120-U/C	4
90	140	CP 644-160/6"	CFS-C P 160/6"	EI 120-U/C	6
110	160	CP 644-160/6"	CFS-C P 160/6"	EI 90-U/C	6
140	200	CP 644-200/8"	CFS-C P 200/8"	EI 120-U/C*	8

Rigid floor ≥ 150mm solid		Product DE, CH	Product EU	Fire resistance	Mounting
d (mm)	**D (mm)**	**CP 644**	**CFS-C P**		**Number of hooks**
32	75	CP 644-75/2.5"	CFS-C P 75/2.5"	EI 120-U/C	3
40	90	CP 644-90/3"	CFS-C P 90/3"	EI 120-U/C	3
50	90	CP 644-90/3"	CFS-C P 90/3"	EI 120-U/C	3
63	110	CP 644-110/4"	CFS-C P 110/4"	EI 120-U/C	4
75	125	CP 644-125/5"	CFS-C P 125/5"	EI 90-U/C	4
90	140	CP 644-160/6"	CFS-C P 160/6"	EI 120-U/C	6
110	160	CP 644-160/6"	CFS-C P 160/6"	EI 120-U/C	6
140	200	CP 644-200/8"	CFS-C P 200/8"	EI 60-U/C*	8

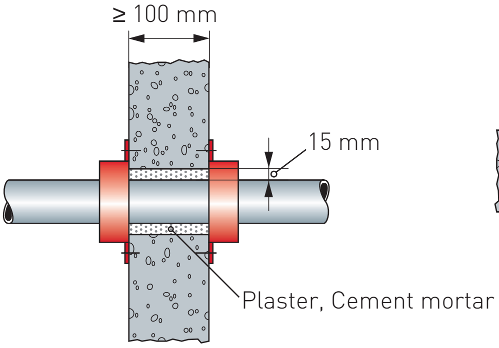
* here exclusively gap sealing with non-combustible construction materials

Annular gap sealing

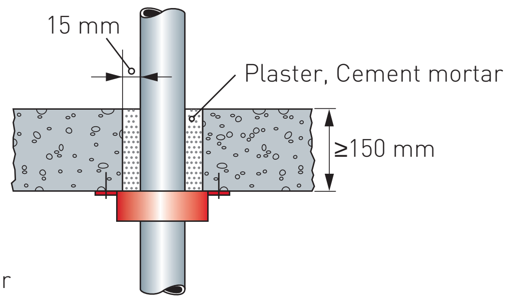
For the installation situations there are several options for sealing gaps against smoke gas.

Gap sealing with non-combustible construction materials:

Rigid wall

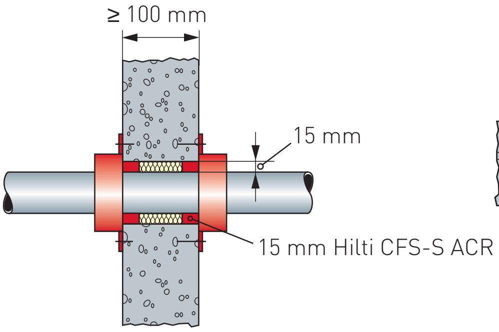


Rigid floor

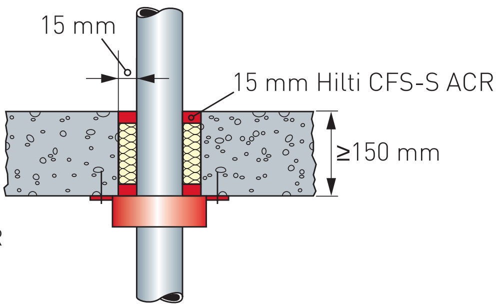


Joint closure with Hilti firestop sealant CFS-S ACR and mineral wool backfill up to 15mm annular gap width for Hilti firestop collar CP 644 and CFS-C P.

Rigid wall



Rigid floor

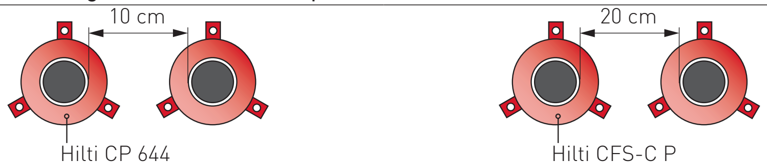


Distance regulations

The distance of the component openings to be closed to other openings or installed elements must comply with the data provided in the following table.

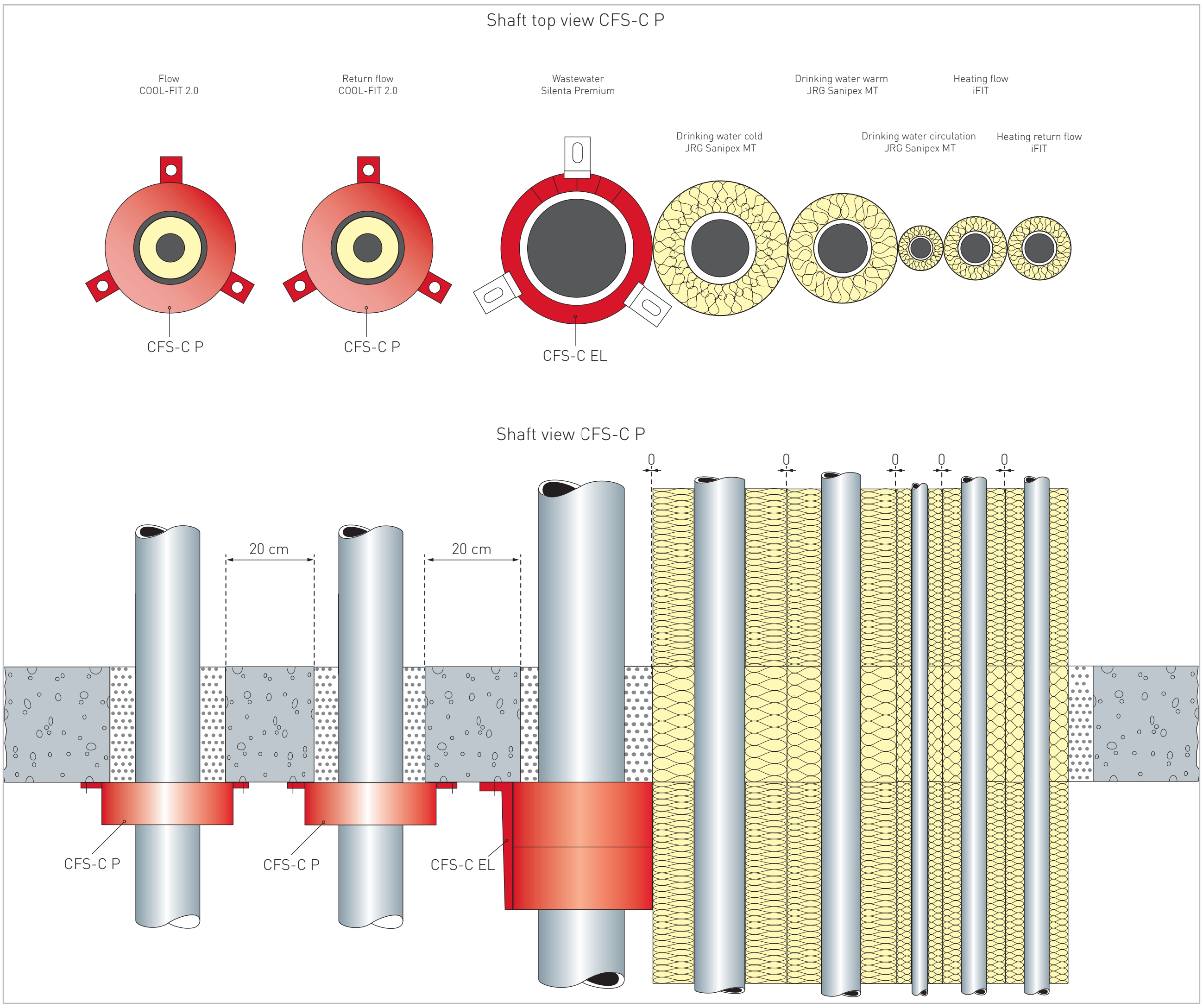
Distance of the pipe sealing to	Size of the adjacent openings	Distance between the openings DE, CH	Distance between the openings EU
Other cable or pipe sealing	one/both openings > 40cm x 40cm	≥ 20cm	≥ 20cm
	Both openings ≤ 40cm	≥ 10cm	
Other openings or installed elements	one/both openings > 20cm x 20cm	≥ 20cm	≥ 20cm
	Both openings ≤ 20cm	≥ 10cm	

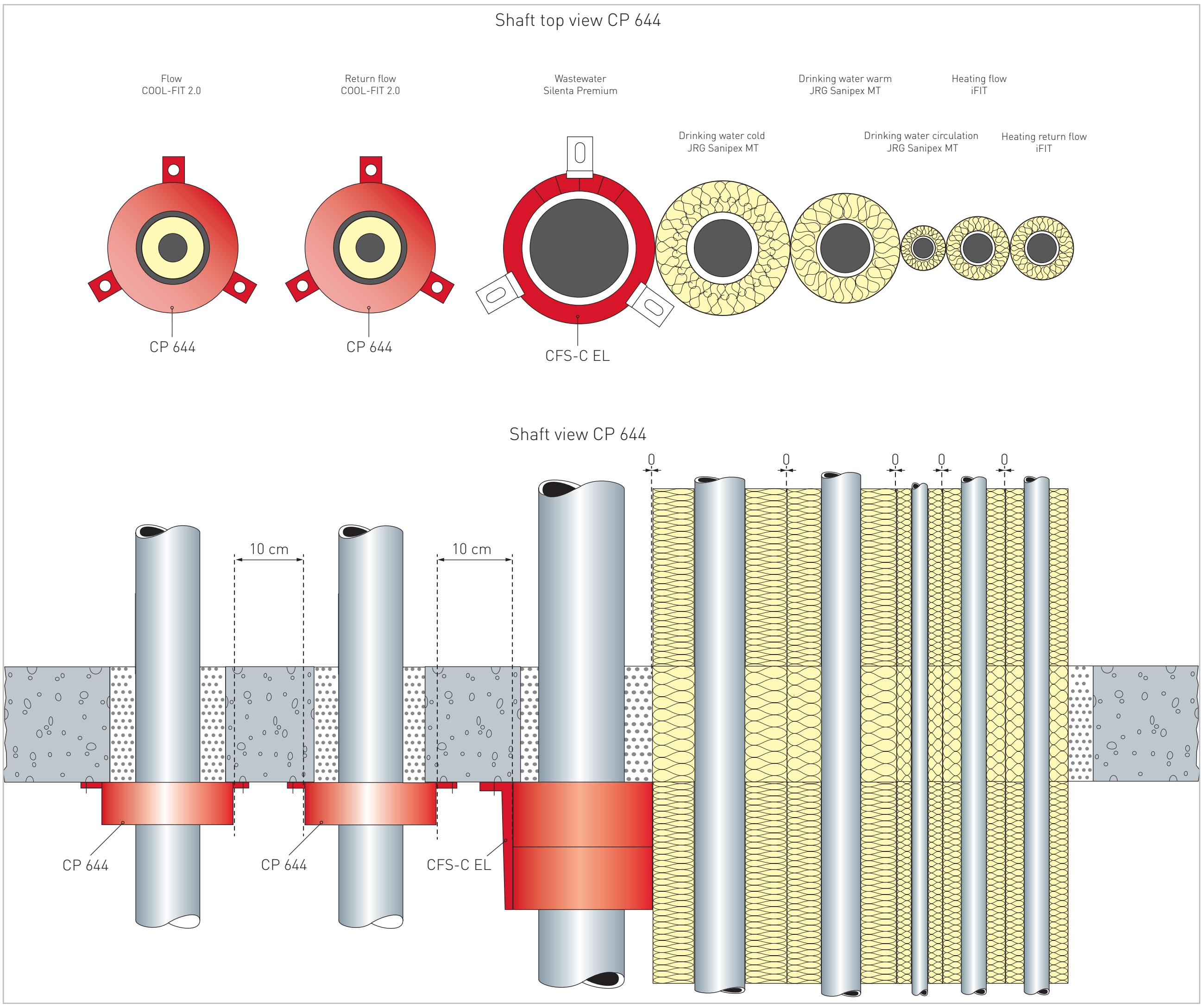
The following pipe distances between the openings of the pipe lead through are derived from this for pipe sealing with the Hilti firestop collar for COOL-FIT 2.0:



Shaft installation

A shaft installation with additional pipelines, for example for heating and drinking water, may look as follows:




Shaft top view CP 644
Flow
COOL-FIT 2.0
Return flow
COOL-FIT 2.0
Wastewater
Silenta Premium
Drinking water warm
JRG Sanipex MT
Heating flow
iFIT
Drinking water cold
JRG Sanipex MT
Drinking water circulation
JRG Sanipex MT
Heating return flow
iFIT
CP 644
CP 644
CFS-C EL
Shaft view CP 644
0
0
0
0
0
10 cm
10 cm
CP 644
CP 644
CFS-C EL

Additional tested fire-retarding sealing

The following firestop collars were tested with COOL-FIT 2.0/2.0F pipes.

Fire-retarding sealing	Manufacturer	Approval
ROKU ® AWM II	Rolf Kuhn GmbH	ETA 17/0753
BIS Pacifyre ® AWM II	Walraven	ETA 17/0753

The firestop system ROKU® R – type AWM II carries the European technical approval ETA 17/0753. COOL-FIT 2.0/2.0F was tested with AWM II firestop collars.

For detailed product information on AWM II see www.kuhnbrandschutz.com.

ROKU® System AWM II

System description

The ROKU® system AWM II consists of a firestop collar housing, which is equipped on the inside with several layers of the highly effective intumescent material "ROKU® Strip." In case of fire, the foaming material reacts with a strong foaming pressure and permanently seals the construction component opening against fire and smoke. On walls, one collar should be fitted on each side, and on ceilings only one collar underneath the ceiling.

Application areas

- Sealing of plastic pipes up to Ø 400 mm in solid walls, light partition walls, and solid ceilings
- For plastic pipes, mineral fiber-reinforced plastics, plastic composite pipes
- Suitable for insulated and non-insulated plastic pipes and acoustically insulating sewage pipes

Solutions for emergency corridors

Within emergency corridors the use of only non-combustible materials is allowed. The supplier Rockwool offers with Rockwool 800 a protection sleeve, made of mineral wool, which allows the use of normal combustible pipe within emergency areas. This solution is approved on pipe outer diameters of up to 160 mm.

For detailed information about Rockwool 800 see: www.rockwool.de.

4.5 Hydraulic design

Determination of pipe diameter based on flow rate

As a first approximation, the required pipe cross-section for a certain flow rate can be calculated using the following formula

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

v	flow velocity (m/s)
di	Pipe internal diameter (mm)
Q_1	Flow rate (m^3/h)
Q_2	Flow rate (l/s)
18.8	Conversion factor for units Q_1 (m^3/h)
35.7	Conversion factor for units Q_2 (l/s)

Example calculation of an internal diameter d_i

COOL-FIT 2.0 pipe	SDR11
Flow rate Q_2	8 l/s
Usual flow velocity v	1.5 m/s

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

A pipe with d90/d140 is used. After the internal diameter has been determined that way, the actual flow rate is determined with the following formula:

$$v = 354 \cdot \frac{Q_1}{d_i^2} = 1.9 \frac{m}{s} \quad \text{or} \quad v = 1275 \cdot \frac{Q_2}{d_i^2} = 1.9 \frac{m}{s}$$

v	Flow velocity v (m/s)
d_i	Pipe internal diameter (mm)
Q_1	Flow rate (m^3/h)
Q_2	Flow rate (l/s)
354	Conversion factor for units Q_1 (m^3/h)
1275	Conversion factor for units Q_2 (l/s)

Determination of pipe diameter based on cooling capacity (kW)

As a first approximation, the required pipe cross section for a certain cooling capacity can be calculated using the following formula.

$$di = 18.8 \cdot \sqrt{\frac{\left(\frac{Q_L \cdot 3600}{\Delta T \cdot c \cdot \rho}\right)}{v}}$$

di	Pipe inner diameter (mm)
Q_L	Cooling capacity in kW
ΔT	Temperature difference supply - return (K)
c	Specific heat capacity (kW*s/(kg*K))
ρ	Density of the medium (kg/m^3)
v	Flow velocity (m/s)

Example for calculating the inner diameter di based on cooling capacity with water medium water

Cooling capacity Q_L	200 kW
Specific heat capacity (20 °C) c	4.187 kJ/(kg*K)
Water density (20 °C) ρ	998.2 kg/m³
Temperature difference ΔT	10 K
Flow velocity v	1.5 m/s

$$di = 18.8 \cdot \sqrt{\frac{\left(\frac{200 \cdot 3600}{10 \cdot 4.187 \cdot 998.2}\right)}{1.5}} = 18.8 \cdot \sqrt{\frac{17.227}{1.5}} = 63.71 \text{ mm}$$

The flow rate should be estimated on the basis of the intended purpose of the pipe. As a guide for the flow rate, the following specifications apply.

Liquids

v = 0.5 – 1.0 m/s for the suction side

v = 1.0 – 3.0 m/s for the pressure side

Gases

v = 10 – 30 m/s

This method of calculation of pipe diameter does not allow for hydraulic losses. They must be calculated separately. The following sections serve that purpose.

Conversion table with units of flow rate.

(m^3/h)	(l/min)	(l/s)	(m^3/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	60 000	1000	1.0

Correlation of outer diameter - inner diameter

To determine the outer diameter based on the internal diameter and SDR, the following formula can be used:

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

Correlation between pipe external and internal diameter

d_i (mm)	16	20	26	33	41	52	61	74	90	102	115
d (mm)	20	25	32	40	50	63	75	90	110	125	140

V

4.6 Nomogram for easy calculation of diameter and pressure loss

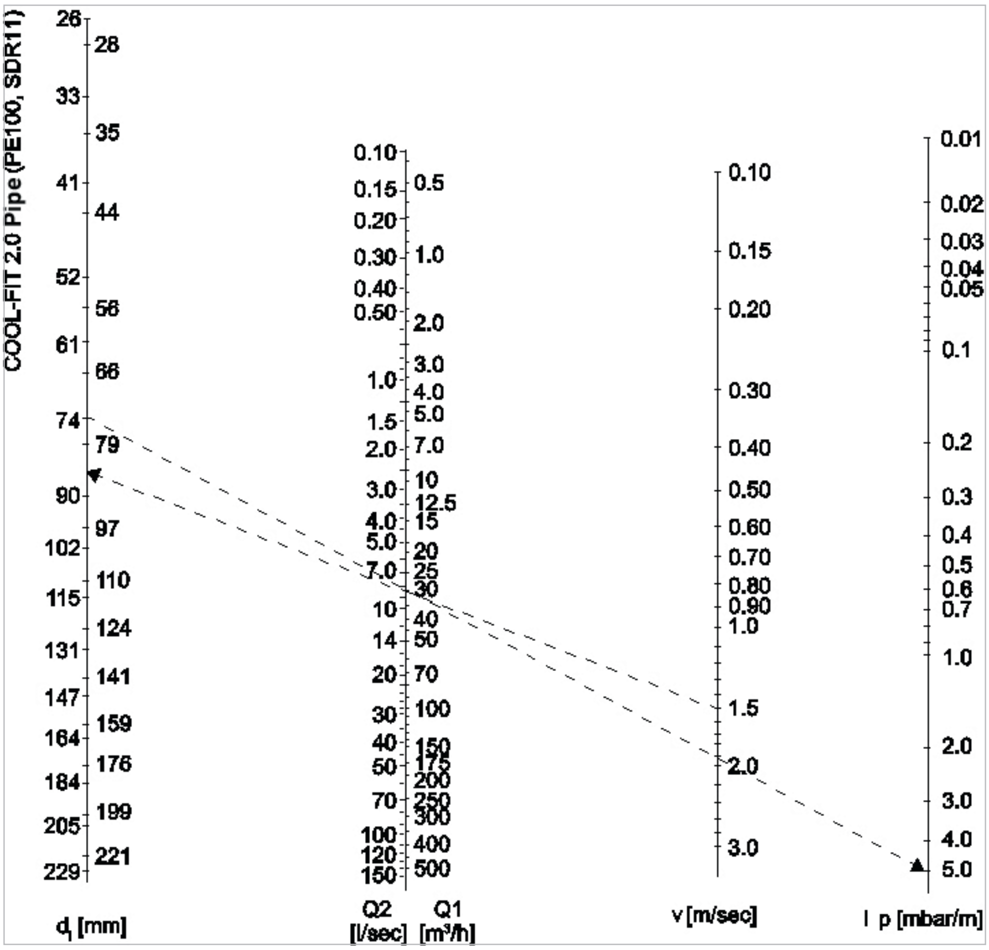
The nomogram below can be used to simplify the determination of the diameter required .The pressure loss in the pipe can be read off per meter of the pipe length.

⚠ **The pressure loss calculated using the nomogram only applies to flows of substances with density 1000 kg/m^3, i.e. water. Further pressure losses from fittings, valves, etc. also need to be considered using the instructions that follow.**

Using the nomogram

Based on a flow velocity of 1.5 m/s, a line is drawn through the desired flow rate (i.e. 30 m^3/h) to the axis which shows an internal diameter di (≈ 84 mm). Here, a closely matching diameter (74 mm for SDR11) and a second line is drawn back through the desired flow rate to the pressure drop axis Δp (5 mbar per meter of pipe).

Nomogram for COOL-FIT 2.0 pipe (PE, SDR11) using the metric system.



ℹ **For detailed information on the determination of diameter and pressure loss, see Planning Fundamentals "Hydraulic calculation and pressure losses of metric industrial piping systems".**

4.7 Pressure loss

Pressure loss in straight pipe

In determining pressure losses in straight pipe sections, a distinction is made between laminar and turbulent flows. The Reynolds number (Re) determines this. The change from laminar to turbulent occurs at the critical Reynolds number $Re_{crit} = 2320$.

In practice laminar flows occur particularly for the movement of viscous liquids such as lubricating oils. In most applications, thus including flows of aqueous materials, there is turbulent flow with a substantially more uniform velocity distribution over the pipe cross-section than in laminar flow.

The pressure loss in a straight pipe section is inversely proportional to the pipe diameter and is calculated as follows:

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

ΔpR	Pressure loss in the straight pipe run (bar)
λ	Pipe friction factor = 0.02
L	Length of the straight pipe section (m)
d_i	Inner diameter of the pipe (mm)
ρ	Density of the flow material (kg/m^3) ($1\ g/cm^3 = 1000\ kg/m^3$)
v	Flow velocity v (m/s)

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.

Pressure losses 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 coefficient of

resistance (ζ-value) is used for calculations.

Fitting type	Coefficient of resistance ζ	
Elbow 90°	1.2	
Elbow 45°	0.3	
T-90 ° [1)]	1.3	
Reducer (contraction)	0.5	
Reducer (enlargement)	1.0	
Connections (couplers, unions, flanges)	d20: 1.0 d25: 0.9 d32: 0.8 d40: 0.7	d50: 0.6 d63: 0.4 d75: 0.3 d90: 0.1 >d90: 0.1
Flexible hoses	½": 2.0 ¾": 1.8 1": 1.4	1 ¼": 1.1 1 ½": 1.0 2": 0.8

1) For a more detailed view, differentiate between coalescence and separation. Values for z 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.

V

Calculation of the pressure loss

Formulas for calculating pressure losses

To calculate the total pressure loss in all fittings in a piping system, 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:

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

Δp_{Fi}	Pressure loss of all fittings (bar)
$\Sigma\zeta$	Sum of all individual losses
v	Flow velocity v (m/s)
ρ	Density of the medium in kg/m³ (1 g/cm³ = 1000 kg/m³)

L laid pipe length

Pressure losses 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. It is defined as the flow rate of water in liters per minute with a pressure drop of 1 bar across the valve. The technical data of the Georg Fischer Piping Systems valves contains the k_v values as well as pressure loss charts. 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:

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

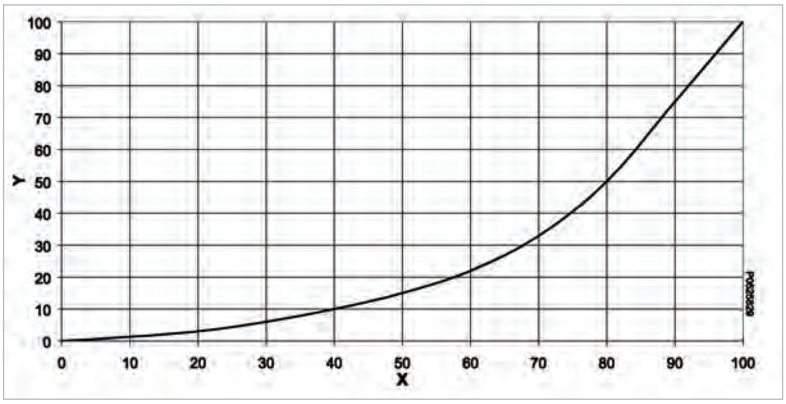
Δp_{Ar}	Pressure loss for the valve (bar)
Q	Flow rate (m³/h)
ρ	Density of the conveyed medium (kg/m³) (1 g/cc = 1000 kg/m³)
k_v	Valve characteristic value (m³/h)

k_v 100-Werte

DN (mm)	Zoll (inch)	d (mm)	k_v 100 (l/min)	Cv 100 (gal/min)	k_v 100 (m³/h)
25[1]	1	32	700	49.0	42
32[1]	1 ¼	40	1000	70.0	60
40[1]	1 ½	50	1600	112.0	96
50[1]	2	63	3100	217.1	186
65[1]	2 ½	75	5000	350.0	300
80[1]	3	90	7000	490.0	420
100[2]	4	110	6500	455	390
125[2]	5	140	8600	602	516

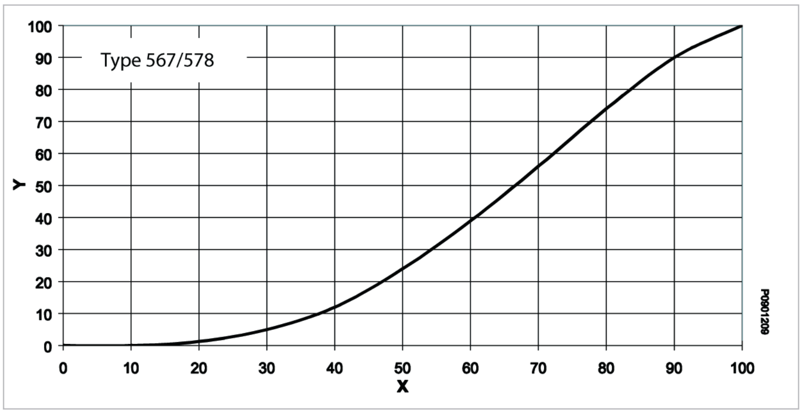
[1] COOL-FIT 2.0 Ball valve
[2] COOL-FIT 2.0 Butterfly valve

Flow characteristic Ball valve



X Opening angle (%)
Y k_v, Cv value (%)

Flow characteristic butterfly valve



X Opening angle (%)
Y k_v, Cv value (%)

Pressure difference between the static pressure

If the piping system is installed vertically, then a geodetic pressure difference must be calculated for it. This pressure difference is calculated as follows:

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

Δp_{geod}	Geodetic pressure difference (bar)
ΔH_{geod}	Difference in elevation of the piping system (m)
ρ	Density of the medium (kg/m^3) (1 g/cm^3 = 1000 kg/m^3)

At closed systems, the geodetic pressure difference does not need to be considered

Sum of pressure losses

The sum of all pressure drops for a piping system is calculated as follows:

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

Example for pressure drop calculations

The following example illustrates the calculation process for determining the pressure loss of a piping system.

		Number of Fittings
COOL-FIT 2.0 pipe	d40 mm	12 x 90° angle
SDR11 – flow rate	1.5 l/s	4 x 45° angle
Medium	Wasser	3 x T-piece
Density of the medium	1.0 g/cm^3	3 x screws
Length straight pipe	15 m	2 x flange connections
Height difference	2.0 m	1 x ball valve, 80 % opened

The wall thickness of the piping system can be calculated as follows with the SDR:

$$e = \frac{d}{SDR} = \frac{40\ mm}{11} = 3.6\ mm$$

The inner diameter of the piping system is as follows:

$$d_i = d - 2 \cdot e = d - \frac{2 \cdot d}{SDR} = 32.8\ mm$$

With the desired flow rate of 1.5 l/s, the flow velocity is as follows:

$$v = 1275 \cdot \frac{Q_2}{d_i^2} = 1275 \cdot \frac{1.5}{32.8^2} \frac{m}{sec} = 1.78 \frac{m}{sec}$$

Pressure loss	Formula
Pressure loss for straight pipe sections	$\Delta p_R = 0.02 \cdot \frac{15}{32.8} \cdot \frac{1000}{2 \cdot 10^2} 1.78^2 = 0.14$ bar
Pressure loss for fittings incl. connections	$\Sigma\zeta = (12 \cdot 1.2) + (4 \cdot 0.3) + (3 \cdot 1.3) + (5 \cdot 0.7) = 23$
	$\Delta p_{Fi} = 23 \cdot \frac{1.78^2}{2 \cdot 10^5} \cdot 1000 = 0.36$ bar
Pressure loss for the valve 80 % opened. With the flow characteristics diagram for ball valves type 546, from an 80% open angle a percentile kv value of 50 % can be read out, that means 50 % of the kv value 100: 0.5 * 60 m^3/ h (flow rate 1.5 l/s = 5.4 m^3/h)	$\Delta p_{Ar} = \left(\frac{5.4}{0.5 \cdot 60}\right)^2 \cdot \frac{1000}{1000} = 0.03$ bar
Pressure loss of height difference	$\Delta p_{geod} = 2.0 \cdot 1000 \cdot 10^{-4} = 0.2$ bar
Whole pressure loss of the piping	$\Sigma\Delta p = 0.14$ bar + 0.36 bar + 0.03 bar + 0.2 bar = 0.73 bar

4.8 Dimension comparison COOL-FIT 2.0 / 2.0F vs metal

COOL-FIT 2.0 / 2.0F			Stainless steel		Copper pipe
d (mm)	d_i (mm)	DN	Inch	da (mm	da (mm)
32	26.3	25	1	33.4	28
40	32.6	32	1¼	42.2	35
50	40.8	40	1½	48.3	42
63	51.4	50	2	60.3	54
75	61.4	65	2½	73.0	76.1
90	73.6	80	3	88.9	88.9
110	90.0	100	4	114.3	108
140	114.6	125	5	141.3	-

d Nominal external diameter of PE pipe
d_i Nominal internal diameter of pipe

4.9 Z-dimension method

Overview

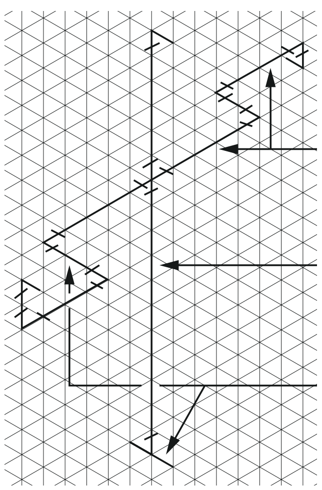
The pressure of competition and high costs on site makes it essential to install piping system systems efficiently. The GF Piping

Systems method of assembly is highly suited to this task. It replaces the tedious and time-consuming cutting to size of one pipe at a time by a fast and precise way of preparing whole groups of pipe according to plans or jigs.

The respective pipe group with the corresponding design dimensions and cut lengths can be entered in the isometric paper of GF Piping Systems.

Please adhere to the following guidelines for drawing:

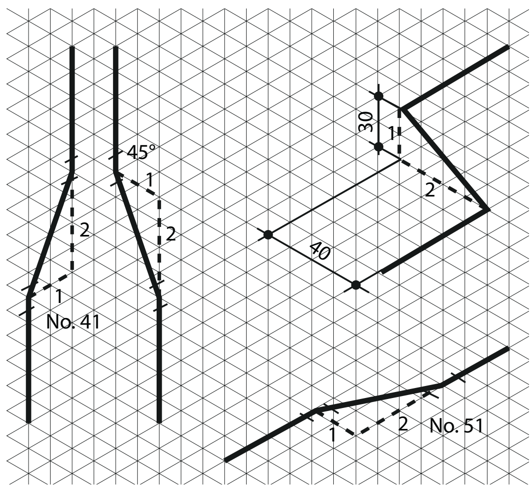
Pipe running perpendicular to one another	Pipe running diagonally



Horizontally: left and right

Vertical

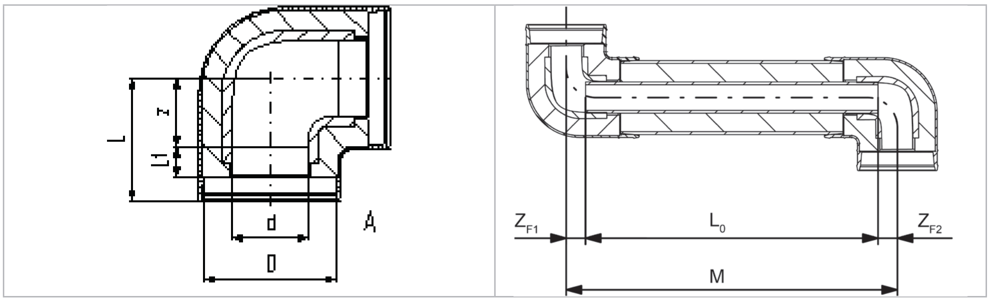
Horizontally: front and rear



The z-dimensions of the fittings are needed for determining the actual cutting lengths of the pipe. The tables in our product ranges and in the online catalogues contain all the relevant data for the fittings. The length of pipe to be cut is given as in the following diagram by the distance between the center of adjoining fittings less the sum of the z-dimension of the fittings.

Procedure

Electrofusion



Formula for determining the required pipe length

$L_0 = M - Z_{F1} - Z_{F2}$

L_0 Pipe length to be cut
M Center to center distance between fittings
z_{F1} z-measurement for fitting 1
z_{F2} z-measurement for fitting 2

Example

Dimension	d32/D75
Center to center distance M	1000 mm
z measurement for 90° elbow z_{F1}	20 mm
z measurement for 90° elbow z_{F2}	20 mm

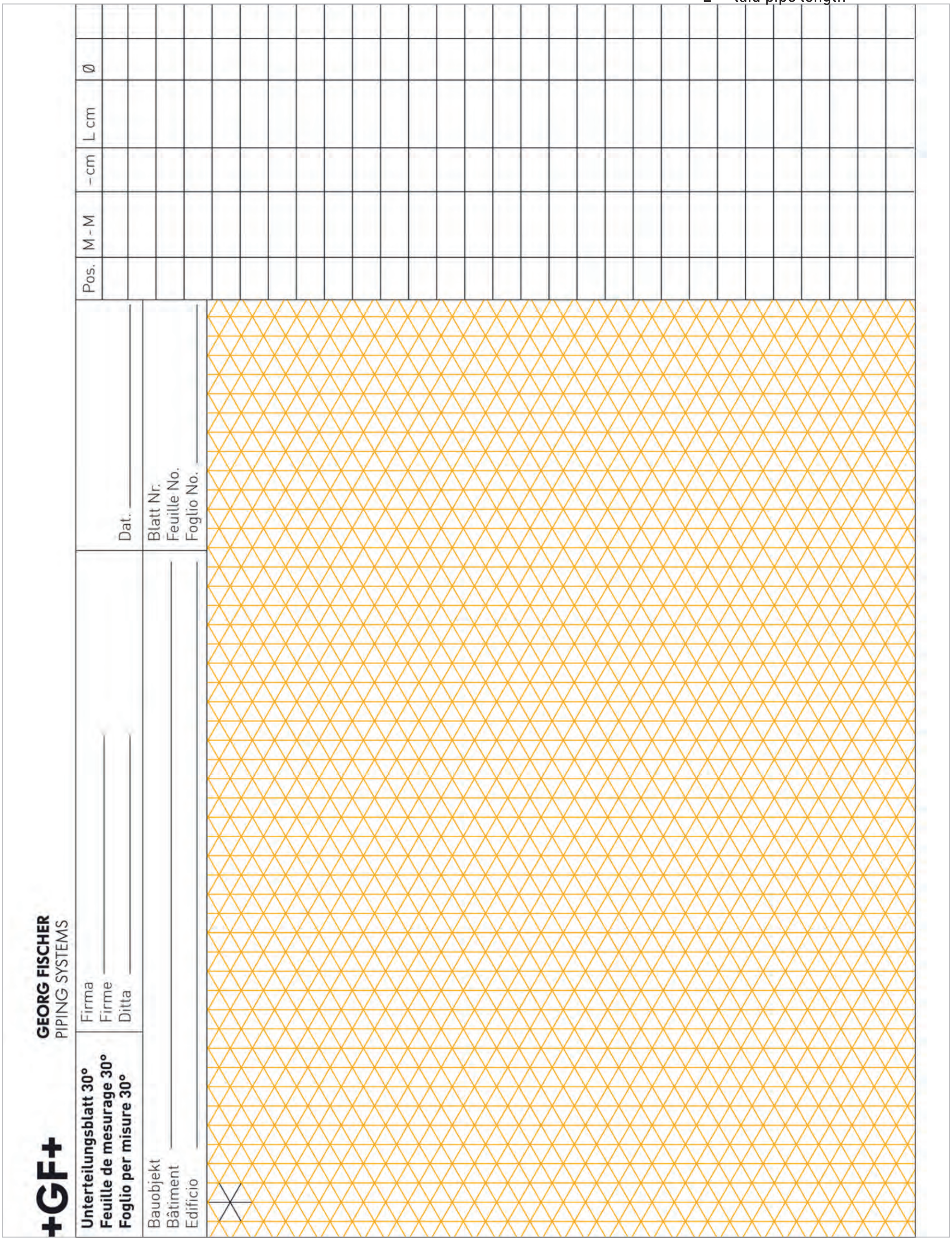
M = 1000 mm; L_0 = ?

L_0 = 1000 mm – 20 mm – 20 mm = 960 mm

L laid pipe length

Measuring sheet

L laid pipe length



4.10 Length changes and flexible sections

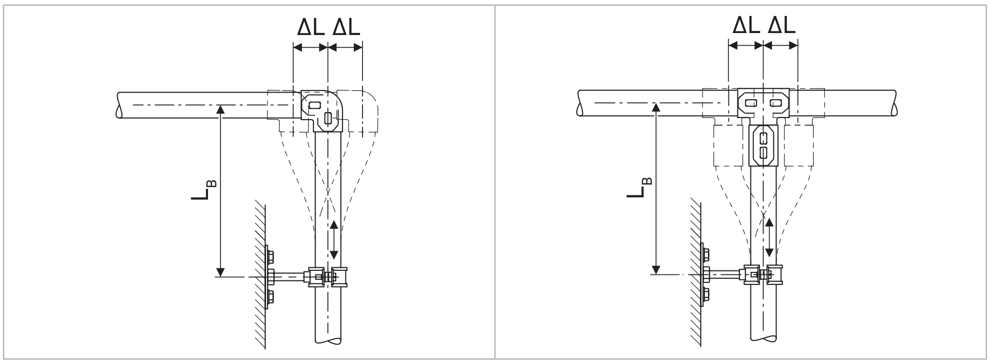
Overview

Length changes ΔL and expansion bend L_B - General

Thermoplastics are subject to higher thermal expansion and contraction than metallic materials. Pipe installed above ground, against walls or in ducts, require changes in length to be taken up in order to prevent any superimposed extra strain on the pipe. This applies especially to pipe exposed to operating temperature variations.

To accommodate a change in length, the following options can be considered:
A Flexible sections
B Flexible hoses
C Compensators

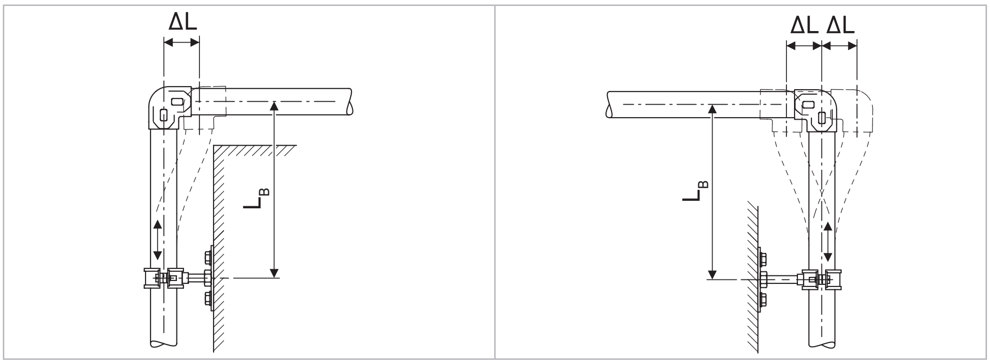
Flexible sections are the most common, the simplest and the most economical solution. The calculations for and the positioning of flexible sections are therefore described in detail.



ΔL Change in length
L_B Flexible section

Fundamentals

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

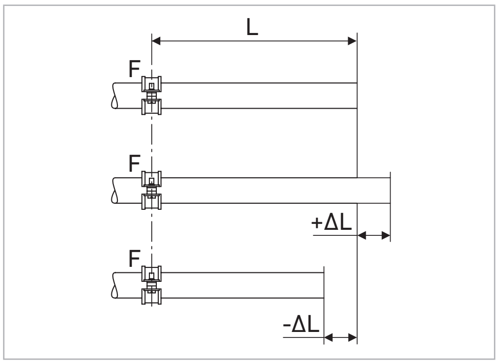


Flexible sections arise naturally at any branching or change in direction of the piping system. The movement LB of the flexible section as a result of a change ΔL in the length must not be restrained by fixed pipe brackets, wall protrusions, girders or the like.

Calculation of length changes

To determine the **change in length due to temperature** ΔL (mm) of COOL-FIT 2.0 / 2.0F pipe, the following temperatures must be known:

1. **Installation temperature**
- Minimum flow temperature
- Maximum flow temperature
- Minimum ambient temperature
- Maximum ambient temperature



F Fixpoint
L Length of pipe section

The following tables show changes in length at different media temperatures for certain conditions. To determine the change in length for other conditions, the Cooling Calculation Tool can be used. Contact your GF Piping Systems representative or visit www.gfps.com

Example of use:

Installation temperature	25 °C
Max. flow temperature	25 °C
Min. flow temperature	**See table**
Max. ambient temperature	25 °C
Min. ambient temperature	25 °C

Length change ΔL (mm) at 20° C flow temperature				
L (m)	**25**	**50**	**100**	**150**
d32	-5	-10	-21	-31
d40	-6	-12	-24	-36
d50	-8	-16	-32	-48
d63	-8	-17	-34	-51
d75	-9	-18	-36	-54
d90	-10	-20	-40	-59
d110	-11	-22	-44	-66
d140	-11	-23	-45	-68

Length change ΔL (mm) at 15° C flow temperature				
L (m)	**25**	**50**	**100**	**150**
d32	-11	-21	-42	-63
d40	-12	-25	-49	-74
d50	-16	-32	-65	-97
d63	-17	-35	-69	-104
d75	-18	-36	-73	-109
d90	-20	-40	-80	-120
d110	-22	-45	-90	-134
d140	-23	-46	-91	-137

L laid pipe length

Length change ΔL (mm) at 10° C flow temperature				
L (m)	**25**	**50**	**100**	**150**
d32	-16	-32	-65	-97
d40	-19	-38	-75	-113
d50	-25	-49	-99	-148
d63	-26	-53	-105	-158
d75	-28	-55	-111	-166
d90	-30	-61	-122	-183
d110	-34	-68	-136	-203
d140	-34	-69	-138	-207

Length change ΔL (mm) at 5° C flow temperature				
L (m)	**25**	**50**	**100**	**150**
d32	-22	-44	-88	-132
d40	-26	-51	-102	-154
d50	-33	-67	-133	-200
d63	-36	-71	-142	-213
d75	-37	-75	-149	-224
d90	-41	-82	-164	-246
d110	-46	-91	-182	-273
d140	-46	-93	-185	-278

L laid pipe length

COOL-FIT 2.0F

L laid pipe length

Length change ΔL (mm) at 20° C flow temperature				
L (m)	25	50	100	150
d32	-3	-6	-12	-17
d40	-4	-7	-14	-21
d50	-5	-10	-20	-29
d63	-6	-12	-23	-35
d75	-7	-13	-26	-39
d90	-6	-13	-25	-38
d110	-7	-15	-30	-45
d140	-9	-17	-34	-51

Length change ΔL (mm) at 15° C flow temperature				
L (m)	25	50	100	150
d32	-6	-12	-24	-36
d40	-7	-15	-29	-44
d50	-10	-20	-40	-60
d63	-12	-24	-47	-71
d75	-13	-27	-54	-80
d90	-13	-26	-52	-78
d110	-15	-31	-61	-92
d140	-17	-35	-70	-104

L laid pipe length

Length change ΔL (mm) at 10° C flow temperature				
L (m)	25	50	100	150
d32	-9	-18	-37	-55
d40	-11	-23	-45	-68
d50	-15	-31	-62	-93
d63	-18	-36	-73	-109
d75	-20	-41	-82	-123
d90	-20	-40	-80	-120
d110	-23	-47	-93	-140
d140	-26	-53	-106	-159

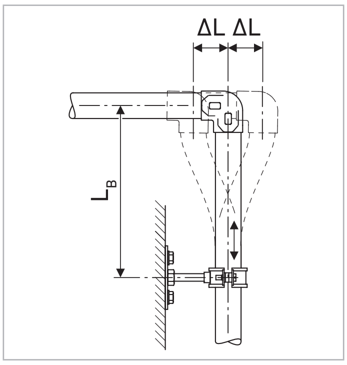
Length change ΔL (mm) at 5° C flow temperature				
L (m)	25	50	100	150
d32	-13	-25	-51	-76
d40	-15	-31	-62	-92
d50	-21	-42	-84	-126
d63	-25	-49	-99	-148
d75	-28	-56	-111	-167
d90	-27	-54	-109	-163
d110	-32	-63	-127	-190
d140	-36	-72	-143	-215

Flexible sections for COOL-FIT 2.0 and COOL-FIT 2.0F

Flexible section for COOL-FIT 2.0

The values for L_B (cm) from this table can be used for a given ΔL (mm) and the relevant pipe size:

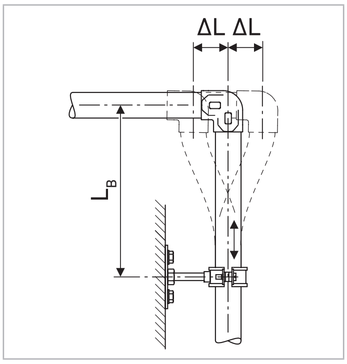
Flexible section L_B (cm)													
ΔL (mm)	10	20	30	40	50	60	70	80	90	100	150	200	300
d32/75	71	101	123	142	159	174	188	201	214	225	276	318	390
d40/90	78	110	135	156	174	191	206	221	234	247	302	349	427
d50/90	78	110	135	156	174	191	206	221	234	247	302	349	427
d63/110	86	122	149	172	193	211	228	244	259	273	334	386	472
d75/125	92	130	159	184	206	225	243	260	276	291	356	411	503
d90/140	97	138	168	195	218	238	257	275	292	308	377	435	533
d110/160	104	147	180	208	233	255	275	294	312	329	403	465	570
d140/200	116	164	201	233	260	285	308	329	349	368	450	520	637



Flexible section for COOL-FIT 2.0F

The values for L_B (cm) from this table can be used for a given ΔL (mm) and the relevant pipe size:

Flexible section L_B (cm)													
ΔL (mm)	10	20	30	40	50	60	70	80	90	100	150	200	300
d32/75	92	130	159	183	205	225	243	259	275	290	355	410	503
d40/90	101	142	174	201	225	246	266	284	302	318	389	449	550
d50/90	101	142	174	201	225	246	266	284	302	318	389	449	550
d63/110	111	157	192	222	248	272	294	314	333	351	430	497	609
d75/125	118	168	205	237	265	290	313	335	355	375	459	530	649
d90/140	125	177	217	251	280	307	332	355	376	396	485	561	687
d110/160	134	190	232	268	300	328	355	379	402	424	519	599	734
d140/200	150	212	259	300	335	367	396	424	449	474	580	670	821

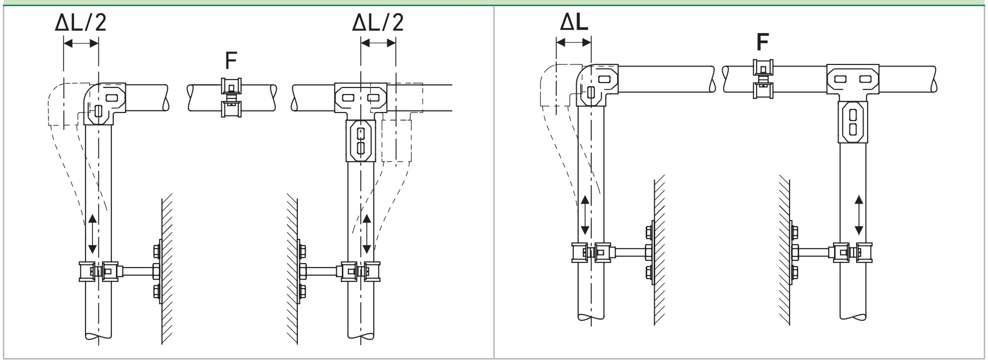


4.11 Installation

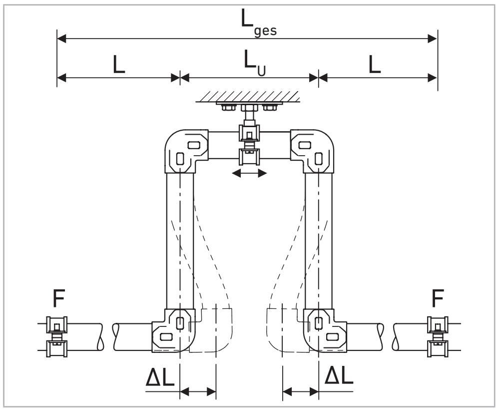
Recommendations for installation

Length changes in pipe sections should always be accommodated through the arrangement of fixed brackets. The following examples show how the changes can be distributed in pipe sections by suitable positioning of fixed brackets:

Recommended installation	Not recommended installation



Expansion loops can be installed to take up changes in length when flexible sections cannot be included at a change in direction or branch in the piping system or if substantial changes in the length of a straight section need to be taken up. In such a case the compensation for changes in length is distributed over two flexible sections.



Bending stress can lead to leaks in mechanical joints.

Do not use any unions or flanged connections close to expansion bends and loops.

Pre-tensioning

In particularly difficult situations with large changes in one direction only, it is possible to pre-tensioning the flexible section during installation and thereby shorten its length L_B, as illustrated in the next example:

Example

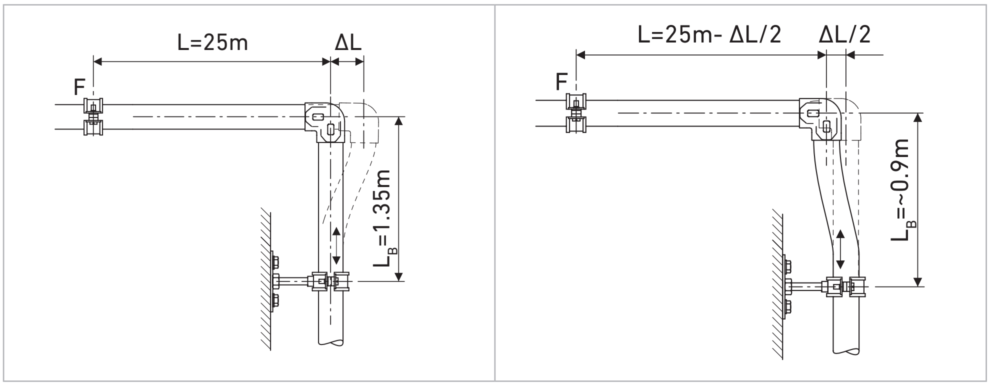
Pipe length L	25 m
Diameter	d50/D90 mm
Installation temperature	25 °C
Min ambient temperature	25 °C konstant
Max ambient temperature	25 °C konstant
Min flow temperature	10 °C
Max flow temperature	25 °C

Change in length from the table or Cooling Calculation Tool:
-ΔL = 29 mm

A flexible section to take up a change in length of +/- ΔL = 29 mm needs to be L_B (mm) = ~1350 mm long according to the table.

If the flexible section is pre-tensioned to ΔL/2, the flexible section required is reduced to ~94 cm. The change in length starting from the 0 position is then +/- ΔL/2 = 29/2 = 14.5 mm.

By pre-tensioning the flexible section makes it possible to reduce its required length in installations where space is restricted. Pre-stressing also reduces the bending of the flexible section in service, improving the appearance of the piping system.



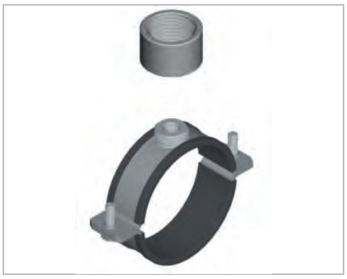
4.12 Pipe bracket spacing and support of piping systems

Overview

Installation of plastic pipe

COOL-FIT 2.0 pipe should be installed using supports designed for use with plastics and should then be installed taking care not to damage or overstress the pipe.

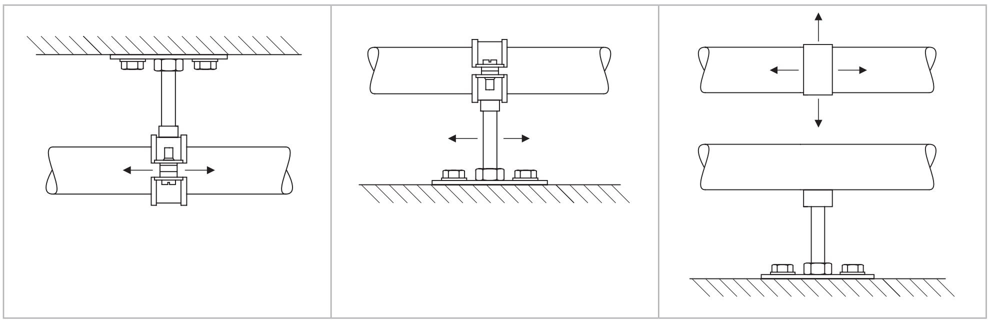
Thanks to the excellent insulating properties of the COOL-FIT 2.0 pipe and its hard, impact resistant outer jacket, standard pipe clamps may be used. Special insulation pipe clamps or cold clamps are not necessary.



Arranging loose brackets

What is a loose bracket?

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



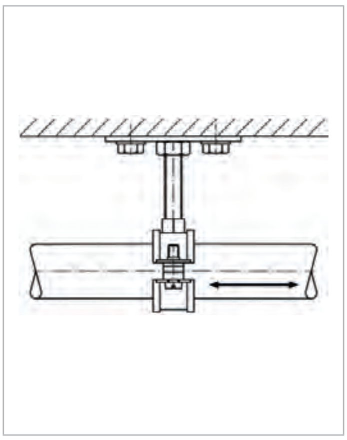
Axial displacement of the pipe in the clamp.	Pipe clamp fitted rigidly to the pipe, axial displacement in the suspension of the pipe clamp.	Displacement of the pipe in 2 axes.

The inner diameter of the bracket must be larger than the outer diameter of the pipe to allow free movement of the pipe. The inner edges of the brackets should be free from any sharp contours to avoid damaging the pipe surface.

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

The axial movement of the piping may not be hindered by fittings arranged next to the pipe bracket or other diameter changes.

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

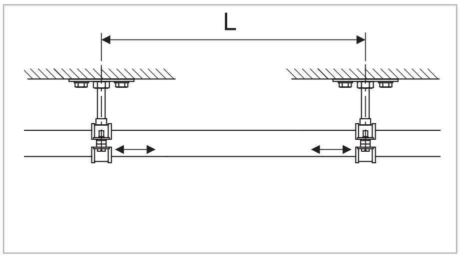


Spacers prevent pinching the pipe

Pipe bracket spacing

The pipe bracket spacing have been determined for conveying water on the basis of a specific deflection of the pipe between two clamps considered acceptable.

The pipe bracket spacing for COOL-FIT 2.0 pipe is always consistent independent of pressure and temperature.



L Pipe clamp spacing

Pipe clamp intervals L for COOL-FIT 2.0

d/D (mm)	32/75	40/90	50/90	63/110	75/125	90/140	110/160	140/200
L (mm)	1600	1700	1700	1850	1950	2000	2100	2350

Pipe clamp intervals L for COOL-FIT 2.0F

d/D (mm)	32/75	40/90	50/90	63/110	75/125	90/140	110/160	140/200
L (mm)	2200	2300	2300	2400	2500	2600	2700	2900

The pipe clamp intervals from the table can be increased by 30% for vertical pipe. Multiply the values given by 1.3 in this case.

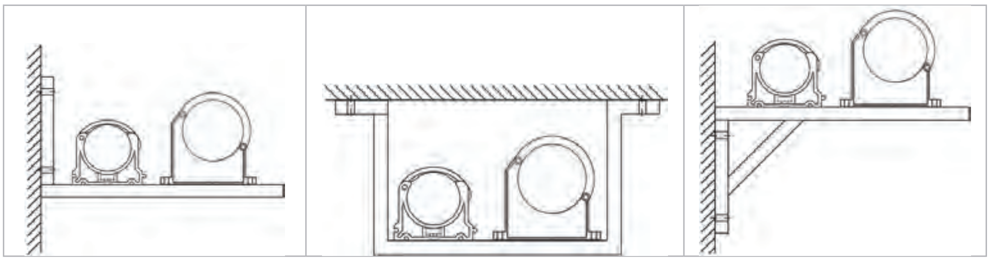
Pipe which are axially clamped and rigidly fixed must be tested for their resistance to kinking. In most cases, this test results in a reduction of the maximum internal pressure and more tightly spaced supports. The forces acting on the fixed points should be considered.

KLIP-IT pipe brackets

These robust plastic pipe brackets can be used not only under rigorous operating conditions, but also where the pipework is subject to aggressive media or atmospheric conditions. Pipe brackets and pipe clamps from GF Piping Systems are suitable for all pipe materials used.

Do not use KLIP-IT pipe brackets as fixed points!

From d90 upwards KLIP-IT pipe clamps must be mounted upright, as in the installation examples below.



* max. allowed force for fixpoint exceeded

Arranging fixed points

A fixed point is a bracket which prevents the pipe from moving in any direction. The purpose of a fixed point is to control tension caused by temperature changes and guide elongation in a certain direction.

⚠ Fixed point design

The pipe must not be fixed by clamping it in the pipe bracket. This can cause deformation and physical damage to the pipe, damage that sometimes does not appear until very much later.

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

COOL-FIT 2.0 fixed point

Fixed points for COOL-FIT 2.0 are established with the special COOL-FIT 2.0 fixed points. The product consists of fusion bands and pipe brackets. Electrofusion bands as permanent joints transmit the forces that occur in the pipe to the fixed point. The supplied pipe brackets serve to build up the fusion pressure during installation of the fusion bands and provide stability during operation. For fusion, use an MSA 2.x, MSA 4.x, MSA 250, 300, 350, 400 or commercially available 220-V electrofusion unit. If you use an MSA electrofusion unit by GF Piping Systems, use the y-cable kit wit code No. 790 156 032. Please take note of the maximum allowed forces in the table below.

Diameter (mm)	d32/ D75	d40/ D90	d50/ D90	d63/ D110	d75/ D125	d90/ D140	d110 / D160	d140 / D200
Maximum force F (kN)	2.0	3.0	5.0	8.0	10.0	10.0	10.0	10.0

⚠ **COOL-FIT 2.0 fixed points must be calculated on the basis of the application. Fixed point brackets and cross braces are not included.**

Scope of delivery

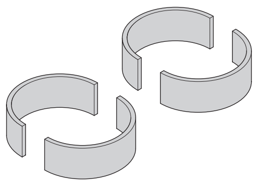
① Clamps to maintain fusion pressure
② Electrofusion band

Y-cable kit for COOL-FIT fixed points

The COOL-FIT Y-cables can be used for a faster installation of COOL-FIT 2.0 fix points. Since electrofusion bands always come in pairs, Y-cables allow for a simultaneous fusion process, cutting fusion time in half.

COOL-FIT 2.0F fixed points

Four half shells which are cemented on both sides to the fixed point pipe clamp.



Diameter (mm)	d32/ D75	d40/ D90	d50/ D90	d63/ D110	d75/ D125	d90/ D140	d110 / D160	d140 / D200
Maximum force F (kN)	2.0	3.0	5.0	8.0	10.0	10.0	10.0	10.0

COOL-FIT 2.0F fixed points must be calculated on the basis of the application. Fixed point brackets and cross braces are not included.

Rigidly fixed installations

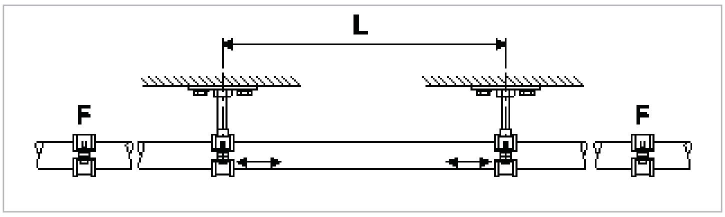
Pipe which are axially clamped and rigidly fixed must be tested for their resistance to kinking. In most cases, this test results in a reduction of the maximum internal pressure and more tightly spaced supports. The forces acting on the fixed points should be considered.

COOL-FIT 2.0 / 2.0F pipes and fittings are suitable for a rigidly fixed installation

Values for forces acting on fixed points as well as the resulting pipe bracket spacing are listed in following tables.

Example of use:

Installation temperature	25 °C
Min. ambient temperature	25 °C constant
Max. ambient temperature	25 °C constant
Min. flow temperature	See table
Max. flow temperature	25 °C



Fixed installation, maximum axial forces (kN) at 15°C fluid temperature								
d/D (mm)	d32/75	d40/90	d50/90	d63/110	d75/125	d90/140	d110/160	d140/200
F (kN)	0.38	0.59	0.87	1.38	1.92	2.74	4.06	6.54
L (mm)	1600	1700	1700	1850	1950	2000	2100	2350
Fixed installation, maximum axial forces (kN) at 10°C fluid temperature								
d/D (mm)	d32/75	d40/90	d50/90	d63/110	d75/125	d90/140	d110/160	d140/200
F (kN)	0.58	0.92	1.36	2.15	2.99	4.28	6.33	10.21*
L (mm)	1600	1700	1700	1850	1950	2000	2100	2350
Fixed installation, maximum axial forces (kN) at 5°C fluid temperature								
d/D (mm)	d32/75	d40/90	d50/90	d63/110	d75/125	d90/140	d110/160	d140/200
F (kN)	0.81	1.27	1.88	2.98	4.13	5.92	8.76	14.13*
L (mm)	1600	1700	1700	1850	1950	2000	2100	2350

COOL-FIT 2.0F

Fixed installation, maximum axial forces (kN) at 15°C fluid temperature								
d/D (mm)	d32/75	d40/90	d50/90	d63/110	d75/125	d90/140	d110/160	d140/200
F (kN)	0.38	0.60	0.88	1.39	1.93	2.75	4.07	6.56
L (mm)	2200	2300	2300	2400	2500	2600	2700	2900
Fixed installation, maximum axial forces (kN) at 10°C fluid temperature								
d/D (mm)	d32/75	d40/90	d50/90	d63/110	d75/125	d90/140	d110/160	d140/200
F (kN)	0.59	0.93	1.37	2.17	3.01	4.29	6.35	10.25*
L (mm)	2200	2300	2300	2400	2500	2600	2700	2900
Fixed installation, maximum axial forces (kN) at 5°C fluid temperature								
d/D (mm)	d32/75	d40/90	d50/90	d63/110	d75/125	d90/140	d110/160	d140/200
F (kN)	0.81	1.28	1.89	2.99	4.16	5.94	8.78	14.18*
L (mm)	2200	2300	2300	2400	2500	2600	2700	2900

Please contact GF Piping Systems for rigidly fixed installations that contain ball valves and mechanical joints as well as if the max. allowed force on the fixed points are exceeded

4.13 Hoses

Installation of elastomer hoses

To ensure the usability of hose lines and to avoid shortening their service life through additional stresses, please note the following:

- Hose lines must be installed so that their natural position and movement is not hindered.
- During operation, hose lines must in principle not be subjected to external forces such as tension, torsion and compression, unless they have been specially made for the purpose.
- The minimum radius of curvature specified by the manufacturer must be observed.
- Buckling is to be avoided, particularly by the joint.
- Before putting the system into operation, check that the mechanical connections are properly tightened.
- If there is visible external damage, the hose line must not be put into operation.
- The connection fittings should be firmly screwed together.

Proper use of the hose line

- Pressure: do not exceed maximum permitted working pressure and operating vacuum
- Temperature: do not exceed maximum permitted temperature for the medium

Storage

- Store in a cool, dry and dust-free area; avoid direct sunlight or ultraviolet irradiation; protect from nearby heat sources. Piping must not come into contact with substances that can cause damage.
- Hoses and hose assemblies must be stored horizontally, free of tension or bending forces.

4.14 COOLING Tool-Box

The GF Piping Systems Cooling Calculation Tool is used to help in the dimensioning and design of cooling systems.

The Cooling Calculation Tool handles:

- Expansion, contraction
- Flexible section design
- Energy savings
- Pipe exterior temperature
- Pipe dimensioning
- Pressure loss
- Dew point/ insulation thickness
- Pipe bracket spacing
- Freezing time
- Weight comparison
- CO_2 footprint

The most common coolants are already stored in the calculation tool. It calculates all system components, such as pipe, fittings and valves. Its menu-based navigation is available in nine languages and allows for efficient and optimized dimensioning of a system. Data for the most commonly used coolants are already stored in the calculation tool. It calculates all system components such as pipe, fittings and valves. The menu is available in nine different languages. It allows system design to be efficient and optimized.

The "comparison" function compares a COOL-FIT system to a steel, stainless steel or copper system.

Cooling Calculations Tool: Get it contact to your GF Piping Systems representative or visit www.gfps.com

5 Jointing and Installation

5.1 Jointing of COOL-FIT 2.0/2.0F

For general notes and information on electrofusion, see Planning Fundamentals Chapter "Jointing technology", section "Electrofusion joints".

General advice

The quality of a weld is largely determined by careful preparation. The welding surface must be protected from adverse weather conditions such as rain, snow or wind. The permissible temperature range for fusion is -10 °C to 45 °C. National regulations must be observed. In direct sunlight, shielding of the welding area can help to create an even temperature profile around the whole circumference of the pipe. It is particularly important to ensure that the climate conditions are the same for both the electrofusion machine and the welding area.

Executing electrofusion

Protect the welding area

The surfaces to be welded on the pipe and the fitting must be carefully protected from dirt, grease, oils and lubricants. Only cleaning agents suitable for PE must be used.

No fats (i.e. hand cream, oily rags, silicone, etc.) must be introduced into the fusion zone!

Without touching the surface, remove product immediately before the installation from packaging

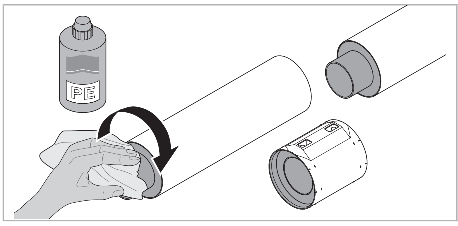
If necessary, prepare the pipe for fusion joints using the Foam removal tool (foam removal, cutting the jacket and peeling the media pipe) and check afterwards that the shaving thickness is 0.2 – 0.4 mm and that the minimum permissible external diameter after peeling is met:

- **COOL-FIT 2.0 valves and COOL-FIT 2.0 fittings (type B and barrel nipple) do not need to be peeled.**

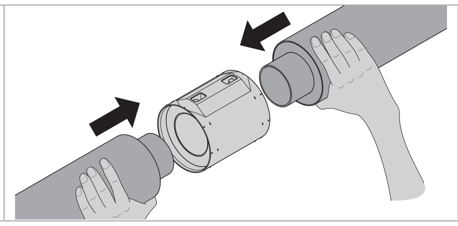
Minimum permitted pipe external diameter after peeling for COOL-FIT 2.0/2.0F:

d/D (mm)	32/75	40/90	50/90	63/110	75/125	90/140	110/160	140/200
Min. d (mm)	31.5	39.5	49.5	62.5	74.4	89.4	109.4	139.4

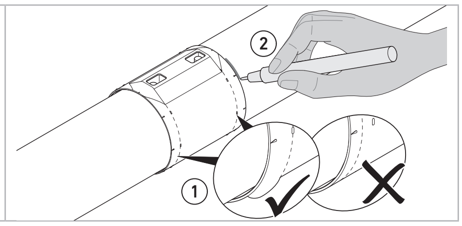
Cleaning and installation for welding preparation



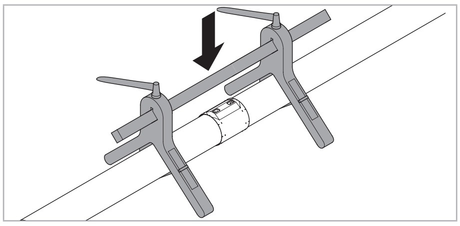
Step 1
Clean the fusion area of the components with PE cleaner and lintfree colourless and clean cloth in circumferential direction.



Step 2
Insert pipe in clamping tool and align free of stress. Push fitting up to the limit stop on the pipe.

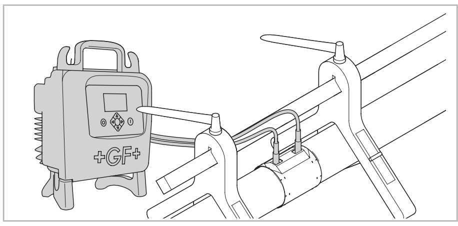


Step 3
Pay attention that the sealing lip arches upwards. Mark end of lip on pipe (to check the change in position during welding).

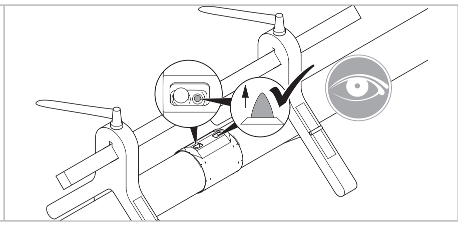


Step 4
Take care for low stress installation and secure the pipe and fitting against dislocation. Tight clamps of clamping tool.

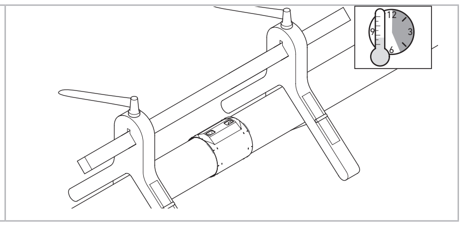
Fusion process



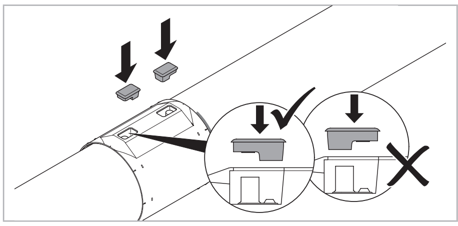
Step 5
Fuse in accordance to the operating instructions of the fusion unit.



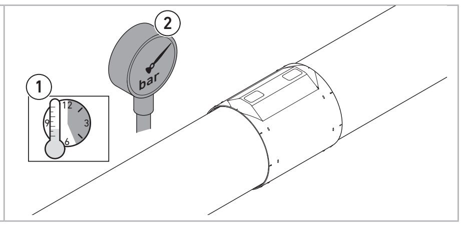
Step 6
During and after fusion, check fusion indicators on the electrofusion fitting and note the messages on the display of the electrofusion machine.
Afterwards mark the fitting with following information
- Date
- Welder/ Weld number
- Time at the end of cooling time



Step 7
Ensure fusion area remains stress free and avoid dislocation until cooling time has elapsed.



Step 8
After fusion process, fit the insulation of the weld pins onto the fusion contacts and remove retaining device



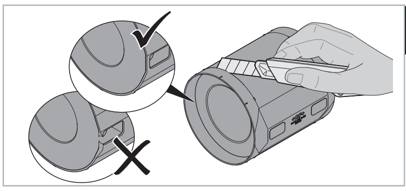
Step 9
After cooling perform pressure tests as per table.

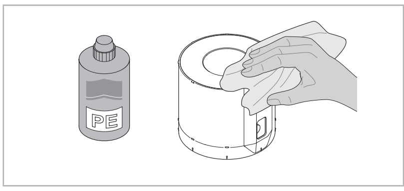
Cooling times before removing retention device and pressure/leak testing

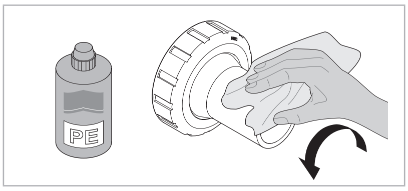
d (mm)	Cooling time before Remove retention device (min.)	Cooling time before internal pressure test at ≤ 6 bar (min.)	Cooling time before internal pressure test at ≤ 18 bar (h)
32	10	15	3
40	10	15	5
50	10	15	4
63	10	20	5
75	15	25	6
90	20	35	8
110	30	35	8
140	45	60	8

The values are valid for pressure tests using a liquid at ≤ 20 ° C. For testing with gas a cooling time of 12 hours is recommended.

Preparation of fitting – remove sealing lip on one side, clean the sealing surfaces

1


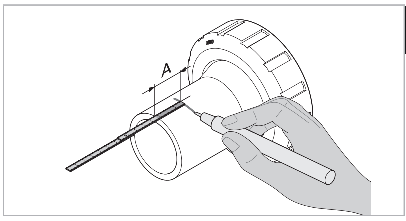
2


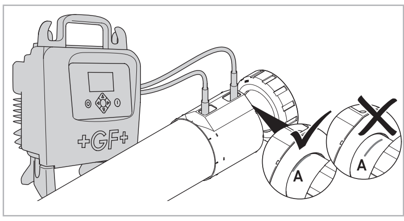
3


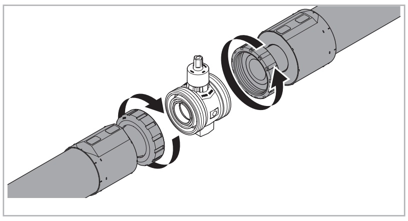
For the jointing to a valve or flange adaptor, the sealing lip of the fitting has to be removed at the valve or flange adaptor side and sealing and fusion surfaces have to be cleaned.

Standard fusion

Fuse both valve ends without valve mounted

4


5


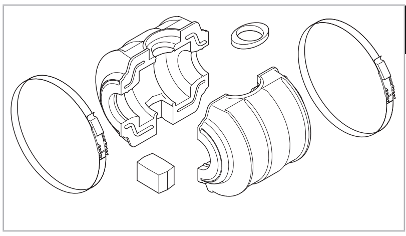
6


Following insertion depths are valid for COOL-FIT 2.0 components:

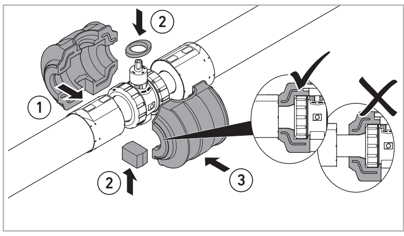
d/D (mm)	32/75	40/90	50/90	63/110	75/125	90/140	110/160	140/200
A (mm)	36	40	44	48	55	62	72	84

V

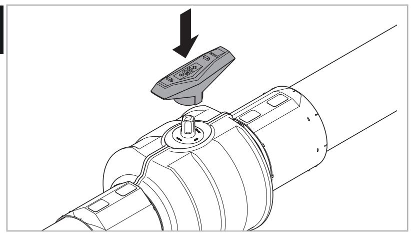
Mounting the valve insulation



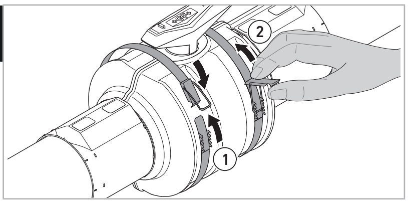
7



8



9



> **i** **Further information can be found in the assembly instructions. "Insalation for Ball Valve" and "Isalation for Butterfly Valve and Flange Adapter".**

Compact connection fitting-to-fitting

When there is enough space, Fitting-to-Pipe-to-Fitting connections can be realized using a short COOL-FIT 2.0 pipe. The foam removal tool enables the foam removal of pipe lengths of ~110mm for the dimensions d32-d90, or respectively ~170mm for the dimensions d110-d140.

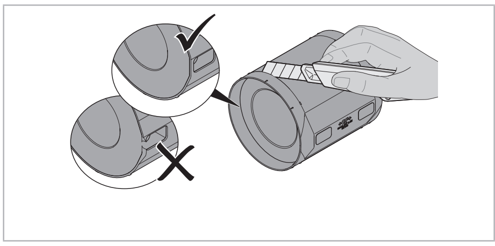
- **Shorter connections Fitting-to-Pipe-to-Fitting can be realized using an un-insulated PE100 SDR11 pipe in combination with a piece of insulation that results of an foam removal process of the foam removal tool.**

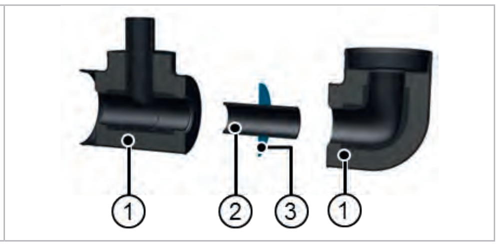
After the peeling of the oxid layer of the un-insulated PE pipe, the insulation ring is pulled over the pipe and the pipe is welded with the fitting.

d	d32	d40	d50	d63	d75	d90	d110	d140
L (mm)	108	120	132	144	165	186	216	252

L : Length of un-insulated PE100 SDR11 pipe needed

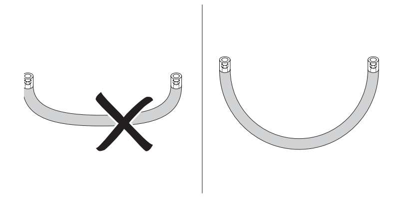
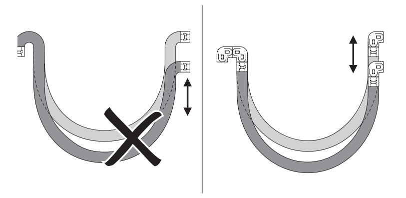
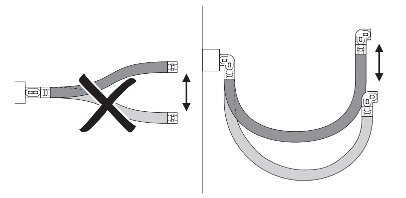
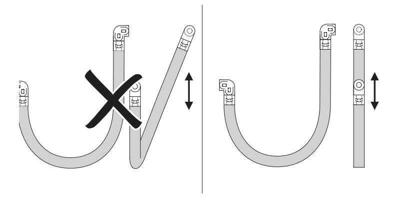
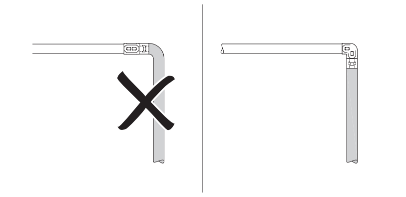
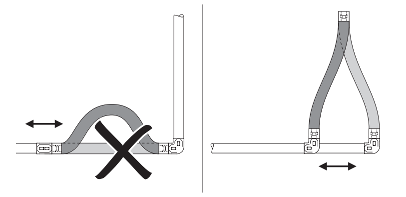
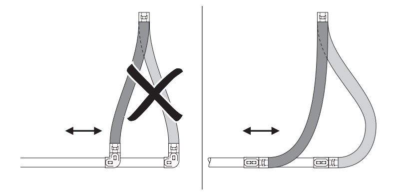
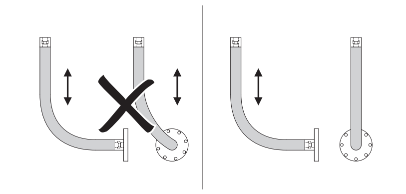
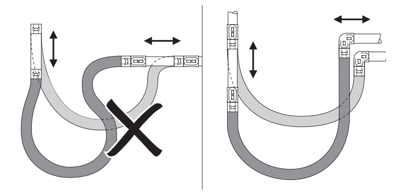
For situations with very limited space the sealing lip at the fittings can be removed at the respective side. The jointing of the Fitting-to-Fitting is performed using a barrel nipple, the sealing of the insulation is being done with an adhesive ring which is to adhered to the cleaned surface of the fittings.





① Fittings
② Barrel nipple
③ Adhesive ring

Hoses

Installation and handling instructions (false/correct)	Description
	Ensure hose is long enough to observe the minimum radius of curvature.
	Avoid excessive bending of hoses, use elbows.
	Avoid fluctuating bending stress and excessive curvature behind the fitting, use elbows.
	Where there is significant axial expansion, the direction of movement and hose axis must lie in the same plane in order to avoid torsion.
	Avoid excessive bending stress by using elbows.
	If the hose absorbs expansion, it must be installed transversally to the direction of expansion.
	For large lateral movements, a 90° angle should be allowed.
	Expansion take-up must be in the plane of the pipe; torsion should be avoided.
	For major axial expansion, the pipe must be installed in a U-shape to avoid kinking.

V

Transition Fittings

The GF Piping Systems range of fittings provides a variety of transitions and threaded fittings to connect plastic piping components to pipe, fittings or valves in metal (or vice versa). The metal threads Rp and R can be sealed with hemp or PTFE tape as long as the counterpart is not made of plastic. Male and female G threads must be sealed with flat gaskets. The advantage of a threaded G connection is radial and torsion-free possibility for installing and uninstalling.

Next to the traditional transition to metal piping, these fittings can also be used to connect a manometers.

⚠ **To prevent electrochemical corrosion, stainless steel connecting elements should preferably be used for steel transitions and brass connecting elements for transitions to non-ferrous metals.**

Combining G and R threads

The connection of a male parallel pipe thread G in accordance with EN ISO 228-1, with a female parallel pipe thread Rp in accordance with ISO 7-1 is not intended according to standards. A tight connection is possible under favorable conditions, but cannot be established reliably.

Connecting the insulations of Transition Fittings and jointing elements of Flexible Hoses

The NBR insulation of the COOL-FIT 2.0 Transition Fittings is applied following the jointing of the COOL-FIT 2.0 Transition Fittings with the COOL-FIT 2.0 Fitting Type A, and the mechanical jointing of the threaded components of Hose and Transition Fitting. The NBR insulation of Transition Fittings is supplied with axial adhesive tapes. The adhesive tapes are used for a condensation proof axial sealing of the NBR insulation. The radial jointing of the jointing face of the NBR insulation can be applied either by adhesive cement of by adhesive tape.

On joining transition fittings to flexibler hoses, the insulation of the flexible hoses can be jointed directly at the COOL-FIT electrofusion fitting using asdhesive cement or adhesive tape.

Jointing Instructions for the adhesive cement

The adhesive should be thoroughly stirred before use. A thin film is applied by means of the brush to both surfaces to be bonded. Doing this, the consumption is ~0.2 – 0.25kg/m^2.

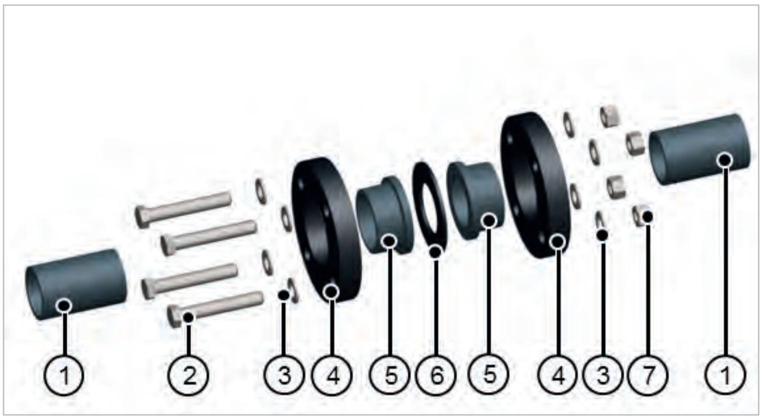
The open joint time is about 3:15 minutes depending on temperature and humidity of air.

Before the coated surfaces are brought together the, the adhesive must still be tacky but should not transfer to the skin when finger-tested. The surfaces should be brought together quickly and firmly and should be held together for a few seconds.

The recommended temperature and for storage and processing is in the range between +15°C and 25°C.The adhesive should not be used below +10°C.

Flange connections

Flanges with sufficient thermal and mechanical stability must be used. The different flange types by GF Piping Systems fulfill these requirements. The gasket dimensions must match the outer and inner diameter of the flange adapter or valve end. Differences between the inner diameters of gasket and flange that are higher than 10 mm may result in malfunctioning flange connections.



1. Pipe
2. Bolt
3. Washer
4. Backing Flange
5. Flange Adaptor/ Valve end
6. Flange gasket
7. Nut

Comparison of flange connections

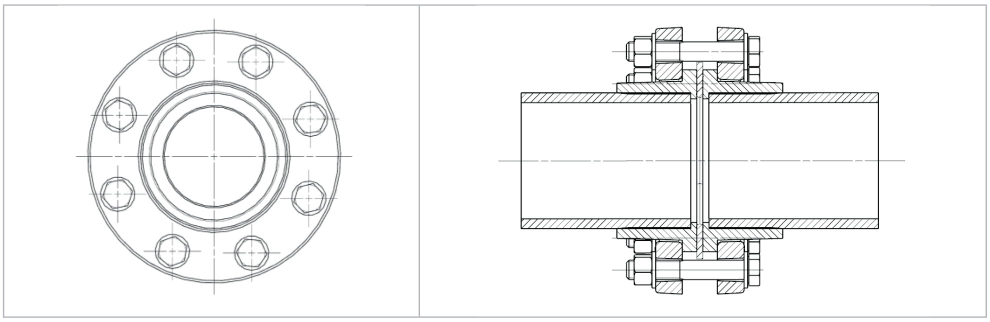
Flange connection	Properties
PP-V flange	• Corrosion-free all-plastic flange made of polypropylene PP-GF30 (fiber-glass reinforced) • High chemical resistance (hydrolysis-resistant) • Maximum possible break resistance due to elasticity (deforms if it is tightened too much) • Use for ambient temperatures up to 80 °C • UV-stabilized • With integrated bolt-fixing • Self-centering aid of the backing flange on the flange adapter • Symmetric design allows assembly on either side: A "reverse" installation is never possible. All important information is readable • V-groove (patented) • Even distribution of forces across the backing flange (conserves components) • Supports a longer-lasting torque for a safe joint
PP-steel flange	• Very robust and stiff due to the steel inlay • Corrosion-free plastic flange made of polypropylene PP-GF30 (fiber-glass reinforced) with steel inlay • High chemical resistance (hydrolysis-resistant) • Maximum ambient temperature 80 °C • UV-stabilized

Creating flange joints

When executing flange joints, the following points should be noted:

Orientation of bolts beyond the two main axes

- For horizontal pipings systems, the orientation shown of the bolts beyond the main axes (see the following figure) is preferred since possible leaks at the flange connection do not cause the medium to run directly onto the bolts.



Flange with main axes (centered crosswise)

- Flange adaptor, valve end or fixed flange, seal and loose flange must be aligned centrally on the pipe axis.
- Before tightening the screws, the sealing surfaces must be aligned parallel and snug against the seal. Tightening misaligned flanges with the resulting tensile stress is to be avoided at all costs.

Selecting and handling bolts

- The length of the bolts should be in such a way that the bolt thread does not protrude more than 2-3 turns of the thread at the nut. Washers must be used at the bolts as well as the nut. If too long bolts are used it's not possible to mount the insulation half shells afterwards.
- To ensure that the connecting bolts can be easily tightened and removed after a lengthy period of use, the thread should be lubricated, e.g. with molybdenum sulphide.
- Tightening the bolts by using a torque wrench.
- The bolts must be tightened diagonally and evenly: First, tighten the bolts by hand so that the gasket is evenly contacting the jointing faces. Then tighten all bolts diagonally to 50 % of the required torque, followed by 100 % of the required torque. The recommended bolt tightening torques are listed in the following table. However, deviations may occur in practice, e.g. through the use of stiff bolts or pipe axes that are not aligned. The Shore hardness of the gasket can also influence the necessary tightening torque.
- We recommend checking the tightening torques 24 hours after assembly according to the specified values and, if necessary, retighten them. Always tighten diagonally here, as well.
- After the pressure test, the tightening torques must be checked in any case and, if necessary, retightened.

> **i** **For more information on flanges, see DVS 2210-1 supplement 3.**

> **i** **In the area of flexible sections and expansion loops, no bolt connections or flange connections should be used since the bending stress may cause leaks.**

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

The indicated torques are recommended by GF Piping systems. These torques already ensure a sufficient tightness of the flange connection. They deviate from the data in the DVS 2210-1 Supplement 3, which are to be understood as upper limits. The individual components of the flange connection (valve ends, flange adapters, flanges) by GF Piping systems are dimensioned for these upper limits.

Pipe outside diameter d (mm)	Nominal Diameter DN (mm)	Tightening torque MD (Nm)		
		Flat ring maximum pressure 10 bar / 40 ° C	Profile seal maximum pressure 16 bar	O-ring maximum pressure 16 bar
d32	DN25	15	10	10
d40	DN32	20	15	15
d50	DN40	25	15	15
d63	DN50	35	20	20
d75	DN65	50	25	25
d90	DN80	30	15	15
d110, 125	DN100	35	20	20
d140	DN125	45	25	25

Length of bolts

In practice, it is often difficult to determine the correct bolt length for flange joints. It can be derived from the following parameters:

- Thickness of the washer (2x)
- Thickness of the nut (1x)
- Thickness of the gasket (1x)
- Flange thickness (2x)
- Thickness of flange collar (valve end or flange adaptor) (2x)
- Valve installation length, if applicable (1x)

In order to ensure the fitting of the insulation half shells of the COOL-FIT 2.0 flange adaptors the used bolts must not be too long.

The following table is useful in determining the necessary bolt length.

Under DVS 2210-1, the screw length should be such that it extends 2 to 3 threads beyond the nut.

Online "screw lengths and tightening torques" tool on www.gfps.com/tools

For a COOL-FIT 2.0 Flange adaptors used together with PP-Steel backing flanges, the following bolt lengths can be used.

Dimension	d32	d40	d50	d63	d75	d90	d110	d140
Screws	M12x80	M16x80	M16x90	M16x90 or M16x100	M16x100	M16x100	M16x100	M16x130

Installation fittings (for sensors)

Transitions and threaded plastic fittings should first be screwed finger tight. The fittings are then screwed in using an appropriate tool until 1 or 2 threads remain visible.

GF Piping Systems recommends using PTFE tape to seal transitions and threaded plastic fittings. Alternatively, Henkel Tangit Uni-Lock or Loctite 55 thread seal or Loctite 5331 thread sealant gel can be used. Follow the manufacturer's instructions. When using other sealants, you must check compatibility with the plastic used.

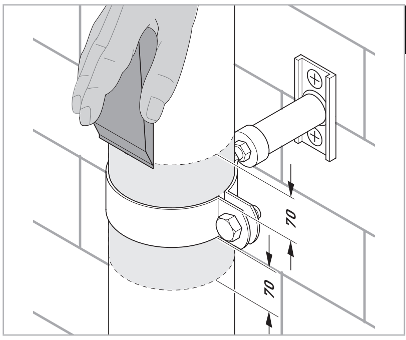
On installing Installation fittings in horizontal piping systems, the sensors should be in 1 – 5 or
7 – 11 clock position.

⚠ **Do not use hemp! It may swell up, putting force on the plastic fittings and damaging plastic threads. Hemp is also not resistant to chemicals used in some media.**

Installation of COOL-FIT 2.0 fixed points

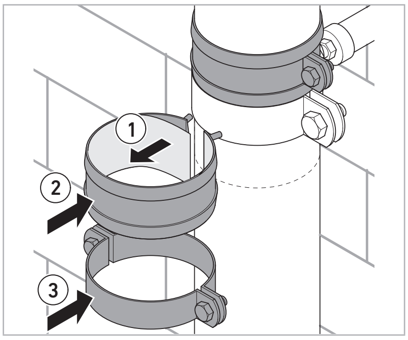
The COOL-FIT pipe shall be intstalled with a standard fix point as shown below.

1



Step 1
Remove the outer layer of the PE jacket with a pipe scraper

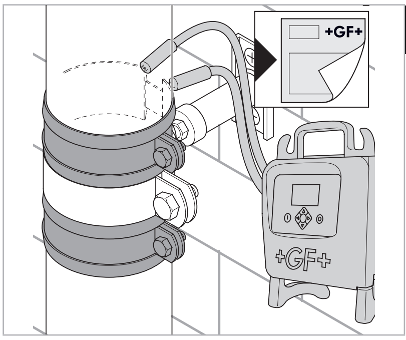
2



Step 2
Remove the yellow protection band from the welding bands and place them on the COOL-FIT pipe. Fix the welding bands with the pipe clips provided.

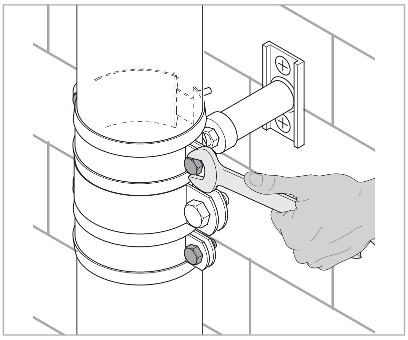
Note: The necessary welding pressure on the clean and dry COOL-FIT pipe is achieved by tightening the pipe clips. Take care that between fixed point clip and weld band there are no visible holes.

3



Step 3
Bond the welding band with the COOL-FIT pipe in accordance with the operating instructions of the electrofusion machine. Use welding adaptors of the y-cable with integrated welding adaptors for the bonding.

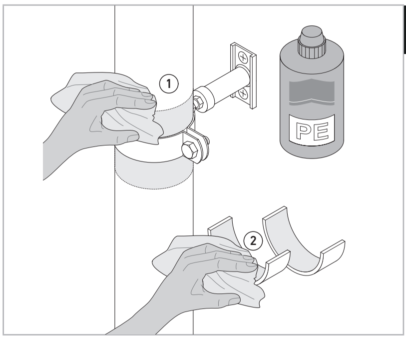
4



Step 4
Retighten the pipe clips after 10 minutes.

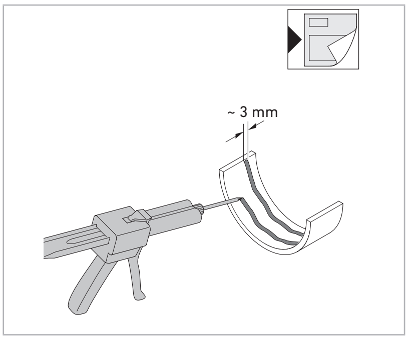
Installation of COOL-FIT 2.0F fixed points

1



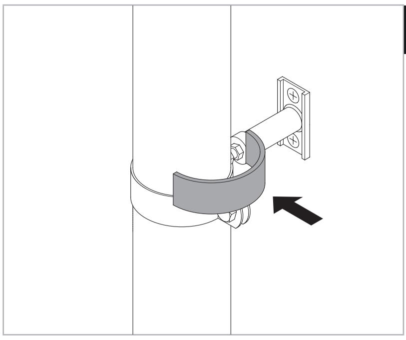
Step 1
Clean the cementing area on the pipe and the components with Tangit PE cleaner and lintfree colourless and clean cloth in circumferential direction.

2



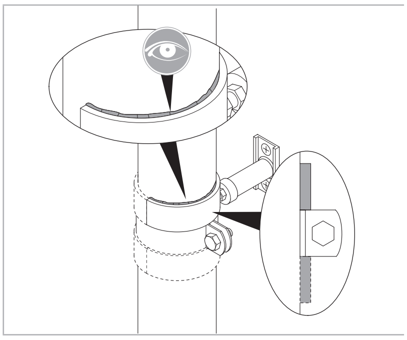
Step 2
Place the Tagit RAPID in about 3mm stripes on the inner side of the fixed point set half shells.

3



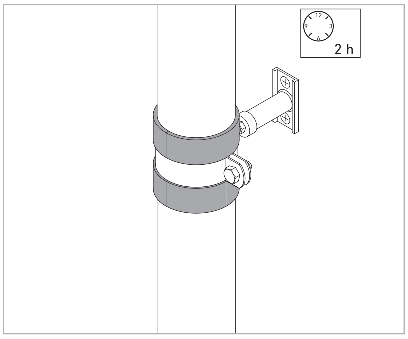
Step 3
Cement the half shelfs on the pipe next to the pipe clamp.

4



Step 4
Check the cementing and ensure the fixed point half shells are next to the pipe clamp.

5



Step 5
Let the fixed point dry for minimum 2hours.

5.2 Pressure test

Internal pressure test

For internal pressure testing and commissioning, the same conditions apply for COOL-FIT 2.0 / 2.0F as for the non-insulated ecoFIT system (PE).

5.3 Internal pressure and leak testing

Introduction to the pressure test

Overview of the various test methods

Leakage test	Inner Pressure test			Leakage test
Medium	Water	Gas[1]	Compressed air[1]	Gas/air (oil-free)
Type	Incompressible	Compressible	Compressible	Compressible
Test pressure (overpressure)	$P_{p\,(perm)}$ or $0.85 \bullet P_{p\,(perm)}$	Operating pressure 2 bar	Operating pressure 2 bar	0.5 bar
Potential risk during the pressure test	Low	High	High	Low
Significance	High: Proof of pressure resistance incl. impermeability to test medium	High: Proof of pressure resistance incl. impermeability to test medium	High: Proof of pressure resistance incl. impermeability to test medium	Gering

[1] Observe the applicable safety precautions. More information is available in DVS 2210-1 addendum 2.

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

The purpose of a pressure test is:
- Ensure the resistance to pressure of the piping system, and
- Show the leak-tightness against the test medium

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

Water is an incompressible medium. In case of a leakage during the pressure test relative low energy is set free. Therefore the hazard potential is significantly lower compared to testing with a compressible medium like e.g. compressed air.

Internal pressure test with water or similar incompressible test medium

The internal pressure test is done when installation work has been completed and presupposes an operational piping system or operational test sections. The test pressure load is intended to furnish experimental proof of operational safety. The test pressure is not based on the operating pressure, but rather on the internal pressure load capacity, based on the pipe wall thickness.

Addendum 2 of DVS 2210-1 forms the basis for the following information. This replaces the data in DVS 2210-1 entirely. The modifications became necessary because the reference value "nominal pressure (PN)" is being used less and less to determine the test pressure (1.5 x PN, or 1.3 x PN) and is being replaced by SDR. In addition, a short-term overload or even a reduction in the service life can occur if the pipe wall temperature TR = 20 °C is exceeded by more than 5 °C in the course of the internal pressure test based on the nominal pressure.

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

Test parameters

The following table provides recommendations on the performance of the internal pressure test

Purpose	Preliminary Review	Main examination
Test pressure p_p (depends on the pipe wall temperature and the permitted test pressure of the installed components, see "determination of the test pressure")	≤ $P_{p\ (zul)}$	≤ 0.85 $P_{p\ (zul)}$
Test duration (depends on the length of the pipe sections)	L ≤ 100 m: 3 hrs 100 m < L ≤ 500 m: 6 hrs	L ≤ 100 m: 3 hrs 100 m <L ≤ 500 m: 6 hrs
Checks during the test (test pressure and temperature curves must be recorded)	At least 3 checks distributed across the test period with test pressure restored	At least 3 checks distributed across the test period without restoring the test pressure

Pre-test

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

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

Material	Pressure drop (bar/h)
COOL-FIT 2.0 / 2.0F	1.2

Main test

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

Observe if using compensators

If the piping system to be tested contains compensators, it has an influence on the expected axial forces on the fixed points of the pipping system. Because the test pressure is higher than the operating pressure, the axial forces on the fixed points increase proportionately. This has to be taken into account when designing the fixed points.

Observe if using valves

When using a valve at the end of a piping system (end or final valve), the valve and the pipe end should be closed by a dummy flange or cap. This prevents an inadvertent opening of the valve and release of the medium.

Filling the pipe

Before starting the pressure test, the following points should be checked:

1. The installation has been carried out in accordance with its plans.
2. All pressure relief and check valves are fitted in the direction of flow.
3. All end valves have been closed.
4. All valves for devices have been closed to secure against pressure.
5. A visual inspection has been made of all connections, pumps, measurement devices and tanks.
6. The waiting time after the last weld or bond has been observed

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

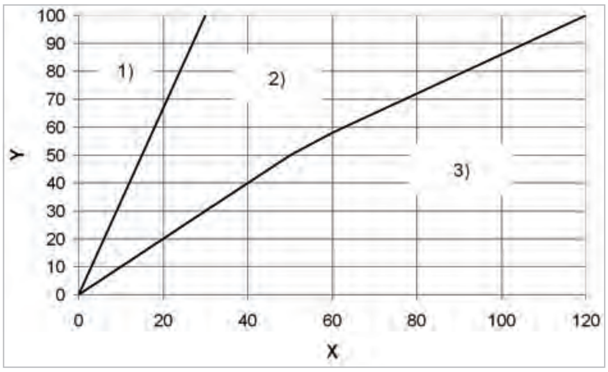
Reference values for the filling volume are given in the table below.

d (mm)	V (l/s)
≤ 90	0.15
110	0.3
140	0.7

Allow sufficient time to pass between filling and testing the pipe for the air in the piping system to escape through the vents: about 6 to 12 hours, depending on nominal diameter.

Applying the test pressure

The test pressure is applied in accordance with this diagram. It is important to ensure that the rate of pressure increase does not cause any water hammers.



Y Test pressure (%)
X Time of test pressure increase (min)
1) Rate of pressure increase up to DN100 mm
2) Range of pressure increase rates between DN100 and DN400 mm
3) Guideline rate of pressure increase for DN500 and higher: 500/DN (bar/10 min)

Determination of the test pressure

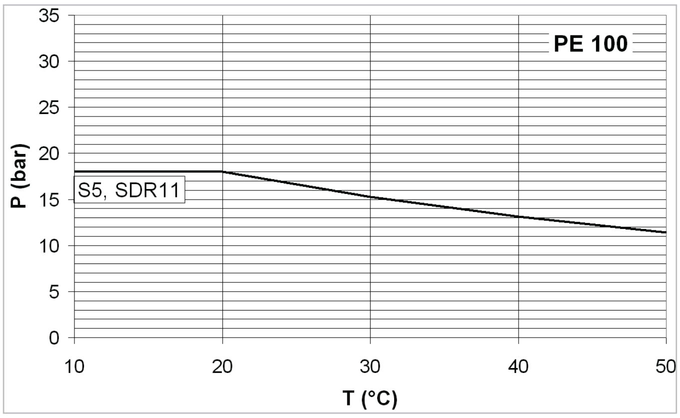
The permissible test pressure is calculated using the following formula:

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

$\sigma_{v(T,\,100\,h)}$ Creep strength for the pipe wall temperature
S_p Minimum safety factor for creep strength
A_G Processing method or geometry specific factor which reduces the permissible test pressure
T_R Pipe metal temperature: mean temperature of test medium and pipe surface

Material	Sp minimum safety factor
PE100	1.25
PVC-U	2.5

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



P permitted test pressure (bar)
T pipe wall temperature (°C)

Checks during testing

The following measurement values must be recorded consistently during testing:

8. Internal pressure at the absolute lowest point of the piping system
9. Medium and ambient temperature
10. Water volume input
11. Water volume output
12. Pressure drop rates

5.4 Start-up with secondary coolants

Secondary coolants such as glycol solutions must only introduced in liquid, pre-mixed form into COOL-FIT 2.0 piping systems. Filling should be performed slowly from the lowest point of the system to allow the piping system to vent at its highest point.

Filling and Venting

It is important to vent air from all piping systems. This is particularly important with saline solutions, because of their corrosive properties. Venting process:

- The system must be filled slowly.
- Manual or automatic venting devices must be fitted at the highest point of the system.
- Long horizontal lines should be installed at a slight gradient.
- The piping layout should be chosen in such a way as to prevent the formation of air pockets.
- Installation of an air vent with a medium column as a reserve.
- Follow the specific manufacturer instructions for the liquids as regards filling

[1] All three materials are firmly bonded together.
[2] At 20 ° C, medium water

V

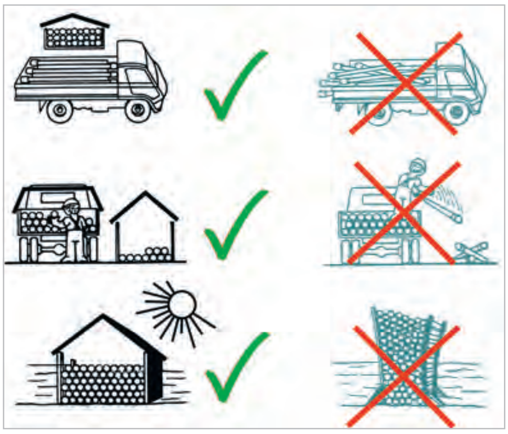
6 Transport and Stocking

6.1 Transport

On trucks/in crates, manual transport

6.2 Storage

All plastic pipe including pre-insulated plastic pipe such as COOL-FIT 2.0 must be stacked on a flat surface with no sharp edges. During handling, care must be taken to avoid damage to the external surface of the pipe, i.e. by dragging along the ground). Pipe should not cross over each other in storage as this is likely to cause bending.



7 Environment

The materials used for COOL-FIT 2.0 are suitable for recycling. GF Piping Systems aims to satisfy its customer's wishes concerning environmental aspects.

For more information at www.coolfit.georgfischer.com

1) All three materials are mechanically fixed to each other.

2) At 20 °C, medium water, the specified value is valid for all system components, with the exception of the valves for which nominal pressure PN10 applies and flexible hoses with lower continuous operating pressure according to the product data sheet.

Build

COOL-FIT 4.0

COOL-FIT 4.0

1 General Information

COOL-FIT 4.0 is a pre-insulated piping system for the delivery of secondary refrigerants. The COOL-FIT 4.0 system is a completely pre-insulated plastic piping system for secondary refrigerant circuits that run with water, brine, or Glycol based solutions. Thanks to its insulation thickness of 40 mm, typical areas of application are industrial refrigeration systems with medium temperatures below 0 °C and chilled water systems for media above 0 °C.

COOL-FIT 4.0 is based on established, impact resistant and corrosion free PE pipe and fittings. The smooth inner surface of the fluid pipe provides minimal losses of pressure. The low thermal conductivity and high quality insulation guarantee low operating cost over the entire lifespan of the system. Thanks to the 3 in 1 design – Fluid pipe / Insulation / Robust jacket – installation time is kept very short.

All components are pre-insulated or supplied with mountable insulation shells.
The COOL-FIT 4.0 tools allow for fast and safe installation of the system.

The COOL-FIT 4.0 system is suitable for use in applications like:

- Fruit and vegetable processing
- Bakeries
- Fish and meat processing
- Cold stores
- Breweries and wineries
- Air conditioning
- Airports
- Apartments
- Hospitals
- Industrial buildings
- Data centers
- Hotels
- Shopping centers
- Sports centre / leisure centre
- Universities
- Bank / public institutions

2 System Specification

Specification		COOL-FIT 4.0	COOL-FIT 4.0F
Materials[1]	Pipe	PE100	PE100
	Insulation	GF-HE foam, halogen free, closed-cell	GF-HE foam, halogen free, closed-cell
	Outer jacket	Pipe HDPE	Flame retardant - GF-FR
		Fitting GF-HE	-
Size		d32DN25 – d450DN450	d160DN150 + d225DN200
Connection technology		Electrofusion	Electrofusion
Nominal pressure[2]	16 bar, SDR 11 10 bar, SDR17	d32DN25-d110DN100 d160DN150-d450DN450	- d160DN150 + d225DN200
Temperature	Medium	-50 °C bis +60 °C	0 °C bis +60 °C
	Environment	-30 °C bis +65 °C	0 °C bis +55 °C
Insulation	Thermal conductivity $\lambda_{20°C}$ PE Inner pipe HE Foam PE jacket GF-FR jacket	 0.38 W/mK 0.022 W/mK (32-d110); 0.026 W/mK (d160-d450) 0.38 W/mK	 0.38 W/mK 0.026 W/mK 0.15 W/mK
	Density	≥ 70 kg/m^3	≥ 70 kg/m^3
	Foam cell size	max. Ø 0.5 mm	max. Ø 0.5 mm
	Nominal thickness	40 mm	40 mm
Mechanical strength (from insulation)	Axial shear strength	≥ 0.12 N/mm^2	≥ 0.12 N/mm^2
	Compressive strength	≥ 0.3 N/mm^2	≥ 0.3 N/mm^2
Colour	Outer jacket	Black	Black
Weight (without medium)	Pipe d32	1.39 kg/m	-
	Pipe d110	6.12 kg/m	-
	Pipe d225	16.42 kg/m	19.84 kg/m
Oxygen diffusion at ≤ 14.5°C	ISO 17455	≤ 0.32 mg/(m^2 d)	≤ 0.32 mg/(m^2 d)
Fire classification[3]	EN 13501-1	E	B-s2, d0

1) All three materials are firmly bonded together.

2) At 20 ° C, medium water, the specified value is valid for all system components, with the exception of the butterfly valves, PN10 applies to the nominal pressure and for flexible hoses with maximum pressure according product datasheet.

3) Additional information in chapter "Fire behavior and fire prevention measures".

V

Specification		COOL-FIT 4.0	COOL-FIT 4.0F
Environment	Stability	Moisture and vapor-tight	Moisture and vapor-tight
	Resistance	Weather resistant UV resistant	-
	Ozone Depletion Potential	Zero	Zero
Standards and Guidelines	EN ISO 15494	Plastic piping systems for industrial applications – polybutene (PB), polyethylene (PE) and polypropylene (PP) – specifications for components and the piping system – metric series	
	ISO 7	Threaded Joints	
	 EN ISO 16135 EN ISO 16136 EN ISO 16137 EN ISO 16138	Industrial valves ... – Ball valves made of thermoplastics – Butterfly valves made of thermoplastics – Backflow protection made of thermoplastics – Diaphragm valve made of thermoplastics	
	EN ISO 16871	Plastic piping and ducting systems – Plastic pipe and fittings – Method for exposure to direct (natural) weathering	
	EN ISO 13501-1	Fire classification of construction products and building elements	
Product declarations Green buildings		BNB BN 2015 BREEAM Int 2016 DGNB 2015 DGNB 2018 LEED V3 LEED V4 WELL V1 2019	
eco-bau	(BKP 240, 244, 250)	201710.1518	201908.5716

3 Technical Details

3.1 COOL-FIT 4.0

COOL-FIT 4.0 Pipe

COOL-FIT 4.0 pipe are made from PE 100. The high efficiency GF-HE hard foam insulation exhibits a thermal conductivity λ of 0.022 W/mK (d32-d110) respectively 0.026 W/mK (d160-d450). The pipe are protected by an impact- and weather resistant PE jacket.

All three materials are firmly bonded in order to ensure good insulation properties and low thermal expansion or contraction for the system.

The pipes are available in 5m lengths for dimensions d32 to d225, and in 5.9m for dimensions d250 to d450. The pipe have free, uninsulated ends, prepared already for the jointing with the COOL-FIT 4.0 fittings.

Standard range (inner pipe SDR17 for d160-d450mm)	Inner pipe	Inner pipe	Pipe class	Outer jacket	Weight empty	Weight with water	Volume	Insulation thickness	Heat transfer coefficient (U)	Fire load
(mm)	d x e (mm)	d_i (mm)	SDR	D x e1 (mm)	(kg/m)	(kg/m)	(l/m)	(mm)	(W/m K)	(kWh/m)
d32/90	32 x 2.9	26.2	11	90 x 3	1.39	1.93	0.54	26.0	0.13	14.96
d40/110	40 x 3.7	32.6	11	110 x 3.4	2.02	2.85	0.83	31.6	0.14	21.66
d50/110	50 x 4.6	40.8	11	110 x 3.4	2.19	3.49	1.31	26.6	0.18	24.02
d63/125	63 x 5.8	51.4	11	125 x 3.8	2.94	5.02	2.07	27.2	0.21	32.72
d75/140	75 x 6.8	61.4	11	140 x 4	3.70	6.66	2.96	28.5	0.23	41.35
d90/160	90 x 8.2	73.6	11	160 x 4	4.75	9.00	4.25	31.0	0.24	53.07
d110/180	110 x 10	90.0	11	180 x 4	6.12	12.48	6.36	31.0	0.28	68.94
d160/250	160 x 9.5	141.0	17	250 x 5	9.81	25.42	15.61	40.0	0.37	109.29
d225/315	225 x 13.4	198.2	17	315 x 6	16.42	47.27	30.85	39.0	0.50	187.00
d250/355	250 x 14.8	220.4	17	355 x 5.1	19.04	57.19	38.15	47.4	0.47	213.97
d280/400	280 x 16.6	246.8	17	400 x 6.3	24.67	72.51	47.84	53.7	0.47	277.80
d315/450	315 x 18.7	277.6	17	450 x 6.4	30.42	90.95	60.52	61.1	0.47	341.40
d355/500	355 x 21.1	312.8	17	500 x 7.4	38.35	115.20	76.85	65.1	0.49	432.43
d400/560	400 x 23.7	352.6	17	560 x 8.4	48.40	146.05	97.65	71.6	0.50	546.74
d450/630	450 x 26.7	396.6	17	630 x 7.6	58.19	181.72	123.54	82.4	0.49	653.01

Extended range (inner pipe SDR11 for d160-d450mm)	Inner pipe	Inner pipe	Pipe class	Outer jacket	Weight empty	Weight with water	Volume	Insulation thickness	Heat transfer coefficient (U)	Fire load
(mm)	d x e (mm)	d_i (mm)	SDR	D x e1 (mm)	(kg/m)	(kg/m)	(l/m)	(mm)	(W/m K)	(kWh/m)
d160/250	160 x 14.6	130.8	11	250 x 5	11.88	25.31	13.44	40	0.37	134.53
d225/315	225 x 20.5	184	11	315 x 6	20.47	47.06	26.59	39	0.49	236.4
d250/355	250 x 22.7	204.6	11	355 x 5.1	24.05	56.92	32.88	47.4	0.46	275.1
d280/400	280 x 25.4	229.2	11	400 x 6.3	30.93	72.18	41.26	53.7	0.46	354.06
d315/450	315 x 28.6	257.8	11	450 x 6.4	38.33	90.53	52.2	61.1	0.46	437.89
d355/500	355 x 32.2	290.6	11	500 x 7.4	48.34	114.67	66.33	65.1	0.48	554.36
d400/560	400 x 36.3	327.4	11	560 x 8.4	61.19	145.37	84.19	71.6	0.49	702.72
d450/630	450 x 40.9	368.2	11	630 x 7.6	74.39	180.87	106.48	82.4	0.49	850.72

d	Nominal outer diameter of the PE pipe
d_i	Nominal inside diameter of the pipe
D	Nominal outside diameter of the outer PE jacket
e, e1	Nominal wall thickness

Energy Saving Ordinance EnEV

COOL-FIT 4.0 meets the specifications of the Energy Saving Ordinance EnEV 2014 for cold distribution and cold water pipes.

Please contact Georg Fischer Piping Systems when using COOL-FIT 4.0 according to EnEV 2014 specification for heating cables.

COOL-FIT 4.0 Fittings

General

The media fitting and insulation used for COOL-FIT 4.0 fittings fulfill the same specifications as the COOL-FIT 4.0 pipe. The COOL-FIT 4.0 fittings are based on ELGEF electrofusion fittings, which have been in use successfully for years. They provide an easy and safe connection.

The pre-insulated COOL-FIT 4.0 fittings are available in two types:

Type A

Electrofusion fitting with integrated heat coils for direct electrofusion pipe-to-fitting connections.

90° elbow and reducer as an example

Type B

Spigot fitting with free ends for electrofusion with COOL-FIT 4.0 electrofusion fittings.

Reduction as an example

Usefull functions

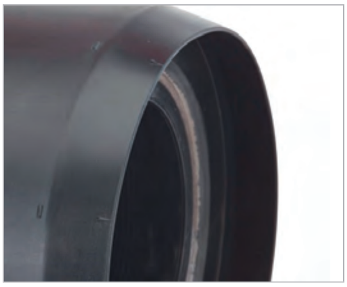
Fusion indicators

After the welding process, the indicator pin shows that energy has been applied to the welding zone.

Sealing lip at fittings Type A d32-d225

The sealing lip ensures a moisture-proof and vapour tight sealing of the insulation towards the outside.

On joining the fittings to the pipe, it's sealing mechanically. Due to this an additional sealing of the joints is not necessary.



Label

The fittings have abrasion-resistant marking.

Trace code

Relevant product data can be traced back to production via traceability codes.

373603063 160120 76701000325 Traceability

Angle marking

By marking the ends of the fittings, connections between pipe and fittings can be optimally aligned.

Jointing

Pipe and Fitting

Type A fittings have integrated resistance wires, which are put under electric current during the welding operation through welding contacts on the fittings. This heats up the inside of the fitting and bonds the melting zone with the pipe.

Type B fittings feature non-insulated spigot ends. They are connected with electrofusion fittings type A to a pipe.

Fitting-to-fitting

Two COOL-FIT 4.0 fittings are usually connected by using a piece of COOL-FIT 4.0 pipe with free ends. For compact joints, the special COOL-FIT 4.0 barrel nipple with insulation can be used.

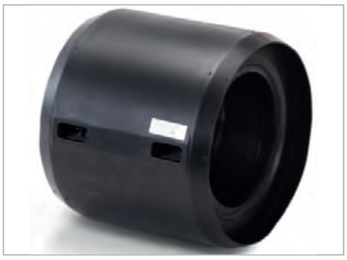
Two COOL-FIT 4.0 Type B fittings can be joined using an electrofusion fittings type A.

The direct connection of a COOL-FIT 4.0 fitting Type A and Type B is also possible.

Components

COOL-FIT 4.0 Electrofusion coupler

COOL-FIT 4.0 electrofusion couplers are used to connect pipe and components with free ends like type B fittings, valves and transition fittings.



COOL-FIT 4.0 Elbows 45° and 90°

(Refer to „General Information“ chapter above)

COOL-FIT 4.0 T90° equal and COOL-FIT T90° reduced

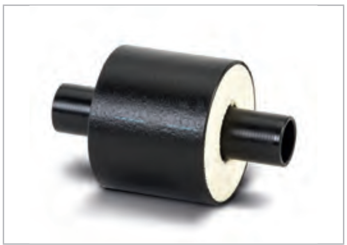
The equal and reduced type A 90° tees have, like the coupler, resistance wires for electrofusion. The central branches can be connected to the type A fitting, so all combinations are possible.


COOL-FIT 4.0 reducer

The COOL-FIT 4.0 reducer can be used to reduce the flow of the starting size by up to 3 to 5 sizes (e.g. from d225 up to d63).


COOL-FIT 4.0 barrel nipple (with insulation)

COOL-FIT 4.0 barrel nipple serves as a compact direct connector for type A fittings.



Combination of T90° and Reducer

If a reducer in a system is fitted behind a tee, either a COOL-FIT 4.0 T90° reduced or a COOL-FIT 4.0 T90° reduced/equal connected to a reducer should be used.

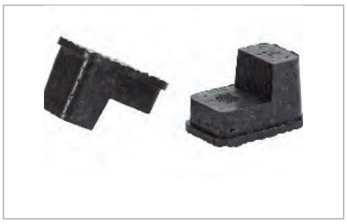
Branch \ Run	40	50	63	75	90	110	160	225
32	X	X	X	O	O	O	O	O
40		X	X	O	O	O	O	O
50			X	O	O	O	O	O
63				Δ	Δ	Δ	Δ	Δ
75					Δ	Δ	□	□
90						Δ	Δ	Δ
110							Δ	Δ

Δ T90° reduced
X T90° equal + reducer type A
O T90° reduced to d63 + reducer type A
□ T90° reduced to d90 + coupler d90 + reducer type B

Accessories for dimensions d32 - d225

Insulation for fusion contacts

Supplied with each fitting. Prevent formation of a cold bridge at the fusion contacts. Insulation parts can also serve as an indicator that a connection has been welded. Install insulation after welding to show that the welding has been completed.

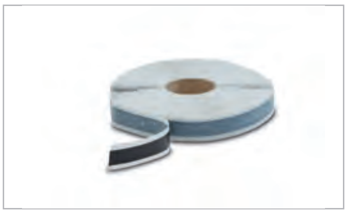


Sealing clamps

For vertical installations outdoors, sealing clamps mounted at the top lip of the fitting are recommended.

Sealing tape

As an alternative to the sealing clamps, the sealing tape with width 25mm is intended to be used for vertical installations outdoors, to seal the top lip of the fitting.



Transition of insulation

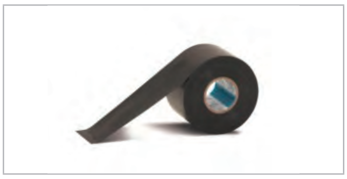
The Transition of insulation is used for a moisture-proof and vapour tight sealing of the interface of COOL-FIT 4.0 Fitting to COOL-FIT 2.0 pipe.

Cement

For frontal bonding of the insulations of transition fittings and flexible hoses.

Adhesive tape

Optional for covering hand-cut faces as well as for bonding of the insulations of transition fittings to the insulation of flexible hoses.

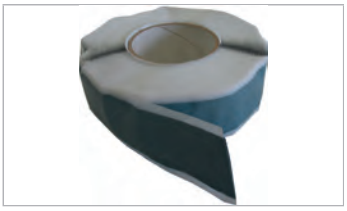


V

Accessories for dimensions d250 - d450

Sealing tape

A roll of 40 mm wide butylene rubber-based sealing tape. For a water- and vapor-tight connection of inspection gaps with shrink sockets. The sealing tape is affixed to the circumference of the pipe or fitting.



Shrink socket

The shrink socket is used to water and vapor seal the respective welded joints on the outer jacket and can seal only components with the same outside diameter. Functionality is ensured only in combination with the butylene-rubber sealing tape. This version provides additional mechanical strength with regard to bending forces. The socket shrinks uniformly, resulting in a good visual appearance. It can be shrunk with an open, soft flame.

End cap

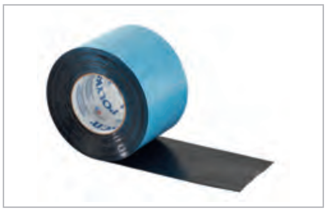
End caps are used to cap the pre-insulated system. They seal the PUR insulation and prevent moisture from entering. Sealing PUR is achieved by using a suitable sealant.

Sealant

The silicone-free sealant is used at the end of the pre-insulated system to seal the PUR insulation. It is used to cement the end caps.

Cold shrink tape

The cold shrink tape is used on the respective welded joints for the water- and vapor-tight sealing of the outer jacket. It is only suitable for indoor applications and can be applied by hand without heat.

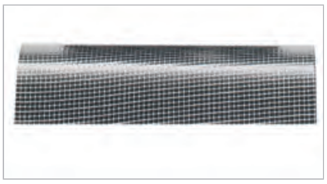


Hot shrink tape

The heat shrink tape is used on the respective welded joints for the water and vapor tight sealing of the outer jacket. The adhesive-coated tape must be glued with a sealing patch and shrunk under the influence of heat.

Sealing patch

The sealing patch is used to close the heat-shrink tape. One patch must be used per sealing.



COOL-FIT 4.0 Heat Tracing

Frozen pipes can cause high costs. When water-filled COOL-FIT pipes are exposed to temperatures below zero °C without circulation and for extended periods of time, the water freezes and proper operation of the cooling system can no longer be maintained.

The heat-tracing system for COOL-FIT 4.0 offers an effective solution for the freeze protection of COOL-FIT lines. The self-regulating heating tape in combination with the insulation of the COOL-FIT 4.0 pipe system prevents the cooling pipe from freezing.

With the COOL-FIT 4.0 heat tracing, reliable frost protection down to -30°C ambient temperature is provided across all COOL-FIT 4.0 dimensions from d32 - d450.

Please contact GF if you need antifreeze protection at ambient temperatures below -30°C.

Tracing cable

The COOL-FIT heat-tracing system uses a self-regulating heat-tracing cable installed inside the pipe. This efficiently protects the medium from freezing directly and without heat loss through the pipe wall insulation.

Cable glands

The entry and exit of the cable into the COOL-FIT system is performed via cable glands, which are connected to the COOL-FIT system via metallic thread transitions.

Thermostat

The thermostat with surface sensor enables efficient control directly via the media temperature. The temperature sensor is installed via COOL-FIT installation fittings using a suitable immersion sleeve.

Cold lead connection and end seal kit

The kit contains all necessary components like crimps and shrink sleeves for the joining of the heating cable to power cable as well as for the end seal of the heating cable.

V

COOL-FIT 4.0 Valves

The plastic valves designed for COOL-FIT 4.0 valves are based on Georg Fischer Piping Systems standard plastic valves. The valves are supplied including PE-/GF-HE insulation shells with a protective PE jacket. The sealing faces between the shells are vapor tight by their design. No additional tape or sealant is required.

Releasable plastic bands for sizes d32DN25 – d63DN50 and metal straps with tension locks for sizes d75DN65 – d225DN200 permit the pre-insulated shells to be fitted to and removed from the valves easily, allowing easy maintenance.

The insulated ball valve in ABS is available in sizes d32DN25 – d90DN80. For the sizes d110DN100 – d225DN125, butterfly valves kits are available that consist of butterfly valve, flange adaptor, backing flange PP-St, screw-kits and insulation half shells.
Both valve types are available either as manually operated or electric actuated version.

The electric actuators used feature following benefits:

- Position feedback via relais (open/close/middle)
- Heating element to prevent condensation
- Optical position indicator with LED status monitoring
- Third position between “open” and “closed” optional
- Relay output for “ready to operate” and 7-segment error display
- Integrated manual override with magnetic lock
- Long service life due to robust design and superior electronics
- Flexible configuration thanks to modular concept
- Numerous monitoring and control options
- Simple handling

COOL-FIT 4.0 transition fittings, flange joints

Transition fittings and flange connectors enable connections to different systems in either metal or plastic, such as the Georg Fischer systems iFIT or Sanipex MT. The components are supplied including PE- insulation half shells with a protective PE jacket. The sealing faces between the shells are vapor tight by their design. No additional tape or sealant is required.

	Size	Material	Thread type/ connector/bolt circle
Adaptor fitting to metal	d32 – d63 ½" – 2"	PE – stainless steel	male thread (R, NPT), female thread (Rp, NPT), loose nut (G)
Adaptor Fitting to iFIT or Sanipex MT	d32	Stainless steel / Brass	iFIT, Sanipex MT
Unions	d32 – d63 d32 – d110	PE – PE, PE – ABS	Welding spigots cementing sockets
Flange Adaptor (flange joints)	d32 – d225	PE	Suitable for Bolt circle PN 16/10

COOL-FIT 4.0 flex hoses

The flexible hoses in EPDM permit mobile access to devices such as chillers and fan coils. In addition to this the flex hose are compensating expansion or contraction within the system. The tear-resistant protective jacket and EPDM insulation ($\lambda_{0°C}$ ≤ 0.036 W/mK) ensure the temperature of the cooling medium remains unchanged. Versatile connectivity options mean that system connection is ensured: G thread (male thread + loose nut including gasket)

d (mm)	DN (mm)	Thread	Length (mm)	Max. compensation ΔL (mm)	Rmin (min. bending radius) (mm)
d20	DN15	½"	1000	276	119
d25	DN20	¾"	1000	161	156
d32	DN25	1"	1000	68	192
d40	DN32	1 ¼"	1500	233	252
d50	DN40	1 ½"	2000	396	312
d63	DN50	2"	2000	233	372

COOL-FIT 4.0 Installation fittings type 313

Installation fittings are used to install various types of sensors to the system. Pressure or temperature sensors can be connected using the ½ "or ¾" Rp or NPT female thread.

The insulation is comprised of highly efficient GF-HE foam with excellent insulating capabilities.

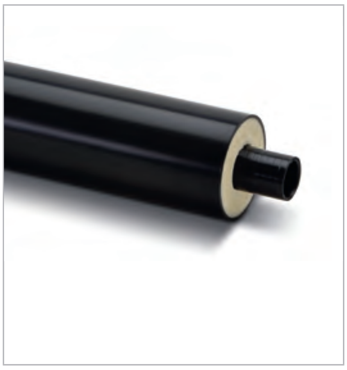
3.2 COOL-FIT 4.0F

COOL-FIT 4.0F pipe

COOL-FIT 4.0F inner pipe is made from PE100. The GF-HE foam insulation has a thermal conductivity λ of 0.026 W/mK. The pipe is protected by the GF fire retardant GF-FR jacket.

All three materials are firmly bonded in order to ensure good insulation properties and low thermal expansion or contraction for the system.

The pipes are available in 5m bars and are already prepared for jointing. They can be connected with all fittings from COOL-FIT 4.0.



Pipe size	Inner Pipe	Inner Pipe	Outer jacket	Weight empty	Weight with Water	Volume	Insulation thickness	Heat transfer coefficient (U)	Fire load
(mm)	d x e (mm)	d_i (mm)	D x e1 (mm)	(kg/m)	(kg/m)	(l/m)	(mm)	(W/m K)	(kWh/m)
d160/250	160 x 9.5	141.0	250 x 3	9.48	25.09	15.61	42.0	0.36	81.51
d225/315	225 x 13.4	198.2	315 x 3.5	15.79	46.65	30.85	41.5	0.48	144.33

d Nominal outer diameter of the PE pipe
d_i Nominal inside diameter of the pipe
D Nominal outside diameter of the outer PE jacket
e, e1 Nominal wall thickness

3.3 COOL-FIT Tools

Electrofusion Machines

Electrofusion machines are required to join COOL-FIT 4.0 components. The range includes dedicated and multipurpose electrofusion machines which are reliable and easy to use.

Georg Fischer Piping Systems recommends: MSA-Series electrofusion machines.

Long Fusion adaptors

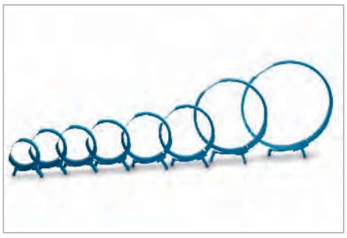
Long Fusion adaptors serve as an extension of the fusion plugs of electrofusion machines. Compared to standard adaptors, the longer adaptor length matches the insulation of the COOL-FIT 4.0 electrofusion Fittings. The long fusion adapters are needed for electrofusion of fittings
d ≥ d160/D250

Y-cable kit for COOL-FIT fixed point

Saves half of the normal welding time of the COOL-FIT fixed points.

Assembly aids

The COOL-FIT 4.0 assembly aids are used for an easy mounting of COOL-FIT 4.0 Fitting on COOL-FIT 4.0 pipe. The assembly aid splays the pre-stressed sealing lips of the fittings enabling the easy insertion of the COOL-FIT 4.0 pipe.



Foam removal tool and peeling tool – manually operated

The foam removal tool is used to prepare shortened COOL-FIT 4.0 pipe for electrofusion. The tool removes the foam and cuts outer jacket, and also peels the surface of the inner pipe. Any oxide layer present is removed when the welding zone is treated.The tool is available in two versions:

1. for sizes d32 – d90,
2. for sizes d110 – d225.
3. for sizes d250 – d450.

Clamping tool

The fusion process gives rise to forces that can pull the pipe out of the coupler. Therefore it is recommended that the assembly should be fitted with COOL-FIT installation clamps. This prevents movement during the welding and cool-down process.
The central hinge allows the use of the clamps on elbows and reducers. Depending on the length of the pipe, 2 or 4 of the glass-reinforced plastic holders can be used. The linkage is made of galvanized steel. Tension bands are included and a T-adapter is optional available.

4 Dimensioning and Design

4.1 General information about the dimensioning and installation of plastic piping

Plastics have different physical characteristics to metals. When designing and installing thermoplastic piping systems, this needs to be taken into account. Although PE and COOL-FIT 4.0 are very robust systems, care should be taken to avoid damage during handling and transportation.

For over 50 years, GF Systems has developed and sold a variety of plastic piping systems which are subjected to very rigorous demands, such as optimized insulation properties in cooling applications. Experience has shown that plastic provides an economical and reliable alternative to metal when designers and installers take account of the recommendations in the technical documentation. In the professional production of plastic piping systems, for example, piping systems must be able to move to accommodate changes in length caused by temperature and pressure changes. To allow for these changes in length, the use of pipe holders that permit this movement is vital.

The following technical information contains the basic information needed to ensure an economical and trouble-free installation. However, this chapter does not contain all of the details. For more information, or if you have specific questions, please call your local GF Piping Systems representative. Additional information is available on the official GF Piping Systems website.

4.2 COOL-FIT 4.0 pressure-temperature diagram

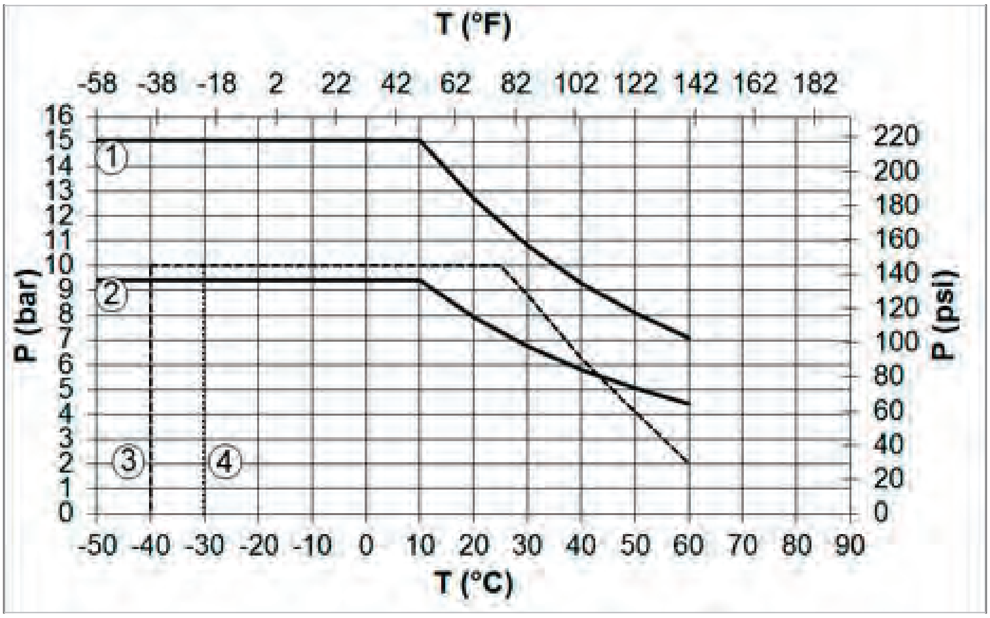
The pressure resistance for thermoplastic pipe for water is always specified at +20 °C. At higher temperatures allowance must be made for a lower maximum operating pressure.

The graph shows the maximum permissible pressure for COOL-FIT 4.0 pipe and fittings at various temperatures, up to the maximum permissible media temperature of +60 °C. The graph is based on an ambient temperature of +20 °C. A safety factor of 1.6 and a minimum lifespan of 25 years have been allowed for in all calculations.

The values given in this chapter apply to both COOL-FIT 4.0 and COOL-FIT 4.0F.

Pressure/temperature limits for COOL-FIT 4.0 pipe, fittings, valves – water as secondary refrigerant

Limits for COOL-FIT 4.0: 25-year values allowing for the safety factor 1.6 (with water as the secondary refrigerant).



P Allowable pressure (bar, psi)
T Temperature (°C, °F)
C Safety factor

① COOL-FIT 4.0 Pipe and fitting d32 – d450, C1.6, SDR11
② COOL-FIT 4.0 Pipe and fitting d160 – d450, C1.6, SDR17
③ COOL-FIT 4.0 Ball valve PN10
④ COOL-FIT 4.0 Butterfly valve PN10

Influence of secondary refrigerants with antifreeze additives

At media temperatures below 0 °C, antifreeze must be used in the water to prevent it from freezing during a plant shut-down.

COOL-FIT 4.0 is generally resistant to secondary refrigerants such as glycol and salt solutions. For some refrigerants a reduction factor is necessary depending on the type and mixing ratio. The permissible operating pressure is corrected downwards from the pressure-temperature curve for water.

Reduction factors	COOL-FIT 4.0 Pipe and Fitting	COOL-FIT 4.0 Valves
Inorganic brine solutions	F = 1	F = 1
Organic salt solutions	F = 1	F = 1.25
Glycol solutions (max. 50 %)	F = 1.1	F = 1.7

For the calculation, the following formula is used:

$$P_{AF} = \frac{P_w}{AF}$$

P_{AF} Permissible pressure with reduction factor
P_W Permissible pressure for water
AF Reduction factor

Glycol solutions

COOL-FIT 4.0 can be used with glycol solutions with concentrations up to 50%. The chemical resistance of COOL-FIT 4.0 systems is suitable for the following antifreeze types:

Brand name	Manufacturer	Type
Antifrogen N	Clariant	Ethylene glycol
Antifrogen L	Clariant	Propylene glycol
Showbrine Blue Showa standard EC brine	Showa Brine	Ethylene glycol
Tyfocor L	Tyfo	Propylene glycol
Tyfocor	Tyfo	Ethylene glycol
DOWFROST	DOW	Propylene glycol
Zytrec FC	Frigol	Propylene glycol
Zytrec LC	Frigol	Propylene glycol
Zytrec MC	Frigol	Ethylene glycol
Neutrogel Neo	Climalife Dehon	Ethylene glycol
Friogel Neo	Climalife Dehon	Propylene glycol
DOWTHERM SR-1	DOW	Ethylene glycol

When using other secondary refriegerants, compatibility with COOL-FIT 4.0 should be clarified with Georg Fischer Piping Systems.

Example – glycol dissolved in water

For water-glycol mixture ≤ 50%, the reduction factor for the pressure-temperature diagram is 1.7 (for COOL-FIT 4.0 valves). Thus, at +10 °C, with a minimum life of 25 years, the maximum allowable working pressure is reduced as follows:

$$P_{AF} = \frac{10 \text{ bar}}{1.7} = 5.88 \text{ bar}$$

Organic salt solutions

These media are usually potassium formates or potassium acetates: aqueous solutions with low viscosity at low temperatures. COOL-FIT 4.0 can be used with the media below. The manufacturer's instructions must be followed.

Brand name	Manufacturer	Type
Antifrogen KF	Clariant	Brine
Zytrec S-55	Frigol	Brine
Temper	Temper	Brine
Hycool	Addcon	Brine

For detailed information on resistance and reduction factors, see Planning Fundamentals "Material selection – Chemical resistance".

4.3 Polyethylene (PE)

The dominant material for the COOL-FIT 4.0 system is polyethylene (PE). As the inner pipe which comes into contact with the media is made of PE-100, its properties are of particularly high relevance.

Properties of PE (approximate)

Property	PE 100-value[1]	Unit	Testing standard
Density	0.95	g/cm³	EN ISO 1183-1
Yield stress at 23 ° C	25	N/mm²	EN ISO 527-1
Tensile modulus at 23 ° C	900	N/mm²	EN ISO 527-1
Charpy notched impact strength at 23 ° C	83	kJ/m²	EN ISO 179-1/1 eA
Charpy notched impact strength at -40 ° C	13	kJ/m²	EN ISO 179-1/1 eA
Crystallite melting point	130	°C	DIN 51007
Thermal conductivity at 23 ° C	0.38	W/m K	EN 12664
Water absorption at 23 ° C	0.01 to 0.04	%	EN ISO 62
Color	9,005	-	RAL
Oxygen Index (LOI)	17.4	%	4589-1

[1] Typical, measured on material characteristics, should not be used for calculations.

General information

All polymers made from hydrocarbons of the formula CnH2n are constructed with a double bond (ethylene, propylene, butene-1, isobutene) are referred to collectively as polyolefins. Among them is polyethylene (PE). It is a semi-crystalline thermoplastic. Polyethylene is probably the best known plastic. The chemical formula is: -(CH2-CH2)n. Polyethylene is an environmentally friendly hydrocarbon product. PE, like PP, is a non-polar material. Therefore, it is insoluble and scarcely swellable in conventional solvents. PE pipe cannot therefore be adhesively bonded to fittings. Welding is the appropriate connection method for the material.

The most widespread in piping system construction is PE for use in underground gas and water pipe. In this area polyethylene has become the dominant material in many countries. However, the advantages of this material mean that it is also used in domestic installations and industrial piping.

Advantages of PE

- Light weight
- Excellent flexibility
- Good wear resistance (abrasion resistance)
- Corrosion resistance
- Ductile fracture properties
- High impact strength even at very low temperatures
- Very good chemical resistance
- Weldable

Mechanical properties, chemicals, weathering and abrasion resistance

UV and weather resistance

Because of the black pigments used, polyethylene is very weather resistant. Even at long exposure to direct sunlight, wind and rain the material can be used without restrictions.

Chemical resistance

Polyethylene exhibits good resistance to a wide range of media. For detailed information, please see the detailed chemical resistance list from Georg Fischer Piping Systems, or contact the person responsible at Georg Fischer Piping Systems directly.

Abrasion resistance

PE has excellent resistance to abrasive wear. You can therefore find PE piping systems in use in numerous applications for transporting solids and media containing solids. For many applications, PE has proven especially advantageous with metals.

Thermal and electrical properties

Operating limits

The application limits of the material depend on both embrittlement and softening temperatures and on the manner and method of application. Details are provided in the relevant pressure-temperature charts.

Electrical properties

Polyethylene, like most thermoplastics, is non-conductive. This means that systems in PE do not suffer from electrolytic corrosion. However, the non-conductive properties must be taken into consideration, as electrostatic charges can build up in the pipe. Polyethylene has good electrical insulation properties. The volume resistance is 3.5×10^{16} Ωcm, the surface resistance 10^{13} Ω. This must be taken into account in applications where there is danger of fire or explosion.

4.4 Fire behavior and fire prevention measures

Firestop classes

Classification of fire behavior

Construction materials are classified into different firestop classes depending on their fire behavior. The classification is decisive for whether specific materials may be legally used for construction in certain areas of construction projects.

European classification according to EN 13501-1

In the year 2001, the EN 13501-1 was introduced, a European classification system for construction materials. EN 13501-1 defines 6 construction material classes from A to F:

A	No contribution to the development of a fire (A1, A2)
B	Very little contribution to the development of a fire
C	Limited contribution to the development of a fire
D	Acceptable contribution to the development of a fire
E	Acceptable fire behavior
F	No performance criteria detected

In addition to the fire behavior, the European standard also rates fire side effects: smoke release (s1, s2, s3) and burning droplets (d0, d1, d2).

Smoke release:

s1	Limited smoke release
s2	Average smoke release
s3	High smoke release, or smoke release not tested

Burning droplets:

d0	No burning droplets/fall off within 600 seconds
d1	No burning droplets/fall off with an afterglow time of more than 10 seconds within 600 seconds
d2	No performance criteria detected

Fire prevention classes COOL-FIT 4.0 EN13501-1, VKF and British building codes

	COOL-FIT 4.0	COOL-FIT 4.0F	COOL-FIT 4.0/ mineral wool [2]
			
EN 13501-1	E	B – s2, d0	$A2_L$
VKF	RF3cr*	RF2	RF1
BS 5422:2009[1]	National Class 3	-	National Class 0

1 Test method according to BS 476-6 and BS 476-7
2 Type: Rockwool 800
* RF3 for d>=d160mm

Thermal load

The thermal load corresponds to a thermal potential (energy release) related to a specific base area, fire section area in m^2, for example an escape route. The physical unit for the thermal load is energy per surface area kWh/m^2. The calculative thermal load is equivalent to the sum of the different thermal potentials of all used combustible used elements, such as pipelines. When the energy released per running meter of the pipe (kWh/m) is known, the thermal load of the pipe is calculated from the used pipe length.

d/D (mm)	32/90	40/110	50/110	63/125	75/140	90/160	110/180
Thermal load COOL-FIT 4.0 SDR11 pipes (kWh/m)	15.0	21.7	24.0	32.7	41.4	53.1	68.9

d/D (mm)	160/250	225/315	250/355	280/400	315/450	355/500	400/560	450/630
Thermal load COOL-FIT 4.0 SDR17 pipes (kWh/m)	109.3	187.0	214.0	277.8	341.4	432.4	546.7	653.0

d/D (mm)	160/250	225/315	250/355	280/400	315/450	355/500	400/560	450/630
Thermal load COOL-FIT 4.0 SDR11 pipes (kWh/m)	134.5	236.4	275.1	354.1	437.9	554.4	702.7	850.7

d/D (mm)	160/250	225/315
Thermal load COOL-FIT 4.0F pipes (kWh/m)	106.75	193.73

Fire resistance of components

While the fire behavior characterizes individual materials, the fire resistance must be considered for complete components, for example a solid wall with pipe perforations. The fire resistance is equivalent to the amount of time in which a component maintains its function during a standard fire.

The European system allows classification according to different criteria, stating the respective fire resistance duration in minutes.

Fire resistance and classification according to the European standards

Pipe insulation systems are exposed to a standard fire according to EN 1363-3. Classification is according to EN 13501-2 and generally includes the criteria integrity (E, Étanchéité) and thermal insulation (I, Insulation).

Abbreviation	Criterion	Rating
E – Étanchéité	Flame protection or integrity	Measurement of an element's capacity of preventing the passage of gases and flames in case of fire.
I – Insulation	Insulation or thermal insulation	Measurement of the insulation capacity of an element, i.e. the duration in which the side of the element facing away from the fire does not exceed 180° C + the ambient temperature.

Firestop collars/Fire sealing

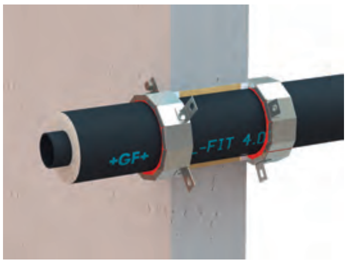
When pipes are installed through fire-rated assemblies, whose reliable functioning must not be affected, firestop collars that comply with local requirements and legislation must be used.

Hilti firestop

System description

The firestop collar (inlc.fastening hook) is made of galvanized steel sheet into which strips of intumescent material (i.e. that swells in case of fire) are inserted.

The fire retardation sealing with straight pipes is regulated in conjunction with the following products in the individual countries:



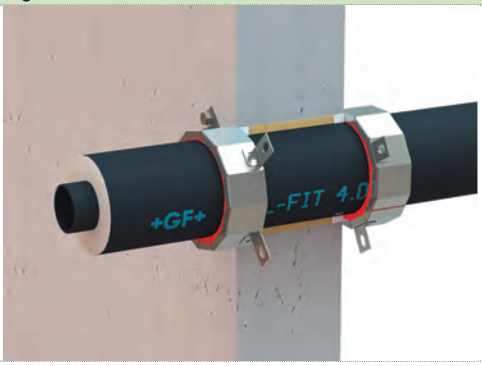
Product	Proof of applicability	Countries
Hilti firestop collar CP 644	Allgemeine Bauartgenehmigung (aBg) Z-19.53-2330	DE
Hilti firestop collar CP 644	VKF Technische Auskunft 14108	CH
Hilti firestop collar CFS-C P	ETA-10/0404	EU

The respective details of the proofs of application must be taken into account.

Additional information is available at Hilti online or from your Hilti contact person.

Hilti CP 644	Hilti CFS-C P
Info | Shop qr.hilti.com/r3069	Info | Shop qr.hilti.com/r4831

The following applications are regulated via the above proofs of application:

Rigid walls, thickness ≥ 100 mm	Rigid floor, thickness ≥ 150 mm
	

Fire-retarding sealing

COOL-FIT 4.0 pipes up to and including an outside diameter D of 250mm, can be sealed in rigid walls and D of 140mm in rigid floors by a Hilti fire protection collar.

Wall ≥ 100mm solid		Product DE, CH	Product EU	Fire resistance	Mounting
d [mm)	**D (mm)**	**CP 644**	**CFS-C P**		**Number of hooks**
32	90	CP 644-90/3"	CFS-C P 90/3"	EI 120-U/C	3
40	110	CP 644-110/4"	CFS-C P 110/4"	EI 120-U/C	4
50	110	CP 644-110/4"	CFS-C P 110/4"	EI 120-U/C	4
63	125	CP 644-125/5"	CFS-C P 125/5"	EI 120-U/C	4
75	140	CP 644-160/6"	CFS-C P 160/6"	EI 120-U/C	6
90	160	CP 644-160/6"	CFS-C P 160/6"	EI 120-U/C	6
110	180	CP 644-180/7"	CFS-C P 180/7"	EI 120-U/C	8
160	250	CP 644-250/10"	CFS-C P 250/10"	EI 120-U/C	12

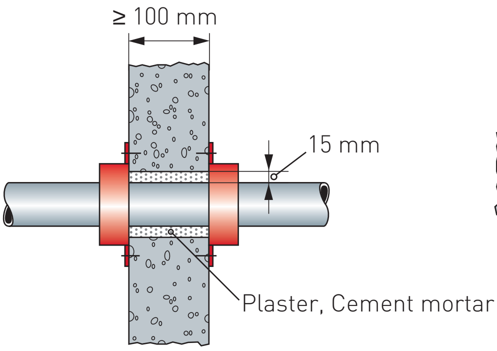
Ceiling ≥ 150mm solid		Product DE, CH	Product EU	Fire resistance	Mounting
d (mm)	**D (mm)**	**CP 644**	**CFS-C P**		**Number of hooks**
32	90	CP 644-90/3"	CFS-C P 90/3"	EI 120-U/C	3
40	110	CP 644-110/4"	CFS-C P 110/4"	EI 120-U/C	4
50	110	CP 644-110/4"	CFS-C P 110/4"	EI 120-U/C	4
63	125	CP 644-125/5"	CFS-C P 125/5"	EI 120-U/C	4
75	140	CP 644-160/6"	CFS-C P 160/6"	EI 120-U/C	6

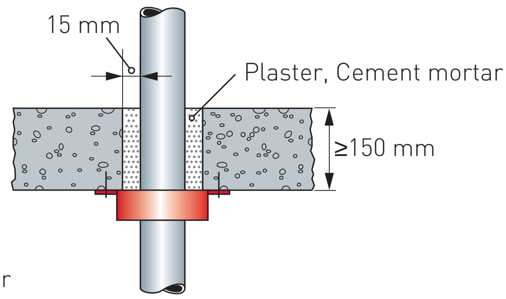
Gap sealing

For the installation situations there are several options for sealing gaps against smoke gas.

Gap sealing with non-combustible construction materials:

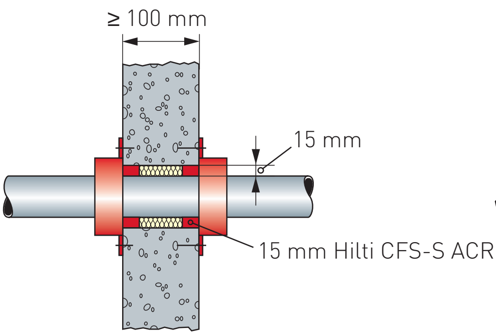
Rigid wall | **Rigid floor**

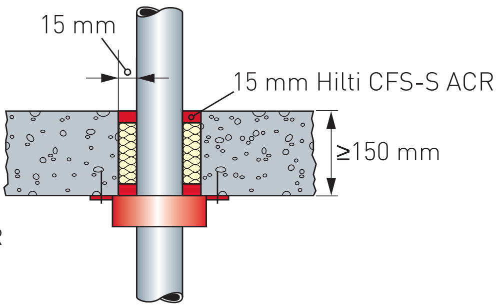




Joint closure with Hilti firestop sealant CFS-S ACR and mineral wool backfill up to 15mm annular gap width for Hilti firestop collar CP 644 and CFS-C P.

Rigid wall | **Rigid floor**



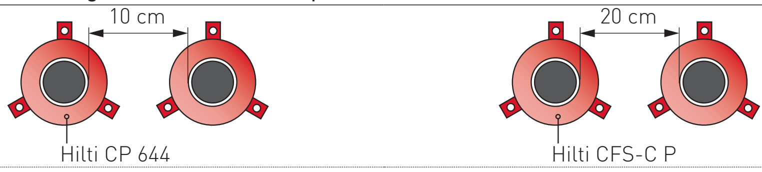


Distance regulations

The distance of the component openings to be closed to other openings or installed elements must comply with the data provided in the following table.

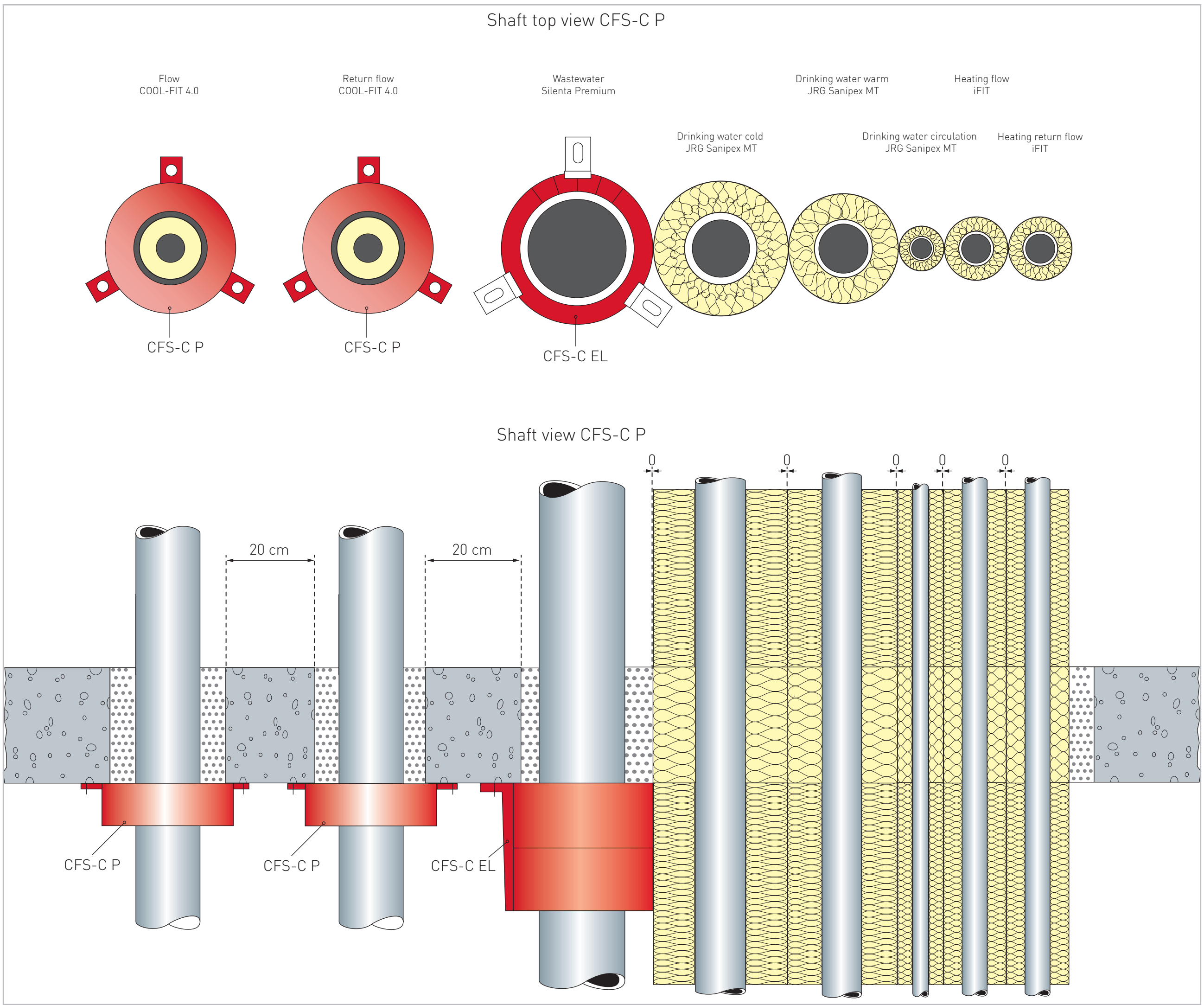
Distance of the pipe sealing to	Size of the adjacent openings	Distance between the openings DE, CH	Distance between the openings EU
Other cable or pipe sealing	one/both openings > 40cm x 40cm	≥ 20cm	≥ 20cm
	Both openings ≤ 40cm	≥ 10cm	
Other openings or installed elements	one/both openings > 20cm x 20cm	≥ 20cm	≥ 20cm
	Both openings ≤ 20cm	≥ 10cm	

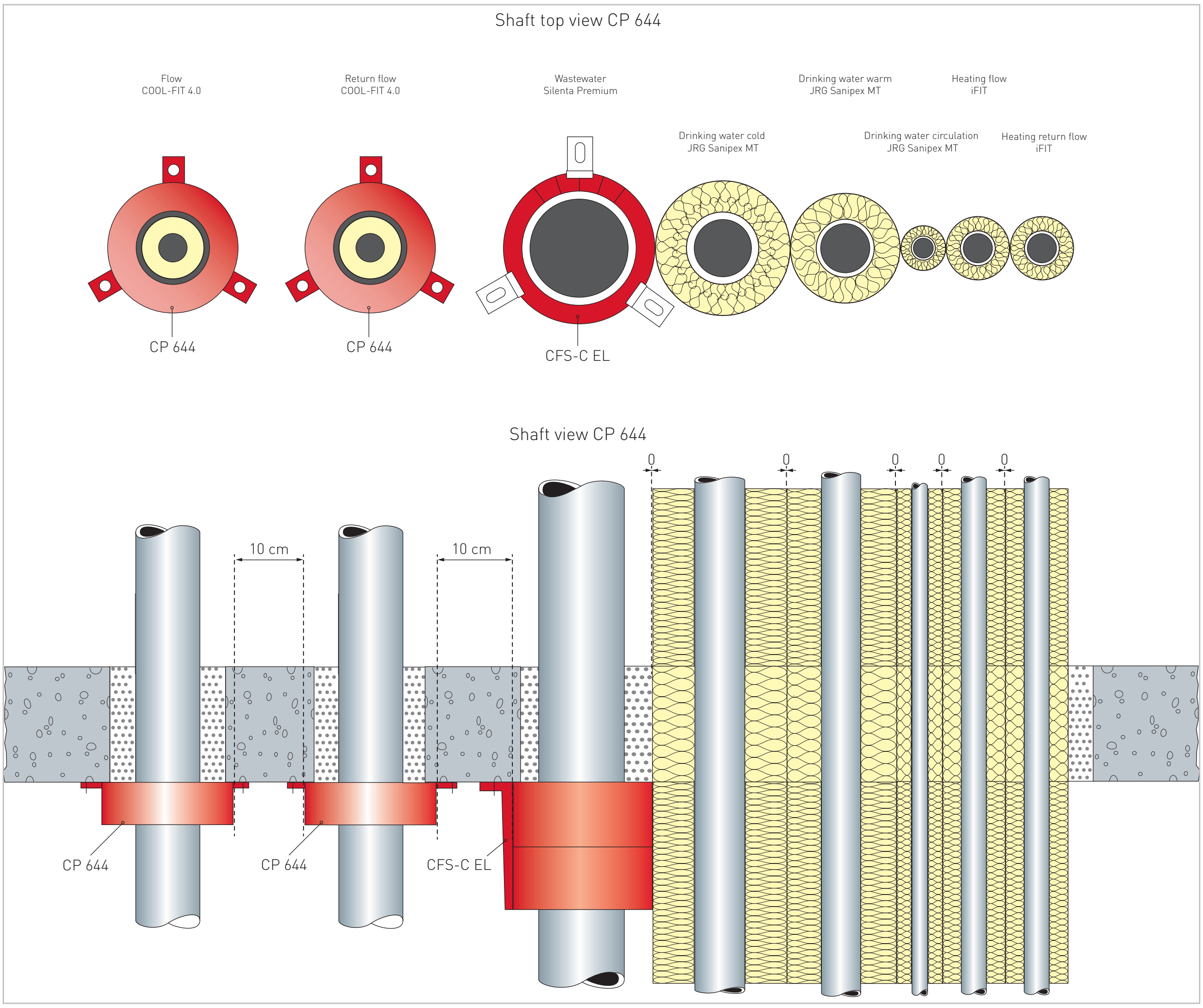
The following pipe distances between the openings of the pipe lead through are derived from this for pipe sealing with the Hilti firestop collar for COOL-FIT 4.0:



Shaft installation

A shaft installation with additional pipelines, for example for heating and drinking water, may look as follows:




Shaft top view CP 644
Flow
COOL-FIT 4.0
Return flow
COOL-FIT 4.0
Wastewater
Silenta Premium
Drinking water cold
JRG Sanipex MT
Drinking water warm
JRG Sanipex MT
Drinking water circulation
JRG Sanipex MT
Heating flow
iFIT
Heating return flow
iFIT
CP 644
CP 644
CFS-C EL
Shaft view CP 644
10 cm
10 cm
0
0
0
0
0
CP 644
CP 644
CFS-C EL

Additional approved fire retarding sealing

The following firestop collars were tested with COOL-FIT 4.0 / 4.0F pipes.

Fire-retarding sealing	Manufacturer	Approval
ROKU ® AWM II	Rolf Kuhn GmbH	ETA 17/0753
BIS Pacifyre ® AWM II	Walraven	ETA 17/0753

The firestop system ROKU® R – type AWM II carries the European technical approval ETA 17/0753. COOL-FIT 4.0 (up to dimensions d355/D500) and 4.0F was tested with AWM II firestop collars.

For detailed product information on AWM II see www.kuhnbrandschutz.com.

ROKU® System AWM II

System description

The ROKU® system AWM II consists of a firestop collar housing, which is equipped on the inside with several layers of the highly effective intumescent material "ROKU® Strip." In case of fire, the foaming material reacts with a strong foaming pressure and permanently seals the construction component opening against fire and smoke. On walls, one collar should be fitted on each side, and on ceilings only one collar underneath the ceiling.

Application areas
- Sealing of plastic pipes up to Ø 400 mm in solid walls, light partition walls, and solid ceilings
- For plastic pipes, mineral fiber-reinforced plastics, plastic composite pipes
- Suitable for insulated and non-insulated plastic pipes and acoustically insulating sewage pipes

Solutions for emergency corridors

Within emergency corridors the use of only non-combustible materials is allowed. The supplier Rockwool offers with Rockwool 800 a protection sleeve, made of mineral wool, which allows the use of normal combustible pipe within emergency areas. This solution is approved on pipe outer diameters of up to 160 mm.

For detailed information about Rockwool 800 see: www.rockwool.de.

4.5 Hydraulic design

Determination of pipe diameter based on flow rate

As a first approximation, the required pipe cross-section for a certain flow rate can be calculated using the following formula:

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

v	flow velocity (m/s)
d_i	Pipe internal diameter (mm)
Q_1	Flow rate (m^3/h)
Q_2	Flow rate (l/s)
18.8	Conversion factor for units Q_1 (m^3/h)
35.7	Conversion factor for units Q_2 (l/s)

Example calculation of an internal diameter d_i

COOL-FIT 4.0 pipe	SDR17
Flow rate Q_2	55 l/s
Usual flow velocity v	1.5 m/s

$$d_i = 35.7 \cdot \sqrt{\frac{55}{1.5}} = 216.2 \text{ mm}$$

A pipe with d225/D315 is used. After the internal diameter has been determined that way, the actual flow rate is determined with the following formula:

$$v = 354 \cdot \frac{Q_1}{d_i^2} = 1.8 \, \frac{m}{s} \quad \text{oder} \quad v = 1275 \cdot \frac{Q_2}{d_i^2} = 1.8 \, \frac{m}{s}$$

v	Flow velocity v (m/s)
d_i	Pipe internal diameter (mm)
Q_1	Flow rate (m^3/h)
Q_2	Flow rate (l/s)
354	Conversion factor for units Q_1 (m^3/h)
1275	Conversion factor for units Q_2 (l/s)

V

Determination of pipe diameter based on cooling capacity

As a first approximation, the required pipe cross section for a certain cooling power can be calculated using the following formula.

Formulas for calculating pressure losses

$$di = 18.8 \cdot \sqrt{\frac{\left(\frac{Q_L \cdot 3600}{\Delta T \cdot c \cdot \rho}\right)}{v}}$$

di Pipe inner diameter (mm)
Q_L Cooling capacity in kW
ΔT Temperature difference supply - return (K)
c Specific heat capacity (kW*s/(kg*K))
ρ Density of the medium (kg/m³)
v Flow velocity (m/s)

L laid pipe length

Example for calculating the inner diameter d_i based on cooling capacity with water medium water

Cooling capacity Q_L	2000 kW
Specific heat capacity (20 °C) c	4.187 kJ/(kg*K)
Water density (20 °C) ρ	998.2 kg/m³
Temperature difference ΔT	10 K
Flow velocity v	1.5 m/s

$$di = 18.8 \cdot \sqrt{\frac{\left(\frac{2000 \cdot 3600}{10 \cdot 4.187 \cdot 998.2}\right)}{1.5}} = 18.8 \cdot \sqrt{\frac{172.3}{1.5}} = 201.5 \text{ mm}$$

The flow rate should be estimated on the basis of the intended purpose of the pipe. As a guide for the flow rate, the following specifications apply.

Liquids

v = 0.5 – 1.0 m/s for the suction side

v = 1.0 – 3.0 m/s for the pressure side

This method of calculation of pipe diameter does not allow for hydraulic losses. They must be calculated separately. The following sections serve that purpose.

Conversion table with units of flow rate.

(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	60 000	1000	1.0

Correlation of outer diameter - inner diameter

To determine the outer diameter based on the internal diameter and SDR, the following formula can be used:

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

Correlation between pipe external and internal diameter

d (mm)	32	40	50	63	75	90	110
di SDR11 (mm)	26.2	32.6	40.8	51.4	61.4	73.6	90
di SDR17 (mm)	-	-	-	-	-	-	-

d (mm)	160	225	250	280	315	355	400	450
di SDR11 (mm)	130.8	184	204.6	229.2	257.8	290.6	327.4	368.2
di SDR17 (mm)	141	198.2	220.4	246.8	277.6	312.8	352.6	396.6

4.6 Nomogram for easy calculation of diameter and pressure loss

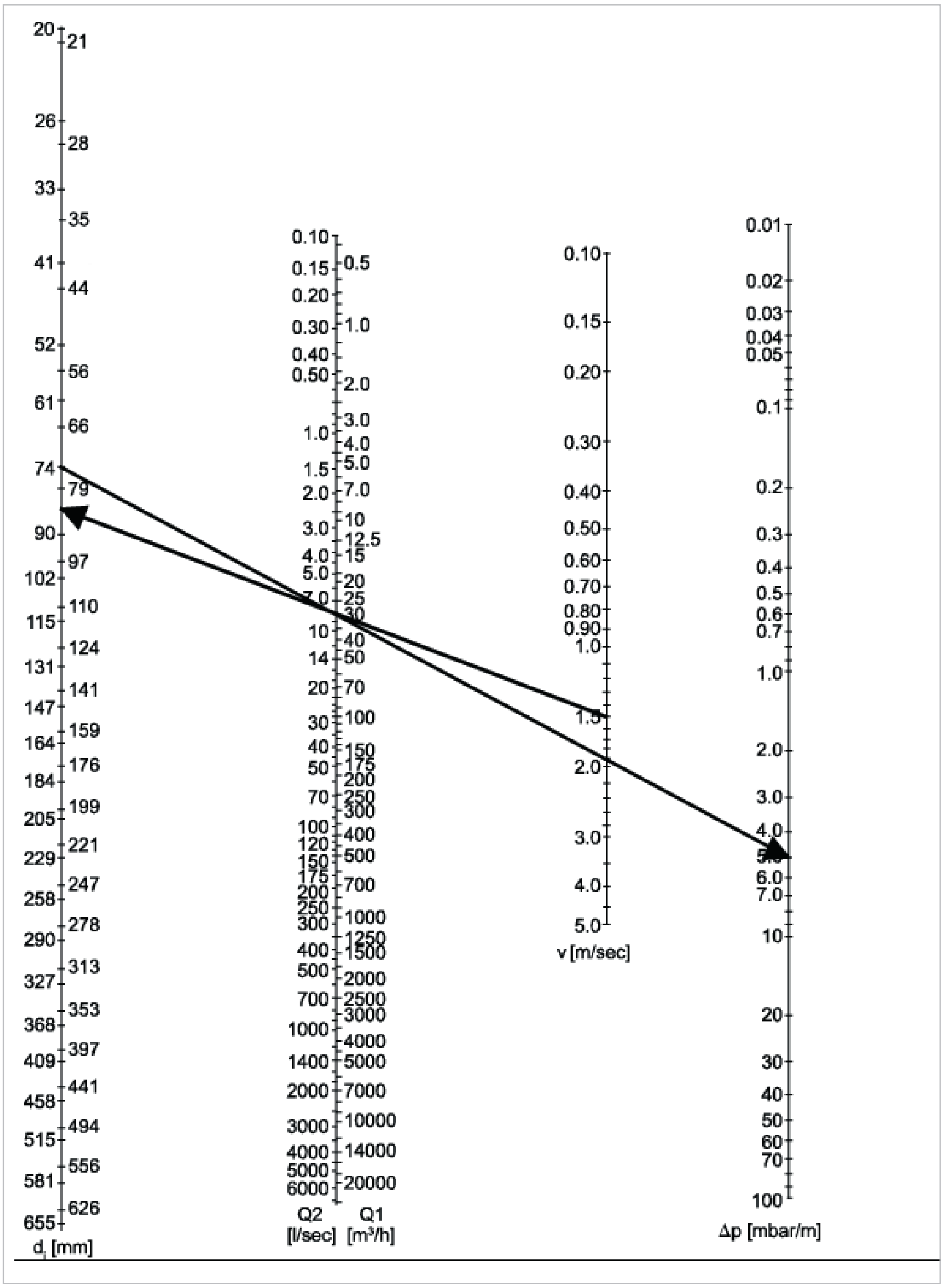
The nomogram below can be used to simplify the determination of the diameter required .The pressure loss in the pipe can be read off per meter of the pipe length.

⚠ **The pressure loss calculated using the nomogram only applies to flows of substances with density 1000 kg/m³, i.e. water. Further pressure losses from fittings, valves, etc. also need to be considered using the instructions that follow.**

Using the nomogram

Based on a flow velocity of 1.5 m/s, a line is drawn through the desired flow rate (i.e. 30 m³/h) to the axis which shows an internal diameter di (≈ 84 mm). Here, a closely matching diameter (74 mm for SDR11) and a second line is drawn back through the desired flow rate to the pressure drop axis Δp (5 mbar per meter of pipe).

Nomogram for COOL-FIT 4.0 pipe (PE, SDR11) using the metric system



V

For detailed information on the determination of diameter and pressure loss, see Planning Fundamentals "Hydraulic calculation and pressure losses of metric industrial piping systems".

4.7 Pressure loss

Pressure loss in straight pipe

In determining pressure losses in straight pipe sections, a distinction is made between laminar and turbulent flows. The Reynolds number (Re) determines this. The change from laminar to turbulent occurs at the critical Reynolds number $Re_{crit} = 2320$.

In practice laminar flows occur particularly for the movement of viscous liquids such as lubricating oils. In most applications, thus including flows of aqueous materials, there is turbulent flow with a substantially more uniform velocity distribution over the pipe cross-section than in laminar flow.

The pressure loss in a straight pipe section is inversely proportional to the pipe diameter and is calculated as follows:

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

Δp_R	Pressure loss in the straight pipe run (bar)
λ	Pipe friction factor
L	Length of the straight pipe section (m)
d_i	Inner diameter of the pipe (mm)
ρ	Density of the flow material (kg/m^3) (1 g/cm^3 = 1000 kg/m^3) for water 20 °C = 998.2 kg/m^3
v	Flow velocity v (m/s)

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.

Pressure losses 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 coefficient of resistance (ζ value) is used for calculations.

Fitting type	Coefficient of resistance ζ	
Elbow 90°	1.2	
Elbow 45°	0.3	
T-90[1)]	1.3	
Reducer (contraction)	0.5	
Reducer (extension)	1.0	
Coupler, Flange joints, Transition Fittings	d32: 0.8 d40: 0.7 d50: 0.6	d63: 0.4 d75: 0.3 d90-d225: 0.1
Flexible hoses	½": 2.0 ¾": 1.8 1": 1.4	1 ¼": 1.1 1 ½": 1.0 2": 0.8

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 T 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 piping system, 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:

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

Δp_{Fi}	Pressure loss of all fittings (bar)
$\Sigma\zeta$	Sum of all individual losses
v	Flow velocity v (m/s)
ρ	Density of the medium in kg/m³ (1 g/cm³ = 1000 kg/m³)

Pressure losses 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. It is defined as the flow rate of water in liters per minute with a pressure drop of 1 bar across the valve. The technical data of the Georg Fischer Piping Systems valves contains the k_v values as well as pressure loss charts. 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:

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

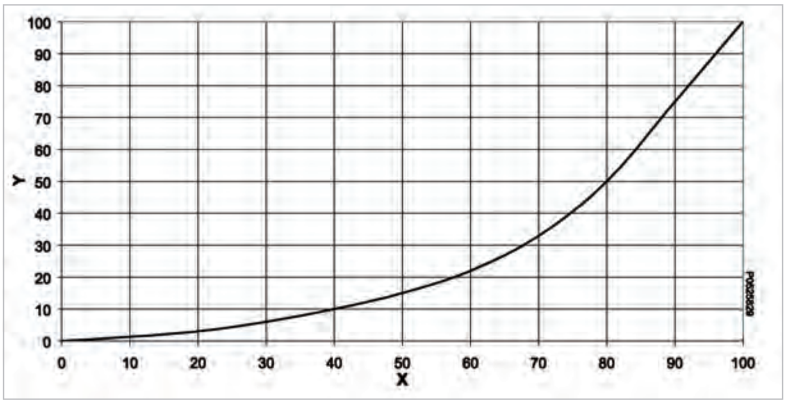
Δp_{Ar}	Pressure loss for the valve (bar)
Q	Flow rate (m³/h)
ρ	Density of the conveyed medium (kg/m³) (1 g/cc = 1000 kg/m³)
k_v	Valve characteristic value (m³/h)

k_v 100-Werte

DN (mm)	Zoll (inch)	d (mm)	k_v 100 (l/min)	Cv 100 (gal/min)	k_v 100 (m³/h)
25[1]	1	32	700	49.0	42
32[1]	1 ¼	40	1000	70.0	60
40[1]	1 ½	50	1600	112.0	96
50[1]	2	63	3100	217.1	186
65[1]	2 ½	75	5000	350.0	300
80[1]	3	90	7000	490.0	420
100[2]	4	110	6500	455	390
150[2]	6	160	16600	1162	1000
200[2]	8	225	39600	2772	2380

1 COOL-FIT 4.0 Ball valve
2 COOL-FIT 4.0 Butterfly valve

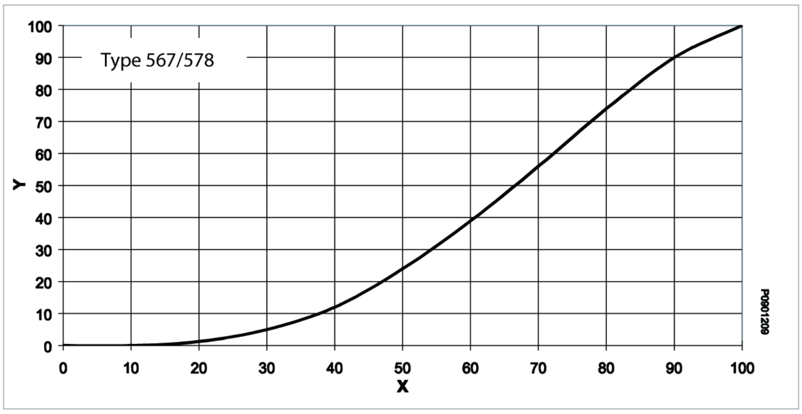
Flow characteristic Ball valve



X Opening angle (%)
Y k_v, Cv value (%)

V

Flow characteristic butterfly valve



X Opening angle (%)
Y k_v, Cv value (%)

Pressure difference between the static pressure

If the piping system is installed vertically, then a geodetic pressure difference must be calculated for it. This pressure difference is calculated as follows:

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

Δp_{geod}	Geodetic pressure difference (bar)
ΔH_{geod}	Difference in elevation of the piping system (m)
ρ	Density of the medium (kg/m³) (1 g/cm³ = 1000 kg/m³)

At closed systems, the geodetic pressure difference does not need to be considered

Sum of pressure losses

The sum of all pressure drops for a piping system is calculated as follows:

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

Example for pressure drop calculations

The following example illustrates the calculation process for determining the pressure loss of a piping system.

		Number of Fittings
COOL-FIT 4.0 pipe	d40 mm	12 x 90° angle
SDR11 - flow rate	1.5 l/s	4 x 45° angle
Medium	Water	3 x T-piece
Density of the medium	1.0 g/cm³	3 x screws
Length straight pipe	15 m	2 x flange connections
Height difference	2.0 m	1 x ball valve, 80 % opened

L laid pipe length

The wall thickness of the piping system can be calculated as follows with the SDR:

$$e = \frac{d}{SDR} = \frac{40\text{ mm}}{11} = 3.6\text{ mm}$$

The inner diameter of the piping system is as follows:

$$d_i = d - 2 \cdot e = d - \frac{2 \cdot d}{SDR} = 32.8\text{ mm}$$

With the desired flow rate of 1.5 l/s, the flow velocity is as follows:

$$v = 1275 \cdot \frac{Q_2}{d_i^2} = 1275 \cdot \frac{1.5}{32.8^2}\frac{m}{sec} = 1.78\frac{m}{sec}$$

Pressure loss	Formula
Pressure loss for straight pipe sections	$\Delta p_R = 0.02 \cdot \frac{15}{32.8} \cdot \frac{1000}{2 \cdot 10^2} 1.78^2 = 0.14$ bar
Pressure loss for fittings incl. connections	$\Sigma\zeta = (12 \cdot 1.2) + (4 \cdot 0.3) + (3 \cdot 1.3) + (5 \cdot 0.7) = 23$ $\Delta p_{Fi} = 23 \cdot \frac{1.78^2}{2 \cdot 10^5} \cdot 1000 = 0.36$ bar
Pressure loss for the valve 80 % opened. With the flow characteristics diagram for ball valves type 546, from an 80 % opening angle a percentile k_v value of 50 % can be read out,that means 50 % of the k_v value 100: 0.5 * 60 m³/ H (flow rate 1.5 l/s = 5.4 m³/h)	$\Delta p_{Ar} = \left(\frac{5.4}{0.5 \cdot 60}\right)^2 \cdot \frac{1000}{1000} = 0.03$ bar
Pressure loss of height difference	$\Delta p_{geod} = 2.0 \cdot 1000 \cdot 10^{-4} = 0.2$ bar
Whole pressure loss of the piping	$\Sigma\Delta p = 0.14$ bar + 0.36 bar + 0.03 bar + 0.2 bar = 0.73 bar

L laid pipe length

4.8 Dimension comparison COOL-FIT 4.0 metal

COOL-FIT 4.0		Stainless steel	
d (mm)	DN	inches	da (mm)
32	25	1	33.4
40	32	1 ¼	42.2
50	40	1 ½	48.3
63	50	2	60.3
75	65	2 ½	73.0
90	80	3	88.9
110	90	4	114.3
160	150	6	168.3
225	200	8	219.1
250	250	10	244.5
280	250	10	273.1
315	300	12	323.9
355	350	14	355.6
400	400	16	406.4
450	450	18	457.2

d Nominal external diameter of PE pipe

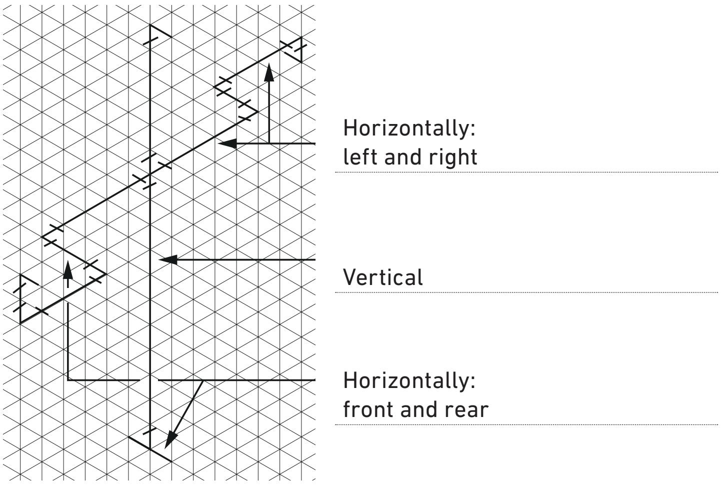
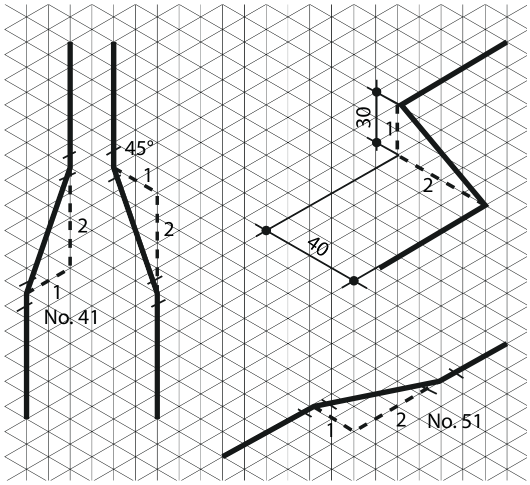
4.9 Z-dimension method

Overview

The pressure of competition and high wages makes it essential to install piping systems efficiently. The Georg Fischer Piping Systems method of assembly is highly suited to this task. It replaces the tedious and time-consuming cutting to size of one pipe at a time by a fast and precise way of preparing whole groups of pipe according to plans or jigs.

The respective pipe group with the corresponding design dimensions and cut lengths can be entered in the isometric paper of Georg Fischer Piping Systems, see Measuring SheetSeite 1243.

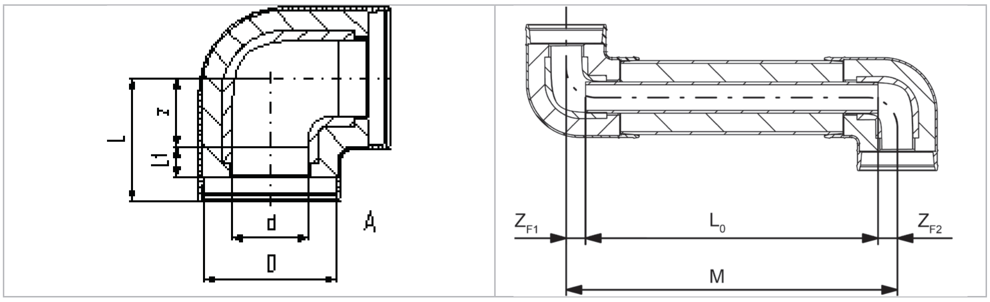
Please adhere to the following guidelines for drawing:

Pipe running perpendicular to one another	Pipe running diagonally
	

The z-dimensions of the fittings are needed for determining the actual cutting lengths of the pipe. The tables in our product ranges and in the online catalogues contain all the relevant data for the fittings. The length of pipe to be cut is given as in the following diagram by the distance between the center of adjoining fittings less the sum of the z-dimension of the fittings.

Procedure

Electrofusion



Formula for determining the required pipe length

$L_0 = M - Z_{F1} - Z_{F2}$

L_0 Pipe length to be cut
M Center to center distance between fittings
z_{F1} z measurement for fitting 1
z_{F2} z measurement for fitting 2

Example

Dimension	d32/D90
Center to center distance M	1000 mm
z measurement for 90° elbow z_{F1}	20 mm
z measurement for 90° elbow z_{F2}	20 mm

M = 1000 mm; L_0 = ?

L_0 = 1000 mm – 20 mm – 20 mm = 960 mm

V

Measuring Sheet

+GF+ **GEORG FISCHER**
PIPING SYSTEMS

Unterteilungsblatt 30°
Feuille de mesurage 30°
Foglio per misure 30°

Firma
Firme ______
Ditta ______

Dat. ______

Bauobjekt
Bâtiment ______
Edificio ______

Blatt Nr.
Feuille No.
Foglio No. ______

Pos.	M - M	– cm	L cm	Ø	

4.10 Length changes and flexible sections

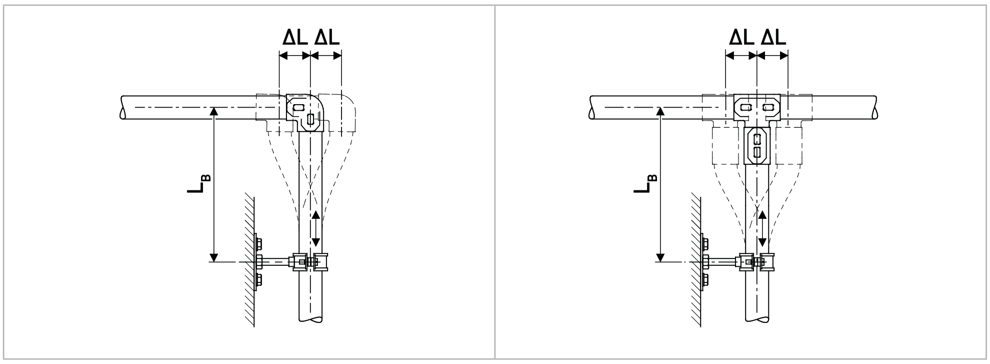
Overview

Length changes ΔL and expansion bend L_B – General

Thermoplastics are subject to higher thermal expansion and contraction than metallic materials. Pipe installed above ground, against walls or in ducts, require changes in length to be taken up in order to prevent any superimposed extra strain on the pipe. This applies especially to pipe exposed to operating temperature variations.

To accommodate a change in length, the following options can be considered:
A Flexible sections
B Flexible hoses
C Compensators

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



ΔL Change in length
L_B Flexible section

Fundamentals

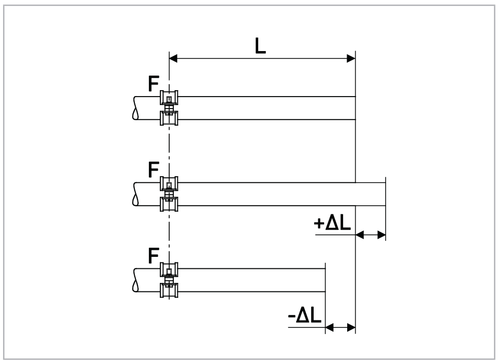
The low elasticity of thermoplastics allows changes in length to be taken up by special pipe sections, where pipe supports are positioned so that they can take advantage of the natural flexibility of the material. The length of such sections is determined by the diameter of the piping system and the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

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

Calculation of length changes

To determine the **change in length due to temperature** ΔL (mm) of COOL-FIT 4.0 pipe, the following temperatures must be known:

Installation temperature
- Minimum flow temperature
- Maximum flow temperature
- Minimum ambient temperature
- Maximum ambient temperature



F Fixpoint
L Length of pipe section

The following tables show changes in length at different media temperatures for certain conditions. To determine the change in length for other conditions, the COOLING Tool-Box can be used. Contact your local GF Piping Systems representative or visit www.gfps.com

Example of use:

Installation temperature	25 °C
Min. ambient temperature	25 °C constant
Max. ambient temperature	25 °C constant
Min. flow temperature	See table
Max. flow temperature	25 °C
Pipe class	d32 - d110 SDR11 and d160 - d450 SDR17

L Laid pipe length

Length change ΔL (mm) at 20° C flow temperature					Length change ΔL (mm) at 15° C flow temperature				
L (m)	25	50	100	150	L (m)	25	50	100	150
d32	-4	-9	-18	-27	d32	-9	-18	-37	-55
d40	-5	-10	-19	-29	d40	-10	-20	-40	-59
d50	-6	-13	-26	-38	d50	-13	-26	-52	-78
d63	-7	-15	-29	-44	d63	-15	-30	-60	-90
d75	-8	-16	-32	-48	d75	-16	-33	-65	-98
d90	-9	-18	-36	-54	d90	-18	-36	-73	-109
d110	-10	-20	-41	-61	d110	-21	-41	-82	-124
d160	-9	-18	-37	-55	d160	-19	-37	-75	-112
d225	-11	-21	-43	-64	d225	-22	-43	-86	-129
d250	-11	-23	-45	-68	d250	-23	-46	-91	-137
d280	-11	-22	-44	-66	d280	-22	-44	-89	-133
d315	-11	-22	-45	-67	d315	-23	-45	-91	-136
d355	-11	-23	-45	-68	d355	-23	-46	-91	-137
d400	-11	-23	-45	-68	d400	-23	-46	-92	-137
d450	-12	-24	-48	-72	d450	-24	-48	-96	-144

L Laid pipe length

Length change ΔL (mm) at 10° C flow temperature					Length change ΔL (mm) at 5° C flow temperature				
L (m)	25	50	100	150	L (m)	25	50	100	150
d32	-14	-28	-56	-84	d32	-19	-38	-76	-115
d40	-15	-30	-61	-91	d40	-21	-41	-83	-124
d50	-20	-40	-80	-120	d50	-27	-54	-109	-163
d63	-23	-46	-91	-137	d63	-31	-62	-124	-185
d75	-25	-50	-100	-150	d75	-34	-67	-135	-202
d90	-28	-55	-111	-166	d90	-37	-75	-149	-224
d110	-31	-62	-125	-187	d110	-42	-84	-168	-252
d160	-28	-57	-114	-171	d160	-38	-77	-154	-230
d225	-33	-65	-130	-196	d225	-44	-88	-175	-263
d250	-34	-69	-138	-207	d250	-46	-93	-185	-278

Length change ΔL (mm) at 10° C flow temperature					Length change ΔL (mm) at 5° C flow temperature				
L (m)	25	50	100	150	L (m)	25	50	100	150
d280	-34	-67	-134	-201	d280	-45	-90	-180	-270
d315	-34	-69	-138	-206	d315	-46	-92	-185	-277
d355	-35	-69	-138	-207	d355	-46	-93	-186	-278
d400	-35	-69	-139	-208	d400	-46	-93	-186	-279
d450	-36	-73	-145	-218	d450	-49	-97	-195	-292

Length change ΔL (mm) at 0° C flow temperature					Length change ΔL (mm) at -5° C flow temperature				
L (m)	25	50	100	150	L (m)	25	50	100	150
d32	-24	-49	-97	-146	d32	-30	-59	-119	-178
d40	-26	-53	-105	-158	d40	-32	-64	-128	-192
d50	-34	-69	-138	-207	d50	-42	-84	-168	-252
d63	-39	-78	-157	-235	d63	-48	-95	-190	-286
d75	-43	-85	-171	-256	d75	-52	-104	-207	-311
d90	-47	-94	-189	-283	d90	-57	-114	-228	-342
d110	-53	-106	-212	-318	d110	-64	-128	-256	-384
d160	-48	-97	-194	-291	d160	-59	-117	-234	-352
d225	-55	-110	-221	-331	d225	-67	-133	-266	-399
d250	-58	-116	-233	-349	d250	-70	-140	-280	-420
d280	-57	-113	-226	-340	d280	-68	-136	-273	-409
d315	-58	-116	-232	-348	d315	-70	-140	-279	-419
d355	-58	-117	-233	-350	d355	-70	-140	-281	-421
d400	-58	-117	-234	-350	d400	-70	-141	-281	-422
d450	-61	-122	-244	-367	d450	-73	-147	-294	-441

L Laid pipe length

Length change ΔL (mm) at -10° C flow temperature					Length change ΔL (mm) at -15° C flow temperature				
L (m)	25	50	100	150	L (m)	25	50	100	150
d32	-35	-71	-141	-212	d32	-41	-82	-163	-245
d40	-38	-76	-152	-228	d40	-44	-88	-176	-264
d50	-50	-99	-198	-297	d50	-57	-115	-229	-344
d63	-56	-112	-225	-337	d63	-65	-130	-259	-389
d75	-61	-122	-244	-366	d75	-70	-140	-281	-421
d90	-67	-134	-268	-402	d90	-77	-154	-308	-463
d110	-75	-150	-300	-450	d110	-86	-172	-344	-516
d160	-69	-138	-275	-413	d160	-79	-158	-316	-475
d225	-78	-156	-312	-467	d225	-89	-178	-357	-535
d250	-82	-164	-328	-491	d250	-94	-187	-375	-562
d280	-80	-160	-319	-479	d280	-91	-183	-366	-549
d315	-82	-163	-327	-490	d315	-93	-187	-374	-561
d355	-82	-164	-328	-492	d355	-94	-188	-376	-563
d400	-82	-164	-329	-493	d400	-94	-188	-376	-564
d450	-86	-172	-343	-515	d450	-98	-196	-392	-588

L Laid pipe length

COOL-FIT 4.0F

Length change ΔL (mm) at 20° C flow temperature					Length change ΔL (mm) at 15° C flow temperature				
L (m)	25	50	100	150	L (m)	25	50	100	150
d160	-6	-12	-25	-37	d160	-13	-25	-51	-76
d225	-7	-15	-30	-45	d225	-15	-30	-61	-91

L Laid pipe length

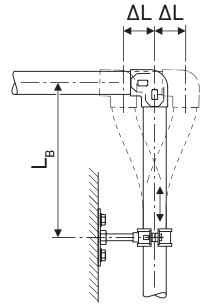
Length change ΔL (mm) at 10° C flow temperature					Length change ΔL (mm) at 5° C flow temperature				
L (m)	25	50	100	150	L (m)	25	50	100	150
d160	-19	-39	-77	-116	d160	-26	-53	-105	-158
d225	-23	-47	-93	-140	d225	-32	-63	-126	-189

Flexible sections for COOL-FIT 4.0

Flexible Section L_B

Valid for SDR11 and SDR17. The values for L_B (cm) from this table can be used for a given ΔL (mm) and the relevant pipe size:

Flexible section L_B (cm)													
ΔL (mm)	10	20	30	40	50	60	70	80	90	100	150	200	300
d32	78	110	135	156	174	191	206	221	234	247	302	349	427
d40	86	122	149	172	193	211	228	244	259	273	334	386	472
d50	86	122	149	172	193	211	228	244	259	273	334	386	472
d63	92	130	159	184	206	225	243	260	276	291	356	411	503
d75	97	138	168	195	218	238	257	275	292	308	377	435	533
d90	104	147	180	208	233	255	275	294	312	329	403	465	570
d110	110	156	191	221	247	270	292	312	331	349	427	493	604
d160	130	184	225	260	291	318	344	368	390	411	503	581	712
d225	146	206	253	292	326	357	386	413	438	461	565	653	799
d250	155	219	268	310	346	379	410	438	465	490	600	693	848
d280	164	233	285	329	368	403	435	465	493	520	637	735	901
d315	174	247	302	349	390	427	461	493	523	552	675	780	955
d355	184	260	318	368	411	450	486	520	552	581	712	822	1007
d400	195	275	337	389	435	477	515	550	584	615	754	870	1066
d450	206	292	357	413	461	505	546	584	619	653	799	923	1130



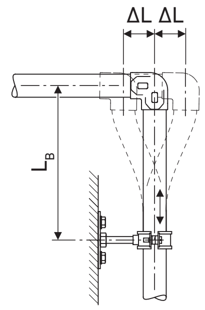
* max. allowed force for fixpoint exceeded

Flexible sections for COOL-FIT 4.0F

Flexible Section L_B

The values for L_B (cm) from this table can be used for a given ΔL (mm) and the relevant pipe size:

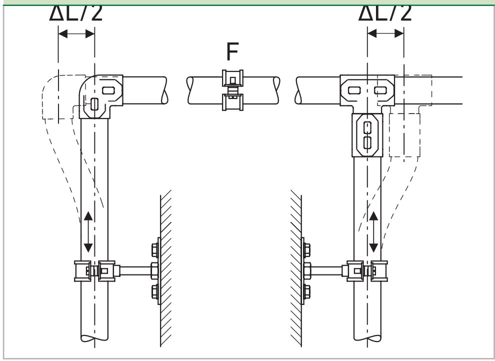
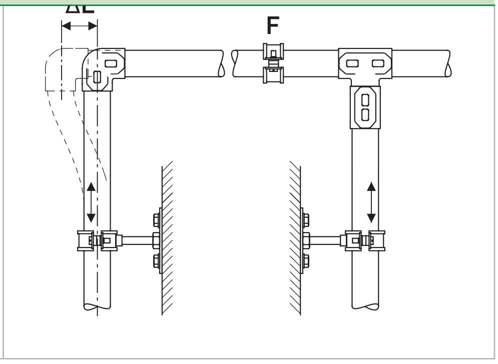
Flexible section L_B (cm)													
ΔL (mm)	10	20	30	40	50	60	70	80	90	100	150	200	300
d160	168	237	290	335	375	410	443	474	503	530	649	749	917
d225	188	266	326	376	420	461	497	532	564	595	728	841	1030



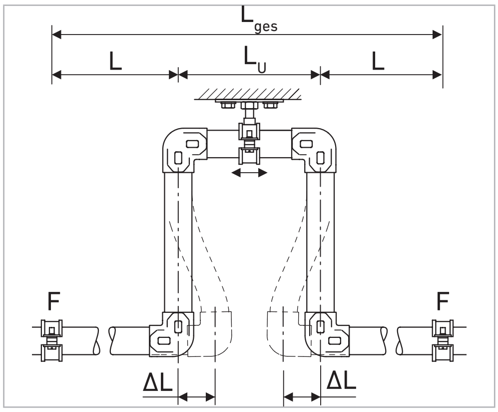
4.11 Installation

Recommendations for installation

Length changes in pipe sections should always be accommodated through the arrangement of fixed brackets. The following examples show how the changes can be distributed in pipe sections by suitable positioning of fixed brackets:

Recommended installation	Not recommended installation
	

Expansion loops can be installed to take up changes in length when flexible sections cannot be included at a change in direction or branch in the piping system or if substantial changes in the length of a straight section need to be taken up. In such a case the compensation for changes in length is distributed over two flexible sections.



Bending stress can lead to leaks in mechanical joints.

Do not use any unions or flanged connections close to expansion bends and loops.

V

Pre-tensioning

In particularly difficult situations with large changes in one direction only, it is possible to pre-tensioning the flexible section during installation and thereby shorten its length LB, as illustrated in the next example:

Example

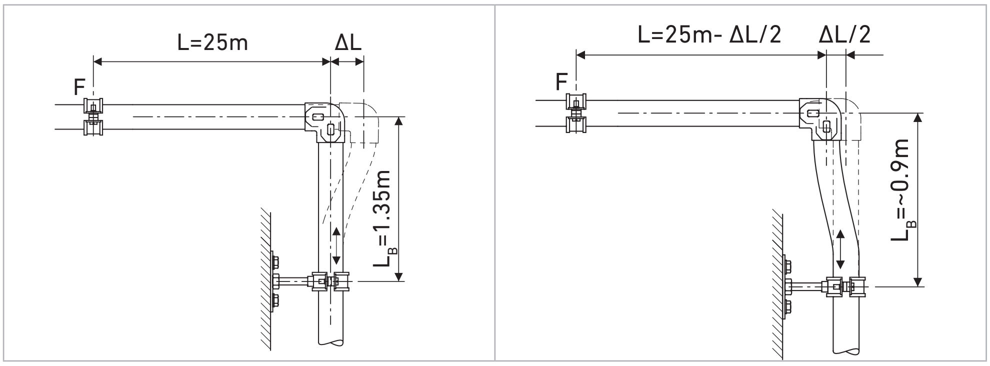
Pipe length L	25 m
Diameter	d225/D315 mm
Installation temperature	25 °C
Min ambient temperature	25 °C constant
Max ambient temperature	25 °C constant
Min flow temperature	10 °C
Max flow temperature	25 °C

Change in length from the table or COOLING Tool-Box:
-ΔL = 39 mm

A flexible section to take up a change in length of +/- ΔL = 40 mm needs to be L_B (mm) = 2920 mm long according to the table.

If the flexible section is pre-tensioned to ΔL/2, the flexible section required is reduced to ~2060 mm. The change in length starting from the 0 position is then +/- ΔL/2 = 39/2 = 19.5 mm.

By pre-tensioning the flexible section makes it possible to reduce its required length in installations where space is restricted. Pre-stressing also reduces the bending of the flexible section in service, improving the appearance of the piping system.



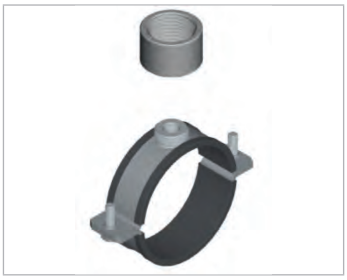
4.12 Pipe bracket spacing and support of piping systems

Overview

Installation of plastic pipe

COOL-FIT 4.0 pipe should be installed using supports designed for use with plastics and should then be installed taking care not to damage or overstress the pipe. Specifically COOL-FIT 4.0 must be installed in order to allow stress-free operation.

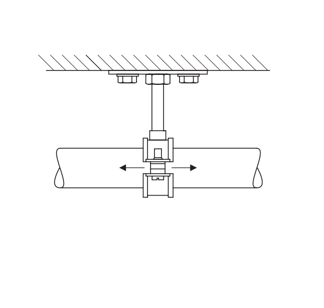
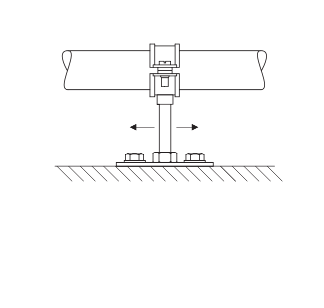
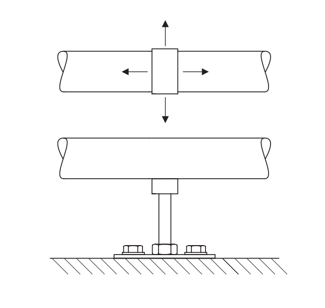
Thanks to the excellent insulating properties of the COOL-FIT 4.0 pipe and its hard, impact resistant outer jacket, standard pipe clamps with hard plastic inlay may be used. Special insulation pipe clamps or cold clamps are not necessary.



Arranging loose brackets

What is a loose bracket?

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

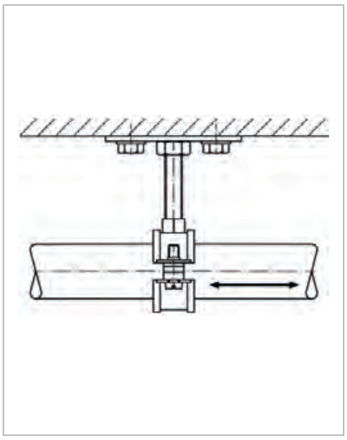
		
Axial displacement of the pipe in the clamp.	Pipe clamp fitted rigidly to the pipe, axial displacement in the suspension of the pipe clamp.	Displacement of the pipe in 2 axes.

The inner diameter of the bracket must be larger than the outer diameter of the pipe to allow free movement of the pipe. The inner edges of the brackets should be free from any sharp contours to avoid damaging the pipe surface.

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

The axial movement of the piping may not be hindered by fittings arranged next to the pipe bracket or other diameter changes.

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



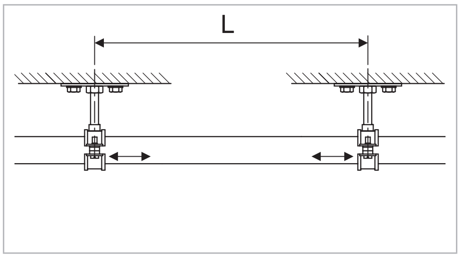
Spacers prevent pinching the pipe

V

Pipe bracket spacing

The pipe bracket spacing have been determined for conveying water on the basis of a specific deflection of the pipe between two clamps considered acceptable.

The pipe bracket spacing for COOL-FIT 4.0 pipe is always consistent independent of pressure and temperature.



L Pipe bracket spacing

Pipe bracket intervals L for COOL-FIT 4.0

d/D (mm)	32/90	40/110	50/110	63/125	75/140	90/160	110/180	160/250	225/315
L (mm)	1800	1950	1950	2000	2100	2150	2300	2600	2850

d/D (mm)	250/355	280/400	315/450	355/500	400/560	450/630
L (mm)	3300	3500	3700	3900	4100	4300

Pipe bracket intervals L for COOL-FIT 4.0F

d/D (mm)	160/250	225/315
L (mm)	3400	3700

The pipe clamp intervals from the table can be increased by 30% for vertical pipe. Multiply the values given by 1.3 in this case.

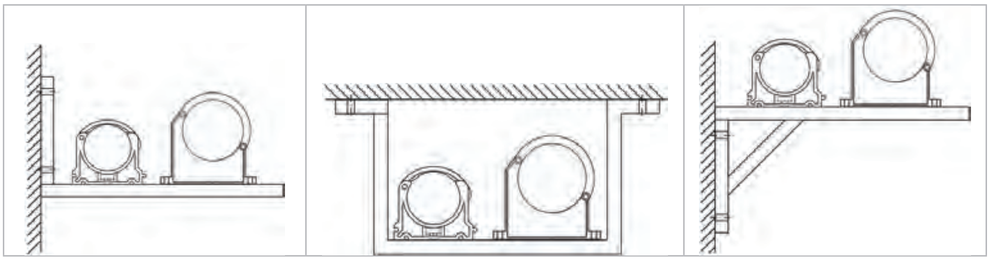
Valid for SDR11 and SDR17.

KLIP-IT pipe brackets

These robust plastic pipe brackets can be used not only under rigorous operating conditions, but also where the pipework is subject to aggressive media or atmospheric conditions. Pipe brackets and pipe clamps from Georg Fischer Piping Systems are suitable for all pipe materials used.

Do not use KLIP-IT pipe brackets as fixed points!

⚠ **From d90 upwards KLIP-IT pipe clamps must be mounted upright, as in the installation examples below.**



Arranging fixed points

A fixed point is a bracket which prevents the pipe from moving in any direction. The purpose of a fixed point is to control tension caused by temperature changes and guide elongation in a certain direction.

⚠ **Fixpoint design**

The pipe must not be fixed by clamping it in the pipe bracket. This can cause deformation and physical damage to the pipe, damage that sometimes does not appear until very much later.

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

COOL-FIT 4.0 Fixpoint

Fixed points for COOL-FIT are established with the special COOL-FIT fixed points. The product consists of fusion tapes and pipe brackets. Electrofusion bands as permanent joints transmit the forces that occur in the pipe to the fixed point. The supplied pipe brackets serve to build up the fusion pressure during installation of the fusion bands and provide stability during operation. For fusion, use an MSA 2.x, MSA 4.x, MSA 250, 300, 350, 400 or commercially available 220-V electrofusion unit. If you use an MSA electrofusion unit by Georg Fischer Piping Systems, use the y-cable kit with code 790.156.032.

Please take note of the maximum allowed forces in the table below.

Diameter (mm)	32/ 90	40/ 110	50/ 110	63/ 125	75/ 140	90/ 160	110/ 180	d160/ D250	d225/ D315	d250/ D355
Maximum force F (kN)	2.0	3.0	5.0	8.0	10.0	10.0	10.0	10.0	10.0	10.0

COOL-FIT 4.0 / 4.0F fixed points must be calculated on the basis of the application. Fixed point brackets and cross braces are not included.

Scope of delivery

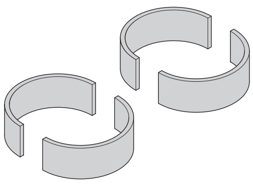
① Clamps to maintain fusion pressure
② Electrofusion band

Y-cable kit for COOL-FIT fixed points

The COOL-FIT Y-cables can be used for a faster installation of COOL-FIT fix points. Since electrofusion tapes always come in pairs, Y-cables allow for a simultaneous fusion process, cutting fusion time in half.

COOL-FIT 4.0F fixed points

Four half shells which are cemented on both sides to the fixed point pipe clamp.



Diameter (mm)	d160/ D250	d225/ D315
Maximum force F (kN)	10.0	10.0

COOL-FIT 4.0 fixed points must be calculated on the basis of the application. Fixed point brackets and cross braces are not included.

Rigidly fixed installations

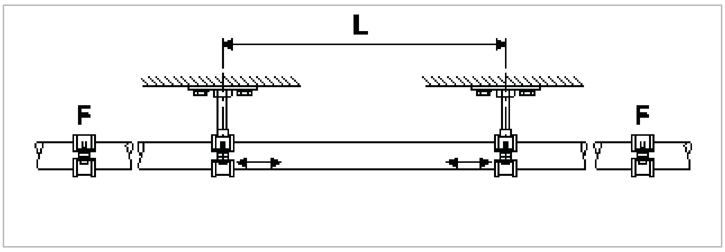
Pipe which are axially clamped and rigidly fixed must be tested for their resistance to kinking. In most cases, this test results in a reduction of the maximum internal pressure and more tightly spaced supports. The forces acting on the fixed points should be considered.

COOL-FIT 4.0 pipe and fittings are suitable for a rigidly fixed installation

Values for forces acting on fixed points as well as the resulting pipe bracket spacing are listed in following tables.

Example of use:

Installation temperature	25 °C
Min. ambient temperature	25 °C constant
Max. ambient temperature	25 °C constant
Min. flow temperature	See table
Max. flow temperature	25 °C
Pipe class d32 - d110 SDR11 and d160 - d450 SDR17	



Fixpoint forces F and maximal pipe bracket spacing L at 15 °C flow temperature

d/D (mm)	32/90	40/110	50/110	63/125	75/140	90/160	110/180	160/250	225/315	250/355	280/400	315/450	355/500	400/560	450/630
F (kN)	0.4	0.6	0.9	1.4	2.0	2.8	4.1	6.0	11.6*	14.3*	18.0*	22.8*	29.0*	36.6*	46.4*
L (mm)	1800	1950	1900	2000	2100	2150	2200	2600	2850	3300	3500	3700	3900	4100	4300

Fixpoint forces F and maximal pipe bracket spacing L at 10 °C flow temperature

d/D (mm)	32/90	40/110	50/110	63/125	75/140	90/160	110/180	160/250	225/315	250/355	280/400	315/450	355/500	400/560	450/630
F (kN)	0.6	1.0	1.4	2.2	3.0	4.4	6.4*	9.3*	18.1*	22.3*	28.1*	36.6*	45.1*	57.1*	72.5*
L (mm)	1800	1950	1900	2000	2100	2150	2200	2600	2850	3300	3500	3700	3900	4100	4300

Fixpoint forces F and maximal pipe bracket spacing L at 5 °C flow temperature

d/D (mm)	32/90	40/110	50/110	63/125	75/140	90/160	110/180	160/250	225/315	250/355	280/400	315/450	355/500	400/560	450/630
F (kN)	0.9	1.4	2.0	3.1	4.2	6.1	8.9*	12.9*	25.1*	30.9*	38.9*	49.3*	62.5*	79.0*	100.2*
L (mm)	1800	1950	1900	2000	2100	2150	2200	2600	2850	3300	3500	3700	3900	4100	4300

Fixpoint forces F and maximal pipe bracket spacing L at 0 °C flow temperature

d/D (mm)	32/90	40/110	50/110	63/125	75/140	90/160	110/180	160/250	225/315	250/355	280/400	315/450	355/500	400/560	450/630
F (kN)	1.1	1.8	2.5	3.9	5.5	7.8	11.5*	16.7*	32.4*	40.0*	50.3*	63.7*	80.8*	102.2*	130.0*
L (mm)	1800	1950	1900	2000	2100	2150	2200	2600	2850	3300	3500	3700	3900	4100	4300

Fixpoint forces F and maximal pipe bracket spacing L at -5 °C flow temperature

d/D (mm)	32/90	40/110	50/110	63/125	75/140	90/160	110/180	160/250	225/315	250/355	280/400	315/450	355/500	400/560	450/630
F (kN)	1.4	2.2	3.1	4.9	6.8	9.7*	14.3*	20.7*	40.2*	49.5*	62.2*	79.0*	100.0*	126.6*	160.6*
L (mm)	1800	1950	1900	2000	2100	2150	2200	2600	2850	3300	3500	3700	3900	4100	4300

Fixpoint forces F and maximal pipe bracket spacing L at -10 °C flow temperature

d/D (mm)	32/90	40/110	50/110	63/125	75/140	90/160	110/180	160/250	225/315	250/355	280/400	315/450	355/500	400/560	450/630
F (kN)	1.6	2.6	3.8	5.9	8.1	11.6*	17.2*	24.8*	48.3*	59.3*	74.8*	94.9*	120.3*	152.1*	193.0*
L (mm)	1800	1950	1900	2000	2100	2150	2200	2600	2850	3300	3500	3700	3900	4100	4300

Fixpoint forces F and maximal pipe bracket spacing L at -15 °C flow temperature

d/D (mm)	32/90	40/110	50/110	63/125	75/140	90/160	110/180	160/250	225/315	250/355	280/400	315/450	355/500	400/560	450/630
F (kN)	1.9	3.0	4.4	6.9	9.5	13.7*	20.2*	29.2*	56.8*	70.0*	87.9	111.5*	141.4*	178.8*	226.8*
L (mm)	1800	1950	1900	2000	2100	2150	2200	2600	2850	3300	3500	3700	3900	4100	4300

* max allowed force for COOL-FIT fixed point exceeded

COOL-FIT 4.0F

Fixpoint forces F and maximal pipe bracket spacing L at 15 °C flow temperature		
d/D (mm)	**d160/250**	**d225/315**
F (kN)	6.01	11.65*
L (mm)	3400	3700
Fixpoint forces F and maximal pipe bracket spacing L at 10 °C flow temperature		
d/D (mm)	**d160/250**	**d225/315**
F (kN)	9.37	18.18*
L (mm)	3400	3700
Fixpoint forces F and maximal pipe bracket spacing L at 5°C flow temperature		
d/D (mm)	**d160/250**	**d225/315**
F (kN)	12.95*	25.14*
L (mm)	3400	3700

* max allowed force for COOL-FIT fixed point exceeded

Please contact GF Piping Systems for rigidly fixed installations that contain ball valves and mechanical joints as well as if the max. allowed force on the fixed points are exceeded

4.13 Hoses

Installation of elastomer hoses

To ensure the usability of hose lines and to avoid shortening their service life through additional stresses, please note the following:

- Hose lines must be installed so that their natural position and movement is not hindered.
- During operation, hose loines must in principle not be subjected to external forces such as tension, torsion and compression, unless they have been specially made for the purpose.
- The minimum radius of curvature specified by the manufacturer must be observed.
- Buckling is to be avoided, particularly by the joint.
- Before putting the system into operation, check that the mechanical connections are properly tightened.
- If there is visible external damage, the hose line must not be put into operation.
- The connection fittings should be firmly screwed together.

Proper use of the hose line

- Pressure: do not exceed maximum permitted working pressure and operating vacuum
- Temperature: do not exceed maximum permitted temperature for the medium

Storage

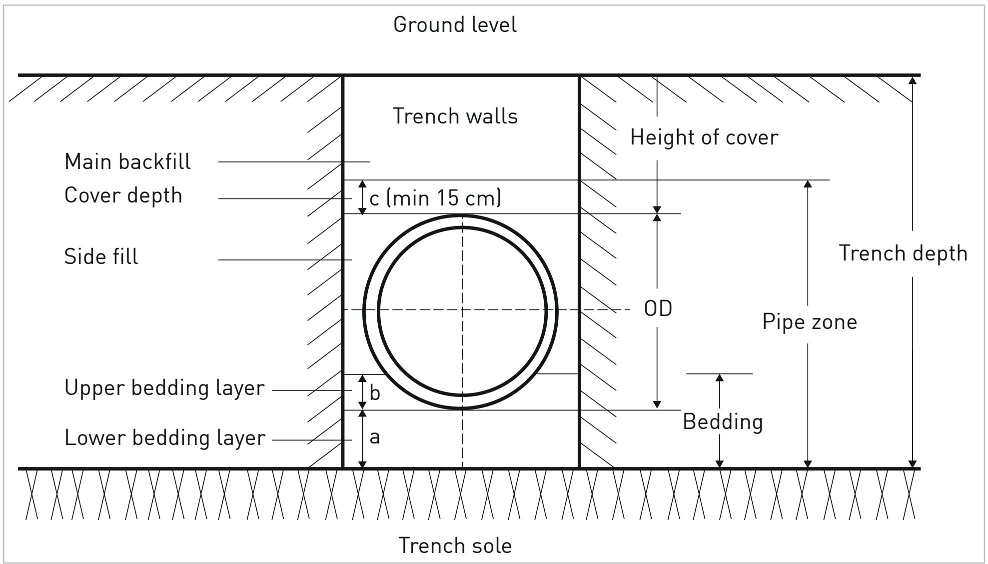
- Store in a cool, dry and dust-free area; avoid direct sunlight or ultraviolet irradiation; protect from nearby heat sources. Piping must not come into contact with substances that can cause damage.
- Hoses and hose assemblies must be stored horizontally, free of tension or bending forces.

Maintenance

We recommend a regular visual inspection of the hose line in case of high temperature fluctuations.

4.14 Underground installation

COOL-FIT 4.0 can be used underground. The corresponding national installation guidelines apply to building the pipe trenches and installing the pipe. In general, trenches should not be less than 1 meter deep, deeper if there is a risk of frost. The sand bed must be built in such a way that the pipe is evenly supported. The pipe must be laid in a sand bed and protected against sharp stones and debris. The sand must be well compacted.



The pipe zone has to be designed according to planning requirements and static calculations. The area between trench sole and side fill is referred to as bedding. A load-carrying bedding must be created by using soil replacement. For regular soil conditions, EN 1610 specifies a minimum thickness of a = 150 mm for the lower bedding. In addition to the minimum thickness, corresponding requirements are also imposed on the building materials that must be used for the bedding.

No building materials with components exceeding the following ranges may be used:

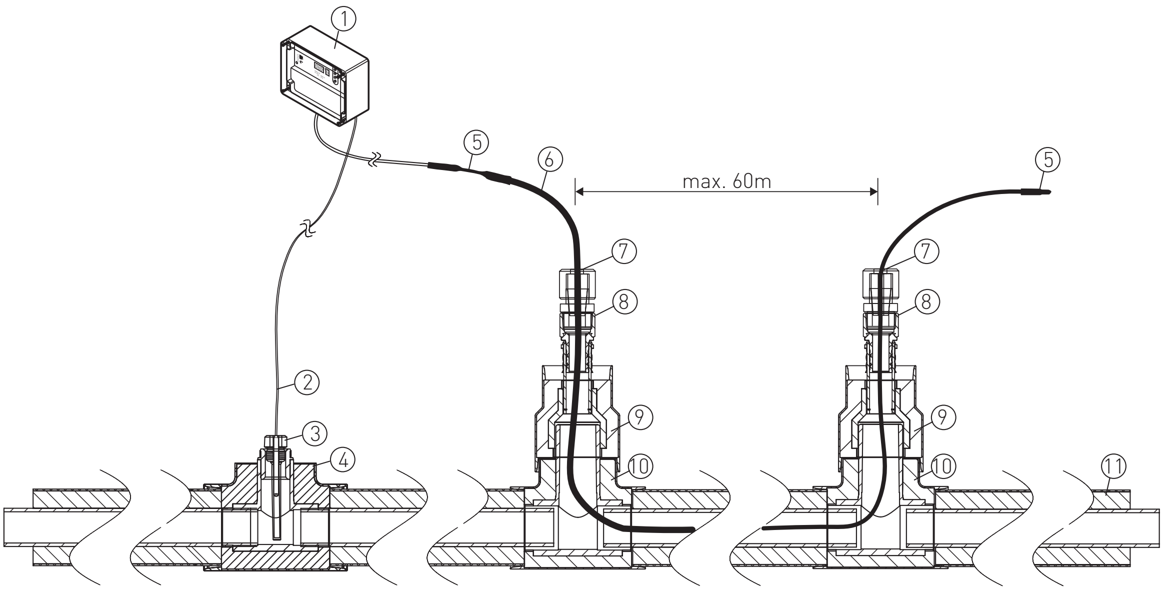
- 22 mm for DN ≤ 200

The upper bedding layer b is derived from static calculations. It is also important to ensure that no cavities are created below the pipe. The bedding dissipates all loads from the pipe securely and evenly into the ground. For this reason, the COOL-FIT 4.0 pipe has to rest solidly on the bedding across its entire length. The upper end of the pipe zone is defined according to EN 1610 as 150 mm above the pipe apex or 100 mm above the pipe connection. Ensure that the pipe is not damaged when the cover and main backfill are filled and compacted.

COOL-FIT 4.0 pipe have a higher degree of stiffness and a higher weight than non-insulated pipe. For this reason, the pipe should always be connected in the trench. Unnecessary stress on the COOL-FIT 4.0 jointing elements is thus avoided. Under normal circumstances, it is not necessary to install expansion loops in the system.

A movement of the pipe before filling the pipe trench should be avoided. Please contact Georg Fischer Piping Systems concerning recommendations for underground installations.

4.15 COOL-FIT 4.0 Heat Tracing Installation



No.	Designation	No.	Designation
1	Thermostat	**7**	Cable glands ¾" male thread R
2	Temperature sensor PT 100	**8**	Adaptor fitting d32-¾" female thread Rp
3	Immersion sleeve for PT sensor	**9**	COOL-FIT 4.0 Reducer to d32
4	COOL-FIT 4.0 Installation fitting ½" Rp	**10**	COOL-FIT 4.0 T90°
5	Cold lead connection and end seal kit	**11**	COOL-FIT 4.0 pipe
6	Heating cable		

Components installation

General notes:

Installation instructions included in the kit must be followed, including those for preparation of the heating cable conductors for connections. Before assembly, use the guide given in the instructions to ensure that the kit is correct for the heating cable and environment.

- ▶ Self-regulating and power-limiting heating cables are parallel circuit design. Do not twist the conductors together as this will result in a short circuit.

Components required

For the installation of all components refer to the relevant component installation instructions.
Required for each heating cable run:

- Cold lead connection and end seal kit
- Cable entry and exit
- Fittings for inlet and outlet

Required for the installation the temperature sensor of each thermostat*:

- COOL-FIT 4.0 Installation fitting ½“ Rp
- Immersion sleeve for PT sensor

Procedure

- ► Insert the heat tracing cable into the inner pipe during installation of the piping components and out again at the end of the heating circuit. If there are more than 2 changes in the direction of the pipe equipped with the heating tape, the use of a suitable lubricant is recommended for simpler installation.
- ► Note that the heating cable must not be routed through the inside of valves. If using COOL-FIT valves, the cable must be routed outwards on both sides of the valve end.

Thermostats and control systems

- ► Follow the installation instructions supplied with the thermostat or control. Use the proper wiring diagram for for the heating cable layout and control method desired.
- ► After switching on the heating cable, the cable ends must be warm after 5 to 10 minutes.

* For the freezer protection on pipe sections with different pipe size ddimensions a separate heating circle with temperature sensor is recommended.

4.16 COOLING Tool-Box

The Georg Fischer Piping Systems COOLING Tool-Box is used to help in the dimensioning and design of cooling systems.

The COOLING Tool-Box handles:

- Expansion, contraction
- Flexible section design
- Energy savings
- Pipe exterior temperature
- Pipe dimensioning
- Pressure loss
- Dew point/ insulation thickness
- Pipe bracket spacing
- Freezing time
- Weight comparison
- CO_2 footprint

Data for the most commonly used secondary refrigerants are already stored in the calculation tool. It calculates all system components such as pipe, fittings and valves. The menu is available in several different languages. It allows system design to be efficient and optimized. With the function "comparison" a COOL-FIT system can be compared to a black steel, stainless steel or copper system.

COOLING Tool-Box: Get in contact with your GF Piping Systems representative or visit www.gfps.com

5 Jointing and Installation

5.1 Jointing of COOL-FIT 4.0

For general information on electrofusion, see Planning Fundamentals chapter "Jointing technology", section "Electrofusion joints".

General advice

The quality of a weld is largely determined by careful preparation. The welding surface must be protected from adverse weather conditions such as rain, snow or wind. The permissible temperature range for fusion is -10 °C to 45 °C. National regulations must be observed. In direct sunlight, shielding of the welding area can help to create an even temperature profile around the whole circumference of the pipe. It is particularly important to ensure that the climate conditions are the same for both the electrofusion machine and the welding area.

Executing electrofusion

Protect the welding area

The surfaces to be welded on the pipe and the fitting must be carefully protected from dirt, grease, oils and lubricants. Only Tangit PE cleaner must be used for cleaning.

No fats (i.e. hand cream, oily rags, silicone, etc.) must be introduced into the fusion zone!

Jointing d32 – d225

1 Without touching the surface, remove product immediately before the installation from packaging

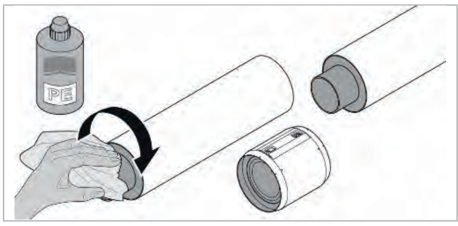
If necessary, prepare the pipe for fusion joints using the Foam removal tool (foam removal, cutting the jacket and peeling the media pipe) and check afterwards that the shaving thickness is 0.2 – 0.4 mm and that the minimum permissible external diameter after peeling is met:

- **COOL-FIT 4.0 already factory-set free pipe ends, COOL-FIT 4.0 Valves und COOL-FIT 4.0 Fittings d32 – d225 (Type B, barrel nipple and transition fittings) don't need to be peeled.**

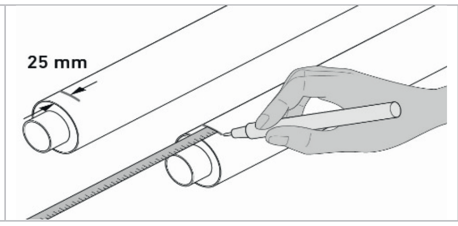
Minimum permitted pipe external diameter after peeling for COOL-FIT 4.0

d/D (mm)	32/90	40/110	50/110	63/125	75/140	90/160	110/180	160/250	225/315
Min. d (mm)	31.5	39.5	49.5	62.5	74.4	89.4	109.4	159.4	224.4

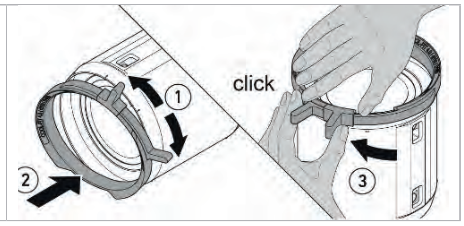
2 Cleaning and installation for welding preparation



Step 1
Clean the fusion area of the components with Henkel Tangit PE cleaner and lintfree colourless and clean cloth in circumferential direction.

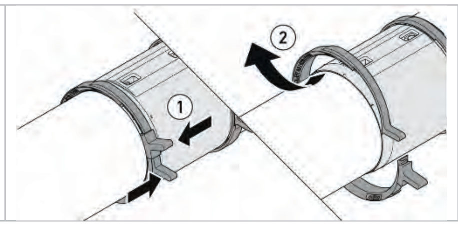


Step 2
Mark the jacket pipe at a distance of 25 mm

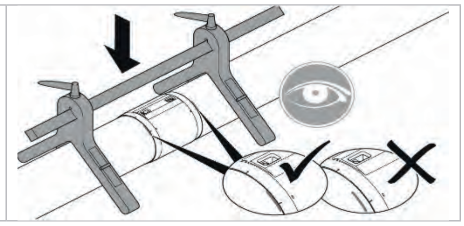


Step 3
Mount the assembly aids on the sealing lips of the COOL-FIT 4.0 fitting

Step 4
Insert pipe in pipe brackets and align free of stress. Push fitting up to the limit stop on the pipe.

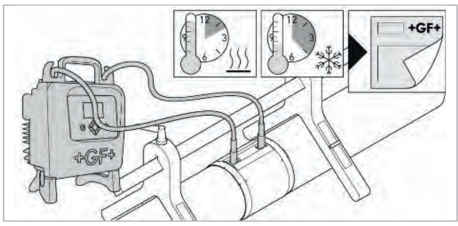


Step 5
Remove the assembly aids

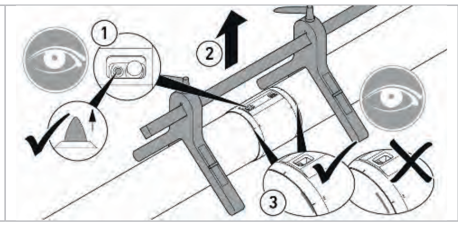


Step 6
Take care for low stress installation and secure the pipe and fitting against dislocation. Check insertions depths of both pipe into the fitting

3 Fusion process

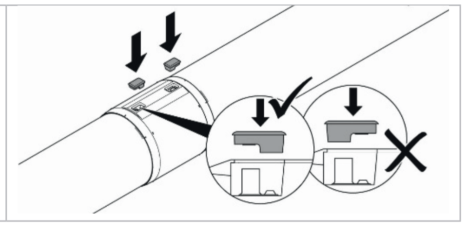


Step 1
Fuse in accordance to the operating instructions of the fusion unit. Use long fusion adaptors (790128035). Pay attention to fusion and cooling time.

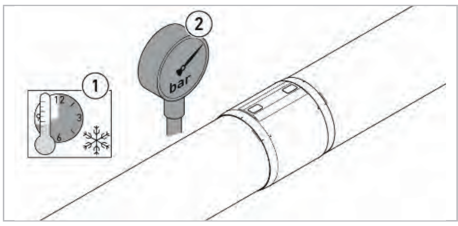


Step 2
After fusion, check fusion indicators on the electrofusion fitting and note the messages on the display of the electrofusion machine.
Mark the fitting with following information
- Date
- Welder/ Weld number
- Time at the end of cooling time

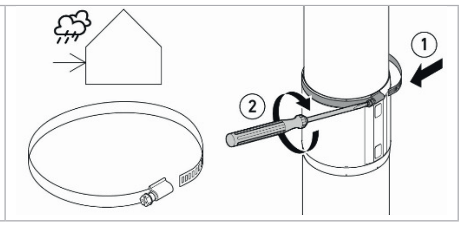
Remove the clamping tool after cooling time



Step 3
Fit the insulation of the weld pins onto the fusion contacts



Step 4
After cooling perform pressure tests as per table.



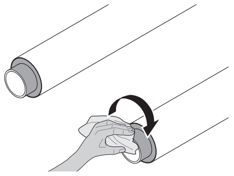
Step 5 (optional)
For vertical installations outside, mount sealing clamps tightly at the top lip of the fitting.
Alternatively to sealing clamps, sealing tapes, 25 mm width can be mounted underneath the top lip of the fittings.

Jointing d250 – d450

Hint: Factory-set free pipe ends at pipe and fittings type B have to be peeled for jointing before.

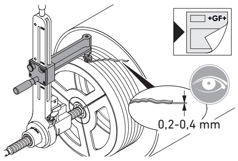
1 Preparation

Step 1



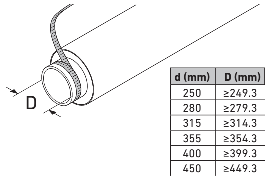
Perform a preliminary cleaning of the media pipe, deburr at a right angle using the pipe cutter, if necessary.

Step 2



Peel the media pipe as well as the fittings type B with the peeler, if not already done with foam removal. Observe min. peel removal of 0.2 to 0.4mm.

Step 3



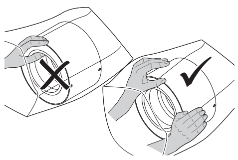
Check the pipe outer diameter
before and after peeling with a circumferential measuring tape.

Overview of pipe outer diameter and open spigot length

Dimension (mm)	Minimum permissible pipe outer diameter after peeling (mm)	Factory-set spigot length (mm)
d250	249.3	120-126
d280	279.3	123-129
d315	314.3	129-137
d355	354.3	144-152
d400	399.3	145-155
d450	449.3	160-170

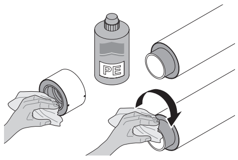
2 Cleaning and installation

Step 1



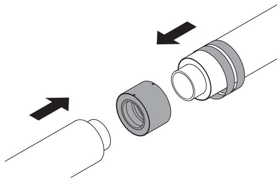
Unpack the coupler. Pay attention that you don't touch the inner surface of the coupler.

Step 2



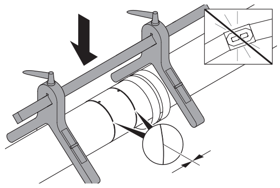
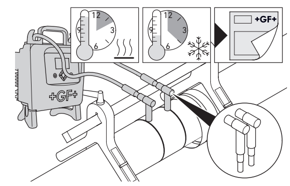
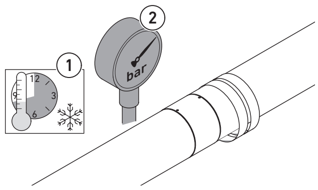
Clean fusion area of the electrofusion coupler, the pipe and as well of the fittings type B with Tangit PE cleaner and lint-free cloth and allow to air out.

Step 3



Slide on the shrink sockets and afterwards the electrofusion coupler up to the insulation without touching the fusion area.

3 Fusion process

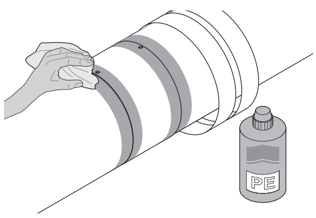
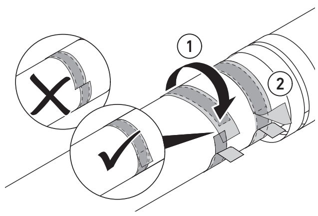
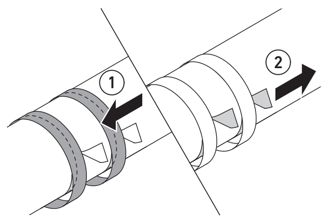
Step 1	Step 2	Step 3
		
Take care for low stress installation and secure the pipe and fitting against dislocation. There must be no gap between coupler and pipes.	Fuse in accordance to the operating instructions of the fusion unit. Use long fusion adaptors (790128035). Pay attention to fusion and cooling time.	After cooling perform pressure tests as per table.

Cooling times before removing clamping tool and pressure/leak testing

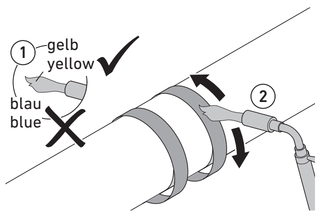
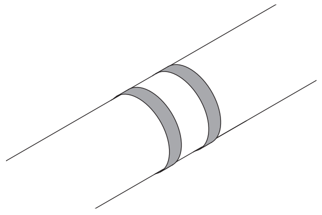
d (mm)	Cooling time before Remove clamping tool (min.)	Cooling time before internal pressure test at ≤ 6 bar (min.)	Cooling time before internal pressure test at ≤ 18 bar (hours)	Cooling time before internal pressure test at ≤ 11 bar (hours)
32	10	15	3	-
40	10	20	5	-
50	10	20	5	-
63	10	20	5	-
75	15	25	6	-
90	20	35	8	-
110	30	50	8	-
160	45	90	-	8
225	45	90	-	9.5
250	30	90	-	9.5
280	30	90	-	9.5
315	30	90	-	9.5
355	60	100	-	9.5
400	75	110	-	9.5
450	75	125	-	9.5

The values are valid for pressure tests using a liquid at ≤ 20 ° C. For testing with gas a cooling time of 12 hours is recommended.

4 Sealing

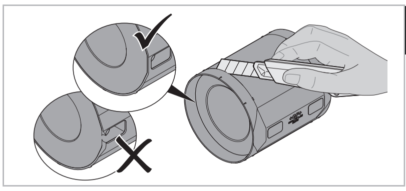
Step 1	Step 2	Step 3
		
Clean the pipe/fitting type B and partially the coupler over the gap with Tangit PE cleaner.	Affix the sealing tape centered over the gap and overlap it at the end. Press it on well and smooth out folds.	Position the shrink socket centered over the sealing tape, than remove the white separating tape.

V

Step 4	Step 5
	
The yellow flame of the gas burner or hot-air stream must strike the shrink socket as vertically as possible. Avoid applying unnecessary heat to the fitting.	The jointing is now finished.

Valves and flange joints

1 Preparation of fitting – remove sealing lip on one side, clean the sealing surfaces

1


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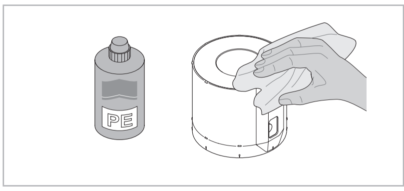

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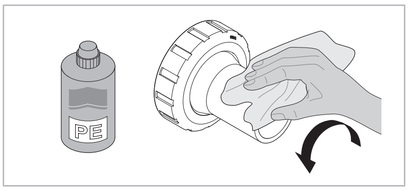
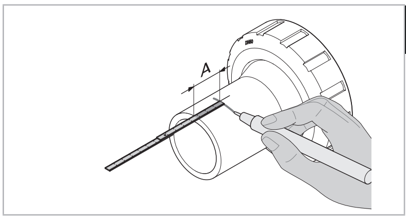


For the jointing to a valve or flange adaptor, the sealing lip of the fitting has to be removed at the valve or flange adaptor side and sealing and fusion surfaces have to be cleaned.

2 Standard fusion

Fuse both valve ends without valve mounted.

4


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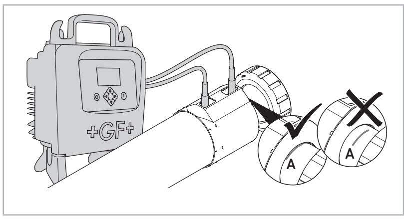

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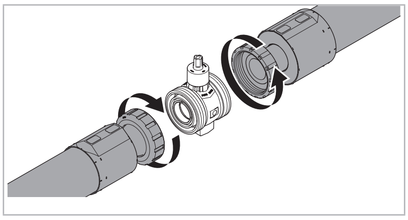
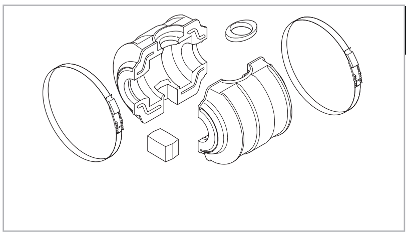


Following insertion depths A are valid for COOL-FIT 4.0 components:

d/D (mm)	32/90	40/110	50/110	63/125	75/140	90/160	110/180	160/250	225/315
L1 (mm)	36	40	44	48	55	62	72	90	110

3 Mounting the valve/flange insulation



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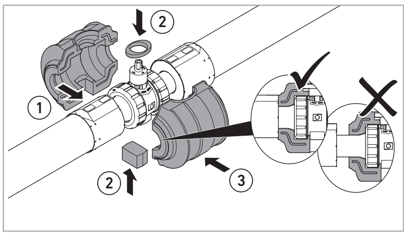
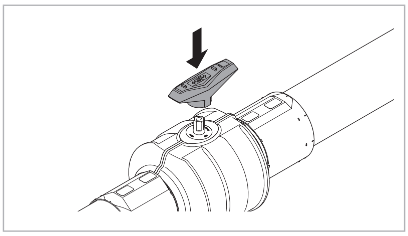
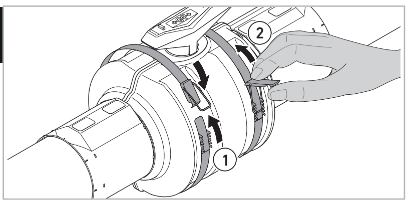


8


9


> **Further information can be found in the assembly instructions "COOL-FIT 2.0 / COOL-FIT 4.0 insulation for Ball Valve and Butterfly Valve".**

> **It's recommended to re-tighten the bolts of COOL-FIT 4.0 butterfly valves and flange joints at operating temperature.**

Compact connection fitting-to-fitting

When there is enough space, Fitting-to-Pipe-to-Fitting connections can be realized using a short COOL-FIT 4.0 pipe. The foam removal tool enables the foam removal of pipe lengths of ~110 mm for the dimensions d32-d90, or respectively ~170 mm for the dimensions d110-d225.

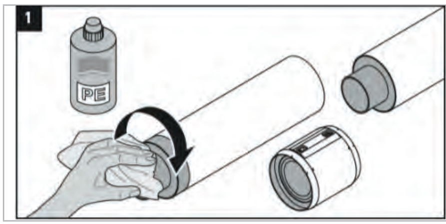
For compact fitting-to-fitting joints, COOL-FIT 4.0 barrel nipple can be used.

- **Shorter connections Fitting-to-Pipe-to-Fitting as of sizes d75mm can be realized using an un-insulated PE100 SDR11 pipe in combination with a piece of insulation that results of an foam removal process of the foam removal tool.**
  After the peeling of the oxid layer of the un-insulated PE pipe, the insulation ring is pulled over the pipe and the pipe is welded with the fitting.

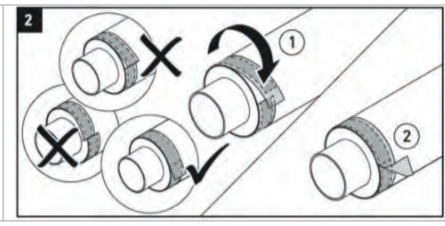
d	d75	d90	d110	d160	d225
L (mm)	165	186	216	270	330

L: Length of un-insulated PE100 SDR11 pipe needed

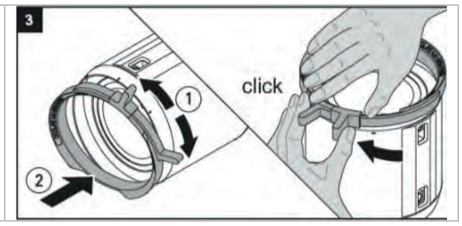
Mounting of sealing tape and transition of insulation



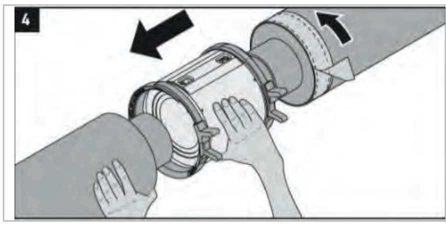
Step 1
In addition to the fusion zone, also clean the jacket of the pipe



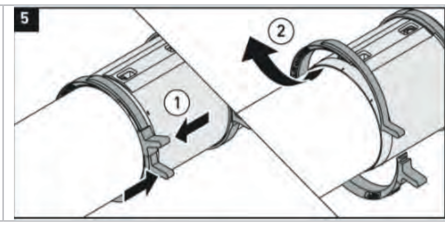
Step 2
Mount sealing tape/ transition of insulation, end to end without offset and fold down liner



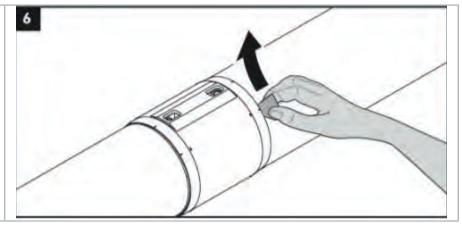
Step 3
Mount the assembly aids on the sealing lips of the COOL-FIT 4.0 fitting



Step 4
On pushing together, slightly turn either fitting or pipe assembled with sealing tape/ transition of insulation



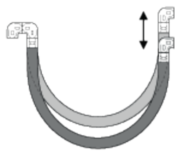
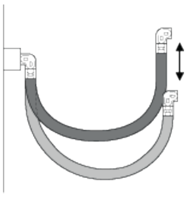
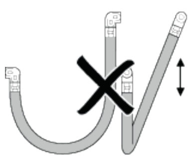
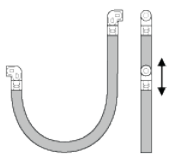
Step 5
Remove the assembly aids

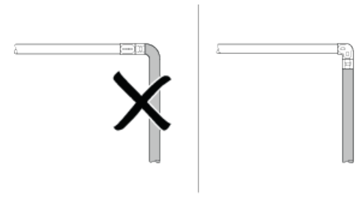
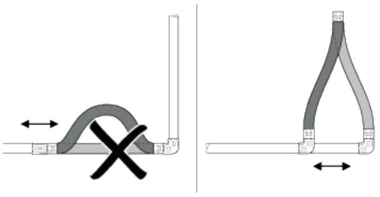
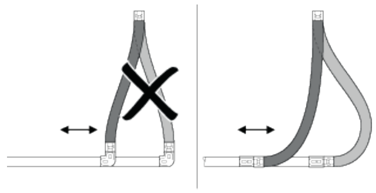
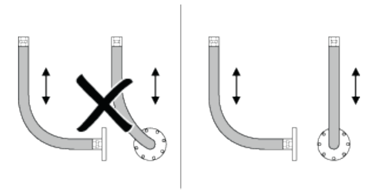
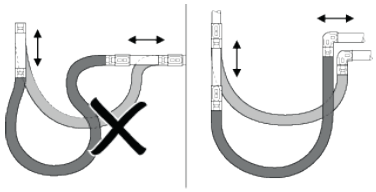


Step 6
Pull off the liner after removal of assembly aids

COOL-FIT Hoses

In order to ensure the functionality of flexible hose joints following installation and handling instructions have to be considered.

Installation and handling instructions (false/correct)		Description
		Ensure hose is long enough to observe the minimum radius of curvature.
		Avoid excessive bending of hoses, use elbows.
		Avoid fluctuating bending stress and excessive curvature behind the fitting, use elbows.
		Where there is significant axial expansion, the direction of movement and hose axis must lie in the same plane in order to avoid torsion.

Installation and handling instructions (false/correct)	Description
	Avoid excessive bending stress by using elbows.
	If the hose absorbs expansion, it must be installed transversally to the direction of expansion.
	For large lateral movements, a 90° angle should be allowed.
	Expansion take-up must be in the plane of the pipe; torsion should be avoided.
	For major axial expansion, the pipe must be installed in a U-shape to avoid kinking.

1) All three materials are firmly bonded together.
2) At 20 °C, medium water

Transition Fittings

The Georg Fischer Piping Systems range of fittings provides a variety of transitions and threaded fittings to connect plastic piping components to pipe, fittings or valves in metal (or vice versa). The metal threads Rp, R or NPT can be sealed with hemp or PTFE tape as long as the counterpart is not made of plastic. Male and female G threads must be sealed with flat gaskets. The advantage of a threaded G connection is radial and torsion-free possibility for installing and uninstalling.

Next to the traditional transition to metal piping, these fittings can also be used to connect a manometers.

⚠ **To prevent electrochemical corrosion, stainless steel connecting elements should preferably be used for steel transitions.**

Combining G and R threads

The connection of an external parallel pipe thread G in accordance with EN ISO 228-1, with an internal parallel pipe thread Rp in accordance with ISO 7-1 is not intended according to standards. A tight connection is possible under favorable conditions, but cannot be established reliably.

Mounting the insulaton half shells of Transition Fittings

Following the jointing of the COOL-FIT 4.0 Transition Fittings with the COOL-FIT 4.0 Fitting Typ A, and the mechanical jointing of the threaded components, the insulation half shells can be mounted. Assembling of the shells can be done in the same way like for the COOL-FIT 4.0 valves. With the exception of COOL-FIT unions, the sealing lip of the type A fitting must not be cut off on mounting the insulation half shells of transition fittings.

> **i** **Further information can be found in the assembly instructions "COOL-FIT 4.0 insulation for transition fittings".**

Connecting the insulations of flexible hoses

The length of the insulation of flexible hoses enabels a direct jointing at the face of the electrofusion fitting.

The radial jointing of the jointing face of the EPDM insulation of flexible hoses to the insulation of transition fittings can be applied either by adhesive cement of by adhesive tape.

Jointing Instructions for the adhesive cement

The adhesive should be thoroughly stirred before use. A thin film is applied by means of the brush to both surfaces to be bonded. Doing this, the consumption is ~0.2 – 0.25 kg/m².

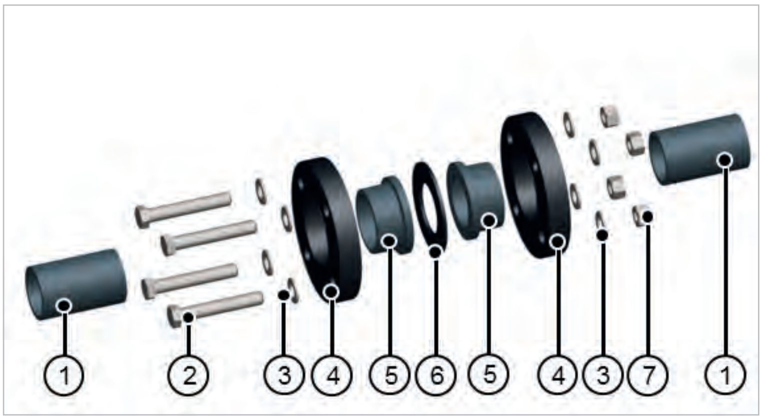
The open joint time is about 3 to 15 minutes depending on temperature and humidity of air.

Before the coated surfaces are brought together the, the adhesive must still be tacky but should not transfer to the skin when finger-tested. The surfaces should be brought together quickly and firmly and should be held together for a few seconds.

The recommended temperature and for storage and processing is in the range between +15 °C and 25 °C.The adhesive should not be used below +10 °C.

Flange joints

Flanges with sufficient thermal and mechanical stability must be used. The different flange types by Georg Fischer Piping Systems fulfill these requirements. The gasket dimensions must match the outer and inner diameter of the flange adapter or valve end. Differences between the inner diameters of gasket and flange that are higher than 10 mm may result in malfunctioning flange connections.



① Pipe
② Bolt
③ Washer
④ Backing Flange
⑤ Flange Adaptor/ Valve end
⑥ Flange gasket
⑦ Nut

Recommended backing flange of COOL-FIT 4.0 flange joints

Flange	Properties
PP-steel flange	• Very robust and stiff due to the steel inlay • Corrosion-free plastic flange made of polypropylene PP-GF30 (fiber-glass reinforced) with steel inlay • High chemical resistance (hydrolysis-resistant) • UV-stabilized

[1] All three materials are mechanically fixed to each other.

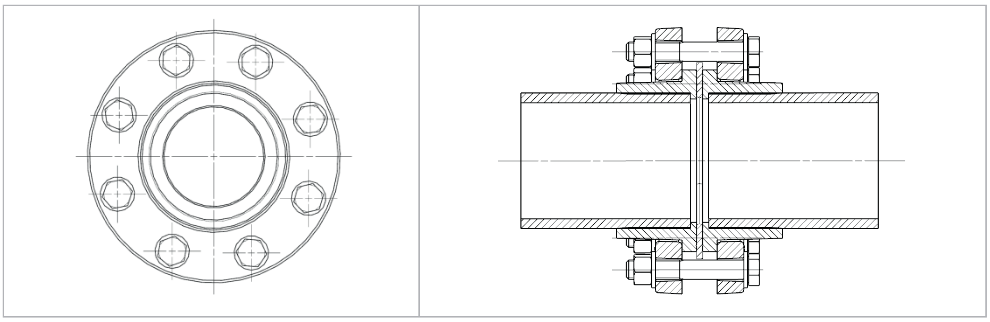
[2] At 20 °C, medium water, the specified value is valid for all system components, with the exception of the valves for which nominal pressure PN10 applies and flexible hoses with lower continuous operating pressure according to the product data sheet.

Creating flange joints

When executing flange joints, the following points should be noted:

Orientation of bolts beyond the two main axes

- For horizontal piping systems, the orientation shown of the bolts beyond the main axes (see the following figure) is preferred since possible leaks at the flange connection do not cause the medium to run directly onto the bolts.



Flange with main axes (centered crosswise)

- Flange adaptor, valve end or fixed flange, seal and loose flange must be aligned centrally on the pipe axis.
- Before tightening the screws, the sealing surfaces must be aligned parallel and snug against the seal. Tightening misaligned flanges with the resulting tensile stress is to be avoided at all costs.

Selecting and handling bolts

- The length of the bolts should be in such a way that the bolt thread does not protrude more than 2-3 turns of the thread at the nut. Washers must be used at the bolts as well as the nut. If too long bolts are used it's not possible to mount the insulation half shells afterwards.
- To ensure that the connecting bolts can be easily tightened and removed after a lengthy period of use, the thread should be lubricated, e.g. with molybdenum sulphide.
- Tightening the bolts by using a torque wrench.
- The bolts must be tightened diagonally and evenly: First, tighten the bolts by hand so that the gasket is evenly contacting the jointing faces. Then tighten all bolts diagonally to 50 % of the required torque, followed by 100 % of the required torque. The recommended bolt tightening torques are listed in the table.
- However, deviations may occur in practice, e. g. through the use of stiff bolts or pipe axes that are not aligned. The Shore hardness of the gasket can also influence the necessary tightening torque.
- We recommend checking the tightening torques 24 hours after assembly according to the specified values and, if necessary, retighten them. Always tighten diagonally here, as well.
- After the pressure test, the tightening torques must be checked in any case and, if necessary, retightened.

> i **For more information on flanges, see DVS 2210-1 supplement 3.**

> i **In the area of flexible sections and expansion loops, no mechanical joints should be used since the bending stress may cause leaks.**

Bolt tightening torque guidelines for metric (ISO) flange connections with PP- steel flanges

The indicated torques are recommended by Georg Fischer Piping systems. These torques already ensure a sufficient tightness of the flange connection. They deviate from the data in the DVS 2210-1 Supplement 3, which are to be understood as upper limits. The individual components of the flange connection (valve ends, flange adapters, flanges) by Georg Fischer Piping systems are dimensioned for these upper limits.

Pipe outside diameter d (mm)	Nominal Diameter DN (mm)	Tightening torque MD (Nm)		
		Flat ring maximum pressure 10 bar / 40 °C	Profile seal maximum pressure 16 bar	O-ring maximum pressure 16 bar
d32	DN25	15	10	10
d40	DN32	20	15	15
d50	DN40	25	15	15
d63	DN50	35	20	20
d75	DN65	50	25	25
d90	DN80	30	15	15
d110	DN100	35	20	20
d160	DN150	45	25	25
d225	DN200	70[1)]	45	35
d250	DN250	65	35	-
d280	DN250	65	35	-
d315	DN300	90	50	-
d355	DN350	90	50	-
d400	DN400	100	60	-
d450	DN450	190	70	-

[1)] Maximum operating pressure 6 bar

Bolt tightening torque guidelines for ISO flange connections

Length of bolts

In practice, it is often difficult to determine the correct bolt length for flange joints. It can be derived from the following parameters:

- Thickness of the washer (2x)
- Thickness of the nut (1x)
- Thickness of the gasket (1x)
- Flange thickness (2x)
- Thickness of flange collar (valve end or flange adaptor) (2x)
- Valve installation length, if applicable (1x)

In order to ensure the fitting of the insulation half shells of the COOL-FIT 4.0 flange adaptors the used bolts must not be too long.

The following table is useful in determining the necessary bolt length.

Under DVS 2210-1, the screw length should be such that it extends 2 to 3 threads beyond the nut.

Online "screw lengths and tightening torques" tool on www.gfps.com/tools

For COOL-FIT 4.0 Flange adaptors used together with PP-Steel backing flanges, the following bolt lengths can be used:

Dimension	d32	d40	d50	d63	d75	d90	d110	d160	d225
Screws	M12x80	M16x80	M16x90	M16x90 or M16x100	M16x100	M16x100	M16x100	M16x200	M20x220

Installation fittings (for sensors)

Transitions and threaded plastic fittings should first be screwed finger tight. The fittings are then screwed in using an appropriate tool until 1 or 2 threads remain visible.

Georg Fischer Piping Systems recommends using PTFE tape to seal transitions and threaded plastic fittings. Alternatively, Henkel Tangit Uni-Lock or Loctite 55 thread seal or Loctite 5331 thread sealant gel can be used. Follow the manufacturer's instructions. When using other sealants, you must check compatibility with the plastic used.

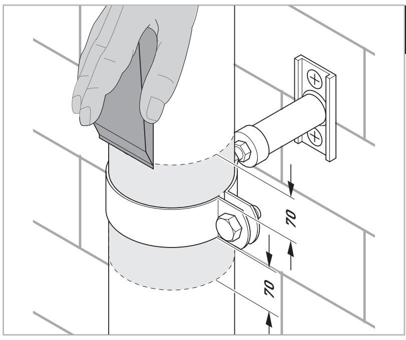
On installing Installation fittings in horizontal piping systems, the sensors should be in 1 – 5 or 7 – 11 clock position.

Do not use hemp! It may swell up, putting force on the plastic fittings and damaging plastic threads. Hemp is also not resistant to chemicals used in some media.

COOL-FIT 4.0 Installation of fixed points

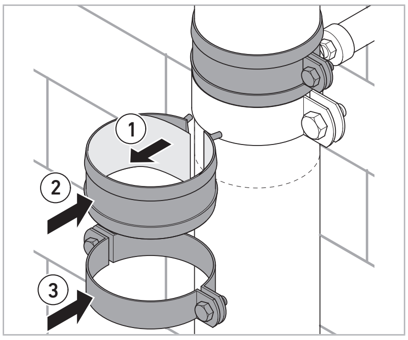
The COOL-FIT piping system must me mounted in final position in the regular fixpoint clamp.

1



Step 1
Remove the outer layer of the PE jacket with a pipe scraper.

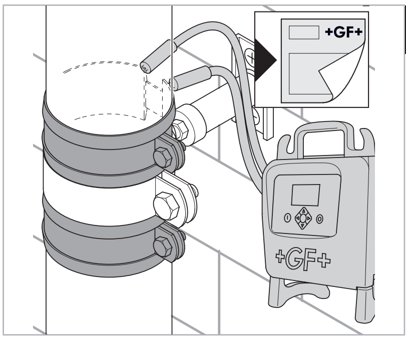
2



Step 2
Remove the yellow protection band from the welding bands and place them on the COOL-FIT pipe. Fix the welding bands with the pipe clips provided.

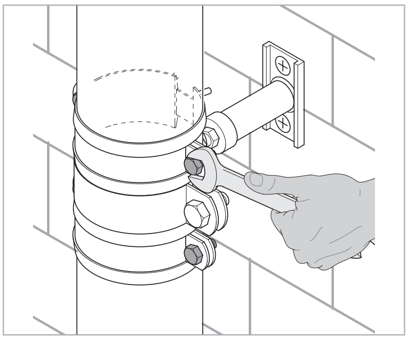
Note: The necessary welding pressure on the clean and dry COOL-FIT pipe is achieved by tightening the pipe clips. Take care that between fixed point clip and weld band there are no visible holes.

3



Step 3
Bond the welding band with the COOL-FIT pipe in accordance with the operating instructions of the electrofusion machine. Use welding adaptors of the y-cable with integrated welding adaptors for the bonding.

4

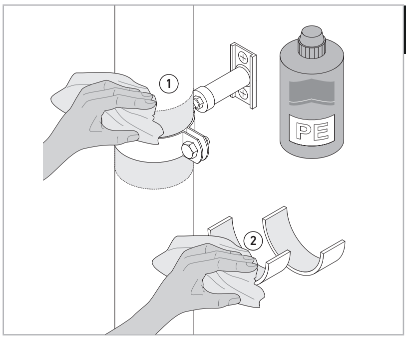


Step 4
Retighten the pipe clips after 10 minutes

V

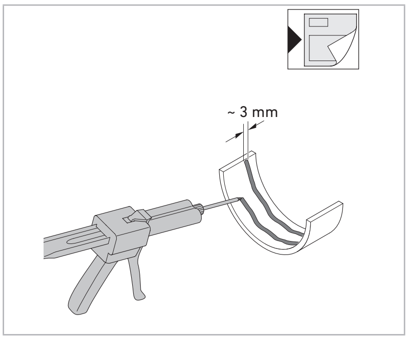
Installation of COOL-FIT 4.0F fixed points

1



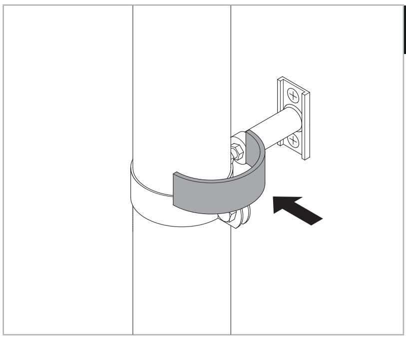
Step 1
Clean the cementing area on the pipe and the components with Tangit PE cleaner and lintfree colourless and clean cloth in circumferential direction.

2



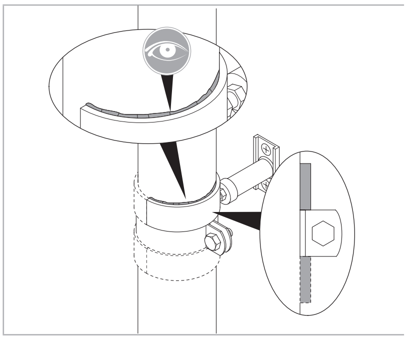
Step 2
Place the Tagit RAPID in about 3mm stripes on the inner side of the fixed point set half shells.

3



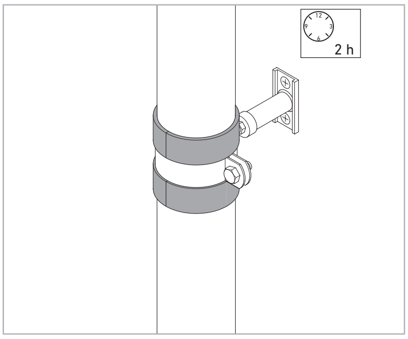
Step 3
Cement the half shelfs on the pipe next to the pipe clamp.

4



Step 4
Check the cementing and ensure the fixed point half shells are next to the pipe clamp.

5



Step 5
Let the fixed point dry for minimum 2 hours.

5.2 Pressure test

Internal pressure test

For internal pressure testing and commissioning, the same conditions apply for COOL-FIT 4.0 as for the non-insulated ecoFIT system (PE).

5.3 Internal pressure and leak testing

Introduction to the pressure test

Overview of the various test methods

Test methods	Inner Pressure test			Leakage test
Medium	Water	Gas[1]	Compressed air[1]	Gas/air (oil-free)
Type	Incompressible	Compressible	Compressible	Compressible
Test pressure (overpressure)	$P_{p\,(perm)}$ or $0.85 \bullet P_{p\,(perm)}$	Operating pressure + 2 bar	Operating pressure + 2 bar	0.5 bar
Potential risk during the pressure test	Low	Hoch	High	Low
Significance	High: Proof of pressure resistance incl. impermeability to test medium	High: Proof of pressure resistance incl. impermeability to test medium	High: Proof of pressure resistance incl. impermeability to test medium	Low

[1] Observe the applicable safety precautions. More information is available in DVS 2210-1 addendum 2.

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

The purpose of a pressure test is:

- Ensure the resistance to pressure of the piping system, and
- Show the leak-tightness against the test medium

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

Water is an incompressible medium. In case of a leakage during the pressure test relative low energy is set free. Therefore the hazard potential is significantly lower compared to testing with a compressible medium like e.g. compressed air.

Internal pressure test with water or similar incompressible test medium

The internal pressure test is done when installation work has been completed and presupposes an operational piping system or operational test sections. The test pressure load is intended to furnish experimental proof of operational safety. The test pressure is not based on the operating pressure, but rather on the internal pressure load capacity, based on the pipe wall thickness.

Addendum 2 of DVS 2210-1 forms the basis for the following information. This replaces the data in DVS 2210-1 entirely. The modifications became necessary because the reference value "nominal pressure (PN)" is being used less and less to determine the test pressure (1.5 x PN, or 1.3 x PN) and is being replaced by SDR. In addition, a short-term overload or even a reduction in the service life can occur if the pipe wall temperature TR = 20 °C is exceeded by more than 5 °C in the course of the internal pressure test based on the nominal pressure.

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

Test parameters

The following table provides recommendations on the performance of the internal pressure test

Purpose	Preliminary Review	Main examination
Test pressure pp (depends on the pipe wall temperature and the permitted test pressure of the installed components, see "determination of the test pressure")	$\leq P_{p\,(perm)}$	$\leq 0.85\ P_{p\,(perm)}$
Test duration (depends on the length of the pipe sections)	L ≤ 100 m: 3 h 100 m < L ≤ 500 m: 6 h	L ≤ 100 m: 3 h 100 m <L ≤ 500 m: 6 h
Checks during the test (test pressure and temperature curves must be recorded)	At least 3 checks distributed across the test period with test pressure restored	At least 3 checks distributed across the test period without restoring the test pressure

Pre-test

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

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

Material	Pressure drop (bar/h)
COOL-FIT 4.0	1.2

Main test

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

Observe if using compensators

If the piping system to be tested contains compensators, it has an influence on the expected axial forces on the fixed points of the piping system. Because the test pressure is higher than the operating pressure, the axial forces on the fixed points increase proportionately. This has to be taken into account when designing the fixed points.

Observe if using valves

When using a valve at the end of a piping system (end or final valve), the valve and the pipe end should be closed by a dummy flange or cap. This prevents an inadvertent opening of the valve and release of the medium.

Filling the pipe

Before starting the pressure test, the following points should be checked:

1. The installation has been carried out in accordance with its plans.
2. All pressure relief and check valves are fitted in the direction of flow.
3. All end valves have been closed.
4. All valves for devices have been closed to secure against pressure.
5. A visual inspection has been made of all connections, pumps, measurement devices and tanks.
6. The waiting time after the last weld or bond has been observed

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

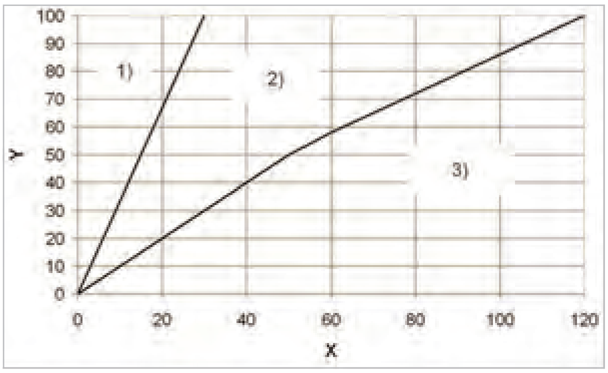
Reference values for the filling volume are given in the table below:

d (mm)	V (l/s)
≤ 90	0.15
110	0.3
160	0.7
225	1.5
250	2.0
315	3.0
400	6.0

Allow sufficient time to pass between filling and testing the pipe for the air in the piping system to escape through the vents: about 6 to 12 hours, depending on nominal diameter.

Applying the test pressure

The test pressure is applied in accordance with this diagram. It is important to ensure that the rate of pressure increase does not cause any water hammers.



Y Test pressure (%)
X Time of test pressure increase (min)
1) Rate of pressure increase up to DN100 mm
2) Range of pressure increase rates between DN100 and DN400 mm
3) Guideline rate of pressure increase for DN500 and higher: 500/DN (bar/10 min)

Determination of the test pressure

The permissible test pressure is calculated using the following formula:

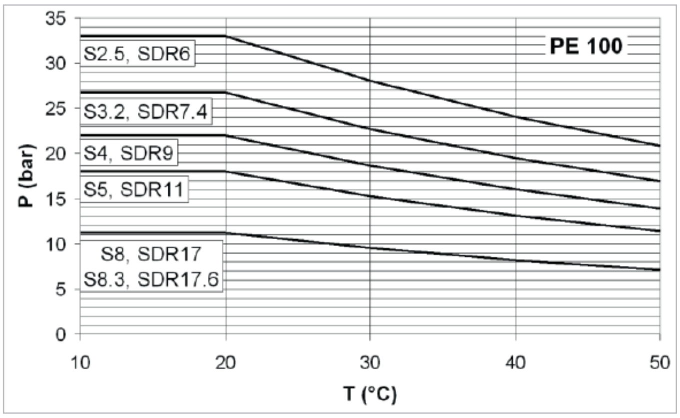
$$P_{p(zul)} = \frac{1}{SDR} \cdot \frac{20 \cdot \sigma_{v(T,\,100\,h)}}{S_p \cdot A_G}$$

$\sigma_{v(T,\,100\,h)}$ Creep strength for the pipe wall temperature (at t= 100h)
S_p Minimum safety factor for creep strength
A_G Processing method or geometry specific factor which reduces the permissible test pressure
T_R Pipe metal temperature: mean temperature of test medium and pipe surface

Material	Sp minimum safety factor
COOL-FIT 4.0 Pipe and Fittings (PE100)	1.25
COOL-FIT 4.0 Valves (ABS)	1.6

V

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



P permitted test pressure (bar)
T pipe wall temperature (°C)

Checks during testing

The following measurement values must be recorded consistently during testing:

1. Internal pressure at the absolute lowest point of the piping system
2. Medium and ambient temperature
3. Water volume input
4. Water volume output
5. Pressure drop rates

5.4 Start-up with secondary refrigerants

Secondary refrigerants such as glycol solutions must only introduced in liquid, pre-mixed form into COOL-FIT 4.0 piping systems. Filling should be performed slowly from the lowest point of the system to allow the piping system to vent at its highest point.

Filling and de-aeration

It is important to vent air from all piping systems. This is particularly important with saline solutions, because of their corrosive properties. Venting process:

- The system must be filled slowly.
- Manual or automatic venting devices must be fitted at the highest point of the system.
- Long horizontal lines should be installed at a slight gradient.
- The piping layout should be chosen in such a way as to prevent the formation of air pockets.
- Installation of an air vent with a medium column as a reserve.
- Follow the specific manufacturer instructions for the liquids as regards filling

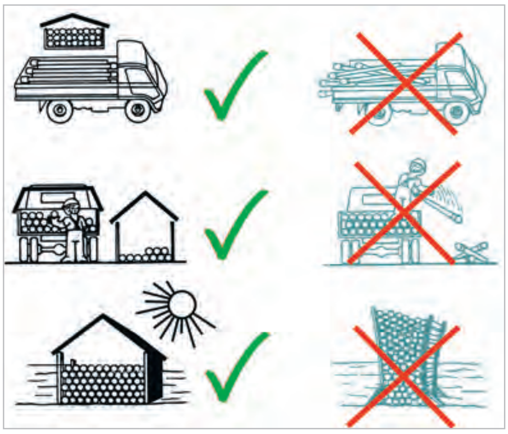
6 Transport, Handling and Storage

6.1 Transport

On trucks/in crates, manual transport

6.2 Storage

All plastic pipe including pre-insulated plastic pipe such as COOL-FIT 4.0 must be stacked on a flat surface with no sharp edges. During handling, care must be taken to avoid damage to the external surface of the pipe, i.e. by dragging along the ground). Pipe should not cross over each other in storage as this is likely to cause bending.



7 Environment

The materials used for COOL-FIT 4.0 are suitable for recycling. Georg Fischer Piping Systems aims to satisfy its customer's wishes concerning environmental aspects.

i For more information at www.coolfit.georgfischer.com

Build

Silenta Premium

V

Silenta Premium

Overview

This chapter contains basic information about the Silenta Premium system.

Additional technical and sales information

More technical information about this system and other ordering information:
➨ GF website and sales catalogue.

1 System overview

1.1 System description

The Silenta Premium is a soundproofing wastewater system for non-pressurised drainage in building and groundwater pursuant to DIN 1986-100 and DIN EN 12056.

Silenta Premium can be used as a universal drainage system in both residential construction (semi-detached dwellings, block of flats, residential complexes) and large properties (office buildings, hotels, large residential complexes, hospitals, schools and universities, conference centres, industrial and commercial buildings).

Silenta Premium can be used both as a standard drainage system without special sound insulation requirements. Furthermore, the system may also be used with increased sound insulation requirements (VDI Guideline 4100).

Silenta Premium is available in nominal diameters DN56 to DN200. The assortment consists of all types of pipes, fittings and transitions needed for the production of drainage systems.

1.2 Scope and application area

The drainage system **Silenta Premium** is intended and suitable for the following types of wastewater and areas of use.

Domestic sewage water and rainwater

- Domestic wastewater from kitchens, laundry rooms, bathrooms, toilets and similar spaces; however, mainly from households or similar facilities, such as hotels, retirement homes, hospitals, office and administrative buildings, sports facilities, washing and toilet facilities in commercial or industrial buildings or other facilities that serve other purposes, but are equivalent to domestic wastewater.
- Rainwater (precipitation) that has not been contaminated by pollution caused by commerce and industry.
- For the supply and discharge of wastewater from rainwater harvesting systems.

Wastewater produced by commerce and industry

When discharging untreated wastewaters of commercial or industrial origin and effluents with comparable harmful substances, the usability of the pipe materials, fittings and gaskets must be checked in accordance with the table **Chemical Resistance Polypropylene** (resistance list) for the **Silenta Premium** drainage system. Because these resistance lists are only a guide to users, the manufacturer should be involved in deciding whether or not to use them.

The following information is required for an assessment and decision on suitability:

- Information on the individual substances
- Concentration and pH values
- Information regarding quantities and throughputs
- Temperatures of the wastewater

Wastewater leading to grease separators

The **Silenta Premium** pipe system is made of polypropylene and is suitable for the incoming and outgoing wastewater pipes as well as for the ventilation pipes of grease separator systems.

Pressure lines from lifting systems and submersible pumps

The Silenta Premium drainage system is suitable for the connection of pressure lines onto lifting systems and submersible pumps up to a pump delivery pressure of 0.1 MPa. This implies, however, that the pipe connections must be secured with pipe claws that prevent the pipes from slipping apart and ensure a resilient fastening with pipe clips and M12 mounting thread.

Drainage system designed as underground pipeline

The Silenta Premium drainage system is suitable to be installed as an inaccessible pipeline (underground line) within the surrounding walls of the building in the ground or in the base plate.

The standards DIN EN 1610 for pipe assemblies and leak testing, as well as DIN 4124 for digging trenches may need to be considered.

The Silenta Premium system is **not** approved for the assembly as underground pipeline on land outside buildings.

Installing pipes in concrete

The Silenta Premium drainage system is suitable for embedding in concrete, however, compliance with the assembly instructions of the manufacturer is mandatory. Among others things, this includes:

- The proper fastening and securing of the pipes in order to prevent the pipes from slipping apart, claws are most suitable choice. This applies in particular in areas where pipes change direction.
- Consideration of the expansion of the pipes under the influence of temperature.
- Masking the sleeves with adhesive tape in order to prevent concrete from entering through the pipe's gap and into the sleeve.
- The leak test before pouring the concrete
- Filling the pipe with water in order to increase its own weight and prevent it from floating on top of the concrete while pouring it.

1.3 Properties and requirements

Materials

Materials Polypropylene (PP)
Detailed information:
➨ Part III 'The basics', Section 'Materials and jointing technology'

Chemical resistance

Silenta Premium pipes, fittings and gaskets are resistant to domestic wastewaters. Wherever chemically aggressive wastewater is used (e.g. for industrial applications), it is suitable for pH 2 to pH 12.

An individual case assessment can be requested from GF specifying the composition of the respective wastewater and the operating conditions.

1.4 Safe application and processing

1.4.1 Transport and storage

☑ Boxes must be protected from moisture during transport and storage.
☑ Pipes: A maximum number of three pipe transport racks may be stacked on top of each other.
☑ The wooden frames of the pipe racks must be stacked on top of each other.
☑ Avoid direct sunlight for a longer period of time.

2 System components

Silenta Premium pipes are coextruded in an innovative 3-layer technology made from polypropylene (PP). The outer layer is impact resistant and protects against mechanical damage. The middle layer is made of mineral-reinforced polypropylene and absorbs sound in a reliable manner. This ensures, pursuant to DIN 4109, Silenta Premium can be safely used in buildings with sound insulation requirements. The smooth and abrasion-resistant inner surface prevents incrustations and deposits and protects against corrosion, for example, if aggressive household chemicals are used. Due to the light grey colouring, the wastewater system is easy to inspect.

2.1 Silenta pipes

2.1.1 Pipe layout and labelling

The design of the Silenta Premium pipes is characterised as follows:

GV.1
Design of the pipe

1. The outer layer is made of PP: Robust and resistant to mechanical and thermal stress during operation and during processing
2. The layer in the centre is made of mineral-reinforced PP: The high mass weight ensures sound absorption and reduces the propagation of sound waves.
3. The inner layer is made of PP: Resistant to domestic wastewater. The smooth and abrasion-resistant surface prevents encrustations and ensures perfect and quiet drainage behaviour

2.1.2 Labelling pipes and fittings

Silenta Premium

Moulded parts

Manufacturer name, brand name, diameter, angles, standards

Pipes

Manufacturer name, brand name, pipe diameter, wall thickness, standard specifications, material specification, AbZ No. (number of the building authorities approval), date of manufacture, machine number, manufacturer country, EAN (European Article Number) code.

An imprinted centimetre scale facilitates the easy cutting of the pipes.

2.1.3 Technical data

TV.1
Technical data

Property	Value
Design	3-layer pipe system (PP – mineral reinforced PP – PP)
Density	1,9 g/cm³ (DIN 53479)
Colour	Light grey (RAL 7035)
Maintenance	Maintenance-free (assuming normal operation)
Attachment	Pipe clips with rubber insert (for example: Bismat by the Walraven Group)
Coefficient of linear thermal expansion	0,04 mm/(m·K)
Tensile strength	13 N/mm²
Chemical resistance	Resistant to domestic wastewater and industrial wastewater with pH2 – pH12
Permissible ambient temperature	Between –20°C and 60°C
Permissible wastewater temperature	For domestic wastewater between 0°C and 90°C, briefly up to 97°C
Labelling pipes	Manufacturer name, brand name, pipe diameter, wall thickness, standard specifications, material specification, AbZ No. (number of the building authorities approval), date of manufacture, machine number, manufacturer country, EAN (European Article Number) code
Labelling moulded parts	Manufacturer name, brand name, diameter, angles, standards
Nominal diameter of the system	DN56, DN70, DN90, DN100, DN125, DN150, DN200
Connection	Push-in sleeves with factory-fitted profile seals
DIBt (Authority of the German State Governments) approvals	AbZ no. Z-42.1-537
Application category	Pursuant to DIN EN 1451-1, category B (inside buildings) and BD (buried within the building structure)
E Module	2,400 – 3,800 MPa pursuant to ISO 178
Ring stiffness	Pursuant to EN ISO 9969. The ring stiffness is at least 8.0 kN/m² across the entire dimension range DN56 - DN200

3 Assembly

3.1 Assembly of the pipes and moulded parts

Assembly – Pipes and moulded parts

How to chamfer and shorten pipes

① → Measure required pipe lengths.
→ Mark the fitting length using the centimetre scale printed on the pipe.

② → Cut the pipe at right angles to its axis, using a plastic pipe cutter, a fine-toothed saw or another suitable cutting tool.

③ → Deburr the outside of the pipe, using a deburring tool or knife.

④ → Suitable for connection to pipe systems with push-in joints: Use a chamfering tool to chamfer the pipe ends with at an angle of approx. 10° to 15° (➨ Table [TV.2]).
→ Heed the dimension ❶ of the chamfer:

Connect the pipes and moulded parts

⑤ → Clean the pipes and moulded parts.
→ Apply a thin layer of suitable lubricant to the end of the pipe and moulded part. Do not use grease.
→ Push pipes and fittings together all the way to the stop.
→ Use a suitable pen to mark the inserted pipe in this position at the edge of the sleeve.

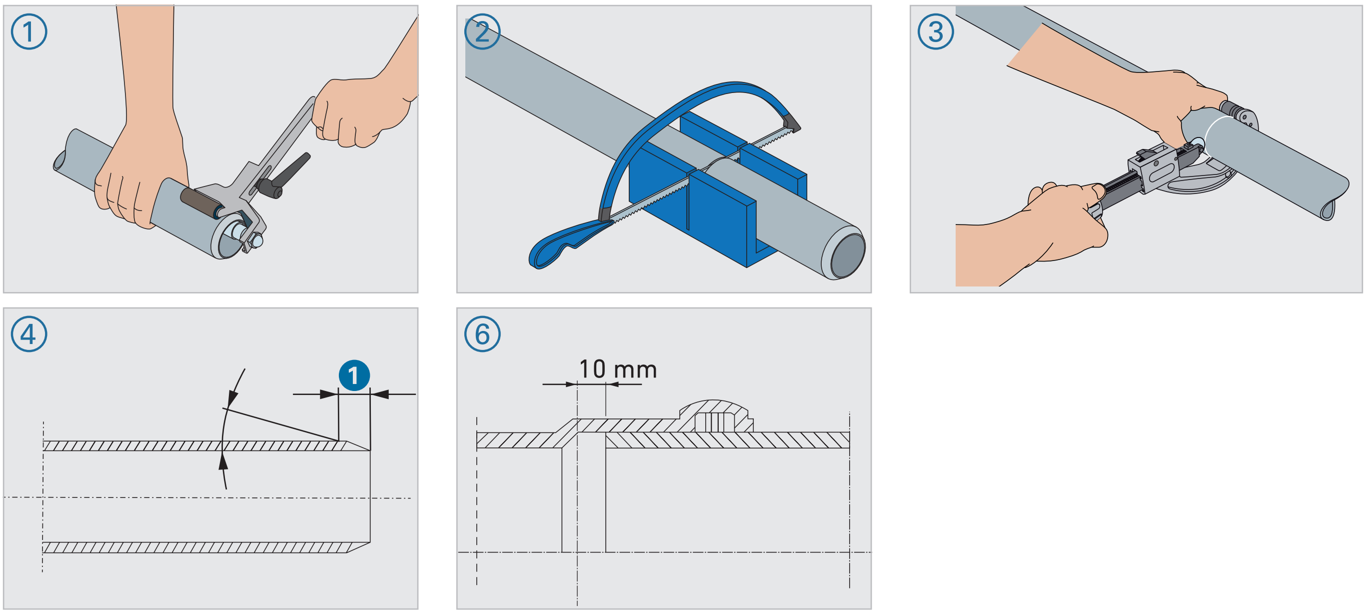
⑥ **When using vertically installed pipelines:**
→ Pull back the push-in joint 10 mm from inside the sleeve at each floor level in order to accommodate for any potential elongation.

For pipelines installed horizontally:
→ Pull back the push-in joint between the pipes and fittings after every 4 m of installed piping. This will create space for the absorption of length changes even with longer vertical pipes.

Dimension d [mm]	58	78	90	110	135	160	200
Chamfer ❶ [mm] (ca.)	4	4	5	6	6	7	8

TV.2
Chamfer dimensions

Assembly – Pipes and moulded parts



3.1.1 Proper assembly

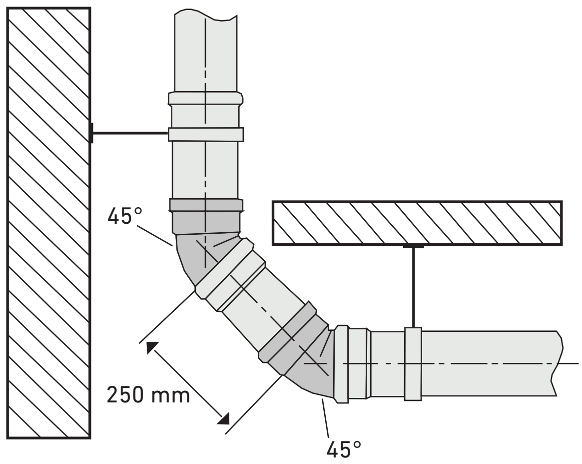
Noise reduction

The proper assembly of the pipes has a considerable influence on the sound reduction as well as the formation of sound waves.

☑ Suitable measures must be taken in order to reduce the flow and sound development in zones where the flow direction changes.

Example

Redirecting the vertical downpipes in a false ceiling area.



GV.2
Redirecting a downpipe

☑ For hydraulic and acoustic reasons, a change in direction by 90°, in which a downpipe enters a horizontal main pipeline, two 45° elbows with an intermediate piece of 250 mm is required.

☑ 87°-elbows must **not** be used when redirecting a downpipe into a horizontal header.

Additional actions to be taken in order to reduce noise

- Using pipe clips with rubber insert
- Use of soundproofing insulation (PE hose 4 mm)

3.2 Attachment

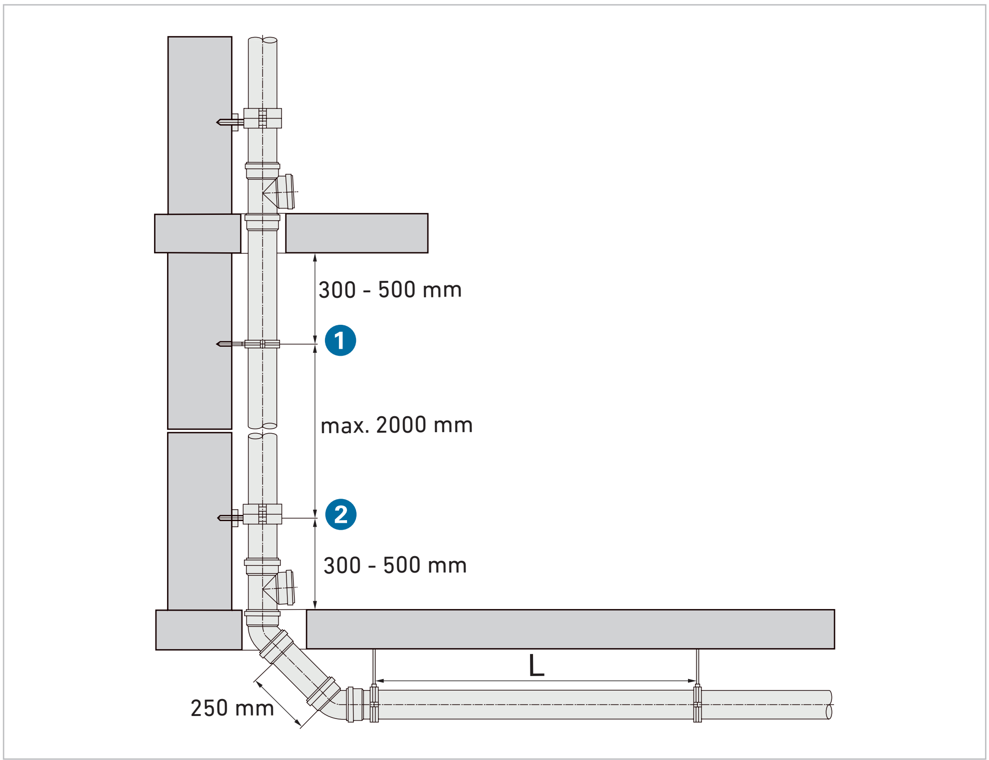
During the installation of wastewater pipe systems, it must be ensured that the pipes are assembled stress-free and that the pipes can elongate, if necessary. All downpipes must be installed vertically. At least two attachment points must be provided on each storey (at least one fixed support bracket and one adjustable pipe clip). The spacing between attachments for downpipes must not exceed 2.00 m.

The maximum permissible spacing between attachments of horizontally installed wastewater pipes depends on the respective pipe dimension (see table).

Pursuant to DIN 4109, pipe clips with sound insulation inserts must be used for fastening all drainage pipes.

Pipeline DN	56	70	90	100	125	150	200
Spacing between attachments L (max.) [mm]	4	4	5	6	6	7	8

TV.3
Max. spacing between attachments (L) for pipelines installed horizontally



GV.3
Attachment

1. Guidance clamp, for example, made by the Walraven Group, type BISMAT© 2000
2. Downpipe pipe clamp, made by the Walraven Group, type BISMAT© 1000

L max. spacing between attachments

Downpipe support bracket

The downpipe support bracket is intended to transfer the weight of the vertical downpipe safely into the structure of the building. Therefore, the transmission of structure-borne noise is largely avoided. Particularly suitable for this purpose is a support bracket consisting of a fixing and a support bracket (for example BISMAT® 1000). The weight of the vertical pipe section is diverted by the tight fitting pipe support clamp onto the support bracket. This type of attachment in combination with the sound insulation inserts in the pipe clips leads to an excellent insertion loss and the resulting very low residual sound levels.

An additional advantage of this type of attachment is that it can be mounted at any point of the down pipe (even on smooth pipe).

Alternatively, commercially available pipe clips with sound insulation insert can be used as a downpipe support bracket. However, these pipe clips must always be arranged below a pipe sleeve in order to prevent the downpipe from “slipping”.

Guidance clamp (adjustable pipe clip)

The adjustable pipe clip is intended to maintain the axial alignment of the downpipe. This clamp should only have little contact with the pipe and thus allow the longitudinal movement of the downpipe.

3.2.1 Components fastening methods

BISMAT® 1000 support bracket

Downpipe support brackets with adjustable wall plate, for soundproofing wastewater downpipes.

Enables stress-free assembly due to optimal adjustability.

BISMAT® 2000

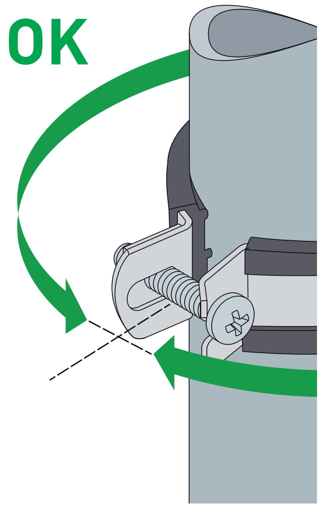
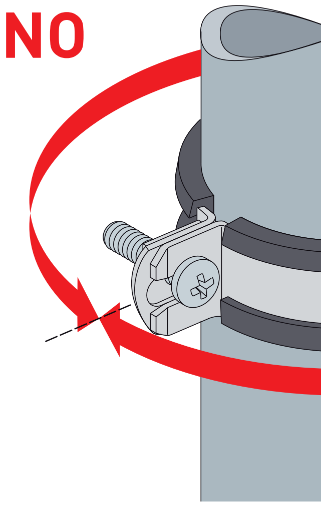
Two-screw clamp with BISMAT® quick release and acoustic insulation made of EPDM. Meets the fire protection requirement of MLAR/LAR/RbALei. Tested, quality assured and externally monitored pursuant to RAL-GZ 655/B and RAL-GZ 656.

BIS heavy-duty clamps HD1501 (BUP1000)

Two-screw clamp in heavy-duty design. With BIS UltraProtect® 1000 surface coating and acoustic insulation made of EPDM. Meets the fire protection requirement of MLAR/LAR/RbALei. Tested, quality assured and externally monitored pursuant to RAL-GZ 655/B and RAL-GZ 656.

3.2.2 Proper assembly of pipe clips

In order to reduce the transmission of structure-borne noise, it is important to ensure that the screw plugs are not tightened excessively during the assembly of pipe clips with sound insulation inserts.

proper assembly	incorrect assembly
	

Build

Safety at work

V

Safety at work

1 Introduction

This chapter contains basic instructions on safety at work.

+ Safety is no accident.

That's why we've set safety rules regardless what country you're in.

Safety rules protect us and others from dangers that we do not recognise immediately, be it because we're following a routine or because of the illusion that "nothing will happen" – until it happens and is too late.

☑ Protect yourself and your colleagues on site, providing you with the highest safety possible at your workplace.

2 Safety Instructions

What to do in an emergency

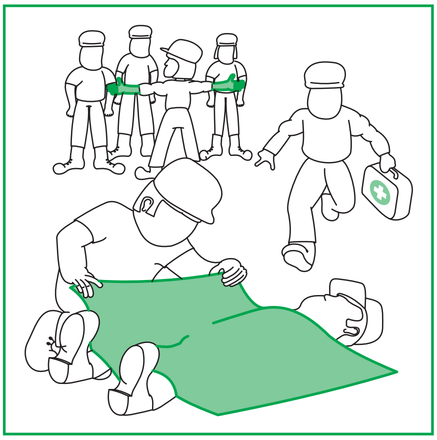
OK ✓

NO ⃠

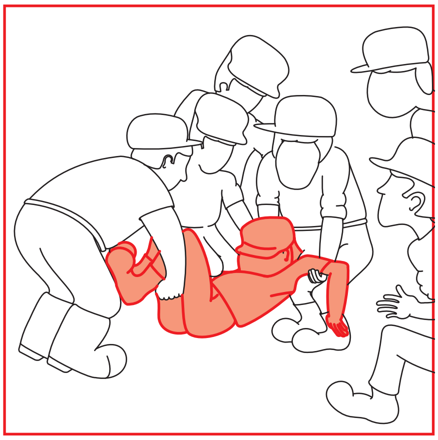
☑ Safety information and emergency addresses must be posted at a suitable place. The instructions must be clearly and instantly recognisable.

Notify first aid workers

OK ✓



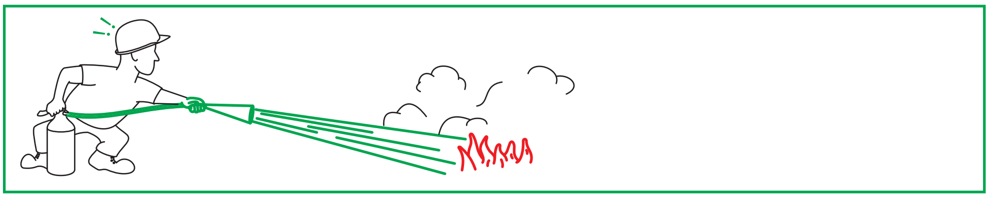
NO ⃠



☑ In the event of an accident, immediately call a doctor or trained first aid personnel.

Fire extinguishers

OK ✓



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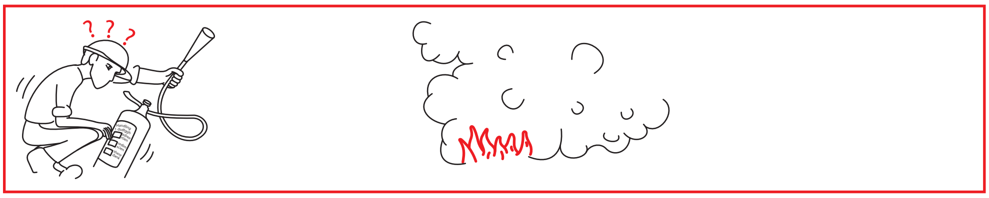
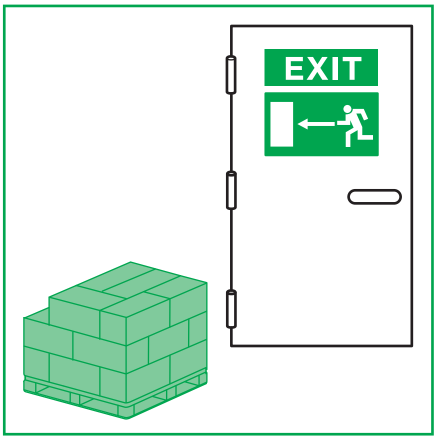


☑ All personnel working on the construction site must be instructed on the proper handling of the fire extinguisher.

Emergency exits

OK ✓



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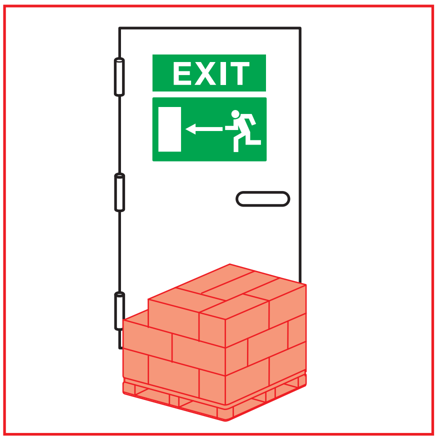
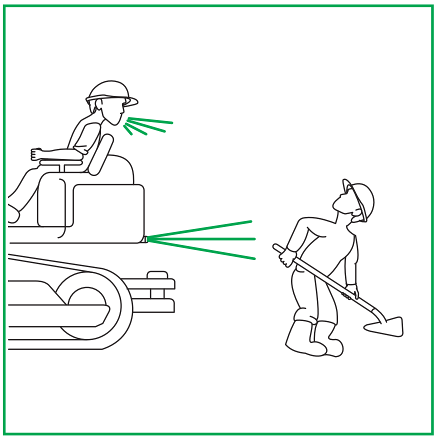


☑ Always keep escape routes unobstructed.

Communication

OK ✓



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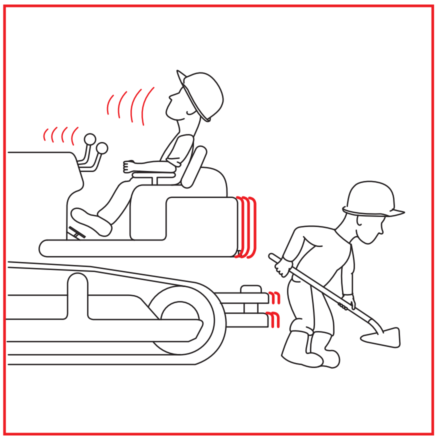
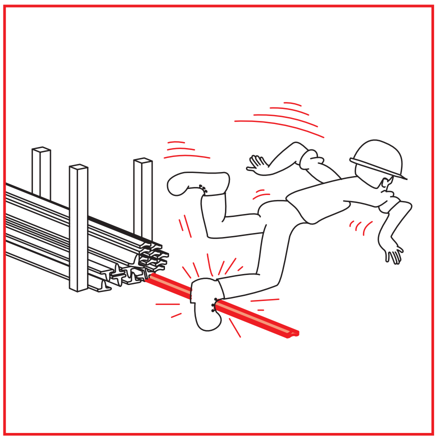


☑ In case of an emergency, make sure all workers can keep an eye on each other and react to each other at all times.

Walkways

OK ✓

NO ⊘

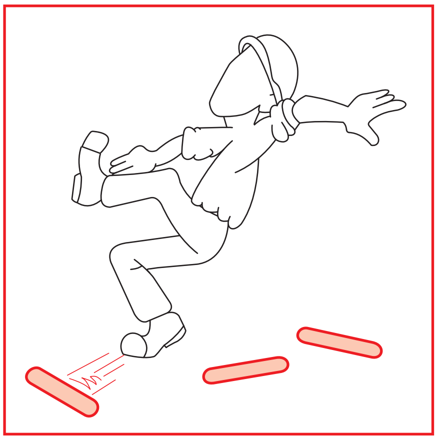


☑ Check walkways for tripping hazards. Clear the paths and remove tripping hazards immediately.

Slip hazards

OK ✓

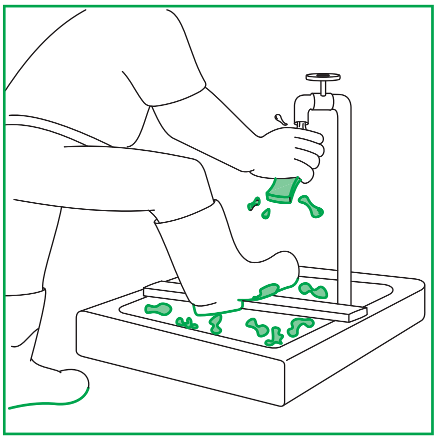
NO ⊘



☑ Make sure to clean all passages and roadways and keep them unobstructed at all times. Pick up any carelessly discarded material.

Cleanliness

OK ✓



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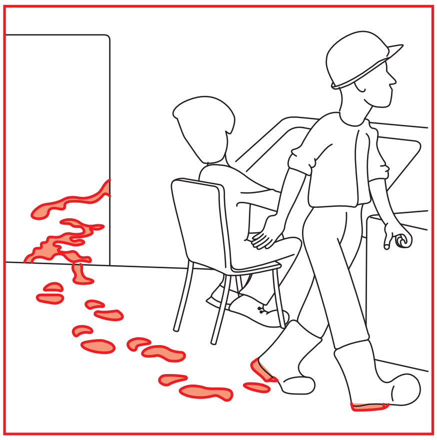


☑ Dirt, liquids and debris on the floor can cause a danger of falling.
To prevent this type of risk, keep construction site offices and work spaces need and tidy all the time.

Safety helmet

OK ✓

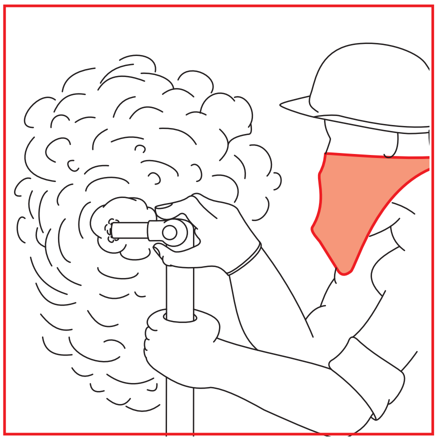
NO ⊘

☑ To protect the head from injury, wear a suitable safety helmet.

Protective mask

OK ✓

NO ⊘



☑ Dust and haze are everywhere. Therefore, always wear an appropriate and approved protective masks.

Safety goggles

OK ✓

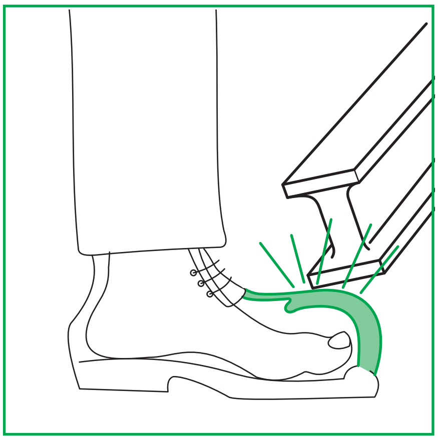
NO ⊘

☑ Wear protective glasses to protect your eyes – whatever you do on the construction site.

Safety boots

☑ To protect the feet from injury, wear suitable steel-toed safety shoes.

OK ✓



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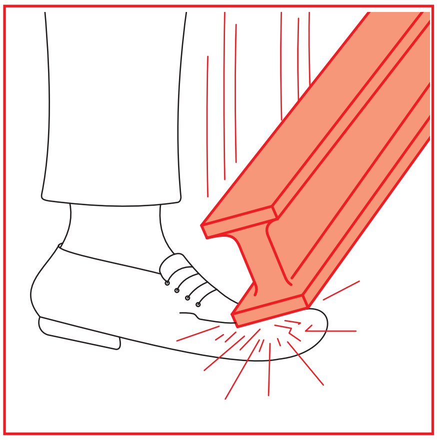
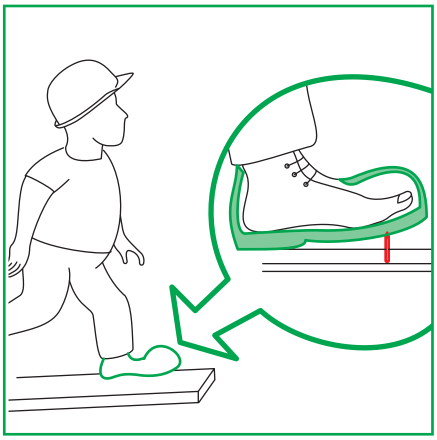


OK ✓



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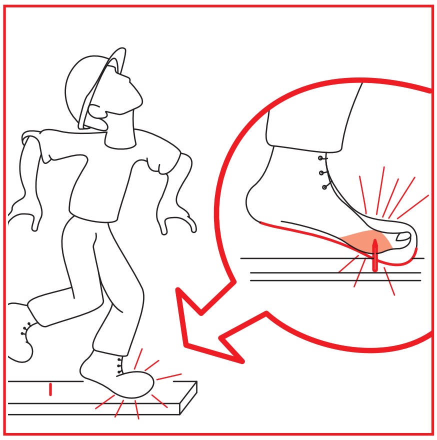
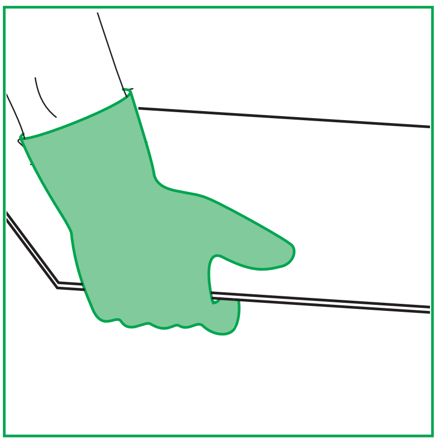


Safety gloves

☑ When working with sharp objects, wear suitable gloves to protect hands and fingers from injury.

OK ✓



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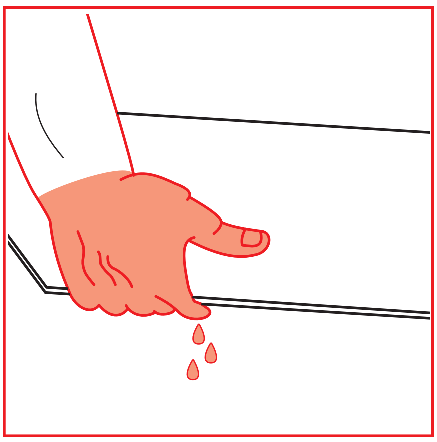
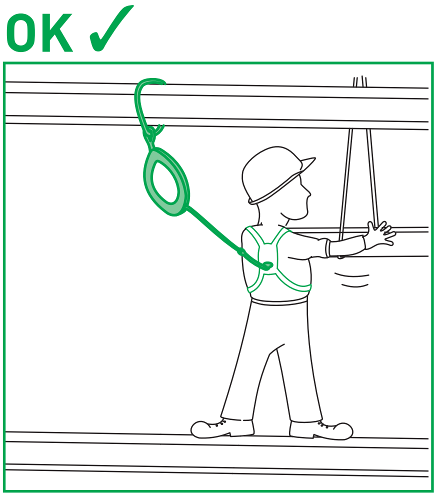
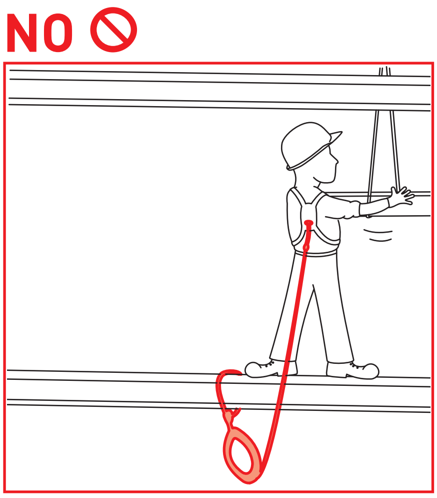


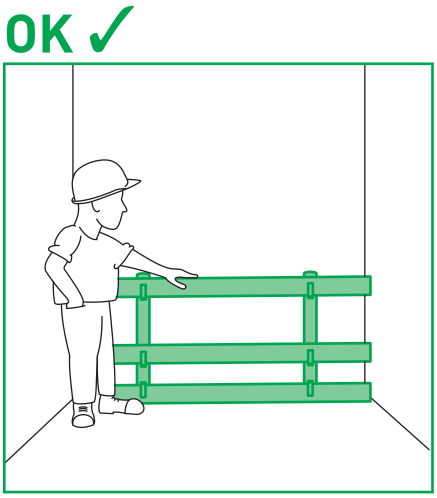
Safety harness

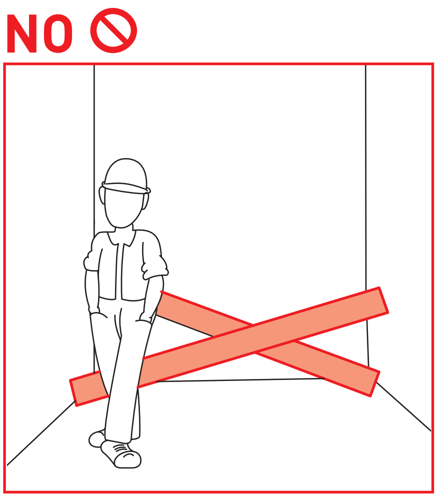




☑ When working at heights, wear a suitable fall arresting device.

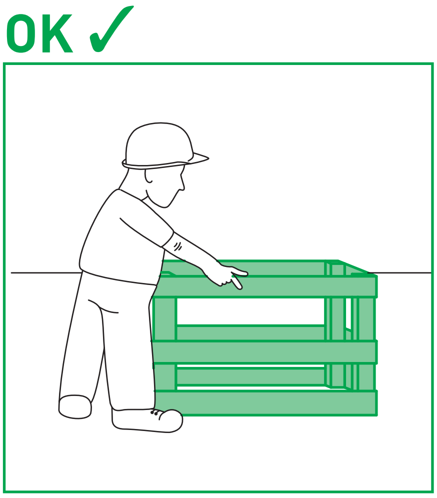
Guard rails

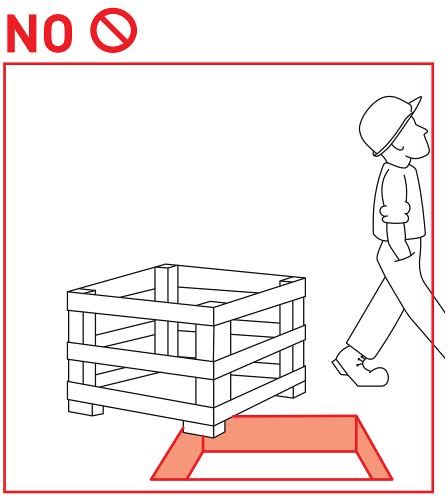




☑ Properly secure all openings on the construction site.

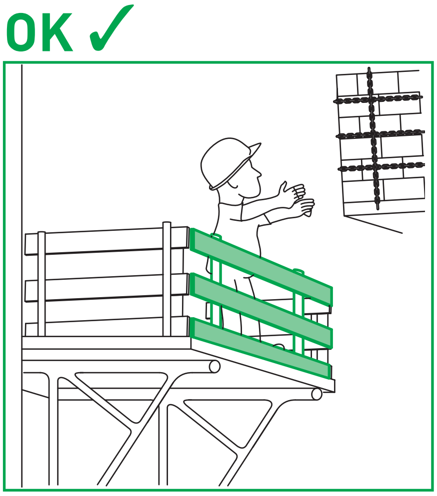
Securing of floor openings

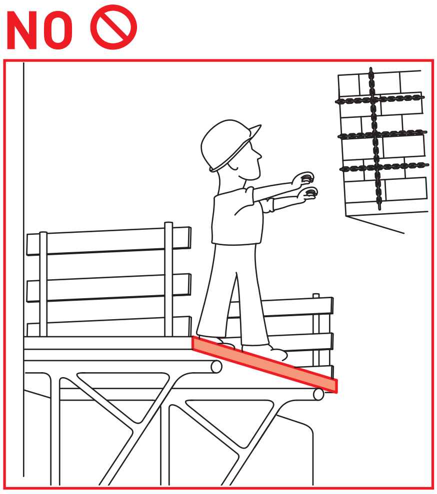




☑ All openings in the floor must be safeguarded properly in order to prevent workers from falling through these floor openings.

Wooden guardrail systems



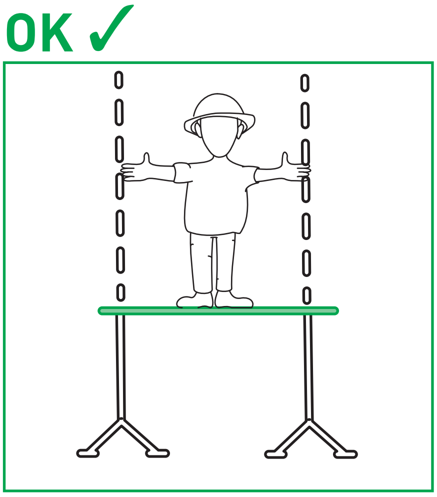


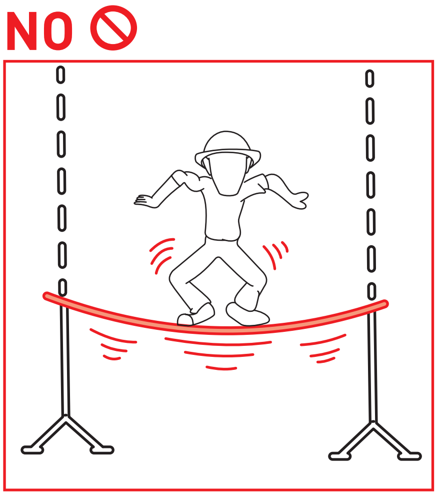
☑ A guard rail must be installed on all sides of a work platform.

Guardrails on scaffolding

☑ All scaffolding must be equipped with a railing.

Scaffolding





☑ Observe the spans of the scaffolding as instructed by the manufacturer.

Safety when assembling scaffolding

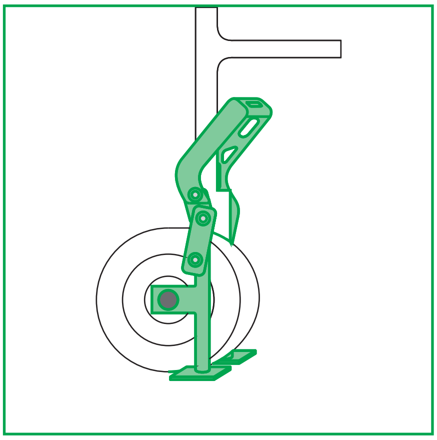
OK ✓

NO ⦸

☑ Always support scaffolding according to the instructions.

Locking wheels

OK ✓



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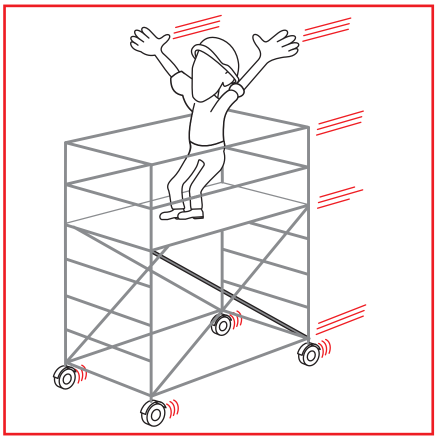
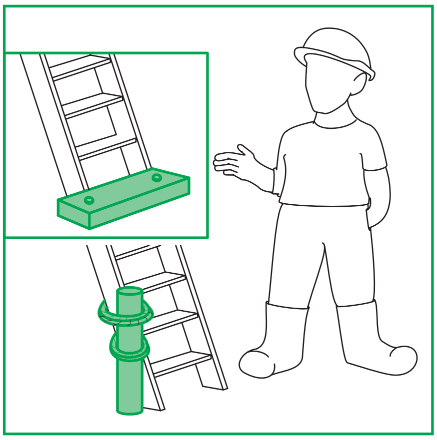


☑ Before climbing onto the scaffold, apply or lock all brakes.

Use of ladders

OK ✓



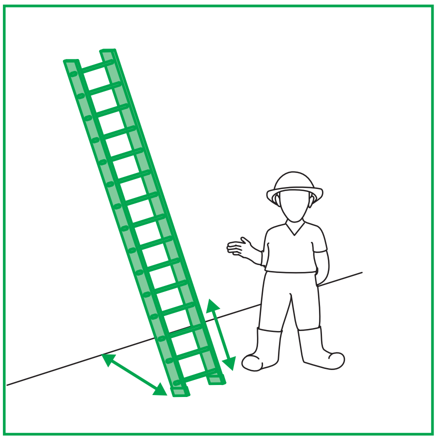
NO ⦸

☑ Make sure the ladder is secure and/or tied to an appropriate object.

☑ Never place an object underneath a ladder you're about to use.

Proper pitch of a ladder

OK ✓



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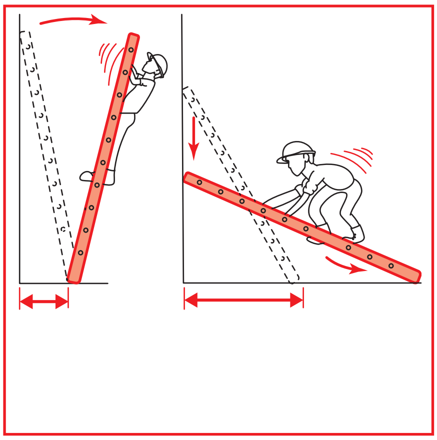
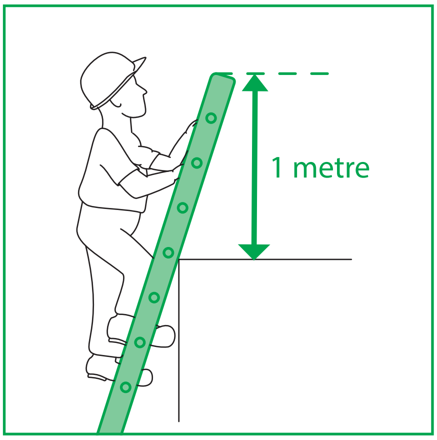


☑ Always observe the proper pitch of the ladder.

Ladder extension

OK ✓



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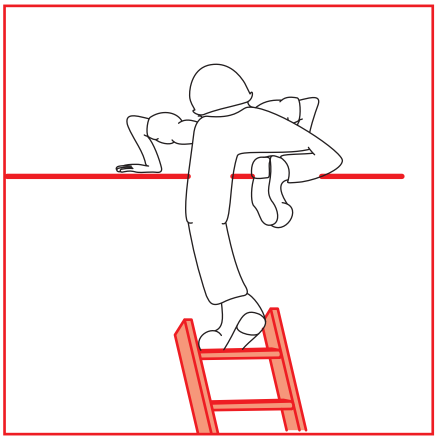


☑ Always extend ladders 1.0 meters above the highest point of the object to be climbed.

Rungs

OK ✓

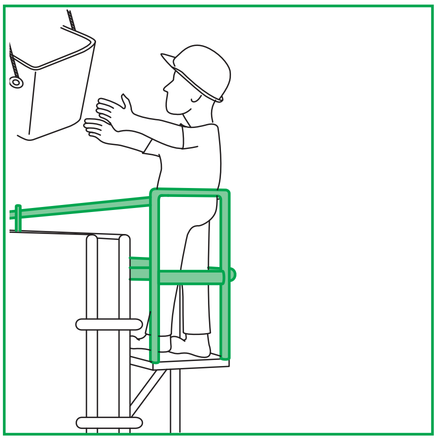
NO ⃠

☑ Always keep ladders in a flawless condition.

☑ Worn out or damaged rungs must be replaced immediately.

Fall protection when handling suspended loads

OK ✓



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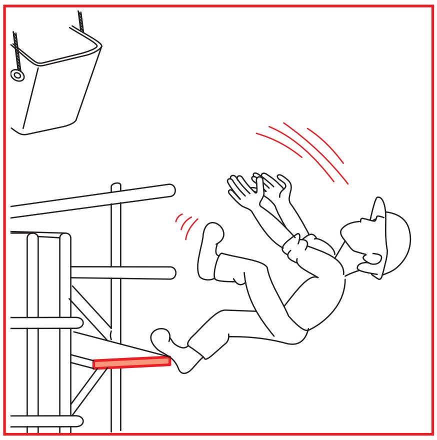
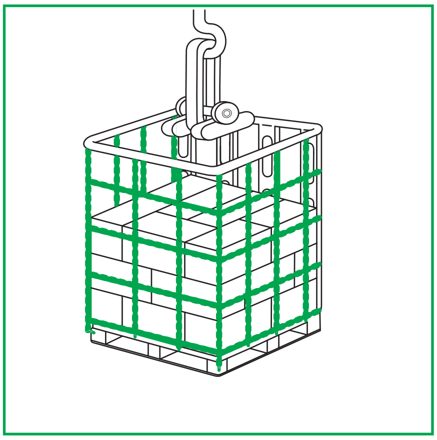


☑ Observe the risk of falling when the load is suspended and avoid falling by using proper load handling equipment.

When using goods lifts, use appropriate methods to secure the load

OK ✓



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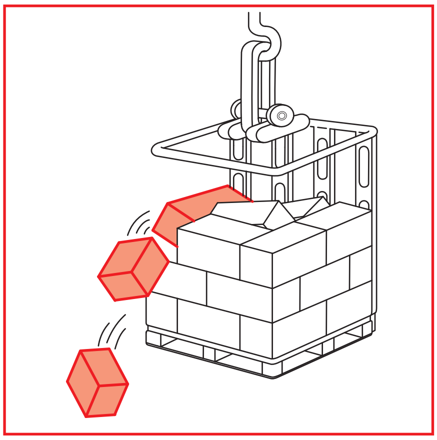


☑ Always secure suspended cargo and loads.

Attaching the loads

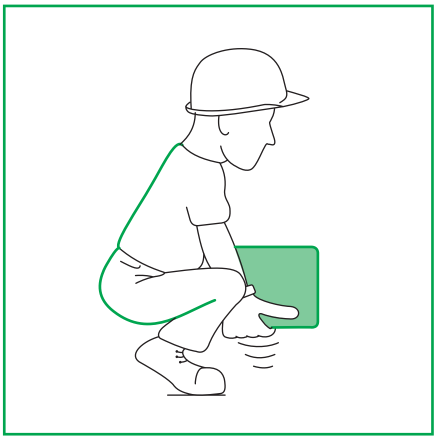
OK ✓

NO

☑ Use only self-locking hooks when attaching suspended cargo and loads.

Proper lifting techniques

OK ✓



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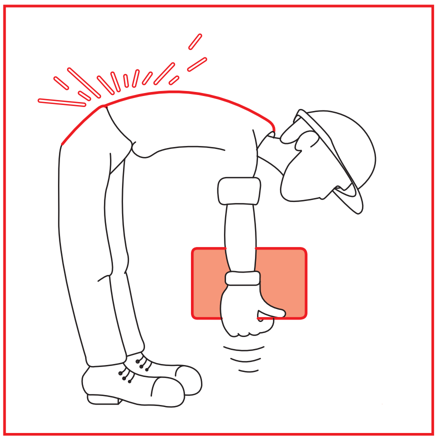
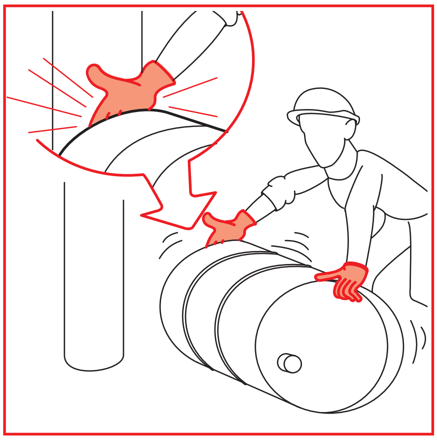


☑ When lifting lighter loads, bend your knees and keep your back straight.

Heavy loads

OK ✓

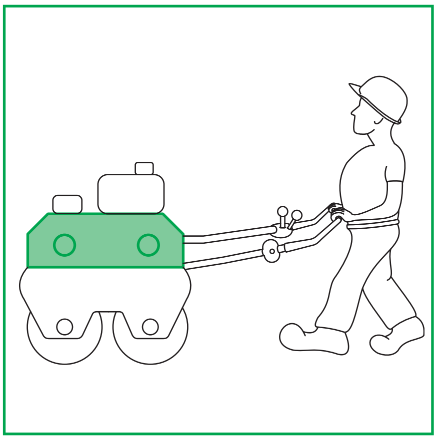
NO ⊘



☑ To prevent the danger of crushing, always use the right tools and appropriate method to move heavy objects.

Protecting your limbs and body

OK ✓



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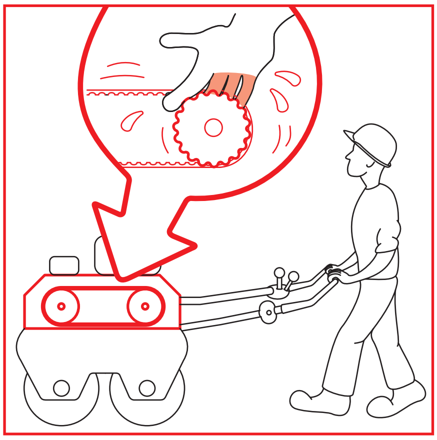
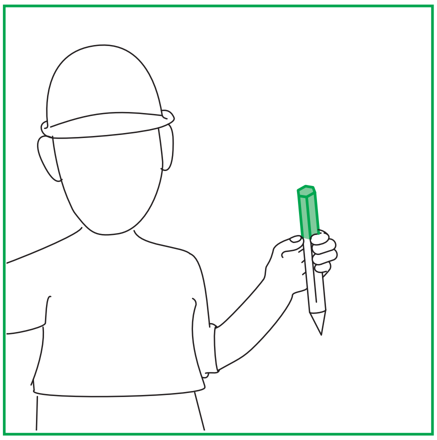


☑ Ensure that all moving parts on a machine or equipment are always completely covered.

Using a hammer

OK ✓



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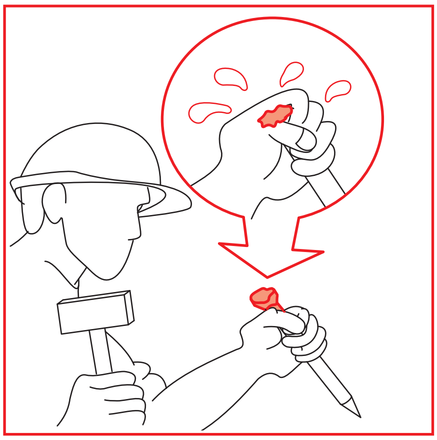
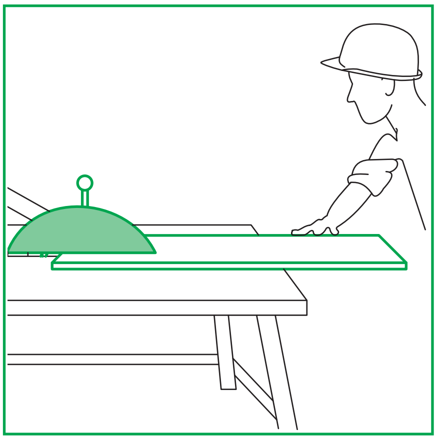


☑ To protect the hands, when using a hammer, hold the nail in the middle instead on the top.

Cutting the right way

OK ✓



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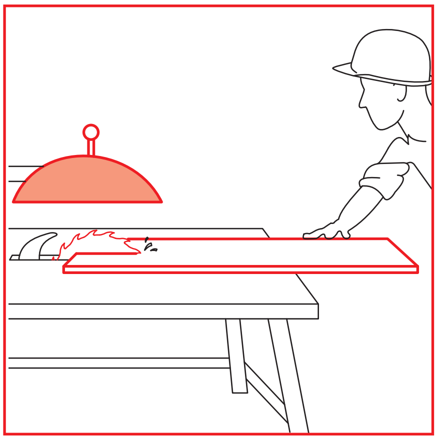
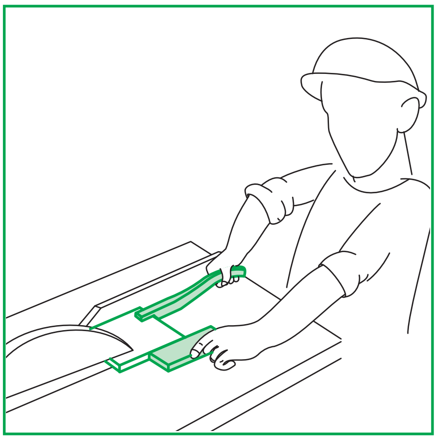


☑ Rotating milling or turning parts must be covered properly.

Protect your hands

OK ✓



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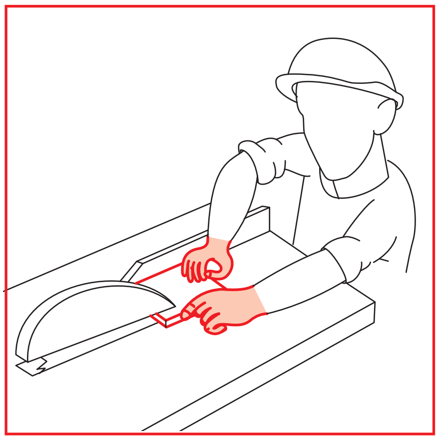
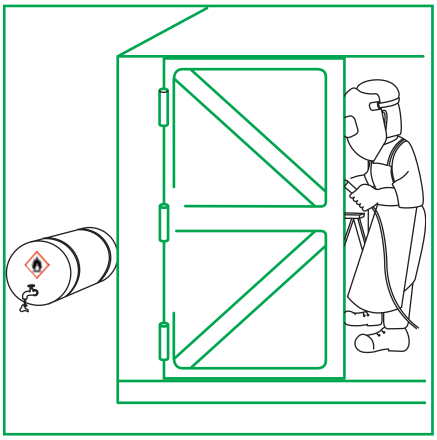


☑ Always use a suitable tool to secure and cut small parts when guiding them on a sawing machine.

Formation of sparks

OK ✓



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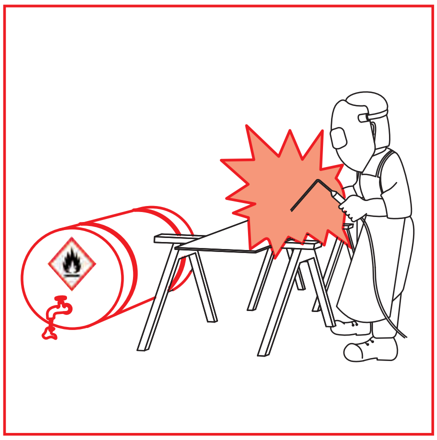
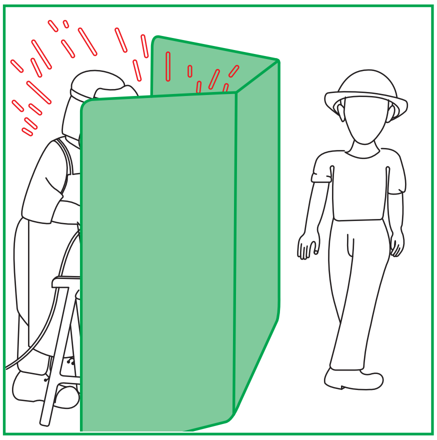


☑ Work that can causes sparks must always be carried out in separate, specially equipped rooms.

Safety when welding

OK ✓



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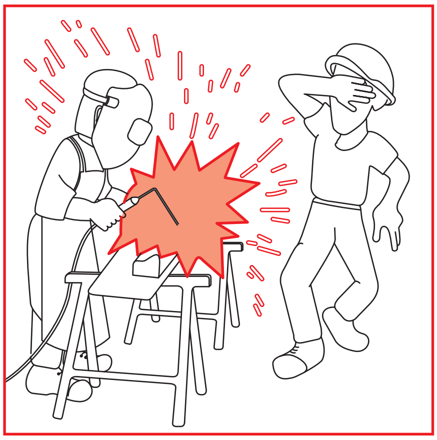
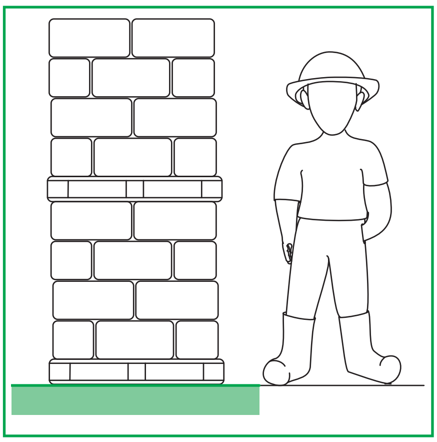


☑ When welding, always protect the surrounding area from air-borne sparks.

How to secure masonry

OK ✓



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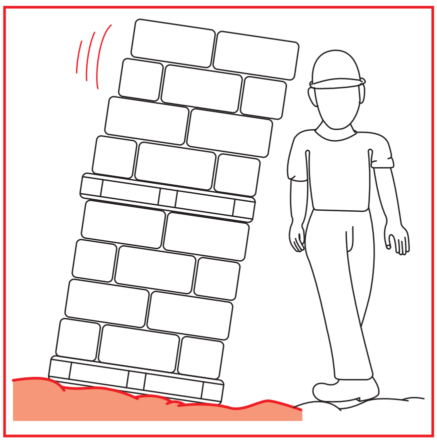
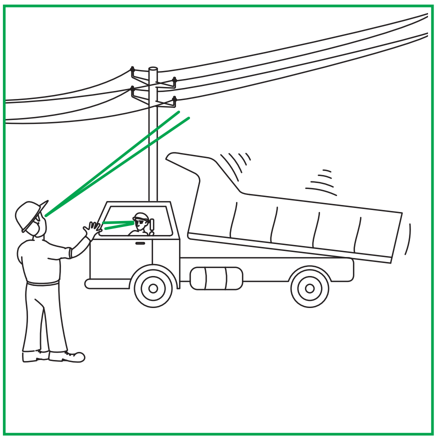


☑ Any type of masonry must be built at right angle on suitable ground.

Vehicles

OK ✓



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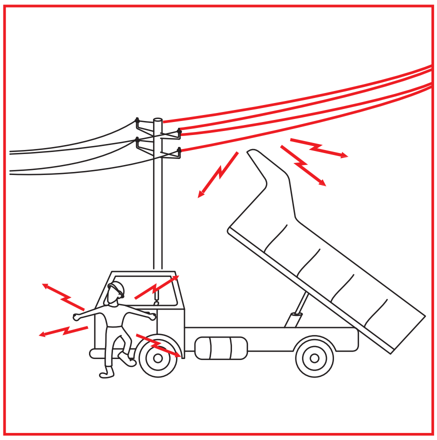
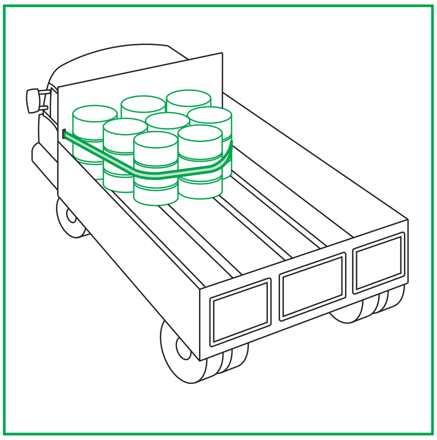


☑ Always observe the maximum overhead clearance of all vehicles.

Securing the load

OK ✓



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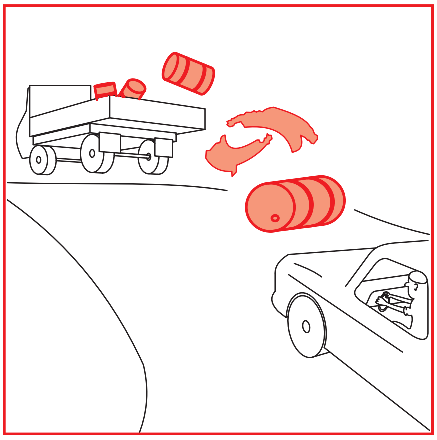
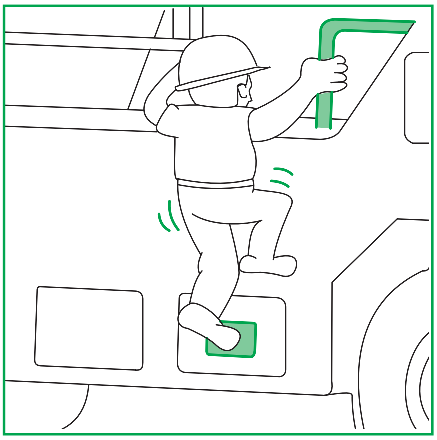


☑ Ensure the entire load on a vehicle is properly secured before starting the transport.

Getting off a vehicle/machinery

OK ✓



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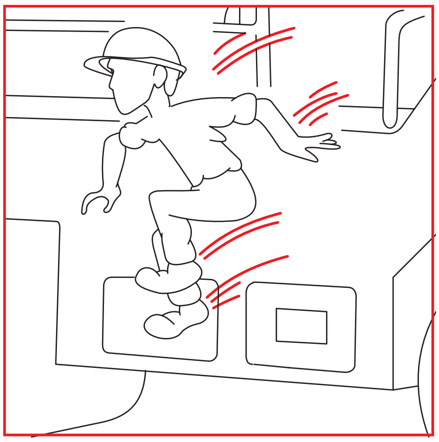
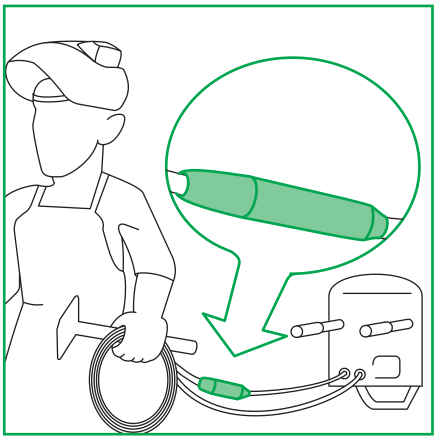


☑ Use railings and steps when getting off a vehicle/ machinery.
☑ Do not jump from elevated levels or machine part.

Safety when working with electrical equipment

OK ✓



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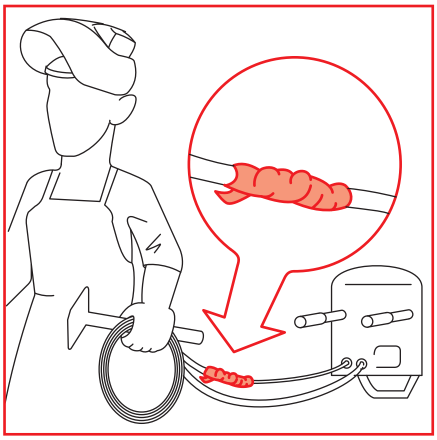
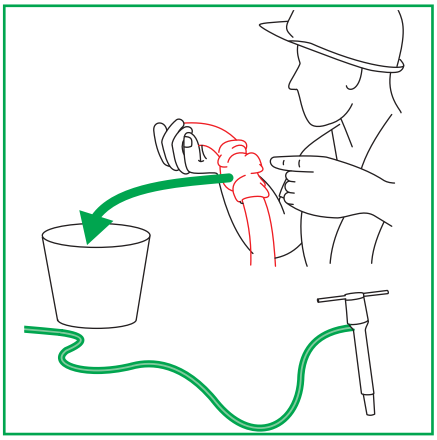


☑ Replace defective cables on equipment and tools immediately or request authorized personnel to do the repair for you.

Protection to prevent electric shock

OK ✓



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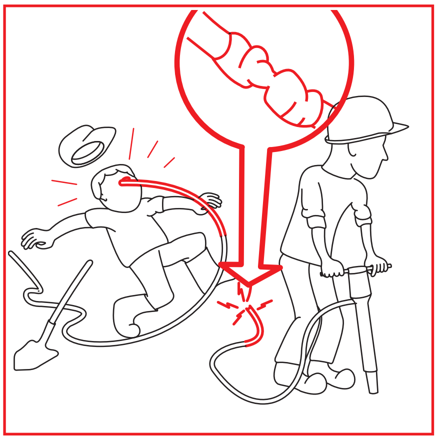
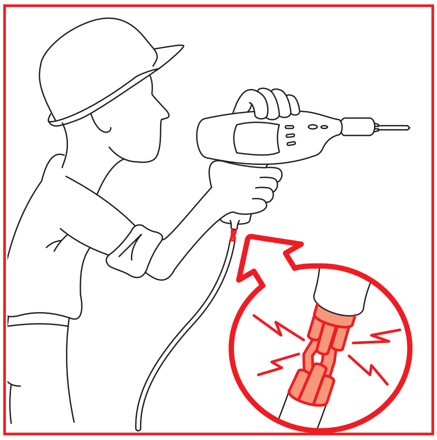


☑ If live cables of electrical equipment are damaged, they must be replaced immediately.

Damaged power cables

OK ✓

NO ⊘



☑ If cables that come in contact with water are damaged, they must be replaced immediately.

Build

Installation

Installation

1 Introduction

This chapter provides information on basic techniques common to all systems and products for the design, assembly, and installation of piping and system components used in building technology.

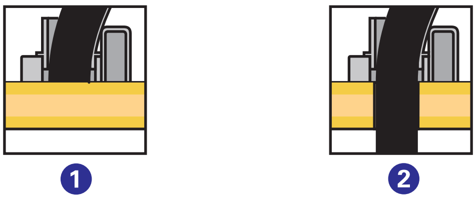
System and product-specific information
The system- and product-specific information on the respective systems and products are presented in the individual chapters of the 'Build' section.

NOTE! Damage to the installation when poring the concrete ceiling
Embedding pipes (e.g. multi-layer composite pipes) in the concrete of massive wall and ceiling constructions may **not** be permitted for certain pipe systems.
☑ Compliance with the assembly instructions on how to install the products is mandatory.

2 Installation using the drilling template

2.1 Installation methods

The drilling template for pipe dimensions d12 to d20 can be assembled "without damage to the formwork" (the formwork is **not** drilled through) or with bore holes through the formwork.



GV.1
Drilling template
1 Form work not drilled through
2 Form work drilled through

Both methods are illustrated step-by-step on the following pages.

2.2 Assembly of the drilling template (drilled through)

The individual steps are illustrated on the next page.

Assembling the drilling template (drilled through)

① → Position the individual modules of the drilling template according to the installation plan.
→ Interlock the individual drilling template modules.

② → Use 2 nails to fasten the drilling template assembly to the form work.
- Use nails with 5 mm diameter head.
- Always use 2 nails to fasten the modules located opposite to each other in the drilling template.

③ → Use a wood bit to drill through the form work.
The individual drilling template modules serve as drilling jigs.

④ → Push the pipe transfer bends into drilling template assembly.
Even after insertion, the pipe transfer bends can still be rotated 360° at the formwork level.

⑤ → Once the pipe transfer bends are properly placed, use nails to attach the pipe transfer bends to the framework. Use nails with 5 mm diameter head.

⑥ ☑ Ensure the length of the pipes extends far below the framework (at least 45 cm).
After the concrete has cured, the pipe can be pulled from the ceiling by this amount.
→ Push the pipes at least 45 cm through the feedthroughs in the formwork and use clips to fix the pipe in place.

⑦ → The protective pipe ends d12 are provided with a reducing socket d12.

⑧ → Use pipe binders to hold the pipes in place.
↳ The installation of the drilling template assembly prior to pouring the concrete is completed.

⑨ **After the concrete surface has cured**
The nails in the drilling template assembly have a predetermined breaking point.
This way, after removing the formwork from the cured concrete surface, the nails can easily be snipped with a pair of pliers.

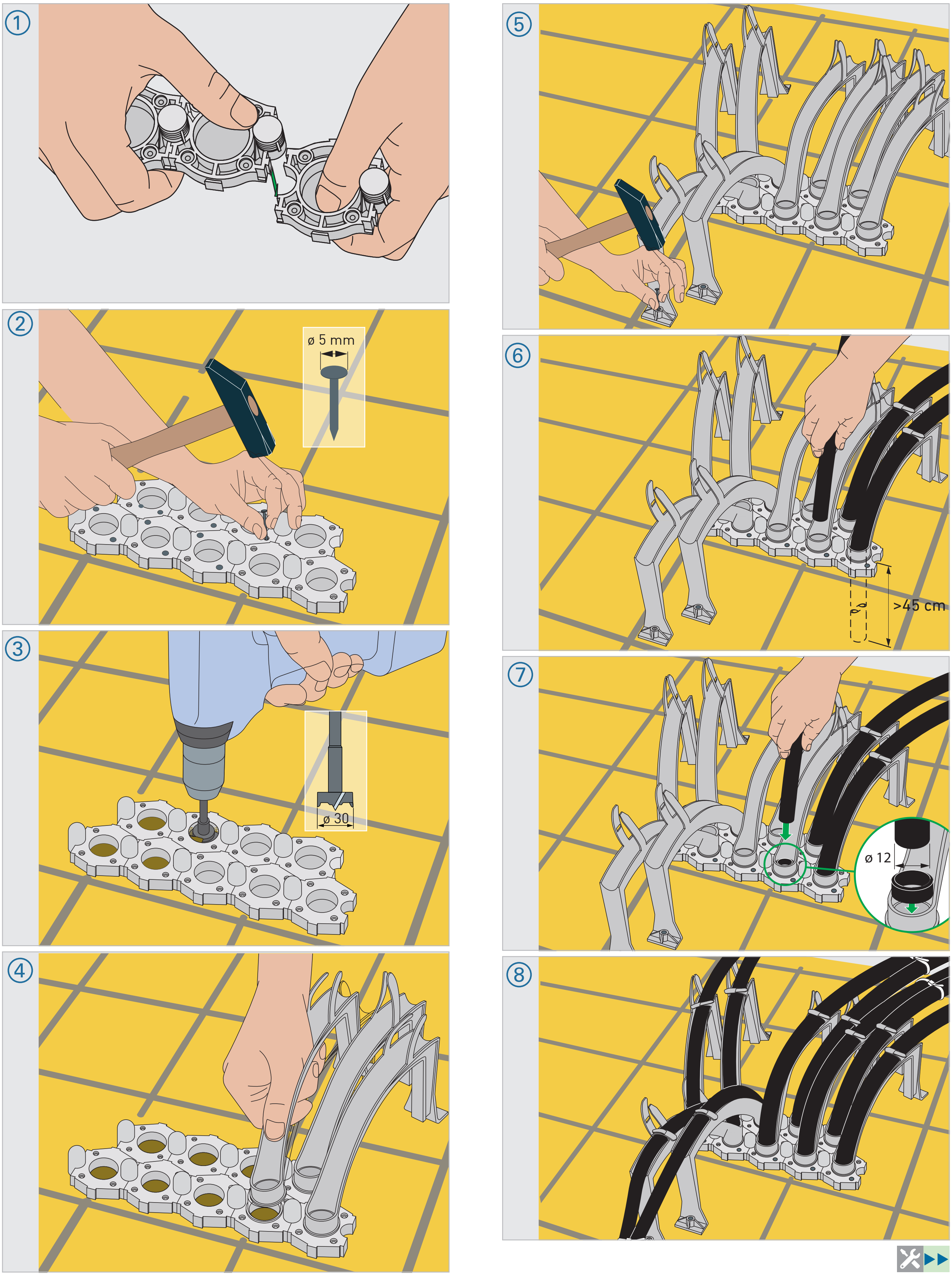
NOTE! Damage to the pipes.
→ Do not drive the nails back into the framework.

→ Use a pair of pliers to break the protruding ends of the nails with from the ceiling.

⑩ → Screw the ceiling hangers for the distributor directly into the threaded holes of the formwork's bores above.
Marking, drilling and dowelling are omitted.

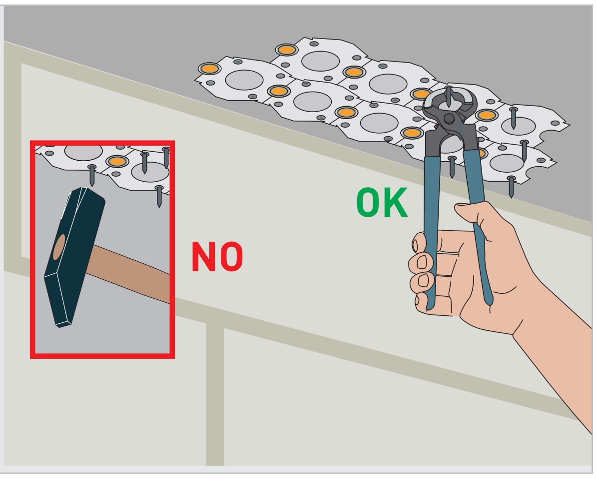
⑪ → Attach the distributor to the ceiling hangers and connect the distributor.
The distributors come with suitable thermal insulation as well as protective shells for the professional installation and are available in the delivery program.

Assembly – Assembling the (drilled through) drilling template

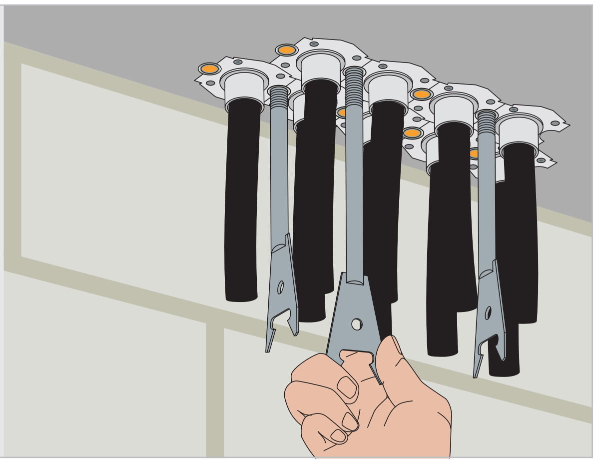


▶▶ Assembly – Assembling the (drilled through) drilling template

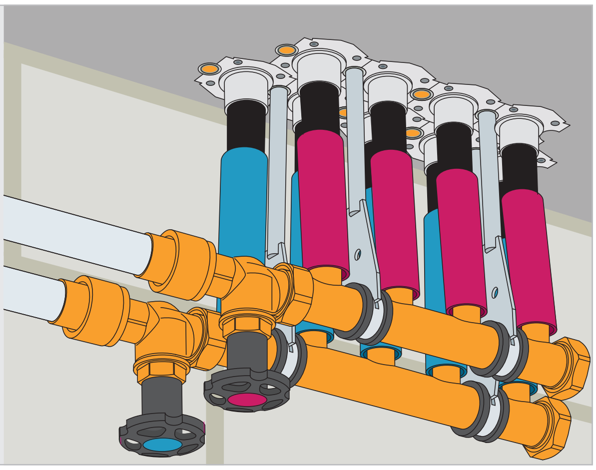
⑨



⑩



⑪



V

2.3 Assembly of the (not drilled through) drilling template

The individual steps are illustrated on the next page.

Assembling the (not drilled through) drilling template

① → Position the individual modules of the drilling template according to the installation plan.
→ Interlock the individual drilling template modules.

② → Use 2 nails to fasten the drilling template assembly to the form work.
- Use nails with 5 mm diameter head.
- Always use 2 nails to fasten the modules located opposite to each other in the drilling template.

③ → Push the pipe transfer bends into drilling template assembly.
Even after insertion, the pipe transfer bends can still be rotated 360° at the formwork level.

④ → Once the pipe transfer bends are properly placed, use nails to attach the pipe transfer bends to the framework.
- Use nails with 5 mm diameter head.

⑤ → Each pipe is provided with a protective cap.
The protective caps are included in the packaging of the pipes.
→ Insert pipes as far as possible into the applicable drilling template and use clips to fasten the pipes.

⑥ → The protective pipe ends d12 are provided with a reducing socket d12.

⑦ → Use pipe binders to hold the pipes in place.
↳ The installation of the drilling template assembly prior to pouring the concrete is completed.

⑧ **After the concrete surface has cured**
The nails in the drilling template assembly have a predetermined breaking point. This way, after removing the formwork from the cured concrete surface, the nails can easily be snipped with a pair of pliers.

NOTE! Damage to the pipes.
→ Do not drive the nails back into the framework.

→ Use a pair of pliers to break the protruding ends of the nails with from the ceiling.

⑨ → Remove the plugs from the drilling template assembly.

⑩ → Install the protective pipe couplings.

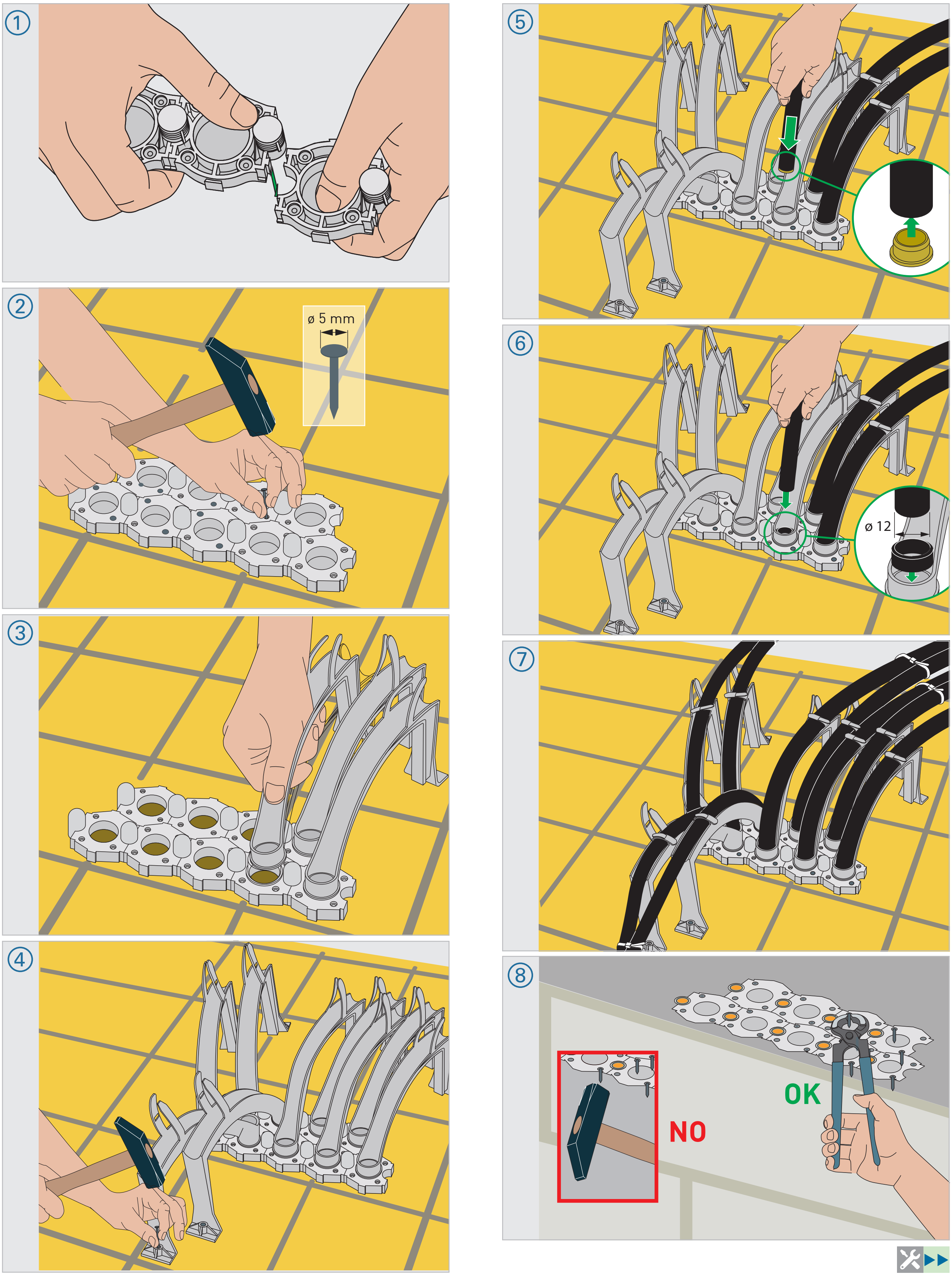
⑪ → Use the pipe puller to pull the pipes least 45 cm out of the ceiling.

⑫ → Connect the protective conduit with the protective pipe couplings.

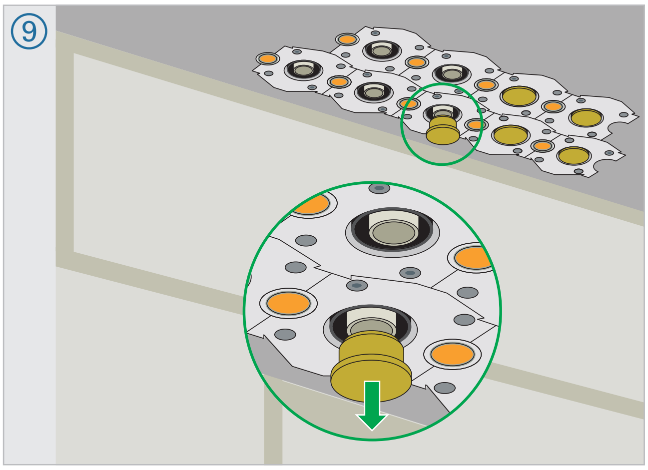
⑬ → Screw the ceiling hangers for the distributor directly into the threaded holes of the formwork's bores above.
Marking, drilling and dowelling are omitted.

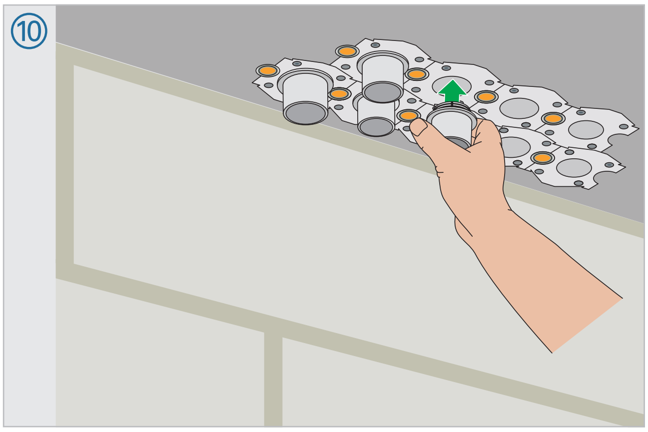
⑭ → Attach the distributor to the ceiling hangers and connect the distributor.
The distributors come with suitable thermal insulation and protective shells for the professional installation and are available in the delivery program.

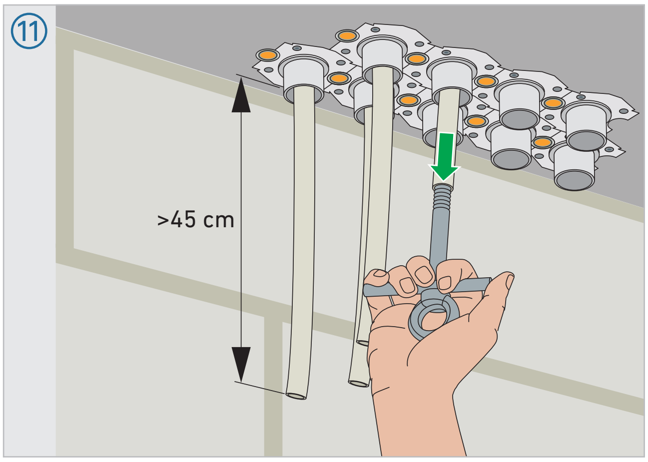
Assembly – Assembling the (not drilled through) drilling template

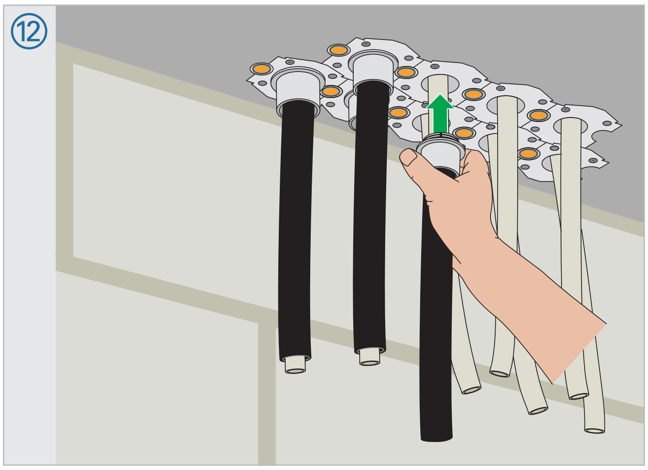


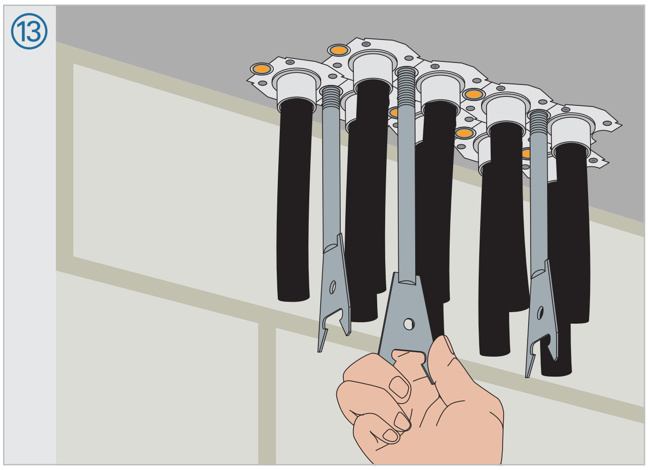
▶▶ Assembly – Assembling the (not drilled through) drilling template

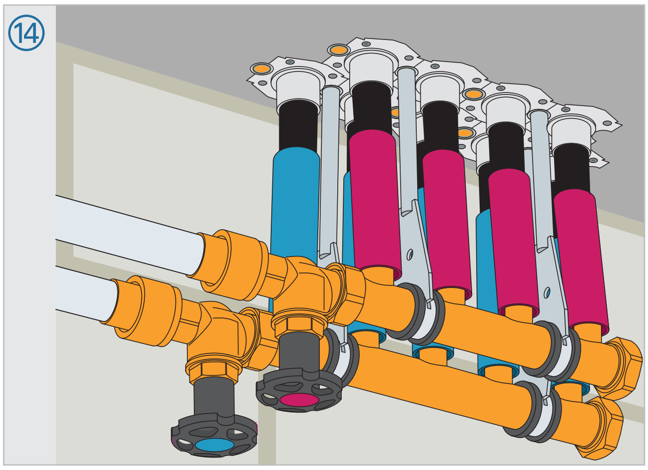










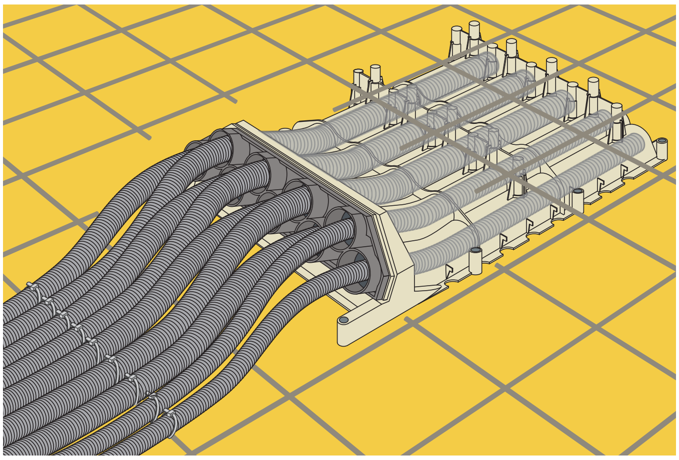


3 Installation using a shuttering box

3.1 Shuttering box – single and multiple

Pipes d12 and d20 can be pushed together **with the protective conduit** into the formwork box.

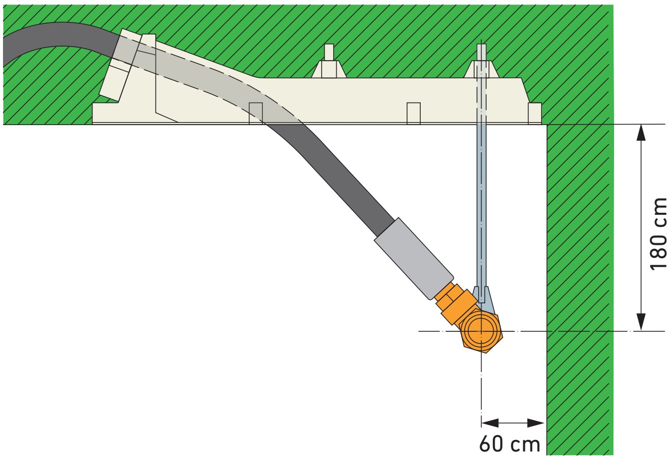
The shuttering boxes can be arranged next to each other at a spacing of 55 mm and assembled running in the same or opposite direction.



Arrangement of distributors if pipes are installed on one side only

The pipeline must face downward when connected to the distributor.

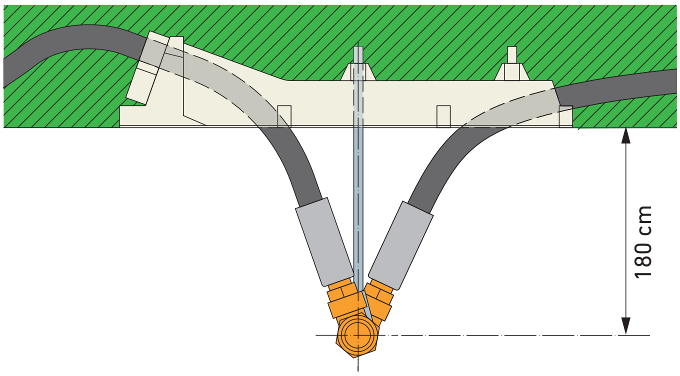
The attachment of the distributor pipe is similar to the attachment of the drilling template assembly.



Arrangement of distributors with opposite pipe routing

If the pipes are running in opposite directions, the distributor is fastened by inserting dowels M12 into the openings provided for this purpose.

The distributor is fastened in place with pipe clips and M10 bolts or with the M12 ceiling hanger.



3.2 Assembly of the shuttering box

The individual steps for the multiple box are shown on the next page.
In general, these steps are also valid for the single box.

Assembling the shuttering box

Positioning the shuttering box and assembling the pipelines

① → Position the shuttering box as shown on the installation plan.
→ Use 4 nails per shuttering box side and nail the box onto the formwork.

② → Break through the protective grommets at the required openings in the pipe feedthrough. (When inserting the pipe, this happens automatically.)
The upper row has 4 openings, the lower row has 5 openings. The cold or hot water pipes must be pushed into openings of the same row.

③ → Close the pipe ends with a protective cap.

④ → Push each pipe end into the openings as far as it will go (approx. 40 cm).

⑤ → Use pipe binders to hold the pipes in place.
↳ The assembly of the shuttering box is completed before the concrete is poured.

⑥ **In order to close the unused, inadvertently opened pipe feedthrough:**
→ Attach a plug to the short piece of pipe.

⑦ → Push the pipe section with the plug into the opening(s).

⑧ **Applicable to pipes passing through the entire opening:**
→ Use a stepped drill bit to bore through the rear opening.

> **NOTE! Sealing the rear opening.**
> → The rear opening must be sealed on-site.

⑨ → Push the continuous pipe through the rear opening.

⑩ → Push the continuous pipe through both openings, front and rear.

⑪ **If additional feedthroughs are required:**
Several individual elements or another multiple box can be attached to the shuttering box.
⑫ Example: Combined multiple boxes

After pouring the concrete ceiling

⑬ **After the concrete surface has cured**

> **NOTE! Damage to the pipes.**
> → Do not drive the nails back into the framework.

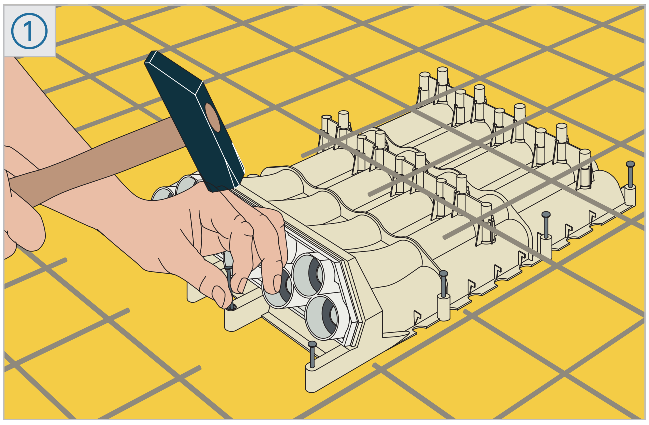
→ Use a pair of pliers to break the protruding ends of the nails with from the ceiling.

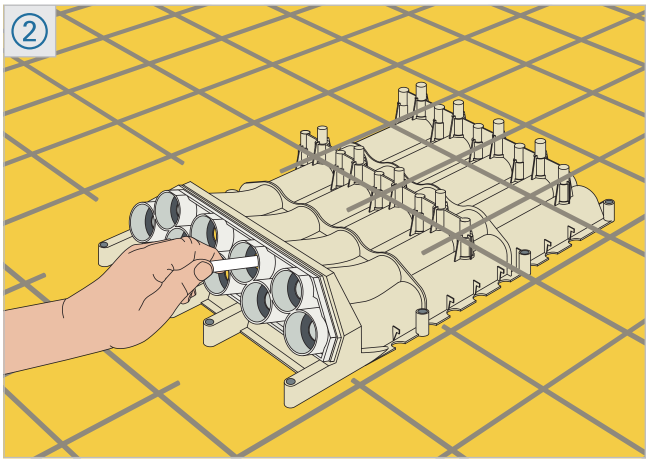
⑭ → Applicable only to multiple box: Remove the intermediate cover.

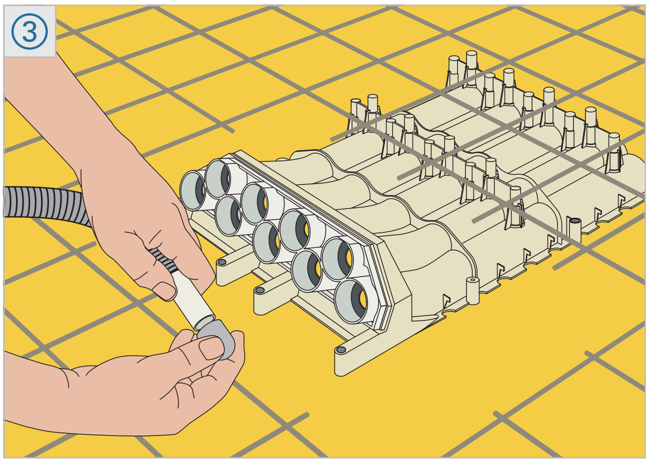
⑮ → Use a hanger bolt in order to screw the distributor (∅12 mm) directly into the threaded holes of the shuttering box (∅10 mm).
Marking, drilling and dowelling are omitted.

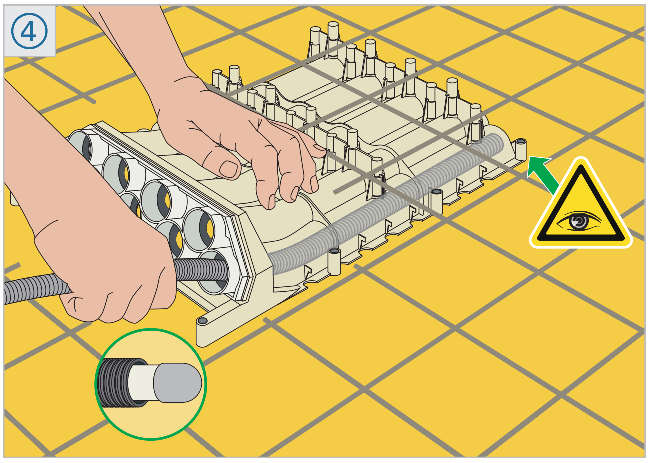
⑯ → Attach the distributor to the ceiling hangers and connect the distributor.

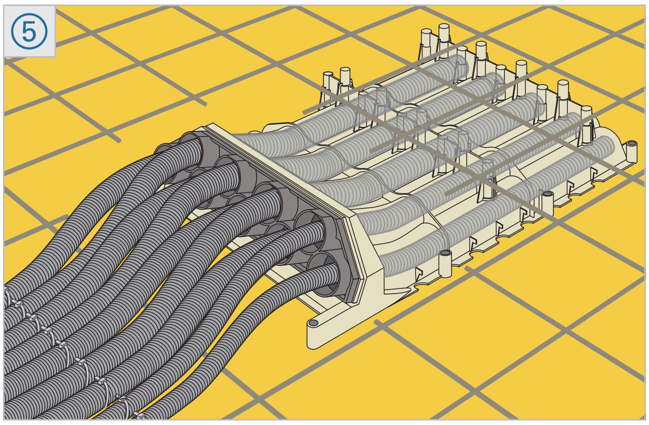
Assembling the shuttering box

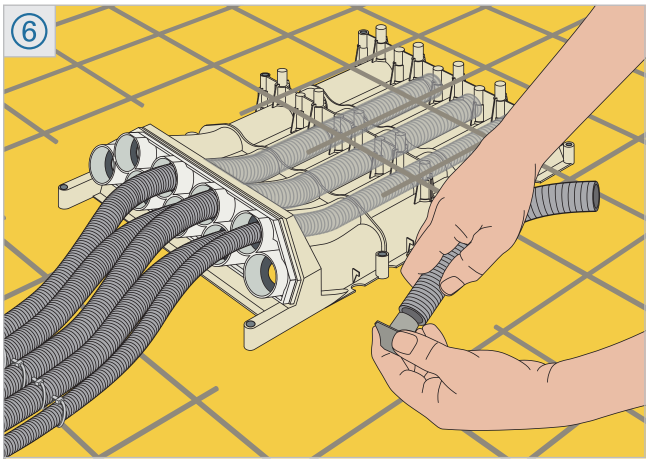


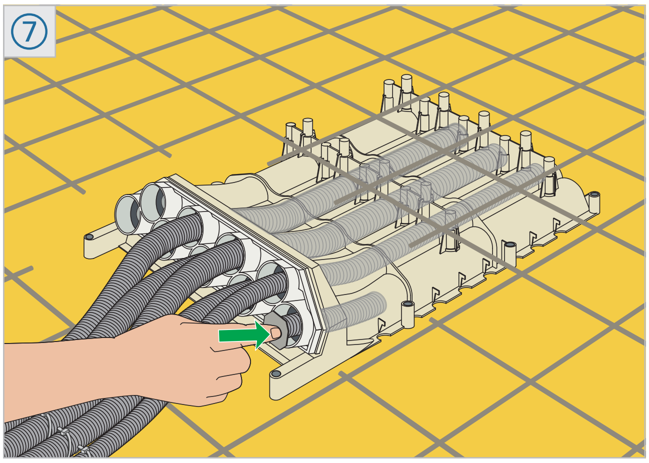


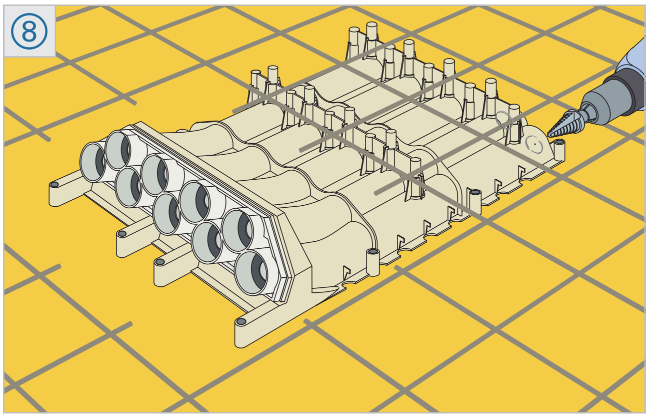




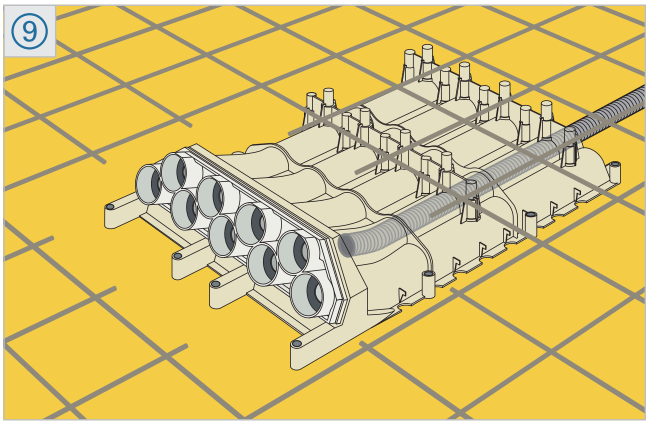


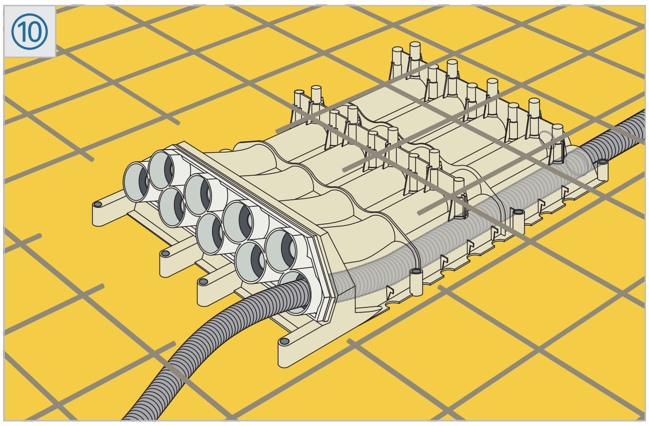


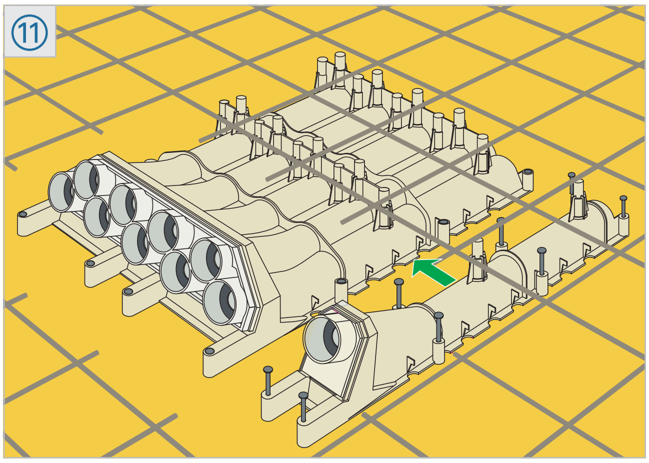


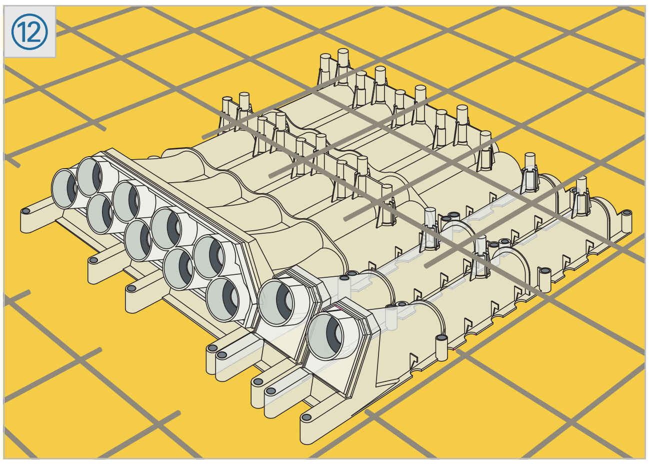


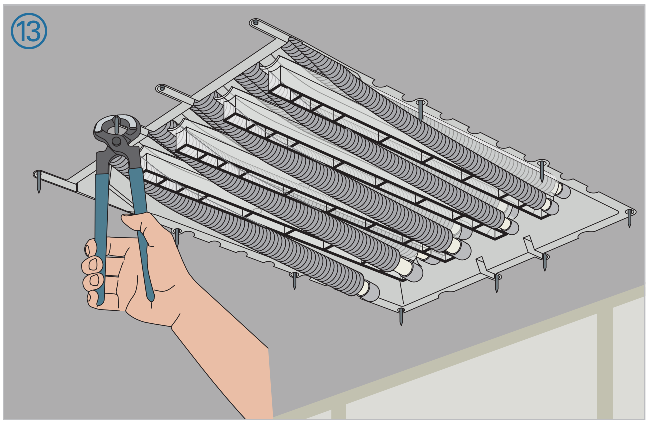
▶▶ Assembling the shuttering box

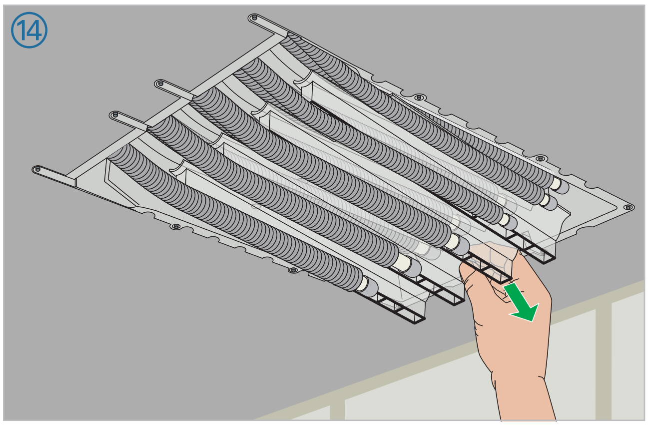


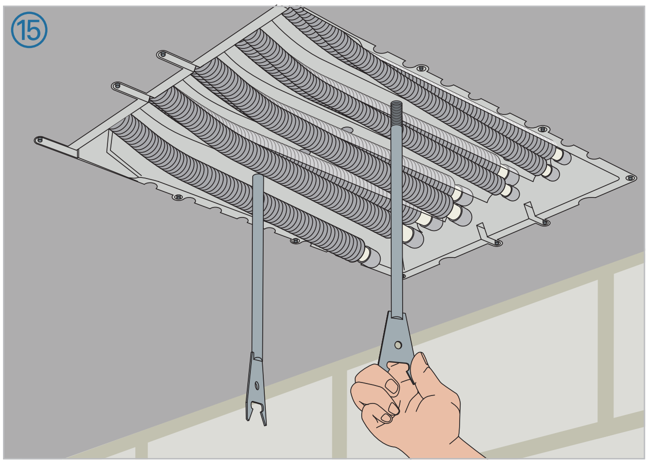


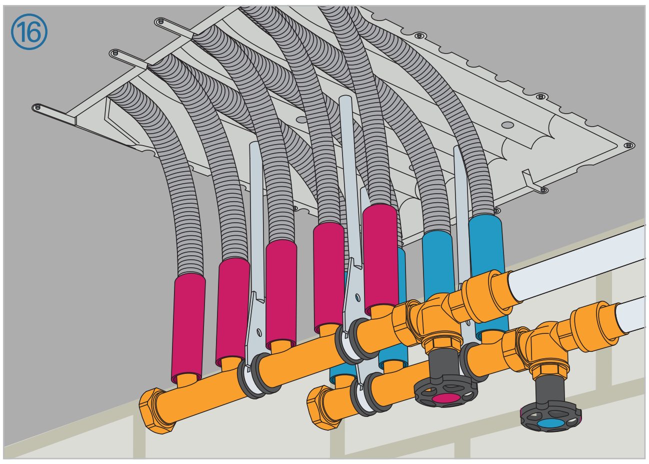












4 Assembly of the pipe supports

4.1 Assembly of the pipe support (single) with reinforced bases

Interchangeability of the medium-carrying pipe
To ensure the interchangeability of the medium-carrying pipe:
→ Observe minimum bending radius per dimension.
→ Do not kink pipes.

Mount the pipe support (single)

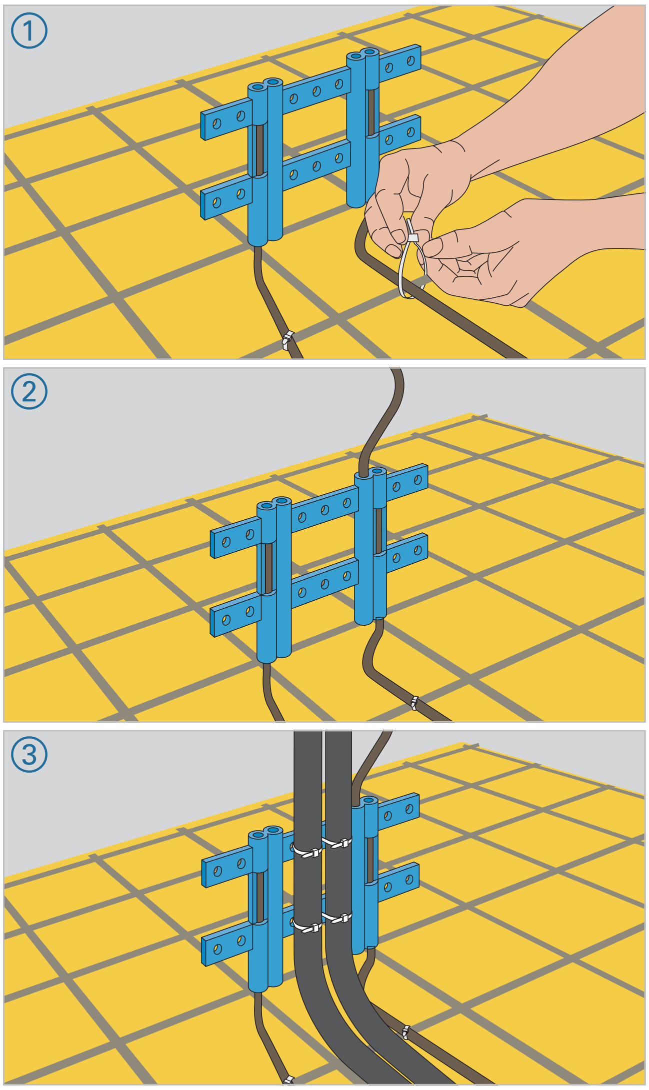
① → Position the pipe support as shown on the installation plan.
→ Use a pipe binder or twist tie to attach the pipe support to the lower reinforcement of the form work.

② → In order to extend and support upward, insert an extension rod into the pipe support.

③ → Fasten the pipe lines (d12/d16/d20) directly to the pipe support using pipe binders.
→ Protect each pipe against dirt, using a cap.
→ Maintain bending radii.

Bending radii (8 · dia)
- d12: 96 mm
- d16: 128 mm
- d20: 160 mm

Mount the pipe support (single)



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4.2 Assembly of the pipe supports (multiple) with reinforced bases

The individual steps are illustrated on the next page.

Interchangeability of the medium-carrying pipe

To ensure the interchangeability of the medium-carrying pipe:

☑ Observe minimum bending radius per dimension.

☑ Do not kink pipes.

Mount the pipe support (multiple)

① → Position the pipe support as shown on the installation plan.

→ Use a pipe binder or twist tie to attach the pipe support to the lower reinforcement of the form work.

② → Fasten the pipe lines (d12, d16, d20) directly to the pipe support using pipe binders.

A centre-to-centre spacing of 55 mm (c-c distributor outlet) is guaranteed.

→ Protect each pipe against dirt, using a cap.

→ Maintain bending radii.

Bending radii (8 · dia)

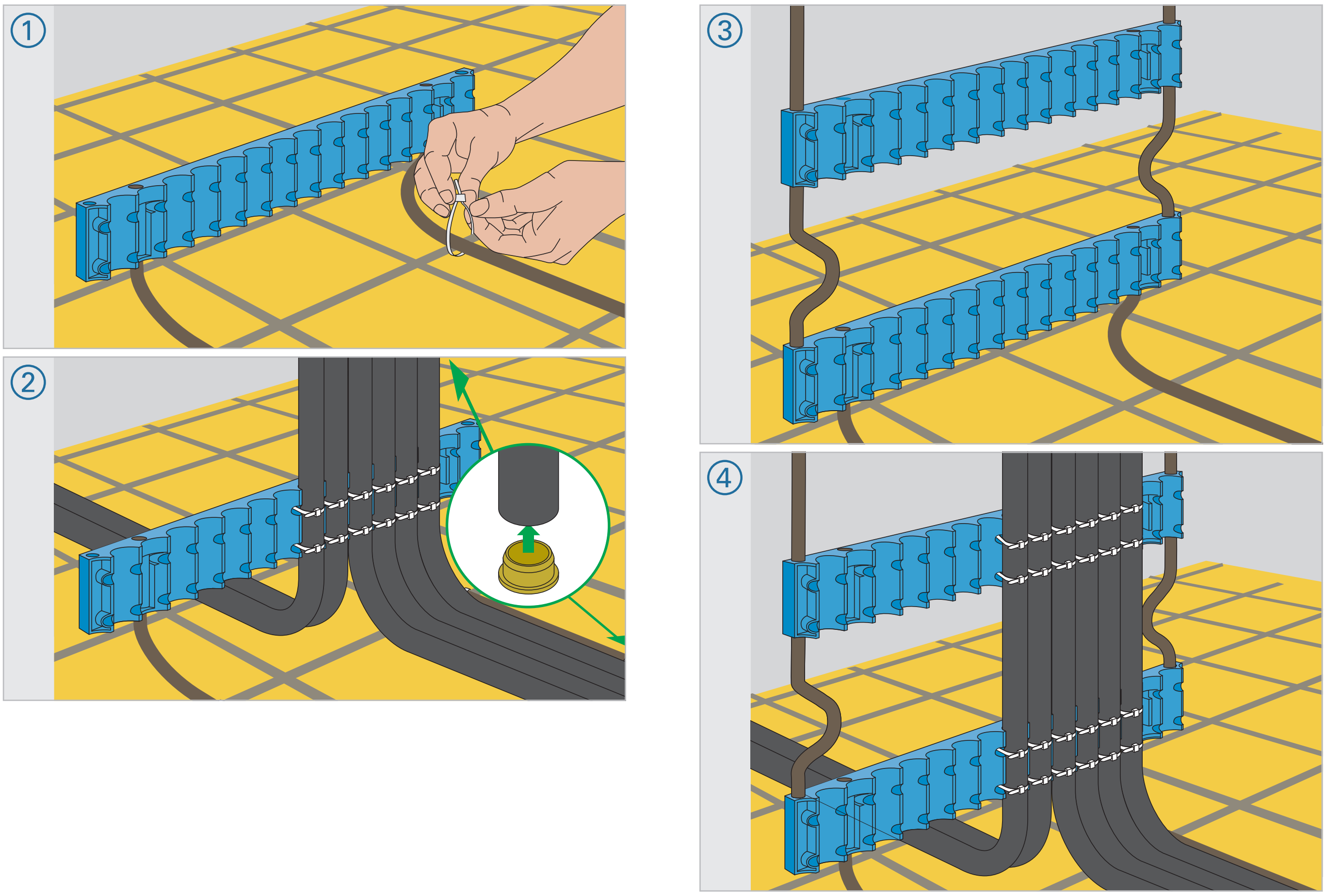
- d12: 96 mm
- d16: 128 mm
- d20: 160 mm

③ **In order to extend and support upward:**

→ Insert 2 extension bars and 1 further pipe support bar into the pipe support.

④ → Fasten the pipelines to the second pipe support bar with pipe binders.

Mount the pipe support (multiple)



4.3 Assembly of the pipe supports on reinforcement/ formwork

The individual steps are illustrated on the next page.

Attaching the pipe supports onto the reinforcement/formwork

① → Position the pipe support as shown on the installation plan.
→ Interlock the pipe supports.

② → Push the re-inforcement bars ∅8 mm through.
or
→ attach feet.
Feet are only needed on the two outer pipe supports.

③ → Use pipe binders to hold the re-inforcement bars in place.

④ → Use one nail to secure the base to the formwork.
- Use nails with 5 mm diameter head.

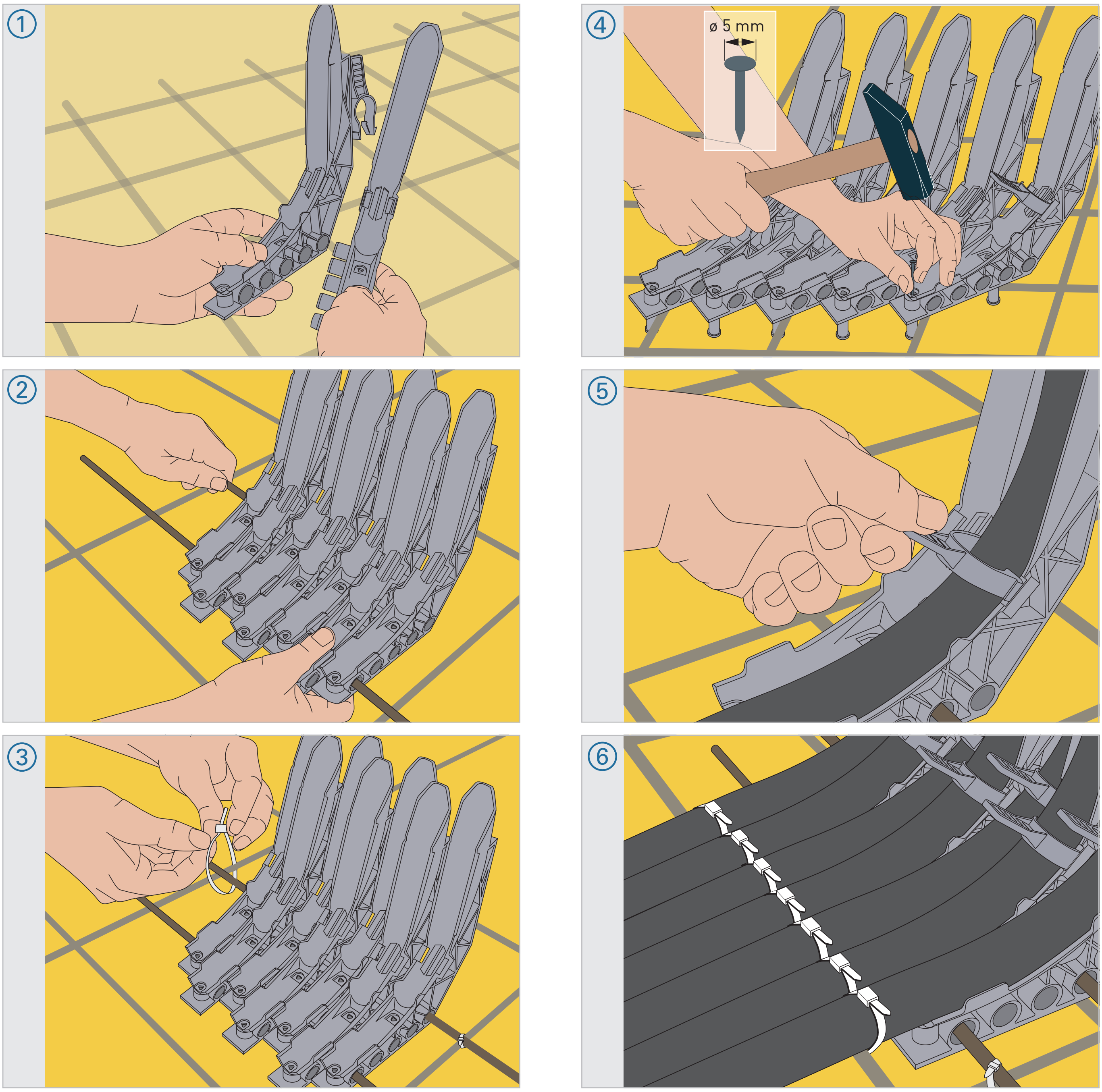
Due to the predetermined breaking point, the nails can easily be torn out from the pipe supports, using a pair of pliers after the formwork has been removed from the cured concrete surface.

NOTE! Damage to the pipes.
→ Do not drive the nails back into the framework.
→ Use a pair of pliers to break the protruding ends of the nails with from the ceiling.

⑤ → Insert the pipes and use pipe clips to hold the pipes in place.

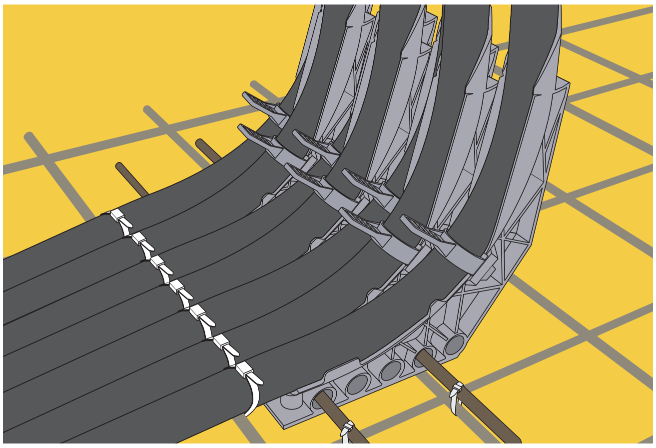
⑥ → Use pipe binders to hold the pipes in place.
↳ The assembly of the pipe supports prior to pouring the concrete is completed.

Attaching the pipe supports onto the reinforcement/formwork



4.3.1 Pipe supports on reinforcement/formwork – Installation example

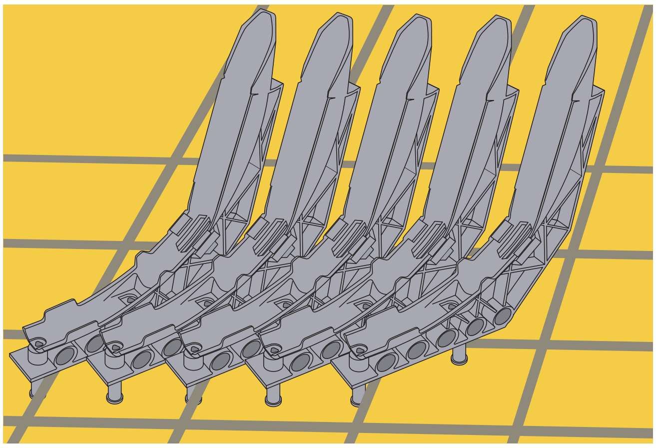
Pipe support combination, 2 rows



2-row pipe support combination on reinforcing rods, for distributor connection in installation box.

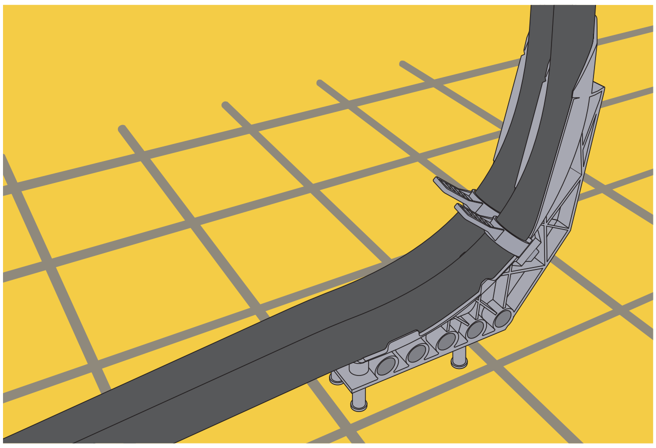
The pipe supports are put together while being offset by one hole each. This results in a spacing of 55 mm for the cold and hot water distributor.

Pipe support combination with feet

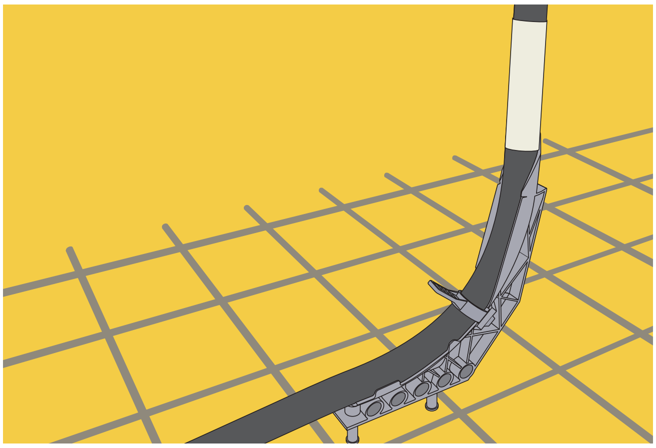


The pipe supports are put together while being offset by two holes each. This results in a spacing of 55 mm.

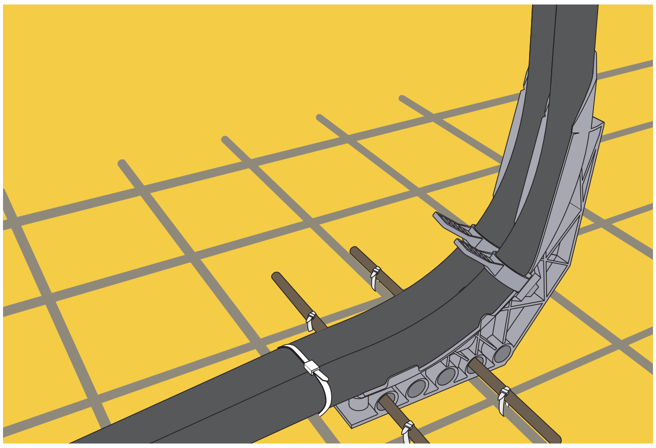
Combination made of 2 pipe supports with feet



Combination with feet and extention



Assembly without causing damage



- with reinforcing bars ∅8 mm and pipe binders

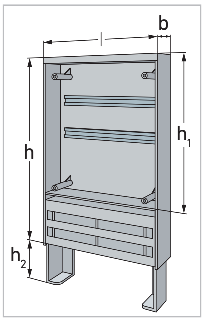
5 Installation of the installation box

5.1 Distributor

The following distributors, with or without shut-off, can be mounted in all our installation boxes:

- Distributor with 1 rack to 5 racks: available in size d16.
- Distributor with 1 rack to 3 racks: available in sizes d12 and d20.

Many accessories are available for the attachment and connection methods.



5.2 Installation box made of plastic

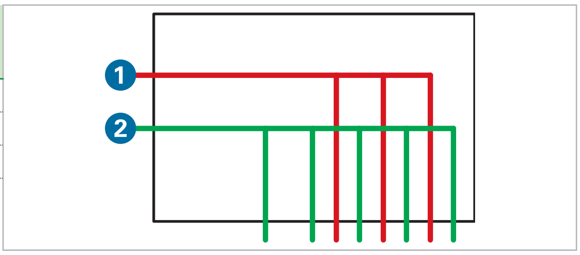
Sizing

☑ Compliance with the assembly instructions of the installation box is mandatory.

L × h	b	h	h1	h2	l
496 × 654	111	654	443	0 – 145	496
649 × 654	111	654	443	0 – 145	649
802 × 654	111	654	443	0 – 145	802

TV.1
Installation box with front panel for distributor, without inspection frame

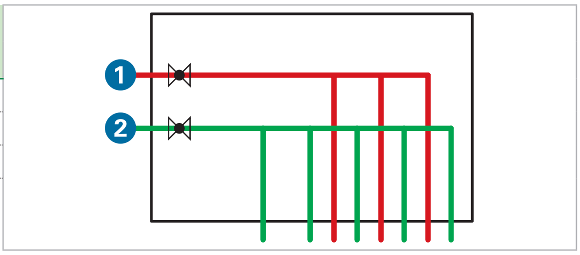
Max. outputs KW	Max. outputs WW	Installation box L × h
7	6	496 × 654
10	9	649 × 654
13	12	802 × 654



TV.2
Distributor

1. Hot water
2. Cold water

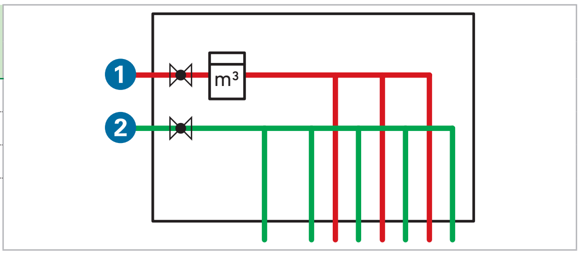
Max. outputs KW	Max. outputs WW	Installation box L × h
6	6	496 × 654
9	8	649 × 654
12	11	802 × 654



TV.3
Distributor with DHW heater water meter and shut-off valves

1. Hot water
2. Cold water

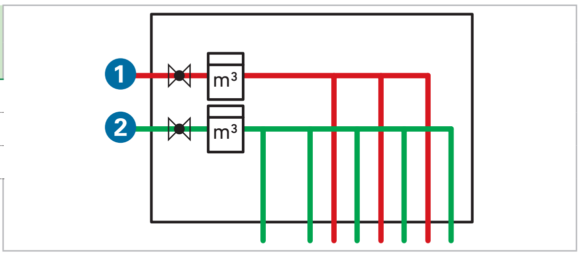
Max. outputs KW	Max. outputs WW	Installation box L × h
6	3	496 × 654
9	6	649 × 654
12	8	802 × 654



TV.4
Distributor with DHW heater water meter and shut-off valves for hot and cold water

1. Hot water
2. Cold water

Max. outputs KW	Max. outputs WW	Installation box L × h
3	3	496 × 654
6	6	649 × 654
8	8	802 × 654



TV.5
Distributor with hot and cold water meter and shut-off valves

1. Hot water
2. Cold water

V

5.3 Splash-proof installation box

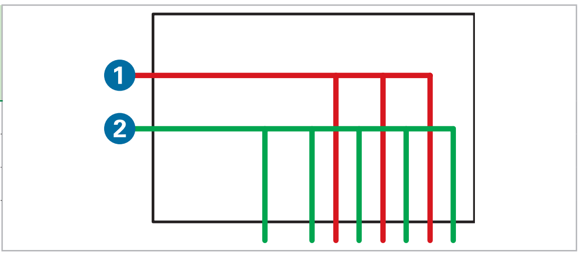
Sizing

☑ Compliance with the assembly instructions of the installation box is mandatory.

L × h	b	h	l
438 × 552	107	552	438
548 × 552	107	552	548
823 × 552	107	552	823

TV.6
Splash-proof installation box

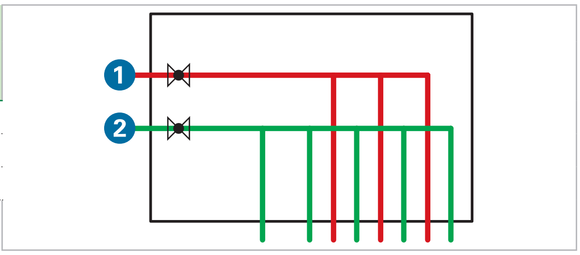
Max. outputs		Installation box
KW	WW	L × h
6	6	438 × 552
8	8	548 × 552
12	12	823 × 552



TV.7
Distributor

1 Hot water
2 Cold water

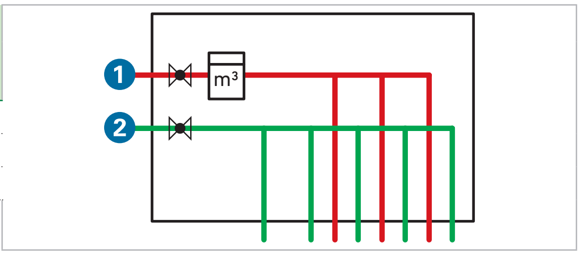
Max. outputs		Installation box
KW	WW	L × h
5	5	438 × 552
7	7	548 × 552
11	11	823 × 552



TV.8
Distributor with DHW heater water meter and shut-off valves

1 Hot water
2 Cold water

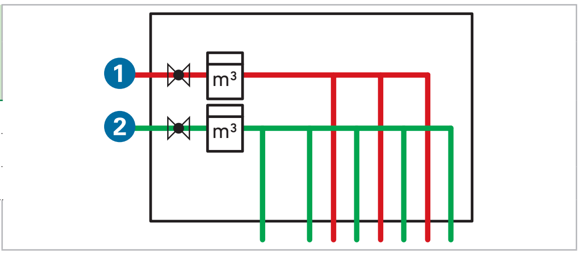
Max. outputs		Installation box
KW	WW	L × h
5	3	438 × 552
7	5	548 × 552
11	9	823 × 552



TV.9
Distributor with DHW heater water meter and shut-off valves for hot and cold water

1 Hot water
2 Cold water

Max. outputs		Installation box
KW	WW	L × h
3	3	438 × 552
5	5	548 × 552
9	9	823 × 552



TV.10
Distributor with hot and cold water meter and shut-off valves

1 Hot water
2 Cold water

5.4 Assembly of the splash-proof installation box

The individual steps are illustrated on the next page.

5.4.1 Install the installation box (Part 1)

Install the installation box (Part 1)

① Splash-proof installation box and appliable accessories

Not shown in the picture are the assembly instructions, which are also included, and the marking stickers for the distributor outlets.

②
- ❶ Assembly in a wooden stud wall
- ❷ Assembly in a metal stud wall
- ❸ Assembly in front of a solid wall or on the ceiling

❶ Assembly between the studs (e.g. timber construction)

① → If the distribution lines are fed in from the side: Remove the protection caps.

② → Use side holes for the assembly.

The mounting material must be provided by the customer.

❷ Assembly on the rear wall (e.g. metal stud construction)

① → Use holes in rear panel for assembly purposes.

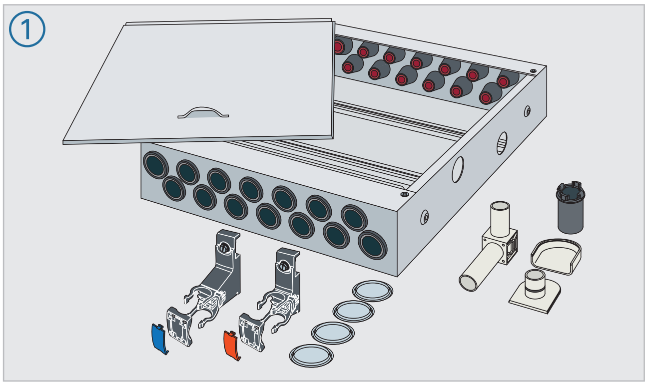
② The mounting material must be provided by the customer.

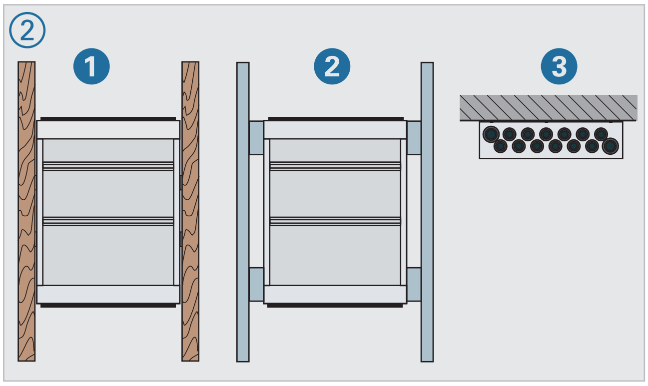
❸ Assembly in front of a solid wall or on the ceiling (e.g. solid construction).

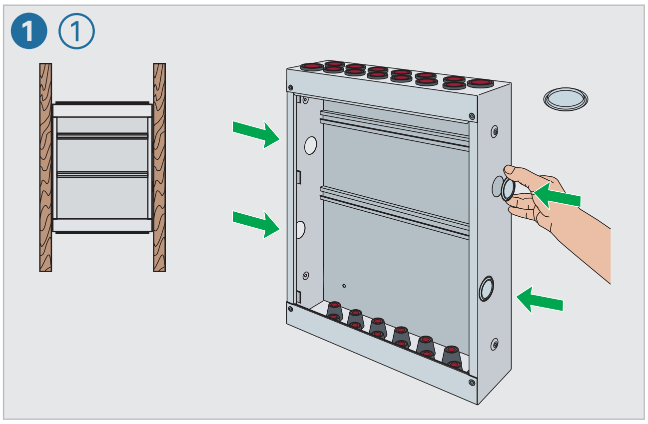
① → Use holes in rear panel for assembly purposes.

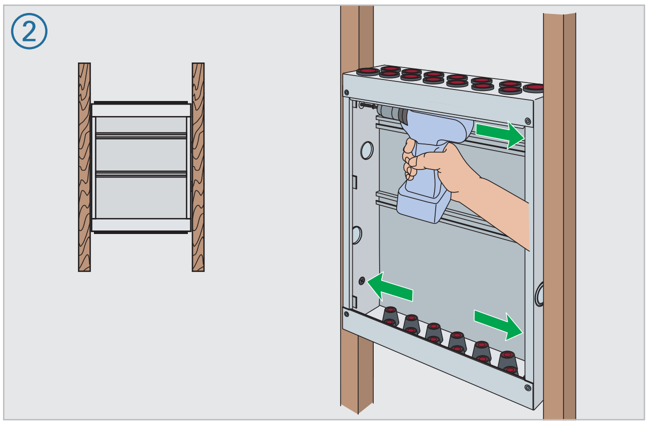
② The mounting material must be provided by the customer.

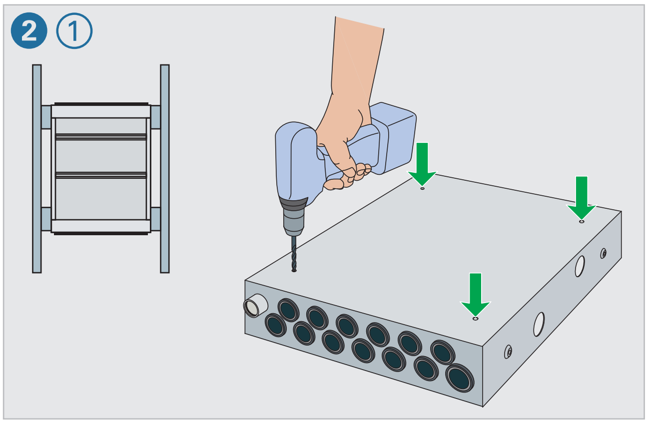
Install the installation box (Part 1)

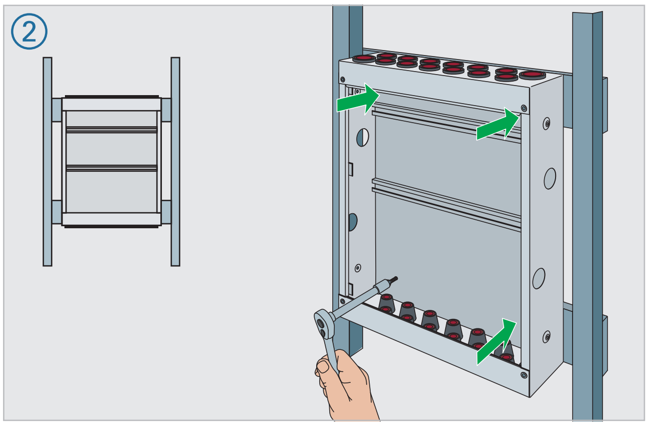


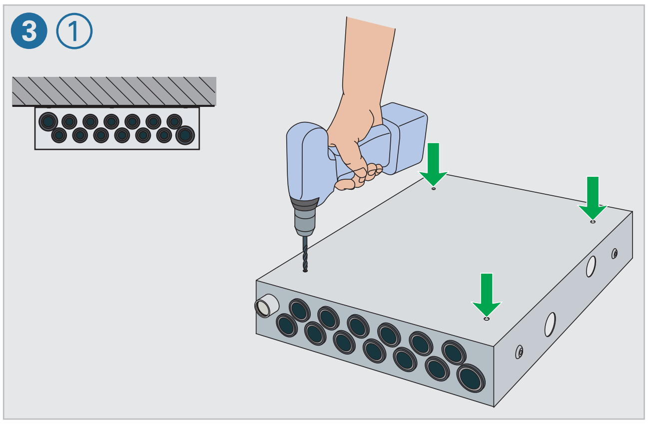


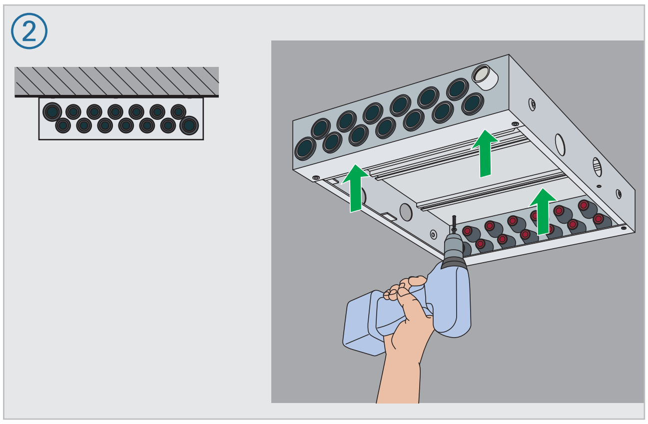












5.4.2 Installing the distributor and waste water connection (part 2)

Installing the distributor/waste water connection (part 2)

① In order to drain any leakage water safely and visibly, the supplied waste water connection must protrude from the building structure in front of the wall.
- → To do this, remove one of the lower rubber plugs for the distribution lines and replace the plug with the waste water connection piece.
- → Install the waste water connection box at a suitable location and connect it to a commercially available drainage pipe (must be provided by the customer).

During the final assembly, the projection of the waste water box extension can be trimmed using a milling cutter before the chrome-plated cover is fitted.

② → Attach the distribution bracket.
- • Consider the length of the brackets.

③ → Insert the distributor into the rubberised distributor holders.
The rubber insert has two different geometries and can therefore be used for distributors of different sizes by simply rotating it.

④ → Push the attachment onto the distributor bracket.

⑤ → Attach the safety plate.
- • Note the colour coding for warm water and cold water.

⑥ → Protection caps on rubberised outlets must only be removed if a connecting pipe is to be routed through the outlet.

⑦ → Insert the pipe through the seal at a right angle.

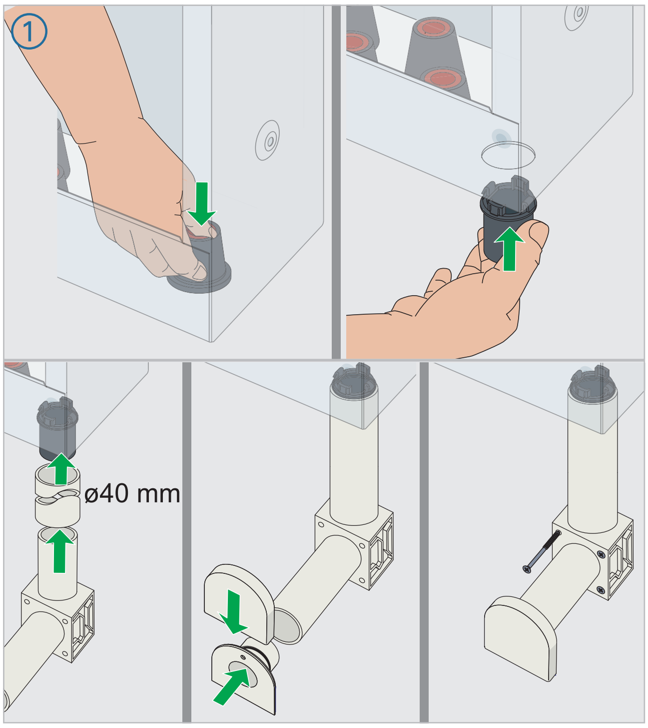
⑧ → Connect the pipe in accordance with the pipe system's assembly instructions.

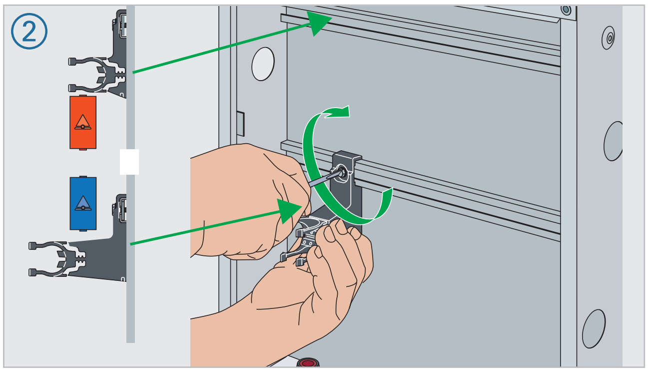
⑨ → Remove seal for the distribution pipes when assembling the pipe through the side openings at the top of the box and provide cover caps.

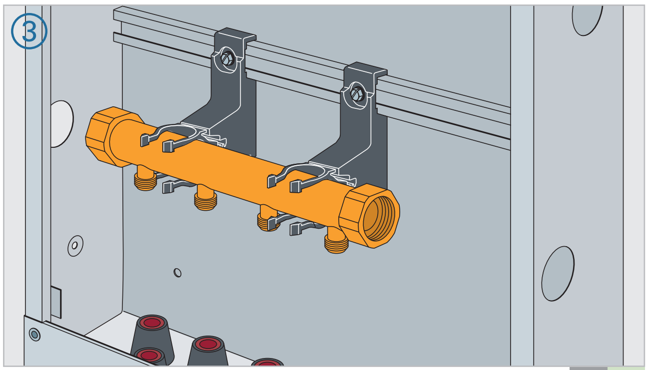
⑩ → If necessary, install the seal along the side and insert the distribution pipes through the seal at a right angle.

⑪ → Insert the splashproof cover.

Installing the distributor/waste water connection (part 2)

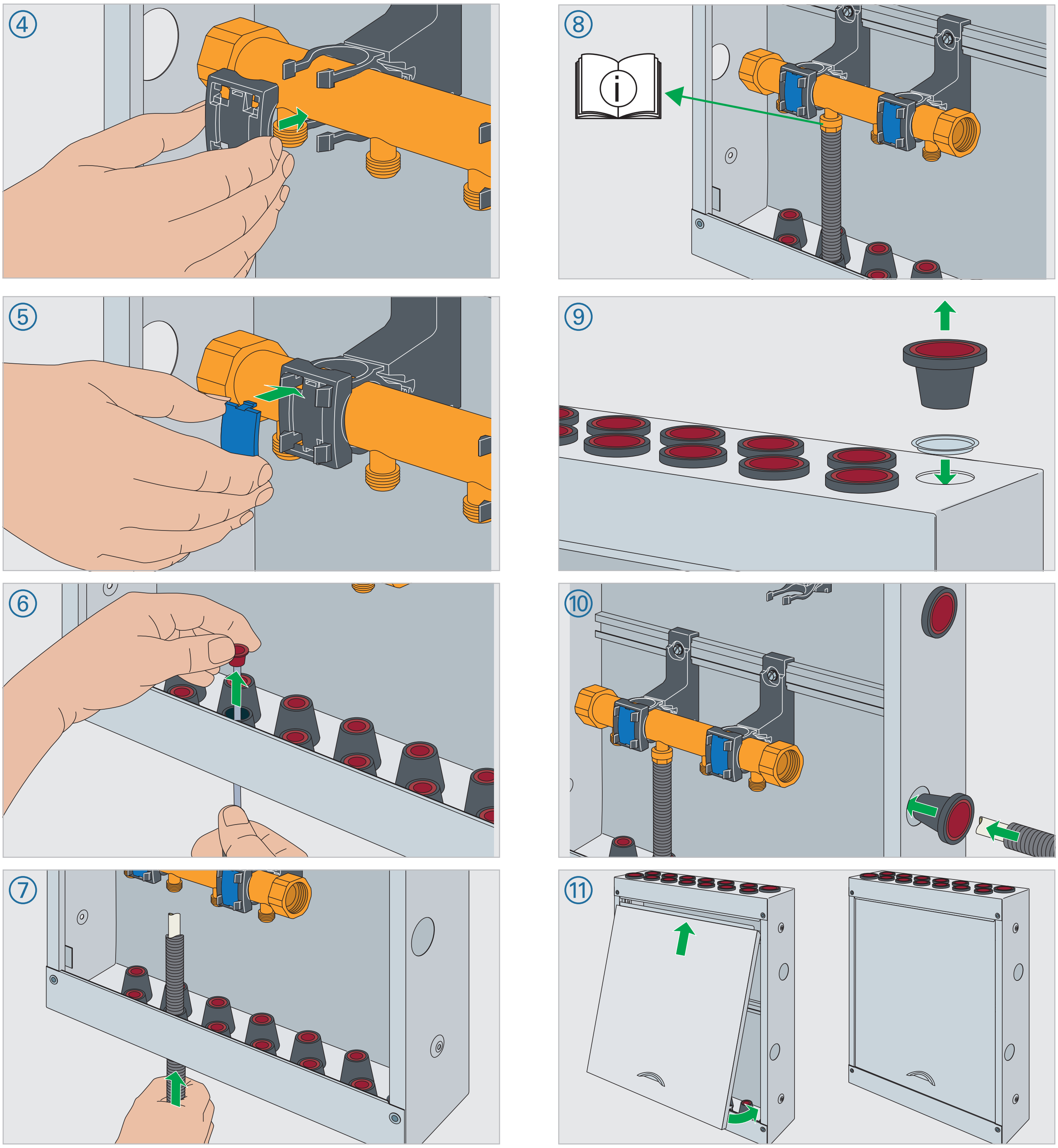






V

▶▶ Installing the distributor/waste water connection (part 2)



5.4.3 Install cover (part 3)

The individual steps are illustrated on the next page.

Install cover (Part 3)

① Cover, applicable accessories, and mounting material

② → Connect corner fittings and profiles to each other according to their length.

③ → If necessary, insert fall-out protection in profile.
This is especially necessary when assembling fittings on the ceiling.

④ → Connect the frame parts.

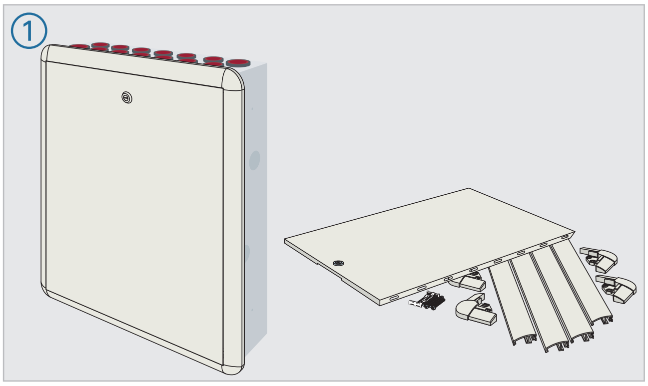
⑤ → Mount the frame on the corresponding threads of the installation box.

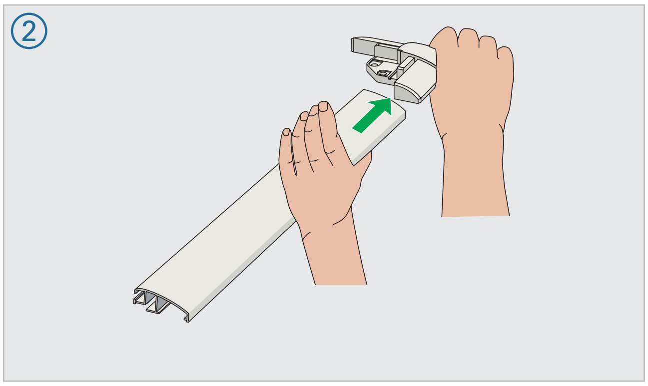
⑥ → Insert the fall-out protection in the door.

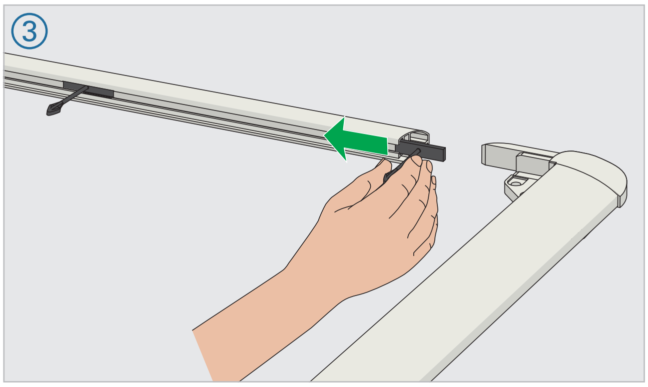
⑦ → Insert door into the profile.

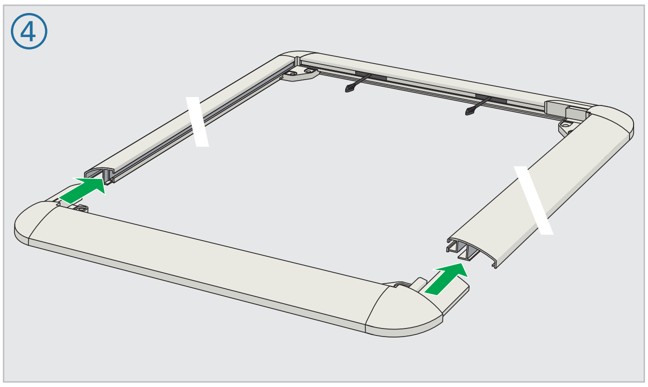
V

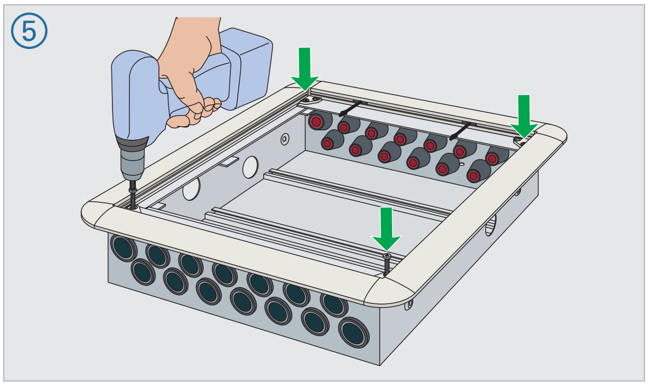
Install cover (Part 3)

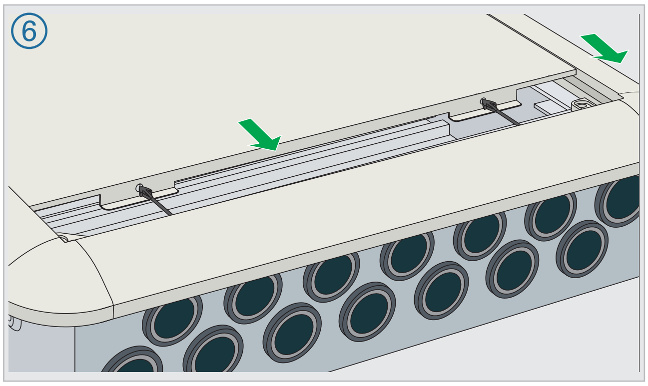


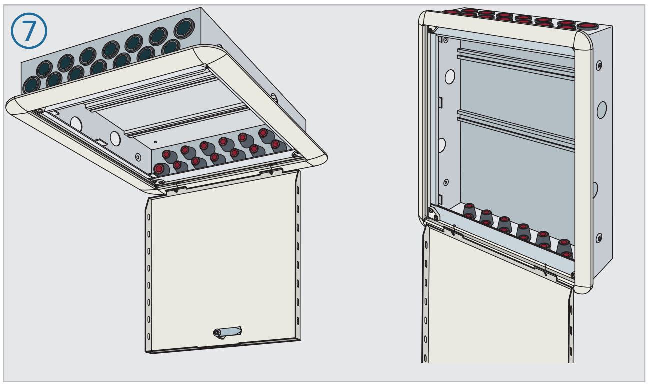












6 Installation of the box

An important link between the plastic pipe and the consumer (a fitting or a piece of equipment) is the **fitting and equipment connection**, which provide a safe transition. The new, standard box is suitable for all piping systems. The box is available in different designs.

Applications

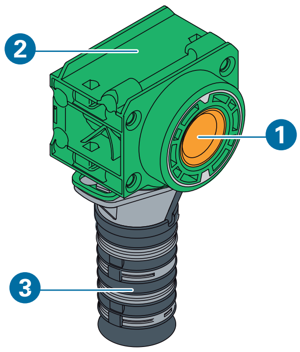
- In-wall installation
- Pre-assembly onto a spacer

The box consists of three parts.

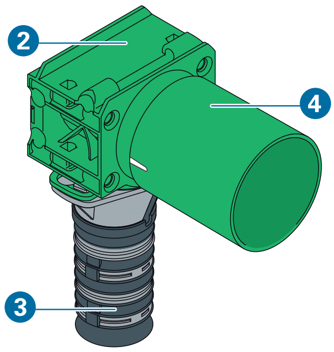
- The **box bend** with clamping connection is pre-assembled in the upper housing part at the factory.
- The **box body**, which is used for mounting onto fasteners, rails or the structure.
- The **foot of the box** serves to connect to the protective conduit and to cover the connecting section against mortar and other building materials.

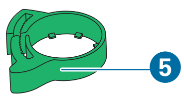
6.1 Designs

Box 90° (single)
Standard version



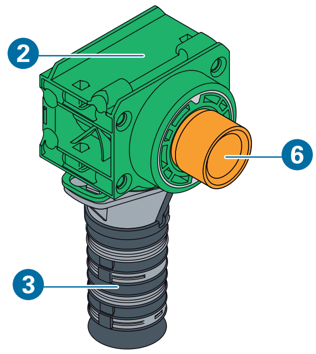
Wall box 90° (single)
with extention





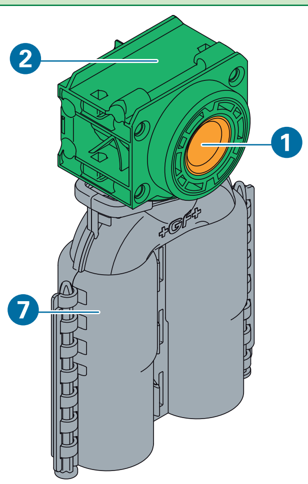
In this version, the body of the box is extended.

Box 90° (single)
with extended connecting thread

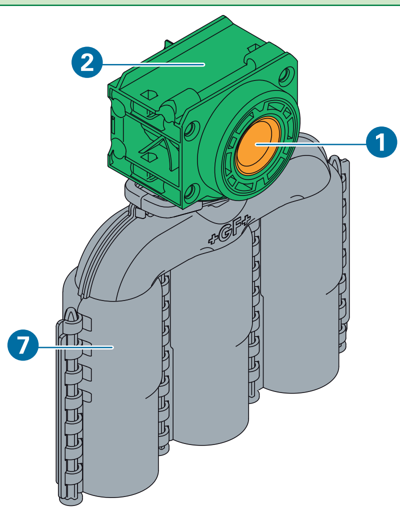


In this version, the connecting thread on the box bend is extended.

Wall box 90°, multiple
(double)



Box 90°, multiple
(triple)

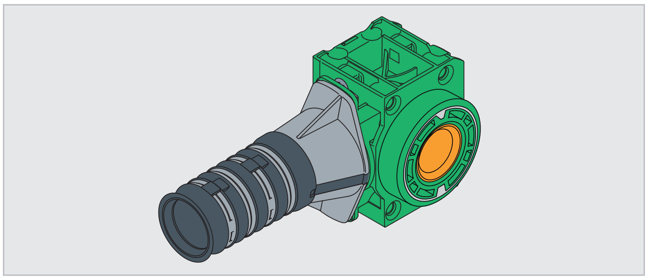


TV.11
Box, single and multiple

1. Box bend
2. Box body
3. Box foot
4. Extension
5. Protective conduit connector
6. Box bend, extended
7. Protective conduit holder

V

6.3 Assembly of the 90° box



Assembling the 90° box (standard)

① → Assembling the box.

Assembly variant A Box on spacer

→ Insert the box into the opening of the spacer from the rear and use 2 M5×18 screws to attach the box. Tighten the screws crosswise.

Assembly variant B: Box installed vertically onto wooden post/formwork

→ Use 4 screws M5×80 to secure the box vertically onto the framework. Tighten the screws crosswise.

Assembly variant C: Box installed horizontally onto wooden post/formwork

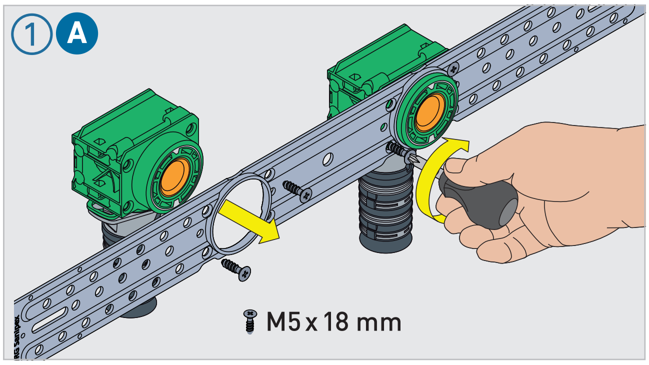
→ Use 4 screws M5×70 to secure the box vertically to the framework. Tighten the screws crosswise.

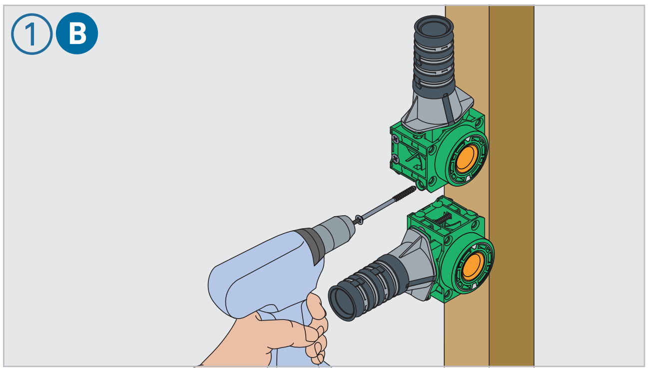
② → Turn the foot of the box to the side and pull the box downwards.

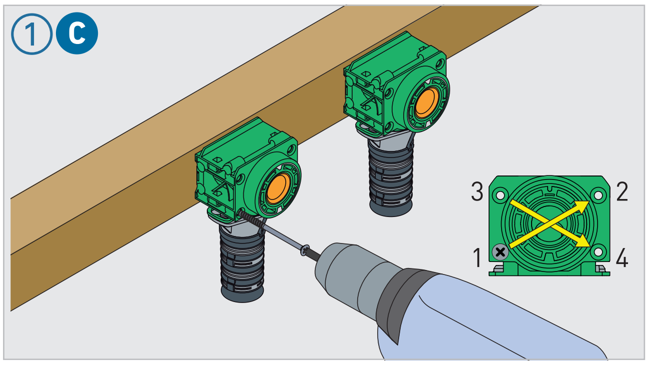
→ Push the pipe through the foot of the box and install the pipe as specified in the assembly instructions of the pipe system.

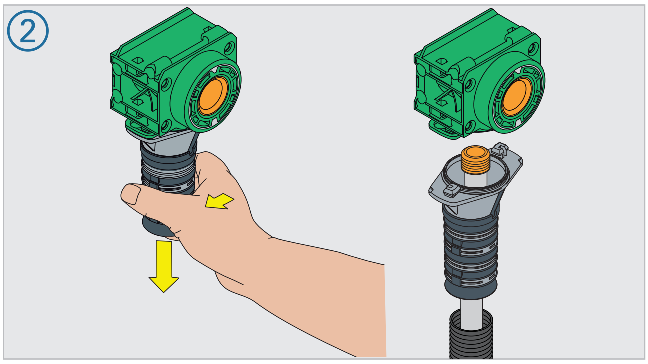
→ Push the foot of the box back onto the box and let it snap into place.

Assembling the 90° box









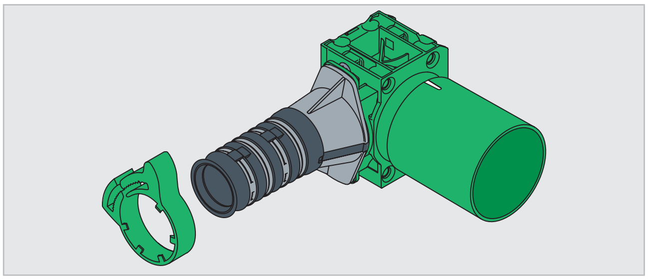
6.2 Assembly of the 90° box with extended connecting thread

The 90° box with extended connecting thread is assembled the same way as the standard 90° box.

Sealing the box

- similar to sealing the box with extension, however, the sealing is done on the long connecting thread

6.4 Assembly of the 90° box with extension



Assembling the 90° box with extension

① → Assembling the box.

Assembly variant A: Box on spacer

→ Turn extension counter-clockwise and remove the extension.

→ Insert the box into the opening of the spacer from the rear and use 2 M5×18 screws to attach the box. Tighten the screws crosswise.

→ Re-assemble the extension.

Assembly variant B: Box installed vertically onto wooden post/formwork

→ Use 4 screws M5×80 to mount the box vertically onto the formwork. Tighten the screws crosswise.

Assembly variant C: Box installed horizontally onto wooden post/formwork

→ Use 4 screws M5×70 to secure the box vertically to the framework. Tighten the screws crosswise.

② → Turn the foot of the box to the side and pull the foot of the box downwards.

→ Slide the foot of the box over the pipe that must be connected.

→ Connect the pipe in accordance with the pipe system's assembly instructions.

→ Push the foot of the box back onto the box and let it snap into place.

Sealing the box

③ → Lead the boxes from the back through the prepared openings.

④ → Put on the collar and glue it to both sides of the waterproof diaphragm.

⑤ → Fill in the surface.

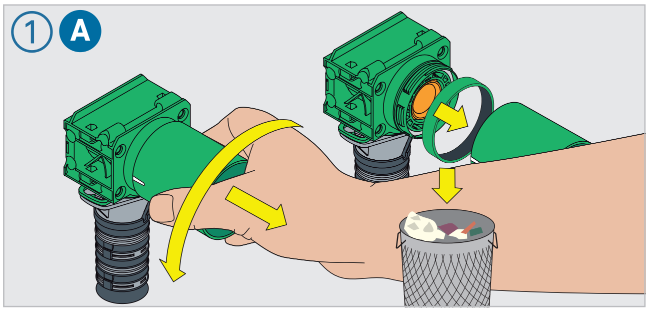
⑥ → Installing the tiles.

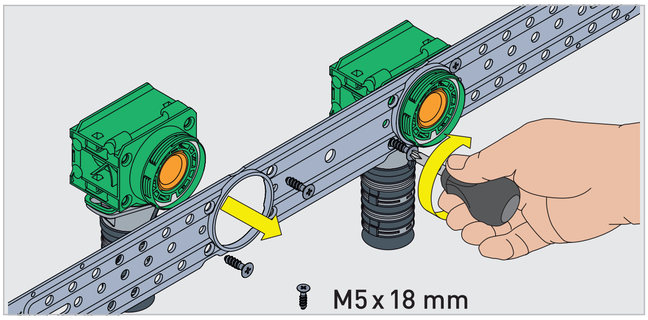
⑦ → Use a milling cutter to trim the box extension to the required length.

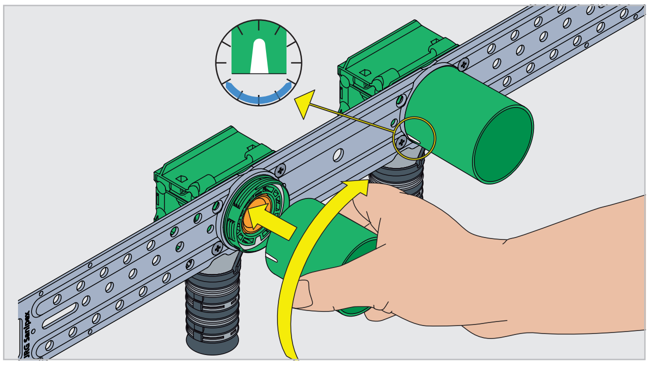
→ Ensure to keep the projection.

Assembling the 90° box with extension

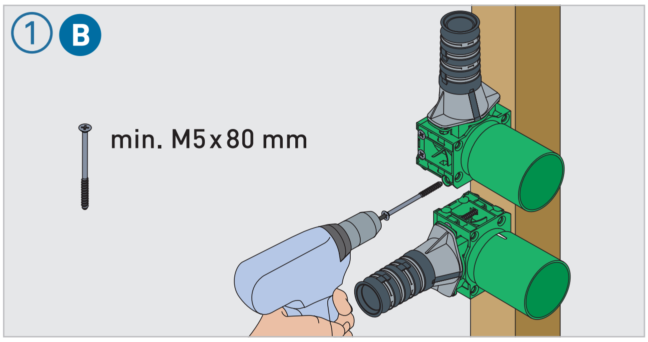
① A



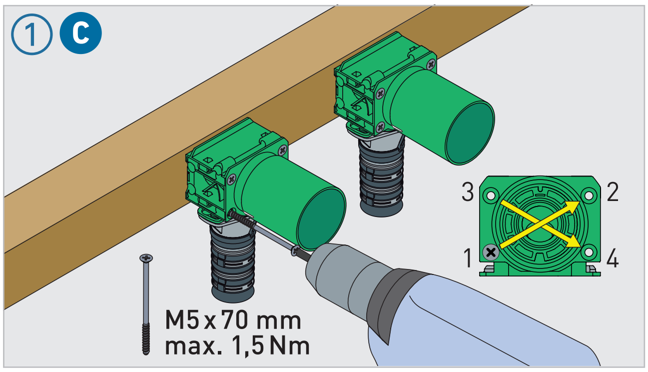




① B

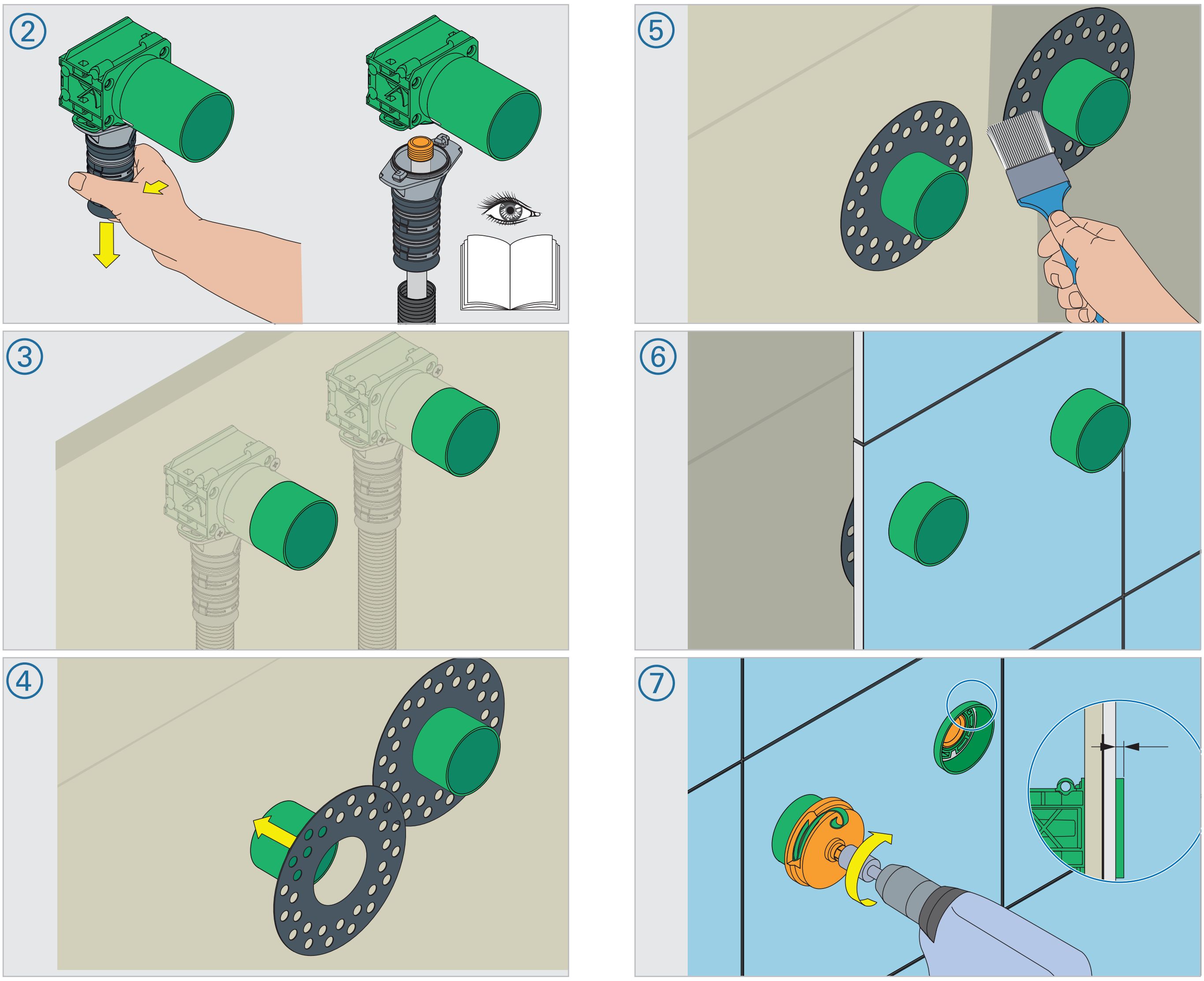


① C

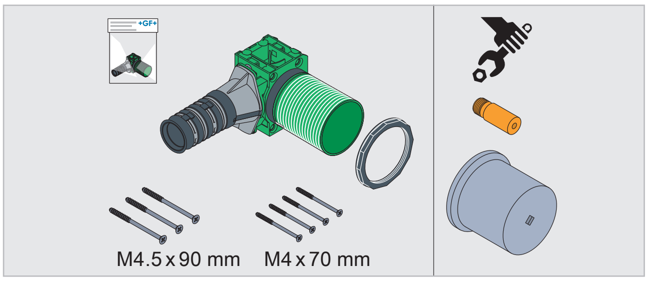


Assembling the 90° box with extension ▶▶

▶▶ Assembling the 90° box with extension



6.5 Assembly of the 90° box with extended connecting thread



The individual steps are illustrated on the next page.

Assembling the 90° box with extended connecting thread

① → Assembling the box.

Assembly variant A: Box installed vertically onto wooden post/formwork
→ Use 4 screws M5×90 to mount the box vertically onto the formwork. Tighten the screws crosswise.

Assembly variant B: Box installed horizontally onto wooden post/formwork
→ Use 4 screws M5×70 to secure the box vertically to the framework. Tighten the screws crosswise.
→ Remove the spacer ring.

Assembly variant C: Box on spacer
→ Turn extension counter-clockwise and remove the extension.
→ Insert the box into the opening of the spacer from the rear and use 2 M5×18 screws to attach the box. Tighten the screws crosswise.
→ Re-assemble the extension.

② → Turn the foot of the box to the side and pull the box downwards.
→ Slide the foot of the box over the pipe that must be connected.
→ Connect the pipe in accordance with the pipe system's assembly instructions.
→ Push the foot of the box back onto the box and let it snap into place.

Box cut-out

③ → Remove the extension and determine the approximate position of the box (≈ thread centre) on panels.

④ → Make a test cut with a hole saw (max. ∅32 mm) and install the panel.

⑤ → Screw the centring aid into the thread of the box.

⑥ → Use a hole saw to make the final cut (max. ∅52 mm).
- The centring aid has a guide in the hole saw.

⑦ → Remove the centring aid and reinstall the extension.

⑧ → Screw on the attachment incl. seal.

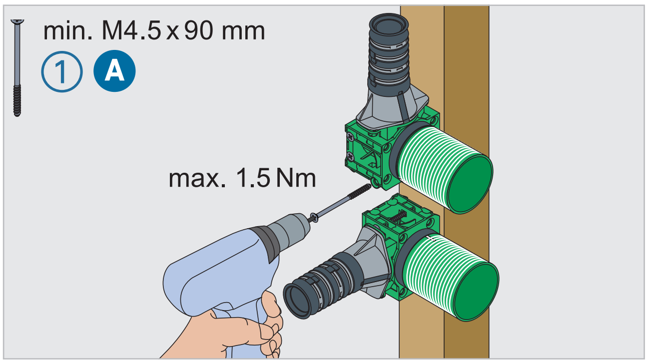
⑨ → Use the turn up device to install the attachment (max. 7 N/m)

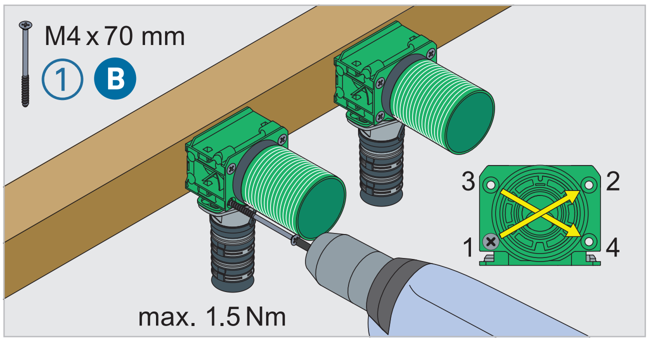
⑩ → Repeat the procedure, if necessary.

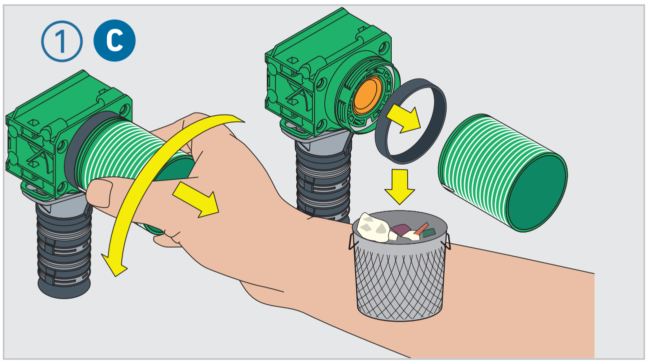
⑪ → Use a milling cutter to trim the box extension to the required length.
- Ensure to keep the projection.

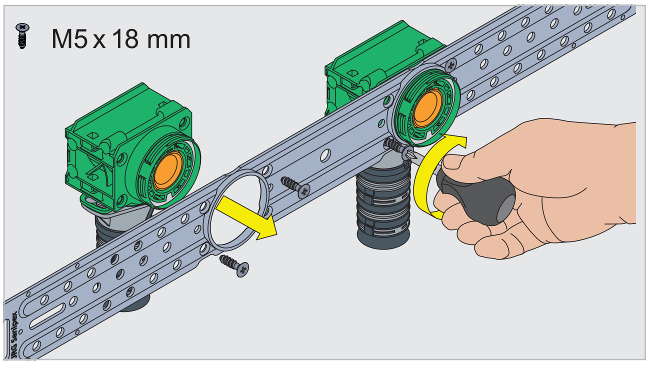
⑫

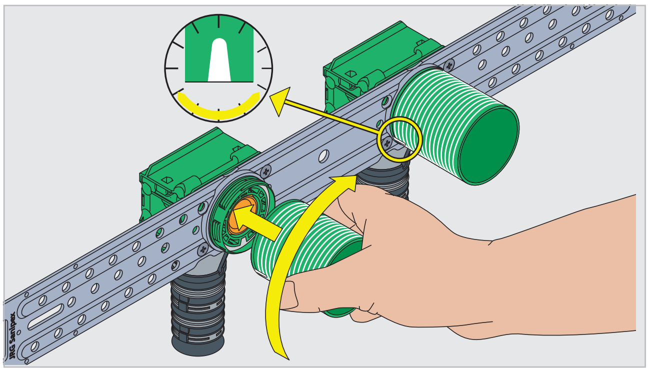
Assembling the 90° box with extended connecting thread

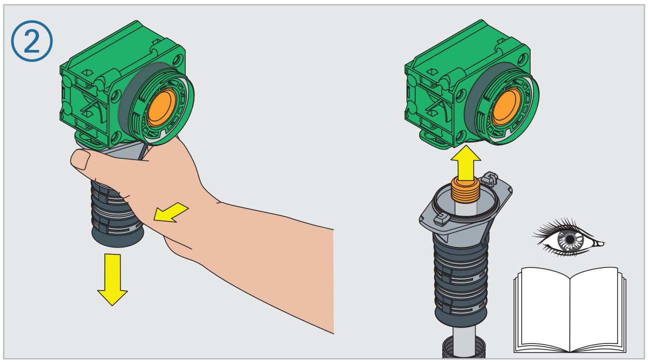


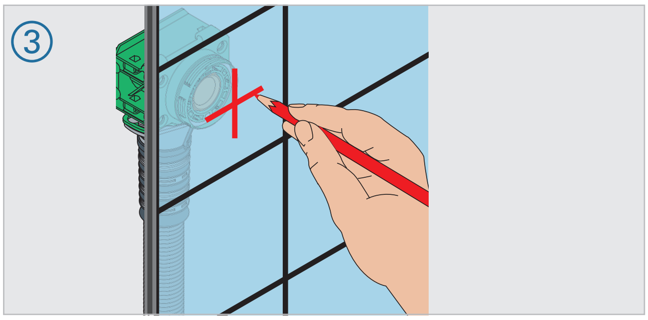


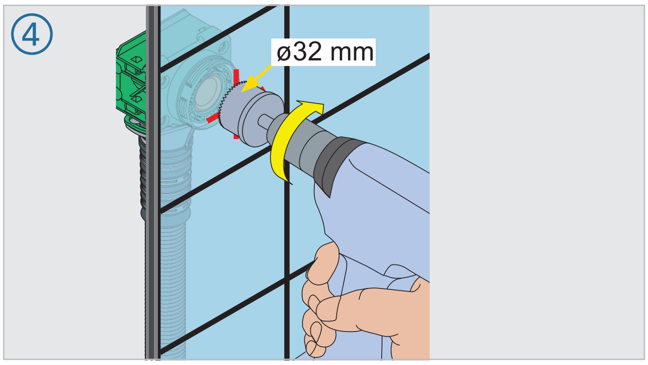


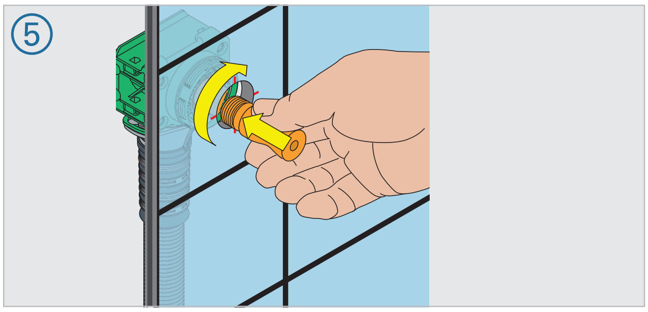


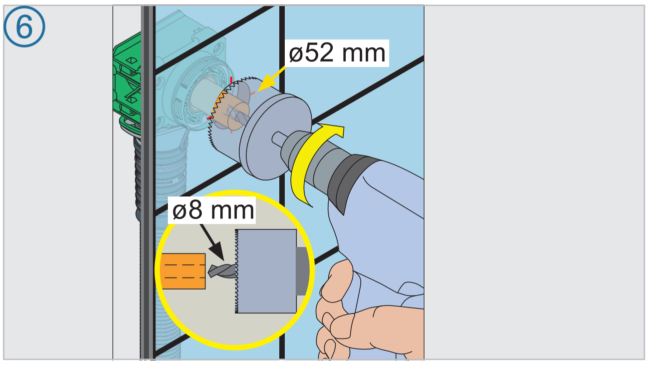






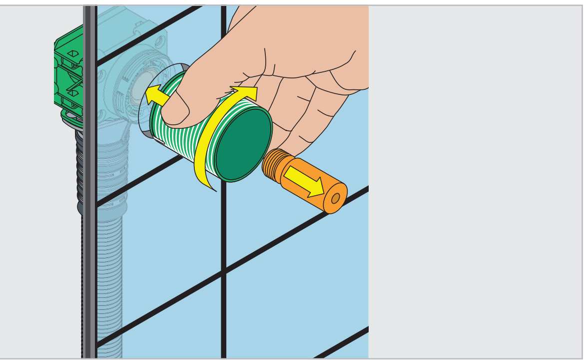






Assembling the 90° box with extended connecting thread ▶▶

▶▶ **Assembling the 90° box with extended connecting thread**

⑦


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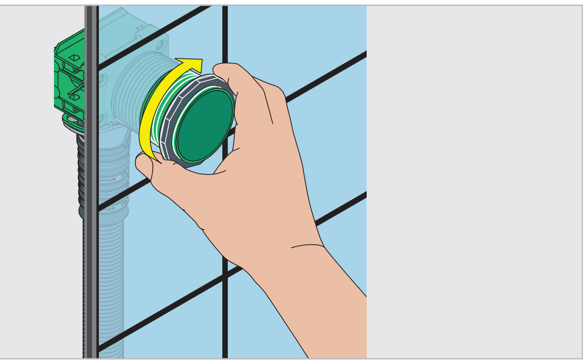

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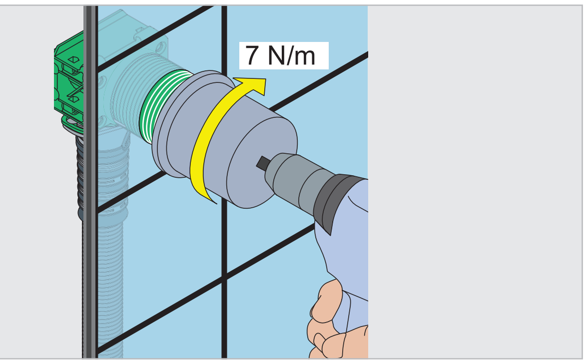

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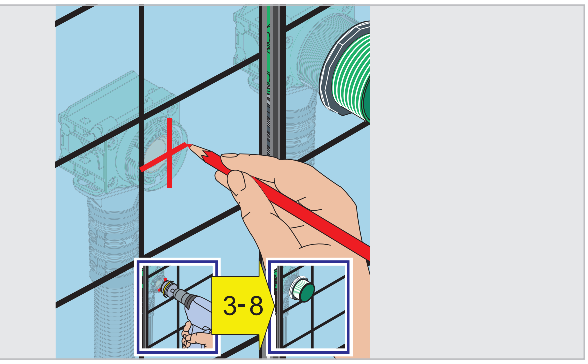
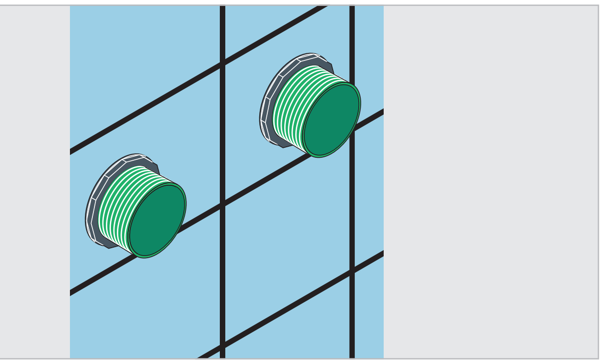
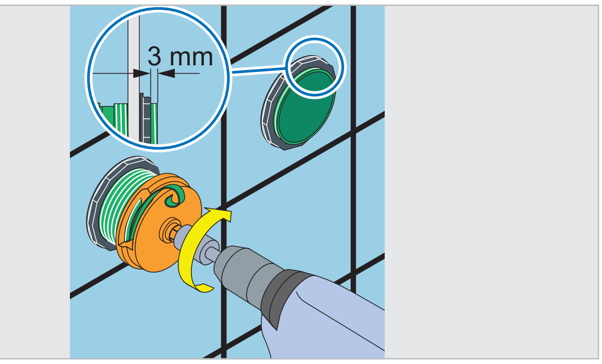


⑪


⑫


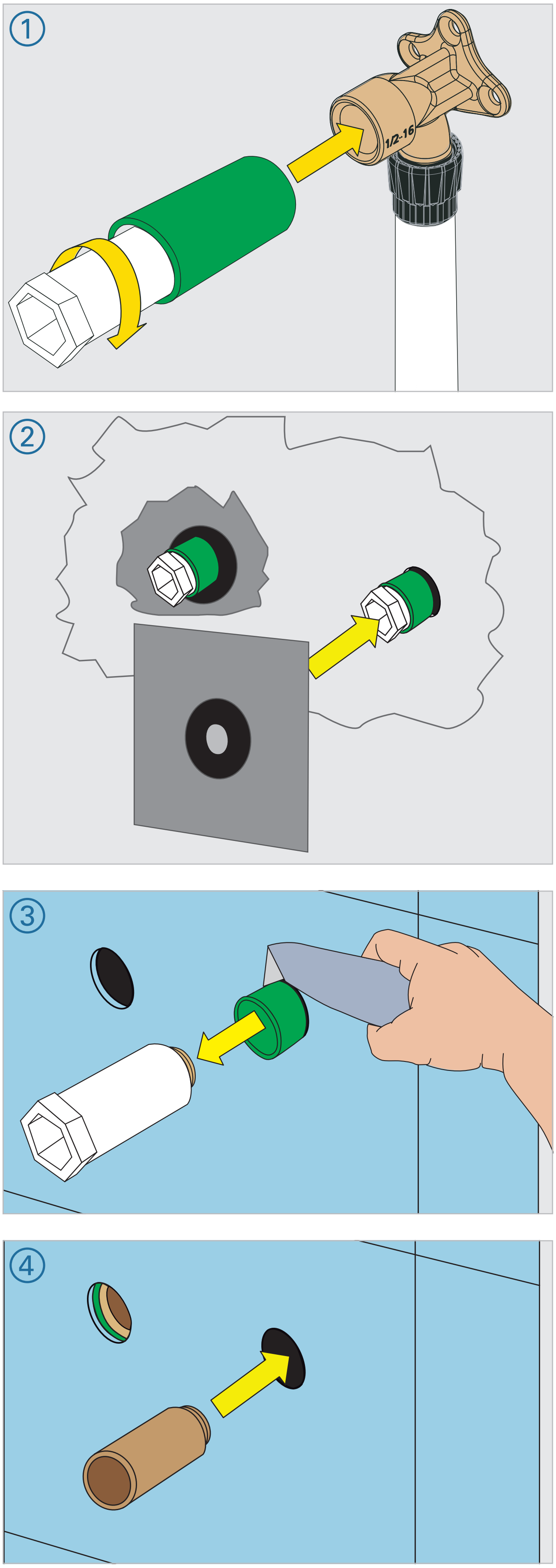
6.6 Sealing of fitting connections, boxes, and flush-mounted valves

The publication of DIN 18534 regarding waterproofing for indoor applications, tightens and precisely defines the requirements for wall penetrations, for example in the shower stalls and for bath tub fittings..

The compatible components of the JRG Sanipex assortment offer a simple, safe and standard-compliant solution that can also be used for valve connections of our other systems as well as other fittings from the JRG valve range across systems.

The combination of drip sleeve and sealing collar provides protection against water penetration (wall front side) and avoids the risk of sound bridges. When installed correctly, the drip sleeve also provides reliable routing of leakage water away from the front of the wall.

- The sleeve can be used for all common fitting connections, wall washers and thread extensions thanks to the lip seal
- Perfectly compatible components (temporary pipe plugs, drip sleeves, and sealing collars) that can also be used individually
- Compliance with DIN 18534 (2017-07) is simple and safe
- Secured jointing face of the wall disc to the tap extension or similar fittings
- Reducing the risk of sound bridges



Processing instructions

(1) The assembly must be completed before installing the temporary pipe plug.

→ Slide the drip sleeve over the fitting's connection and align.

The drip sleeve seals to the outside.

(2) → Pull the sealing collar over the drip sleeve.

↳ The sealing collar is in direct contact with the drip sleeve's surface.

→ Bond the sealing collar to the waterproof diaphragm provided by the customer.

(3) → Before assembling the fitting, trim the drip sleeve so that it is flush with the wall.

A cutter or hook knife is sufficient for trimming the drip sleeve to length. Subsequently, the temporary pipe plug can simply be unscrewed.

(4) → If necessary, screw in the tap extensions after-wards.

Otherwise, teh assembly of the fitting, angle valves or similar components are in the usual way.

6.7 Attachment accessories

In order to secure boxes and controls & instruments for bathtubs, showers and wash basins so that their function is not adversely affected, it is necessary to anchor the connection unit as a fixed point onto the masonry. **Spacers** are fastening elements that are included in the wall construction. These spacers are considered lost fastening elements (in this case, they remain attached inside or on the sub-structure), or they serve as reusable assembly aids, ensuring the boxes and controls/instruments are securely attached to the masonry, in-wall element, studded wall construction, etc.

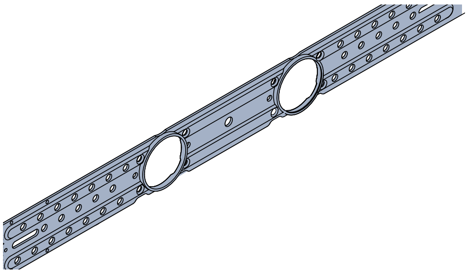
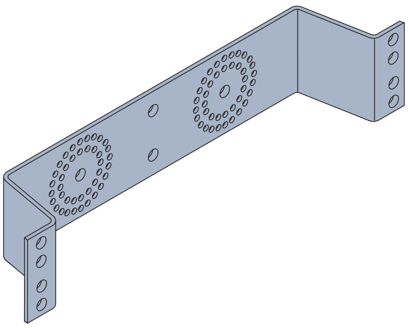
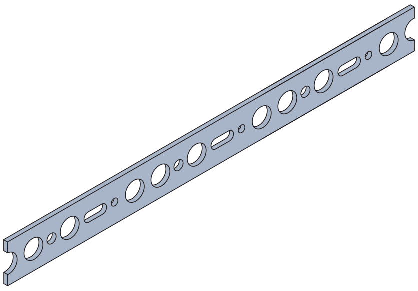
On the one hand, the spacers are used to attach the boxes and fitting connections onto the respective substructure, but on the other hand they also ensure compliance with the mandatory connecting dimensions of the fittings.

+ **The actual dimensions between the connecting points refers to the spacing between the cold and hot water connection.**

Various versions of the spacers allow the anchoring of boxes and controls & instruments in a variety of wall constructions. The spacers are usually made of one piece, thereby reducing the assembly effort and simplifying the assembly process. However, there are also designs made of multiple parts.

The flexible attachment is also important as it eliminates the source of the sound—especially when using fittings connections—to counteract the introduction of structure-borne noise in the building. When designing this structure-borne sound insulation, special care is required, because a single acoustic bridge can have devastating consequences and put the entire sound insulation concept in question. To prevent this, our product assortment offers suitable rubber sleeves. In addition, we recommend the use of boxes provide an optimal combination of strength and soundproofing. Regardless, all fitting connections must be decoupled from the building structure.

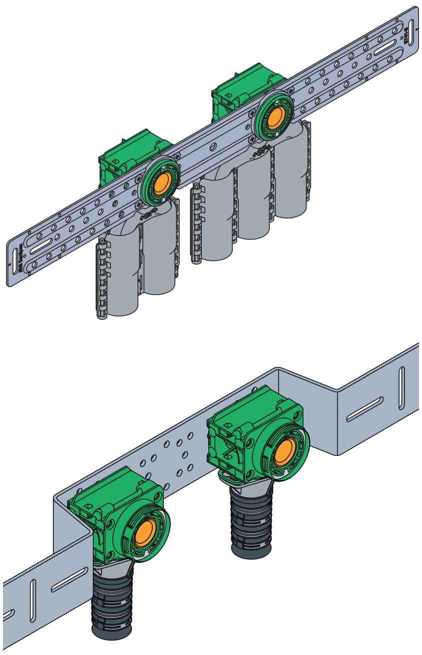
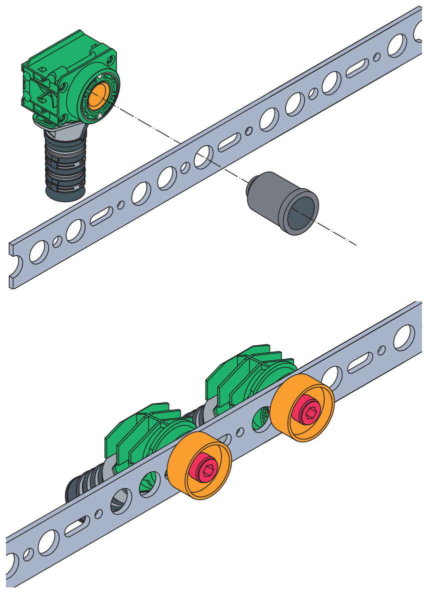
TV.12 **Versions of the spacers and mounting rails**

Box holder	Spacer for drywall installations	Mounting rails
		
This box holder is used in combination with the boxes and, among other things, can be used in wall slots.	For example, for stud walls by GIS, Knauf, Rigips and Glock separate spacers were designed, which are adapted to the fastening elements supplied by the manufacturers of the stud wall. ☑ Observe the documentation of the manufacturers of the stud walls.	In contrast to the "lost" spacers, rod or T-gauge mounting rails can be reused many times. The mounting rails are removed after filling the wall slots and before plastering the wall.

6.8 Assembly variants

6.8.1 Wall recess, slot mounting

TV.13
Slot assembly

Assembly with box holder and rail	Assembly with bar gauge and T-gauge
	
Box, single and/or multiple • A: with box holder • B: with mounting rails	Use the **wall inlet plug** to attach the controls & instruments connection onto the mounting rail.

Use of spacers

TV.14
Use of spacers

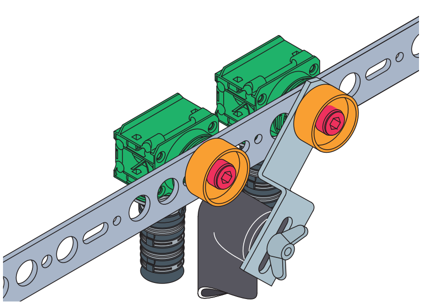
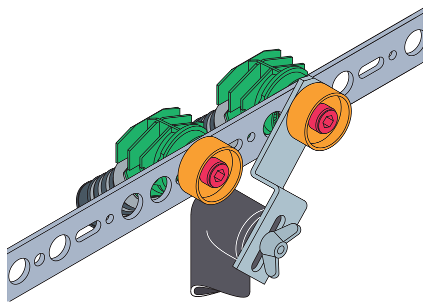
Distance [mm]	Application
153 and 150	for bathtub and shower equipment and other fittings
100	for DHW heaters, storage and other equipment
80	for pedestal washbasins
simple bracket	for on-the-wall (AP) cisterns, washing machines and other units

Use with drain pipe clamp

When connecting washbasins and kitchen sinks via angle valves, the **drainage** must be taken into consideration during the assembly of the connections to the controls and instruments.

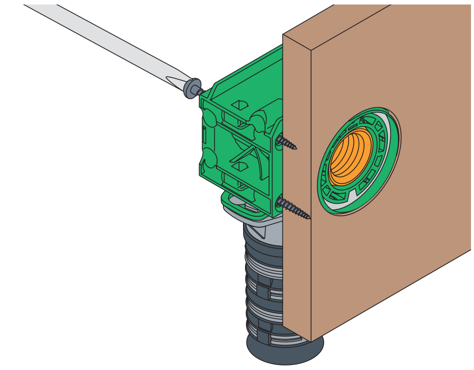
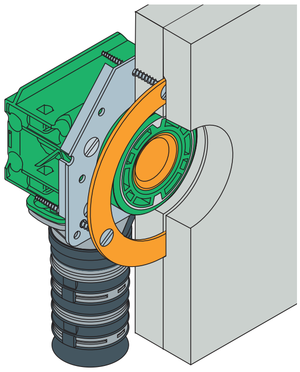
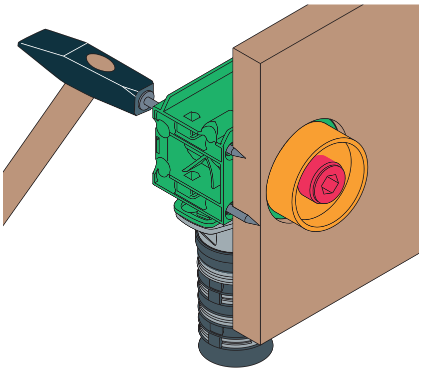
Depending on the type of washbasin (with or without pedestal), the actual dimensions between the connecting points is between 80 and 153 mm. The boxes and fitting connections can be mounted **at an angle,** provided the **drain clamp** is installed between 60 and 80 mm below the connections.

TV.15
Boxes with drain pipe clamps

90° boxes with adjustable drain pipe clamps	45° boxes with adjustable drain pipe clamps
	

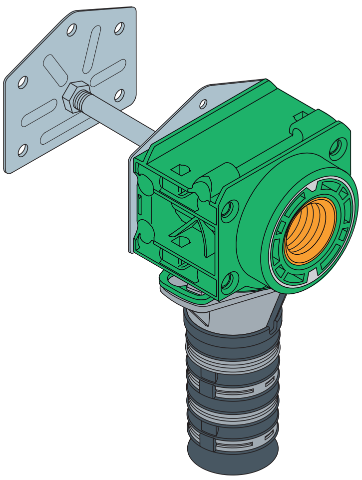
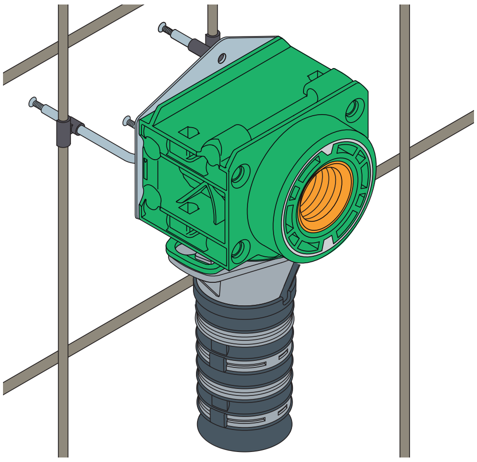
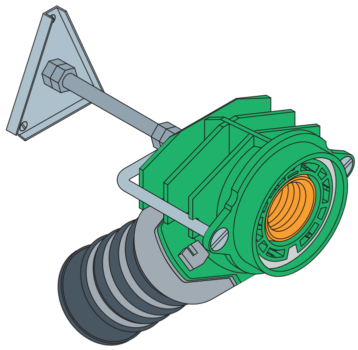
6.8.2 Assembly options on a wooden wall, gypsum board, wall formwork

TV.16 **Assembly variants**

90° box installed onto wooden formwork	90° box installed on plaster boards	90° box installed onto wall formwork
		
• with wood screws and auxiliary ring	• with gypsum board attachment set • with 2nd gypsum board on top of the first board	• with nails and protection cap

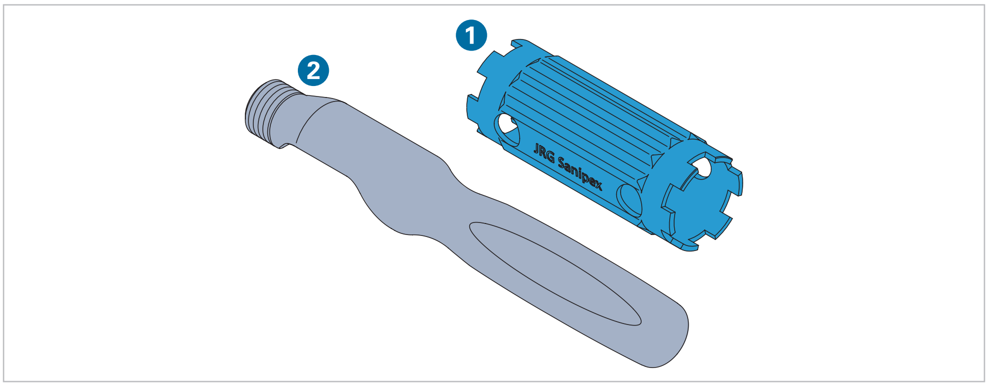
6.8.3 Assembly variant integrated into an in-wall installation or intermediate formwork

TV.17 **Assembly variants**

90° box in in-wall installation		45° box inside intermediate formwork
		
• with protective and press-on plug, attachment set, threaded rod, base plate and spacers	• with attachment set on re-inforcement bars	• with attachment set for in-wall installation, attachment set for intermediate formwork, protection cap, threaded rod and spacer

6.9 Disassembly of the box

The example of the disassembly shown here applies to all types of d12 and d16 single boxes for the JRG Sanipex system with PE-X pipes. For example, the disassembly is necessary when replacing a pipe. When using pipe dimension d20, or other systems (e.g. iFIT), or in combination with multilayer composite pipes, it is not possible to replace the box body. If this is the case, the replacement must proceed according to the assembly steps when replacing the pipe (see chapter [6.10] 'Replacing the pipe').



GV.2
Tool

1. Key for disassembling the box
2. Alignment gauge

The individual steps are illustrated on the next page.

Disassembling the box

① → Place the key for disassembling the box onto attachment ring.

② → Turn the key for disassembling the box counter-clockwise.

③ → Remove the attachment ring.

④ → If necessary, press the key for the box installation slightly downwards and pull the key out.

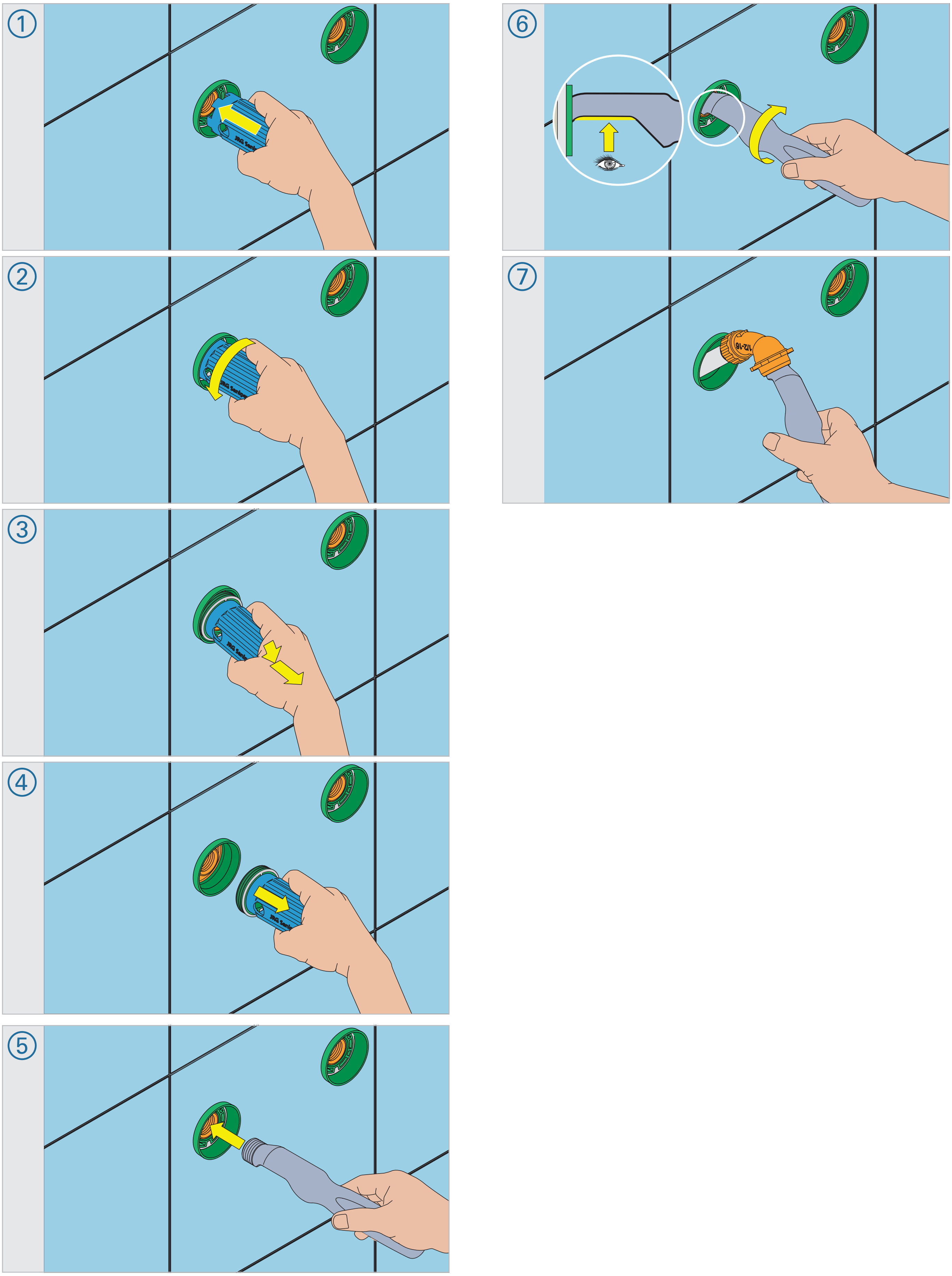
Remove inner part of the box with the piping

⑤ → Insert alignment gauge into box.

⑥ → Turn the alignment gauge clockwise.
→ Ensure the indentation in the alignment gauge points downwards.

⑦ → Pull the elbow of the pipeline including the pipe that is inside the wall upwards and out.
↳ Now the pipe can be replaced.

Disassembling the box



6.10 Replacing the pipe

NOTE! Odour and taste might be adversely affect due to lubricants and anti-friction agents!

→ Do not use lubricants or anti-friction agents for replacement purposes.

The individual steps are illustrated on the next page.

Replacing the pipes

Remove damaged pipe

① → Close shut-off valves upstream of distributor.
→ Disassemble discharge fitting.

② → Loosen the pipe end of the defective pipe from the distributor.
→ Remove crimping clamp from pipe end.
→ Use a pipe draw coupling to connect the new pipe to the pipe that must be replaced. When doing so, observe the direction of rotation of the thread.

③ → Use the mounting wrench to remove the fastening ring.

④ → Insert alignment gauge into box bend.

⑤ → Pull the pipe bend out of the wall box.

Replacing the pipe

⑥ → Proceed with the replacement of the pipe by using the alignment gauge to pull on the pipe that must be replaced and to strike the new pipe simultaneously.

If the pipe can not be replaced by striking and pulling it:

→ Pull out the old pipe.
→ Use a nylon string or wire rope and pull in the new pipe with the pipe draw coupling.

NOTE! Improvement of the sliding properties of the pipe.

If necessary, the sliding properties of the pipe can also be improved by using a silicone spray.

→ Be sure to contact Technical Support before using the method.
→ Spray silicone spray between protective conduit and carrier pipe and spread with compressed air.
→ Repeat step several times, if necessary.

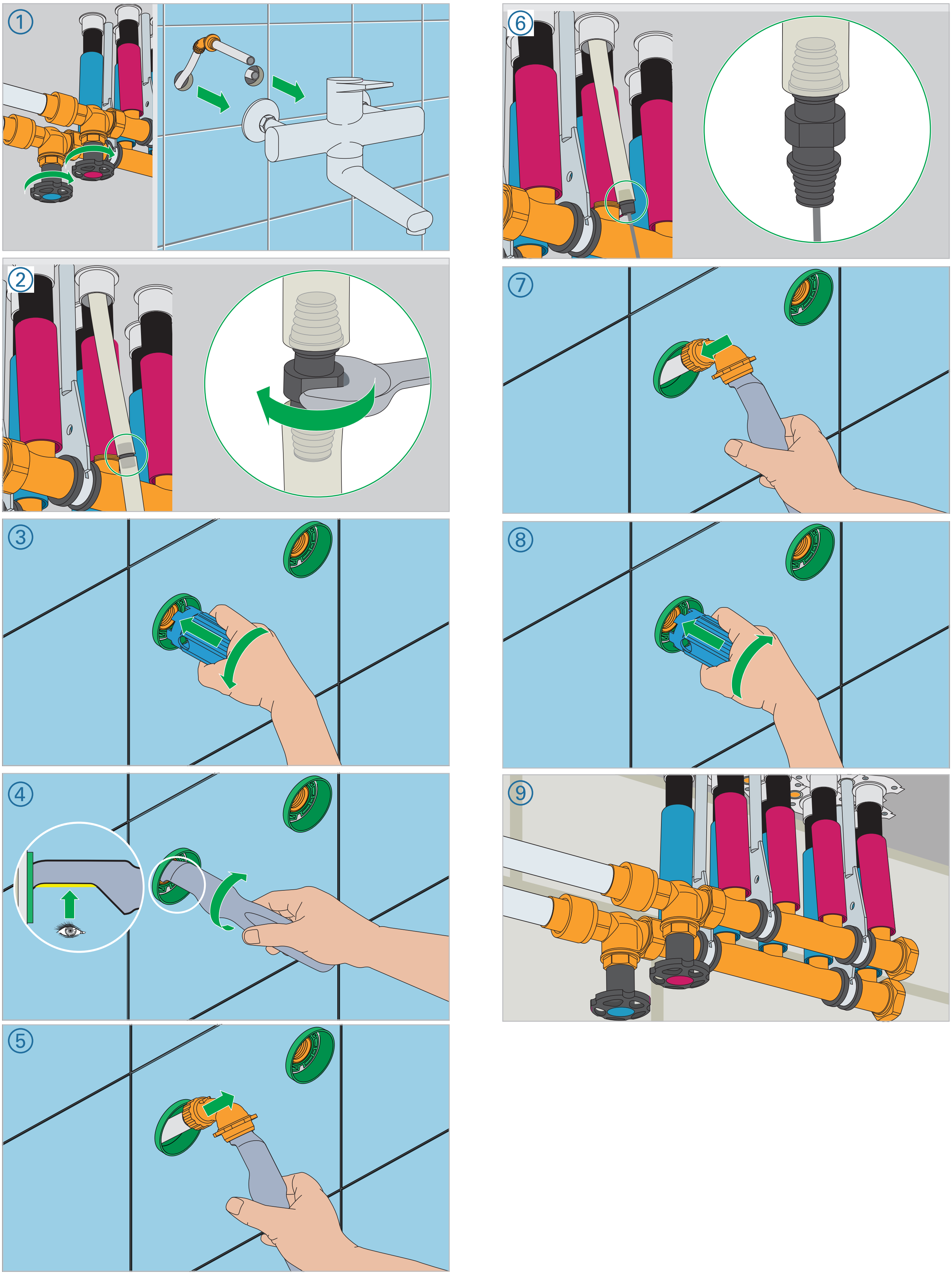
Install new pipe

⑦ → Attach crimped clamp connectors on both sides of the new pipe.
→ Screw the pipe to the box bend.

⑧ → Position the box bend in the box and use the fastening ring to secure it.
→ Install discharge fitting.

⑨ → Connect the pipe end to the distributor.
→ Open shut-off valves upstream of distributor.
→ Check for leaks.

Replacing the pipe



Build

Putting into operation

V

Putting into operation

1 Leak and pressure test

§ **Country-specific regulations**
In the following text, the pressure tests are introduced in accordance with the current standards. These regulations are representative for Germany and Switzerland.
Due to applicable regulations in other countries, these procedures may differ from the following information and recommendations.
→ Compliance with the country-specific deviations of these regulations is mandatory.

Pipelines transport fluids of all kinds and must therefore be **leakproof** in all circumstances. During normal operation, pipelines and their connections are exposed to loads which the pipes must withstand. In concrete terms, this means: The theoretical service life is 50 years, during which time the pipeline must always be leakproof. For this purpose, leak tests are performed – they serve to prove sufficient strength and tightness.

Designations

The pressure test is also often referred to as “strength test” or “stress test”.

Material-specific differences

The tests may differ for plastic and metal piping systems.

Media

For leak tests different test media can be used. The decision for or against a particular test medium depends on the construction project and the risk of the respective test procedure.

In addition to the traditional test medium **water** also **inert gases** (for example nitrogen or carbon dioxide) and **compressed air** are used for the test procedures. The test procedures apply to all materials and mixed installations.

Procedure

After completion, drinking water pipes are to be subjected to a leak and pressure test. These tests are carried out as long as the lines are still visible.

Pressure test and **leak tests** can also be performed in a combined process.

i **Examination in subsections**
The leak test does not have to be carried out in its entirety, but can be carried out successively in subsections. This may be necessary for larger buildings (for example short installations, different construction steps) or depending on the on-site requirements.

☑ A leak test must be performed before putting the installation into operation.
☑ The installation must be inspected before the pipes are covered and become inaccessible or installed behind a brick wall.

1.1 Description of the test procedures

Safety-relevant information

Test procedures with **inert gases** and with **compressed air** harbour risks: Due to the compressibility of the gases, hazards arise that must be considered.

+ **Example: The compressed air can suddenly depressurise due to a chopped off plug, which can turn into a projectile. If a pipe connection is not performed properly and has not been secured, the pipe may burst and fly apart.**

Test pressure

For safety reasons, the test pressures must therefore not exceed a maximum of 3 MPa (3 bar).

☑ If using safety devices (e.g. pressure reducers on compressors), it can be ensured that the test pressure is not exceeded.

1.1.1 Test methods using inert gas

A leak test with inert gases is recommended in all buildings in which hygiene is of the utmost concern. This group of buildings include, for example, the following types:

- Hospitals
- Doctor's offices
- Retirement homes
- Food companies

1.1.2 Test methods using compressed air

Test methods with compressed air are suitable for all buildings in which increased hygiene is not a high priority. These include, for example, residential buildings, hotels, administrative buildings, commercial and industrial buildings.

☑ In order to ensure safety at work: Only qualified personnel shall be permitted to proceed with the work.

Basic information

Moisture in the pipes can cause microbiological stress.

☑ Make sure that the inner walls of the pipes remain dry until shortly before putting them into operation.

☑ Before carrying out the test procedure, make sure that the compressed air used is oil-free and clean.

1.1.3 Test methods using drinking water

Drinking water has long been the leading medium for leak testing. From a hygienic point of view, however, this procedure is no longer completely harmless. Moisture or stagnant water in the pipes can lead to microbiological contamination of the drinking water system. For this reason, pipelines must remain dry until shortly before putting them into operation. If one decides in favour of test methods with drinking water, compliance with the following requirements is mandatory.

Basic information

- From the time of testing to putting into operation, the water must be regularly replaced at all taps.
- This water exchange must take place at regular intervals and at the latest after 7 days. In buildings with special use and increased hygiene requirements, the exchange must take every 3 days.
- The components used during the filling process must be hygienically flawless.
- Until putting the pipeline, which will be tested with drinking water into operation, it must remain completely filled.
- For hygienic and corrosion-chemical reasons, filling the pipeline partially must be avoided.

V

1.2 Implementation of the procedure

1.2.1 Test methods using inert gas and compressed air

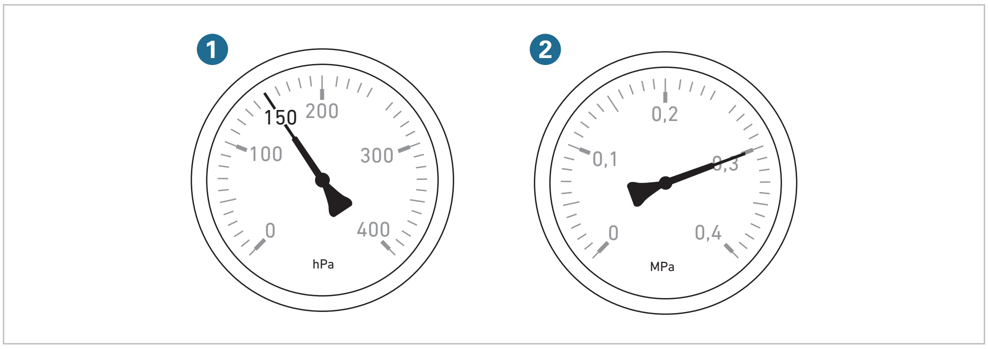
Basic information

- For safety reasons, the pressure must be increased slowly and must remain under constant control.
- Drinking water heaters or other devices in which a larger volume of air can lead to a safety hazard, must be removed before the leak test.
- Plugs must be made of metal. Closed shut-off valves are not considered tight seals.

If pressure drops and leaks can be detected on the pressure gauges during the leak test period and the load test time on the pressure gauges, proceed as listed below:

→ Repeat the test procedure.
→ Use pressure gauges with a 10 hPa (10 mbar) accuracy to detect the smallest leaks.
→ For safety reasons and a matter of accuracy, the pipeline shall be subdivided in short test sections.

Leak test	first 150 hPa (150 mbar)	
Test duration	up to 100 litres of pipe volume	120 minutes
	each additional 100 litres of pipe volume	• extend the test duration by 20 minutes
Stress test	subsequently	
Nominal widths	≤DN50 >DN50	maximum 0.3 MPa (3 bar) maximum 0.1 MPa (1 bar)
Test duration	10 minutes	



GV.1
Pressure gauge

1. with display accuracy of 100 hPa (0.1 bar)
2. with display accuracy of 0.1 MPa (1 bar)

1.2.2 Test methods using drinking water

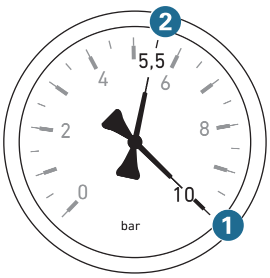
Basic information

- For safety reasons, the pressure must be increased slowly and must remain under constant control.
- The pressure gauge must be installed at the lowest point of the pipe that must be tested.
- All pipe ends must be vented.
- At differences of >10 K: A temperature stability between ambient temperature and the water temperature is produced by a waiting time of about 30 minutes.
- The test time begins only if the pressure remains constant.

If pressure drops and leaks can be detected on the pressure gauges during the leak test period and the load test time on the pressure gauges, proceed as listed below:

→ Repeat the test procedure.
→ Use a pressure gauge with a display accuracy of 100 hPa (0.1 bar); this allows that the smallest leaks can be detected.
→ For safety reasons and a matter of accuracy, the installation shall be subdivided in **short test sections**.

Stress test	first 1 MPa (10 bar)	corresponds to 1.1 times the operating pressure
Test duration	30 minutes	
Leak test	Subsequently, lower the pressure to 50% of the stress test by lowering the pressure to 0.55 MPa (5.5 bar)	
Test duration	120 minutes	



GV.2
Pressure gauge

1. Stress test: Pointer at 10 bar
2. Leak test: Pointer at 5.5 bar

V

1.3 Pressure test for plastic piping systems

1.3.1 Pressure test acc. to DVGW (DIN 1988)

The test pressure must be 1.5 times the operating pressure or at least 15 bar. In order to perform the test properly, the installation must be filled slowly with media and fully vented again. Calibrated measuring instruments are required for the test method. Pressure changes of 0.1 bar must be readable.

A temperature change of 10 K will change the test pressure. Depending on the size of the system, changes of up to 2 bar and more are possible.

Test sections

The pressure test consists of **two test sections**:

- Pre-test
- Main test

Time of the pressure test

- When using clamping connections: **immediately** after the last connection is completed
- When using welded joints: the earliest **1 hour after** the last welding

Technical rules and standards for pressure testing (for example in Germany and Switzerland)

Germany

- Pressure test acc. to DVGW (DIN 1988-2, TRWI)

Switzerland

- Pressure test according to SVGW (guidelines for drinking water installation: W3d, 2013)

1.3.2 Pressure test according to ZVSHK with compressed air or inert gases

Conducting a pressure test with air or inert gases for drinking water installations according to DIN 1988-2 (TRWI)

Note

If a pressure test with **water** is only possible with disproportionately high effort or not possible at all, a pressure test with oil-free **compressed air** or with **inert gases** can be carried out in exceptional cases.

Exceptional cases

- Piping systems that cannot be completely emptied and that are susceptible to localised corrosion due to the critical three-phase boundary of water, material and air
- Piping systems where, due to the effects of frost, a pressure test with water cannot be carried out
- Prefabrication of pipe parts in workshops
- Piping systems that must be subjected to a pressure test for reasons due to the progress of the construction, but are not yet connected to the main line

Implementation of the pressure test

Pressure tests with air or inert gases are more expensive than pressure tests with water. Therefore, the pressure tests must be listed in detail in the specifications. Compliance with the safety regulations, as listed in ZVSHK bulletin, Point 3, is mandatory.

The test is divided into strength and leak tests.

➨ ZVSHK bulletin (D-53757 St. Augustin)

➨ The pressure test procedures are illustrated in this book.

The **leak test** is carried out before the strength test, using a pressure of 110 mbar.
The test duration is 10 minutes per 100 litres of piping volume.

The **strength test** is carried out with increased pressure.

- up to DN50: with 3 bar
- above DN50: with 1 bar

When using pipe systems made of **plastic**, the equilibrium must be awaited before the start of the test duration. For each 100 litres of piping volume, the test duration is 10 minutes after application of the test pressure.

Suitable media for pressure testing

- oil-free compressed air
- inert gases, e.g. nitrogen, carbon dioxide

1.3.3 Pressure test according to GF factory specification

Implementation of the pressure test

1. Slowly pressurise the system to 15 bar.
   ↳ Retain this pressure for 10 minutes.
2. Depressurise the system to 0 bar.
   ↳ Retain this pressure for 5 minutes.
3. Slowly pressurise the system to 15 bar.
   ↳ Retain this pressure for 10 minutes.
4. Depressurise the system to 0 bar.
   ↳ Retain this pressure for 5 minutes.
5. Slowly pressurise the system to 15 bar. Use a shut-off device to close the system.
6. After 60 minutes, read the system pressure and enter the reading into the log.
7. Lower the pressure to 3 bar.
8. After 90 minutes, read the pressure on the pressure gauge and enter the reading into the log.

☑ At the end of the test, the pressure must be at or above 3 bar.

Instructions for the implementation

The pressure rise above 3 bar depends on the length of the pipeline and the type of installation; therefore, the pressure cannot be precisely defined.

☑ Check the individual drinking water distribution circuits separately. This means that the cold water and hot water distribution must be checked separately, as well as the cold water riser pipe and the hot water riser pipe incl. the circulation.

In order to save time, several drinking water distribution circuits can be tested simultaneously.

After pressurising the system three times to 15 bar, a shut-off valve will be used to close the system. The pressure pump can be removed. The next distribution circuit can be pressurised according to the same pattern, permitting continuous pressure testing.
Thus, the time required is limited.

Units (according to DVGW, DIN 1988)

Pressure gauges must be used which allow a flawless reading of a pressure change of 0.1 bar.

1.4 Reports – Leak test and pressure test

After completion of the leak test, the responsible specialist must issue a report in which the tightness of the tested pipeline (if necessary in subsections) is confirmed.

Reports
On the following pages all relevant reports are collected.
If necessary, the master copy may be used as a template.

Report ①: Pressure test of a drinking water installation

- Test medium: Water
- combined report for different materials

Report ②: Leak test of a drinking water installation

- Test medium: Compressed air or inert gas

Report ③: Pressure test of a drinking water installation (GF recommendation)

- Test medium: Water
- combined report for different materials

Report 1: Pressure test of a drinking water installation

Report based on information provided in ZVSHK

Test medium: Water

Construction project: ....

....

....

Client represented by: ....

Contractor represented by: ....

☐ The test medium water is filtered, the pipeline system completely vented.

The permissible operating pressure is P_{zul} = 1 MPa (10 bar) or (if higher than) .... MPa / .... bar

Ambient temperature ϑu: .... °C Temperature of the test medium ϑw: .... °C

$$\Delta\vartheta = \vartheta u - \vartheta w = \ldots\ K$$

Material of the piping system

A ☐ Metal, multilayer composite and PVC pipelines

B ☐ Plastic materials PP, PE, PE-X, PB pipelines and combined installations of metal and multilayer composite pipes

Test methods and test sequence

1. ☐ $\Delta\vartheta \leq 10$ K ambient temperature to filling temperature

2. When using press connections (not crimped, leaking), first apply a test pressure using supply pressure: max. 0.6 MPa/6.0 bar or as specified by the manufacturer

   Test duration: 15 min

   Pressure applied: .... MPa / .... bar

3. Apply pressure: min. 1.1 MPa/11 bar ($P_{prüf} = P_{zul} \times 1.1$ = ... MPa / .... bar)

4. Test duration: 30 min

   Additionally, only for material B

   4.1 Check for obvious leaks, visual inspection and pressure gauge.

   4.2 Lower pressure to 0.5 times test pressure (at 1.1 MPa / 11 bar to 0.55 MPa / 5.5 bar).

   4.3 Test duration: 120 min

5. Assessment:

☐ During the test duration, no pressure drop ($\Delta p = 0$) has occurred. Leaks are not detectable.

Result

☐ The pipelines are tight.

....

Place Date

....

Client/Representative Contractor/Representative

Report 2: Leak test of a drinking water installation

Report based on information from the ZVSHK

Test medium: Compressed air or inert gas

Construction project: ....

Client represented by: ....

Contractor/
Responsible specialist represented by: ....

Material of the piping system: ....

Type of connection: ....

System pressure: .... bar

Ambient temperature: .... °C Temperature of the test medium: .... °C

Test medium: ☐ oil-free compressed air ☐ Nitrogen ☐ Carbon dioxide ☐ ....

The drinking water installation was tested as: ☐ overall system
☐ tested in .... (number of) subsections

☐ Metal plugs, caps, stoppers or blind flanges are used to close all pipelines.

☐ Equipment, pressure vessels or DHW heaters are disconnected from the pipes.

☐ A visual inspection of all pipe connections in order to ensure proper workmanship was carried out.

☐ **Leak test**

Test pressure: 150 hPa (150 mbar)

Test duration for up to 100 litres of pipe volume: min. 120 minutes

For every additional 100 litres, the test duration must be increased by 20 minutes.

Pipeline volume: .... Litre Test duration: .... minutes

☐ **Stress test with increased pressure**

Test pressure: ≤DN50: max. 0.3 MPa (3 bar) >DN50: max. 0.1 MPa (1 bar)

Test duration: 10 minutes

☐ Applicable to materials made of **plastic**: Waiting for temperature balance and equilibrium. Thereafter, the test duration begins.

Result:

☐ During the test duration, a pressure drop was not detected.

☐ The pipelines are tight.

....

Place Date

....

Client/Representative Contractor/Representative

Report 3: Pressure test of a drinking water installation

Report based on GF recommendation
Applicable ONLY to systems made of 100% plastic!

Test medium: Water

Construction project: ....

Builder/construction management: ....

Installation company represented by: ....

Material of the piping system: ....

Type of connection: ....

System pressure: .... kPa

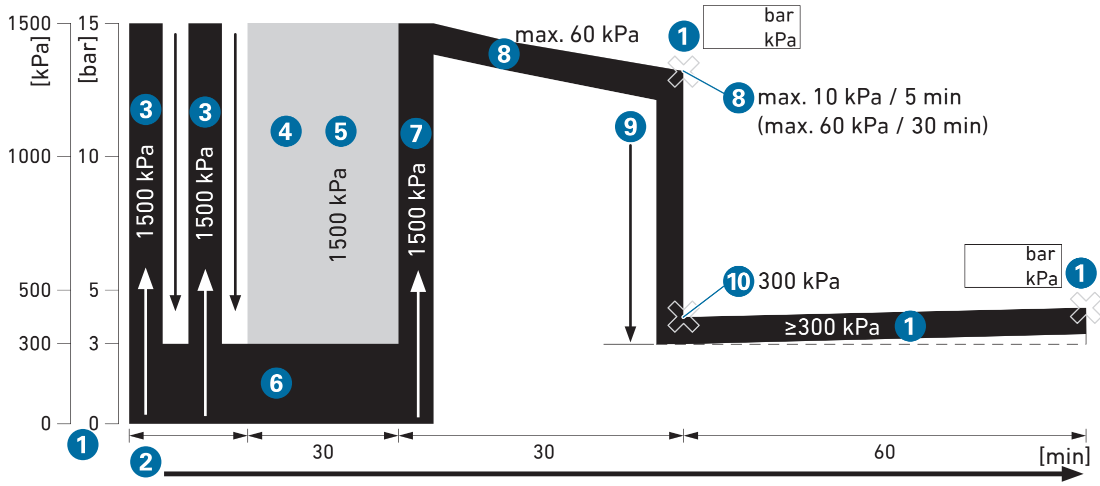
Ambient temperature: .... °C Water temperature: .... °C

Test medium: ☐ Drinking water

The drinking water installation was tested as: ☐ Overall system / ☐ tested in ...... (number of subsections

☐ The test medium water is filtered, the pipeline system completely vented.

Test methods and test sequence



☐ compliant ☐ compliant ☐ compliant ☐ compliant

1 Pressure
2 Time
3 Pressure (pumps)
4 Temperature balance (if >10 K)
5 Pressure
6 Lower the pressure
7 Test pressure (pumps)
8 Pressure loss
9 Lower the pressure (to 300 kPa)
10 Test pressure
x independent of time
A Stress test, in cycles
B Temperature balance
C Pre-test (stress)
D Main test (tightness)

....

Place, Date

....

Client/Representative

....

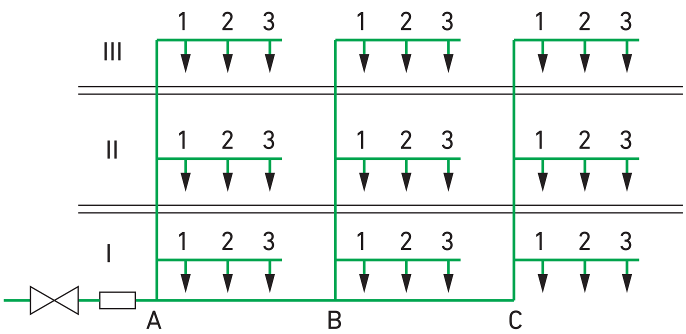
Contractor/Representative

2 Flushing

Before putting the system into operation, the piping system must be drained and flushed effectively in order to remove debris, foreign objects and impurities.

The **flushing** of the installation is carried out with the maximum possible volumetric flow or with a suitable flushing device until the drinking water quality is guaranteed. Flushing fulfils many tasks: It serves to safeguard the drinking water quality, corrosion damage and malfunction of controls & instruments and equipment are avoided and the inner surfaces of the pipes are cleaned, so that the specified requirements for hygiene are met.

Specific **flushing** procedures are used to meet the hygienic requirements of the piping system. In order to ensure that the flushing process works effectively, compliance with a **flushing order** is mandatory. Figure [GV.3] illustrates an overview of the optimal sequence: This sequence starts from the nearest to the most remote riser pipe and from the nearest to the farthest tab in the applicable floor level.



GV.3
Flushing sequence

A ... C	Riser pipe
I ... III	Floor level
1 ... 3	Tap

There are two common flushing methods:

- Flushing with drinking water
- Flushing with a drinking water/air mixture (acc. to DIN 1988-2)

2.1 Flushing method with drinking water

The flushing method with drinking water is suitable for clean new installations. The method is carried out shortly before putting the system into operation, using the available supply pressure and the built-in controls and instruments.

Flow velocities of 2 m/s must be achieved in the pipelines' largest nominal diameter in order to flush out all impurities. In order to flush out impurities, a temporary pressure increase may be necessary for this required flow rate.

Basic information

- The water volume must be changed 20 times in the flushing section.
- The flushing points must be fully open for at least 5 minutes.
- In order to increase the flow rate with built-in equipment, jet regulators, flow restrictors, fine filters, shower heads and hand showers must be removed.
- In order to prevent any solids from being washed in, equipment and devices with a larger volume must be removed during the flushing process (e.g. DHW heaters).

Implementation

During the flushing process, the pressure reducer must be relieved, that is to say, the pressure reducer must not be throttled, but must remain fully open.

→ Prior to flushing, all sensitive fittings and equipment must be removed and replaced with adaptors, or hoses that will bypass the locations where the fittings and equipment used to be.
→ Remove aerators, tap aerators and flow restrictors.
→ Flush in a sequence of sections with filtered drinking water at a specified static pressure. Start with the main shut-off valve, and continue to the farthest tapping point. To do this, all shut-off valves must be fully open.

Moreover, a certain minimum number of tapping points must be opened in the relevant flushing section. The number of tapping points depends on two criteria:

- largest nominal diameter in the current flushing section
- minimum volumetric flow with completely filled pipe section

An overview of the tapping points that must be opened is illustrated in the following table.

TV.1
Nominal diameter and taps that must be opened

Maximum nominal diameter [DN] of the distribution line in the current flushing section	25	32	40	50	65	80	100
Minimum number of tapping points (DN15) that must be fully opened	2	4	6	8	14	22	32

Strainers and dust traps in all equipment must be cleaned after rinsing the system. After the rinsing time of 5 minutes, the opened flushing points on the tap fittings are closed one after the other.

2.2 Flushing method with drinking water/air mixture

The flushing process with a drinking water/air mixture is only necessary if an increased cleaning performance has to be achieved – e.g. in existing pipelines with incrustations, deposits or biofilms. Before flushing, there are some tasks that must be considered in order to achieve the best result.

Basic information

- In order to comply with intermittent flushing operations (alternating flushing with air and water), the manufacturers' flushing equipment must be used.
- The drinking water used during the intermittent flushing process, must be filtered through a mechanical filter.
- The air used in this process must be oil-free and clean.
- Length of the pipeline: <100 m. Longer pipelines must be divided into sections and the flushing device must be used in the applicable sections.
- Minimum flow velocity: >0.5 m/s

The flushing duration depends on the length of the pipeline.

☑ Make sure that the flushing time per running meter does not drop below 15 seconds and the flushing time at each tapping point is at least 2 minutes.

☑ Close the flushing points in reverse order.

Implementation

→ Perform intermittent flushes with combined shut-off and flushing plugs. If tapping valves are already installed: Disassemble the tapping valves.

→ Reconnect the flushing device downstream of the equipment.

→ Flush the following pipes separately.

→ Flush the cold and hot water pipes including the circulation separately.

Moreover, a certain minimum number of tapping points must be opened in the relevant flushing section. The number of tapping points depends on two criteria:

- largest nominal diameter in the current flushing section
- Minimum volumetric flow with completely filled pipe section

An overview of the tapping points that must be opened is illustrated in the following table.

Maximum nominal diameter [DN] of the distribution line in the current flushing section	25	32	40	50	65	80	100
Minimum volumetric flow [l/min] (while the distribution line is filled completely)	15	25	38	59	100	151	236
Minimum number of tapping points (DN15) that must be fully opened	1	2	3	4	6	9	14

TV.2
Nominal diameter, minimum volumetric flow and tapping points to be opened

2.2.1 Flushing report

After completing the flushing, the responsible specialist must issue a report listing the flushing procedure used and confirming proper execution.

➨ Flushing report 4 and 5 , see next page

Report ④: Flushing of a drinking water installation

Flushing method: Flushing with water

Construction project: ....

(Street) ....

(Country/city) ....

Client represented by ....

Contractor represented by: ....

Pressure test completed on (date): ....

Material used: ....

Nominal diameter and taps that must be opened

Maximum nominal diameter [DN] of the distribution line in the current flushing section	25	32	40	50	65	80	100
Minimum number of tapping points (DN15) that must be fully opened	2	4	6	8	14	22	32

Requirements

☐ The drinking water used for rinsing is filtered. Stagnation pressure: .... bar

☐ Maintenance equipment (floor shut-off valves, preliminary shut-off valves) are fully open.

☐ Delicate controls and instruments and equipment are removed and replaced by adaptors.

☐ Flexible lines are bypassed.

☐ Aerators, tap aerators and flow restrictors are removed.

Procedure

1. Within a storey, the tapping points are fully opened, starting with the tapping point farthest from the riser pipe.

The flushing takes place (starting from the main shut-off valve) in the flushing sequence in the sections to the farthest tapping point.

2. After a flushing time of 5 minutes, at the flushing point that was opened last: The tapping points are closed one after the other.

☐ Built-in strainers and dust traps in front of equipment were cleaned after flushing with water.

☐ The flushing of the drinking water installation has been carried out properly.

....

Place Date

....

Client/Representative Contractor/Representative

Report 5: Flushing of a drinking water installation

Flushing method: Flushing with air/water mixture

Construction project: ....

(Street) ....

(Country/city) ....

Client represented by ....

Contractor represented by: ....

Pressure test completed on (date): ....

Material used: ....

☐ The drinking water used for rinsing is filtered. Stagnation pressure P_W: .... bar
☐ The compressed air is free of oil. Compressed air: Stagnation pressure P_L: .... bar ($\geq P_W$)
☐ Cold and hot water pipes (including circulation) are separated.
☐ Delicate controls and instruments and equipment are removed and replaced by adaptors.
☐ Flexible lines are bypassed.
☐ The largest pipeline length is:
for TWW .... running meters for TW .... running meters

Sections 1	2	3	4	5	Overall system		Overall system	Sections 1	2	3	4	5	6	7
						Caution! If overall length exceeds 100 m, flush one section at a time!								
						Largest nominal values of the distribution line								
						Minimum number of open taps (table below)								
						Longest length of the pipeline								
						Minimum flushing time at 15 s/running meter								

Table for minimum volumetric flow and minimum number of tapping points to be opened for rinsing at a minimum flow rate of 0.5 m/s								
	Maximum nominal diameter of the distribution line [DN]	25	32	40	50	65	80	100
	Minimum volumetric flow while the distribution line is filled completely Q [l/min]	15	25	38	59	100	151	236
	Minimum number of tapping points (DN15) that must be opened	1	2	3	4	6	9	14

1. The pipes are flushed from bottom to top, from the closest riser pipe to the farthest one.
2. Within a riser pipe, the pipes are flushed from bottom to top and from floor to floor.
3. For each floor and within each pipeline on each floor level – starting with riser pipe located the farthest to the nearest – the minimum number of tapping points that must be opened are listed in the table below.

4. The minimum flushing time of the flushing point last opened is 2 min. The minimum requirement of 15 s/running metre of pipe length must be considered. The flushing points are closed one after the other in reverse order.

☐ The flushing of the drinking water installation has been carried out properly.

....

Place Date

....

Client/Representative Contractor/Representative

Operate

VI

Operate

1 Operational safety

✚ **The operator must be instructed by the system designer and familiarised with the system's operation so that the operator can fulfil his duties and ensure proper operation of the drinking water installation.**

The "operators" of a system are determined according to the building type:

TVI.1
Operator of a system

Type of building	Operating company
Privately owned home	Owner
Owner-occupied flat	Owner, also custodian or manager of the building
Rented flat	Homeowner, representative of the homeowner (engineer, technician or custodian), tenant
trade/industry	Owner, owner's representative (technical director, safety engineer, technician, custodian)

1.1 Operating phases

✚ **The following basic safety instructions for the operating phases (e.g. operation, inspection, maintenance, repair, decommissioning and disposal) are for the safety of the installation and all persons who use or work on it.**

§ **Country-specific regulations**
Individual operating phases may be regulated differently in each country, controlled by laws, directives, ordinances, standards, regulations and bulletins.
→ Compliance with the local regulations is mandatory.

Ensuring a flawless operation!

☑ To ensure trouble-free operation: Check all components of the installation and all control and safety valves regularly.

Risk of injury due to pressure or explosion!

If the system is not completely depressurised, media may escape uncontrollably from the installation.

☑ Before removal/maintenance/disassembly: Pipeline must be completely depressurised.
☑ If harmful, combustible or explosive media is used: Completely empty and flush the pipeline before disassembling it. Look for potential residues.
☑ Use appropriate measures to ensure the medium is collected properly.

Risk of injury due to media harmful to health and the environment!

Risk of personal injury and/or environmental damage due to uncontrolled escape of hazardous media.

☑ During maintenance, servicing, repair and decommissioning, prescribed protective clothing must be worn.
☑ Compliance with the media safety data sheets is mandatory.
☑ Any escaping media must be collected and dispose of according to local regulations.

Risk of injury due to the use of unsuitable spare parts!

Damage to the installation and risk of injury.

☑ Only use replacement parts from the current product range during the installation and repairs.

1.2 Intended use

+ After the handover, it is the duty of the property owner to ensure the intended operation (target condition).

In the future, the challenge will increasingly be to harmonise the factors **comfort**, **energy (-saving)** and **drinking water hygiene**.

The intended operation is characterised by the following key points:

- The drinking water installation is operated as planned (with regard to water consumption, use of space, etc.).
- All taps use a regular water exchange.
- The cold and hot water temperatures are maintained.
- The maintenance intervals are adhered to.
- Regular checks of the chemical and microbiological state of drinking water by using laboratory analyses.

1.3 Drinking water quality

☑ Check the quality of the drinking water at regular intervals.
☑ Check drinking water for chemical and microbiological composition.

Further information on the implementation in the context of monitoring

➨ Part II 'Plan – Build – Operate', chapter [4] 'The Hycleen Concept'

1.4 Inspection

+ The regular inspection serves to determine the actual state of the drinking water installation.

If the actual state deviates from the nominal state that must be observed, the necessary measures must be taken to ensure that operation as intended is restored as quickly as possible.

Further information on the implementation in the context of monitoring

Detailed information for monitoring the actual state of the drinking water installation:

➨ Part II 'Plan – Build – Operate', chapter [4] 'The Hycleen Concept', there, read the section about Monitoring.

1.5 Disposal

§ **Country-specific regulations**

Disposal and recycling may be regulated differently in each country by laws, ordinances, standards, regulations, and bulletins.

→ When disposing of or recycling products, the system and its individual components as well as the packaging, observe the locally applicable regulations.

☑ Before disposing of individual materials, they must be separated according to their recyclability, and whether these materials are considered normal waste or special waste.

2 Sample analysis and evaluation of the drinking water quality

If the drinking water installation is not operated as intended or subsequent changes have been made, this can have negative effects on the water quality, in particular on its hygienic condition. The quality of the drinking water must be checked regularly. Special attention must be paid to Legionella in drinking water, as they pose the greatest health risk.

General information on drinking water quality
- Chemical parameters
- Organoleptic parameters
- Microbiological parameters

➨ Part III 'The basics', Section 'Media', chapter [1] 'Water'

Detail information on drinking water test

➨ Part II 'Plan – Build – Operate', chapter [4] 'The Hycleen Concept'

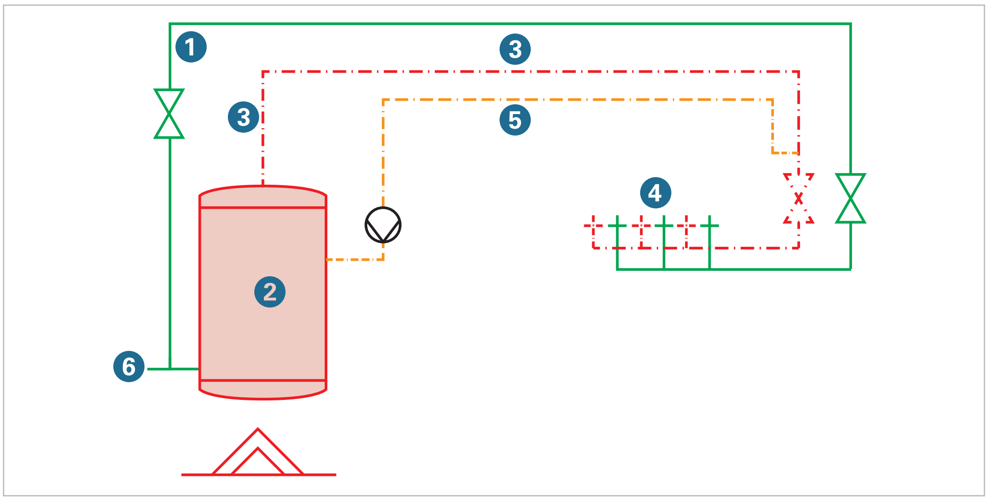
2.1 Sample analysis and evaluation according to building type

Different types of buildings are subject to different hygiene risks. Therefore, building-specific basic rules apply to the regular testing of drinking water.

TVI.2
Basic rules for tests
KBE Colony forming unit

Type of building	Type of test and frequency
Buildings with a **large system** for drinking water heating; with showers or misting systems (whirlpool)	Regular sample analysis and evaluation for legionella contamination via sampling valves
Buildings with commercial activity or multi-family dwellings with more than two residential units	Sampling on the technical measure of Legionella (100 KBE/100 ml) must be performed at least every three years
Public buildings, e.g. hospitals, schools kindergartens or retirement homes	At least one annual sampling with tests focusing on legionella contamination (100 KBE/100 ml)

Large systems for DHW heaters are systems in which a DHW heater with more than 400 litres capacity and at least one pipe between the outlet of the domestic water heater and the tap (usually the remotest) are available. One- and two-family dwellings do not belong to this group.



GVI.1
Large system for heating of drinking water
1. Drinking water pipelines, cold
2. Drinking water heater, volume >400 l
3. Hat water, pipeline volume >3 l
4. Shower and washer system
5. Circulation pipeline
6. Domestic water entry

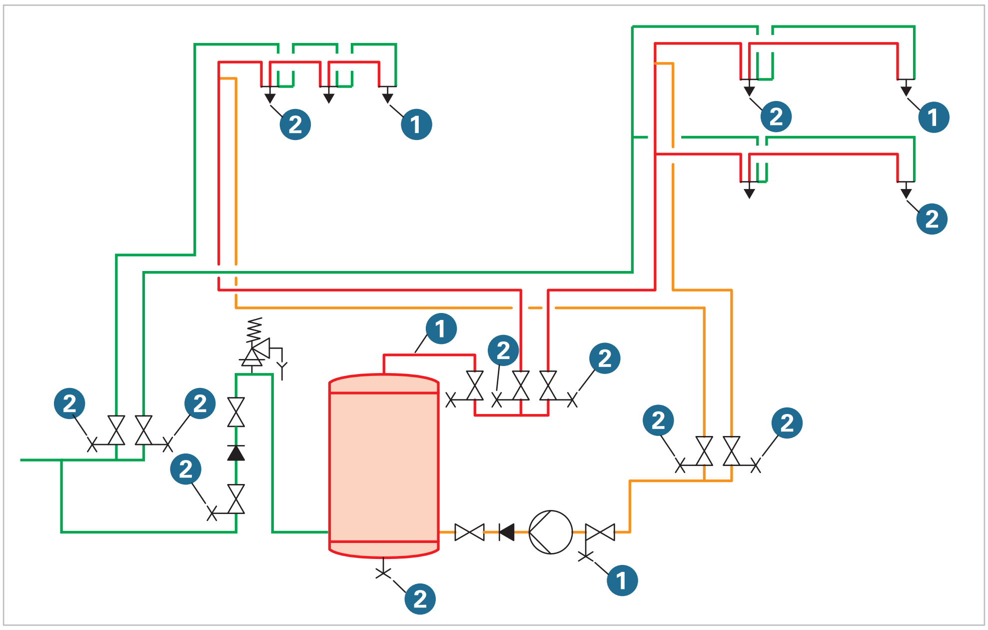
In buildings intended for special use, the operating parameters, such as pressure, temperature and flow rates, must be regularly monitored. Preferably, these parameters should be documented and evaluated, using a building automation system suitably designed for this purpose.

2.2 Evaluation of inventory

If a microbial contamination is detected after sampling the drinking water and the value of the technical measure of 100 KBE/100 ml for the **legionella concentration (Legionella spp.)** is exceeded, a **risk analysis** is necessary.

But other encroachments, such as microbiological, chemical or physical changes, may require an accurate assessment of the causes. This is applicable, for example, when during the sample taking an increased number of substances from metallic or non-metallic components is detected.

In addition, technical abnormalities found during tests may also be an indication of possible contamination. If **tests** focusing on legionella contamination exceed the limit and guideline values, their causes must be narrowed down more precisely through **further examinations**.



GVI.2
Systemic inspection locations

1 orienting checks
2 additional checks

Action plan

All deficiencies discovered must be evaluated, the causes determined and finally the necessary measures must be prioritised. The shortcomings which can be remedied in the short term by means of an immediate measure and those deficiencies which can only be remedied in the medium or long term, must be listed separately in the action plan.

TVI.3
Type of actions

Type	Actions to be taken
Immediate actions	Operational measures such as temperature settings and thermal adjustments
Medium-term measures	Procedural measures, such as chemical or thermal disinfection and pipe flushing.
Long-term measures	Structural measures, such as repairs, partial or complete renewals.

Following the measures or renovations that have been carried out, water samples must be taken again and evaluated so that the successful course of the measures has been proven.

VI

3 Custodian's responsibility, Maintenance

All fittings and components installed in the building technology system require regular upkeep, maintenance and regular inspections.

This is the only way to ensure the safety, reliability and proper operation of the system.

3.1 Maintenance

§ **Maintenance intervals required by the manufacturer**
Basically, maintenance intervals may differ from the general information and recommendations given in the documentation provided by the manufacturers of components, fittings, etc.
Therefore, we recommend setting up a maintenance schedule for the entire system.
→ Compliance with maintenance intervals by the manufacturer is mandatory.

Maintenance intervals (examples)

Maintenance intervals can be recorded in simple tables as shown below:

TVI.4 **Maintenance interval (examples)**

Component / Maintenance	Type of upkeep, explanation	weekly	monthly	annually	other interval
Component 1	→ Proceed with visual inspection.	X	X		min. 2 x a year
	→ Proceed with functional check			X	
Water consumption cold/hot	→ Read consumption.		X		
Equipment 1	→ Read consumption.		X		
Fine filter	→ Flush filter.	X			

Basic maintenance activities are listed below. They are categorised according to device types and system components and include the recommended service intervals.

Maintenance intervals recommendations
The following information on maintenance intervals are recommendations only.
Compliance with the specifications of the manufacturers of equipment, devices and system components is mandatory.

☑ Compliance with the specifications of the equipment, fittings and system components manufacturers is mandatory.
☑ If necessary, create suitable collection lists.

3.2 Regular activities – Maintenance intervals

General maintenance tasks can be organised and carried out in simple form according to the intervals:

Weekly	
Inspection	→ Visual inspection of the functioning of the various components and checking for leaks.
Softening	→ Salt container: Check the amount of salt.
Other equipment	→ Observe displays for error messages.

Monthly	
Pressure boosting system	→ Pressure loss: Check filter and replace as required.
Sewage pump Heater	→ Check operating times and function.
Sanitary appliances	→ Check water loss at cistern.
Meter (water, gas)	→ Record water level.

Annually	
Floor drains	→ Clean and flush.
Softening	→ Check water hardness after hardening.
Seepage water drain pipe	→ Flushing.
Roof drainage	→ Clean gutters.
Dishwasher	→ Check hoses.
Boiler	→ Check for lime sediment.

if risk of frost (garden / external distribution)	
Pipelines	→ Empty and shut off pipelines.

3.3 Checklist – Maintenance of equipment, fittings and system components

Drain pipes

A well-functioning wastewater treatment system must not be used as a "waste pit", for example for kitchen waste, cat sand, fats, oils etc. All components of the waste water system must therefore be regularly checked and maintained.

Annually

☑ Flush seepage water drain pipes.
☑ Clean and flush the underground pipelines (installer).

Shut-off valves of the distribution fitting/at the entrance to the house

A shut-off valve blocks a flow rate in a pipe. Normally, a shut-off valve is set to allow an unobstructed flow and is closed only before proceeding with maintenance or repair tasks.

Annually

☑ Check function.
☑ Check the stem seal for leaks.
☑ Handwheel 3–Rotate 4 times in order to prevent it from blocking.
☑ Check function of drain valves.

Controls and instruments

Even modern fittings require regular testing and maintenance. Leaking, dripping valves can lose large amounts of precious drinking water. Fittings are also for your safety. Pressure reducers and safety valves must function properly, otherwise the water heaters will be damaged due the overpressure.

Annually

☑ Regularly check the following fittings/instruments:
- Safety equipment
- Control valves
- Check valves
- Pressure reducing valves
- Mixing valves
- Maintenance fittings
- Taps
- Thermostats

Floor drains

The floor drains must be visually inspected for possible blockages.

It is particularly important that the siphoning (the odour trap) is always kept moist, otherwise sewage odours may occur.

Annually

☑ Check, clean and flush the floor drains of the following areas of the building annually:
- Garage
- Light well
- Entrance to basement, outside
- Patios
- Laundry
- Shelters

Roof drainage and retention overflows

Emergency overflows are designed for extreme situations and prevent the water accumulated on terraces and flat roofs from penetrating into the houses.

! **NOTE! Property damage due to overloaded roof surfaces.**
Clogged roof drainage and overflows can cause significant loads on the roof.
→ Regularly check roof drainage and retention overflows for sediments and dirt deposits.

Monthly

☑ Check patio inlets for function and effects caused by the cold.
☑ Check and clear emergency overflows.
☑ Flush roof water pipes installed on accessible roofs and terraces (washout).

Disinfection system

A disinfection system in the building ensures the disinfection of surfaces and disinfection of the building structure.

Weekly

- ☑ Flush water connections.
- ☑ Check function of inlet and outlet valve (open, close).
- ☑ Open taps until disinfectant flows out. Check proper discharge of disinfectant.

In case of faults

- ☑ Check the following item:
  - Power supply
  - Pressure in the water pipe
  - Amount of disinfectant/concentrate

Pressure boosting system

Pressure boosting systems (DEA) are used to ensure the minimum flow pressure for all discharge points in the drinking water pipeline and extinguishing water areas. At present, the DEAs have to meet a multitude of requirements that have to be taken into account during planning, during operation and during maintenance.

Monthly

- ☑ Check direction of rotation and thermal tripping.
- ☑ Ensure the pump cannot run dry, otherwise the mechanical seal will be damaged.
- ☑ When the pump is out of service: To avoid standstill damage put into operation every four weeks.

If there is a risk of frost

- ☑ If there is a risk of frost, ensure to empty the system.

Pressure reducing valve

Depending on the distribution network, water pressures from the supply network must be reduced to a permissible pressure so that approximately the same pressure conditions prevail in both the cold water and hot water pipes. Pressure reducers are installed in the cold water pipe downstream of the water meter system. The pressure reducer in the fitting combination reduces the pre-pressure to a lower, constant pressure.

Annually

- ☑ Check function of gauge.
- ☑ Clean filter insert.

Compressed air installations/air compressor

A compressed air installation transports compressed atmospheric air from the generator to the consumer, keeping the pressure loss as low as possible. **Air compressors** (compressors) are used to generate the compressed air. Today, modern facilities are equipped with heat recovery systems.

Annually

☑ Replace dirty filter cartridges only when the device is depressurized. (Replace if pressure drops of approx. 0.6 bar)

According to the manufacturer's information

☑ Check the following components regularly (e.g. 500 h, 2,000 h, etc.):
- Leak tightness
- Pressure
- Temperature
- Oil filter
- Oil level (under load)
- Intake filter

☑ Air compressor must be maintained according to the manufacturer's maintenance chart.

Drinking water fine filter

Mechanical filters belong to the water treatment systems and are indispensable regardless of the pipe material used. The filters are always installed immediately downstream of the water meter system before filling the drinking water installation for the first time.

For reasons of hygiene, it is recommended to observe a maintenance interval of 6 months.

Weekly

☑ Backwash the filter (flushing time: at least 15 seconds).

Annually

☑ Replace filter insert if necessary (cleanliness).

Filter, backwashing

Foreign particles of a certain size are retained in the backwash filter. Depending on their size and weight, these particles either fall directly into the lower part of the filter housing or adhere to the filter element. Backwash filters require a drainage connection for the backwashing process.

Backwashing
A backwash should be carried out if, as a result of increasing contamination of the filter element, the water pressure decreases; however, the backwash shall be carried out at least once a month. The filtering process is not interrupted during the backwashing process.

Weekly

☑ Check filter cup for dirt (backwashing).
☑ Flush filter.

Dish washer / Washing machine

For most of these devices, damage is caused by defective hoses. Since the hoses are always under pressure, only special hoses with the appropriate approval may be used. When connecting the water, a water damage protection valve should be installed.

Weekly

- ☑ Check cold and hot water hose.
- ☑ Check drain hose for brittleness and kinks.
- ☑ Check the machine's attachment.
- ☑ Softener: Add salt according to water hardness.
- ☑ Check for unusual noises.
- ☑ During longer holidays and vacations, the units must be taken out of service (disconnect power and water supplies).

Safety valves

Safety valves are used to prevent dangerous operating conditions. These valves react to a state deviating from the nominal state or setpoint in the system, and restore the setpoint or set a system, e.g. to "malfunction".

Annually

- ☑ Check function (visual inspection only).
- ☑ Check for leaks (not during heat up process).
- ☑ Check for unobstructed drainage.

Sewage water pump

⚠ **DANGER! Inhaling sewer gases can be fatal.**
Life-threatening sewer gases can be present in shafts.
→ Shafts must be vented sufficiently before entering.
→ If necessary, wear suitable protective equipment.

Sewage water pumps and their installation places (shafts) must be regularly maintained and cleaned.

Monthly

- ☑ Maintain and clean system components on a regular basis:
  - Shaft and bottom of shaft
  - Step irons and ladder
  - On/off switch of the controller
  - Alarm device
  - Shaft cover and seal

Urinal systems

If using water-flushing urinals, the user must initiate the flushing process or (depending on the type) the flushing is triggered automatically. The high frequency of use, especially in public buildings, requires regular cleaning (possibly even several times a day) and an equally regular, thorough maintenance.

Daily

☑ Clean the outer surfaces of the system and inside the bowl.

Weekly

☑ Check wall attachment.
☑ Check system for cracks and leaks.
☑ Check the water inlet opening for unobstructed discharge.
☑ Check rinsing function and ensure sufficient amount of flushing water is available.
☑ Ensure that water loss does not occurs when the unit is not in use.
☑ Check siphon for urine scale formation.

Urinal systems, waterless

Dry urinals are operated with a siphon, which is filled with a biodegradable “barrier liquid”. Another design of dry urinal works with a liquid-permeable membrane. A third system works with a float in a liquid-filled container.

! NOTE! Material damage to the system due to incorrect cleaning.

→ Do not use warm or hot water to clean the system.
→ When cleaning the system, use only suitable cleaning agents as specified by the manufacturer.

Daily

☑ Clean the outer surfaces of the system and inside the bowl. Flush with cold water.

Weekly

☑ Check wall attachment.
☑ Check system for cracks and leaks.
☑ Use a sanitary cleaner (3 dl of detergent per 10 l of water) to clean the system. Subsequently, flush with cold water.
☑ Fill with 0.2 dl urinal odour barrier liquid.

Monthly

Top up the barrier layer or replace the membrane

If clogged

☑ Remove siphon insert, flush the drain with clean water. Reinstall the siphon insert.
☑ Check system for leaks.

Dryer (dehumidifier)

A dryer based on the condensation principle optimises the available heat.

Monthly

☑ Clean air filter regularly.

Washbasin/sink

☑ Clean vanity unit and sink with soapy water or conventional detergents.

Remove stubborn stains as described below:

☑ Clean matt finished working surfaces with scouring powder such as Ecover or Vim and a green Scotch Brite sponge.
☑ Clean shiny work surfaces with a creamy detergent such as Ecover or VIF and a white Scotch Brite sponge.
☑ If necessary, apply a mild polish to restore the shine.

Sink

☑ Clean regularly with Ecover and a green Scotch Brite sponge.
☑ From time to time, leave the solution of dishwashing detergent with water sit on the surface overnight.
☑ Wipe off any aggressive household chemicals (e.g. paint thinner and drain cleaner) immediately and rinse the surface with water.

Semi-annually

☑ Check drain and overflow function.
☑ Check wall attachment.
☑ Check system for cracks and leaks.
☑ Check condition of pelvic tank surface.
☑ Check the condition of the connection joint on the wall.
☑ Check the connection line (transition from the washbasin outlet to the wall).

Water softener system

Water softeners use sodium ions to replace calcium and magnesium ions in drinking water. This ion exchange produces a **fully softened water**, which is no longer prone to the formation of scales. Fully softened water is needed in industrial or commercial applications for a variety of applications. For domestic applications in drinking water installations, bypass mixing valves are incorporated into the pipeline in order to adjust **partially softened drinking water** with a residual hardness as required.

Annually

- ☑ Check hardness of mixed water.
- ☑ Check regeneration time (resin bed cleaning and sodium loading). Regeneration takes place at the night.
- ☑ Check the duration and proper functioning of the regeneration according to the manufacturer's instructions.
- ☑ Check for proper drainage of backwash water. The dish water must drain without obstruction.
- ☑ Check salt supply. If necessary, top up according to the manufacturer's instructions.
- ☑ Ensure the salt tank is properly closed.
- ☑ Record the salt consumption and (if possible) raw and mixed water consumption.
- ☑ Check all connections and fittings for leaks.

Annual service interval

- ☑ Empty the auxiliary container, top up with salt and check the automatic water supply function.
- ☑ Check and clean the water softener unit.
- ☑ Check electrical or electronic parts.
- ☑ Restart, proceed with functional check and adjustment.

Water heater/Boiler

The hot water temperature must not exceed 60°C in order to prevent to limestone formation. To avoid unnecessary energy consumption, it is advisable to check the hot water systems periodically.

Annually

- ☑ Check the tightness of the connections and tanks. Lime deposits cause leaks.
- ☑ Check temperature.
- ☑ Check function of thermostat: Thermostat must turn off at lower temperature.
- ☑ Check thermal insulation for visible damage.
- ☑ Descale system.

Residential water meter

The water meter measures the consumption amount of a usage unit, e.g. a flat, a floor or a building.

Annually

☑ Check standstill at zero consumption.
☑ Record water consumption.

WC units

In toilet systems, the water in the cistern is used as a means of removing faeces. For this reason, the amount of water must not be reduced. In order to flush the urine, a partial flush is sufficient, which is determined by the user.

Annually

☑ Check wall attachment.
☑ Check system for cracks and leaks.
☑ Check condition of toilet seat with cover and its fastening.
☑ Pollution of the ceramic bowl due to rainwater harvesting
☑ Ensure that water loss does not occur when the unit is not in use.
☑ Check flushing volume and drain pipe.
☑ Check filling and draining process.
☑ Check for leaks. (The formation of a lime edge is a sign of a leak.)
☑ Check attachments.

Circulation pump

Circulation pumps are an integral part of the circulation system in a building, ensuring compliance with temperatures and pressures. The circulation pump in the hot water supply is time- and temperature-controlled. The temperature difference between the hot water outlet and the circulation inlet should be 2 – 4°C.

Annually

☑ Check direction of rotation when putting into operation.
☑ Measure temperature difference.
☑ Check timer.
☑ Check running noises (bearing).
☑ For longer shutdown of the operation: Adjust the settings so that the circulation pump runs periodically.

4 Disinfection

§ **Country-specific regulations**
Disinfection procedures may be regulated differently in each country, controlled by laws, directives, ordinances, standards, regulations and bulletins.
→ When disinfecting, compliance with the national regulations is mandatory.

§ **Disinfection information in this chapter provided as examples**
The information on disinfection procedures and technical requirements in this chapter refers to regulations that are valid for Germany.

General information on disinfection
➨ Part II 'Plan – Build – Operate', chapter [4] 'The Hycleen Concept'

Repair measures, microbial contamination (biofilm) or deposits such as limescale, which form over time in the pipelines, can adversely affect the proper operation of the drinking water installation and, in the worst case, may negatively impact the quality of the drinking water. To counter this, in addition to the implementation of necessary preventive measures in the operation, cleaning of the drinking water installation is needed.

The first action to be taken is a mechanical cleaning of the installation by flushing (possibly pressure-pulse flushing) the system. In case of microbial contamination disinfection is necessary in addition to cleaning.

Preparing to perform a disinfection

☑ Analysing the drinking water quality (chemically and microbiologically)
☑ Recording the various materials that come in contact with drinking water
☑ Determining the hydraulic states of the cold and hot water
☑ Recording operating conditions and critical connections of the installation
☑ Recording existing water treatments at the domestic water inlet
☑ Assessment of the “intended operation” of the drinking water installation

There are two common disinfection procedures for disinfecting a drinking water installation in a building. These procedures are explained below:

- thermal disinfection
- chemical disinfection

Which disinfection method to use, must be determined on a case-by-case basis and subject to a risk analysis. The procedure must be compatible with the installation in question and its materials and agreed upon by all parties involved.

Basic information
Any thermal or chemical system disinfection can pollute and damage the materials and components in the drinking water installation. Therefore, it is recommended to resort to a system disinfection only in cases where it is really necessary.

Recommendations
Based on many years of experience, GF Piping System recommends the following products for the disinfection of a contaminated drinking water installation in the building:
- Controlled thermal disinfection: Hycleen Automation System, JRGUTHERM 2T
- Chemical disinfection: Hycleen Des 30

Disinfection reports

After completing the flushing, the responsible technician must issue a report confirming proper procedures were followed.

In addition, the report must contain the following items:

- the applied procedure
- the disinfectant used including the respective concentration, temperature and time
- Information about the materials
- whether rinsing was done in order to discharge the disinfectant

☑ Add the results of the control tests of the water samples according to the disinfection procedure.

☑ Indicate whether the requirements for the water quality have been achieved by the disinfection procedure or whether further steps are necessary.

4.1 Thermal disinfection

A thermal disinfection has the goal to capture the whole system including the removal fittings.

Thermal disinfections are usually only used in contaminated hot water systems. It is only successful if the whole system reaches a temperature of at least 70°C over 3 minutes. If necessary, cold water pipes can also be thermally disinfected via cross connections.

However, it is not always easy to reach this temperature at the pipe surface when dealing with pipe systems containing many branches. Pipes that are heavily crusted will make heating up to the pipe's surface impossible to achieve.

Implementation

Basic information

- Before starting the thermal disinfection, it must be checked whether available heating power is sufficient.
- During disinfection, scalding injuries are possible and appropriate protection must be available. The areas of the building that are being thermally disinfected must be closed off for use or otherwise made safe to use.
- The timing of a thermal disinfection should be kept as short as possible, so that the cold drinking water is not unnecessarily heated.

Only if the time and temperature specifications are reached at all points of the area to be disinfected, is a thermal disinfection effective. This can be achieved fully automatically throughout the drinking water installation by using intelligent fittings (Hycleen Automation System).

If these fittings are not available, a manual thermal disinfection can be carried out according to the following instructions:

☑ These measures must be taken outside normal operating hours.

☑ Ensure a temperature of 70°C is maintained for 3 minutes in the entire disinfection area and must include the outer walls of the pipeline and all outlet fittings.

☑ Run the circulation pump in continuous operation; this will ensure the circulation line is included in the disinfection procedure.

☑ Set DHW heater to priority switching and heat to at least 70°C.

First, the circulation line is disinfected. To do this, the pipe surface of the DHW heater's inlet must reach 70°C.

☑ Measurements of the temperature at the pipe surfaces in the whole circulating system must be checked: At least 70°C must be reached everywhere.

Only when this temperature has been reached in the system, the taps, starting from the nearest to the most remote tap, can be opened.

☑ Keep all taps open until 70°C is reached and maintain this temperature for at least 3 minutes.

☑ Measure and record temperatures and time for all taps.

4.2 Chemical disinfection

Chemical disinfectants are used for cold and hot water pipes as well as for the disinfection of large surfaces (e.g. drinking water heaters).

If the risk analysis verifies that the thermal disinfection process does not allow for effective remedy and the drinking water installation is contaminated with biofilm, a chemical disinfection procedure may be considered.

Depending on the type of microbial contamination, the most effective disinfectant must be chosen, taking into account the different materials used in the installation. The most common chemical disinfectants are sodium hypochlorite and chlorine dioxide.

However, chemical substances must not be present in drinking water to the extent where the concentrations are harmful to human health. If drinking water installations are disinfected, the concentration of chemical substances must be kept as low as is possible under the generally accepted rules of technology (with reasonable effort and taking into account individual cases).

Continuous dosing with disinfectant chemicals should be avoided wherever possible. Preventive chemical disinfection does not make sense unless microorganism contamination has been identified on the basis of a risk analysis.

The basic prerequisite for a successful disinfection is always cleaning of the whole drinking water installation before the procedure. When repairing microbially heavily contaminated systems, it is recommended to carry out an intermittent flushing with an air/water mixture before the disinfection measure. The aim of this flushing process is to mechanically detach and remove biofilms and dirt.

The permissible, necessary concentrations and reaction times of the chemical disinfectants are specified in the drinking water ordinance of the respective country.

Recommendations

Recommendations for the disinfection of GF piping systems for building technology:
Chap. [4.3] 'Recommendation for the disinfection of GF building technology products'

Principles for a safe chemical disinfection

- Before the disinfection measure, proceed with a cleaning flush.
- The disinfectants used must be approved for the drinking water installation.
- Only use cold water for disinfecting purposes. Hot pipe parts must be cooled to a cold water temperature level.
- The disinfectant must reach all parts of the pipeline.

The disinfectant must drain at the taps until the intended concentration has been confirmed by appropriate measurements.

Implementation

☑ The disinfection procedures must be performed outside normal business hours.
☑ Make sure that the materials used in the installation are suitable for the intended disinfectant. If in doubt, call the manufacturer.
☑ Quantity proportional addition: Adjust the dosing pump to the appropriate stroke according to the intended concentration.
☑ Open the pipe sections that must be disinfected one by one, starting at the nearest tap to the tap at farthest point.
☑ Activate all pipeline fittings during the disinfection procedure.

After process is completed, compliance with the following instruction is mandatory:

- The disinfectant used must still be detectable at the end of the exposure time.
- The drinking water installation must be flushed and all chemicals must be removed.
- The conditions under which the sewer system operator accepts the disinfectant to enter into the sewer system must be taken into account when discharging the disinfectants into the public sewage system.

☑ During disinfection and after flushing out all taps: Create a measurement protocol about the concentrations.
☑ Put the system back into operating condition.
☑ Check to ensure that the performed disinfection measure was correct.

4.3 Recommendation for the disinfection of GF building technology products

Recommendations for drinking water installation systems and product groups
Based on many years of experience, the recommendations in this chapter can be made for the following drinking water installation systems and product groups.

- JRG Sanipex, JRG Sanipex MT, JRG Armaturen, iLITE, iFIT and INSTAFLEX

Disinfection can pollute and damage the materials and components of the drinking water installation. In order to ensure the success of a disinfection procedure and not to interfere with the materials coming in contact with the drinking water, compliance with the object-specific clarifications described in the chapter “Disinfection” (Preparations for performing a disinfection) is mandatory.

The selection of the disinfection process takes place in each case object-specifically and primarily according to the suitability for the materials that come in contact with the drinking water. The common chemical disinfectants in drinking water such as sodium hypochlorite, chlorine dioxide as well as the thermal disinfection are described. Other disinfection procedures and deviations from the conditions described (e.g. increased concentrations of disinfectants or elevated temperatures) should be discussed with your GF Piping Systems representative.

Based on many years of experience, in cases where a chemical disinfection is unavoidable, we recommend the use of a sodium hypochlorite disinfectant solution.

➨ Part II 'Plan – Build – Operate', chapter [4] 'The Hycleen Concept'

VI

The following list contains references for the material resistance of the GF piping systems for building technology. By complying to these conditions, as a rule, the service life is not expected to be shortened. Restrictions can result from the drinking water ingredients as well as the indicator parameters (pH value, conductivity, etc.). Likewise, compliance with the national laws and regulations on the disinfection of drinking water, in particular limit values, is mandatory. The specified limits are based on the state-of-the-art technology used in Germany.

TVI.5
Recommendation for disinfection

Parameters	Disinfectant	Concentration [mg/l]	Temperature [°C]	Duration [h]
Continuous disinfection	Sodium hypochlorite (free chlorine)	max. 0.3	≤70	–
Shock disinfection (max. 2 x per year)		max. 50	≤30	≤24

Thermal disinfection

When using thermal disinfection, it is recommended to raise the temperature to 70°C for at least 3 minutes. As a rule, this temperature increase has no negative effects on the GF building technology products. Compliance with the applicable rules when using thermal disinfection is mandatory.

Sodium hypochlorite (NaClO)

When using **continuous disinfection** with sodium hypochlorite, the concentration of 0.3 mg/l free chlorine and a maximum temperature of +70°C must not be exceeded.

A **discontinuous disinfection** (shock disinfection) may be carried out twice a year, using a concentration of free chlorine of max. 50 mg/l over a period of 24 h. During the shock disinfection, the drinking water temperature of 30°C must not be exceeded. A subsequent, thorough flushing of the whole drinking water installation is most important.

Explanation of terms

- **Free chlorine** (oxidative form): sum of the mass concentration of elemental dissolved chlorine (Cl_2), hypochlorous acid (HClO) and hypochlorite (ClO^-), expressed in mg/L.
- **Bound chlorine** (already reacted form): Mass concentration of inorganic and organic chloramines, calculated as chlorine in mg/L.
- **Total chlorine**: The sum of mass concentrations of free and bound chlorine in mg/l.

Chlorine dioxide

The use of chlorine dioxide for the chemical disinfection of drinking water is not recommended because it attacks the materials due to its strong oxidizing power and thus significantly shortens the lifetime of the entire drinking water installation. Take special care with the use of chlorine dioxide in hot water, a massive impact on the lifetime is expected. If chlorine dioxide is still used, the conditions on site must be precisely recorded and discussed with your GF Piping Systems representative.

Annex A

Approvals

Approvals

1 Accreditation bodies

Country	Institute	Logo	Name	Building Technology	Marine
Belgium BEL	BUtgb (UBAtc)	BUtgb	Belgische Unie voor de technische goedkeuring in de bouw	x	
	ARGB-KVBG		Koninklijke Vereniging van Belgische Gasvaklieden	x	
Germany GER	DVGW	DIN DVGW CERT	Deutscher Verein des Gas- und Wasserfaches e.V.	x	
	DNV-GL	DNV·GL	Det Norske Veritas – Germanischer Llyod		x
Finland FIN	STF-eurof-ins	eurofins Expert Services	Eurofins Expert Services Oy	x	
France FRA	CSTB	CSTB le futur en construction	Centre Scientifique et Technique du Bâtiment	x	
	BV	BUREAU VERITAS 1828	Buerau Veritas		x
Great Britain UK	BSi	bsi.	British Standards Institution	x	
	WRAS	WRAS APPROVED MATERIAL	Water Regulations Advisory Scheme	x	
	LR	Lloyd's Register	Lloyd's Register		x
Italy ITA	KIWA-UNI	kiwa UNI	Kiwa Cermet Italia S.p.A.	x	
	RINA	RINA	–		x

Country	Institute	Logo	Name	Building Technology	Marine
The Neatherlands NL	KIWA		Kiwa NV	x	
	GASTEC		GASTEC Qa	x	
Norway NOR	SINTEF		Stiftelsen för industriell og teknisk forskning	x	
	DNV-GL		Det Norske Veritas – German Llyod		x
Austria AUT	ÖVGW		Österreichische Vereinigung für das Gas- und Wasserfach	x	
Portugal POR	certif		Associação para a Certificação	x	
Russia RU	RMROS		Russian Maritime Register of Shipping		x
Sweden SWE	RI.SE		Research Institutes of Sweden	x	
	KIWA SWE		Kiwa Sverige	x	
Switzerland CH	SVGW		Schweizerischer Verein des Gas- und Wasserfaches	x	
	VKF		Vereinigung Kantonaler Feuerversicherungen	x	
	eco-bau		eco-bau		
Spain ESP	AENOR		Asociatión Española de Normalización Certificación	x	
United States of America USA	ABS		American Bureau of Shipping		x
International	FM Approvals		Factory Mutual Approvals, Member of the FM Global Group	x	

2 INSTAFLEX

System approvals
Up-to-date information on system approvals is available from Technical Support.

2.1 Building Technology approvals

Country	Institute	Certificate number
AUT	ÖVGW	W 1.119
BEL	BUtgb	ATG 1871
CH	SVGW VKF eco-bau	8703-1961 16819 202010.8649
ESP	AENOR	001/006238 001/006456 001/006457
FRA	CSTB	QB-109-1777-V2 QB-167-1777-V2
GER	DVGW	DW-8501BR0424 DW-8501AQ3144 DW-8501AT2528
NL	KIWA	K48336 K48377 K48341
POR	certif	TMP-044/2019
SWE	KIWA	0898
UK	BSI WRAS	KM 39698 1811513 1811514

* Hygiene certificates (such as ACS, UBA/KTW, W270, BS6920 etc.) are not listed individually. These are part of the approvals for the respective products.

2.2 Marine equipment approvals

Country	Institute	Certificate number
FRA	BV	35855/C0 BV
NOR / GER	DNV-GL	TAK00000WG, Rev. no.2
ITA	RINA	MAC375614CS
RU	RMROS	20.40053.250
UK	LR	12/00071(E5)
USA	ABS	20-1971252-PDA

3 JRG Sanipex

System approvals
Up-to-date information on system approvals is available from Technical Support.

3.1 Building Technology approvals

Country	Institute	Certificate number
AUT	ÖVGW	W 1.183
CH	SVGW VKF	8611-1923 4005 26652
FIN	STF-eurofins	EUF/29-20003053-TH
FRA	CSTB (QB)	41-1785
GER	DVGW	DW-8501AS2141
NOR	SINTEF	0049 1814 TG 2464
SWE	RI.SE KIWA SWE	SC0035-13 1313 / 1314 / 1315

* Hygiene certificates (such as ACS, UBA/KTW, W270, BS6920 etc.) are not listed individually. These are part of the approvals for the respective products.

4 JRG Sanipex MT

System approvals
Up-to-date information on system approvals is available from Technical Support.

4.1 Building Technology approvals

Country	Institute	Certificate number
AUT	ÖVGW	W 1.390
CH	SVGW VKF	1103-5840 12923
FIN	STF-eurofins	EUF/29-20001778-TH
FRA	CSTB (QB)	19-2153_V1 41-2153_V1 76-2153_V1 154-2153_V1
GER	DVGW	DW-8501BM0013
ITA	KIWA UNI	KIP-103469
NOR	SINTEF	0631
SWE	RI.SE	SC0918-11
UK	WRAS	1703564 1608552

* Hygiene certificates (such as ACS, UBA/KTW, W270, BS6920 etc.) are not listed individually. These are part of the approvals for the respective products.

4.2 Marine equipment approvals

Country	Institute	Certificate number
FRA	BV	27999/B0 BV
NOR/ GER	DNV-GL	TAK00000WD, Rev. no.1
ITA	RINA	MAC060217CS/002
RUS	RMROS	16.40004.250
UK	LR	12/20009 (E4)
USA	ABS	16-HG1581396-PDA

5 iFIT

System approvals
Up-to-date information on system approvals is available from Technical Support.

5.1 Building Technology approvals

Country	Institute	Certificate number
AUT	ÖVGW	W 1.424 W 1.425
BEL	BUtgb	ATG 2723
CH	SVGW VKF	0406-4834 1212-6106 24759 24757
GER	DVGW	DW-8501BP0047 DW-8501BP0059
NL	KIWA KOMO	K44842 K44843 K48377 K48947 K44872 K44871
UK	WRAS	1711573 2002517

* Hygiene certificates (such as ACS, UBA/KTW, W270, BS6920 etc.) are not listed individually. These are part of the approvals for the respective products.

5.2 Marine equipment approvals

Country	Institute	Certificate number
FRA	BV	46408/C0 BV
NOR/ GER	DNV-GL	TAK00000WH
ITA	RINA	MAC093220CS
UK	LR	LR2023631TA
USA	ABS	202000796-PDA
RUS	RMROS	20.40053.250

6 iLITE

System approvals
Up-to-date information on system approvals is available from Technical Support.

6.1 Building Technology approvals

Country	Institute	Certificate number
GER	DVGW	DW-8501CS0320 DW-8501CT0037
ITA	KIWA-UNI	KIP-103468
UK	WRAS	1811041

* Hygiene certificates (such as ACS, UBA/KTW, W270, BS6920 etc.) are not listed individually. These are part of the approvals for the respective products.

7 Malleable Cast Iron Fittings

System approvals
Up-to-date information on system approvals is available from Technical Support.

7.1 Approvals

Country	Institute	Certificate number
AUT	ÖVGW	W 1.601
CH	SVGW	99-086-6
		7912-786
GER	DVGW	NV-7641AU2014
international	FM Approvals	3005845

* Hygiene certificates (such as ACS, UBA/KTW, W270, BS6920 etc.) are not listed individually. These are part of the approvals for the respective products.

8 PRIMOFIT

System approvals
Up-to-date information on system approvals is available from Technical Support.

8.1 Approvals

Country	Institute	Certificate number
AUT	ÖVGW	G 2.515
		W 1.602
BEL	ARGB-KVBG	C-11-3552-A
CH	SVGW	8704-1985
		05-045-6
GER	DVGW	DG-4502CN0373
		DG-4502CN0374
		DG-7521BP5519
		DW-7611BT0591
		DW-8511BL0157
NL	GASTEC	Q 96/086 – 56584/03
		Q 96/086 – 56585/02
UK	BSI	KM 539621 (PL3)
		KM 539622 (F2)

* Hygiene certificates (such as ACS, UBA/KTW, W270, BS6920 etc.) are not listed individually. These are part of the approvals for the respective products.

9 Silenta Premium

System approvals
Up-to-date information on system approvals is available from Technical Support.

9.1 Approvals

Country	Institute	Certificate number*
GER	-	Z-42.1-537

* German general national approvals

Annex B

Directories, glossary, literature, index

B

Directories, glossary, literature, index

1 Directories

1.1 Abbreviations

The list of abbreviations provides abbreviated technical terms in the field of pipe, pipelines, installation, about the processed substances and materials, as well as in the area of planning, institutions, and organizations.

Abbreviation	Long form of abbreviation	Explanation/Translation
ABS	Acrylnitril-Butadien-Styrol-Copolymer	Acrylonitrile-butadiene-styrene
ACS	American Chemical Society	
ARA	Abwasserreinigungsanlage	Wastewater treatment system
ASTM	American Society for Testing and Materials	
BA	Betriebsanleitung	Instruction manual
BGA	Bundesgesundheitsamt	German Federal Health Agency
BgVV	Bundesinstitut für gesundheitlichen Verbraucherschutz und Veterinärmedizin	German Federal Institute for Health Protection of Consumers and Veterinary Medicine
BIM	Building Information Modelling	
BKZ	Brandkennziffer	Fire code
BRT	Batch Release Test	
BS	Biegeschenkel	Flexible pipe leg
BS	British Standard	
BW	Belastungswert	Loading unit
CAD	Computer Aided Design	
CAFM	Computer Aided Facility Management	
COBie	Construction Operations Building Information Exchange	
CSV	Comma Separated Values	
d/D	Durchmesser	Diameter
DEA	Druckerhöhungsanlage	Pressure boosting system
DIBt	Deutsches Institut für Bautechnik	German Approval Body for Non-Regulated Construction Products
DIN	Deutsches Institut für Normung	German Institute for Standardization
DN	Diamètre Nominal	Nominal width
DS	Dehnungsschenkel	2D expansion loop
DVGW	Deutscher Verein des Gas- und Wasserfaches	German Gas and Waterworks Association
DVS	Deutscher Verein für Schweisstechnik	German Welding Society
ECA	Elektro-Chemische Aktivierung	Membrane electrolysis
ECHA	Europäische Chemikalienagentur	European Chemicals Agency
EN	Europäische Norm	European Standard
EnEV	Energieeinsparverordnung	German Energy Saving Ordinance
EPC	Engineering, Procurement, Construction	
EPD	Environmental Product Declaration	
EPDM	Ethylen-Propylen-Dien-Kautschuk	Ethylene propylene diene monomer rubber
F+E	Füll- und Entleerstation	Filling and emptying station
FAR	Federal Aviation Regulations	
FDA	Food and Drug Administration	
FEM	Finite-Element-Methode	Finite Element Method
FKM, FPM	Fluorkautschuk	Fluoro rubber
FM	Facility Management	
FP	Fixpunkt	Fixed point

Abbreviation	Long form of abbreviation	Explanation/Translation
G	Gewinde	Threads
gbXML	Green Building XML	
GFK	Glasfaserverstärkte Kunststoffe	Glass fibre-reinforced plastics
GLT	Gebäudeleittechnik	Building Management System
GN	Normgewinde	Standard unified thread
GP	Gleitpunkt	Floating point
GRP	Glass Reinforced Plastic	
HAE	Hauptabsperreinrichtung	Main shut-off device
HDPE	High Density Polyethylene	
HMS	Heizelement-Muffenschweissen	Socket fusion welding
H-RL	Heizung, Rücklauf	Heating, return line
HTB	höher thermisch belastbar	Higher thermal load capacity
HVAC	Heating, Ventilation and Air Conditioning	
H-VL	Heizung, Vorlauf	Heating, supply line
HWS	Heizwendel-Schweissen	Electrofusion welding
ICT	Information and Computer Technology	
IEC	International Electrotechnical Commission	
IFC	Industry Foundation Classes	
ILAC	International Laboratory Accreditation Cooperation	
IMO	International Maritime Organization	
ISO	International Organization for Standardization	
ITT	Initial Type Test	
KBE	Kolonie bildende Einheit	Colony forming unit
KTW	Kunststoff-Trinkwasser-Empfehlung des BGA	German recommendation concerning the levels of polymers in drinking water
KW	Kaltwasser	Cold water
LCA	Life Cycle Assessment	
LU	Loading Unit	
LWÜ	Löschwasserübergabestelle	Fire extinguishing water hand-over point (HOP)
M	metrisches Gewinde (nach DIN ISO 261)	Metric thread (acc. to ISO 261)
MFI	Melt Flow Index	
MFR	Melt Flow Rate	
Ml	Multi Layer ..	
MRS	Minimum Required Strength	
MuKEn	Mustervorschriften der Kantone im Energiebereich	Model regulations of the cantons in the field of energy
NBR	Nitrilkautschuk	Nitrile rubber
NDT	Non Destructive Testing	
NR	Naturkautschuk	Natural rubber
OEM	Original Equipment Manufacturer	
OHSAS	Occupational Health- and Safety Assessment Series	
ÖNORM	Österreichische Norm	Austrian standard
ORP	Oxidation Reduction Potential	Oxidation Reduction Potential Oxidation Reduction Potential
ÖVGW	Österreichische Vereinigung für das Gas- und Wasserfach	Austrian Association for Gas and Water
PB	Polybuten	Polybutene
PE	Polyethylen	Polyethylene
PE-X	vernetztes Polyethylen	Crosslinked polyethylene
PFA	Perfluoralkoxy-Polymer	Perfluoroalkoxy polymer
PN	Pressure Nominal	Nominal pressure
PP	Polypropylen	Polypropylene
PPSU	Polyphenylsulfon	Polyphenylsulfone
PTFE	Polytetrafluorethylen	Polytetrafluorethylene
PUR	Polyurethan	Polyurethane
PVC	Polyvinylchlorid	Polyvinyl chloride
PVC-C	Polyvinylchlorid, nachchloriert; erhöhter Chlorgehalt	Polyvinyl chloride, postchlorinated; increased chlorine content
PVC-U	Polyvinylchlorid, weichmacher-frei	Polyvinyl chloride, without softener

Abbreviation	Long form of abbreviation	Explanation/Translation
PVDF	Polyvinylidenfluorid	Polyvinylidene fluoride
PVT	Process Verification Test	
PW	Portable Water	Drinking water pipeline
PWC	Portable Water, Cold	
PWH	Portable Water, Hot	
PWH-C	Portable Water, Hot, Circulation	
QA	durchschnittlicher Durchfluss	Average flow rate
R	kegeliges Rohr-Aussengewinde	Tapered male pipe thread
Rc	kegeliges Rohr-Innengewinde	Tapered female pipe thread
REACH	Regulation Concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals	
RF	Réaction feu	Fire reaction
RoHS	Restriction of (the use of certain) Hazardous Substances in electrical and electronic Equipment	
Rp	zylindrisches Rohr-Innengewinde	Cylindrical female pipe thread
RT	Raised Temperature	
s	Wandstärke des Rohrs	Wall thickness of the pipe
SAS	Schweizerische Akkreditierungsstelle	Swiss Accreditation Service
SDR	Standard Dimension Ratio	
SF	Sicherheitsfaktor	Safety factor
SIA	Schweizerischer Ingenieur- und Architektenverein	Swiss Society of Engineers and Architects
SINTEF	Stiftelsen for industriell og teknisk forskning	Foundation for Scientific and Industrial Research
SK	Sechskant	Hexagon
SVGW	Schweizerischer Verein des Gas- und Wasserfaches	Swiss Gas and Waterworks Association
SW	Schlüsselweite	Spanner size
TEPPFA	European Plastic Pipes and Fitting Association	
TG	Temperguss	Malleable cast iron
TrinkwV	Trinkwasserverordnung	Drinking water ordinance
TRWI	Technische Regeln für Trinkwasser-Installationen	German codes of practice for drinking water installations
TT	Type Test	Type Test
TWE	Trinkwassererwärmer	DHW heater
TWK	Trinkwasser, kalt	Drinking water, cold
TWW	Trinkwasser, warm	Drinking water, hot
TWZ	Trinkwasser, Zirkulation	Drinking water, circulation
TZW	DVGW-Technologiezentrum Wasser	DVGW Water Technology Center
UBA	Umweltbundesamt	German Federal Environmental Agency
UP	Unterputz	Concealed installation
UP-GF	ungesättigtes Polyesterharz, glasfaserverstärkt	Unsaturated polyester resin, glass-fibre reinforced
VDI	Verein Deutscher Ingenieure	Association of German Engineers
VdS	Institut für Unternehmenssicherheit	Institute for Corporate Security
VKF	Vereinigung Kantonaler Feuerversicherungen	Swiss Cantonal Fire Insurance Association
VOB	Vergabe- und Vertragsordnung für Bauleistungen	German Construction Contract Procedures
VPE	vernetztes Polyethylen	crosslinked polyethylene
WLG	Wärmeleitfähigkeitsgruppe	Thermal conductivity group
WW	Warmwasser	Hot water
WWR	Warmwasser, Rücklauf	Hot water, return line
WWV	Warmwasser, Vorlauf	Hot water, supply line

1.2 Signs and symbols

Pipelines, Devices, Equipment and Controls and Instruments

DIN EN 806-1 defines the graphic symbols, abbreviations and graphic representations of all components required in design, assembly and as-built drawings:

- Water pipelines
- Pipe connections
- Taps and accessories
- Safety valves
- Safety equipment
- Wastewater treatment systems
- Fixtures made of rotating parts
- Measuring and control equipment
- Actuators and controls & instruments
- Containers and DHW heaters
- Fire protection systems
- Additional graphic symbols

Identification

The following symbols can be used for the graphic representation of drinking water pipes:

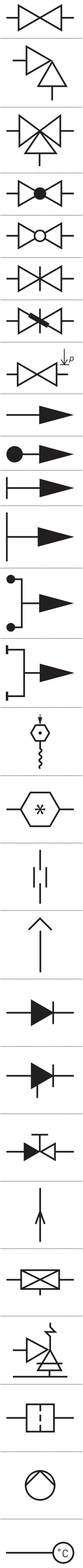
TB.1
Labelling of pipelines

Designation	Abbreviations	Colour of the pipeline	
Drinking water pipelines, cold	PWC	Green	—●—
Drinking water pipelines, hot	PWH	Red	-·-·●-·-·
Drinking water pipes, hot water circulation	PWH-C	Orange	-·--●--·-
Drinking water pipes, hot mixed water	PWH-M	Purple	-··—●—··-
Heating, supply line	H-SL	Red	—●—
Heating, return line	H-RL	Blue	----●----

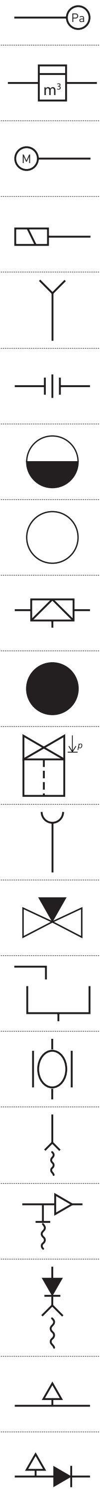
B

Symbols

Excerpt from DIN EN 806-1



Symbol	Designation
	Shut-off valve
	Corner valve
	Three-way valve
	Straight seat valve, Y-type valve
	Ball valve
	Gate valve
	Butterfly valve
	Pressure reducer
	Drainage valve, discharge valve
	Wash basin drain valve
	Wall drain valve
	Mixer tap
	Wash basin mixing tap
	Wall-mounted mixing valve
	Drainage valve, with safety valve and hose fitting
	Safety valve of type *
	Pipe interrupter
	Pipe aerator
	Return flow inhibitor (not controllable)
	Return flow inhibitor (controllable)
	Shut-off valve with integrated return flow inhibitor
	Pipe aerators in flow through design
	System separator unit with controllable pressure zones
	Safety valve, spring-loaded
	Mechanical filter
	Fluid pump with mechanical actuator
	Thermometer



Symbol	Designation
	Pressure gauge
	Residential water meter
	Actuated by electric motor
	Actuated by electric magnet
	Funnel
	Threaded connection
	Equipment and controls and instruments connection, with shut-off device
	Equipment and controls & instruments connection
	System separator unit, not controllable
	Thermostatic mixer
	Pressure reducer with filter
	Connection point for measuring or control device
	Circulation control valve
	Unobstructed discharge Design: AA, AB, AC, AD, AF
	Pipe interrupter Design: DB
	Pipe aerator Design: HB
	Automatic converter Design: HC
	Pipe aerator Design: HD
	Aerator Design: LA
	Aerator Design: LB

2 Glossary

The definition of uniform terms, symbols and graphic representations is the most important prerequisite for understanding the technical rules. The terms defined below are the basis for understanding the manual.

2.1 Drinking water

The terms are based on the standards DIN EN 1717, DIN EN 806-1, DIN 1986 300, 500 and 600.

Backflow – Flow of non-drinking water within a drinking water installation and moving contrary to the intended direction of flow.

Below-ground hydrant/above-ground hydrant – Hydrants installed below and above ground level are connected to water distribution pipes installed in the ground of a property. These hydrants are used by the fire brigade for property protection.

Circulation pipe – The circulation pipe has the task to ensure that the water temperature in the entire drinking water system (hot) does not drop below 5 K compared to the outlet temperature of the DHW heater.

Coefficient of drag – Metrologically determined, fluidic parameter for a single resistor, which is required for sizing the pipe.

Collector supply pipeline – The collector supply line is the section of the consumption line that leads horizontally (usually installed in the basement) to the riser pipes.

Control valve – Control valves allow to regulate the required operating conditions, such as a certain pressure or required temperatures. These include in particular hydraulic or thermostatic circulation control valves for hydraulic balancing in drinking water installations (warm).

Defensive fire protection – The fire brigade is responsible for the defensive fire protection. Combined with preventive fire safety measures, the fire brigade can more effectively extinguish and contain fires and prevent fire from spreading.

Degradation – Decomposition of chemical compounds in the material, for example, in plastic, caused by external influences

Delivery pressure – The delivery pressure of a pressure booster system is the difference between the static pressures in the inlet and outlet ports of a pressure booster.

Drain valve – The drain valve can be used to empty the supply line partially or completely.

Drinking water – Drinking water is intended for human consumption and used for a variety of purposes: drinking, cooking, preparing food and beverages, personal hygiene and cleansing, cleaning of objects, for example, when washing dishes or doing the laundry. This includes all the water that is used in the food businesses.

Drinking water installation – The drinking water installation is the entirety of the piping system. It includes all fittings and equipment that are located between the point of transfer (main shut-off valve) of the drinking water from a water supply system to the user and the tapping point of the drinking water (tap) at the user.

Effective volume – Effective volume is the actual supply of water available in an upstream tank at an indirect connection of a pressure booster.

Equipment – Instrument in which drinking water is consumed or modified, e.g. DHW heater, water treatment equipment and vending machines.

Extinguishing water handover point – The extinguishing water handover point is a safety device that separates the drinking water installation from the extinguishing water device at the interface.

Extinguishing water pipe – The extinguishing water pipe is a pipeline conveying non-drinking water and starts behind the firefighting water hand-over point or receives extinguishing water from another water supply unit. It provides partially or exclusively water for fire fighting purposes.

Filling and emptying station – Filling and emptying stations are safety devices that separate drinking water installations from the extinguishing water pipes (wet/dry) in order to protect the drinking water and prevent backflow. These stations are controlled by electric signal transmitters on hose connection valves, they open if necessary, fill the fire extinguishing water lines with water and empty the lines after use.

Fire protection concept – A fire protection concept comprises a holistic view of the fire extinguishing and fire protection systems. It is the basis for a building and operating permit of the respective building.

Fittings – The term fittings is the generic term for all components in an installation except the pipelines. These include, for example, shut-off and drain valves, taps, safety valves and safety fittings, or control valves.

Flow – see volumetric flow rate

Flow pressure – The flow pressure is the indicated pressure at a tapping point while water is withdrawn.

Flow velocity – The flow velocity is determined in practice as quotient of volumetric flow and flow velocity.

Inert gases – for example, nitrogen or noble gases

Main shut-off valve – The main shut-off valve is the first fitting on the property (inside the water meter shaft) or in the building and belongs to the water meter system with which the entire consumption system can be centrally shut off.

Maintenance equipment – When using the maintenance equipment, an installation or a pipe can be shut off for maintenance or repair purposes.

Maximum supply pressure – The maximum supply pressure is the highest overpressure at the handover point, as it is indicated by the water supplier during a period of low consumption.

Minimum supply pressure – The minimum supply pressure is the lowest fluid pressure at the handover point as indicated by the water utility company during a period of high consumption.

Nominal pressure – Nominal pressure is the maximum pressure for which a pipe, fitting, controls and instruments, or any other component used in drinking water installations is designed.

Operating pressure – The operating pressure is the internal pressure inside an pipe installation under normal operating conditions and usually does not exceed 1 MPa (10 bar).

Peak flow (Peak volumetric flow rate) – In the drinking water installation, the expected peak volumetric flow rate in a particular section of the pipeline is largely determined by the number of taps installed in the pipeline, the calculation of the flow and the simultaneius concurrence of use of the taps.

Pipelines on individual floor levels – A pipeline on individual floor levels usually branches off from a riser pipe and leads to more to just one pipeline.

Pressure loss – The pressure loss is the pressure difference between two points in the drinking water installation and is caused by pipe friction and individual resistances inside the pipe.

Pressure surges – A pressure surge is a flow change within a very short period. It can arise when a tap is closed suddenly.

Preventive fire protection – Preventive fire protection refers to the measures that limit or prevent in advance the formation, the spread of fires and their effects, and enable the fire brigade to carry out the extinguishing task.

Riser pipes/downpipe – Riser pipes branch off from the collector supply pipeline and run vertically from the bottom to the top inside the building. If the distribution takes place on the upper floor, the collector supply pipeline runs along the top floor and the branching off downpipes run from top to bottom.

Single supply line – A single supply line is the line that leads directly to a tapping point without diversion.

Safety valve – A safety valve prevents dangerous physical operating conditions, such as switching independently from the open or closed position, causing too high pressure or excessive temperatures, for example. After reaching the intended operating condition, the valve switches back to the starting position.

Safety devices – Safety devices are designed to prevent backflow, sucking back and pressing back of non-potable water of categories 1 to 5 into the drinking water installation. Safety devices consist of a combination of different fittings.

Stagnation pressure – The stagnation pressure is the static overpressure of a static fluid, which results from the density of the medium and the height difference.

Supply line – The supply line refers to the entirety of the system components in buildings and on properties downstream of the main shut-off valve or the water meter leading up to all tapping points.

Supply pressure – The supply pressure refers to the internal pressure at the transfer point, e.g. water meter system, when the volumetric flow in the service line is zero.

Tap – Drinking water is withdrawn at the tapping point, or tap. This is the final poinr of the drinking water installation.

Tap and fitting – Taps and fittings are also referred to as sanitary fittings and installed with the sanitary equipment, such as bathtubs and shower basins, vanities, bidet or kitchen sinks.

Unobstucted drainage – The unobstucted drainage is between the lower edge of the draining piece of equipment or the installation and the upper edge of the drainage object, which receives this water.

Unrestricted drainage – In contrast to the “unobstucted drainage” across a drainage object, the “unrestricted drainage” describes a safety device that reliably prevents backflow of category 5 water.

Volumetric flow (flow rate) – The volumetric flow (flow rate) is the ratio of the volume of water that flows through a specific flow cross section and the applicable time.

Wall hydrant – The fire hydrant systems, which are located in buildings, can be used by fire fighters and laymen to fight a fire in its development phase.

Water meter system – The water meter system includes the measuring device and the main shut-off valve. Both are the responsibility of the local water utilities company.

2.2 Wastewater

The terms are listed in accordance with the standards DIN EN 752, DIN EN 12056 and DIN 1986.

General information

Backwater level – The highest level up to which water inside the drainage system can rise.

Domestic wastewater – Wastewater originating from sanitary equipment and areas such as kitchens, laundry rooms, bathrooms, toilets or similar locations and flows into the drainage system.

Drainage system – A system that is installed comprising drainage objects, pipelines and other components that collect wastewater and uses gravity to drain it.

Industrial wastewater – Wastewater that is modified and contaminated by industrial or commercial use.

Odour trap – A device that prevents seepage of sewer gases from draining through a water trap.

Mixing system – Drainage system for the common discharge of dirty water an precipitation in the same pipeline or duct system

Rainwater – Water from natural precipitation that has not been contaminated by use is also referred to as rainwater.

Self-cleaning capability – Ability of the drainage pipes to recover themselves from impurities by natural processes and to avoid blockages when used as intended.

Separation system – Drainage systems consist of two piping or sewer systems for the separate discharge of precepitation and rainwater

Wastewater – Wastewater is domestic effluence.

Waste water – Water that flows during use into the drainage system, such as domestic sewage water, commercial and industrial wastewater and rainwater.

Pipelines

Bypass – A line receiving connecting lines in an area of a downpipe offset where water accumulates, or in the area of a transition of a downpipe feeding into a collecting or underground pipeline.

Collecting pipe – This pipeline receives the wastewater from several individual connecting pipes, conveying it to a secondary pipeline or to a lifting system.

Connecting duct – Channel between the public sewer and the boundary of the property or the first cleaning opening, e.g. entrance shaft on the property.

Header – A horizontal pipe holding the wastewater from the down, collection and single connection pipes. A header is not installed in the ground or in the concrete slab.

Rainwater discharge pipe – Internal or external, vertical pipe, if necessary, with an offset for the discharge of rainwater from roof areas, balconies and loggias.

Sewer mains – An inaccessible pipeline, installed under ground or in the concrete slab, and commonly conveying the wastewater to the sewer.

Single connection line – Line from the odour trap of a drainage object to a secondary pipeline.

Wastewater down pipe – A vertical pipe, possibly with offsets, which leads through one or more storeys, is ventilated through the roof and supplies the wastewater to a sewer main or collective pipe.

Ventilation systems

Main ventilation – Ventilation of single or multiple combined downpipes up to and above the roof.

Recirculating ventilation – Ventilation of a connecting pipeline or a bypass line by returning to the applicable downpipe.

Ventilation valves – Valve that introduces air into the drainage system, but not out again in order to limit pressure fluctuations within the drainage system.

Dimensioning

Calculation rainfall intensity – A rain event defined according to the rain duration and occurance per year

Connection load – Average value of wastewater drainage in l/s from a sanitary drainage object.

Continuous runoff – Continuous runoff in l/s of all constant drainages, e.g. runoffs from equipment, machinery or cooling water.

Discharge coefficient – The discharge coefficient indicates the ratio of the rainwater entering the drainage system to the surface condition of the rain catchment area and relative to the total rainwater in the applicable rainfall area.

Discharge indicator – Code indicating how frequently sanitary drainage objects in different types of buildings are used.

Effective drainage area – The roof area projected from the floor plan or the property area shown in the outdoor facility digram.

Emergency drainage – Additional rain drainage down emergency drains or emergency overflows with unrestricted discharge to the property. **Pump delivery flow** – Waste water discharge in l/s from sewage pumps.

Total wastewater drainage – Total wastewater drainage in l/s is the sum of wastewater drainage, continuous drain and pump flow rate.

Wastewater drainage – Total drainage water in l/s from sanitary drainage objects in a drainage system.

3 Literature

Information on the applicable standards
In the preparation of the manual, the standards, guidelines and regulations in their respective German-language version were used as a basis.
Some parts of his literature may be available in other languages, possibly with different formulations from those listed here.

3.1 Standards

3.1.1 Drinking water installation

AVBWasserV	German Ordinance on the General Conditions for the Supply of Water
DIN EN 1717	Protection against pollution of potable water installations and general requirements of devices to prevent pollution by backflow
DIN EN 806-1	Specifications for installations inside buildings conveying water for human consumption – Part 1: General information
DIN EN 806-2	Specifications for installations inside buildings conveying water for human consumption – Part 2: Plan
DIN EN 806-3	Specifications for installations inside buildings conveying water for human consumption – Part 3: Calculation of internal pipe diameters – Simplified procedure
DIN EN 806-4	Specifications for installations inside buildings conveying water for human consumption – Part 4: Installation
DIN EN 806-5	Specifications for installations inside buildings conveying water for human consumption – Part 5: Operation and maintenance
DIN 1988-100	Codes of practice for drinking water installations – Part 100: Protection of drinking water, drinking water quality control; DVGW code of practice
DIN 1988-200	Codes of practice for drinking water installations – Part 200: Installation Type A (closed system) – Planning, components, apparatus, materials; DVGW code of practice
DIN 1988-300	Codes of practice for drinking water installations – Part 300: Pipe sizing; DVGW code of practice
DIN 1988-500	Codes of practice for drinking water installations – Part 500: Pressure boosting stations with RPM-regulated pumps; DVGW code of practice
DIN 1988-600	Codes of practice for drinking water installations – Part 600: Drinking water installations in connection with fire fighting and fire protection installations; DVGW code of practice
DIN 14462	Water conduit for fire extinguishing – Planning, installation, operation and maintenance of fire hose systems and pillar fire hydrant and underground fire systems
DIN 14462 Supplement 1	Water conduit for fire extinguishing – Planning, installation, operation and maintenance of fire hose systems and pillar fire hydrant and underground fire systems; Supplement 1: Control instuments
DIN EN 12502-1	Protection of metallic materials against corrosion – Guidance on the assessment of corrosion likelihood in water distribution and storage systems – Part 1: General information
DIN EN 12502-2	Protection of metallic materials against corrosion – Guidance on the assessment of corrosion likelihood in water distribution and storage systems – Part 2: Influencing factors for copper and copper alloys

DIN EN 12502-3	Protection of metallic materials against corrosion – Guidance on the assessment of corrosion likelihood in water distribution and storage systems – Part 3: Influencing factors for hot-dip galvanised iron materials
DIN EN 12502-4	Protection of metallic materials against corrosion – Guidance on the assessment of corrosion likelihood in water distribution and storage systems – Part 4: Influencing factors for stainless steels
DIN 50930-6	Corrosion of metals – Corrosion of metallic materials under corrosion load by water inside of pipes, tanks and apparatus – Part 6: Evaluation process and requirements regarding the hygienic suitability in contact with drinking water
DIN 50929	Corrosion of metals – Corrosion likelihood of corrosion of metallic materials when subject to corrosion from the outside – Part 1: General information
DIN 18195-9	Water-proofing of buildings – Part 9: Penetrations, transitions, connections and endings
DIN 18381	German construction contract procedures (VOB) – Part C: General technical specifications in construction contracts (ATV) – Installation of gas, water and drainage pipework inside buildings
DIN EN 13501-1	Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests
DVGW W551 (A)	Drinking water heating and drinking water piping systems – Technical measures to reduce Legionella growth – Design, construction, operation and rehabilitation of drinking water installations
DVGW W556 (A)	Hygienic-microbial irregularities in drinking water installations – Methods and measures to remedy
DVGW W557 (A)	Cleaning and disinfecting drinking water installations
EnEV	German Energy Saving Ordinance
TrinkwV	German drinking water ordinance 2nd Amendment 2012. With hazard analysis leaflet
VDI/DVGW 6023	Hygiene in drinking water installations – Requirements for planning, execution, operation and maintenance
ZVSHK	Leaflet – Leak testing of drinking water installations with compressed air, inert gas or water
ZVSHK	Leaflet – Rinsing, disinfecting and putting drinking water installations into operation
ZVSHK	Instruction manual – Drinking water installation
ZVSHK	Trade journal – Technical measures for maintaining drinking water hygiene
ZVSHK	Trade journal – Reconstruction of contaminated drinking water installations.

3.1.2 Wastewater installation

DIN EN 12056-1	Gravity drainage systems inside buildings – Part 1: General and performance requirements
DIN EN 12056-2	Gravity drainage systems inside buildings – Part 2: Sanitary pipework, layout and calculation
DIN EN 12056-3	Gravity drainage systems inside buildings – Part 3: Roof drainage, layout and calculation
DIN EN 12056-4	Gravity drainage systems inside buildings – Part 4: Wastewater lifting plants, layout and calculation
DIN EN 12056-5	Gravity drainage systems inside buildings – Part 5: Installation and testing, instructions for operation, maintenance and use
DIN EN 752	Drain and sewer systems outside buildings

DIN 1986-100	Drainage systems on private ground – Part 100: Specifications in relation to: DIN EN 752 and DIN EN 12056
DIN 1986-3	Drainage systems on private ground – Part 3: Specifications for service and maintenance
DIN 1986-4	Drainage systems on private ground – Part 4: Fields of application of sewage pipes and fittings of different materials
DIN 1986-30	Drainage systems on private ground – Part 30: Maintenance
DIN 18381	German construction contract procedures (VOB) – Part C: General technical specifications in construction contracts (ATV) – Installation of gas, water and drainage pipework inside buildings
DIN 4124	Excavations and trenches – Slopes, planking and strutting breadths of working spaces
DIN 4040-100	Grease separators – Part 100: Application provisions for grease separators in accordance with DIN EN 1825-2
DIN 2425-4	Plans for public utilities, water resources and long-distance lines; sewer network drawings of public sewerage systems
DIN 18195	Waterproofing of buildings (all parts)
DIN EN 1253-1	Gullies for buildings – Part 1: Requirements
DIN EN 1610	Construction and testing of drains and sewers
DIN EN 12050	Wastewater lifting plants for buildings and sites – Construction and testing principles – Part 1: Faecal matter lifting plants
DIN EN 12050	Wastewater lifting plants for buildings and sites – Construction and testing principles – Part 2: Lifting plants for wastewater containing faecal matter
DIN EN 12050	Wastewater lifting plants for buildings and sites – Construction and testing principles – Part 3: Lifting plants for limited applications
DIN EN 12380	Air admittance valves for drainage systems – Requirements, test methods and evaluation of conformity
DIN EN 1825-2	Grease separators – Part 2: Selection of nominal size, installation, operation and maintenance
DIN 4109	Sound insulation in buildings (all parts)
VDI 4100	Sound insulation between rooms in buildings – Dwellings – Assessment and proposals for enhanced sound insulation between rooms
ZVSHK	Instruction manual drainage systems and model maintenance contracts Zentralverband Sanitär Heizung Klima, Rathausallee 6, 53757 St. Augustin, Germany

3.2 Additional sources

The information in this manual was compiled using common publicly available GF sources and writings.

In addition to the standards mentioned, data sheets of the German Copper Institute and information from the WIAM database were used for the material information.

For the information on CuZn21Si3P partial information of the datasheet "CuZn21Si3P" of Otto Fuchs Dülken GmbH & Co. KG was used.

Furthermore, individual information from the following writings was used:

VKF, AEAI: Fire protection directive, building materials and components, classification. Bern 2016

Büsser, S., Frischknecht, R. (2008): Life cycle assessment of pipes – Comparison of various pipe materials for building technology, industry and supply. ESU-Services Ltd., on behalf of Georg Fischer Piping Systems, Uster and Schaffhausen.

Pilz, H., Brandt, B., Fehringer, R. (2010): The impact of plastics on energy consumption and greenhouse gas emissions in Europe. Denkstatt GmbH on behalf of PlasticsEurope, Brussels, Belgium.

4 Index

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Annex C

Formulary

Formulary

1 Symbols and signs

Abbreviations
Directories for other abbreviations used in the book:
➨ Annex B , Chapter [1] 'Directories'

1.1 Greek alphabet

TC.1
Alphabet, Greek

Letter		Designation	Usage for ...
Α	α	Alpha	• α: Angles • α: Coefficient of linear thermal expansion
Β	β	Beta	Angles
Γ	γ	Gamma	Angles
Δ	δ	Delta	Difference
Ε	ε	Epsilon	• ε: Emissivity • ε: Energy efficiency ratio (heat pump, Refrigeration machine)
Ζ	ζ	Zeta	ζ: Drag coefficient
Η	η	Eta	• Efficiency • Quality grade • dynamic viscosity
Θ	θ	Theta	Temperature
Ι	ι	Iota	-
Κ	κ	Kappa	-
Λ	λ	Lambda	• Thermal conductivity • Pipe friction factor
Μ	μ	My	-
Ν	ν	Ny	Viscosity
Ξ	ξ	Xi	-
Ο	ο	Omicron	-
Π	π	Pi	Number Pi
Ρ	ρ	Rho	Density
Σ	σ	Sigma	• Σ: Sum • σ: Stefan-Boltzmann constant
Τ	τ	Tau	-
Υ	υ	Epsilon	-
Φ	ϕ	Phi	• relative humidity • Heat flow • Φ: Radiation power (heating power, heat output, cooling capacity)
Χ	χ	Chi	-
Ψ	ψ	Psi	-
Ω	ω	Omega	electrical resistance

The “Formulars” were created in collaboration with the Lucerne University of Applied Sciences and Arts, Horw, Switzerland

1.2 Mathematical signs

TC.2
Mathematical signs

Signs	Designation	Example, notation (formula)
+	Addition	a + b
–	Subtraction	a – b
: **or** /	Division	a : b **or** 1/2
·	Multiplication	a · b
>	greater than...	2 > 1
<	less than...	1 < 2
≥	greater or equal to...	a ≥ b
≤	less than or equal to...	a ≤ b
≅	equals...	a + b ≅ c
≈	approximately equal to...	a + b ≈ c
=	equal to...	a + b = c
~	correlated	a ~ b
∑	Sum	∑(a + b)
√	Root	√x
∅	Diameter	∅15 mm
×	geometric dimension	16 × 2.2
±	Deviation plus/minus for values	±0.1

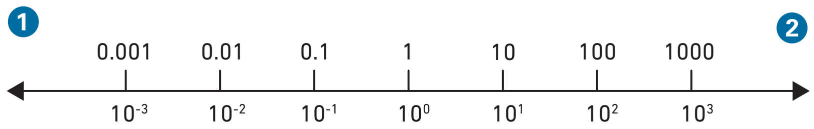
2 Dimensions and units of measure

2.1 Prefix symbol

TC.3
Prefix symbol for units of measure

Prefix symbol	Prefix	Power of ten	Factor	Expression
Amplification				
P	Peta	10^{15}	1,000,000,000,000,000	Quadrillion
T	Tera	10^{12}	1,000,000,000,000	Trillion
G	Giga	10^{9}	1,000,000,000	Billion
M	Mega	10^{6}	1,000,000	Million
k	kilo	10^{3}	1,000	thousand
h	hecto	10^{2}	100	hundred
da	deca	10^{1}	10	ten
—	—	10^{0}	1	one
Scaling down				
d	deci	10^{-1}	0.1	one tenth
c	centi	10^{-2}	0.01	one hundredth
m	milli	10^{-3}	0.001	one thousandth
µ	micro	10^{-6}	0.000 001	one millionth
n	nano	10^{-9}	0.000 000 001	one billionth
p	piko	10^{-12}	0.000 000 000 001	one trillionth
f	Femto	10^{-15}	0.000 000 000 000 001	one trillionth

Power of ten



TC.4
Power of ten
1 Value <1
2 Value >1

Example: 0.001 = 10^{-3} ; 10^{3} = 1,000

2.2 SI units

International System of Units (SI, French Système international d'unités) for physical quantities

TC.5
SI base units

Base size	Base unit	Abbreviations
Length	Metre	m
Time	Second	s
Dimensions	Kilogram	kg
Current	Ampere	A
Temperature	Kelvin	K
Amount of solids	Mol	mol
Luminous intensity	Candela	cd

TC.6
Derived SI units

Size	Base unit	Abbreviations	Conversion
Force	Newton	N	$(m \cdot kg)/s^2$
Work	Joule	J, Ws	$(m^2 \cdot kg)/s^2$
Output	Watt	W	$(m^2 \cdot kg)/s^3$
Pressure	Pascal	Pa	$kg/(m \cdot s^2)$
Electrical voltage	Volt	V	$(m^2 \cdot kg)/(s^3 \cdot A)$
Electrical resistance	Ohm	Ω	$(m^2 \cdot kg)/(s^3 \cdot A^2)$
Angle (level)	Radiant	rad	m/m

2.3 Conversion tables

TC.7
Lengths (l)

Unit of measure	mm	cm	dm	m	km	in	ft
1 mm	1	0.1	0.01	10^{-3}	10^{-6}	0.0393	$3.28 \cdot 10^{-3}$
1 cm	10	1	0.1	0.01	10^{-5}	0.3937	$3.28 \cdot 10^{-2}$
1 dm	100	10	1	0.1	0.0001	3.937	0.328
1 m	1,000	100	10	1	0.001	39.37	3.28
1 km	1,000 000	100,000	10,000	1,000	1	39,370	3,280
1 in	25.4	2.54	0.254	0.0254	$2.54 \cdot 10^{-5}$	1	0.0833
1 ft	304.8	30.48	3.048	0.3048	$3.048 \cdot 10^{-4}$	12	1

mm millimetre
cm centimetre
dm decimetre
km kilometre
in inch
ft foot

TC.8
Areas (A)

Unit of measure	mm²	cm²	dm²	m²	a	ha	km²
1 mm²	1	0.01	0.0001	10^{-6}	10^{-8}	10^{-10}	10^{-12}
1 cm²	100	1	0.01	0.0001	10^{-6}	10^{-8}	10^{-10}
1 dm²	10^{4}	100	1	0.01	10^{-4}	10^{-6}	10^{-8}
1 m²	10^{6}	10^{4}	100	1	0.01	10^{-4}	10^{-6}
1 a	10^{8}	10^{6}	10^{4}	100	1	0.01	10^{-4}
1 ha	10^{10}	10^{8}	10^{6}	10^{4}	100	1	0.01
1 km²	10^{12}	10^{10}	10^{8}	10^{6}	10^{4}	100	1

km² Square kilometre
ha hectare
a are
m² square metre
dm² square decimetre
cm² square centimetre
mm² square millimetre

TC.9
Volumes (V)

Unit of measure	m³	hl	dm³ (l)	dl	cl	cm³ (ml)
1 m³	1	10	1,000	10^{4}	10^{5}	10^{6}
1 hl	0.1	1	100	1,000	10^{4}	10^{5}
1 dm³ (l)	0.001	0.1	1	100	100	1,000
1 dl	10^{-4}	0.001	0.1	1	10	100
1 cl	10^{-5}	10^{-4}	0.01	0.1	1	10
1 cm³ (ml)	10^{-6}	10^{-5}	0.001	0.01	0.1	1

m³ cubic metre
hl hectolitre
dm³ cubic decimetre
dl decilitre
l litre
cl centilitre
cm³ cubic centimetre
ml millilitre

TC.10
Conversion of dimensions (m)

Unit of measure	t	kg	g
1 t	1	1,000	10^{6}
1 kg	0.001	1	1,000
1 g	10^{-6}	0.001	1

t Ton
g Gram

TC.11
Pressures (p)

Unit of measure	N/m² (Pa)	kPa	bar	mbar	mmWS	Torr [mmHg]
1 N/m² (Pa)	1	0.001	10^{-5}	0.01	0.102	0.0075
1 kPa	1,000	1	0.01	10	102	7.5
1 bar	10^{5}	100	1	1,000	10,200	750
1 mbar	100	0.1	0.001	1	10.2	0.75
1 mmWS	9.81	0.00981	$9.81 \cdot 10^{-5}$	0.0981	1	0.07355
1 Torr (mmHg)	133	0.133	0.00133	1.33	13.6	1

Pa Newton/square metre (Pascal)
kPa kilopascal
bar bar
mbar millibar
Torr Torricelli (millimetre of mercury)
mmWS millimetre of water column

TC.12
Energy and work (W)

Unit of measure	J (= WS = Nm)	kJ	kWh	Kacl
1 J (= WS = Nm)	1	0.001	$2.78 \cdot 10^{-7}$	$2.39 \cdot 10^{-4}$
1 kJ	1,000	1	$2.78 \cdot 10^{-4}$	0.239
1 kWh	$3.6 \cdot 10^{6}$	3,600	1	860
1 kcal	4 187	4.187	1 160	1

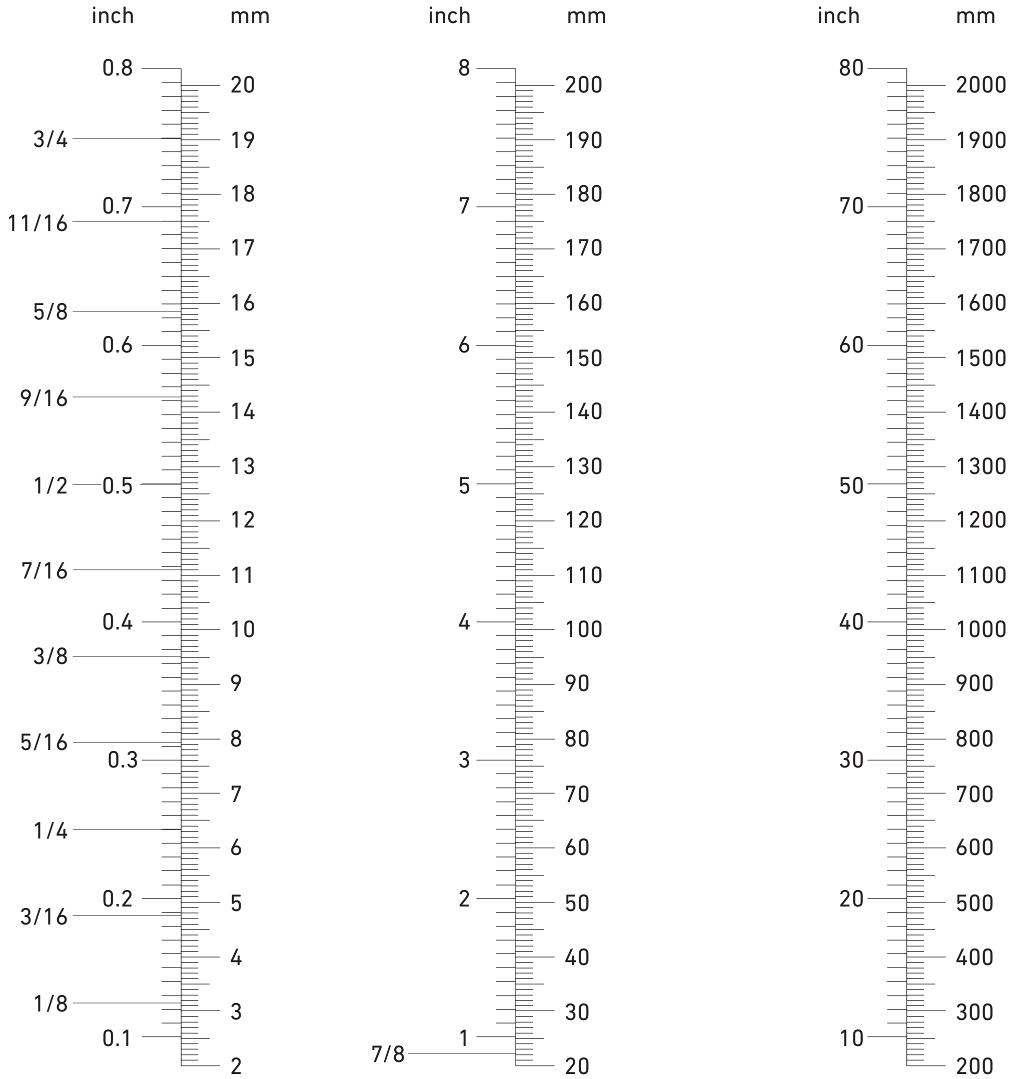
kJ Kilojoule
Ws Watt second
kWh Kilowatt hour
Nm Newton metre
kcal Kilocalorie

Unit of measure	W (= J/s = Nm/s)	kW	kJ/h	PS	kcal/h
1 W (= J/s = Nm/s)	1	0.001	3.6	0.00136	0.859
1 kW	1,000	1	3,600	1.36	859
1 kJ/h	0.278	$2.78 \cdot 10^{-4}$	1	$3.78 \cdot 10^{-4}$	0.239
1 PS	735	0.735	2,650	1	632
1 kcal/h	1.16	0.00116	4.19	0.00158	1

TC.13
Power (P)

kJ/h	Kilojoule/hour
J/s	Joule/second
PS	Horsepower
Nm/s	Newton meter/second
Kcal/h	Kilocalorie/hour
kW	Kilowatt

2.3.1 Nomogram – conversion inch to mm

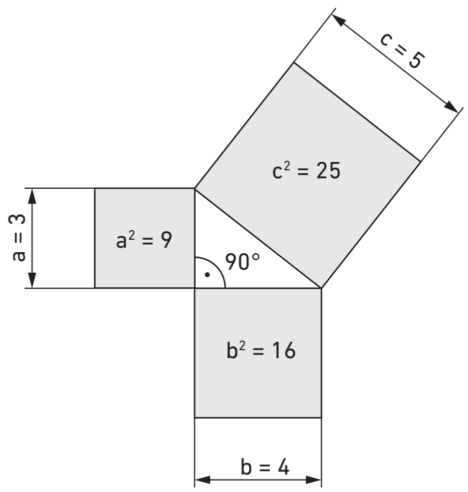


C

3 Geometry

3.1 Calculating the sides in a triangle

In the right-angled triangle, the legs are referred to as catheters a and b and as hypotenuse c. By using the simple relationships of the surfaces along these legs, the areas and lengths based on these slopes can be quickly calculated.



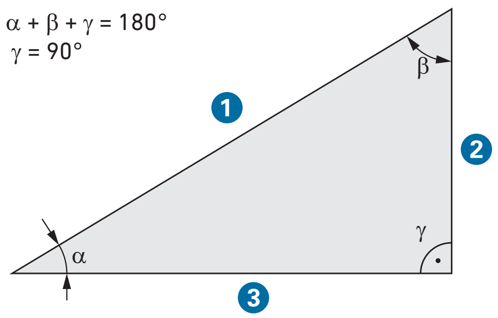
Formula	Units of measure (using metres as an example)
$c^2 = a^2 + b^2$	$[m^2 + m^2 = m^2]$
$c = \sqrt{a^2 + b^2}$	$[\sqrt{m^2} = m]$
$b = \sqrt{c^2 - a^2}$	$[\sqrt{m^2} = m]$
$a = \sqrt{c^2 - b^2}$	$[\sqrt{m^2} = m]$

TC.14
Lengths inside a triangle

a	Opposite leg
b	Adjacent leg
c	Hypotenuse

3.2 Calculating angles

The calculation of angles is referred to as trigonometry. In order to determine angels using straight lengths, the simple relationships are helpful.



GC.1
Lengths inside a triangle

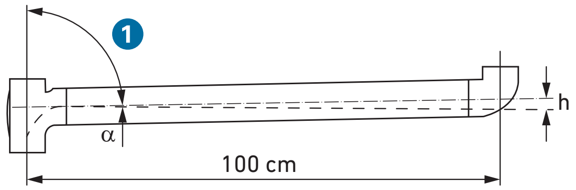
1	Hypotenuse c
2	Opposite leg a
3	Adjacent leg b
α, β, γ	Angles

Designation	Abbreviations	Aspect ratio for the angle
Sine	sin	$\sin\alpha = \frac{a}{b}$
Cosine	cos	$\cos\alpha = \frac{b}{c}$
Tangents	tan	$\tan\alpha = \frac{b}{c}$

TC.15
Angles in a triangle

α	Sine
β	Cosine
γ	Tangents

3.3 Calculating slopes



GC.2
Slope
1 Tee

TC.16
Slope

Branch	Angles α	Slope [%]	h [cm/h]
	0.25	0.5	0.5
	0.57	1.0	1.0
	0.86	1.5	1.5
	1.14	2.0	2.0
88.5°	1.5	2.62	2.62
	1.71	3.0	3.0
	2.86	5.0	5.0
87°	3	5.24	5.24

4 Fundamental principles of mechanics

The term **mechanics** refers to the theory of the movements of the bodies and the forces acting on them.

4.1 Force

The force is calculated according to the following formula:

$$F = m \cdot a \qquad [F] = kg \cdot \frac{m}{s^2} = N$$

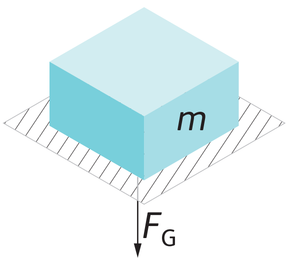
Size	Designation	Unit of measure
F	Force	N
m	Dimensions	kg
a	Acceleration	m/s^2

4.2 Weight force

Weight is the force exerted on a body caused by the action of a gravitational field. The weight is calculated according to the following formula:

$$F_G = m \cdot g \qquad [F] = kg \cdot \frac{m}{s^2} = N$$

Size	Designation	Unit of measure	Addition
F_G	Force	N	–
m	Dimensions	kg	–
g	Gravitational acceleration	m/s^2	$g = 9.81\ m/s^2$



GC.3
Weight force

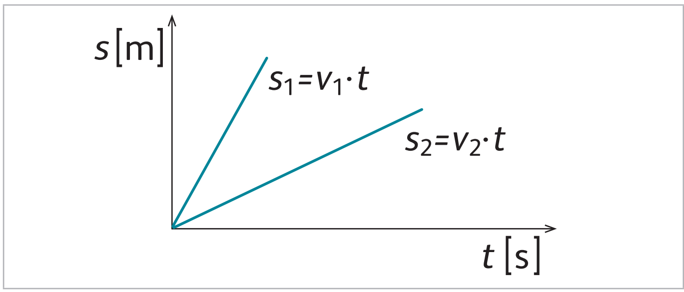
4.3 Uniform movement

Velocity with uniform movement is calculated according to the following formula:

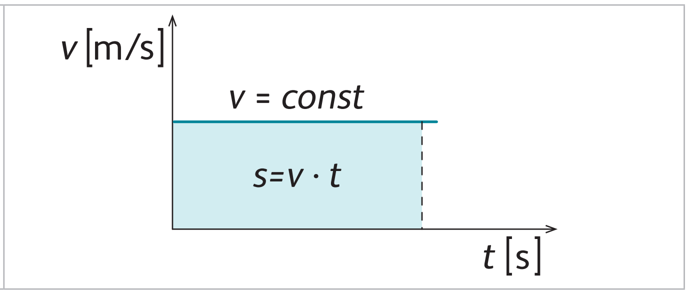
$v = \frac{s}{t}$	$[v] = \frac{m}{s}$

Size	Designation	Unit of measure
v	Velocity	m/s
s	Distance, displacement	m
t	Time	s

The following diagrams illustrate the relationship for uniform movement, that is to say, constant velocities:



GC.4 **Distance-time diagram**



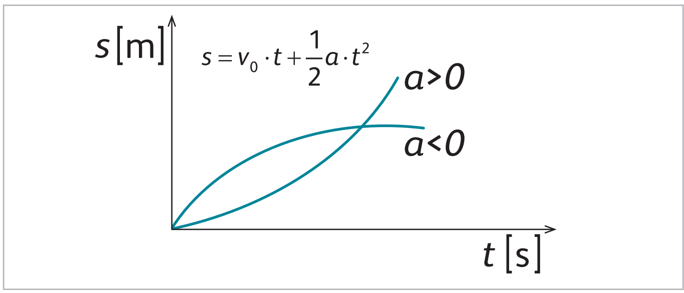
GC.5 **Speed-time diagram**

4.4 Uniform accelerated movement

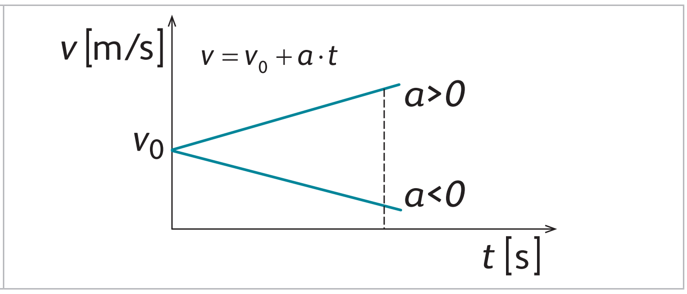
The velocity at uniform accelerated movement is calculated according to the following formulas:

$a = \frac{v}{t}$	$[a] = \frac{m}{s^2}$
$v = v_0 + a \cdot t$	$[v] = \frac{m}{s}$
$s = v_0 \cdot t + \frac{1}{2} a \cdot t^2$	$[s] = m$

Size	Designation	Unit of measure	Addition
v	Velocity	m/s	–
v_0	Initial velocity	m/s	–
a	Acceleration	m/s^2	a >0 at acceleration a <0 at deceleration (braking)
s	Distance, displacement	m	–
t	Time	s	–



GC.6 **Distance-time diagram**



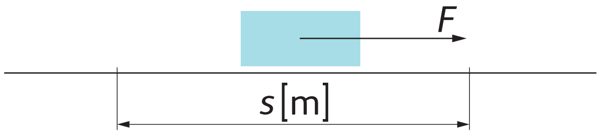
GC.7 **Speed-time diagram**

4.5 Work

Work is the energy that is mechanically transferred to a body. Work is calculated according to the following formula:

$$W = F \cdot s \qquad [W] = N \cdot m = kg \cdot \frac{m^2}{s^2} = J$$

Size	Designation	Unit of measure
W	Work	J
F	Force	N
s	Displacement	m



GC.8
Work

TC.17
Conversion of working units

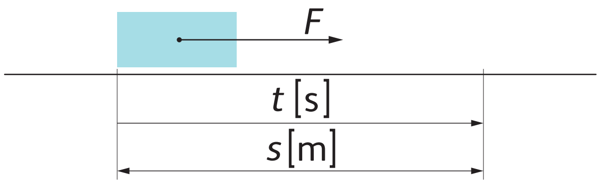
Work	J	kJ	MJ	kWh
J	1	0.001	0.000 001	0.0000003
kJ	1,000	1	0.001	0.000278
MJ	1,000,000	1,000	1	0.278
kWh	3,600,000	3,600	3.6	1

4.6 Output

Output refers to the energy converted over a period of time in relation to this time span. Output is calculated according to the following formula:

$$P = \frac{W}{t} \qquad [P] = kg \cdot \frac{m^2}{s^3} = W$$

Size	Designation	Unit of measure
P	Output	W
W	Work	J
t	Time	s



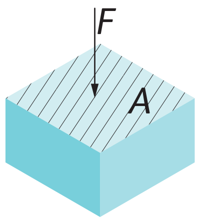
GC.9
Output

4.7 Pressure

Pressure is the result of a force acting on an area. Pressure is calculated according to the following formula:

$$p = \frac{F}{A} \qquad [p] = \frac{N}{m^2} = \frac{m \cdot kg}{m^2 \cdot s^2} = Pa$$

Size	Designation	Unit of measure
p	Pressure	Pa
F	Force	N
A	Area	m^2



GC.10
Pressure

TC.18
Conversion of pressure units

Pressure	Pa	mbar	kPa	mWS*	bar
Pa	1	0.01	0.001	0.000102	0.00001
mbar	100	1	0.1	0.0102	0.001
kPa	1,000	10	1	0.102	0.01
mWS*	9,810	98.1	9.81	1	0.0981
bar	100,000	1,000	100	10.2	1

* The numerical values for the conversion of mWS refer to a density of 1,000 kg/m^3.

4.8 Density

The density describes the relationship of the mass of a body to its volume. The density of a body is calculated according to the following formula:

$$\rho = \frac{m}{V} \qquad [\rho] = \frac{kg}{m^3}$$

Size	Designation	Unit of measure
ρ	Density	kg/m^3
m	Dimensions	kg
V	Volumes	m^3

C

4.9 Energy

The work stored in a body is commonly referred to as energy. Work and energy each use the Joule as unit of measure.
(See also thermodynamics, first and second law ➨ [5] 'Thermodynamics')

TC.19 **Example of forms of energy**

Form of energy	Equation	
Potential energy	$W_L = m \cdot g \cdot h$	$[W_L] = kg \cdot \frac{m}{s^2} \cdot m = J$
Kinetic energy	$W_{kin} = \frac{1}{2} \cdot m \cdot v^2$	$[W_{kin}] = kg \cdot \frac{m^2}{s^2} = J$
Electrical energy	$W_e = e_0 \cdot U$	$[W_e] = C \cdot V = A \cdot s \cdot V = A \cdot s \cdot \frac{m^2 \cdot kg}{s^3 \cdot A} = J$
Thermal energy	$Q = m \cdot c_p \cdot \Delta T$	$[Q] = kg \cdot \frac{J}{kg \cdot K} \cdot K = J$

5 Thermodynamics

Thermodynamics investigates the behaviour of solids to which heat is added or removed.

5.1 Temperature

The temperature describes a temperature value related to a zero point. This zero point depends on the temperature scale used. Examples are the Kelvin scale, which refers to the lowest possible, the absolute zero, and the Celsius scale, which defines the freezing point of water as the zero point, that is to say 20°C corresponds to 293.15 K.

Size	Designation	Unit of measure	Addition
T	absolute temperature	K	$\{T\} = \{\theta\} + 273{,}15$
θ	Temperature	°C	$\{\theta\} = \{T\} - 273{,}15$

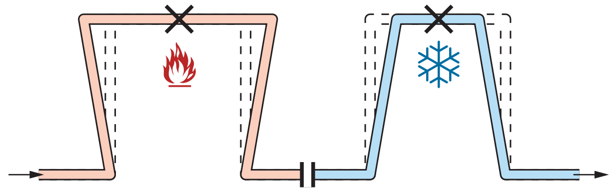
5.2 Expansion of solids

Expansion of solids is calculated according to the following formula:

$$\Delta l = l_1 \cdot \alpha \cdot \Delta T \qquad [\Delta l] = m \cdot \frac{1}{K} \cdot K = m$$

$$l_2 = l_1 \cdot (1 + \alpha \cdot \Delta T) \qquad [l_2] = m$$

Size	Designation	Unit of measure
Δl	Change of length	m
l_1	Initial length	m
l_2	Final length	m
α	Coefficient of linear thermal expansion	K^{-1}
ΔT	Temperature difference	K



GC.11
Length expansion during heating and cooling

TC.20
Coefficient of linear thermal expansion of some solids

Solid	Temperature [°C]	$\alpha \cdot 10^{-5}$ [K^{-1}]
Copper	0 ... 100	16,8
Steel, non-alloy	0 ... 100	11,5
Steel, chromium-nickel-molybdenum	20 ... 100	16,0
Steel, structural steel	0 ... 100	12,0
Reinforced concrete	0 ... 100	14,0
Brass (62% copper)	0 ... 100	18,4
Polyethylene	0 ... 80	150 ... 230
Polyvinyl chloride (PVC hard)	0 ... 100	70,0
Mepla (metal composite pipe)	20 ... 100	26,0

5.3 Volumetric thermal expansion of liquids

Volumetric thermal expansion refers to the change in the volume of a body by changing the temperature and pressure. Volumetric thermal expansion is calculated according to the following formula:

$$\Delta V = V_1 \cdot \frac{\rho_1}{\rho_2} - V_1 \qquad [\Delta V] = m^3$$

Size	Designation	Unit of measure	Addition
ΔV	Volume change	m^3	$\Delta V = V_2 - V_1$
V_1	Initial volume	m^3	–
V_2	End volume	m^3	–
ρ_1	Density at temperature 1	kg/m^3	–
ρ_2	Density at temperature 2	kg/m^3	–

TC.21 **Density of water**

Temperature [°C]	ρ [kg/m^3]
0	999.8
10	999.7
20	998.2
60	983.2
100	958.3

5.4 Standard conditions of the ideal gas

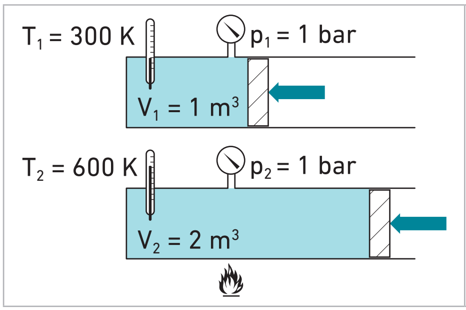
An "Ideal Gas" is a highly simplified model of a real gas that describes the complexity of many thermodynamic processes of gases.

Size	Designation	Unit of measure	Addition
p_0	Standard pressure	Pa	p_0 = 101.325 Pa
T_0	Standard temperature	K	T_0 = 273.15 K
V_0	Molar standard volume	m^3/mol	$V_0 = 22.414 \cdot 10^{-3}\ m^3/mol$

TC.22 **Equations of the ideal gas**

Form	Equation	Condition
General equation of state	$\frac{p_1 \cdot V_1}{T_1} = \frac{p_2 \cdot V_2}{T_2}$	$m = const$
General equation of state	$p \cdot V = n \cdot R \cdot T$	$R = 8{,}31451 \frac{J}{mol \cdot K}$
Specific equation of state	$p \cdot V = m \cdot R_S \cdot T$	$R_S = \frac{R}{M}$
General density	$\frac{m}{V} = \rho = \frac{p}{R_s \cdot T}$	$[\rho] = \frac{kg}{m^3}$
Density of condition “x”	$\rho_x = \rho_0 \cdot \frac{p_x \cdot T_0}{p_0 \cdot T_x}$	$[\rho] = \frac{kg}{m^3} \cdot \frac{Pa \cdot K}{K \cdot Pa}$
1. Gay-Lussac’s law	$\frac{V_2}{V_1} = \frac{T_2}{T_1}$	$p = const$
2. Gay-Lussac’s law	$\frac{p_2}{p_1} = \frac{T_2}{T_1}$	$V = const$
Boyle-Mariotte’s law	$p_1 \cdot V_1 = p_2 \cdot V_2$	$T = const$

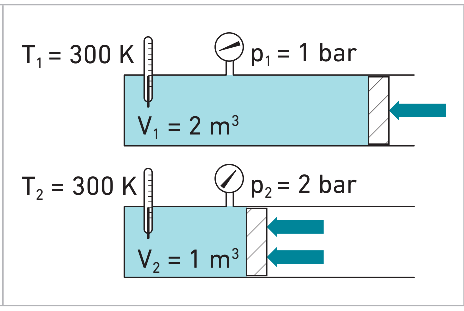
Size	Designation	Unit of measure
R	General gas constant	J/(mol K)
R_S	Specific gas constant	J/(kg K)
n	Amount of solids	mol
$p_{1,2,x}$	Pressure, condition 1, 2, x	Pa
$V_{1,2,x}$	Volume, condition 1, 2, x	m^3
$T_{1,2,x}$	Temperature, condition 1, 2, x	K
M	Molar mass	kg/mol



GC.12 **Isobars**

The isobar describes the change of state while at constant pressure.

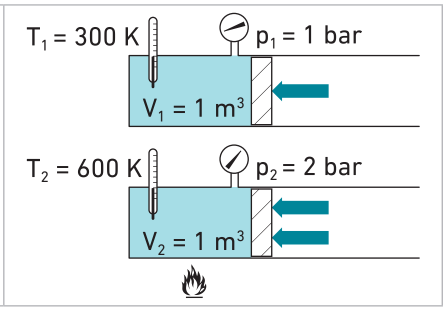
According to the general equation of state, this means that the ratio of volume and temperature also remains constant.



GC.13 **Isotherm**

The isotherm describe a state change with constant temperature.

According to the general equation of state, this means a that the product of pressure and volume also remains constant.



GC.14 **Isochore**

The isochore describes a state change with constant volume.

According to the general equation of state, this means that the ratio of pressure and temperature also remains constant.

TC.23
Gas constant R_s of some gases

Gas	R_s [J/(kg K)]
Air	287.2
Methane	518.3
Carbon dioxide	188.9
Ammonia	488.2

TC.24
Standard density ρ of some gases

Gas	ρ_0 [kg/m³]
Air	1.293
Methane	0.717
Carbon dioxide	1.977
Ammonia	0.771
Propane	2.004

C

5.5 Heat capacity

The heat capacity refers to the ratio between the thermally supplied energy and the temperature change of the body under certain conditions. The heat capacity of solids is calculated according to the following formula:

$$Q = m \cdot c_p \cdot (\theta_2 - \theta_1) \qquad [Q] = kg \cdot \frac{J}{kg \cdot K} \cdot K = J$$

Size	Designation	Unit of measure	Addition
Q	Amount of heat	J	–
m	Dimensions	kg	–
c_p	Specific heat capacity	J/(kg K)	p = const
$\theta_{1,2}$	Temperature of solid 1, 2	°C	–
ΔT	Temperature difference	K	–

TC.25
Specific heat capacity c_p of some solids

Solid	c_p [J/(kg K)]
Water (20°C)	4.182
Water (60°C)	4.184
Air (20°C)	1.005
Air (60°C)	1.009
Ice (0°C)	2.090
Concrete (0 ... 100°C)	880
Steel (0 ... 100 °C)	500

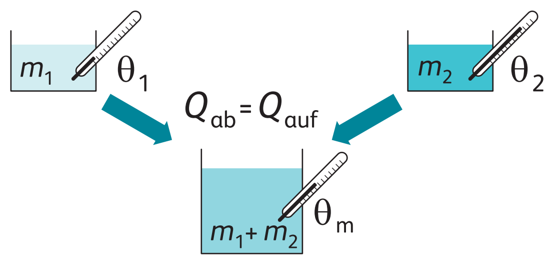
5.6 Mixing temperature

The mixing temperature applies to all mixing operations in which no medium changes the state of aggregation and there is no heat transfer between the system and its surroundings. The mixing temperature is calculated according to the following formula:

$$\theta_m = \frac{m_1 \cdot c_{p1} \cdot \theta_1 + m_2 \cdot c_{p2} \cdot \theta_2}{m_1 \cdot c_{p1} + m_2 \cdot c_{p2}} \qquad [\theta_m] = °C$$

$$m_1 \cdot c_{p1} \cdot (\theta_1 - \theta_m) = m_2 \cdot c_{p2} \cdot (\theta_m - \theta_2)$$

Size	Designation	Unit of measure	Addition
Q_{ab}	emitted amount of heat (Q_{emit})	J	Energy balance: $Q_{emit} = Q_{absorb}$
Q_{auf}	absorbed amount of heat (Q_{absorb})	J	
$m_{1,2}$	Weight of solid 1, 2	kg	–
$c_{p1,2}$	specific heat capacity, solid 1, 2	J/(kg K)	–
$\theta_{1,2}$	Temperature of solid 1, 2	°C	–
θ_m	Mixing temperature	°C	–



GC.15
Mixing temperature

5.7 Heat conduction through a flat wall

Heat is describable as the movement of particles (atoms, molecules).

Heat energy can be transmitted through three effects:

- Heat conduction
- Convection (heat flow)
- Thermal radiation

These processes overlap in solids.

The heat conduction is a form of heat transfer and considers the heat transfer in solids or quiescent liquids due to a temperature difference. It describes the transfer of kinetic energy between neighbouring particles, whereby the kinetic energy of atoms and molecules is transferred to their neighbours through “collisions”. This heat conduction is described as heat flow. The heat flow refers to the heat energy flowing from a high temperature location to a low temperature location over a period of time.

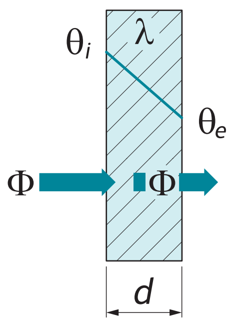
The formula describes the heat energy that flows through a wall with a certain area and within a period of time. This raises the question of how well the heat is conducted. A central material property is therefore the thermal conductivity.

The heat flow is the physical quantity of the respective heat transfer. The heat conduction is calculated according to the following formula:

$$\Phi = \frac{\lambda}{d} \cdot A \cdot (\theta_i - \theta_e) \qquad [\Phi] = \frac{W}{m \cdot K \cdot m} \cdot m^2 \cdot K = W$$

Size	Designation	Unit of measure
Φ	Heat flow	W
λ	Thermal conductivity*	W/(m · K)
d	Wall thickness	m
A	Area	m_2
θ_e	Temperature of wall/pipe on the outside	°C
θ_i	Temperature of wall/pipe on the inside	°C
ΔT	Temperature difference	K

* Definition: ➨ [5.11] 'Heat transfer through a flat wall'



GC.16
Heat conduction through a flat wall

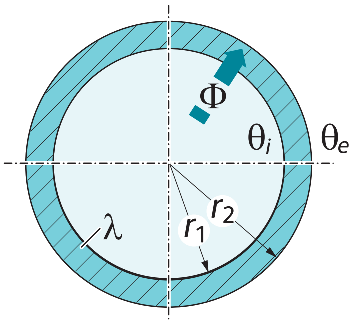
5.8 Heat conduction through a single-layer pipe

In contrast to the calculation of the heat conduction through a flat wall, when calculating the heat conduction through a (curved) surface, for example, the wall of a pipe, this results in a slightly modified formula. This difference must be taken into account when making a precise calculation. The heat conduction through a pipe is calculated according to the following formula:

$$\Phi = \frac{\lambda \cdot 2\,\pi \cdot l \cdot (\theta_i - \theta_e)}{ln \frac{r_2}{r_1}} \qquad [\Phi] = W$$

Size	Designation	Unit of measure
Φ	Heat flow	W
λ	Thermal conductivity*	W/(m · K)
l	Length of pipe segment	m
r_1	Inside radius	m
r_2	Outside radius	m
θ_e	Temperature of wall/pipe on the outside	°C
θ_i	Temperature of wall/pipe on the inside	°C
ΔT	Temperature difference	K

* Definition: ➨ [5.11] 'Heat transfer through a flat wall'



GC.17
Heat conduction through a single-layer pipe

5.9 Convection on a wall

The convection is a form of heat transfer. Convection considers the transfer of heat energy through a flowing fluid (gases or liquids). This flow must not be forced, but can also be caused by thermal imbalances (temperature difference, diffusion). The convection on a wall is calculated according to the following formula:

$$\Phi = h \cdot A \cdot (\theta_f - \theta_W) \qquad [\Phi] = \frac{W}{m^2 \cdot K} \cdot m^2 \cdot K = W$$

Size	Designation	Unit of measure
Φ	Heat flow	W
h	Heat transfer coefficient*	W/(m² · K)
A	Area	m²
θ_f	Temperature of fluid	°C
θ_w	Temperature of wall	°C
ΔT	Temperature difference	K

* Definition: ➨ [5.11] 'Heat transfer through a flat wall'

5.10 Thermal radiation

Thermal radiation is a form of heat transfer. The thermal radiation describes the heat transfer by electromagnetic waves (infrared light). (The thermal radiation can also spread in a vacuum.)

Radiation power of a body

The radiant power corresponds to the energy output of a body by electromagnetic waves (light) within a certain period of time. (It applies to the radiation into the vacuum, with good approximation this also applies tor the radiation of air.)

The thermal radiation of a body is calculated according to the following formula:

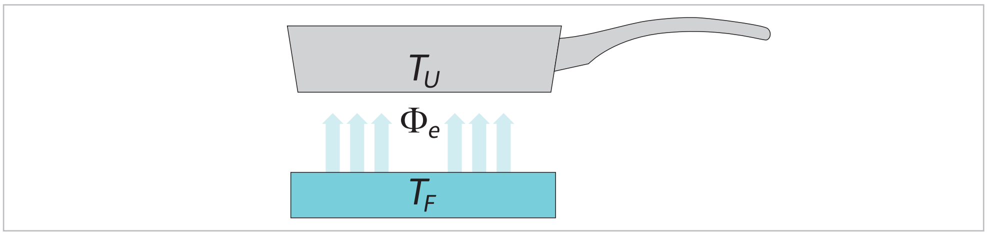
$$\Phi_e = \varepsilon_F \cdot \sigma \cdot A \cdot T_F^4 \qquad [\Phi_e] = \frac{W}{m^2 \cdot K^4} \cdot m^2 \cdot K^4 = W$$

Radiated heat output to the surrounding area

Radiation power of a surface with the temperature T_F to a parallel surrounding surface with the temperature T_U. Radiated heat output to the surrounding area is calculated according to the following formula:

$$\Phi_e = C_{FU} \cdot A \cdot \left(T_F^4 - T_U^4\right) \qquad [\Phi_e] = \frac{W}{m^2 \cdot K^4} \cdot m^2 \cdot K^4 = W$$

Size	Designation	Unit of measure	Addition
Φ_e	Radiation power	W	–
ε_F	Emissivity area/body	–	–
ε_U	Emissivity surrounding areas	–	ε = 1, applies to black bodies
C_{FU}	Radiation exchange constant	$W/(m^2 \cdot K^4)$	$C_{FU} = \dfrac{\sigma}{\dfrac{1}{\varepsilon_F} + \dfrac{1}{\varepsilon_U} - 1}$
σ	Stefan-Boltzmann constant	$W/(m^2 \cdot K^4)$	$\sigma = 5.67 \cdot 10^{-8}\ W/(m^2 \cdot K^4)$
A	Area	m_2	–
T_F	Temperature of area/body	K	–
T_U	Temperature of surrounding areas	K	–



GC.18
Radiated heat output

TC.26
Emissivity of some solids

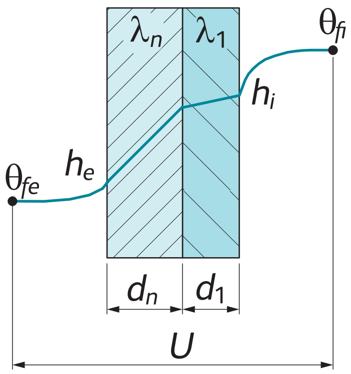
Solid	Temperature [°C]	Emissivity ε
Water	0 ... 100	0.95 ... 0.96
Soot	100 ... 300	0.95
Brick, plaster	20	0.93
Wall colour	20	0.95
Roofing felt	20	0.93
Oak wood	20	0.89
Lacquers, enamel	20	0.85
Steel, polished	20	0.29
Steel, corroded	20	0.85
Aluminium, polished	20	0.04

5.11 Heat transfer through a flat wall

The heat transfer describes the transmission of the heat through the area of a flat wall. Heat transfer through a wall is calculated according to the following formula:

$$\Phi = U \cdot A \cdot \left(\theta_{fi} - \theta_{fe}\right) \qquad [\Phi] = \frac{W}{m^2 \cdot K} \cdot m^2 \cdot K = W$$

Size	Designation	Unit of measure	Addition
Φ	Heat flow	W	
U	Heat transfer coefficient	W/(m² · K)	$U = \frac{1}{\frac{1}{h_i} + \frac{d_1}{\lambda_1} + \ldots + \frac{d_n}{\lambda_n} + \frac{1}{h_e}}$ $[U] = \frac{W}{m^2 \cdot K}$
A	Area	m^2	
$h_{i,e}$	Heat transmission coefficient	W/(m² · K)	
$\lambda_{1 \ldots n}$	Thermal conductivity	W/(m · K)	
$d_{1 \ldots n}$	Wall thickness	m	
θ_{fi}	Inside temperature	°C	
θ_{fe}	Outside temperature	°C	
ΔT	Temperature difference	K	



GC.19
Heat transfer through a flat wall

TC.27
Heat transmission coefficient h from experience

Component	h [W/(m² · K)]
Building wall, inside h_i	8
Building wall, outside h_e	25

TC.28
Thermal conductivity λ of some solids

Solid	Temperature [°C]	λ [W/(m · K)]
Copper	20	384
Steel (0.2% C)	20	50
Steel (0.6% C)	20	46
CrNiMo steel	20	15
Gravel concrete	20	2.1
Glass (window glass)	20	0.8 ... 1.1
Brick	20	0.35 ... 0.9
Glass wool	20	0.04
Polyvinyl chloride, PVC-hart	20	0.15
Polyethylene, PE-HD	20	0.4
Polypropylene, PP	20	0.23
Polybutene, PB	20	0.19

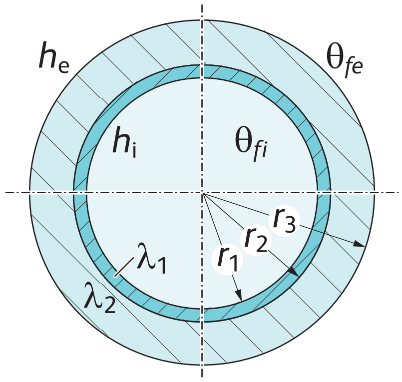
5.12 Heat transfer through a two-layer pipe

The heat transfer describes the transmission of the heat through a two-layer pipe. The heat transfer through a pipe is calculated according to the following formula:

$$\Phi = \frac{2 \cdot \pi \cdot l \cdot \left(\theta_{fi} - \theta_{fe}\right)}{\frac{1}{h_i \cdot r_1} + \frac{1}{\lambda_1} \cdot ln\frac{r_2}{r_1} + \frac{1}{\lambda_2} \cdot ln\frac{r_3}{r_2} + \frac{1}{h_e \cdot r_3}} \qquad [\Phi] = W$$

Size	Designation	Unit of measure
Φ	Heat flow	W
$\lambda_{1,2}$	Thermal conductivity	W/(m · K)
$h_{i,e}$	Heat transfer coefficient* is determined by flow and heat conduction processes	W/(m² · K)
l	Length of pipe segment	m
$r_{1,2,3}$	Radius	m
θ_e	Temperature of wall/pipe on the outside	°C
θ_i	Temperature of wall/pipe on the inside	°C
θ_{fi}	Temperature of fluid	°C
θ_{fe}	Temperature ambient temperature	°C
ΔT	Temperature difference	K

* Definition: ➨ [5.11] 'Heat transfer through a flat wall'



GC.20
Heat transfer through a two-layer pipe

5.13 Heat exchanger

The heat exchanger transmits heat through a heat transfer area from a warmer to a colder fluid (gases or liquids). The heat flow is calculated according to the following formula:

$$\Phi_{WÜ} = U \cdot A \cdot \Delta T_m \qquad \left[\Phi_{WÜ}\right] = \frac{W}{m^2 \cdot K} \cdot m^2 \cdot K = W$$

Size	Designation	Unit of measure
$\Phi_{WÜ}$	Heat flow	W
U	Heat transfer coefficient*	W/(m² · K)
A	Heat exchanger surface	m²
ΔT_m	Mean logarithmic temperature difference	K

* Definition: ➨ [5.11] 'Heat transfer through a flat wall'

Counterflow heat exchanger

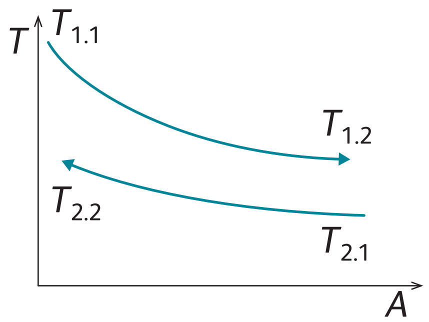
Counter flow heat exchanger bypasses two fluids (gases or liquids) of different temperatures and transfers the heat from the warmer to the colder fluid. The temperature difference is calculated according to the following formula:

$$\Delta T_m = \frac{\Delta T_{max} - \Delta T_{min}}{ln\left(\frac{\Delta T_{max}}{\Delta T_{min}}\right)}$$

$$[\Delta T_m] = K$$

$$\Delta T_{max} = T_{1.1} - T_{2.2}$$

$$\Delta T_{min} = T_{1.2} - T_{2.1}$$



GC.21
Heat exchanger, temperature profile

Direct current heat exchanger

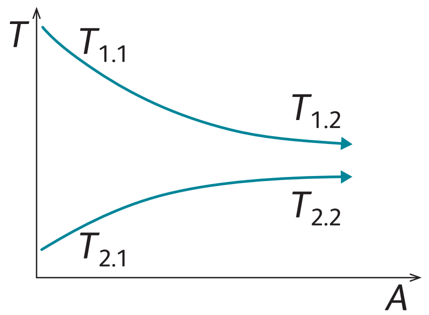
The direct current heat exchanger passes two fluids (gases or liquids) of different temperature in parallel to each other and transfers the heat from the warmer to the colder fluid. The temperature difference is calculated according to the following formula:

$$\Delta T_m = \frac{\Delta T_{max} - \Delta T_{min}}{ln\left(\frac{\Delta T_{max}}{\Delta T_{min}}\right)}$$

$$[\Delta T_m] = K$$

$$\Delta T_{max} = T_{1.1} - T_{2.1}$$

$$\Delta T_{min} = T_{1.2} - T_{2.2}$$



GC.22
Direct current heat exchanger, temperature profile

5.14 First law of thermodynamics

The first law of thermodynamics describes the conservation of energy in thermodynamic systems. In closed systems, energy can neither be created nor destroyed, but only transformed from one form to another.

Energy = exergy + anergy = const.

In all processes, the sum of exergy and anergy is constant.
- **Exergy:** The part of the energy that can be transformed into any form of energy.
- **Anergy:** The part of the energy that cannot be converted into exergy.

Forms of pure exergy	Forms of pure anergy
Electrical energy	Ambient heat
Potential energy	
Kinetic energy	

5.15 Second law of thermodynamics

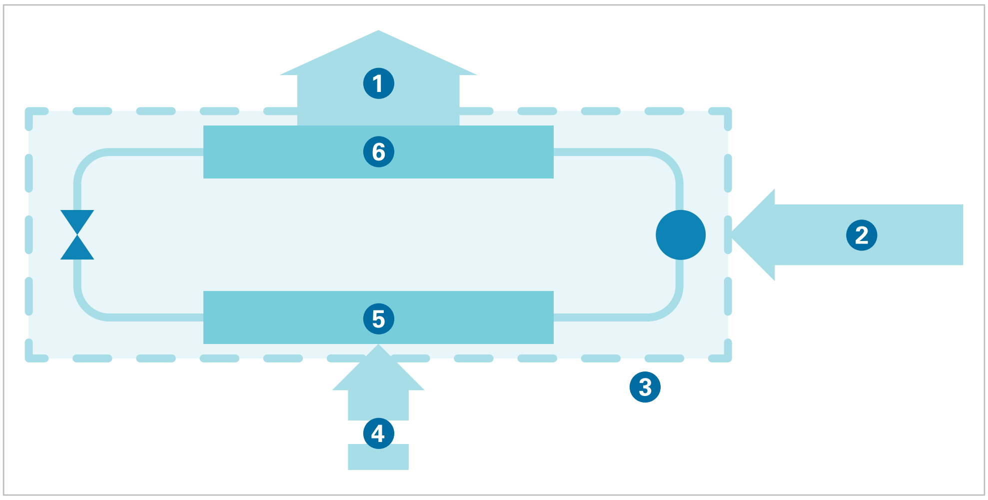
The second law of thermodynamics describes that energy cannot be arbitrarily transformed from one form of energy to another.

Example

Electrical energy can be converted almost completely into heat. However, heat can only be converted into electrical energy to a certain limit.

Definition through exergy

In all naturally occurring, irreversible processes, exergy is converted into anergy.



GC.23
Anergy and exergy
1. Useful energy
2. Exergy
3. System limit
4. Anergy
5. Evaporator
6. Condenser

5.16 Circular processes in the building technology

Carnot's coefficient of performance ε_{car} indicates the ratio between the power generated and the power being used. It is a theoretical value and describes the ideal, maximum possible efficiency. In practice, this performance takes place as a comparison between the real coefficient of performance (ε) to the theoretical maximum coefficient of performance (ε_{car}).

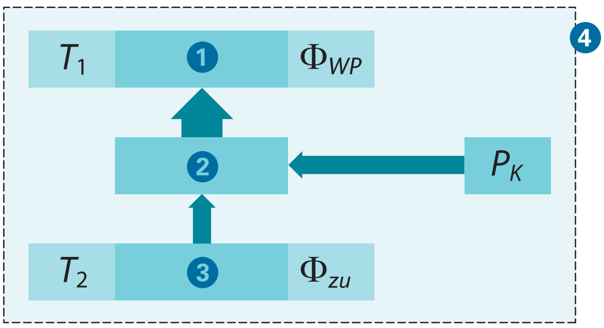
- A **quality grade** describes the relationship between a defined real situation and the theoretically possible situation. It is a measure of how well a real situation approaches its theoretical maximum.
- A **heat pump** uses the heat from the surroundings and generates a higher interior temperature through rapid compression.
- A **refrigeration machine** removes heat from an interior and releases the heat to the environment.

The performance figures and the grades are calculated according to the following individual formulas:

Carnot's coefficient of performance of the heat pump

$$\varepsilon_{WP,car} = \frac{\Phi_{WP}}{P_{K,th}} = \frac{T_1}{T_1 - T_2}$$

Size	Designation	Unit of measure
$\varepsilon_{WP,car}$	Maximum coefficient of performance of the heat pump	–
Φ_{WP}	Heat output of the heat pump	W
Φ_{zu}	Heat output from the environment	W
$P_{K,th}$	Compressor power (without losses)	W
T_1	Outlet temperature of the heating medium	K
T_2	Inlet temperature of surrounding medium	K

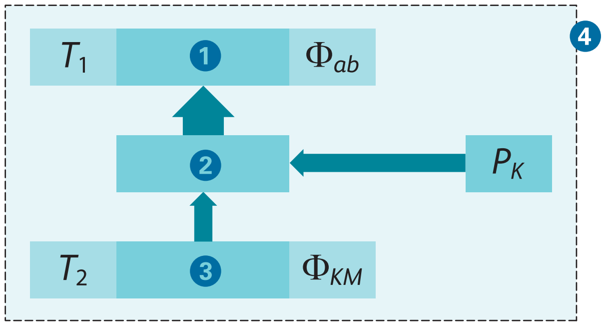


GC.24
Carnot's coefficient of performance of the heat pump
1 Heating system
2 Heat pump
3 Environment
4 System limit

Carnot's coefficient of performance of the refrigeration machine

$$\varepsilon_{KM,car} = \frac{\Phi_{KM}}{P_{K,th}} = \frac{T_2}{T_1 - T_2}$$

Size	Designation	Unit of measure
$\varepsilon_{KM,car}$	Maximum coefficient of performance of the refrigeration machine	–
Φ_{ab}	Heat output to the surrounding area	W
Φ_{KM}	Cooling capacity of the refrigeration machine	W
$P_{K,th}$	Compressor power (without losses)	W
T_1	Inlet temperature of surrounding medium	K
T_2	Outlet temperature of the refrigerant medium	K



GC.25
Carnot's coefficient of performance of the refrigeration machine

1. Heating system
2. Refrigeration machine
3. Environment
4. System limit

Real coefficient of performance of the heat pump

$$\varepsilon_{WP} = \frac{\Phi_{WP}}{P_K}$$

Size	Designation	Unit of measure
ε_{WP}	Coefficient of performance of the heat pump	–
Φ_{WP}	Heat output of the heat pump	W
P_K	Power consumption of the heat pump	W

Real coefficient of performance of the refrigeration machine

$$\varepsilon_{KM} = \frac{\Phi_{KM}}{P_K}$$

Size	Designation	Unit of measure
ε_{KM}	Coefficient of performance of the refrigeration machine	–
Φ_{KM}	Cooling capacity of the refrigeration machine	W
P_K	Power consumption of the refrigeration machine	W

Quality grade of the heat pump

$$\eta_{WP} = \frac{\varepsilon_{WP}}{\varepsilon_{WP,car}}$$

Size	Designation	Unit of measure
η_{WP}	Quality grade of the heat pump	–
ε_{WP}	Coefficient of performance of the heat pump	W
$\varepsilon_{WP,car}$	Maximum coefficient of performance of the heat pump	W

Quality grade of the refrigeration machine

$$\eta_{KM} = \frac{\varepsilon_{KM}}{\varepsilon_{KM,car}}$$

Size	Designation	Unit of measure
η_{KM}	Quality grade of the refrigeration machine	–
ε_{KM}	Coefficient of performance of the refrigeration machine	W
$\varepsilon_{WP,car}$	Maximum coefficient of performance of the refrigeration machine	W

6 Fluid dynamics

Fluid dynamics is a branch of fluid mechanics and deals with liquids and gases (fluids) in motion.

6.1 Hydrostatic pressure

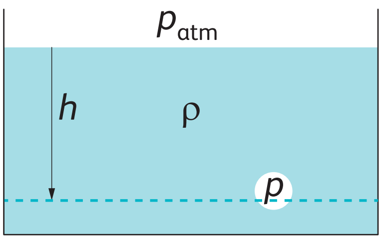
Hydrostatic pressure is the pressure that occurs within a quiescent fluid due to the influence of gravity.

Gravitational pressure in depth h

Gravitational pressure is calculated according to the following formula:

$$p = \rho \cdot g \cdot h \qquad [p] = \frac{kg \cdot m \cdot m}{m^3 \cdot s^2}$$

Size	Designation	Unit of measure	Addition
p	Pressure	Pa	–
g	Gravitational acceleration	m/s^2	$g = 9.81\ m/s^2$
ρ	Density	kg/m^3	–
h	Height (column of fluid)	m	–



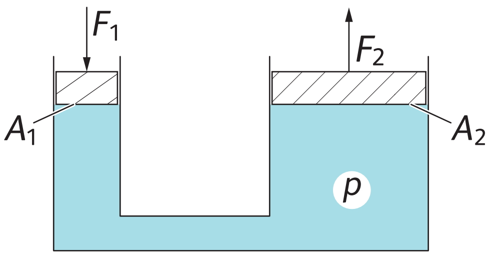
GC.26
Gravitational pressure in depth h

6.2 Basic principle of hydraulics (hydraulic press)

The basic principle of hydraulics describes the independence of the pressure from the shape of the vessel. The basic principle of hydraulics reads:

$$\frac{F_1}{F_2} = \frac{A_1}{A_2}$$

Size	Designation	Unit of measure
F_1	Force of the pump's piston	N
F_2	Force of the press piston	N
A_1	Area of the pump's piston	m^2
A_2	Area of the press piston	m^2



GC.27
Hydraulic press

C

6.3 Buoyancy

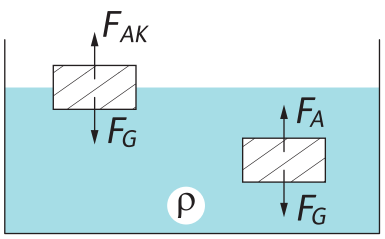
The buoyancy of a body opposes the force of gravity and is dependent on its volume and the density of the fluid surrounding the body. Buoyancy is calculated according to the following formula:

$$F_A = \rho_{Fl} \cdot g \cdot V \qquad [F_A] = \frac{kg \cdot m \cdot m^3}{m^3 \cdot s^2} = N$$

$$F_{AK} = \rho_{Fl} \cdot g \cdot V_K \qquad [F_{AK}] = \frac{kg \cdot m \cdot m^3}{m^3 \cdot s^2} = N$$

$$F_G = m \cdot g \qquad [F_G] = \frac{kg \cdot m}{s^2} = N$$

Size	Designation	Unit of measure
F_A	Buoyancy (of solids)	N
F_{AK}	Buoyancy (of an immersed body)	N
F_G	Weight force	N
ρ_{Fl}	Density of the liquid	kg/m³
g	Gravitational acceleration	m/s²
V	Volumes (of solids)	m³
V_K	Volumes (of an immersed body)	m³
m	Mass of the body	kg



GC.28
Buoyancy

6.4 Air pressure

The air pressure describes the pressure exerted on a body, which is caused by the weight of the air column above the body. The air pressure decreases with increasing altitude and is described by the barometric altitude formula. The barometric height is calculated according to the following formula:

$$p = p_0 \cdot e^{\left(-\frac{\rho_0}{p_0} \cdot g \cdot h\right)} \qquad [p] = Pa$$

Size	Designation	Unit of measure	Addition
p	Air pressure at height h	Pa	–
p_0	Normal air pressure	Pa	p_0 = 101,325 Pa
ρ_0	Normal air density	kg/m³	ρ_0 = 1.293 kg/m³
g	Gravitational acceleration	m/s²	g = 9.81 m/s²
h	Height	m	–

6.5 Volumetric flow rate with flowing fluids

Symbol for volumetric flow rate
→ In the formulas and calculations of building technology, the volumetric flow rate is different from the notation here identified with the letter **Q**.

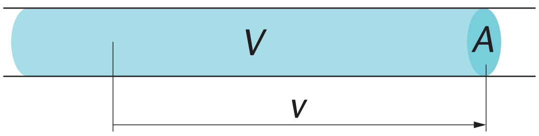
The volumetric flow rate with flowing fluids is calculated according to the following formula:

$$\dot{V} = \frac{V}{t}$$

$$\dot{V} = A \cdot v$$

$$[\dot{V}] = \frac{m^2 \cdot m}{s} = \frac{m^3}{s}$$

Size	Designation	Unit of measure
$\dot{V}$	Volumetric flow rate	m^3/s
V	Volumes	m^3
t	Time	s
A	Area	m^2
v	Velocity	m/s



GC.29
Volumetric flow rate

The following **conversion table** is helpful when applying the calculations.

TC.29
Conversion table with units of flow rate

[m³/h]	[l/min]	[l/s]	[m³/s]
1.0	16.67	0.278	$2.78 \cdot 10^{-4}$
0.06	1.0	0.017	$1.67 \cdot 10^{-5}$
3.6	60	1.0	$1.00 \cdot 10^{-3}$
3,600	60,000	1,000	1.0

6.6 Mass flow rate with flowing fluids

The mass flow rate with flowing fluids is calculated according to the following formula:

$$\dot{m} = \dot{V} \cdot \rho$$

$$[\dot{m}] = \frac{m^3 \cdot kg}{s \cdot m^3} = \frac{kg}{s}$$

Size	Designation	Unit of measure
$\dot{m}$	Mass flow rate	kg/s
$\dot{V}$	Volumetric flow rate	m^3/s
ρ	Density	kg/m^3

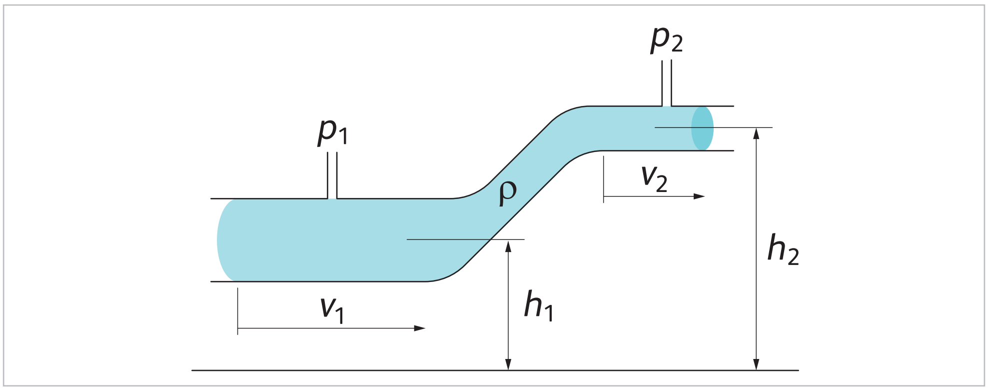
6.7 Bernoulli equation

The Bernoulli equation describes the relationship between the velocity of the fluid (gases and liquids) and the geodesic level and the static pressure in a fluid (gases and liquids).
The Bernoulli equation applies in different forms:

Form of the equation	Dynamic part		Geodesic part		Static part		Total	SI unit
Specific energy*	$\frac{v^2}{2}$	+	$g \cdot h$	+	$\frac{p}{\rho}$	=	const	$\left[\frac{Nm}{kg}, \frac{m^2}{s^2}\right]$
Pressure	$\rho \cdot \frac{v^2}{2}$	+	$\rho \cdot g \cdot h$	+	p	=	const	$\left[Pa, \frac{N}{m^2}\right]$
Height	$\frac{v^2}{2 \cdot g}$	+	h	+	$\frac{p}{\rho \cdot g}$	=	const	[m]

* The specific energy refers to the dimension m = 1 kg

Size	Designation	Unit of measure
v_1	Velocity of fluid at point 1	m/s
v_2	Velocity of fluid at point 2	m/s
g	Gravitational acceleration (g = 9.81 m/s²)	m/s^2
h_1	Geodesic height at point 1	m
h_2	Geodesic height at point 2	m
p_1	Static pressure at point 1	Pa
p_2	Static pressure at point 2	Pa
ρ	Density of the fluid	kg/m^3



GC.30
Bernoulli equation

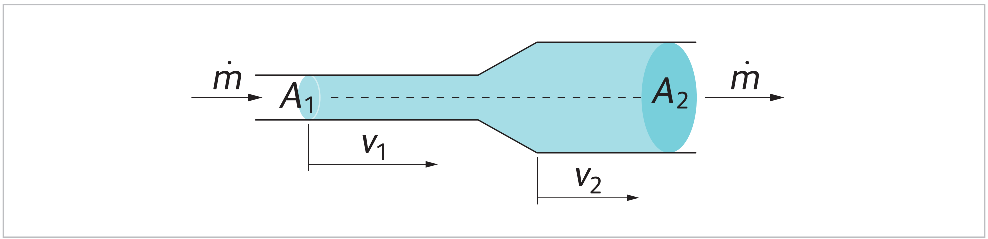
6.8 Continuity equation

At constant flow, the mass flow of a fluid (gas or liquid) is independent of the cross-sectional area or the velocity of the fluid. The continuity equation is calculated according to the following formula.

Along a fluid conduit, the following applies: $\dot{m}$ = const

$$A_1 \cdot v_1 = A_2 \cdot v_2$$

Size	Designation	Unit of measure
$\dot{m}$	Mass flow rate of the fluid	kg/s
$\dot{V}$	Volumetric flow rate of the fluid	m^3/s
$A_{1,2}$	Cross-section of the fluid conduit	m^2
$v_{1,2}$	Velocity of the fluid	m/s
ρ	Density of the fluid	kg/m^3



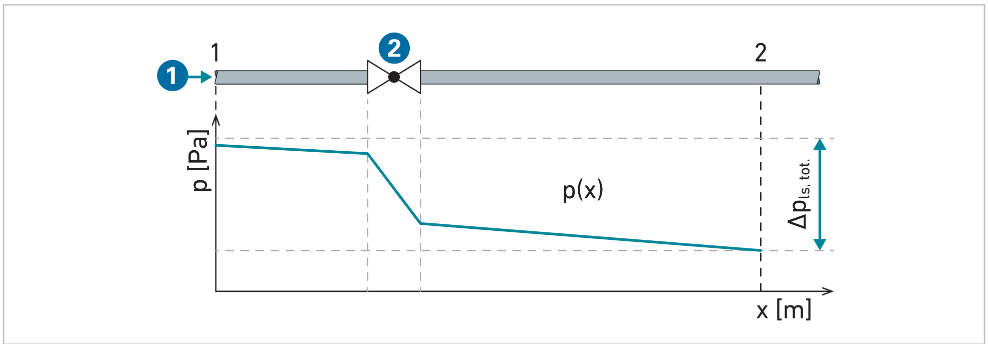
GC.31
Continuity equation

6.9 Pressure loss

The total pressure loss inside a conduit is calculated according to the following formula:

Pipe		Local resistance		Total pressure loss
$\sum \Delta p_{ls,R}$	+	$\sum \Delta p_{ls,E}$	=	$\Delta p_{ls,tot}$
$\sum \lambda \cdot \frac{l}{d_h} \cdot \frac{\rho \cdot v^2}{2}$	+	$\sum \zeta \cdot \rho \cdot \frac{v^2}{2}$	=	$\Delta p_{ls,tot}$

Size	Designation	Unit of measure
Δp_{ls}	Pressure loss	Pa
ζ	Drag coefficient of the built-in fixtures	–
λ	Pipe friction factor	–
ρ	Density of the fluid	kg/m^3
v	Flow velocity of the fluid	m/s
l	Length of the pipeline	m
d_h	hydraulic diameter	m



GC.32
Pressure loss

1. Flow direction of the fluid, e.g. water
2. Built-in fixtures: e.g. valve, fitting, instrument

1 Condition at the start
2 Condition at x
p Pressure
p(x) Pressure loss along distance x
x Pipe section (pipe length [m])

C

6.10 Reynolds number

The Reynolds number is used in fluid mechanics and is a tool for determining the type of flow. The Reynolds number is defined by the ratio of inertial forces to viscous forces. The Reynolds number is calculated according to the following formula:

$$Re = \frac{d_h \cdot v}{\nu} \qquad [Re] = \frac{m \cdot m \cdot s}{s \cdot m^2}$$

$$d_h = \frac{4 \cdot A}{U} \qquad d_h = \frac{m^2}{m} = m$$

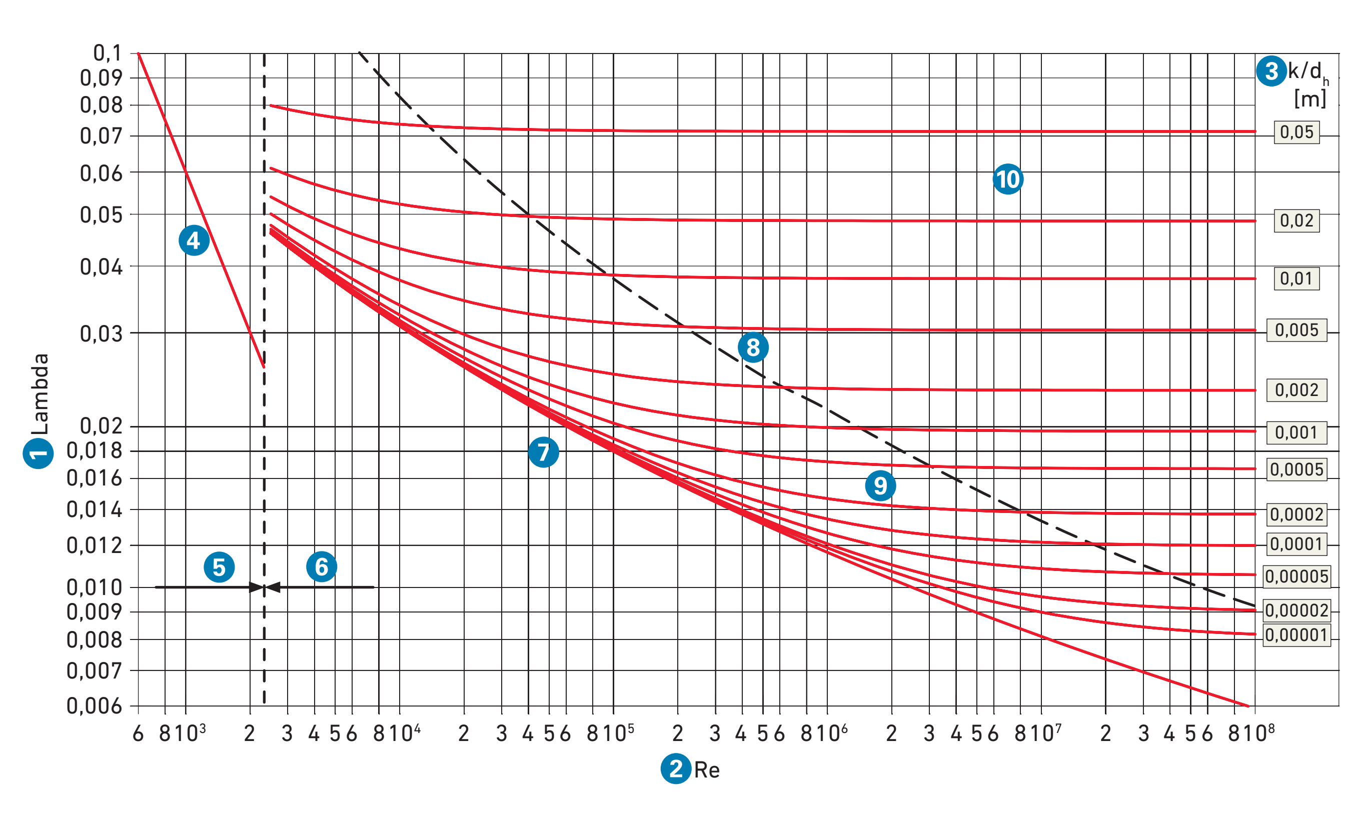
Size	Designation	Unit of measure	Note
Re	Reynolds number	–	Re <2,320 = laminar pipe flow Re >2,320 = turbulent pipe flow
v	Flow velocity of the fluid	m/s	–
d_h	Hydraulic diameter	m	For a pipe, the following applies $d_i = d_h$
d_i	Internal diameter	m	
ν	Kinematic viscosity of the fluid	m^2/s	–
U	Scope	m	–
A	Area	m^2	–

TC.30
Pipe roughness of some materials

Material	Pipe roughness k [mm]
Copper/brass	0.001 ... 0.005
Fibre cement	0.05 ... 0.1
Steel pipe. new	0.02 ... 0.1
Steel pipe. corroded	0.15 ... 1.5
Sheet metal duct. folded	0.15 ... 0.2
Spiral duct	0.1 ... 2.0
Plastic pipe	0.007

TC.31
Kinematic viscosity ν of water and air

Solid	Temperature [°C]	Kinematic viscosity ν [m^2/s]
Water	0	$1.789 \cdot 10^{-6}$
	20	$1.006 \cdot 10^{-6}$
	60	$0.478 \cdot 10^{-6}$
	100	$0.294 \cdot 10^{-6}$
Air	–20	$11.78 \cdot 10^{-6}$
	0	$13.52 \cdot 10^{-6}$
	20	$15.35 \cdot 10^{-6}$
	40	$17.26 \cdot 10^{-6}$
	60	$19.27 \cdot 10^{-6}$



GC.33 **Moody chart for determining the pipe roughness λ***

1. Lambda
2. Reynolds number
3. Pipe roughness per diameter
4. λ = 64/Re
5. laminar
6. turbulent
7. Hydraulically smooth
8. Limiting curve
9. Transition section
10. Hydraulically rough area

* Source: Recktenwald, Gerald (2007), Pipe Flow Analysis with Matlab

6.11 Pumps and fans

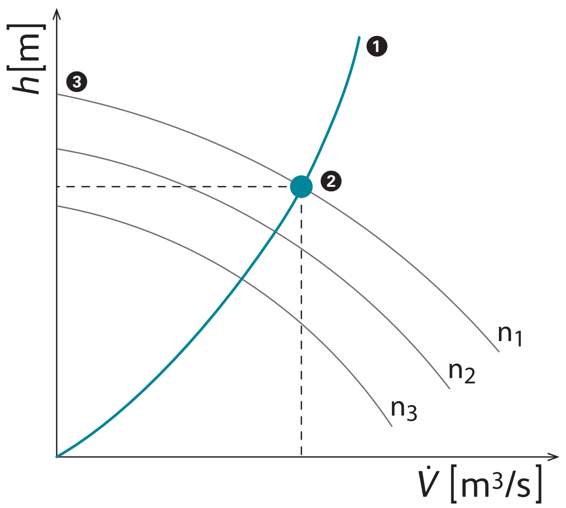
Pumps and fans are continuous flow machines. They transfer the energy to a fluid (gases or liquids) through movement. The energy supply is synonymous with the increase in pressure. Pumps and fans can be used to control the pressure in the pipe network or in the system. In this case, however, the pressure can drop due to effects of friction. When using the system/ pipe network characteristic curve, the operating point of a continuous flow machine is determined in order to achieve a stable system. For the system/pipe network the following applies: The pressure loss of a system is approximately proportional to the square of the volumetric flow rate.

$$\Delta p \sim \dot{V}^2$$

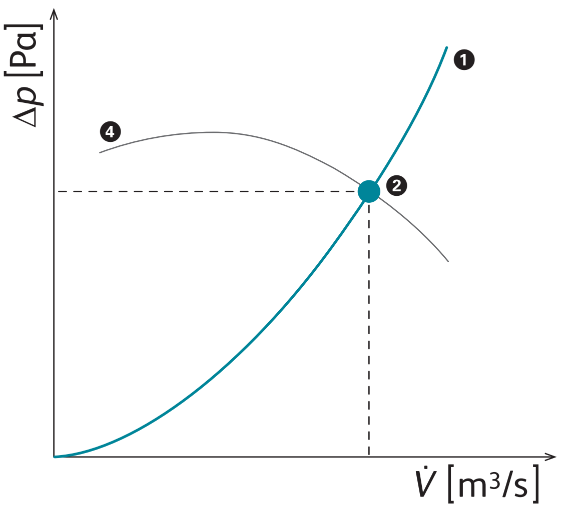
Size	Designation	Unit of measure
$\dot{V}$	Rate of delivery	m^3/s
h	Static head	m
Δp	Pressure loss/pressure difference	Pa
n	Rotational speed	min^{-1}
P_2	Hydraulic output	W
P_1	Electric power consumption	W
η_P	Hydraulic efficiency of the pump	–
η_V	Hydraulic efficiency of the fan	–
η_M	Efficiency of the actuator motor	–
η_W	Efficiency of the shaft	–

1 System curve
2 Operating point
3 Pump capacity curve
4 Fan characteristic curve

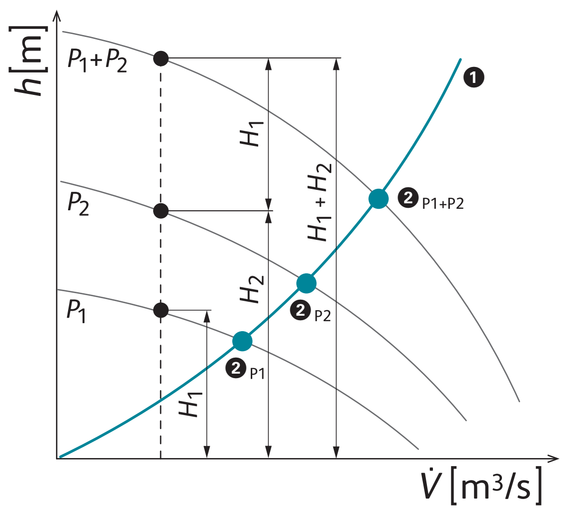
Pump capacity curve



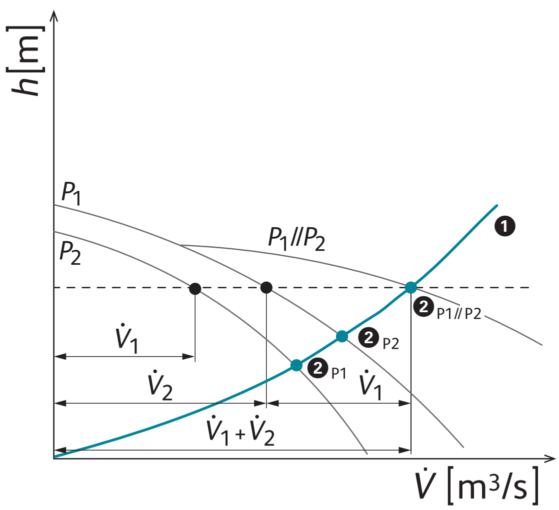
Fan characteristic curve



Parallel connection



Serial connection



6.12 Proportionality laws

The proportionality laws allow conversion at speed change to the new performance of the rate of delivery, pressure loss and power consumption. The proportionality laws listed here apply to frictionless, incompressible flows. For technical applications, they are to be regarded as a **approximation method**. The volumetric flow rate is calculated according to the following formulas:

$$\dot{V}_2 = \frac{n_2}{n_1} \cdot \dot{V}_1 \qquad [\dot{V}_2] = \frac{m^3}{s}$$

The pressure loss is calculated according to the following formulas:

$$\Delta p_2 = \left(\frac{n_2}{n_1}\right)^2 \cdot \Delta p_1 \qquad [\Delta p_2] = Pa$$

The power consumption is calculated according to the following formulas:

$$P_2 = \left(\frac{n_2}{n_1}\right)^3 \cdot P_1 \qquad [P_2] = W$$

Size	Designation	Unit of measure
$\dot{V}_{1,2}$	Volumetric flow rate	m^3/s
$n_{1,2}$	Rotational speed	min^{-1}
$\Delta p_{1,2}$	Pressure loss	Pa
$P_{1,2}$	Power consumption	W

TC.32 **Power consumption of pumps and fans**

Parameters	Pump	Fan	Unit of measure
Hydraulic output	$P_2 = \dot{V} \cdot \rho \cdot g \cdot h$	$P_2 = \dot{V} \cdot \Delta p$	$[P_2] = W$
Electric power consumption/ shaft output	$P_1 = \frac{P_2}{\eta_P}$	$P_1 = \frac{P_2}{\eta_V}$	$[P_1] = W$
Efficiency	$\eta_P = \frac{P_2}{P_1}$	$\eta_V = \frac{P_2}{P_1}$	$[\eta_{P/V}] = 1$
Total efficiency	$\eta_{P,ges} = \eta_P \cdot \eta_M \cdot \eta_W$	$\eta_{V,ges} = \eta_V \cdot \eta_M \cdot \eta_W$	$[\eta_{ges}] = 1$

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