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REHAU PP-R fiber technical manual

Large diameter pipework for heating and plumbing applications

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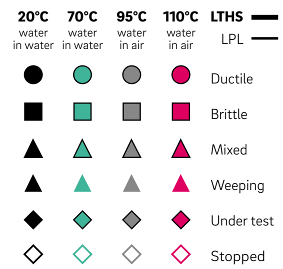
REHAU

Contents

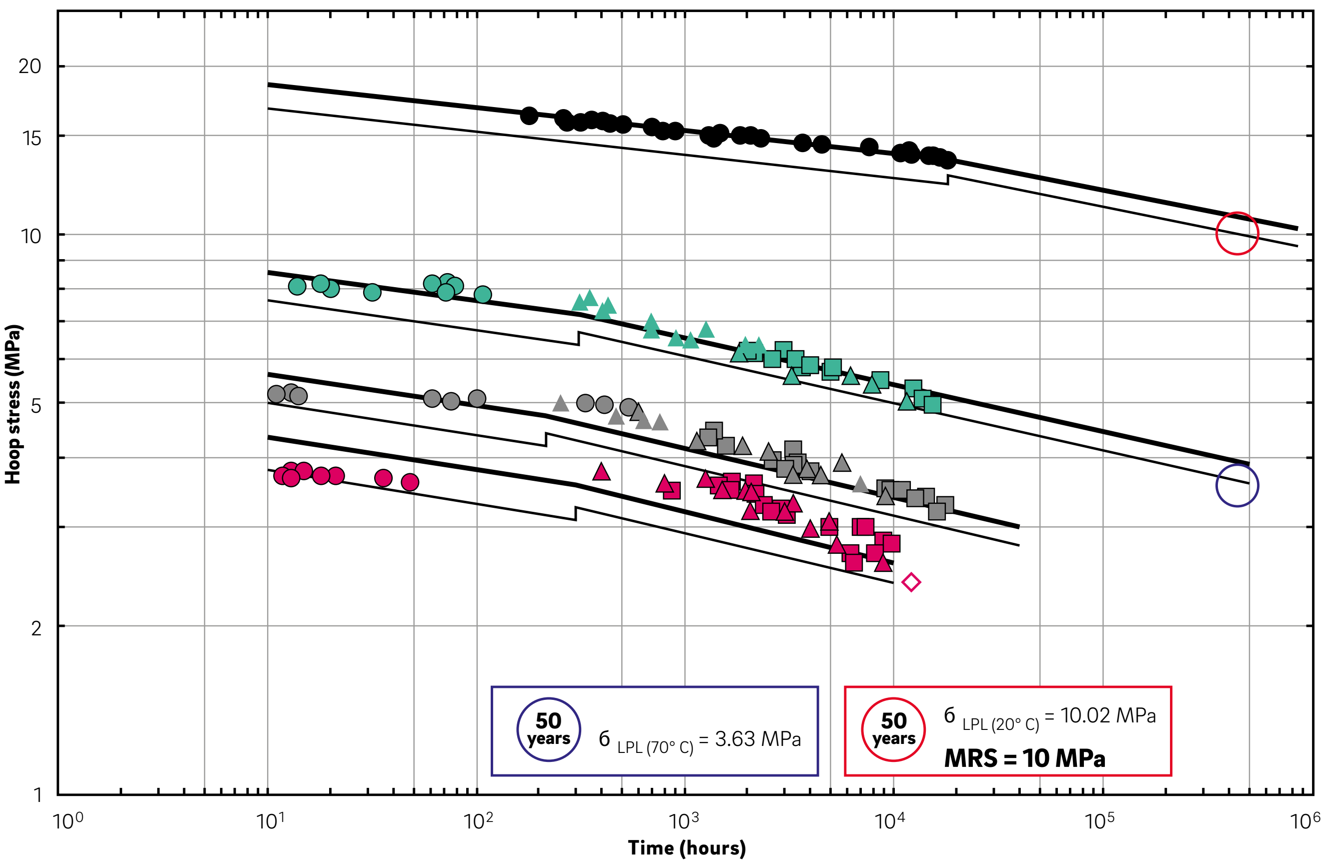
01 Pipework materials

Fitting Material
For over two decades the PP-R 80 Super material grade has proven itself to give a superior performance over the old PP-R 80 material grade.

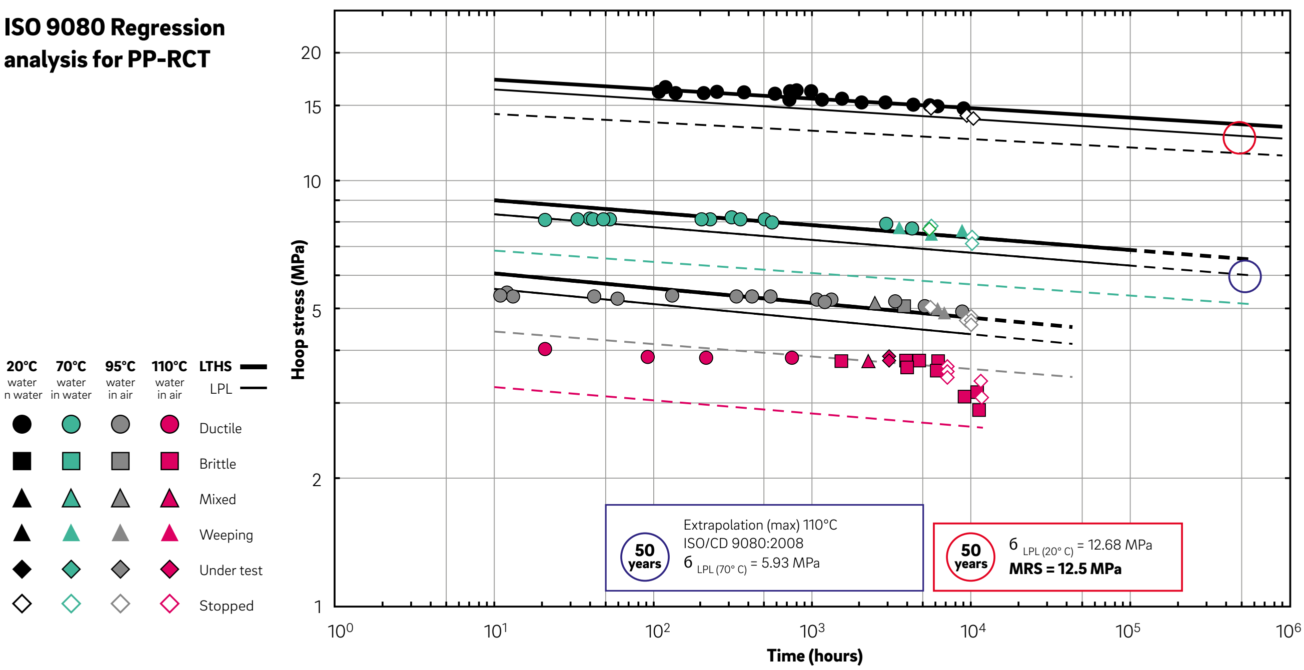
The regression curves illustrate how components made from PP-R 80 Super have an increased stress / pressure resistance compared to PP-R 80 materials. At 20degC the pressure capability over 50 years is with 10MPa 20% higher than that of PP-R 80.



ISO 9080 Regression analysis for PP-R 80 Super



ISO 9080 Regression analysis for PP-RCT



PP-R fiber pipes
A 3-layer SDR 7.4 pipe using a fiber-reinforced middle layer, PP-R 80 super as an outer jacket and a specially crafted inner layer made of PP-RCT WOR represents the new generation of Polypropylene pipes.

PP-RCT allows for most stringent classification and reduced wall thickness, even reaching EN ISO 15874 class 5 (work at high temperature class).

By adding a package of WOR (White Oxidation Resistance) additives to these already exceptional features of the raw material, with the dual function of improving performance at high temperatures over time and significantly slowing the oxidation process of plastic materials under the aggressive effect of highly oxidising substances that may be dissolved in water.

Table comparing PP-R 80 Super and PP-RCT

	Unit of measurement	PP-R 80 Super	PP-RCT
σ LPL (20°C)	MPa	10.0	12.7
σ LPL (70°C)	MPa	3.6	6.0
Melt Flow Rate 190/5	g/10 min	0.5	0.4
Melt Flow Rate 230/5	g/10 min	1.3	1.0
Melt Flow Rate 230/2.16	g/10 min	0.3	0.2
Elongation at yield	%	10	12
Crystallisation temperature	°C	97.5	100.5
Tensile modulus	MPa	848	850

Advantages

The main advantages of the products made with these raw materials are as follows:

- high resistance to oxidation
- reduced wall thickness
- increased flow rate
- high resistance to pressure
- increased working temperatures
- reduced weight
- reduced thermal expansion
- decreased number of clamping points
- total compliance with standards regulating potable water transport
- resistance to typical corrosive phenomena
- 100% recyclable material
- low environmental impact LCA product cycle.

Classification of service conditions according to UNI EN ISO 15874

Application class	T_D	Years[1] at T_D	T_{max}	Years at T_{max}	T_{mal}	Hours at T_{mal}	Application fields
	(°C)[2]		(°C)[2]		(°C)[2]		
1	60	49	80	1	95	100	Hot water (60°C)
2	70	49	80	1	95	100	Hot water (70°C)
4[1]	20 followed by 40 followed by 60	2.5 followed by 20 followed by 25	70	2.5	100	100	Floor heating and low temperature installations
5[1]	20 followed by 60 followed by 80	14 followed by 25 followed by 10	90	1	100	100	High temperature radiator

(1) In the event that more than one design temperature is present in a single class, the times must be combined/summed up (Example: the 50-year design temperature for a class 2 is: 70°C for 49 years combined with 80°C for 1 year and 95°C for 100 hours). (2) T_D (Design temperature), T_{max} (Maximum design temperature) and T_{mal} (Malfunction temperature) for temperatures above those given in the table, this classification is not applicable.

Correlation between application classes, SDR/series and design pressures P_D for polypropylene pipes UNI EN ISO 15874

PP-RCT

	Classes of application						P_D			
	1	2	4	5			10	8	6	4
P_D	SDR					SDR	Admissible classes			
						7.4	1/2/4	5	5	5
8	–	–	–	7.4						
10	7.4	7.4	7.4	--						

A given SDR/S can also be used with lower P_D.

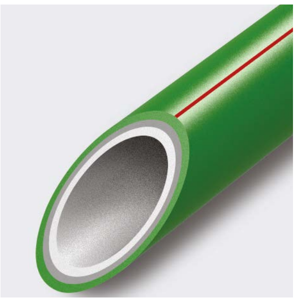
02 PP-R fiber-reinforced multilayer pipes

The PP-R fiber fiber-reinforced system represents a smart evolution of single layer ones: the use of the latest generation of polymeric raw materials, as well as the use of innovative additives, has given these products special performance that place them at the top list in the hydraulic sector.

The wall composition of the multilayer pipe allowed the material and the specific additives to be concentrated where they are most effective.

These features can be summarized as follows:
- pipe inner layer made of PP-RCT (polypropylene random copolymer with modified crystallinity) with high long-term resistance (MRS 12.5 MPa) and high chemical resistance (oxidising agents as chlorine-type); the addition of antioxidant additives of the latest generation make pipes particularly resistant to the chemical extraction and extremely effective in terms of stabilization of the polymeric material
- the intermediate layer made of PP-RF (polypropylene copolymer fiber-reinforced) ensures a drastic elongation reduction due to thermal expansion
- the outer layer made with PP-R 80 Super gives proper ductility and resilience to the pipe.

All these features give to the pipes the following advantages:
- a reduction of linear thermal expansion (α) of 70% compared to single layer pipes, making laying easier (clamping)
- higher operating conditions (pressure/temperature/duration) for the same thickness of single layer pipes or, in other words, it's possible to use thinner pipes granting higher operating conditions with the benefit of lightness and flow.



PP-R fiber pipes

PP-RCT and PP-R 80 Super fiber-reinforced pipe to connect by polyfusion with welding and threaded fittings. For surface mounted and/or concealed laying.

Description
PP-R fiber pipes in SDR 7.4, of PP-RCT WOR (White Oxidation Resistance) is especially recommended when creating sanitary systems. In the event of transporting chemical products, check suitability with our Technical Department.

Data sheet and marking
Raw material: PP-RCT WOR/PP-RF/PP-R
Series: S 3.2
Thermal conductivity at 20°C: λ 0.90 W/mK
Coefficient of linear thermal expansion (CLTE): α 0.035 mm/mK
Internal roughness: 0.007 mm
Colour: from Ø 20 to Ø 125mm: inner layer white, external layer green, red strips -
Range: from Ø 20 to Ø 125 mm
Marking: inscription printed along the trajectory with dashed spaces on every linear metre, as shown below:
aquatechnik art. XXXXX -- PP-RCT/PP-RF/PP-R -- fusio-technik faser FIBER-T -- mm dia x thk -- (standard and product certification references) -- HH:MM DD. MM.YY -- LX -- Lotto XXXXX -- IDONEO al trasporto di acqua potabile/SUITABLE for drinking water conveyance -- made in Italy ---------- (hatch up to 95-98 cm)

Working conditions
See the tables on page 13.

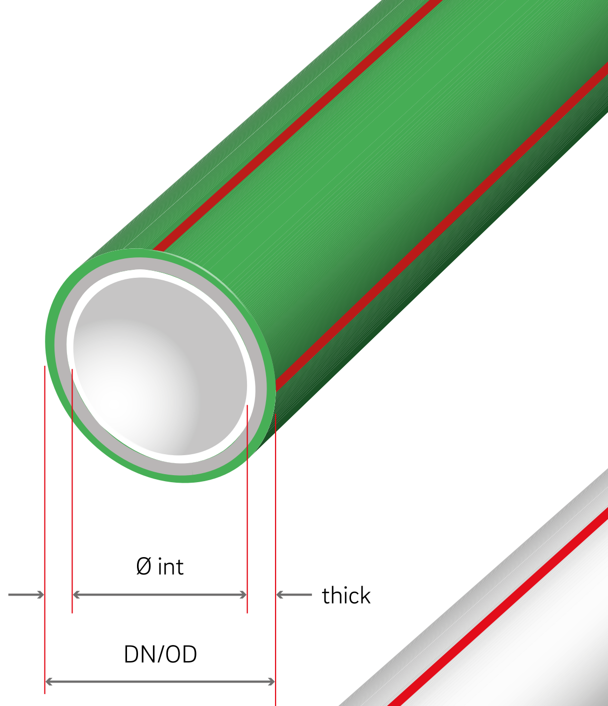
Fields of application
The large diameter range and the wide choice of pipes allow the system to be used in the most varied fields in the civil, industrial and service sectors for sanitary, and heating.

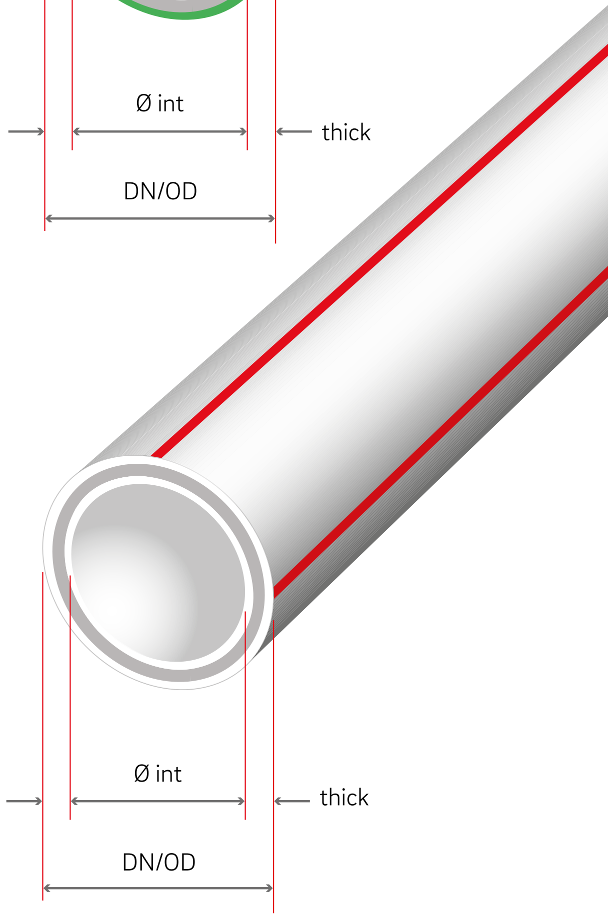
The pipes are suitable for the transport of hot and cold drinking water at the temperatures and pressures given in the tables on pages 06 and 13.

To set up for the conveyance of liquids and/or different substances, contact our Technical Department.

Standards and Certifications
Product in reference with the requirements requested by the EN ISO 15874-2, DIN 8077-8078, ASTM F2389 standards (regarding the dimensions and pressure fields for polypropylene piping), to transport hot and cold fluids for human consumption, for heating, air conditioning and mechanical systems in general.

The system has also obtained certification from around the world including KIWA UK, IIP, ICC-ES and Lloyd's Register.





Product specifications

SDR	DN/OD	int. Ø	Thick.	DN*	H_2O cont.	Weight**	Stick length	Quantity per bundle
	mm	mm	mm	mm	l/m	Kg/m	m	m
7.4	20	14.4	2.8	15	0.163	0.158	4	100
7.4	25	18.0	3.5	20	0.254	0.245	4	100
7.4	32	23.2	4.4	25	0.423	0.393	4	40
7.4	40	29.0	5.5	32	0.661	0.606	4	40
7.4	50	36.2	6.9	40	1.029	0.939	4	20
7.4	63	45.8	8.6	50	1.647	1.478	4	20
7.4	75	54.4	10.3	--	2.324	2.090	4	20
7.4	90	65.4	12.3	65	3.359	2.995	4	12
7.4	110	79.8	15.1	80	5.001	4.519	4	8
7.4	125	90.8	17.1	--	6.475	5.572	4	4

*The DN value shown in the tables refers to metal pipes and indicates the corresponding plastic pipe. **NB: the indicated weights are the real ones of the item during the production phases, therefore they can change according to the dimensional variations of the product.

03 Pipe Applications

- ■ (green) Recommended for technical advantages
- ■ (grey) Possible use
- ■ (magenta) Not suitable

	PP-R Fiber SDR 7.4
Drinking water at high temperature	Recommended for technical advantages
Drinking water at low temperature	Recommended for technical advantages
Heating	Possible use
Conditioning/cooling	Possible use
Chilled water	Possible use
Swimming pools	Possible use
Heating/Cooling for sports facilities	Possible use
Conveying chemicals*	Recommended for technical advantages
Rainwater	Possible use
Irrigation	Possible use
Floor heating and cooling	Recommended for technical advantages
Naval	Recommended for technical advantages
Civil geothermal plants	Possible use
Industrial geothermal plants	Possible use
Agriculture	Possible use
UV exposure	Not suitable
Fire resistance	Not suitable

04 Fittings

REHAU offer a wide, comprehensive series of PP-R 80 Super, PP-RCT and fabricated fittings to complete the pipe systems.

The range includes transition fittings, end parts made with male and female threaded inserts, flanged joints, valves, in addition to supplementary fittings that allow you to join and create connections with all the pipe and fitting systems offered by the company.

The jointing between the parts is done through polyfusion welding (socket welding)_ up to Ø 125mm, a process that ensure maximum seal safety even in the most extreme conditions of use. Pre-fabrication is possible to make sections such as manifolds or distribution headers.

Technical features and marking:

Colour and material:
- up to Ø 125 mm: green or white (with metal insert) , made of PP-R 80 Super

Thickness:
- Fittings up to Ø 125: SDR 5 (see exceptions)

Threads and metal parts:
Made according to ISO 7 and ISO 228, of CW 617 N brass alloy. Some fittings are made with a lead-free gunmetal alloy CuSn4Zn2PS. Please refer to the end of this manual for further information on fitting alloys and compatible water quality.

Reference standards:
Product in compliance with the requirements requested by the EN ISO 15874, DIN 8077-8078 European standards.

Marking:
All the PP-R fiber range fittings (except when the reduced dimensions of the parts do not allow it) bear the company information, the year of manufacture, pipe size.

Field of application:
Can be used with all the PP-R fiber pipe ranges in the related fields of use.

Reference standards:
Product in compliance with the requirements requested by the EN ISO 15874, DIN 8077-8078 European standards.

05 Design

The specific solutions and the diameter range available allow even the design process to be optimised. PP-R fiber systems allow for the development of cold or hot potable water distribution networks, reuse water distribution networks, heating/cooling networks and technological systems. Designing with PP-R fiber systems offers the following advantages:

- simplified calculation and application of product designs
- consistency in line processing and clamping
- a contribution in reducing heat loss from the networks (λ 0.19 W/mK for multilayer pipes)
- extended life cycle, following the catalogue instructions, exceeding 50 years
- 100% recyclable.

How to choose the most suitable system
Choosing the most suitable system will be guided by the specificity of the system to create, based on whether you intend to create lines for potable water or mechanical systems (cooling, compressed air and industrial in general). In this last case, the chemical compatibility with the fluid carried needs to be verified.

The reduced thermal elongation behaviour of the PP-R fiber reinforced pipes make them very suitable for surface mounted installations.

It is also necessary to consider the working temperatures and pressures and desired life span indicated in the respective tables for open loop systems, typically hot & cold water supply and closed loop systems, such as heating & cooling systems.

Systems with different fluids
For any non-standard applications, please contact the REHAU technical department with the requested fluids, temperatures and pressure.

Sizing
The PP-R fiber system allows systems to be designed in compliance with the EN 806 standard regarding pipe sizing for potable water systems. This standard contains information for the simplified method that considers uses as LU (load units).

To size the more complex pipes, we will establish the water supply necessity to satisfy, considering maximum admissible speeds, containment of flowing noises, water hammer and overall pressure drops.

Recommended max flow speed, sanitary networks inside buildings

		Pipe section			
		Connection lines	Intake pipe: sections with full-bore minimum pressure drop valves (<2.5*)	Sections of pipe with valves with high pressure drop coefficient**	Sanitary hot water recirculation
Maximum flow speed considered for a flow duration	≤ 15 min not-continuous (sanitary)	2 m/s	5 m/s	2.5 m/s	1 m/s
	> 15 min continuous (sanitary)	2 m/s	2 m/s	2 m/s	1 m/s

for example * ball valves, inclined-seat valves ** flat-seat valves.

Operating conditions closed loop systems

Operating profile	Temperature	Years of operation	Bar SDR 7.4 *SF 1.25
Constant temperature at 70°C 30 days/year of which	75°C	5	16.2
		10	15.7
		25	15.2
		50	15.0
	80°C	5	15.0
		10	14.8
		25	14.3
		50	14.0
	85°C	5	13.8
		10	13.5
		25	13.0
		50	12.8
	95°C	5	11.4
		10	10.9
		25	10.6
		50	9.8
Constant temperature at 70°C 60 days/year of which	75°C	5	16.0
		10	15.5
		25	15.2
		50	14.6
	80°C	5	14.8
		10	14.3
		25	14.0
		50	13.4
	85°C	5	13.5
		10	13.0
		25	12.8
		50	12.2
	95°C	5	10.9
		10	10.6
		25	10.4
		50	9.8
Constant temperature at 70°C 90 days/year of which	75°C	5	15.5
		10	15.4
		25	14.7
		50	14.2
	80°C	5	14.3
		10	14.2
		25	13.5
		50	13.0
	85°C	5	13.0
		10	12.9
		25	12.3
		50	11.8
	95°C	5	10.6
		10	10.5
		25	9.8
		50	9.4

*SF = Safety factor

Note: for applications with chilled water mixed with ethylene glycol or glycerine, -20°C limit temperature. In this case, separate the lines from the circulators with specific anti-vibration joints.

Operating conditions for open loop hot & cold water systems

Temperature	Years of operation	Bar SDR 7.4 *SF 1.5
		bar
10°C	10	31.3
	25	30.4
	50	29.6
	100	28.0
20°C	10	28.5
	25	27.4
	50	26.8
	100	25.3
30°C	10	25.4
	25	24.5
	50	23.9
	100	22.7
40°C	10	22.3
	25	21.5
	50	21.1
	100	20.1
50°C	10	19.2
	25	18.7
	50	18.2
	100	17.5
60°C	10	16.2
	25	15.5
	50	15.4
70°C	10	13.1
	25	12.7
	50	12.5
80°C	10	11.0
	25	10.4
95°C	5	8.5
	10	7.9

Pipe continuous pressure drops
Pressure drops are a reduction in pressure caused by resistances that oppose the movement of a fluid.
Frictional losses can be either continuous or localised: the continuous ones occur along the length of a pipe; whereas localised losses occur at fitting changes in direction or pipe size (i.e. reductions, diverters, tee, elbows, influxes, valves, filters, etc.).

Calculating continuous pressure drops
For every metre of pipe, continuous water pressure drops can be calculated with the general formula:

$$r = (F_a \bullet \frac{1}{D} \bullet \rho \bullet \frac{v^2}{2}) / 100$$

r = unitary continuous pressure drop (mbar/m)
F_a = friction factor, dimensionless
ρ = water density (Kg/m3)
v = average water speed (m/s)
D = internal pipe diameter (m)

Note the pipe diameter, water speed and its density. The only unknown parameter is the friction factor (F_a), which depends on the fluid flow speed and the pipe roughness.

PP-R pipes have smooth inner surfaces that pose low resistance to hot and cold fluid flow and, as such, are less prone to limescale build-up which, over time, reduces the actual end user flow rates.

These factors allow for higher water speeds in distribution networks without the negative consequences that can arise in metal piping (turbulence, noise, reduced flow rate).

The tables below are helpful in properly sizing the hot and cold water adduction lines for every type of system
The present tables have been determined by using the formula for pipes with low roughness.

Continous pressure drop SDR 7.4

Pipe roughness	0.007 mm	
Specific weight	998.19 kg/m^3	977.75 kg/m^3
Temperature	20°C	70°C
Viscosity	1.00E-06 m^2/s	4.13E-07 m^2/s

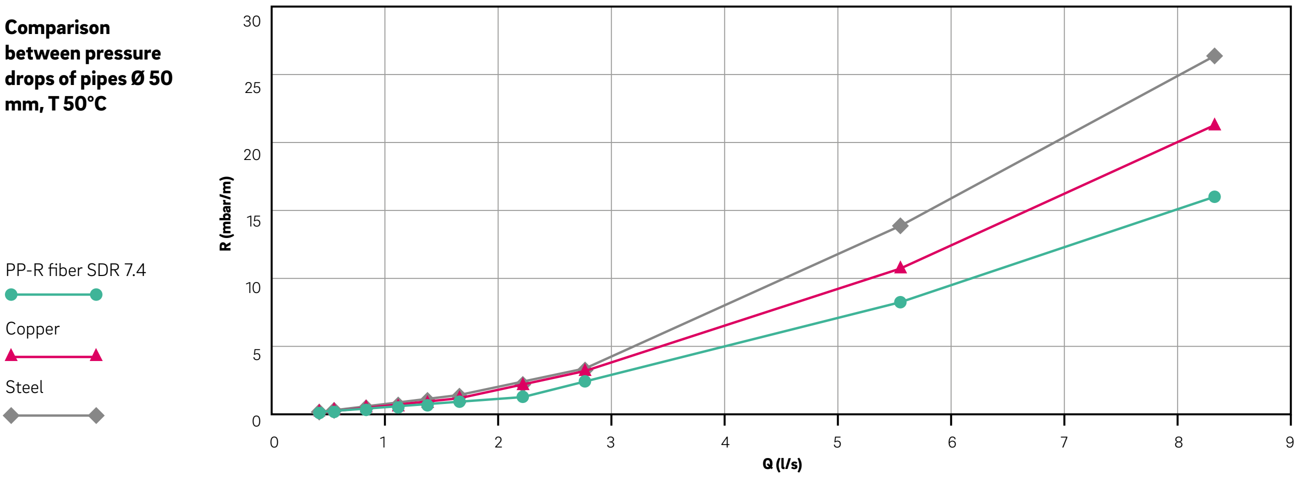
Q	De	20		25		32		40		50		63		75		90		110		125	
	Di	14.4		18.0		23.2		29.0		36.2		45.8		54.4		65.4		79.8		90.8	
3.20	R	0.08	0.06	0.03	0.02	0.01	0.01	0.00	0.00												
	V	0.06		0.04		0.02		0.02													
3.40	R	0.26	0.20	0.09	0.07	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00								
	V	0.12		0.08		0.05		0.03		0.02		0.01									
3.60	R	0.53	0.41	0.18	0.14	0.05	0.04	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00						
	V	0.18				0.12		0.07		0.05		0.03		0.02		0.01					
3.80	R	0.87	0.69	0.30	0.24	0.09	0.07	0.03	0.02	0.01	0.01	0	0	0.00	0.00	0.00	0.00				
	V	0.25		0.16		0.09		0.06		0.04		0.02		0.02		0.01					
4.00	R	1.29	1.01	0.45	0.35	0.13	0.11	0.05	0.04	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	V	0.31		0.20		0.12		0.08		0.05		0.03		0.02		0.01		0.01			
4.20	R	1.78	1.39	0.62	0.48	0.18	0.14	0.06	0.05	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00		
	V	0.37		0.24		0.14		0.09		0.06		0.04		0.03		0.02		0.01			
4.40	R	2.33	1.82	0.81	0.63	0.24	0.19	0.08	0.07	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	V	0.43		0.28		0.17		0.11		0.07		0.04		0.03		0.02		0.01		0.01	
4.60	R	2.94	2.31	1.02	0.80	0.30	0.24	0.11	0.08	0.04	0.03	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	V	0.49		0.31		0.19		0.12		0.08		0.05		0.03		0.02		0.02		0.01	
4.80	R	3.61	2.83	1.25	0.98	0.37	0.29	0.13	0.10	0.05	0.04	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	V	0.55		0.35		0.21		0.14		0.09		0.05		0.04		0.03		0.02		0.01	
5.00	R	4.34	3.41	1.50	1.18	0.45	0.35	0.16	0.12	0.05	0.04	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	V	0.61		0.39		0.24		0.15		0.10		0.06		0.04		0.03		0.02		0.02	
5.20	R	5.97	4.69	2.07	1.62	0.62	0.49	0.21	0.17	0.07	0.06	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	V	0.74		0.47		0.28		0.18		0.12		0.07		0.05		0.04		0.02		0.02	
5.40	R	7.82	6.14	2.71	2.13	0.81	0.64	0.28	0.22	0.10	0.08	0.03	0.03	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
	V	0.86		0.55		0.33		0.21		0.14		0.09		0.06		0.04		0.03		0.02	
5.60	R	9.88	7.75	3.42	2.69	1.03	0.80	0.36	0.28	0.12	0.10	0.04	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00
	V	0.98		0.63		0.38		0.24		0.16		0.10		0.07		0.05		0.03		0.02	
5.80	R	12.15	9.53	4.21	3.30	1.26	0.99	0.44	0.34	0.15	0.12	0.05	0.04	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00
	V	1.11		0.71		0.43		0.27		0.17		0.11		0.08		0.05		0.04		0.03	
6.00	R	14.60	11.46	5.06	3.97	1.52	1.19	0.53	0.41	0.18	0.14	0.06	0.05	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00
	V	1.23		0.79		0.47		0.30		0.19		0.12		0.09		0.06		0.04		0.03	
6.20	R	29.69	23.30	10.29	8.07	3.08	2.42	1.07	0.84	0.37	0.29	0.12	0.10	0.05	0.04	0.02	0.02	0.01	0.01	0.00	0.00
	V	1.84		1.18		0.71		0.45		0.29		0.18		0.13		0.09		0.06		0.05	
6.40	R	49.12	38.54	17.02	13.35	5.10	4.00	1.77	1.39	0.62	0.48	0.20	0.16	0.09	0.07	0.04	0.03	0.01	0.01	0.01	0.01
	V	2.46		1.57		0.95		0.61		0.39		0.24		0.17		0.12		0.08		0.06	
6.60	R	72.59	56.95	25.15	19.73	7.53	5.91	2.61	2.05	0.91	0.71	0.30	0.23	0.13	0.10	0.05	0.04	0.02	0.02	0.01	0.01
	V	3.07		1.97		1.18		0.76		0.49		0.30		0.22		0.15		0.10		0.08	
6.80	R	99.87	78.35	34.60	27.15	10.37	8.13	3.59	2.82	1.25	0.98	0.41	0.32	0.18	0.14	0.08	0.06	0.03	0.02	0.02	0.01
	V	3.69		2.36		1.42		0.91		0.58		0.36		0.26		0.18		0.12		0.09	
7.00	R	130.80	102.62	45.32	35.55	13.58	10.65	4.70	3.69	1.64	1.29	0.54	0.42	0.24	0.19	0.10	0.08	0.04	0.03	0.02	0.02
	V	4.30		2.75		1.66		1.06		0.68		0.43		0.30		0.21		0.14		0.11	
7.50	R	165.23	129.63	57.25	44.91	17.15	13.45	5.94	4.66	2.07	1.63	0.68	0.53	0.30	0.23	0.12	0.10	0.05	0.04	0.03	0.02
	V	4.91		3.15		1.89		1.21		0.78		0.49		0.34		0.24		0.16		0.12	
8.00	R	203.05	159.30	70.35	55.20	21.07	16.53	7.30	5.73	2.55	2.00	0.83	0.65	0.37	0.29	0.15	0.12	0.06	0.05	0.03	0.03
	V	5.53		3.54		2.13		1.36		0.87		0.55		0.39		0.27		0.18		0.14	
9.00	R			84.60	66.37	25.34	19.88	8.78	6.89	3.06	2.40	1.00	0.79	0.44	0.35	0.18	0.14	0.07	0.06	0.04	0.03
	V			3.93		2.37		1.51		0.97		0.61		0.43		0.30		0.20		0.15	
10.00	R			116.39	91.32	34.87	27.35	12.08	9.48	4.21	3.31	1.38	1.08	0.61	0.48	0.25	0.20	0.10	0.08	0.05	0.04
	V			4.72		2.84		1.82		1.17		0.73		0.52		0.36		0.24		0.19	
20.00	R			152.43	119.59	45.66	35.82	15.82	12.41	5.52	4.33	1.81	1.42	0.80	0.63	0.33	0.26	0.13	0.10	0.07	0.05
	V			5.50		3.31		2.12		1.36		0.85		0.60		0.42		0.28		0.22	
30.00	R					57.68	45.25	19.99	15.68	6.97	5.47	2.28	1.79	1.01	0.79	0.42	0.33	0.16	0.13	0.09	0.07
	V					3.79		2.42		1.56		0.97		0.69		0.48		0.32		0.25	
40.00	R					70.89	55.61	24.56	19.27	8.57	6.72	2.80	2.20	1.24	0.97	0.52	0.40	0.20	0.16	0.11	0.09
	V					4.26		2.73		1.75		1.09		0.77		0.54		0.36		0.28	
50.00	R					85.24	66.87	29.53	23.17	10.30	8.08	3.37	2.64	1.49	1.17	0.62	0.49	0.24	0.19	0.13	0.10
	V					4.73		3.03		1.94		1.21		0.86		0.60		0.40		0.31	
60.00	R					100.71	79.01	34.89	27.38	12.17	9.55	3.98	3.12	1.76	1.38	0.73	0.58	0.28	0.22	0.15	0.12
	V					5.21		3.33		2.14		1.34		0.95		0.66		0.44		0.34	
30.00	R					117.27	92.01	40.63	31.88	14.17	11.12	4.64	3.64	2.05	1.61	0.85	0.67	0.33	0.26	0.18	0.14
	V					5.68		3.64		2.33		1.46		1.03		0.71		0.48		0.37	
50.00	R							46.74	36.67	16.30	12.79	5.33	4.18	2.36	1.85	0.98	0.77	0.38	0.30	0.21	0.16
	V							3.94		2.53		1.58		1.12		0.77		0.52		0.40	
60.00	R							53.22	41.75	18.56	14.56	6.07	4.76	2.68	2.10	1.12	0.88	0.43	0.34	0.24	0.18
	V							4.24		2.72		1.70		1.21		0.83		0.56		0.43	
80.00	R							60.04	47.11	20.94	16.43	6.85	5.37	3.03	2.37	1.26	0.99	0.49	0.38	0.27	0.21
	V							4.54		2.92		1.82		1.29		0.89		0.60		0.46	

Q	De	20	25	32	40	50	63	75	90	110	125
	Di	**14.4**	**18.0**	**23.2**	**29.0**	**36.2**	**45.8**	**54.4**	**65.4**	**79.8**	**90.8**
3.20	R				67.22 52.74	23.44 18.39	7.67 6.02	3.39 2.66	1.41 1.11	0.55 0.43	0.30 0.23
	V				4.85	3.11	1.94	1.38	0.95	0.64	0.49
3.40	R				74.75 58.64	26.07 20.45	8.53 6.69	3.77 2.95	1.57 1.23	0.61 0.48	0.33 0.26
	V				5.15	3.31	2.06	1.46	1.01	0.68	0.53
3.60	R				82.61 64.81	28.81 22.60	9.43 7.43	4.16 3.27	1.74 1.36	0.67 0.53	0.37 0.29
	V				5.45	3.50	2.19	1.55	1.07	0.72	0.56
3.80	R				90.81 71.24	31.67 24.85	10.36 8.13	4.58 3.59	1.91 1.50	0.74 0.58	0.40 0.31
	V				5.76	3.69	2.31	1.64	1.13	0.76	0.59
4.00	R					34.65 27.18	11.33 8.89	5.01 3.93	2.09 1.64	0.81 0.64	0.44 0.34
	V					3.89	2.43	1.72	1.19	0.80	0.62
4.20	R					37.73 29.60	12.34 9.68	5.45 4.28	2.27 1.78	0.88 0.69	0.48 0.38
	V					4.08	2.55	1.81	1.25	0.84	0.65
4.40	R					40.93 32.11	13.39 10.51	5.91 4.64	2.47 1.93	0.96 0.75	0.52 0.41
	V					4.28	2.67	1.89	1.31	0.88	0.68
4.60	R					44.24 34.71	14.47 11.36	6.39 5.01	2.67 2.09	1.04 0.81	0.56 0.44
	V					4.47	2.79	1.98	1.37	0.92	0.71
4.80	R					47.67 37.40	15.59 12.23	6.89 5.40	2.87 2.25	1.12 0.88	0.60 0.47
	V					4.67	2.92	2.07	1.43	0.96	0.74
5.00	R					51.20 40.17	16.75 13.14	7.40 5.80	3.08 2.42	1.20 0.94	0.65 0.51
	V					4.86	3.04	2.15	1.49	1.00	0.77
5.20	R					54.83 43.02	17.94 14.07	7.92 6.21	3.30 2.59	1.28 1.01	0.70 0.55
	V					5.05	3.16	2.24	1.55	1.04	0.80
5.40	R					58.58 45.96	19.16 15.03	8.46 6.64	3.53 2.77	1.37 1.08	0.74 0.58
	V					5.25	3.28	2.32	1.61	1.08	0.83
5.60	R					62.43 48.98	20.42 16.02	9.02 7.08	3.76 2.95	1.46 1.15	0.79 0.62
	V					5.44	3.40	2.41	1.67	1.12	0.87
5.80	R					66.38 52.08	21.72 17.04	9.59 7.52	4.00 3.14	1.55 1.22	0.84 0.66
	V					5.64	3.52	2.50	1.73	1.16	0.90
6.00	R					70.44 55.26	23.04 18.08	10.18 7.98	4.24 3.33	1.65 1.29	0.89 0.70
	V					5.83	3.64	2.58	1.79	1.20	0.93
6.20	R						24.40 19.15	10.78 8.46	4.49 3.53	1.75 1.37	0.95 0.74
	V						3.77	2.67	1.85	1.24	0.96
6.40	R						25.80 20.24	11.39 8.94	4.75 3.73	1.85 1.45	1.00 0.78
	V						3.89	2.75	1.91	1.28	0.99
6.60	R						27.23 21.36	12.02 9.43	5.01 3.93	1.95 1.53	1.05 0.83
	V						4.01	2.84	1.97	1.32	1.02
6.80	R						28.69 22.51	12.67 9.94	5.28 4.14	2.05 1.61	1.11 0.87
	V						4.13	2.93	2.03	1.36	1.05
7.00	R						30.18 23.68	13.33 10.46	5.56 4.36	2.16 1.69	1.17 0.92
	V						4.25	3.01	2.08	1.40	1.08
7.50	R						34.05 26.72	15.04 11.80	6.27 4.92	2.44 1.91	1.32 1.04
	V						4.55	3.23	2.23	1.50	1.16
8.00	R						38.12 29.91	16.84 13.21	7.02 5.51	2.73 2.14	1.48 1.16
	V						4.86	3.44	2.38	1.60	1.24
9.00	R						46.85 36.76	20.69 16.23	8.63 6.77	3.35 2.63	1.82 1.42
	V						5.47	3.87	2.68	1.80	1.39
10.00	R							24.88 19.52	10.37 8.14	4.03 3.16	2.18 1.71
	V							4.30	2.98	2.00	1.55
20.00	R								34.89 27.37	13.56 10.64	7.34 5.76
	V								5.96	4.00	3.09
30.00	R										14.93 11.71
	V										4.64
40.00	R										
	V										
50.00	R										
	V										
60.00	R										
	V										
80.00	R										
	V										

Q= flow (l/s)   De= Ø ext.Ø (mm)   Di= Ø int.Ø (mm) R= continuous pressure drop (mbar/m)   V= velocity (m/s)

Comparison between pressure drops in systems built with different materials
The following is a comparison between pipes in different materials with comparable internal diameters. Note how the low level of roughness in the PP-R fiber pipe internal walls significantly reduces pressure drop values.

Comparison between pressure drops of pipes Ø 50 mm, T 50°C



As we can see from the graph, for SDR 7.4 pipes, the aspects highlighted by the previous tables are amplified, thanks to the reduced wall thickness, which increases pipe flow rate, reducing pressure drops.

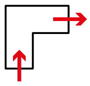
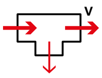
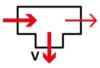
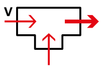
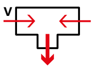
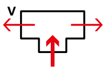
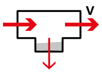
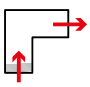
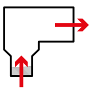
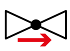
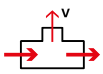
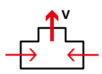
Fitting localised pressure drops
Localised pressure drops are due to the presence of fittings (tee, elbow, curves, etc.) that vary the fluid flow direction or cross-section. They can be calculated using one of the following methods:

- direct method: uses coefficients that depend on the shape and sizes of the fittings
- nominal flow rate method: for every part, it uses the value of its nominal flow rate; that is, to the flow rate that corresponds with a pre-defined unitary pressure drop (for example, 1 bar)
- equivalent length method: for every part, it replaces a section of linear pipe corresponding to the individual pressure drop.

Fitting localised pressure drops
In general, the direct method is used for pipe and pump sizing, as it is accurate enough and easy to use.
According to this method, localised pressure drops can be calculated with the following formula:

$$z = (\xi \cdot \rho \cdot \frac{v^2}{2}) / 100$$

z = localised pressure drop (mbar)
ξ = localised drop coefficient, dimensionless
ρ = water density (Kg/m^3)
v = average velocity (m/s)

Localised pressure drop coefficient table			Localised drop coefficient (ξ)
		Pipe coupling	0.25
		Reduction of 1 size Reduction of 2 size Reduction of 3 size Reduction of 4 size	0.40 0.50 0.60 0.70
		Elbow 90°	1.20
		Elbow 45°	0.50
TD		Tee duct	0.25
TA		Tee with flow separation Reduced tee add reduction value	1.20
TVD		Tee with flow union Reduced tee add reduction value	0.80
TVG		Tee union with opposite flow Reduced tee add reduction value	3.00
TG		Tee separation with divided flow Reduced tee add reduction value	1.80
		Tee with thread	
		Fitting with thread	0.40
		Fitting with reduced threading	0.85
		Elbow with threading	1.40
		Elbow with reduced threading	3.50
		20 mm stopcock 25 mm stopcock 32 mm stopcock	9.50 8.50 7.60
		Saddle socket with flow separation	0.50
		Saddle socket with opposite flow	1.00

UNI/TS 11589 2015   v= Reference flow

Table for localised pressure drops (z)
Allows fitting pressure drops (z) to be determined based on knowing the ξ coefficient and the flow speed (V) according to the following formula:

$$z = 5V^2 \cdot \Sigma\xi$$

Velocity v (m/s)

0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5

Pressure drop z • Σ ξ = 1 bar

0.05	0.20	0.45	0.80	1.25	1.80	2.45	3.20	4.05	5.00	6.05	7.20	8.45	9.80	11.25	12.80	14.45	16.20	18.05	20.00	22.05	24.20	26.45	28.80	31.25

Velocity v (m/s)

2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0

Pressure drop z • Σ ξ = 1 bar

33.80	36.45	39.20	42.05	45.00	48.05	51.20	54.45	57.80	61.25	64.80	68.45	72. 20	76.05	80.00	84.05	88.20	92.45	96.80	101.25	105.80	110.45	115.20	120.05	125.00

ⓘ

The values shown in the table refer to localised pressure drops (z) calculated for a sum equal to 1. Once the velocity (v) is established, the corresponding value in the table must be multiplied by the actual sum of the localised drop coefficients (ξ).

System data

A. 5 couplers (with ξ value for each part = to 0.25)

B. 3 90° elbows (with ξ value for each part = to 1.20)

C. 4 separation tees with metal threading

D. Velocity (v) = 0.8

Calculation

(Total of A + Total of B + Total of C) x 5 x V^2 = z

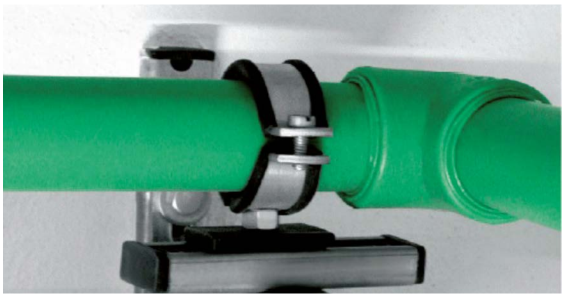
(5x0.25)+(3x1.20)+(4x0.80)] x 3.20 = 25.76

06 Laying techniques

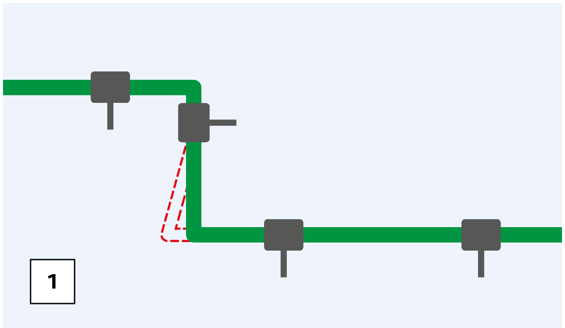
Any pipe, be it made of plastic material or metal, undergoes elongation when the temperature of the carried fluid increases (linear thermal expansion). Linear expansion creates mechanical stresses that, if not appropriately contained, can damage the system itself.
Laying pipes inside of buildings can be either surface-mounted or embedded or concealed.
In the event of embedded laying, the effects of linear thermal expansion are not considered, as the pipes are considered to be self-compensating.
Instead, in the event of surface-mounted or concealed, linear thermal expansion must be considered. When securing pipes made of synthetic materials, specific sliding clamps to allow the pipe to slide and fixed point clamps to lock the pipe must be used. In creating the fixed point, you must ensure absolutely rigid anchoring, using threaded bars with an appropriate diameter and limited length.
As far as the vertical pipes are concerned (risers), the effects of linear thermal expansion are not considered from an aesthetic standpoint but, in any case, appropriate clamping is necessary for the operational aspect.

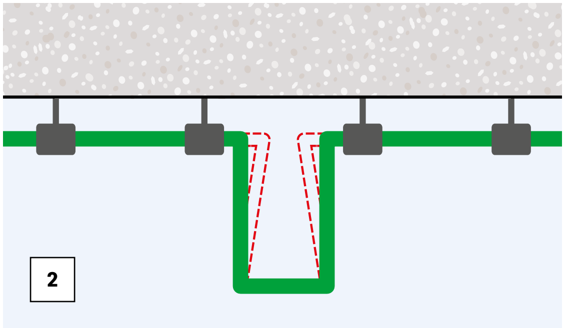
Calculating and compensating thermal linear expansion
In general the pipes must be fixed using fixed / anchor points. This is fundamental especially near Tee branches: the fixed points must be positioned both immediately after the fitting (following the flow direction) and at the start of the branch line.
For the riser pipes, the clamping distances must be increased by 20% compared to what is shown in the tables.
When installing exposed pipes with external anchoring (for example, basements, boiler rooms and power stations), straight and extended, omega expansion compensators or direction changes with flex curves must be created.
For installations with many direction or level changes and with short straight sections, the effects of expansion can be ignored, securing only with fixed points.
Apply specific rules for seismic clamping. PP-R fiber having a 70% lower linear expansion compared to other unfilled pipes, reduced significantly the risk of bends in the piping, particularly when carrying hot fluids or in cases with a significant difference between laying temperature and environment working temperature.

In the following paragraphs, we will describe how to keep track of the effects of linear expansion. The risks deriving from linear expansion must be compared to the type of installation done: if, for example, the section of pipe and its fittings are walled, the force of the expansion is much lower and pipe elongation is contained by the wall itself. Instead, if the system is created in free laying, it is essential to arrange for appropriate clamping. In any case, additional expansion compensation techniques must be provided for.
Expansion compensators must be created, that is, appropriate U-shaped (or Omega) loops, direction changes (L-shaped) that give the piping a way to discharge the expansion.



1 Curved or L-shaped expansion compensators
2 Omega- or U-shaped expansion compensators





Calculating linear thermal expansion

Linear thermal expansion is calculated via the following formula:

$$DL = \alpha \cdot L \cdot \Delta t$$

DL = expansion (mm)
α = coefficient linear thermal expansion (see table below)
L = pipe length (m)
ΔT = temperature variation

	Tube type
	PP-R fiber
CLTE α = mm/mK	0.035

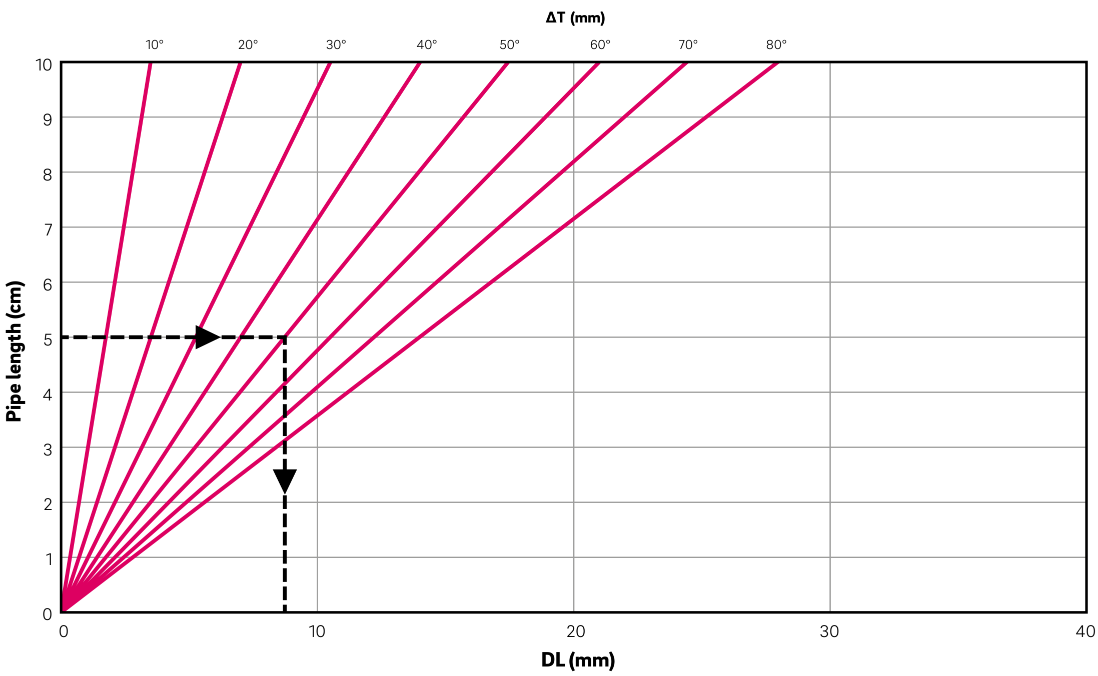
Example of linear expansion calculation

Refer to the tables on page 22 for quick consultation.
These show, for the entire PP-R fiber piping range, the linear expansion values for pipes with lengths between 0.5 and 100 linear metres, with ΔT between 10 and 80°C.

Example of Δt calculation	Data	Calculation
Temperature of carried fluid = **70°C (343° K)** Environment laying temperature = **20°C (293° K)** **ΔT = 70°- 20°= 50°C (343° K-293° K = 50° K)**	α = 0.035 mm/m°K L = 6 m ΔT = 50°K	0.035 x 6.0 x 50 = 10.5 mm (DL)

PP-R fiber pipes linear expansion (mm)

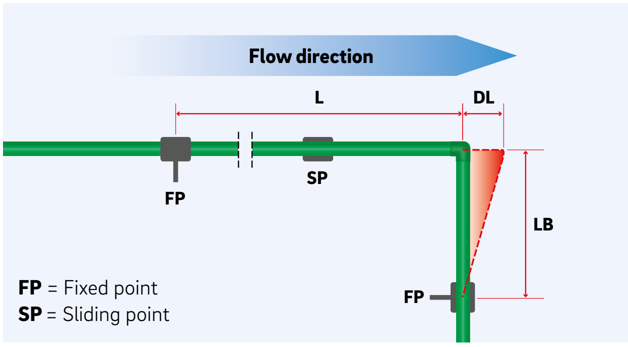
Pipe length	ΔT 10	ΔT 20	ΔT 30	ΔT 40	ΔT 50	ΔT 60	ΔT 70	ΔT 80
cm	mm	mm	mm	mm	mm	mm	mm	mm
0.5	0.18	0.35	0.53	0.70	0.88	1.05	1.26	1.40
1.0	0.35	0.70	1.05	1.40	1.75	2.10	2.45	2.80
2.0	0.70	1.40	2.10	2.80	3.50	4.20	4.90	5.60
3.0	1.05	2.10	3.15	4.20	5.25	6.30	7.35	8.40
4.0	1.40	2.80	4.20	5.60	7.00	8.40	9.80	11.20
5.0	1.75	3.50	5.25	7.00	8.75	10.50	12.25	14.00
6.0	2.10	4.20	6.30	8.40	10.50	12.60	14.70	16.80
7.0	2.45	4.90	7.35	9.80	12.25	14.70	17.15	19.60
8.0	2.80	5.60	8.40	11.20	14.00	16.80	19.60	22.40
9.0	3.15	6.30	9.45	12.60	15.75	18.90	22.05	25.20
10.0	3.50	7.00	10.50	14.00	17.50	21.00	24.50	28.00
50.0	17.50	35.00	52.50	70.00	87.50	105.00	122.50	140.00
100.0	35.00	70.00	105.00	140.00	175.00	210.00	245.00	280.00

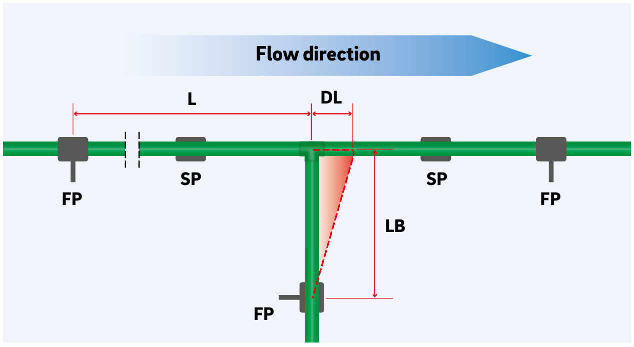


Calculating expansion compensators
To calculate expansion compensator sizing (be they L- or U-shaped), it is necessary to know the constant value (C) shown below. NB: the reported value was experimentally determined in qualified structures. A proper safety factor is recommended where necessary.

	PP-R fiber
Constant value C	16

Curved or L-shaped expansion compensators

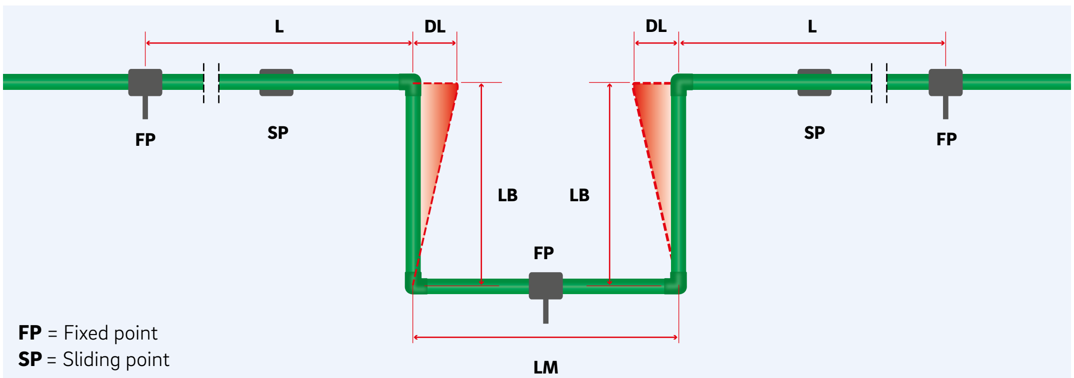




This is the most commonly used type of compensator, as it is usually possible to exploit the pipe route change to create it. The length of the expansion compensator curved sides is calculated using the following formula:

$$LB = C \cdot \sqrt{(D \cdot DL)}$$

LB = bending arm length (mm)
C = material constant (see data in the table)
D = external pipe diameter (mm)
DL = linear thermal expansion (mm)
(for the DL calculation, see the “Calculating linear thermal expansion” paragraph)

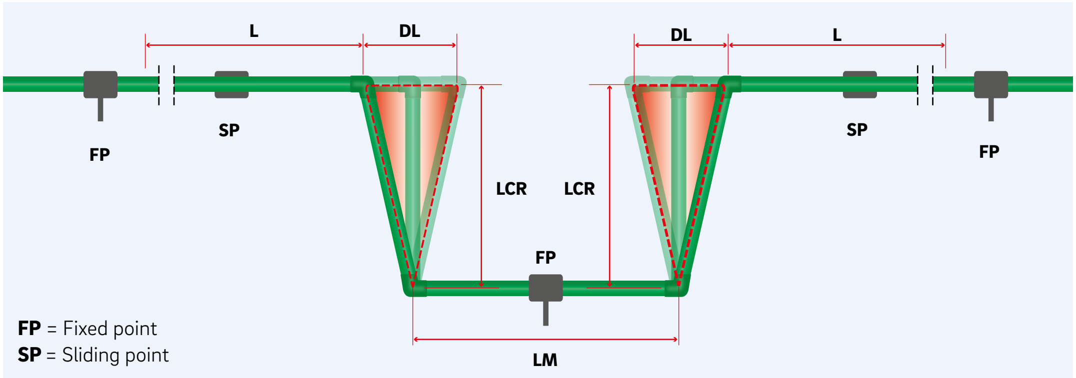


Should it not be possible to compensate the expansion exploiting the pipe route change (via curved or L-shaped expansion compensators) like, for example, if there are long straight sections, omega- or U-shaped expansion compensators need to be created.

As such, in addition to calculating the length of the bending arm (LB), the distance (LM) between the two arms that will form the "U" of the compensator needs to be calculated using the following formula:

$$LM = 2 \cdot DL$$

LM = distance between the bending arms (mm)
DL = linear thermal expansion (mm)
2 = fixed value

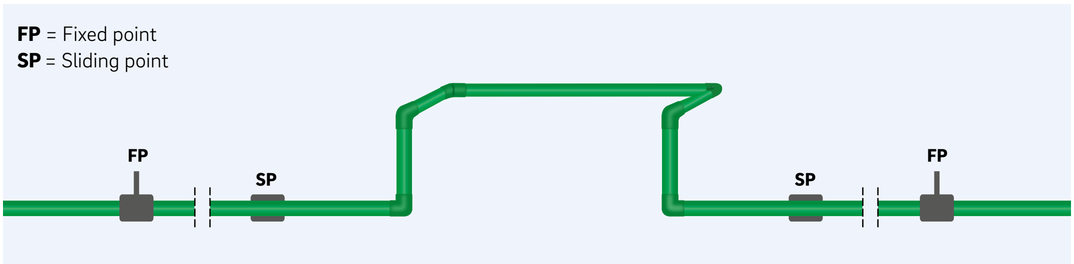


Should limited spaces not allow the previous sizes to be created, it is possible to reduce the extent of the bending arm via the pre-tensioned compensator technique. During expansion, the installer must pre-tension the omega, acting on the arm, thus absorbing half of the linear expansion. The formula for the calculation is:

$$LCR = C \cdot \sqrt{(D \cdot (DL/2))}$$

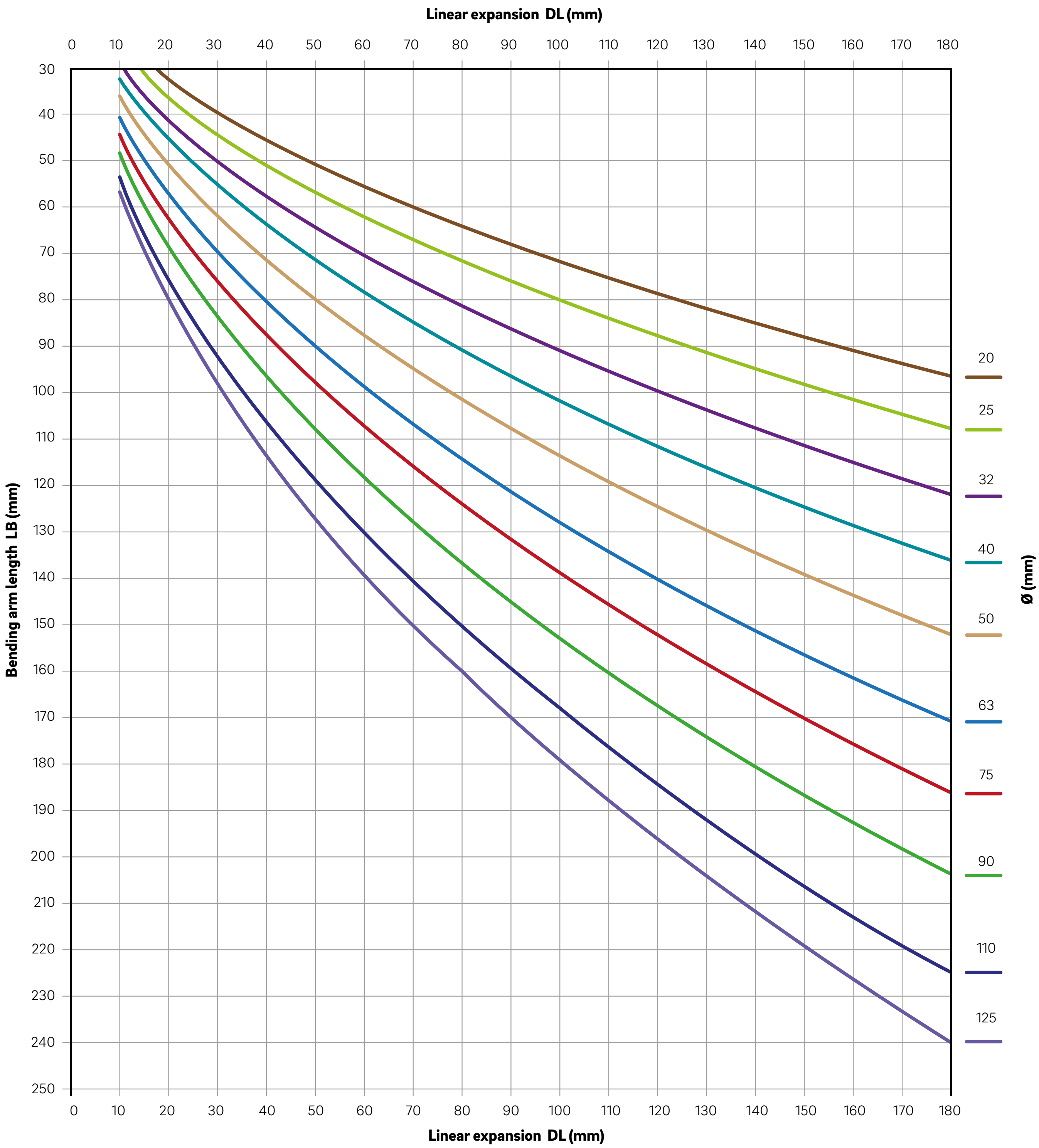
LCR = reduced curved side length (mm)
C = material constant (see data in the table)
D = external pipe diameter (mm)
DL = linear thermal expansion (mm)
2 = fixed value

Six-elbow omega



For restricted spaces, it is possible to create six-elbow omegas as per the drawing shown. Calculating the bending arm is the same as for omega compensators.
In order to speed up the operations needed to obtain the lengths of the curved sides, below are the graphs for the entire PP-R fiber pipe range, from which the LB value can be obtained.

Diagram to calculate the fixed points (FP) and the bending arm length (LB)
by branches and right angle pipelines for all pipes.

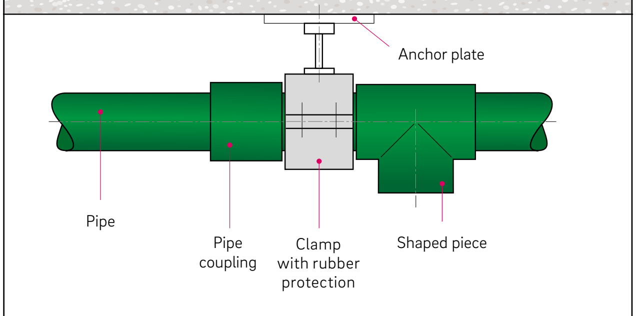


07 Clamping

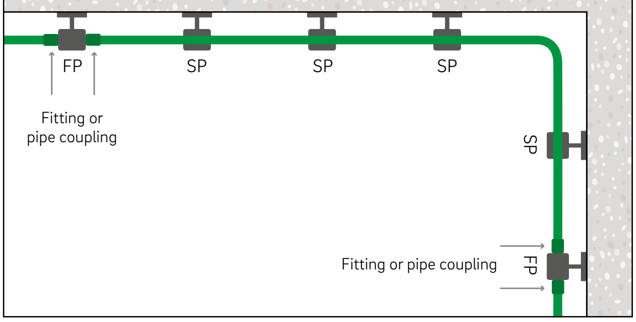
Pipe clamping is a fundamental operation to contain thermal linear expansion in systems. Clamping can sometimes be used on its own to control thermal expansion without the need for U-shaped or six-elbow omega compensator arrangements..
Correct locking clamp positioning and sizing must be done based on the type of pipe used and the temperature of the fluid to be carried.
It is also good to know that to cancel and compensate for all the effects deriving from linear expansion, it is necessary to provide for clamping that, in addition to the correct sizing, completely locks any possibility the pipes have of moving (fixed points, for example, near the fittings) and to provide for clamps that allow the pipes to slide. In this case, make sure that clamping is done in such a way that the valves and/or fittings do not impede sliding.

Fixed points impede pipe movement and divide them into individual sections of linear expansion.
In creating fixed points, you must consider all the forces that act simultaneously on the section of pipe (linear expansion, weight of the material, fluid and other additional loads).
The fixed points must be sturdier than a sliding support needs to be; we recommend always creating fixed points where there are branches.
Fixed points can also be made in points of the system of your choice: in this case, they must be located so as to exploit the pipe direction changes in favour of absorbing linear expansion. Pipe clamping must be carried out with specific brackets that protect the pipe itself. We recommend that seismic clamping require specialist assessments

Fixed point (FP) arrangement



Clamping arrangement using a combination of fixed points (FP) and sliding points (SP)



Clamping values

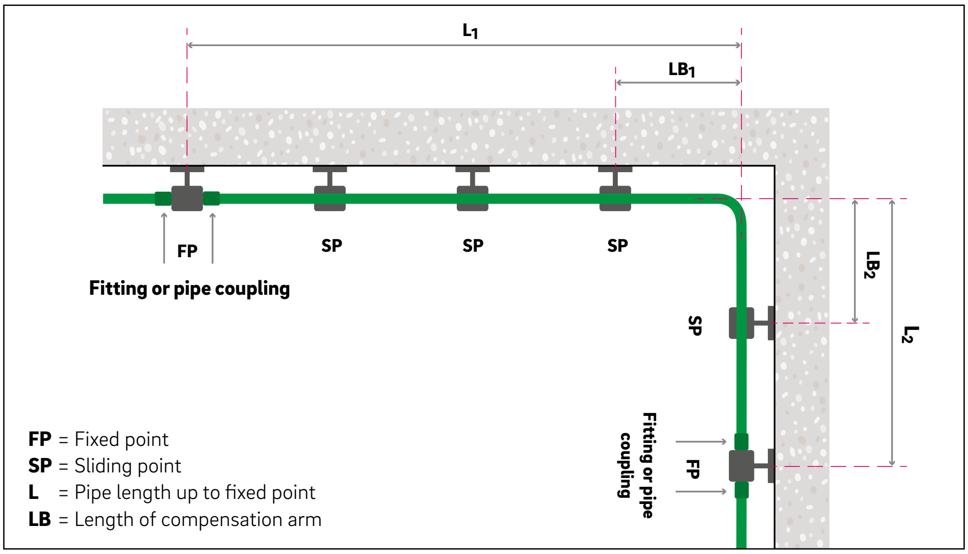
For proper pipe clamping, below are tables indicating the clamp positioning distances based on the temperature of the carried fluid. NB: a fixed point clamp must always be installed near curves or branches. This is fundamental especially near Tee branches: the fixed points must be positioned both immediately after the fitting (following the flow direction) and at the start of the branch line.

The intermediate layer, made with PP-R loaded fiberglass, with which the pipes series are produced, considerably reduces linear expansion caused by heat compared to normal PP-R pipes; this allows the pipes to be clamped at greater distances compared to single layer PP-R pipes. The following table shows the distances at which to position the clamps based on linear expansion, due to the vehicled temperature Δt.

Multilayer PP-R fiber SDR 7.4 pipes clamping (cm)

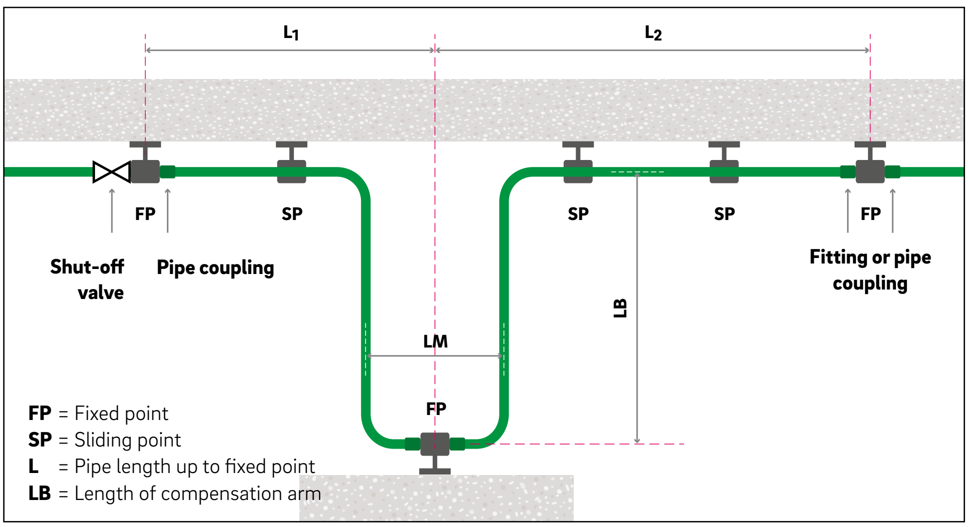
ΔT	Ø 20	Ø 25	Ø 32	Ø 40	Ø 50	Ø 63	Ø 75	Ø 90	Ø 110	Ø 125
0°C	120	140	160	180	205	230	245	260	290	320
20°C	90	105	120	135	155	175	185	195	215	240
30°C	90	105	120	135	155	175	185	195	210	225
40°C	85	95	110	125	145	165	175	185	200	215
50°C	85	95	110	125	145	165	175	185	190	195
60°C	80	90	105	120	135	155	165	175	180	185
70°C	70	80	95	110	130	145	155	165	170	175

Examples of clamping



Example 1

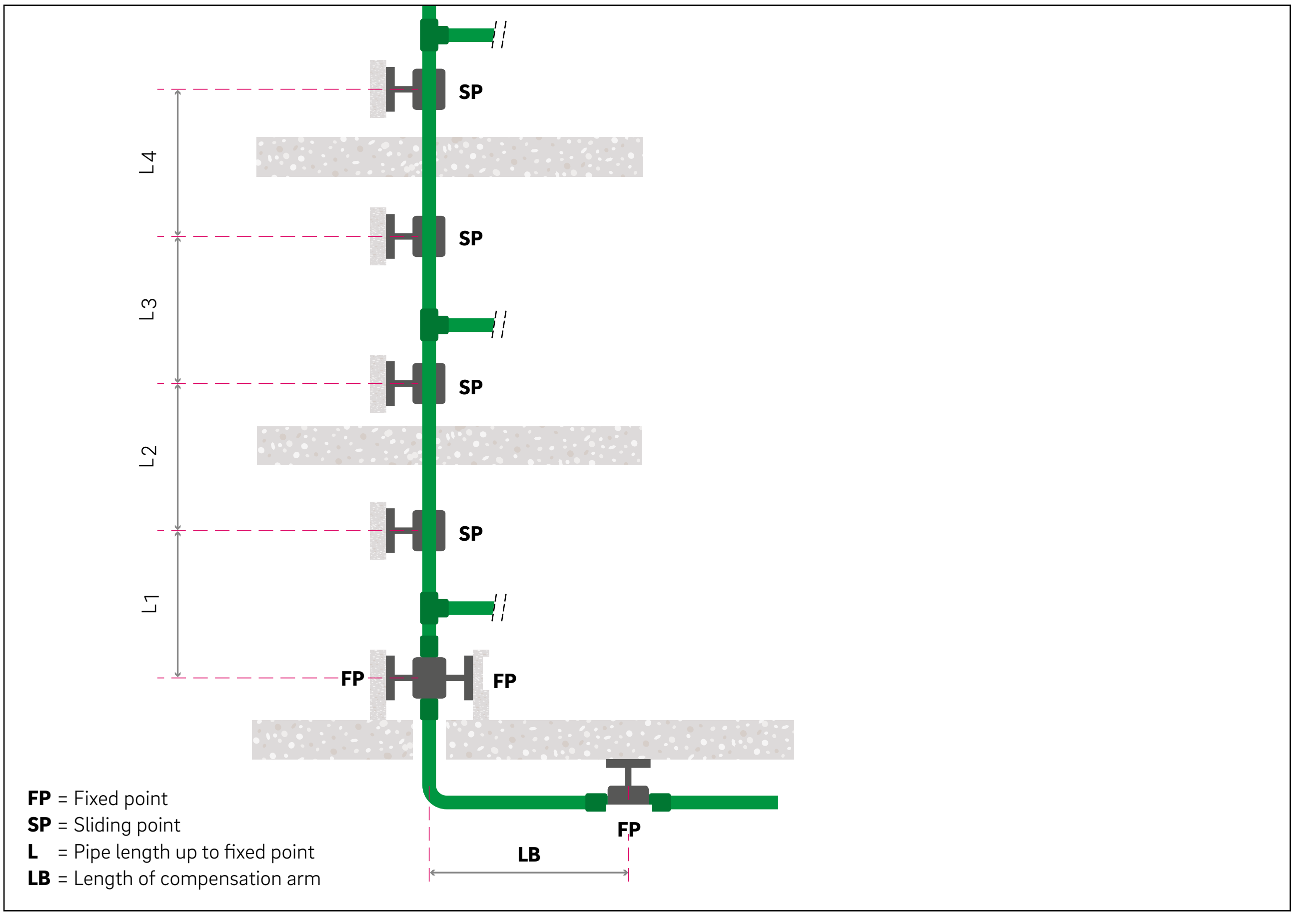
Horizontal piping distribution with fixed points of your choice and expansion compensation via direction change. Calculate the distance between the clampings with the tables in the section "Clamping values" on page 27 and the width of the compensation arm (LB) with formula on page 23 or with diagram on page 25.



Example 2

Horizontal piping with compensator of the same material. Calculate the supports according to the tables on the section "Clamping values" on page 27; the width of the compensation arm (LB) with formula on page 23 or with diagram on page 25. Calculate the distance between compensation arm (LM) according to the formulas on page 24.

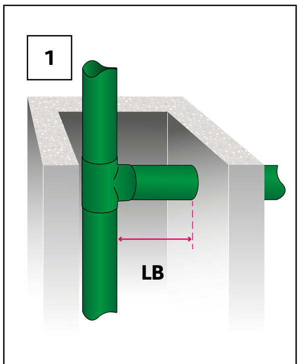
Example 3
Vertical distribution in multi-floor buildings. Through channels or shafts.

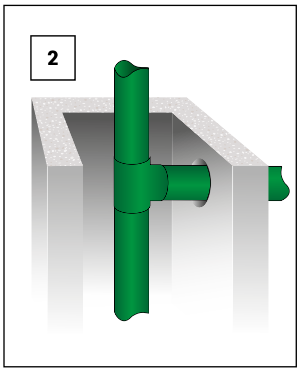


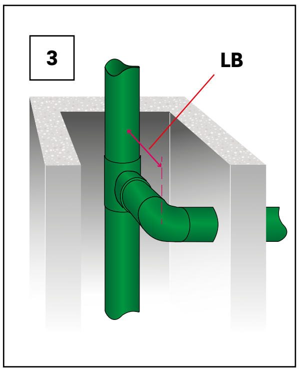
Calculation to install in compartments and through separating walls

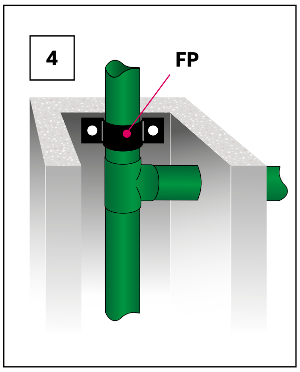
When branching a riser pipe to various floors, be sure to pay attention to the movement (due to expansion) of the pipe itself and arrange, for the branching, ways to absorb the movement as follows:

1. positioning the riser pipe in the right point of the shaft so that the LB distance is calculated according to the formula on page 23 or diagrams on page 25.
2. leaving space for the branched pipe to absorb the expansion
3. installing a compensation arm with an elbow
4. in the riser pipe, it is absolutely necessary for there to be a fixed point immediately after the branch so as to prevent uncontrolled pipe movements.

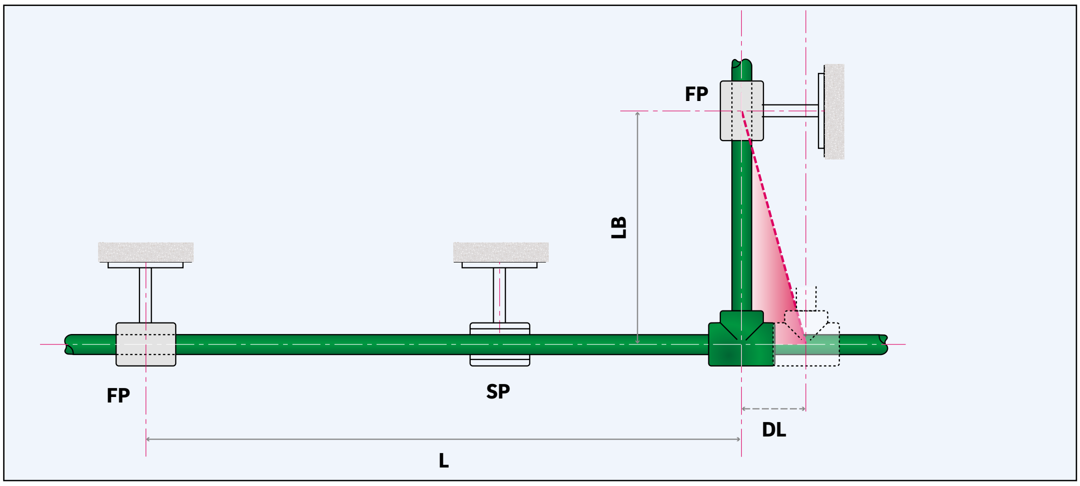




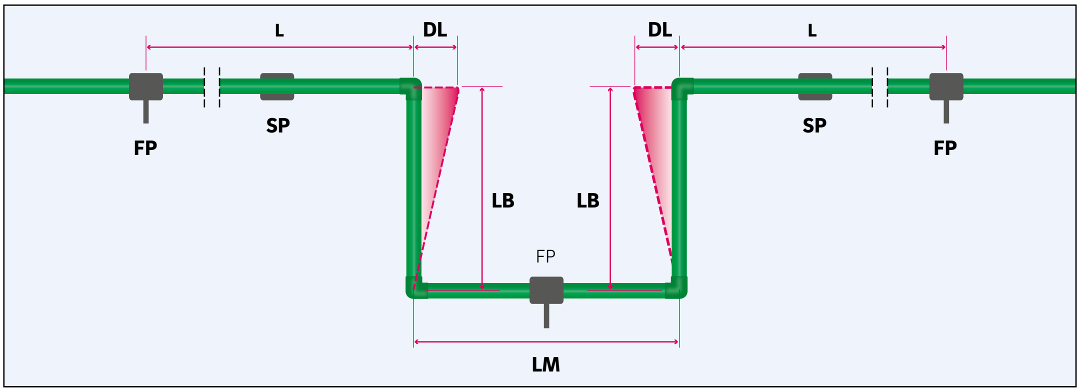




Compensation break examples



Compensation breaks need to be made to absorb linear expansion in order to compensate, in the direction changes (90° elbows) or branching (tee), the expansion of a section of pipe determined by a fixed point.



Using the formulas on pages 23 and 24, you can calculate expansion compensation break (LB) based on pipe length and working temperature. Length L is determined by the fixed points (FP).

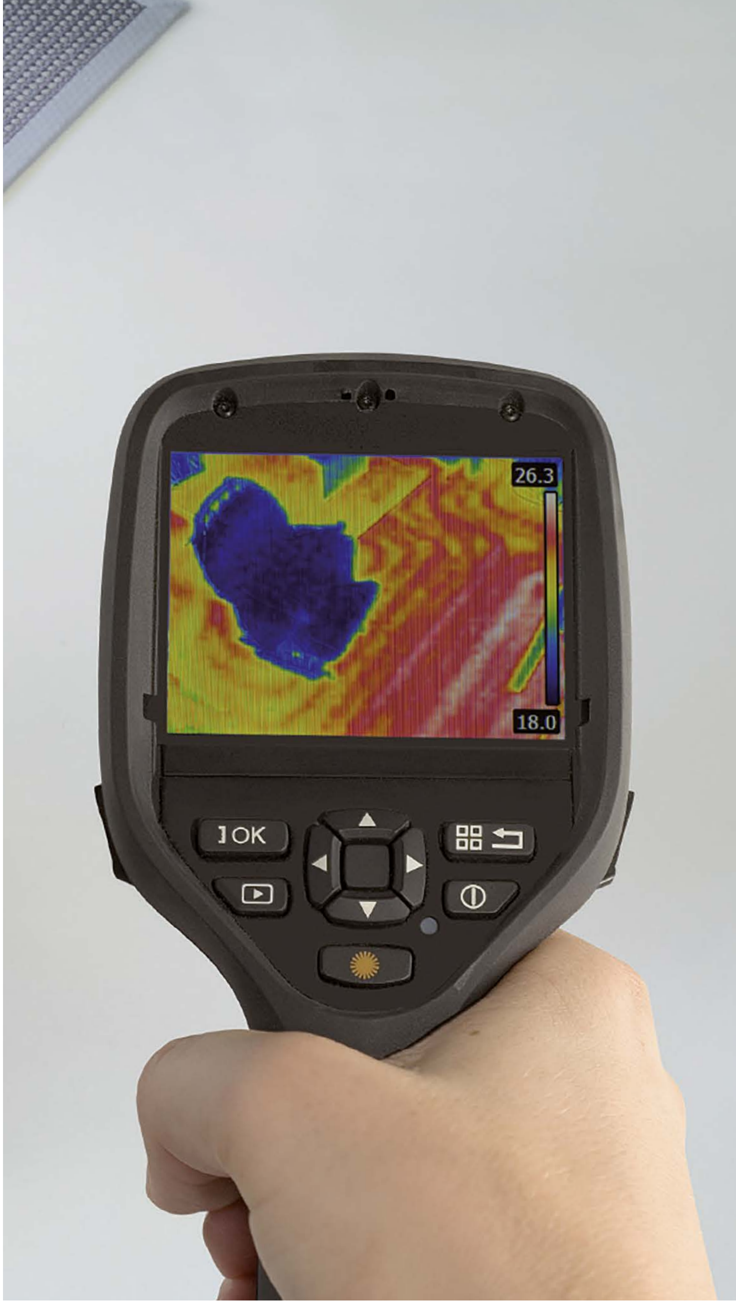
08 Energy efficiency

In order to reduce heat dispersion from PP-R fiber piping systems, the standards and national regulations in force regarding energy saving must be applied. PP-R fiber thermal conductivity is equal to λ0.19 W/mK for multilayer pipes.

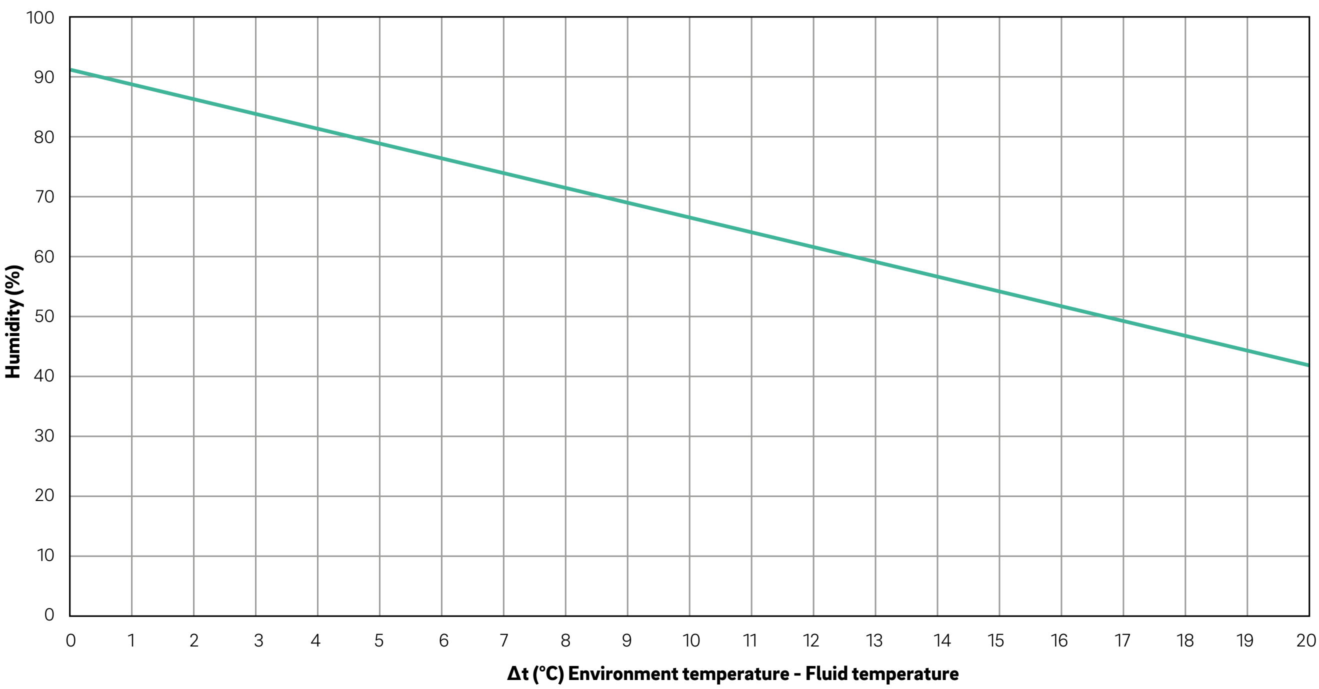
Piping for sanitary or heating hot water
The reference standards regarding energy savings provide useful indications to calculate the minimum insulation thickness, which depends on the material making up the insulation, its dimensions and the type of system to create.

Piping for sanitary or cooling cold water
For this type of system, the insulation has the purpose of maintaining the water temperature constant to prevent the formation of surface condensate.

Determination of dew point
The table below shows whether there is a risk of condensate under specific use conditions. In the event of a risk, a proper thermal insulation shall be provided.



SDR 7.4 dew points



09 Connecting to other pipe systems

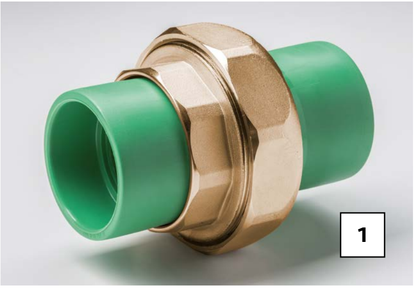
Plastic metal threaded joints
The first and most classic junction system is the threading according to ISO 228 & ISO 7.

The threaded metal inserts are made from a range of low zinc and/or low lead brass alloys with some even available in lead-free gun metal. All feature a special design that allows them to be coupled with PP-R 80 Super during the moulding stage, ensuring hydraulic seal efficiency and reliability over time. Available in sizes from ½" to 5" in male and female threads compatible with the respective ISO 228 or ISO 7 threads of other systems as straight or elbow transitions or as branch outlets from Tee fittings. Please refer to the end of this manual for further information on fitting alloys and compatible water quality.

Joint systems

Flange and collar
A series of alloy flanges covered in PP and a series of PP-RCT collars to weld connect to various types of flanges. Particularly suitable for large diameters, this type of junction is highly appreciated for how easy it is to disassemble and for seal efficiency. Generally used to connect to accessories that may require servicing (valves, pumps, heat or cold water generators, etc.), the range is available in diameters from 20 to 125mm.

The collar is designed to be coupled via socket or butt welding to all the types of PP-R fiber pipes, while the side opposite the welding socket houses a special flat gasket in EPDM to ensure the connection seal both between REHAU collars and with other elements equipped with compliant flanging.



The coupling flange is made sturdier by a special steel core which, thanks to the particular sheet spheroidal cast design, allows it to sustain extremely high loads and, therefore, high pressure (PN 10/16 classification up to Ø 125 mm.

The flanges that are perforated according to the EN 1092 and ISO 7005 standard are protected by an external homopolymer polypropylene PP coating that protects the metal from possible oxidation while ensuring reduced weight and high mechanical resistance.

All the collars are equipped with a 30° chamfer for coupling with most butterfly valves. Consult our Technical Department to check compatibility with these valves.

$\boxed{1}$ **Female pipe union to weld with flat seat seal**
Another non-permanent jointing solution is the 4-piece pipe union. Available in diameters from Ø 20 to Ø 63 mm, it features two collars with flat gasket seal (like in the flanges) and two external metal parts that never come into contact with the fluid but ensure the peroxide EPDM flat gasket is pressed down through a standard threading.

$\boxed{2}$ **Threaded male pipe union to weld with OR seal**
This type of connection features a male part in PP-R to weld (compatible with the entire PP-R fiber fitting range), connected via a metal nut with standard ISO 228 threading in a special brass alloy, available in the male or female version. Sealing is guaranteed by a special peroxide EPDM OR gasket. Easy removable and appreciated to their elevated sealing performance, the pipe unions are available in diameters from Ø 20 mm x ½" to Ø 63 mm x 2".

Direct joint
Direct joints are elements that make the REHAU range stand out. These special fittings allow you to branch off a larger pipe to connect it to a much smaller pipe in confined spaces with limited equipment and extremely reduced time. This operation is possible even on piping that has already been installed. Direct joints are available in various sizes and in three different types:

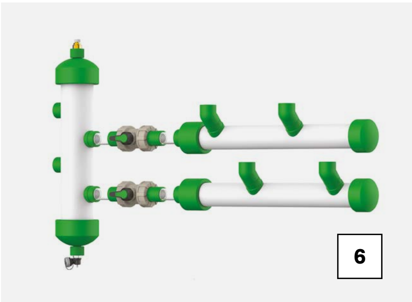
$\boxed{3}$ **Direct joint to weld:** allows a branch of the same material to be welded on a main PP-R fiber pipe

$\boxed{4}$ **Threaded direct joint:** allows a female ½" or ¾" threading to be welded on a main PP-R fiber pipe, where any threaded accessory can be coupled, for example, thermometers, flow metres, pressure gauges in power stations, taps, shut-off valves


5

All the direct branches are installed simply by drilling a hole into the main pipe (which must be at least 4 diameters larger than the branched one) and welding the branch with the normal dies used for standard fittings.

5 Saddle
Similar to direct joints, they allow the connection of a much smaller pipe via saddle welding.
This technique requires the use of specific dies to install on a standard polyfusion welding machine to weld both on the pipe thickness as well as on the external wall of the main pipe.
This way, it is possible to makes breaks on existing piping without the help of reduced tees.


6

6 Manifolds and special items
For a long time REHAU has been offering a custom-made service through a dedicated production department able to produce manifolds and special fittings up to 630 mm on specific project or demand to support and facilitate the work of installers and designers.
The service includes the design of the workpiece, the quotation and the implementation, with the advantage of definite time and cost.
Ask for a quotation by getting in touch with our team:
rehau.uk/pprfiber

10 Fire resistance

The PP-R fiber, assessed according to DIN 4102, is classified B2 and according to EN 13501, is placed in Euroclass E. In case of fire, the PP-R fiber causes neither toxic gas emissions nor the development of dioxins.

Fire load

During combustion, the PP-R 80 Super and PP-RCT material is comparable to common natural products like wood, cork, wool, etc. and its calorific value is equal to oil. Ignoring the massivity factor, that is, the ratio between the side exposed to the flame and the structure of the element, the material participating in the combustion is mi 0.8 (m/factor).
The pipes installed on site subject to Fire Prevention must be arranged according to established fire prevention protection requirements. Refer to the specific instructions of the sector laws and standards in force in the individual countries.
To correctly project and to properly calculate the compartmentalisation areas, the Specific Fire Load value (qf) shall be determined.
This is given by the outcome of the developed Combustion Heat (kWh/m) of each material present in the concerned area. The developed heat is in turn determined considering the material calorific value according to the dimensional characteristics of the item concerned.
The calorific value can be lower or higher.
In the case of polypropylene pipes, the available references are:

- Lower Calorific Value according to DIN 18230, Hu=12.2 kWh/kg
- Higher Calorific Value certified by the producers of raw material, Hs=12.8 kWh/kg.

In the following table we give the Combustion Heat value developed by the pipe, considering the Higher Calorific Value. To respect a conservative design reflecting high safety standards, the presence of glass fibers in fiber reinforced pipes is not to be considered.

Flammability values V (kWh/m)

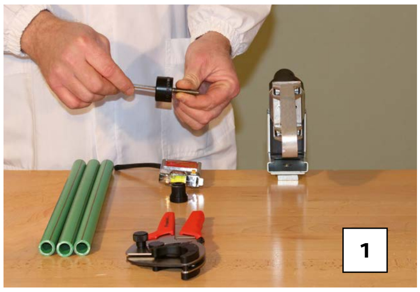
	Dimensions (mm)										
	Ø	20	25	32	40	50	63	75	90	110	125
	Kwh/kg										
PP-R fiber SDR 7.4*	12.8	2.02	3.14	5.03	7.76	12.02	18.92	26.75	38.34	57.84	71.32

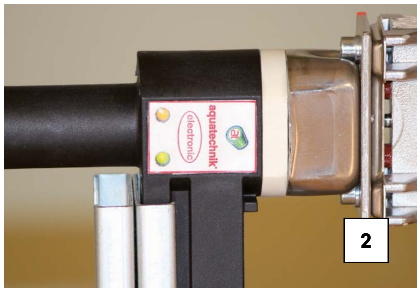
Fire protection requirements

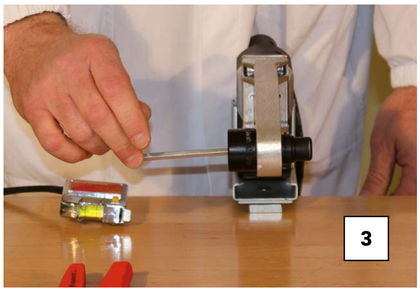
For fire protection of penetrations through fire-rated ceilings and walls, it is compulsory to install suitable fire collars that will not reduce the fire-rating of the particular building elements.
With regard to fire protection, the applicable national regulations and the valid codes/regulations of building practice are to be observed.
The PP-R fiber system can be installed with suitable fire collars, which have been tested according to EN 1366-3 and either carry a local type approval or a UKCA mark based on a European Technical Assessment (ETA).
Not all tested and approved fire collars have the same performance in identical installation scenarios. Contact the manufacturer of the fire collar for information on fire test results and assembly/installation instructions or refer to the corresponding ETA to determine which solution suits your requirements
Avoid direct contact between PP-R fiber pipe and the wall or floor to avoid transmission of structure-born noise into the building structure. Use fire rated soft caulking material to close gaps between the floor/wall and the pipe and/or fire collar. The caulking material must be tested and approved by the manufacturer of the fire collar to be installed together with PP-R fiber pipe.
We recommend to always get an approval from the responsible building control authority for compliance with any applicable national and local requirements.

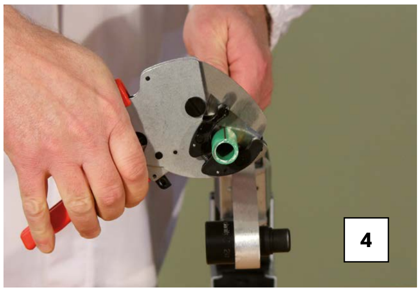

GRUNDFOS

11 Jointing and Equipment









Welding techniques
The PP-R piping system component junctions are done via different types of welding, depending on the indications shown below.

Dimensions (mm)

Ø	20	25	32	40	50	63	75	90	110	125
Socket polyfusion	■	■	■	■	■	■	■	■	■	■
Electro-fusion welding	■	■	■	■	■	■	■	■	■	■

Socket polyfusion welding

1 Assemble and secure the dies to the polyfusion welding machine, making sure that the dies are in perfect condition: dies with damaged Teflon, uneven surfaces due to indentation or residual material deposits which cannot be removed must be replaced.

2 Switch on the polyfusion welding machine and wait for it to reach working temperature. When the yellow light is off, a sound signal will start: this means that the welding machine is ready.

3 Re-tighten the dies and wait for a further switch off cycle and for the temperature light to come on.

4 Cut the pipe perpendicularly and with care. To cut, use tools intended for plastic materials like shears/scissors and rotary pipecutters.

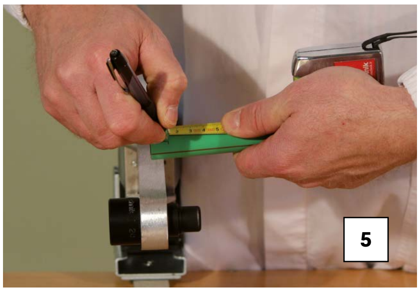
⚠

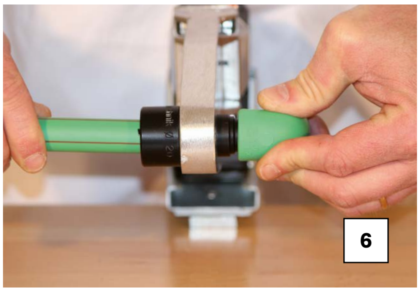
Warnings
- PPE must be worn at all times when working with high temperature equipment and tooling.

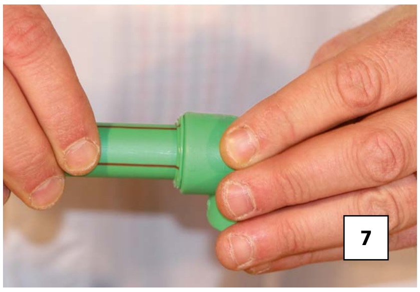
5 For proper polyfusion welding, use the specific markers to mark welding depth and the assembly direction.

6 Begin the polyfusion welding process by pushing the pipe and fitting simultaneously until they hit the die stop, working axially and without rotating the elements. Once you have hit the stop, wait for it to preheat, according to the DVS 2207 “Preheating Times” table to obtain an even temperature.

7 Once preheating is complete, remove the parts from the die and assemble them, respecting the maximum junction times (DVS 2207 “Assembly Times” table).







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Warnings

- Once polyfusion welding is complete, do not use tension and force on hot parts.
- When removing the parts from the die and during assembly, do not rotate the parts.
- Do not perform polyfusion welding with any water or fluid being present.
- Proceed to pressure testing (chapter on page 46) after at least 1 hour from the last welding. The product can sustain the simple passage of fluids with working pressure just a few minutes after welding (consult the DVS 2207 table).
- Avoid any debris or contaminants on the elements during the assembly stage.
- Work away from air currents.
- Prevent the dies from becoming loose on the polyfusion welding plate.
- The welding dies must be periodically cleaned (or replaced), using cloth rags dampened in a mixture of 50% water and alcohol.
- Make sure the polyfusion welding machine works at the correct temperature (260°C on the dies).

During system polyfusion welding processing, you must observe the following warnings:

1. All welding machines always require the electrical system to be grounded.
2. Welding machines are equipped with a system indicating when the correct working temperature is reached: refer to the manual attached to the tool.
3. Tampering, even partially, with equipment voids the warranty.
4. Do not use malfunctioning or ruined welding machines.
5. Do not use polyfusion welders that show nicks in the dies, worn Teflon and deposits of burned residues: these factors compromise welding machine results.

Working time table, according to DVS 2207 part 11 (German institute for plastic material welding)

NB: a) part preheating times are intended as pauses for the pipe and fitting that have hit the limit stop in the respective dies; b) once the parts have reached the limit, avoid pushing them further so as not to create burrs of welded material that would reduce the internal pipe cross-section; c) with external temperatures lower than +5°C, use the times shown in the specific column.

Ext pipe Ø	Welding depth	Warm up times		Assembly	Cooling
mm	mm	sec DVS	sec ≤+5°C	sec	min
20	14.0	5	8	4	2
25	15.0	7	11	4	2
32	16.5	8	12	6	4
40	18.0	12	18	6	4
50	20.0	18	27	6	4
63	24.0	24	36	8	6
75	26.0	30	45	8	8
90	29.0	40	60	8	8
110	32.5	50	75	10	8
125	40.0	60	90	10	8

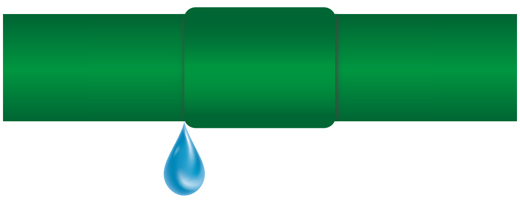
Socket welding errors

Cracks

Notches

Misaligned during welding process

Not cut square



Wet components

Electro-fusion welding

1 Extract the electro-fusion coupler of the package. Keep the label as useful for the settings of the electric-welder machine

2 Measure the length of the electro-fusion coupler and divide the result by two.

3 Add 1cm to the obtained measurement so that the jointing end to be scraped has a clear and visible mark: indicate the measurement on the pipe with a suitable marker.

4 Scrape the pipe heads for at least 0.1mm on pipes up to Ø 63mm and at least 0.2mm on larger diameters.

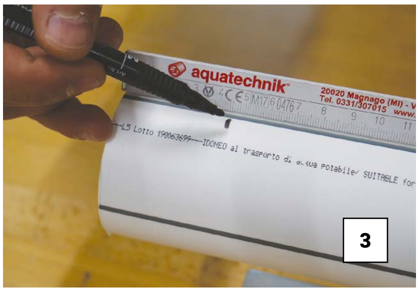
5 Remove the swarf. For this purpose, use the specific scraper (code 50479).

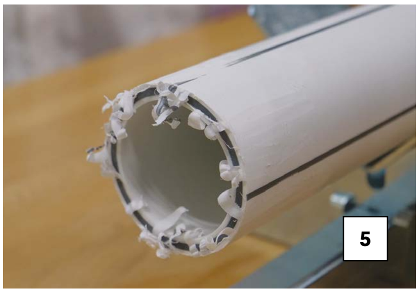
6 Clean the pipe ends with the specific fluid (code 71405).

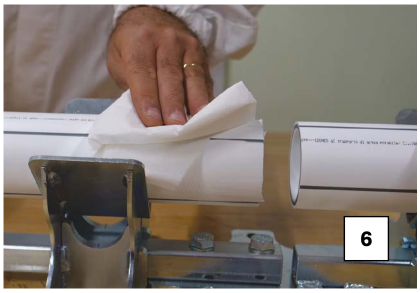
7 Slide the pipe ends into the electric sleeve until they hit the stop.

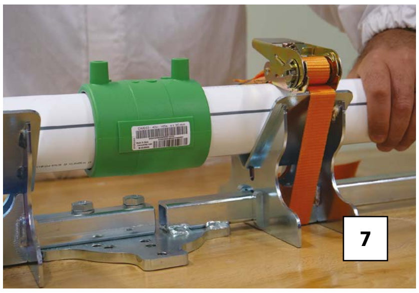
8 Connect the electric sleeve with the electric welder via the specific connectors.

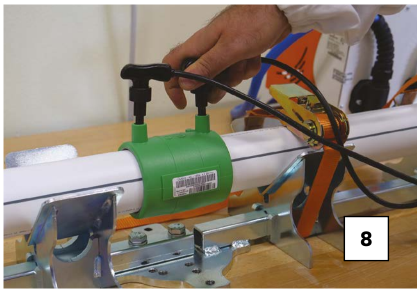
9 Set the electric-welder machine with the correct values of temperature and voltage: • by reading the bar code on the label affixed to the sleeve • by inserting values manually though the suitable display. Proceed to the welding cycle according to the technical manuals.











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Warning
Keep a safe distance during the electric welding.
Please check any Electrofusion machines are suitable for PP-R pipework.

Code	Ext. pipe Ø	Voltage	Welding time	Cooling time
	mvm	v	sec	min
69508	20	17	76	10
69510	25	20	86	10
69512	32	18	86	10
69514	40	20	122	10
69516	50	40	87	10
69518	63	40	165	15
69520	75	40	150	15
69522	90	40	125	20
69524	110	38	190	20
69526	125	40	160	20

NB: Given values are indicative. Always refer to the values on the label on the fitting.

Direct joint
Direct joints can be made with pipes of diameters from 50 mm to 630 mm.

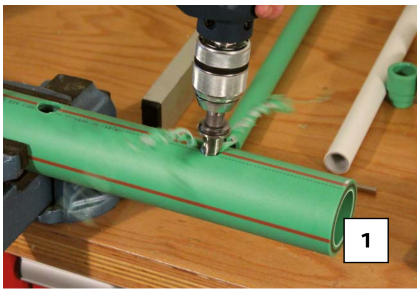
1 With the stepped drill bit, make a hole in the PP-R pipe, checking that it is perpendicular.

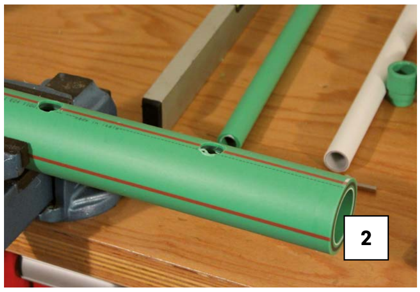
2 Remove burrs and slag.

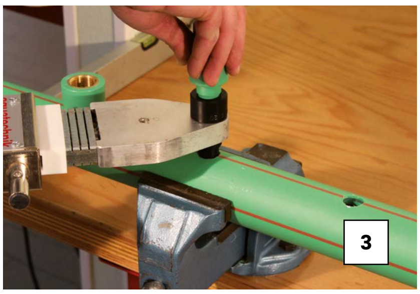
3 Proceed in polyfusion welding the elements according to the instruction on pages 36-37, using the standard dies.

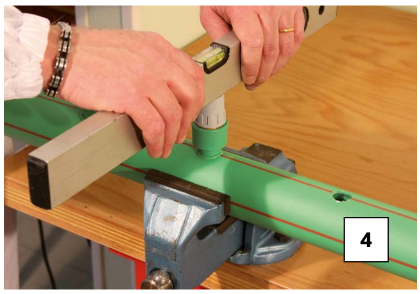
4 Assemble the elements, making sure that the branch is perpendicular compared to the pipe.

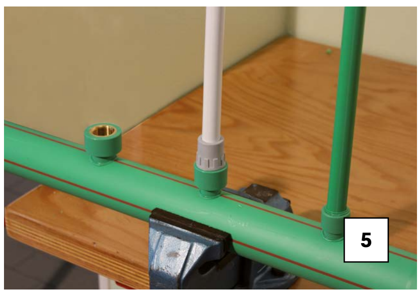
5 Respect the cooling times before continuing processing.











Saddle
Saddles can be made with pipes of diameters from 40 mm to 125 mm.

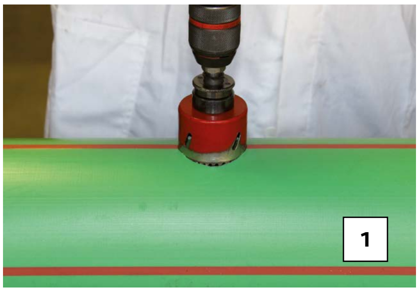
1 With a hole saw, make a hole in the PP-R pipe, checking that it is perpendicular. For hole saw sizes please see table on page 42.

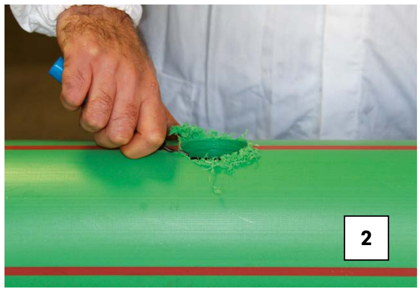
2 Remove burrs and slag.

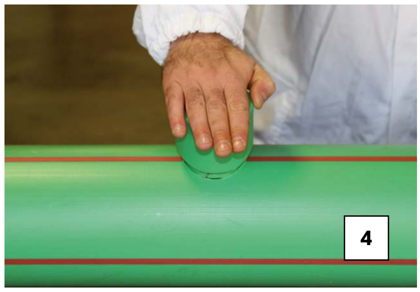
3 Proceed in polyfusion welding the elements according to the instructions on pages 36 and 37 using the specific saddle dies.

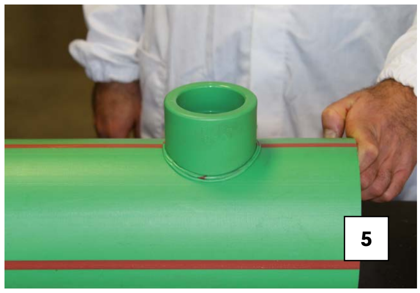
4 Assemble the elements, keeping them pressed for at least 15 seconds, paying attention to the axiality of the parts.

5 Wait 10 minutes for it to cool before continuing processing.









Welding time estimates
To calculate the required time, follow the estimated times shown in the following table (in minutes):

Piping Ø	Elbow	Tee	Flange collars	Valves	Transition fittings	Electric welding
	2 welds	3 welds	1 welds	2 welds	1 welds	2 contemporary welds
20	0.6	0.9	0.3	0.6	0.3	10.0
25	1.0	1.5	0.5	1.0	0.5	10.0
32	1.5	2.3	0.8	1.5	0.8	10.0
40	2.0	3.0	1.0	2.0	1.0	10.0
50	2.5	3.8	1.3	2.5	1.3	12.0
63	3.2	4.8	1.6	3.2	1.6	14.0
75	3.9	5.9	2.0	3.9	2.0	16.0
90	4.7	7.1	2.4	4.7	2.4	20.0
110	5.5	8.3	2.8	5.5	2.8	24.0
125	6.4	9.6	3.2	6.4	3.2	28.0

The indicated times are based on the jointing done according to our technical guidelines in a team of two operators.

Welding times are given exclusive of pipe / fitting preparation.

Cooling times in the machine/equipment of the welded parts are not to be considered as they do not require the employment of personnel.

NB: any clamping implementation times, transport to site times and insulation implementation times are excluded. The lightweight nature of the materials allows for quick, safe handling without using lifting equipment.

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Warnings for appropriate use of the systems
In the event of low temperatures (below +5°C), thermo plastic materials become brittle at low temperatures and are more prone to get damaged by impacts and carelessness.

Drill size requirements

Fitting nominal diameter (mm)	Hole diameter (mm)
20	18
25	24
32	30
40	38
50	48
63	60
75	73
90	86
110	108
125	121

Yes	No
Handle the product with caution and pay attention to the pipe ends.	Avoid violent impacts during storage, transport and installation on construction sites.
Protect installations at risk of damage.	Avoid impacts, falling objects and stress on the pipes, especially during the cold season or when temperatures are low.
Cut pipes with suitable cutting tools. Any pipe sections with partial cuts must be removed.	Do not use pipes with any damage such as cuts, scratches or similar.
Respect the processing times indicated in the polyfusion welding and electric welding tables.	Do not push the elements excessively during the welding stage.
Electro-fusion coupler and pipes to weld must be at the same temperature.	Do not use electro-fusion couplers with an ambient temperature lower than +5°C.
Always use calibrated tools on threaded joints to prevent over-tightening.	Avoid fittings with incompatible threads, particularly in relation to female threads.
Protect piping exposed to UV.	Avoid prolonged (longer than 6 months) direct exposure to sunlight.

12 Pressure testing

Every sanitary, heating or other system installed must be tested by the installing company in compliance with the law. The installer is legally responsible for the work done and must guarantee perfect operation in all of its parts. Therefore, all the tests carried out must be recorded.

We recommend testing the system according to BS EN 806-4 (procedure C), but applying a 15-bar pressure. If it is impossible to apply 15 bar, the test can be performed at reduced pressures which in any case must always be higher than 1.1 times the Maximum Design Pressure in the case of pipelines inside buildings: in this case the time must be increased proportionally (for example, at 8 bar the times could be doubled, at 5 bar the times could be tripled).
This indication is aimed at ensuring a high degree of safety in the testing without compromising the operation of the system in any way.

In case of air testing, apply the provisions of the BS EN 806-4 standard: "where permitted by the national regulations, use clean, oil-free low-pressure air or inert gases. Pay attention to the possible danger caused by gas or air in the system".

Testing is, therefore, recommended by carrying out the following procedures:

1. Pre-test – Duration 60 minutes (1 hour)

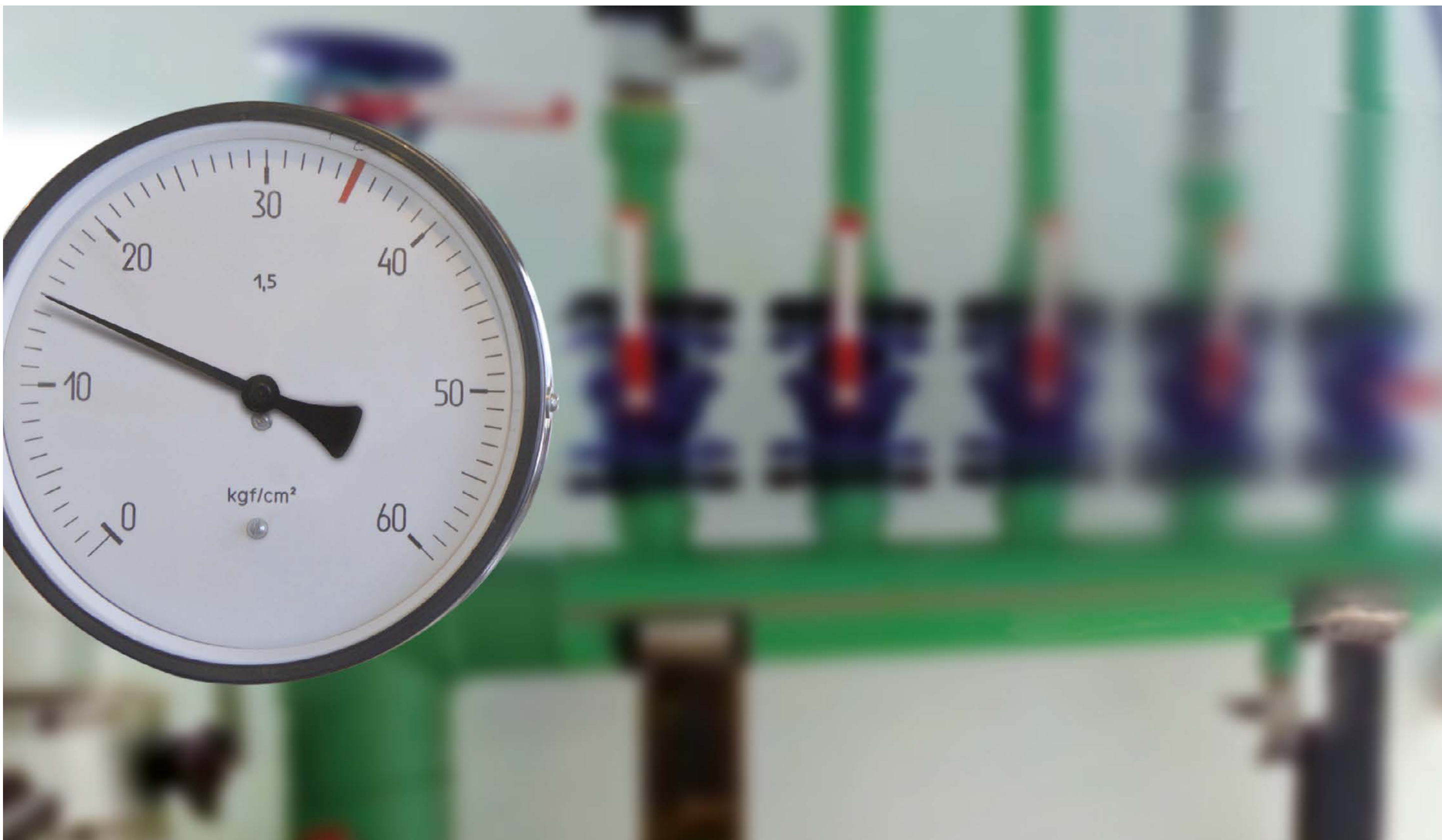
- Fill the system, making sure all the air pockets have been removed, then close the vents and drain valves.
- Connect the variable pressure pump to the most suitable terminal, and fill the system up to the maximum pressure of 15 bar.

NB: if there are heating elements, shut-off valves in the system, reduce the pressure.

- After 30 minutes, record the measured pressure and make a visual inspection to detect any leaks in the system
- After a further 30 minutes, record the measured pressure. If the pressure drop is less than 0.6 bar, the system can be considered to be leak-free and the pre-test can be considered successful.

2. Definitive test – Duration 120 minutes (2 hours)

- If the pre-test gave a positive result, maintain the same pressure for the next 120 minutes (2 hours). During this time, carry out an additional visual inspection to detect any leaks in the system.
- After 120 minutes (2 hours), if the pressure drop is less than 0.2 bar, the test can be considered successful.
- Fill in all the fields of the test report.



13 Filling, flushing and cleaning the system

Once the systems have been installed and a pressure test been carried out as indicated by the EN 806-4 European standard, proceed with flushing; if using water-air mixtures, the compressor or compressed air tanks must be equipped with an oil separating filter.

Flush sections of piping not exceeding 100 m in length. Start from the grip point, ascending through the standpipes and proceeding floor by floor.
The flow speed must be at least 2 m/s, the water change at least 20 times the volume contained by the piping. For each floor, open the sample point furthest from the riser and continue on all the other points.

When the operation is complete, close the sample points in reverse, drain the system if it is unused or if there is a risk of ice forming.

Write up the procedure registration report to hand in to the Work Management and building owner.

Preventive measures against the spread of Legionella
Prevention during the design phase is an efficient way to combat the risk of Legionella proliferation.
Regarding sanitary systems, be sure to:
- avoid pipes with dead legs or without circulation
- prevent the lines from ending in a dead end and create a ring by connecting the flow and return lines at the end of a distribution section
- provide for periodic, simple cleaning
- carefully choose the materials (using pipes with extremely low surface roughness, p.e. PP-R 0.007 mm with total passage fittings reduces the risk of deposits that may favour bacterial proliferation)
- prevent the formation of biofilm, sedimentation and limescale.

The PP-RCT WOR pipes are especially suitable for systems that require line sanitation via the continuous chlorination technique, to guarantee the water potability.

Disinfection techniques
Disinfection processes must be designed and carried out with the goal of:
- safeguarding humans from the presence of bacteria in water, overexposure to oxidising agents and the risk of burns
- maintaining the chemical-physical requirements required by European Directive 98/83/EC regarding the quality of potable water intended for human consumption
- conserving the environment from pollution by oxidising loads deriving from waste waters
- ensuring the integrity and duration of the components making up the systems.

A) Chemical disinfection of potable water
Continuously disinfecting potable water chemically must be done with a maximum concentration of 0.2mg/l of free chlorine.

The water temperature must not exceed 70°C.
Should the presence of bacteria be ascertained, it is possible to carry out a hyperchlorination process up to twice a year. To define times, temperatures and doses, consult the Technical Department.
Once complete, flush the systems with cold potable water. If necessary, neutralise the oxidising loads in the waste water in order to avoid polluting the environment.

Chlorine super shock has extremely negative effects on metal pipes in that it accelerates corrosion.
PP-R fiber pipes, however, have a greater resistance to chemical compounds and can undergo this type of treatment for several years without any reduction in performance. There are new types of treatment available using both chlorine dioxide and

B) Thermal disinfection of the system
Temperatures at 70°C for at least 3 minutes in every part of the system. To carry out in the event of ascertained bacterial presence, protecting people from the risk of burns and scalds.

Thermal and hyperchlorination disinfections must never be carried out at the same time.

Disinfection processes must be carried out by properly qualified personnel; we recommend filling out a log with the doses, temperatures and pressures detected during the processes.

14 Project Responsibilities

The purpose of the following is to clarify the competences and responsibilities regarding heating, cooling and hydrothermal sanitary systems in general, installed using PP-R fiber components.

The competences and responsibilities of REHAU exclusively regard the materials of its own construction and supply, covered by a standard warranty, for any manufacturing flaws or defects.

The company is relieved from any possible claims that may regard:

A. Any type and kind of malfunctioning systems.
B. Broken pipes and/or fittings caused by transport in the construction or work sites; failure to carry out hydraulic testing as indicated in the technical guide; carrying aggressive fluids; materials from other origins inserted into the system that can cause collateral damage or wear on the original piping.
C. Errors in hydraulic, electrical or electronic connections made by installation technicians.
D. Substandard or failed fusion welding.

The competences and responsibilities in making the systems are shown in a table below.

The competences and responsibilities in making the systems are shown in a table below.

Object of the system	Responsible individual
System estimate, calculation and sizing according to the standards in force.	Professional office and/or freelancer qualified for thermotechnical design
Installation of the necessary materials, including: thermoplastic pipes and fittings, insulation in compliance with the standard to form distribution and connection networks to terminal heating elements, distribution manifolds, regulation equipment, boiler and central heating plant, various testing, system start-up and all other work pertaining to the system.	Company specialised in thermo-hydraulic installations and technical service centres
Electrical connections to control equipment, to service thermostats, safety devices and all other work pertaining to the electrical or electronic parts.	Company specialised in electrical installations
Thermoplastic pipes and fittings for hydraulic circuits, accessories and components made by the company itself.	REHAU

15 Metal alloys and water Quality

The drinking water must comply with the currently valid limits of the following standards:

- BS 6700
- National water supply regulations[1])
- Council directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption

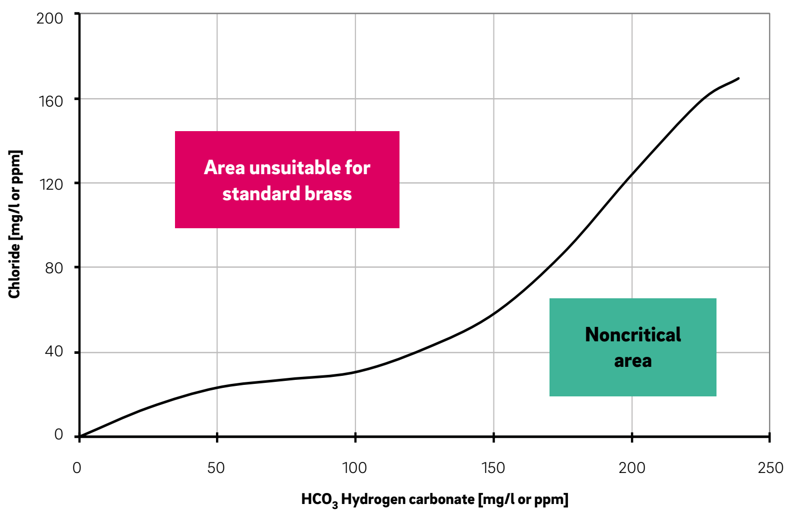
With its fittings made of standard brass CW617N, REHAU meets the requirements according to DIN EN 1254-3. Nonetheless, there is no universal material which can be used for every application. Water quality which can cause corrosion and special interaction within a drinking water installation (according to DIN EN 12502-1) can damage brass fittings.

The ratio of chloride and hydrogen carbonate contents can negatively influence the water's corrosiveness and lead to the selective form of corrosion, dezincification, in standard brass fittings. To avoid the corrosion of the fittings, the following maximal concentration shall not be exceeded:

- Chloride content (Cl–) ≤ 200 mg/l
- Sulphate content (SO4–2) ≤ 250 mg/l
- Calculated calcite solubility capacity ≤ 5 mg/l
- (achieved as soon as pH value ≥7.7)

Furthermore to evaluate whether or not unfavourable conditions exist in relation to this, the Turner diagram (below) should be used.

Turner diagram (Source Wieland Werke Germany)



For water qualities which are above the limit curve for standard brass fittings, dezincification will need to be assumed. In this case, standard brass fittings may no longer be used. The usability of alternative fitting materials is to be evaluated. In such water supplying regions we recommend the use of fittings made of corrosion resistant alloys such as gunmetal.

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The application of water after-treatment, like, for example, water softening, in principle, changes the corrosive-chemical behaviour of the water. To avoid corrosion damage due to an incorrect use and operation of a water treatment system, we explicitly recommend that you have your individual situation examined beforehand by an expert or, for example, by the system manufacturer.

Furthermore, practical experiences with the water which is to be distributed in the area of use should be drawn upon when it comes to evaluating the likelihood of corrosion.

It is the responsibility of the system design that the above-mentioned factors and parameters be taken into account when it comes to corrosion protection and stone formation in actual application.

If the drinking water quality is outside the limits of the drinking water regulation, evaluation and approval is definitely required if the RAUTITAN system is intended to be used. In this case, please contact your REHAU sales office.

1) The maximum allowed limits for disinfectants detailed in the drinking water regulation are not to be interpreted as permanent, lasting application concentrations. They represent the maximum short term limits defined under hygienic and toxicological aspects. Key principle of the drinking water regulation is to avoid any unnecessary addition of chemicals. Only if a chemical additive is required due to contamination may the minimum amount required be added.

Notes

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