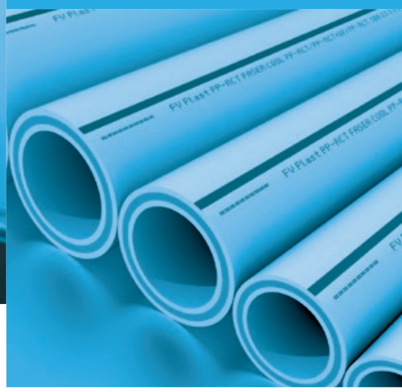
TECHNICAL MANUAL

FV AQUA






WWW.FV-PLAST.CZ

TABLE OF CONTENTS

The documents is subject to a change procedure. Make sure , that you are using the current valid version.

TECHNICAL MANUAL

1. Usage advantages of the FV AQUA PPR system

Basic material

FV Plastic pipes and fittings are made of a statistical copolymer, polypropylene (also known as a random copolymer or type 3 polypropylene). This material has excellent characteristics, such as elasticity, tightness, rigidity, particular resistance against high temperatures, etc. The following abbreviations are used for this marking this material: PPR and PP-R.

A new, improved alternative of this basic statistical copolymer is represented by the so-called nucleic random copolymer of polypropylene. This material is has a finer and stronger crystalline structure, thus being more resistant against high pressures and temperatures in comparison with the "classic" PP-R. It is particularly used for pipe production and it is fully compatible with the classic PP-R. The material is usually abbreviated as PP-RCT (C = crystallinity, T = temperature).

Main advantages of the FV AQUA PPR system

- Hygienic harmlessness
- Is not susceptible to corrosion and to being overgrown
- Easy, fast and clean installation
- Low noisiness, low pressure losses by friction
- When installed properly, its lifespan is more than 50 years, provided the given operation conditions are fulfilled
- Environmentally friendly product (can be recycled or harmlessly incinerated)

2. Basic characteristics of the PP-R and PP-RCT materials

TABLE 1

Characteristic		PP-R	PP-RCT	
Specific weight		0,905	0,905	g/cm³
Liquid alloy flow index MFI 230°C/2,16 kg		0,25	0,25	g/10 min
Tensile strength limit		25	25	MPa
Extension at the tensile strength limit		13,5	10	%
E bend flexibility module		900	900	N/mm²
Impact strength Charpy	23 °C	20	40	kJ/m²
	0 °C	3,5	4	kJ/m²
Coefficient of the linear calorific expansion		0,15	0,15	mm/m °C
Calorific conduction coefficient		0,24	0,24	W/m °C

3. Basic technical standards and regulations

Basic guidelines for the production, testing and use of the FV AQUA PPR system are specified by the European EN standards, international ISO standards and German DIN standards. Welding of individual system elements is governed by the German DVS regulations.
Most important standards: ČSN EN ISO 15874, EN ISO 21003, DIN 8077, DIN 8078, DIN 16962, DVS 2207, DVS 2208 and ISO 10508.

Most important tests:

- Measuring material flow index before and after production
- Measuring dimensions of the final products
- Checking long-term lifespan
- Stability after heating and cooling down
- Impact resistance and inspections of the outer (and possibly inner) surfaces

4. Usage areas of the FV AQUA PPR system

The FV AQUA PPR system is ideal for water distribution lines and distribution lines of other liquids, particularly in the following areas:

- **Sanitary technology and air-conditioning systems**
- **Transportation of drinking water and other food-processing liquids**
- **Heating systems**
- **Transportation of water, air and possibly other chemicals in industrial companies**

TABLE 2

USE
● suitable
○ usable
- unsuitable

	Drinking water	Cold water	Hot water	Floor heating	Low-temperature heating	High-temperature heating	Cooling	Compressed air
PP-R pipes								
CLASSIC PN 10	●	●	-	●	-	-	●	●
CLASSIC PN 16	●	●	○	○	-	-	○	●
CLASSIC PN 20	●	●	●	-	●	●	●	●
FASER PN 20	●	●	●	-	●	○	○	●
PP-RCT pipes								
UNI S3,2 / S4 / S5	●	●	●	●	○	-	●	●
HOT S3,2	●	●	●	○	●	●	○	●
FASER COOL S5 / S8	●	●	●	-	○	-	●	●
FASER HOT S3,2 / S4 /S5	○	○	●	-	●	●	○	○
STABIOXY S3,2 / S4	○	○	●	-	●	●	○	○

5. Assortment

5.1. Marking overview of the FV AQUA PPR system elements, usage suitability

The pipes and fittings are made in nominal dimension lines **16, 20, 25, 32, 40, 50, 63, 75, 90, 110, 125, 160, 200 and 250 mm**.

PIPES

Depending on their wall thickness (pressure lines) and based on their expected use, the pipes are divided into:

- **FV PPR CLASSIC S5 SDR11 (PN10)** - for cold water and floor heating
- **FV PPR CLASSIC S3,2 SDR7,4 (PN16)** - for cold and hot water
- **FV PPR CLASSIC S2,5 SDR6 (PN20)** - for hot water and central heating
- **FV PPR FASER S3,2 SDR7,4 (PN16)**
  - for drinking, cold and hot water, for heating and for compressed air distribution lines
- **FV PPR FASER S2,5 SDR6 (PN20)** - for drinking, cold and hot water, for heating and for compressed air distribution lines
- **FV PP-RCT UNI SDR7,4 (Ø 16 mm), SDR9 (Ø 20-25 mm), SDR11 (Ø 32-250 mm)** - for drinking, cold and hot water
- **FV PP-RCT HOT S3,2 SDR7,4**
  - for drinking, cold and hot water and for heating
- **FV PP-RCT FASER COOL SDR11 (Ø 40-125 mm), SDR17 (Ø160-250 mm)** - for cold water and for compressed air distribution lines
- **FV PP-RCT FASER HOT SDR 7,4 (Ø 20-25mm), SDR 9 (Ø 32-125mm), SDR 11 (Ø 160-250mm)** - for hot water distribution lines
- **FV PP-RCT STABIOXY SDR 7,4 (Ø 20mm), SDR 9 (Ø 25-110mm)**
  - for hot water and heating

Note: For permitted operation pressures in individual classes, see Chapter 9.

PP-R

CLASSIC pipes are single-layer pipes:

The pipes are made of the classic random copolymer of polypropylene. Individual pipes differ only by their particular wall thickness. The pipes can be marked PP-R.

FASER pipes are three-layer pipes:

The outer and inner layers are formed by PP-R polypropylene, armed with glass fiber (GF). Thanks to their arming with glass fibers, the pipes are stronger and less expandable under high temperatures (similarly to the CLASSIC pipes). The pipes can be marked PP-R/PP-R-GF/PP-R.

PP-RCT

The UNI and HOT pipes are single-layer pipes:

The pipes are made of the new PP-RCT polypropylene with a higher pressure and thermal resistance. Individual pipes differ only by their particular wall thickness. The pipes can be marked PP-RCT.

FASER COOL and FASER HOT pipes are three-layer pipes:

The outer and inner layers are formed by PP-RCT polypropylene. The middle layer is formed by nucleic PP-RCT polypropylene, armed with glass fibers (GF). Thanks to their arming with glass fibers, the pipes are stronger and less expandable under high temperatures (similarly to the UNI and HOT pipes). The pipes can be marked PP-RCT/PP-RCT-GF/PP-RCT.

STABIOXY pipes are three-layer pipes:

During the production process, the inner polypropylene pipes made of PP-RCT is firmly connected along their perimeter with an aluminum foil and subsequently coated with a polypropylene layer. Thanks to the aluminum foil, the pipes acquire not only the same pressure and thermal resistance as the UNI and HOT pipes, but also an oxygen barrier, greater strength and lower thermal expandability. Because of the mechanical protection provided by the aluminum foil, the pipes are furnished with an outer polypropylene layer, which has to be removed prior to welding along the length of the given welding extension. The pipes can be marked PP-RCT/A/PP-R.

In some cases, residual humidity from the production process of the inner polypropylene pipe can condense in the form of small bubbles and blisters under this outer layer. Since this layer had no impact on the mechanical characteristics of the pipes, the reaction represents only an esthetic issue.

Note: PP-RCT pipes are fully compatible and can be normally welded to PP-R pipes and fittings, as well as to STABIOXY pipes upon cutting the aluminum layer off.

FITTINGS

They are made of PP-R. Their sizes guarantee at least the same resistance as all the pipes from the highest pressure class. They can be divided into the following categories:

- **All-plastic fittings** (elbows, T-pieces, couplings, reductions, plugs, etc.)
- **Fittings combined with brass, zinc-coated threaded connections** (reducers, elbows, T-pieces, wall elbows, etc.)
- **Valves** (straight valves, ball valves, etc.)
- **Other** (cross pieces, compensation loops, etc.)

AUXILIARY PRODUCTS

Fastening elements, tools (flanges, welding machines, extensions, shears, etc.)

ELEMENT MARKING:

PIPES

Pursuant to ČSN EN ISO 15 874, marking has to include at least the given standard number, name of the manufacturer and/or business name (code, abbreviation), outer diameter, wall thickness, pipe dimension class, material identification (abbreviation), usage class together with the given calculation pressure (see Chapter 9), other manufacturer information.

Sample marking of a "CLASSIC SDR6" pipe:

FV PLAST PP-R 20x3.4 SDR 6 (S 2.5) EN ISO 15874 (Class 1/10bar, 2/8bar, 4/10bar, 5/6bar) - time - date – line number - Made in EU (Czech Republic)

FITTINGS

Pursuant to ČSN EN ISO 15 874, marking located directly on the fitting has to include at least the name of the manufacturer and/or business name (code, abbreviation), nominal outer diameter of the given dimension line, material identification (abbreviation), other manufacturer information. All other information can be stated on an attached tag or packaging label.

Sample marking of a FV PPR fitting, straight plastic valve 20:

Marking on the fitting:

FV Ø 20 PP-R date marking (production month and year)

Marking on the label:

Fitting name – code – diameter – packaging date – number of pieces in the given box – logo – PP-R (type 3) – CLASS 1/10, 2/8, 4/10, 5/6 – according to CSN EN ISO 15874 - MADE in EU (CZ)

5.2. Pipe dimension lines and their marking

Generally speaking, plastic pipeline systems are made and marked within the frame of the metric system, particularly in millimeters. These dimensions (millimeters) specify the pipe outer diameters and, at the same time (for connections implemented by the means of polyfusion welding), the inner diameter of the given fitting, as showed on PICTURE 2.

The most commonly used polypropylene pipes come from the following dimension lines: **16, 20, 25, 32, 40, 50, 63, 75, 90, 110 mm**. A comparison between the stated dimension lines and steel pipes is showed in TABLE 3 and TABLE 4.

Moreover, plastic pipes are divided based on their corresponding wall thickness (for identical outer diameters of the pipes) into several categories. Pursuant to the international ISO standards and European EN standards, these categories are marked with the letter S (Series). In the German DIN standards, they are also marked as SDR (Standard Dimension Ratio).

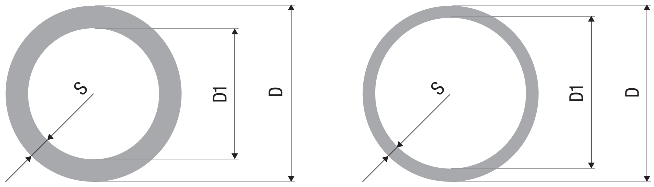
Pursuant to the ČSN EN ISO 15874 standard, Plastic pipeline systems for the distribution of hot and cold water – Polypropylene (PP), pipeline lines S are defined for the pipes. The standard does not use the PN marking any more. We have kept the PN marking of the stated pipes (included in parentheses) to accommodate the general knowledge of our customers.

$$S = (SDR-1)/2, \quad SDR \approx D/s$$

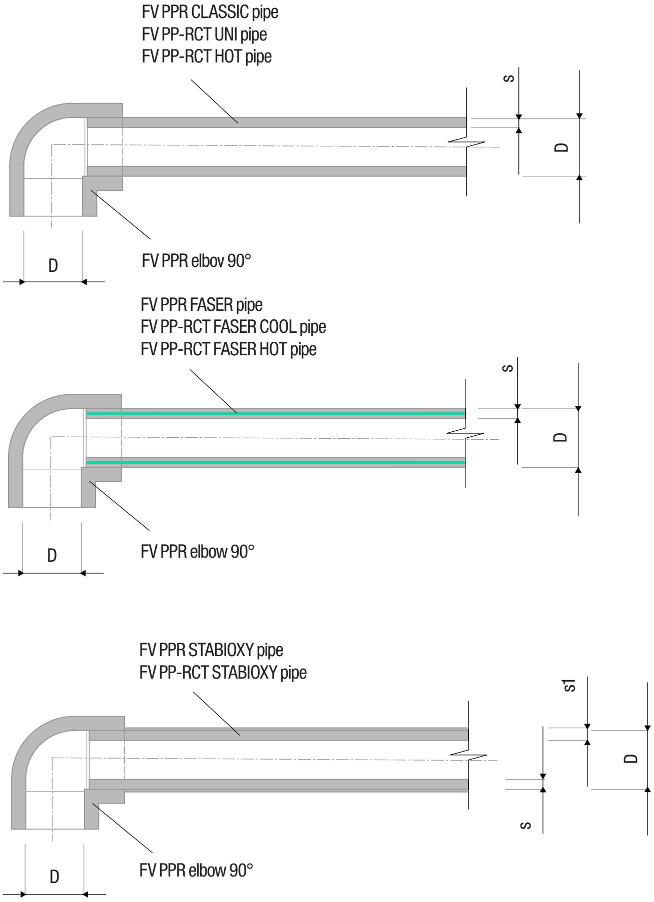
D – outer diameter of the pipe [mm]

s – thickness of the pipe wall [mm]

PICTURE 1



PICTURE 2



Information about the usage suitability of the pipes is included in the given description in the following form: **Pipe name, dimension, pipeline line pursuant to the standard, usage class / operation pressure.**

The following lines are the lines that are used the most for building and industrial water distribution: SDR 11, SDR 7.4 and SDR 6.

TABLE 3 - Relations among S, SDR and PN for the PP-R pipes

SDR	**17**	**11**	**7,4**	**6**
S	8	5	3,2	2,5
Formerly PN	6	10	16	20

TABLE 4 - Relations among S, SDR and PN for the PP-RCT pipes

SDR	**17**	**11**	**9**	**7,4**	**6**
S	8	5	4	3,2	2,5
Formerly PN	Not used				

**) Note: The PP-R pipes used to be also marked PN. This abbreviation essentially specified the maximal permitted operation pressure (bar) of cold water during long-term operation. Recent improved characteristics of the basic materials allow for increased operation pressures and/or operation temperatures. As a result, the PN marking basically loses its significance. We included the PN marking in our catalogue (in parentheses) only to accommodate the wide-spread knowledge of this marking system.*

5.3. Usage classes

Pursuant to the ISO 10508 standard, the following typical usage areas – classes are defined:

- **Class 1** (delivery of hot water 60 °C, lifespan 50 years)
- **Class 2** (delivery of hot water 70 °C, lifespan 50 years)
- **Class 4** (floor heating, low-temperature radiators, lifespan 50 years, with the stipulation that 20 years are expected (overall, during the entire lifespan) for operation temperature of 40 °C, 25 years for 60 °C and 2.5 years for 70 °C)
- **Class 5** (high-temperature radiators, lifespan 50 years, with the stipulation that 14 years are expected (overall, during the entire lifespan) for operation temperature of 20 °C, 25 years for 60 °C, 10 years for 80 °C, and 1 year for 90 °C)

Maximal operation pressures (4, 6, 8 and 10 bar) are determined by calculation for each material and pipeline line S for each usage class.

TABLE 5 - Pipe dimensions for individual usage classes pursuant to EN 15874

Usage class	**Operation pressure 8 bar**		**Operation pressure 10 bar**	
	PP-R	**PP-RCT**	**PP-R**	**PP-RCT**
Usage class 1 60°C, hot water delivery	S3,2 SDR7,4	S2,5 SDR6	S2,5 SDR6	S3,2 SDR7,4
Usage class 2 70°C, hot water delivery	S2,5 SDR6	S4 SDR9	S2 SDR5	S3,2 SDR7,4
Usage class 4 Floor heating and low--temperature radiators	S3,2 SDR7,4	S4 SDR9	S3,2 SDR7,4	S3,2 SDR7,4
Usage class 5 High-temperature radiators	S2 SDR5	S3,2 SDR7,4	-	S2,5 SDR6

5.4. Classification of the usage classes

Pursuant to standard ISO 10508, operation conditions are classified for individual usage classes.

TABLE 6 - Classification of the operation conditions pursuant to ISO 10508-2006 E

Usage class	T_D		T_{max}		T_{mal}		**Typical usage area**
	°C	Time[a] years	°C	Time years	°C	Time hours	
1[b]	60	49	80	1	95	100	60°C, Hot water delivery
2[b]	70	49	80	1	95	100	70°C, Hot water delivery
3[c]	20	0,5	50	4,5	65	100	Low-temperature floor heating
	30	20					
	40	25					
4	20	2,5	70	2,5	100	100	Floor heating and low-temperature radiators
	40	20					
	60	25					
5	20	14	90	1	100	100	High-temperature radiators
	60	25					
	80	10					

Note: This international standard is usable only for enclosed systems, in which the T_D, T_{max} and T_{mal} do not exceed the values specified for class 5.

[a]) The temperature range for any class should consist of individual time sections (for example, the range of operation temperatures for the period of 50 years for class 5 is: 20 °C for 14 years, 60 °C for 25 years, 80 °C for 10 years, 90 °C for 1 year and 100 °C for 100 hours).

[b]) Depending on the corresponding international, national and local regulations.

[c]) Permitted only if the temperature during an accident does not exceed 65 °C.

DIAGRAM 1 - 1 – 50-year lifespan diagram for pipes based on temperature and time for **usage class 1** pursuant to ISO 10508:2006 (E)

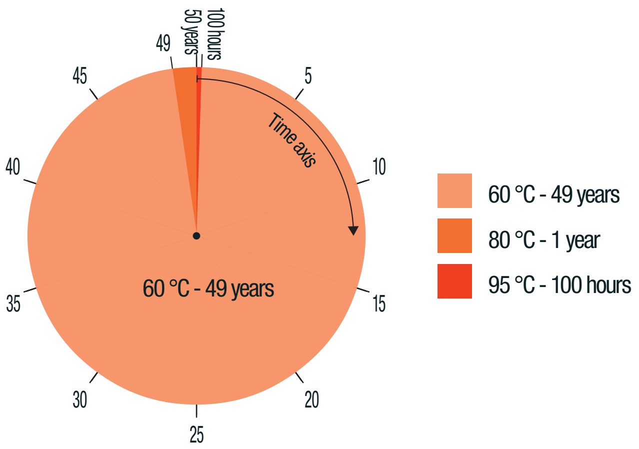


DIAGRAM 2 - 50-year lifespan diagram for pipes based on temperature and time for **usage class 2** pursuant to ISO 10508:2006 (E)

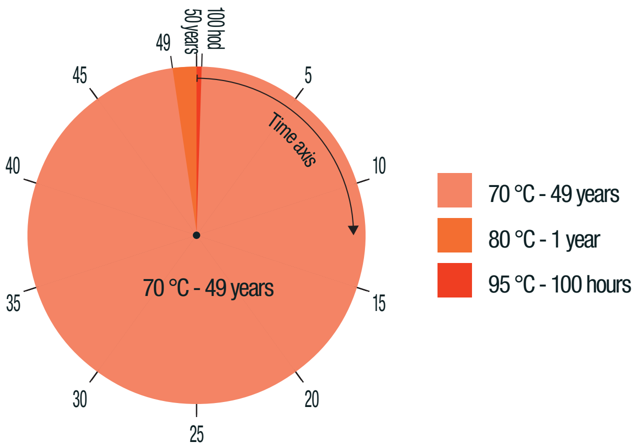


DIAGRAM 3 - 50-year lifespan diagram for pipes based on temperature and time for **usage class 4** pursuant to ISO 10508:2006 (E)

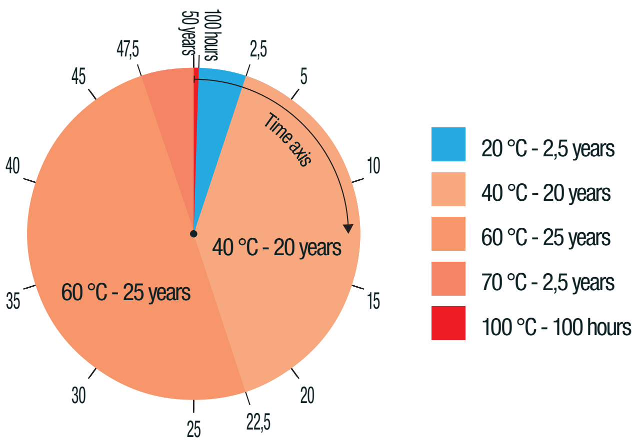
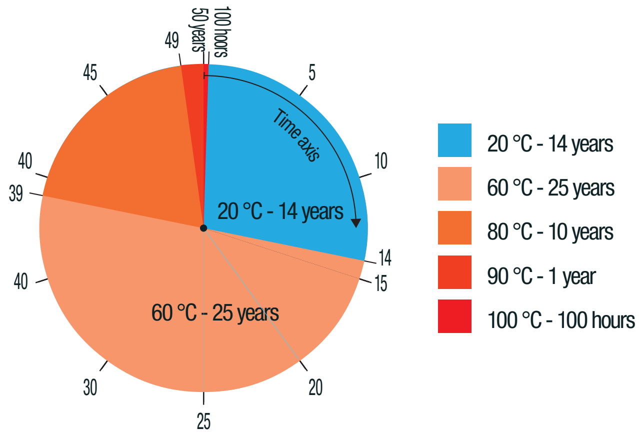


DIAGRAM 4 - 50-year lifespan diagram for pipes based on temperature and time for **usage class 5** pursuant to ISO 10508:2006 (E)



6. Basic parameters for the water-filled systems

6.1. Water parameters for sanitary purposes

TABLE 7 - Basic water parameters in the sanitary distribution systems (pressure, temperature)

Medium	Operation pressure [bar]	Max. operation temp [°C]
Drinking water	0 - 10	up to 20*
Cold water	0 - 10	up to 20
Hot water	0 - 10	up to 60 (70)**

**) For hygienic reasons, the maximal drinking water temperature is 20 °C.*

***) It is expected that the maximal regular operation temperature in the hot water distribution lines is 60 °C; in order to be able to eliminate pathogenic mycobacteria and Legionella pneumophila bacteria, the hot water can be, in a short term, heated maximally to 70 °C. This so-called thermic disinfection is effective only if water with the given increased temperature is discharges from all discharge valves. Caution has to be exercised in order to avoid scalding.*

6.2. Operation parameters – WATER MAINS

Operation parameters are represented by (maximal) operation pressure and temperature and their mutual relation with regard to the given pipeline lifespan. Operation parameters for water mains are stated in TABLE 11 and TABLE 12. The tables also state the usage manner of individual pressure lines for the cold and hot water distribution lines. Safety coefficient of 1.25 was used in TABLE 12 (pursuant to DIN 8077) for the purposes of the given calculation.

The CLASSIC S3.2 SDR7.4 pipes can be used only for hot water distribution lines, in which the required heating regulation is ensured, thus making sure the maximal temperature of hot water is not exceeded.

6.3. Operation parameters – HEATING

Operation parameters are represented by (maximal) operation pressure and temperature and their mutual relation with regard to the given pipeline lifespan. Suitable pipe selection for a particular heating system is determined by the given project engineer. Operation parameters for are stated in TABLE 11 and TABLE 13. The tables also state the usage manner of individual pressure lines for the heating distribution lines. Safety coefficient of 1.5 was used in TABLE 13 (pursuant to DIN 8077) for the purposes of the given calculation. The CLASSIC and FASER pipes within the SDR 6 pressure line and the STABIOXY pipes are suitable for being used in central heating systems with a water temperature of up to 80 °C. The HOT, FASER HOT and STABIOXY pipes are suitable for being used in central heating systems with a water temperature of up to 90 °C. The overall lifespan and temperature changes during the specified lifespan time pursuant to Diagram 4 have to be taken into account and, if applicable, Table 13 (Heating operation parameters) has to be considered. Nevertheless, the pipe usage manner has to also comply with the conditions stated in corresponding technical sheets for individual pipe types.

The principle for the heating system calculations is identical to traditional metal pipelines. The main difference when comparing metal and plastic pipelines from the proposal point of view is the fact that plastic pipes are not suitable for being installed freely, with the exception of technical floors and similar installation areas. Emergency situations related to older boiler types (overheating) can result in damages to the given pipeline. That is why we recommend to install 2-3 m of metal piping starting at the boiler, and to use plastic pipes only pass this point.

6.4. Fire water mains

The PP-R and/or PP-RCT polypropylene pipes can be used for fire water distribution lines, however, only for permanently water-filled fire water mains and provided some other conditions are fulfilled:

Pipes can be installed freely in areas, in which they cannot be exposed to temperatures that exceed 150 °C in case of fire. In all other cases the pipes have to be installed in installation shafts or ducts with a fire resistance that corresponds to the given national regulations. Polypropylene pipes are included to fire reaction class E to F (pursuant to ČSN EN 13 501).

6.5. Water freezing in pipes

Water main pipes have to be protected against freezing. Should it not be possible to avoid negative temperatures and should there thus be a possibility of the given medium to freeze, the pipes have to be emptied. Due to the fact that water expands when changing its state to ice as well as to the changes of pipe characteristics as a result of low temperatures, the pipe lifespan could be compromised. Pipes exposed to negative temperatures can be also protected against mechanical damages.

7. Chemical resistance for other fillings

Suitability of the usage manner of pipeline systems for transporting various chemical compounds, liquid as well as loose, cannot be unambiguously determined at a general level without a detailed assessment of each particular intention. For each particular case, we have to know the exact concentration of the given chemical solution, operation temperature, maximal temperature, operation pressure and required lifespan time. These assessments are conducted by specialized project engineering companies. The German DIN 8078 standard can be used for basic orientation. Its appendix Bb1 defines the basic chemical resistances of polypropylene. It is also possible to consult their usage manner in chemical industry with given system manufacturers. Chemical resistances of the most common types of chemicals can be found in paragraph 20, Chemical resistance of the PP-R and PP-RCT materials.

8. Strength isotherms

The curves, known as strength isotherms, show the lifespan of the pipes made of a given material as a mutual relation between the tension in the pipe wall (caused by the pressure inside of the pipes) and the given medium temperature. The strength isotherms for different materials are different. They demonstrate the corresponding different lifespans of the pipes of the same dimensions. The tension in the pipe wall is caused by a higher pressure inside of the pipe and it is calculated pursuant to the so-called "pipe formula":

$$\sigma v = \frac{p \cdot (D - s)}{2 \cdot s}$$

σv – perimeter tension [MPa]
D – outer diameter of the pipe [mm]
s – pipe wall thickness [mm]
p – maximal pressure [MPa]

Pipe lifespan in diagrams 5 and 6 is then determined as the point of intersection of the calculated pressure and the corresponding temperature, to which the pipe will be exposed. In real life, the maximal operation pressure in the pipes is determined based on the isotherm of the given material in the corresponding technical standard, utilizing safety coefficient "k". For the FV AQUA PPR systems, a coefficient of 1.25 is used for water mains calculations and a coefficient of 1.5 for heating.

DIAGRAM 5 – Strength isotherms of the PP-R materials

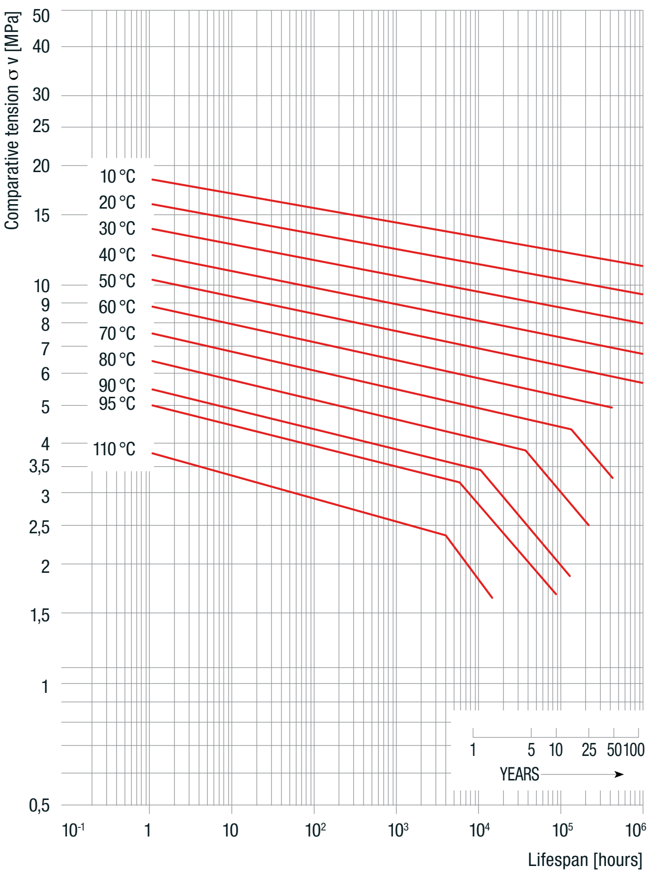
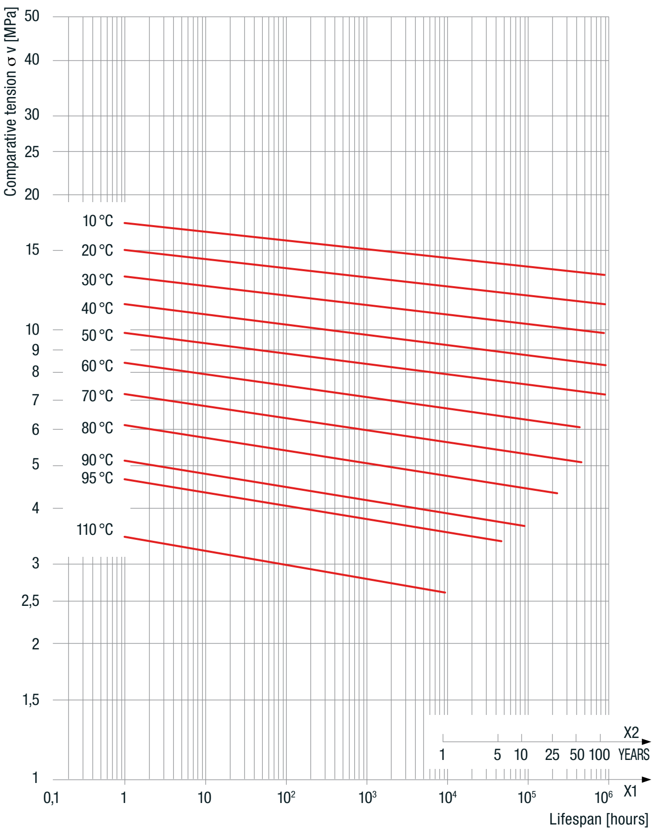


DIAGRAM 6 – Strength isotherms of the PP-RCT materials



Comparison of the crystalline structure of the PP-R and PP-RCT materials

Usual **PP-R materials** crystalize in the so-called α-structure (monolithic). The crystals are of a relatively greater dimensions of a smaller volume.

PP-RCT material crystalizes in the so-called β-structure (hexagonal). The crystals are of a relatively smaller dimensions of a greater volume. Due to this β-structure, the intermolecular connections are stronger than in the case of the α-structure, which allows for increasing the operation temperature and/or pressures in the pipes.

Note: Fittings of the same diameter line have thicker walls than the corresponding pipes and that is why they are made of PP-R and can still be exposed to the same operation pressure and/or temperature as the pipes made of the PP-RCT material.

9. Tables of the FV AQUA PPR system pipe parameters

The operation parameter tables show particular values of the permitted maximal pipe operation pressures for concrete water temperatures with regard to the required system lifespan. These values are determined based on the strength curves (isotherms) that are included in the previous chapter.

Two basic principles for assessing individual operation parameters are currently applied to water mains and heating systems in residential buildings:

Pursuant to EN ISO 15874 - a basic condition is the overall system lifespan of 50 year; temperature changes of the transported water during the lifespan period are taken into account.

Pursuant to DIN 8077 - a basic condition is a constant temperature of the transported water under a constant pressure and the system lifespan calculated from these values.

9.1. Operation parameters pursuant to standard EN ISO 15874

The EN ISO 15874 standard specifies 4 operation classes (1, 2, 4 and 5) for water transportation in the sanitary and heating pipeline systems. A maximal operation pressure of 4, 6, 8 or 10 bar is permitted for each of these classes depending on the dimension characteristics and pipeline material.

Dimension characteristic S_{calc} is determined based on the formulas for SDR and S, stated in chapter 5.2, while applying the smallest dimension tolerances pursuant to EN ISO 15874 for the given pipe or for the smallest dimension tolerances stated by individual manufacturers for their respective products in accordance with the corresponding company standards. The EN ISO 15874 standard also determines the maximal value of S_{calc} as the $S_{calc,max}$ value for various material types. The $S_{calc,max}$ values for the PP-R and PP-RCT materials are stated in TABLE 9 and TABLE 10. TABLE 8 shows the S_{calc} values for particular dimension lines of the FV AQUA PP system. We can determine the maximal permitted pressure for individual operation classes pursuant to TABLE 11 based on a mutual comparison of the S_{calc} values from TABLE 8 and the $S_{calc,max}$ values from TABLE 9 and TABLE 10 (it applies that $S_{calc} \leq S_{calc,max}$).

**) The maximal permitted operation pressure in sanitary systems used for transporting drinking and/or cold water is 10 bar for all the stated pipeline types.*

TABLE 8 - S_{calc} values for the FV PPR AQUA system group

Pipe name		Ø16	Ø20	Ø25	Ø32	Ø40	Ø50	Ø63	Ø75	Ø90	Ø110	Ø125	Ø160	Ø200	Ø250
FV PPR CLASSIC S5 SDR11 (PN10)	[mm]		20x2,0	25x2,3	32x2,9	40x3,7	50x4,6	63x5,8	75x6,8	90x8,2	110x10				
	S_{calc}		4,5	4,9	5,0	4,9	4,9	4,9	5,0	5,0	5,0				
FV PPR CLASSIC S3,2 SDR7,4 (PN16)	[mm]	16x2,2	20x2,8	25x3,5	32x4,4	40x5,5	50x6,9	63x8,6	75x10,3	90x12,3	110x15,1				
	S_{calc}	3,1	3,1	3,1	3,1	3,1	3,1	3,1	3,1	3,1	3,1				
FV PPR CLASSIC S2,5 SDR6 (PN20)	[mm]	16x2,7	20x3,4	25x4,2	32x5,4	40x6,7	50x8,3	63x10,5	75x12,5	90 x 15	110x18,3				
	S_{calc}	2,5	2,4	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5				
FV PPR FASER S3,2 SDR7,4 (PN16)	[mm]		20x2,8	25x3,5	32x4,4	40x5,5	50x6,9	63x8,6	75x10,3	90x12,3	110x15,1				
	S_{calc}		3,1	3,1	3,1	3,1	3,1	3,2	3,1	3,2	3,1				
FV PPR FASER S2,5 SDR6 (PN20)	[mm]		20x3,4	25x4,2	32x5,4	40x6,7	50x8,3	63x10,5	75x12,5	90x15	110x18,3				
	S_{calc}		2,4	2,5	2,5	2,5	2,5	2,5	2,5	2,5	2,5				
FV PP-RCT UNI S3,2 SDR7,4 (Ø 16 mm), S4 SDR9 (Ø 20-25 mm), S5 SDR11 (Ø 32-250 mm)	[mm]	16x2,2	20x2,3	25x2,8	32x2,9	40x3,7	50x4,6	63x5,8	75x6,8	90x8,2	110x10	125x11,4	160x14,6	200x18,2	250x22,7
	S_{calc}	3,1	3,8	4,0	5,0	4,9	4,9	4,9	5,0	5,0	5,0	5,0	5,0	5,0	5,0
FV PP-RCT HOT S3,2 SDR7,4	[mm]		20x2,8	25x3,5	32x4,4	40x5,5	50x6,9	63x8,6	75x10,3	90x12,3	110x15,1	125x17,1			
	S_{calc}		3,1	3,1	3,1	3,1	3,1	3,2	3,1	3,2	3,1	3.2			
FV PP-RCT FASER COOL S5 SDR11 (Ø 40-125 mm), S8 SDR17 (Ø160-250 mm)	[mm]					40x3,7	50x4,6	63x5,8	75x6,8	90x8,2	110x10,0	125x11,4	160x9,5	200x11,9	250x14,8
	S_{calc}					4,9	4,9	4,9	5,0	5,0	5,0	5,0	7,9	7,9	7.9
FV PP-RCT FASER HOT S3,2 SDR7,4 (Ø 20-25 mm), S4 SDR9 (Ø32-125 mm), S5 SDR11 (Ø160-250 mm)	[mm]		20x2,8	25x2,8	32x3,6	40x4,5	50x5,6	63x7,1	75x8,4	90x10,1	110x12,3	125x14,0	160x14,6	200x8,2	200x8,2
	S_{calc}		3,1	3,1	3,9	3,9	4,0	3,9	4,0	4,0	4,0	4,0	5,0	5,0	5.,0
FV PP-RCT STABIOXY S3,2 SDR7,4 (Ø 20 mm), S4 SDR9 (Ø25-110 mm)	[mm]		20x2,8	25x2,8	32x3,6	40x4,5	50x5,6	63x7,1	75x8,4	90x10,1	110x12,3				
	S_{calc}		3,1	4,0	3,9	3,9	4,0	3,9	4,0	4,0	4,0				

TABLE 9 - $S_{calc,max}$ values for the PP-R material

Calculation pressure PD [bar]	Use			
	Class 1	Class 2	Class 4	Class 5
	[$S_{calc.max}$ values]			
4	6,9	5,3	6,9	4,7
6	5,0	3,5	5,5	3,2
8	3,8	2,6	4,1	2,4
10	3,0	2,1	3,3	1,9

TABLE 10 - $S_{calc,max}$ values for the PP-RCT material

Calculation pressure PD [bar]	Use			
	Class 1	Class 2	Class 4	Class 5
	[$S_{calc.max}$ values]			
4	8,2	8,2	8,2	7,3
6	6,1	5,7	6,1	4,9
8	4,5	4,3	4,6	3,7
10	3,6	3,4	3,7	2,9

Example: The S_{calc} value for the PP-R Classic SDR 6 pipe is 2.5. We can see from TABLE 11 that this pipe in class 1 can be permanently exposed to a pressure of 10 bar, while in class 2 this value is 8 bar, for class 4 it is 10 bar and for class 5 it amounts to 6 bar.

Information about the operation parameters is recorded on the pipes in the following form: **class 1/10 bar, 2/8 bar, 4/10 bar, 5/6 bar.**

TABLE 11 - PP-R and PP-RCT operation parameters

Class	Lifespan (years)	Operation time (years/hours	Operation temperature (°C)	Usage	**PP-R** SDR 7,4 / S 3,2	**PP-R** SDR 6 / S 2,5	**PP-RCT** SDR 11 / S 5	**PP-RCT** SDR 9 / S 4	**PP-RCT** SDR 7,4 / S 3,2
					Max. operation pressure (bar)				
1	50	49 yers	60	**Hot water 60°C**	8	10	6	8	10
		1 yer	80						
		100 hours	95						
2	50	49 yers	70	**Hot water 70°C**	6	8	6	8	10
		1 yer	80						
		100 hours	95						
4	50	2,5 years	20	**Floor and low-temperature heating**	10	10	6	8	10
		20 yers	40						
		25 yers	60						
		2,5 yers	70						
		100 hours	100						
5	50	14 yers	20	**High-temperature heating**	-	6	-	6	8
		25 yers	60						
		10 yers	80						
		1 yer	90						
		100 hours	100						

9.2. Operation parameters pursuant to standard DIN 8077

The operation parameter tables show particular values of the permitted maximal pipe operation pressures for concrete water temperatures with regard to the required system lifespan. These values are determined based on the strength isotherms that are included in the chapter 8. A safety coefficient of 1.25 is incorporated in TABLE 12 (chapter 9.2.1). A safety coefficient of 1.5 is incorporated in TABLE 13 (chapter 9.2.2).

9.2.1. WATER MAINS - Operation param. pursuant to stand. DIN 8077

TABLE 12 - Water main operation parameters

VODOVODY - safety coefficient 1,25							
Temperature [°C]	Operation time [years]	Maximal permitted operation pressure [bar]					
		PP-R CLASSIC	PP-R CLASSIC PP-R FASER	PP-R CLASSIC PP-R FASER	PP-RCT UNI PP-RCT FASER COOL	PP-RCT UNI PP-RCT FASER HOT PP-RCT STABIOXY	PP-RCT HOT PP-RCT FASER HOT PP-RCT STABIOXY
		SDR 11	**SDR 7,4**	**SDR 6**	**SDR 11**	**SDR 9**	**SDR 7,4**
10	1	21,1	33,4	42,1	22,8	28,8	36,2
	5	19,8	31,5	39,7	22,1	27,9	35,1
	10	19,3	30,7	38,6	21,9	27,5	34,7
	25	18,7	29,7	37,4	21,5	27,1	34,1
	50	18,2	28,9	36,4	21,2	26,7	33,6
20	1	18,0	28,5	35,9	19,9	25,0	31,5
	5	16,9	26,8	33,7	19,3	24,2	30,5
	10	16,4	26,1	32,8	19,0	23,9	30,1
	25	15,9	25,2	31,7	18,6	23,5	29,6
	50	15,4	24,5	30,9	18,4	23,1	29,2
30	1	15,3	24,2	30,5	17,2	21,7	27,3
	5	14,3	22,7	28,6	16,6	20,9	26,4
	10	13,9	22,1	27,8	16,4	20,6	26,0
	25	13,4	21,3	26,8	16,1	20,2	25,5
	50	13,0	20,7	26,1	15,8	19,9	25,1
40	1	13,0	20,6	25,9	14,8	18,6	23,5
	5	12,1	19,2	24,2	14,3	18,0	22,6
	10	11,8	18,7	23,5	14,1	17,7	22,3
	25	11,3	18,0	22,6	13,8	17,3	21,8
	50	11,0	17,4	22,0	13,6	17,1	21,5
50	1	11,0	17,4	21,9	12,6	15,9	20,1
	5	10,2	16,2	20,4	12,2	15,3	19,3
	10	9,9	15,7	19,8	12,0	15,1	19,0
	25	9,5	15,1	19,0	11,7	14,7	18,6
	50	9,2	14,7	18,5	11,5	14,5	18,3
60	1	9,2	14,7	18,5	10,7	13,5	17,0
	5	8,6	13,6	17,2	10,3	13,0	16,3
	10	8,3	13,2	16,6	10,1	12,7	16,0
	25	8,0	12,7	16,0	9,9	12,4	15,7
	50	7,7	12,3	15,5	9,7	12,2	15,4
70	1	7,8	12,3	15,5	9,0	11,3	14,3
	5	7,2	11,4	14,4	8,6	10,9	13,7
	10	7,0	11,1	13,9	8,5	10,7	13,5
	25	6,0	9,6	12,1	8,3	10,4	13,1
	50	5,1	8,1	10,2	8,1	10,2	12,9

9.2.2. HEATING - Operation parameters related to standard DIN 8077

TABLE 13 - Heating operation parameters

HEATING -safety coefficient 1,5							
Temperature [°C]	Operation time [years]	Maximal permitted operation pressure [bar]					
		PP-R CLASSIC	PP-R CLASSIC PP-R FASER	PP-R CLASSIC PP-R FASER	PP-RCT UNI PP-RCT FASER COOL PP-RCT	PP-RCT UNI PP-RCT FASER HOT PP-RCT STABIOXY	PP-RCT HOT PP-RCT FASER HOT PP-RCT STABIOXY
		SDR 11	SDR 7,4	SDR 6	SDR 11	SDR 9	SDR 7,4
30	1	12,7	20,2	25,4	14,3	18,1	22,7
	5	11,9	18,9	23,8	13,9	17,4	22,0
	10	11,6	18,4	23,2	13,6	17,2	21,7
	25	11,2	17,7	22,3	13,4	16,9	21,2
	50	10,9	17,2	21,7	13,2	16,6	20,9
40	1	10,8	17,1	21,6	12,3	15,5	19,6
	5	10,1	16,0	20,2	11,9	15,0	18,9
	10	9,8	15,5	19,6	11,7	14,7	18,6
	25	9,4	15,0	18,8	11,5	14,4	18,2
	50	9,2	14,5	18,3	11,3	14,2	17,9
50	1	9,1	14,5	18,2	10,5	13,3	16,7
	5	8,5	13,5	17,0	10,1	12,8	16,1
	10	8,2	13,1	16,5	10,0	12,6	15,8
	25	7,9	12,6	15,9	9,7	12,3	15,5
	50	7,7	12,2	15,4	9,6	12,1	15,2
60	1	7,7	12,2	15,4	8,9	11,2	14,2
	5	7,1	11,3	14,3	8,6	10,8	13,6
	10	6,9	11,0	13,9	8,4	10,6	13,4
	25	6,6	10,5	13,3	8,2	10,4	13,1
	50	6,4	10,2	12,9	8,1	10,2	12,8
70	1	6,5	10,3	12,9	7,5	9,4	11,9
	5	6,0	9,5	12,0	7,2	9,1	11,4
	10	5,8	9,2	11,6	7,0	8,9	11,2
	25	5,0	8,0	10,0	6,9	8,7	10,9
	50	4,2	6,7	8,5	6,8	8,5	10,7
80	1	5,4	8,6	10,8	6,2	7,9	9,9
	5	4,8	7,6	9,6	6,0	7,5	9,5
	10	4	6,4	8,1	5,9	7,4	9,3
	25	3,2	5,1	6,5	5,7	7,2	9,1
95	1	3,8	6,1	7,6	4,7	5,9	7,4
	5	2,6	4,1	5,2	4,4	5,6	7,1

10. Basic information related to the pipeline route proposal

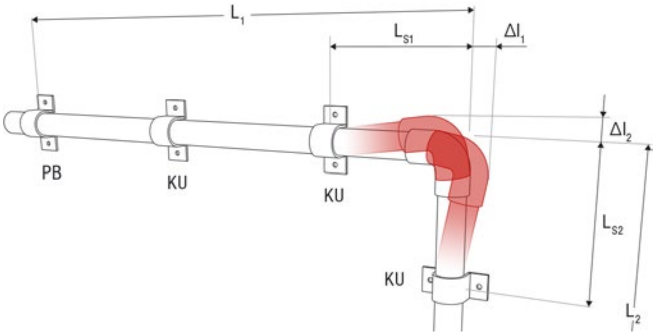
10.1. Specification of the length changes

Temp. differences during the assembly process and later during the regular operation cause length changes of the straight pipeline sections – extension or shortening (Δl). When proposing routes of interior water main and heating distribution lines, one has to consider the given material of the lines, length expandability of the given material, compensation needs, operation conditions (combination of pressure and temperature) and the selected welding method.

Fixed point (PB) is such a pipe attachment method that does not allow the pipes to move along its own axis (no pipe dilatation is permitted).

Slide mounting (KU) is such a pipe attachment method that allows the pipes to contract or extend along their length but does not allow them to deviate from their axis.

PICTURE 3 „ L " - compensator



$$\Delta l = \alpha \cdot L \cdot t \ [mm]$$

- Δl length change [mm]
- α temperature length extendibility coefficient [mm/m °C],
  - for single-layer PP-R and PP-RCT pipes, α=0,15
  - for multilayer PP-R and PP-RCT pipes, α=0,05
- L calculation length (distance of 2 adjoining fixed points along a line) [m]
- t difference between the assembly and operation temperatures [°C]

Length extension: for single-layer PP-R and PP-RCT pipes

Example: L = 8 m, Δt = 46 °C

DIAGRAM 7

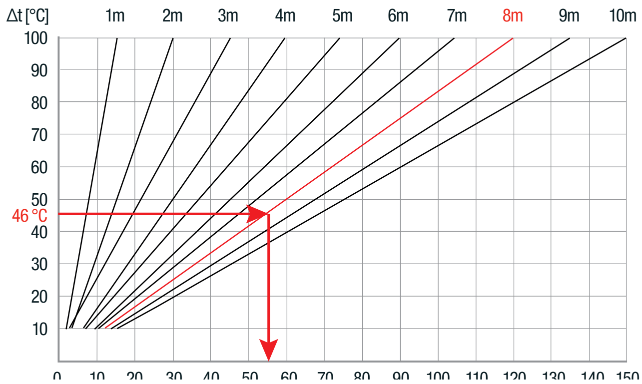


TABLE 14

Pipeline length [m]	Temperature difference Δt							
	10 °C	20 °C	30 °C	40 °C	50 °C	60 °C	70 °C	80 °C
	Length change Δl [mm]							
1	1,5	3	5	6	8	9	11	12
2	3	6	9	12	15	18	21	24
3	5	9	14	18	23	27	32	36
4	5	9	14	18	23	27	32	36
5	8	15	23	30	38	45	53	60
6	9	18	27	36	45	54	63	72
7	11	21	32	42	53	63	74	84
8	12	24	36	48	60	72	84	96
9	14	27	41	54	68	81	95	108
10	15	30	45	60	75	90	105	120
15	23	45	68	90	113	135	158	150

Length extension: for multilayer PP-R and PP-RCT pipes

Example: L = 10 m, Δt = 40 °C

DIAGRAM 8

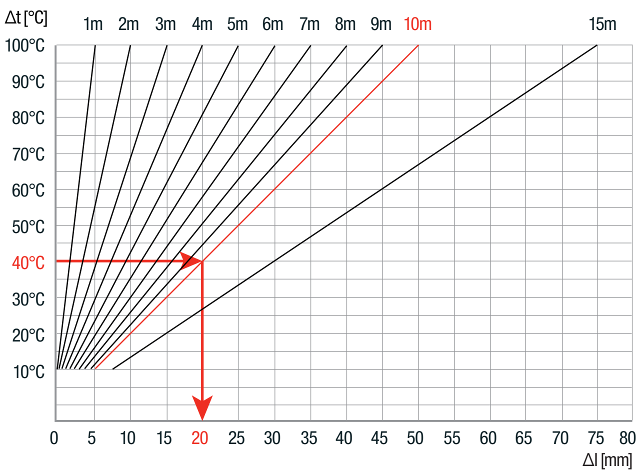


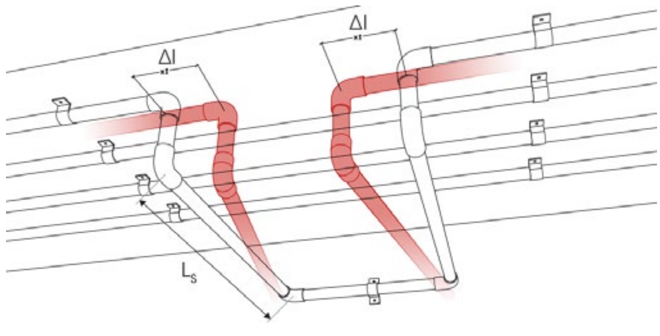
TABLE 15

Pipeline length [m]	Temperature difference Δt							
	10 °C	20 °C	30 °C	40 °C	50 °C	60 °C	70 °C	80 °C
	Length change Δl [mm]							
1	1	1	2	2	3	3	4	4
2	1	2	3	4	5	6	7	8
3	2	3	5	6	8	9	11	12
4	2	4	6	8	10	12	14	16
5	3	5	8	10	13	15	18	20
6	3	6	9	12	15	18	21	24
7	4	7	11	14	18	21	25	28
8	4	8	12	16	20	24	28	32
9	5	9	14	18	23	27	32	36
10	5	10	15	20	25	30	35	40
15	8	15	23	30	38	45	53	60

10.2. Compensation of the length changes

Pipe length changes (pursuant to the previous chapter 10.1) have to be compensated for, thus making sure the pipes do not twist and additional tensions, which could shorten their lifespan, are not created. Basic compensation methods are showed on PICTURE 3, PICTURE 4 and PICTURE 5.

PICTURE 4 Plastic pipeline compensation by the means of changing the pipeline route



Calculation of the arm length radius for U compensators

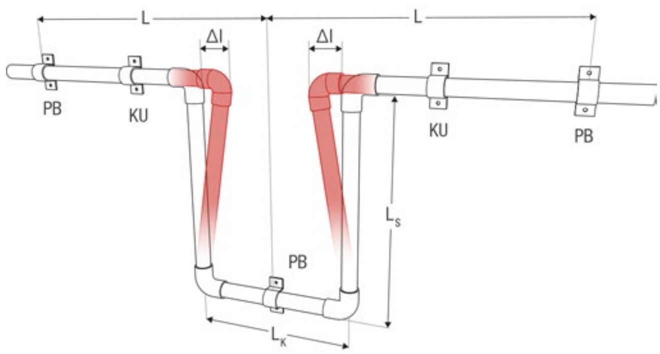
$$L_S = k \cdot \sqrt{(D \cdot \Delta l)}\ [mm]$$

L_S free compensation length
k material constant, k = 20 for PPR
D outer pipe diameter [mm]
Δl length change [mm] calculated using the previous formula

„U“ compensator

The calculated free length of the compensator arm (compensation length) LS is the given length without any fixed supports or suspensions that would prevent dilatation. The free length (LS) should not exceed the maximal distance between individual supports pursuant to the given pipeline diameter and medium temperature – see paragraph 10.3.

PICTURE 5 „ U ” - compensator



PB fixed point
L calculation pipeline length
Δl length change
KU slide mounting
L_s compensation length
L_K compensator width

Calculation of the width L_k for U compensators

$$L_k = 2 \cdot \Delta l + 150\ [mm] \text{ and at the same time } L_k \geq 10 \cdot D$$

L_K compensator width
Δl length change [mm]
D outer diameter of the pipeline

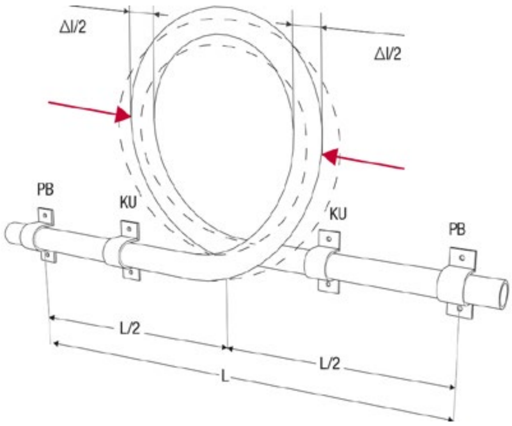
Suitable compensation method: pipeline is deflected in the direction that is perpendicular to the original route. Free compensation length is then left along this perpendicular (marked L_S), which ensures that dilatation of the straight route does not cause any significant additional pressure and tug tensions in the pipe walls. Compensation length L_S depends on the calculated length extension (contraction) of the route, material and pipeline diameter.

Material flexibility is used for compensating length changes in the case of polypropylene. Apart from pipeline route bend compensations - „L“ compensators bend “U” compensators, “Z” compensators and compensation loops are used.

The value of a given length change Δl can be also determined from DIAGRAM 7 and DIAGRAM 8 and TABLE 14 and TABLE 15.

FV PPR compensation loop

PICTURE 6 - FV PPR compensation loop



PB fixed point
KU slide mounting
L calculation pipeline length

TABLE 16- Installation table for the FV PPR compensation loop

Pipeline length [mm]	Distance among the fixed points [m]	
	FASER, STABI, STABIOXY	PP-R a PP-RCT
16	24	8
20	27	9
25	30	10
32	36	12
40	42	14

10.3. Pipeline attachment (support) distances

TABLE 18a through TABLE 18e show the maximal attachment distances for horizontal pipeline installations. For vertical pipelines, these maximal attachment distances are multiplied by coefficient 1.3. Individual attachment and support types are specified in chapter 15.

TABLE 18a – Maximal distances between individual supports
for PPR S 5 (PN 10) and PP-RCT UNI pipes for horizontal pipelines

Pipeline diameter [mm]	Distance of individual supports [cm] pursuant to water temperature		
	20 °C	30 °C	40 °C
16	75	70	70
20	80	75	70
25	85	85	85
32	100	95	95
40	110	110	105
50	125	120	115
63	140	135	130
75	155	150	145
90	165	165	155
110	185	180	175
125	200	195	185
160	205	195	190
200	230	220	210
250	250	240	230

Determining pipeline compensation length L_s.

TABLE 17 - Pipeline compensation length L_s.

Pipeline diameter [mm]	**Length change Δl [mm]**														
	10	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**80**	**90**
	Compensation length L_s [m]														
16	0,25	0,31	0,36	0,40	0,44	0,47	0,51	0,54	0,57	0,59	0,62	0,64	0,67	0,72	0,76
20	0,28	0,35	0,40	0,45	0,49	0,53	0,57	0,60	0,63	0,66	0,69	0,72	0,75	0,80	0,85
25	0,32	0,39	0,45	0,50	0,55	0,59	0,63	0,67	0,71	0,74	0,77	0,81	0,84	0,89	0,95
32	0,36	0,44	0,51	0,57	0,62	0,67	0,72	0,76	0,80	0,84	0,88	0,91	0,95	1,01	1,07
40	0,40	0,49	0,57	0,63	0,69	0,75	0,80	0,85	0,89	0,94	0,98	1,02	1,06	1,13	1,20
50	0,45	0,55	0,63	0,71	0,77	0,84	0,89	0,95	1,00	1,05	1,10	1,14	1,18	1,26	1,34
63	0,50	0,61	0,71	0,79	0,87	0,94	1,00	1,06	1,12	1,18	1,23	1,28	1,33	1,42	1,50
75	0,55	0,67	0,77	0,87	0,95	1,02	1,10	1,16	1,22	1,28	1,34	1,40	1,45	1,55	1,64
90	0,60	0,73	0,85	0,95	1,04	1,12	1,20	1,27	1,34	1,41	1,47	1,53	1,59	1,70	1,80
110	0,66	0,81	0,94	1,05	1,15	1,24	1,33	1,41	1,48	1,56	1,62	1,69	1,75	1,88	1,99
125	0,71	0,87	1,00	1,12	1,22	1,32	1,41	1,50	1,58	1,66	1,73	1,80	1,87	2,00	2,12
160	0,80	0,98	1,13	1,26	1,39	1,50	1,60	1,70	1,79	1,88	1,96	2,04	2,12	2,26	2,40
200	0,89	1,10	1,26	1,41	1,55	1,67	1,79	1,90	2,00	2,10	2,19	2,28	2,37	2,53	2,68
250	1,00	1,22	1,41	1,58	1,73	1,87	2,00	2,12	2,24	2,35	2,45	2,55	2,65	2,83	3,00

TABLE 18b – Maximal distances between individual supports for FV PPR S 3,2 (PN 16) pipes for horizontal pipelines

Pipeline diameter [mm]	Distance of individual supports [cm] pursuant to water temperature						
	20 °C	30 °C	40 °C	50 °C	60 °C	70 °C	80 °C
16	80	75	75	70	70	65	60
20	90	80	80	80	70	70	65
25	95	95	95	90	80	80	75
32	110	105	105	100	95	85	80
40	120	120	115	105	100	100	95
50	135	130	125	120	115	110	100
63	155	150	145	135	130	120	115
75	170	165	160	150	145	135	125
90	180	180	170	165	160	145	135
110	200	195	190	180	175	165	155
125	220	215	200	195	190	175	165
160	220	210	205	195	185	175	165
200	245	235	230	220	210	200	190
250	275	265	255	245	235	255	210

TABLE 18c - Maximal distances between individual supports for FV PPR S 2,5 (PN 20) and FV PP-RCT HOT pipes for horizontal pipelines

Pipeline diameter [mm]	Distance of individual supports [cm] pursuant to water temperature						
	20 °C	30 °C	40 °C	50 °C	60 °C	70 °C	80 °C
16	90	85	85	80	80	70	65
20	95	90	85	85	80	75	70
25	100	100	100	95	90	90	85
32	120	115	115	110	100	95	90
40	130	130	125	120	115	110	100
50	150	150	140	130	125	120	110
63	170	160	155	150	145	135	125
75	185	180	175	160	155	145	140
90	200	200	185	180	175	160	150
110	220	210	205	195	185	175	165
125	220	215	210	195	190	175	165
160	235	230	225	210	200	185	170
200	245	235	230	220	210	200	190
250	275	265	255	245	235	225	210

TABLE 18d - Maximal distances between individual supports for FV PPR FASER (PN16) and FV PP-RCT FASER COOL multilayer pipes

Pipeline diameter [mm]	Distance of individual supports [cm] pursuant to water temperature						
	20 °C	30 °C	40 °C	50 °C	60 °C	70 °C	80 °C
20	80	80	75	75	70	60	55
25	95	90	85	80	75	70	65
32	110	105	100	95	90	85	80
40	120	115	110	95	100	95	90
50	140	135	130	105	120	115	110
63	150	145	140	125	130	125	120
75	165	160	155	135	145	140	130
90	175	170	165	150	155	150	135
110	185	180	175	160	160	155	145
125	205	195	190	165	170	160	150
160	205	195	190	180	170	160	150
200	230	220	210	200	190	180	170
250	250	240	230	220	210	200	185

These maximal distances are multiplied by coefficient 1.3 for vertical pipelines.

TABLE 18e - Maximal distances between individual supports for FV PP-RCT STABIOXY, FV PPR FASER (PN20) and FV PP-RCT FASER HOT multilayer pipes

Pipeline diameter [mm]	Distance of individual supports [cm] pursuant to water temperature						
	20 °C	30 °C	40 °C	50 °C	60 °C	70 °C	80 °C
20	100	90	85	85	80	70	65
25	105	100	95	90	85	80	75
32	110	115	110	105	100	95	90
40	120	125	120	115	110	105	100
50	140	145	140	135	130	125	120
63	150	155	150	145	140	135	130
75	165	175	170	165	160	155	145
90	175	185	180	175	170	165	150
110	185	195	190	180	175	170	160
125	205	210	205	195	185	175	165
160	205	210	205	195	185	175	165
200	245	235	230	220	210	200	190
250	275	265	255	245	235	225	210

These maximal distances are multiplied by coefficient 1.3 for vertical pipelines.

10.4. Pipeline insulation

It is important to remember that pipelines should be insulated along their entire length, i.e. including fittings. Foamed polyethylene is the most commonly used form of thermal insulation. At least the minimal proposed thermal insulation thickness should be ensured along the entire length of the given pipeline.

It is recommended that the thickness of all insulations at crossing locations and at locations where cold and hot water lines are installed next to each other (in installation ducts) is increased by 30%.

Cold water distribution pipelines need to be insulated against thermal gains and against water condensation on the pipes.

Hot water distribution pipelines need to be insulated against thermal losses.

Insulation thickness is always determined by calculation pursuant to the corresponding national regulations, while considering the given thermal resistance (λ) of the insulation that is supposed to be used. TABLE 19 and TABLE 20 demonstrate only the most common situations.

TABLE 19 -COLD WATER: insulation thickness examples for λ = 0,035 W/mK

Pipeline installation manner	Insulation thickness [mm]
Freely installed in unheated rooms	4
Freely installed in heated rooms	9
In installation ducts, not installed side by side with a hot pipeline	4
In installation ducts, installed side by side with a hot pipeline	13
In grooves under plaster, installed separately	4
In grooves under plaster, installed side by side with a hot pipeline	13
In concrete	4

TABLE 20 - HOT WATER: insulation thickness examples

Pipeline diameter [mm]	Insulation thickness [mm]	
	λ = 0,030	λ = 0,035
20	6	10
25	6	10
32	10	13
40	10	13
50	10	13
60	13	20
75	20	20
90	20	25
110	25	32

11. Preparation, handling and storage

Il FV AQUA PPR system products have to handled and transported while exercising appropriate care. The products have to be protected against UV radiation, bad weather conditions and pollution. The products have to be always stored away from areas where solvents, glues, paints and or other chemicals are stored. Individual pipes should be stored in a way that prevents their bending. When storing freely laid pipes on top of one another, the maximal stacking height is 1 m.

IMPORTANT: FV PPR FASER, FV PP-RCT FASER COOL and FV PP-RCT FASER HOT pipes have to be handled very carefully, particularly during the winter months when temperatures drop below +5 °C. Since te pipes are filled with glass fibers, they are very fragile.

12. Warranty and warranty conditions

The warranty period for the FV AQUA fittings is 15 years.

One of the conditions for exercising the warranty is compliance with the stipulations of this Technical Manual and the appropriate generally valid technical standards and other legislative regulations.

The warranty period for other products and tools (sockets, fasteners, welding machines, etc.) is 2 years.

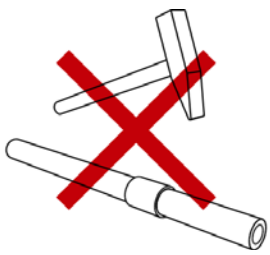
13. Basic assembly principles

Prior to assembling the pipes and fittings into a system, you need to make sure that the individual elements have not been polluted or damaged (during transportation, long-term unsuitable storage, etc.).

In the case of closing valves (such as ball valves), you need to check their proper function prior to their actual assembly

Compared to metal pipelines, plastic pipelines expand and contract much more due to temperature changes. That is why it is necessary to compensate for these length changes in accordance with the principles stated in chapters 10.1 and 10.2.

Considering the welding process, the minimal temperature for assembling plastic distributions lines amounts to +5 °C. To achieve high-quality connections under lower temperatures is extremely difficult.

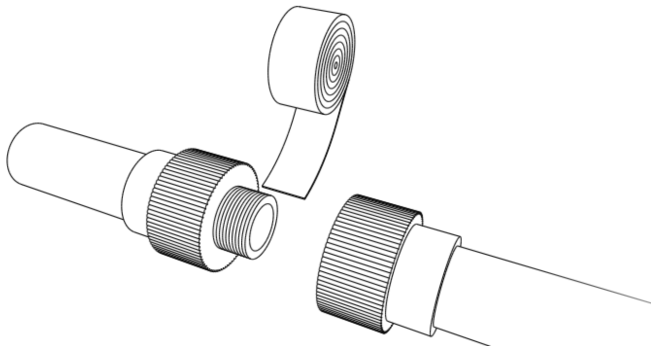


The plastic system elements have to be protected against impacts, hits, falling material and other situations that could mechanically damage them during the entire transportation and assembly time.

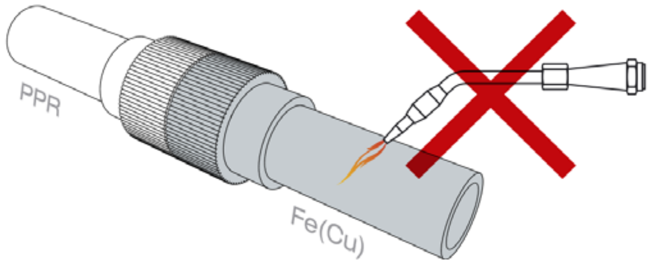
The pipes should be bent without heating under a minimal temperature of +15 °C. For pipes with a diameter of 16-32 mm, the minimal bend radius is 8 times the diameter of the pipeline (D).

It is not acceptable to bend the pipes by heating them with open flame or hot air.

Pipe crossings are implemented using special fittings designed for this purpose.

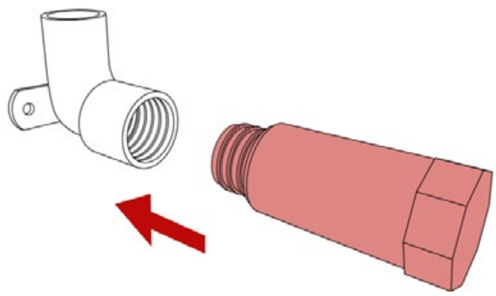


Fittings furnished with metal threads have to be used for permanent threaded joints. Cutting threads onto plastic elements is forbidden. The threads need to be sealed by a Teflon tape, sealing thread or special sealants.



Should a combined fitting be followed be metal piping, it cannot be joined by soldering or welding near the given fitting because of the heat would spread into the fitting.

We recommend to use plastic threads (plastic plugs have been designed only for temporary use – for example, for pressure tests) for temporary or short-term closures of wall elbows, UNI elbows or wall systems prior to the installation of discharge valves. Long-term closures have to be implemented using plugs with metal threads.



14. Welding process

The pipes are connected to individual fitting by welding (heating and making mutual connections) with the help of heating bodies and heating extensions. The following 3 welding methods can be essentially used:

1. Polyfusion welding
2. Welding using electro fittings
3. Butt welding

The basic and most commonly used welding method is polyfusion welding. The welding process is particularly governed by the German DVS 2207 and DVS 2208 rules. Operation temperature of the heating extensions installed on the welding machine is 260 ± 10 °C. Most welding machines designed for polyfusion welding include a correct temperature light indicator. The basic welding process is showed in a schematic form on pages 17-19. For welding pipes and fittings with a diameter of up to 40 mm, pin welders with jaw extensions are recommended. For welding pipes and fittings with a diameter of up to 50 mm, flat welders with pair extensions are recommended. At the same time, it is recommended to use mechanical welding machines and preparations in order to reach the necessary pressures and to maintain the pipeline alignment.

PICTURE 7 Pin welding machine 650 W for jaw extensions

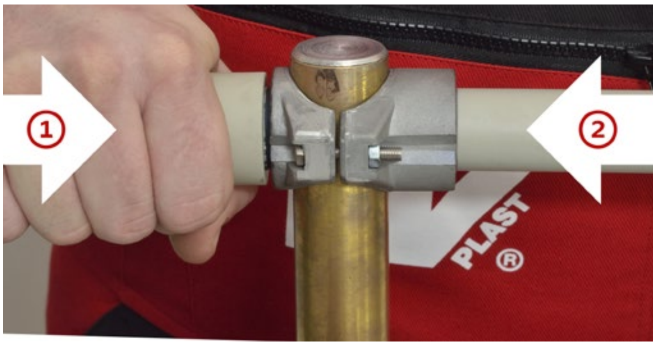
14.1. Polyfusion welding

1. Measure the necessary pipe length.

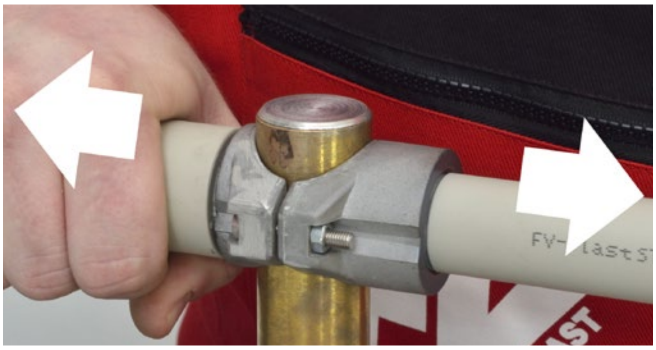
2. Cut the pipe, remove fins and, if necessary, bevel the edges.

3. Clean and degrease (using alcohol or special agent Tangit) the surfaces that are supposed to be welded. Use a rag made of non-synthetic material.

4. First, slide the given fitting over the extension heated to 260 ± 10 °C. Next, slide the pipe over it. Heat both parts – see TABLE 21.



5. In the end of the heating period, remove the pipe and fitting simultaneously from the welding extension.



6. Applying a slight, uniform pressure, slide the pipe into the fitting. Make sure the fitting and the corresponding pipe are aligned. For cooling times, see TABLE 21.

TABLE 21 - Welding work times

	Pipeline diameter [mm]										
	16	20	25	32	40	50	63	75	90	110	125
Heating time [s]	5	5	7	8	12	18	24	30	40	50	60
Reconfiguration time [s]	4	4	4	6	6	6	8	8	8	10	10
Cooling time [min]	2	2	2	4	4	4	6	6	6	8	8

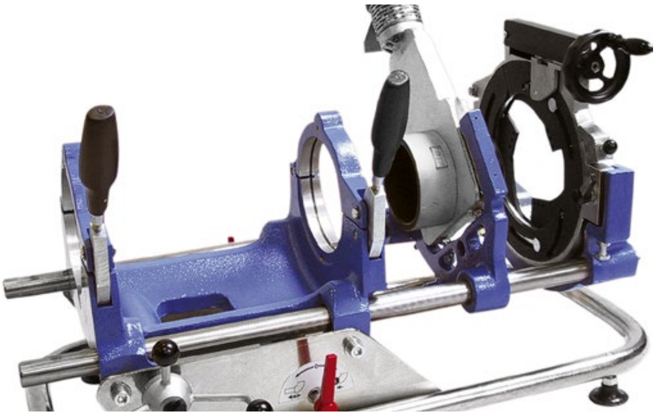
Welding process for the FV PPR FASER, FV PP-RCT FASER COOL and FV PP-RCT FASER HOT pipes is identical to the welding process for the single-layer PP-R pipes.
The same welding rules, stated in this Technical Manual for the FV AQUA PPR system, apply. The pipes do not have to be specially modified for the actual welding process.

14.1.1. Welding large diameters

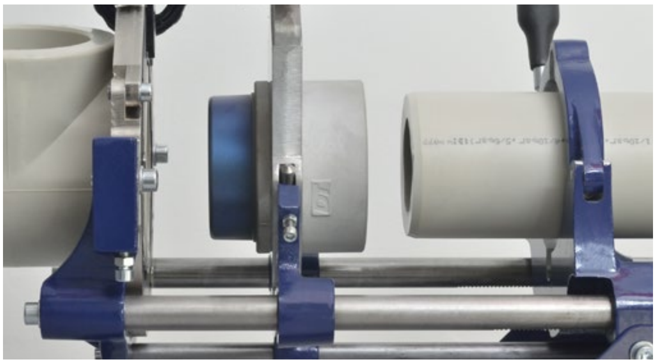
1. Scrape the oxidized layer from the surface prior to the actual welding.

2. Clean and degrease the surfaces that are supposed to be welded using alcohol or special agent Tangit.

3. Portable welding jig.



4. Fasten the pipe and the corresponding fitting into the jig and center them.



5. Heat the elements for the required time – see TABLE 21. Upon the end of the heating time, slide the fitting over the pipe.

6. Unfastened the finished weld and let it cool down in the jig – see TABLE 21.

14.1.2. Welding STABIOXY pipes

1. In the case of STABIOXY pipes, the aluminum foil has to be initially removed. The necessary aluminum layer can be removed using a STABIOXY pipe cutter.

2. Clean and degrease STABIOXY pipes cut in this manner prior to welding.

14.2. Welding using electro fittings

1. Welding pipes using electric welding machines (corresponding machine manuals are provided by the given machine manufacturers).
2. Clean and degrease the pipe and mark the depth, up to which the given pipe is supposed to slide into the fitting.
3. Slide the pipe into the fitting.
4. The material expands upon being heated. A correct welding procedure is demonstrated by extruded plastic material at the check points of the fitting.

PICTURE 8 FV PPR electro-coupling

14.3. Butt welding

Welding principle

Butt welding represents a connection method that can be used for thoroughly prepared and melted ends of pipes and fittings by pressing, while complying with the specified pressure, temperature and time values and all general welding conditions. The butt welding principle is mostly used for large pipe diameters – 160-250 mm.

Butt welding is always executed with the help of a welding jig – welding machine with a hydraulic pressure mechanism – in order to be able to apply a sufficient welding pressure, while preserving plane alignment that is needed for welding large diameters. Butt welding can be conducted only by holders of the appropriate welding certificate.

Butt welding can be used for welding pipes and fittings of the same dimensions – identical pipe diameter, identical wall thickness and identical MFI value (LIQUID ALLOY FLOW INDEX). Guide parameters for polypropylene – butt welding with a heating element are addressed by **DVS 2207,part11**.

The necessary pressure for the welding process consists of the pressure values specified in the corresponding welding tables and of negative resistance, i.e. pressure that is necessary for overcoming the resistance caused by external factors, such as friction of the given mechanism or resistance of the welded pipe.

The determined values of the negative resistance related to particular welding jigs are specified by their respective manufacturers.

Warning: When setting up the prescribed welding pressure, one must always add the passive resistance pressure to the value of the required welding pressure from TABLE 22!!!

Warning: The pressure of the passive resistance is different for every welding process! It depends on many factors, particularly on the diameter and length of the welded pipe.

Tip: To ensure correct welding, particularly when welding longer pipelines, roller supports should be installed in order to achieve a minimal passive resistance.

Basic butt welding procedure

Pre-welding preparation

One of the conditions for creating a high-quality joint by butt welding is compliance with all standard welding requirements.

The temperature of the surroundings must not drop under 5 °C. The welding environment must not be dusty or windy. The actual welding should be executed at locations that are not exposed to unfavorable weather conditions. When this cannot be guaranteed, an assembly tent should be erected to protect the welding location against unsuitable climatic conditions (rain, direct sunlight, wind).

Technical condition of the welding machine as well as all welding aids should be inspected prior to welding (cleanliness of the mirror surface, mirror temperature, alignment of the fixed as well as movable parts, functionality and sharpness of the plan

You should also verity that the given materials are welding-compatible prior to the actual welding. You need to ensure identical temperatures of the welded materials by placing them to areas with identical surrounding temperatures for a sufficient time period. Pipes and fittings designated for butt welding have to be of the same wall thickness.

Material preparation

Once you place and fasten a given pipe designated for welding into the jaws of the welding device and once you determine the corresponding passive resistance, cut both ends of the pipe perpendicularly to the pipe axis. Never use a chainsaw with an oil-lubricated chain for the cutting.

The pipe ends have to be thoroughly cleaned, making sure there are free of fins and sawdust, and degreased. Pipe ends should be leveled using a plane, which forms a part of the welding device. Once the pipe faces are worked in the above stated manner, you need to make sure that they fit tightly to each other.

Welding mirror preparation

Upon inspecting and preheating the mirror to the required temperature, the welding mirror is inserted in the device and the pipe is heated under the specified pressure. The welding process is divided into individual technological stages with specified temperatures, pressures and times – see TABLE 22.

Technological stages of the butt welding process

1. Collar creation process

Press the pipe faces prepared for welding onto the heated mirror (indicative heating temperature for polypropylene pursuant to DVS 2207, Part 11, is 200 – 220 °C 210 +/- 10 °C) until both of the welded surfaces are aligned. The welding temperature represents the temperature of the machine work surface.

The pressure for creating the collar is 0.10 N/mm². The time necessary for forming the collar depends on the given pipe wall thickness and collar height on the heated body. The minimal collar heights are stated in TABLE 22.

2 Heating process

Once the collar is sufficient, reduce the pressure and continue heating the welded surfaces only under a minimal pressure (see TABLE 22). The heating stage lasts until the welding zone is plasticized. Heating times are determined by welding tables. They depend on the given wall thickness.

3 Resetting process

Remove the faces of the welding surfaces away from the mirror upon expiry of the heating time. Remove the mirror. Slide the faces back towards each other as soon as possible, until they make a contact. The recommended resetting times are stated in seconds. They are showed in TABLE 22.

4 Connection process

Once the welded surfaces touch each other, gradually increase the pressure until you reach the full welding pressure. The welding pressure for making a connection is p = 0.10 N/mm2 +/- 0.01 N/mm2. The times the connection pressure should be increasing are stated in TABLE 22. The welding pressure has to be applied until the temperature inside of the given weld drops under 100 °C (this value applies to PE and PVC, it can be higher for PP).

5 Cooling process

The welder should make sure that a constant pressure is applied during the cooling stage until the specified cooling time runs out. Once the weld is completed, inspect it visually pursuant to the requirements of the given customer. The minimal cooling times under the corresponding connection pressures are stated in TABLE 22.

TABLE 22 - Butt welding technological times

BUTT WELDING PROCESS STAGES					
1	2	3	4	5	
	Collar creation	Heating	Resetting	Connection	
Nominal pipe wall thickness	Temperature of the hot unit 210 +/- 10°C Collar height on the hot unit at the end of the collar creation time (min. values) Collar creation pressure p = 0,10 N/mm²	Reduction of the heating pressure to p ≤ 0,01 N/mm²	Resetting time (max. time)	Connection pressure growing time	Cooling time under the connection pressure (min. values) p = 0.10 N/mm²+/-0.01
(mm)	(mm)	(s)	(s)	(s)	(min)
up to 4,5	0,5	up to 135	5	6	6
4,5 - 7	0,5	135 - 175	5 - 6	6 - 7	6 -12
7 - 12	1,0	175 - 245	6 - 7	7 - 11	12 - 20
12 -19	1,0	245 - 330	7 - 9	11 - 17	20 - 30
19 -26	1,5	330 - 400	9 - 11	17 - 22	30 - 40
26 - 37	2,0	400 - 485	11 - 14	22 - 32	40 - 55
37 - 50	2,0	485 - 560	14 - 17	32 - 43	55 - 70

14.4. Repairs of drilled pipes using correction pins

1. Using a drill bit, adjust the pipes with an incorrectly drilled hole in a way that the diameter of the hole is 10 mm. Clean and degrease the hole and the corresponding correction pin.

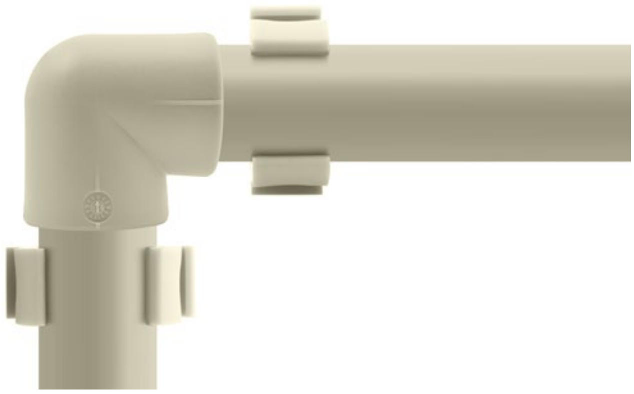
2. Mark the length that is equal to the thickness of the repaired wall on the correction pin. Heat the correction pin and the pipe on the welding extension for about 5 seconds. The indicator lights up when the correct temperature is reached.

3. Slowly insert the heated correction pin in the heated hole in the pipe.

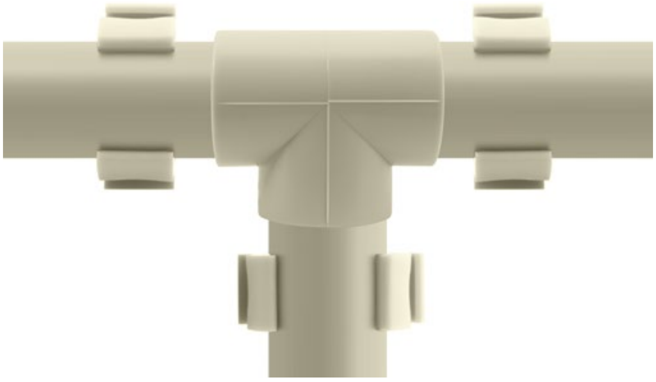
4. When it cools down completely, cut the remaining part of the correction pin.

15. Pipeline installation in floors, walls and shafts

When proposing the routes of internal water main and heating distribution lines, you need to consider the material of the give distribution lines, length expandability of the material, necessity to implement compensations, given operation conditions (combination of pressure and temperature) and the selected welding method.
The pipeline has to be fastened in regular intervals – see TABLES 18a through 18e - using **fixed points (PB)** and **slide mountings(KU)** for the expected pipeline length change.

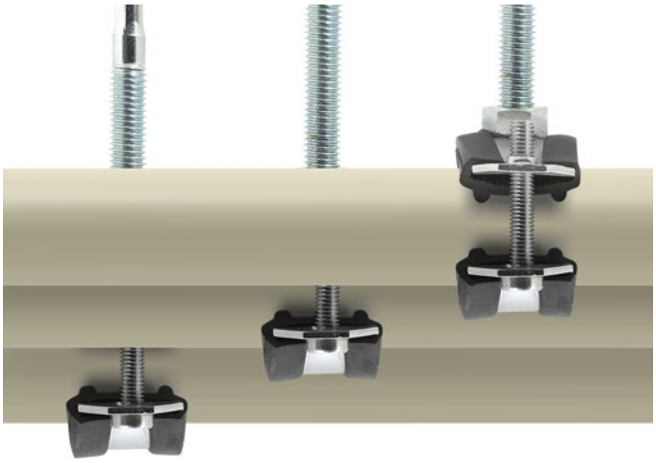


KU at the pipe bend



KU at the split

KU at the pipe valve



PB using firmly tied clamps (only for horizontal pipelines)

PB by the fitting

KU using free clamp

Using clamps for hot water

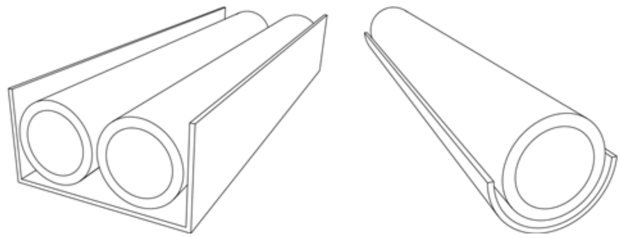
Suitable for cold water distribution lines

Using clamps for hot water

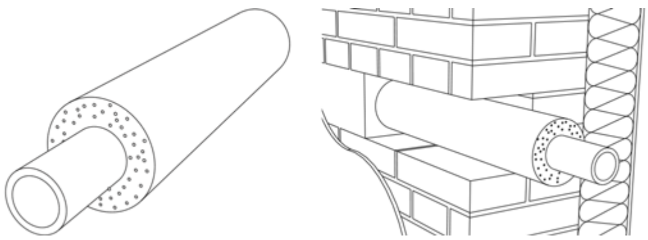
The clamps for hot water are installed over insulation that is one size bigger

Other plastic pipeline installation methods

PICTURE 9 By installing pipes in a free duct



PICTURE 10 By installing insulated pipes under plaster



15.1. Pipeline installation – general

Pipelines have to be installed with a downward gradient of at least 0.5% towards the lowest points, where they can be discharged by an independent discharge mechanism or by discharge valves with draining.

Individual pipelines have to be divided into separate closable parts. Direct or plastic valves are used for the actual closing, Under-plaster valves are used for under-plaster installations. The ability of these elements to close have to be inspected prior to their installation.

It is recommended to use a FV PPR wall system (double message board) for terminating under-plaster pipelines at the location of the mixing discharge valve installation. In this case the span of the threads is moved, thus allowing to align the given distribution line using reductions when it deviates from its horizontal axis. FV PPR under-drywall elbows are designed for under-drywall installations.

When installing water main pipelines in installation partitions, their position has to be secured using suitable attachments, for example, a system of metal clamps with support elements. The pipelines have to be installed in a way that allows for dilatation. Furthermore, they have to be insulated along their entire length, including in fittings.

15.2. Horizontal pipeline installation

When installing water main lines in floor or ceiling structures, plastic protectors (made of polyethylene) are used on the pipes. They provide mechanical protection of the pipes and the air gap between the pipeline and the protector also works as a thermal insulation. Freely installed plastic pipelines have to be furnished with a high-quality insulation (for example, when a cold water pipeline is installed freely along a wall in a heated room, there is great danger that condensation will occur on the pipe walls). Pipelines can be installed freely along walls only when there is no risk of mechanical damages caused by the given operation.

15.3. Rising pipeline installation

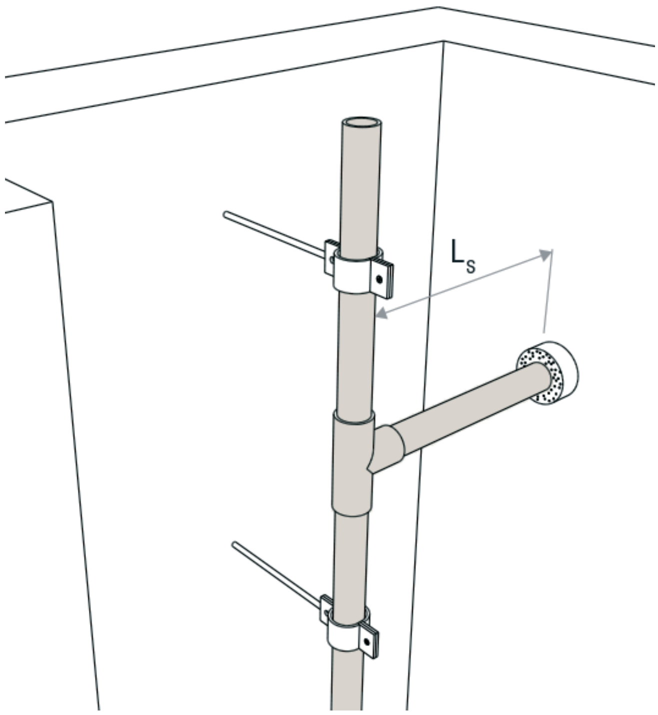
When installing rising pipelines, the layout of individual fixed points (PB), slide mountings (KU) and implementation of a suitable compensation manner have to be thoroughly considered. A compensation loop should be inserted in between two adjoining fixed points (PB) along a single axis. Alternatively, compensator should be created using elbows. Compensation on rising pipelines is secured by a slide mounting on the riser base, by using a compensation loop or by a U-compensator.

15.4. Partitioning pipelines into individual dilatation sections

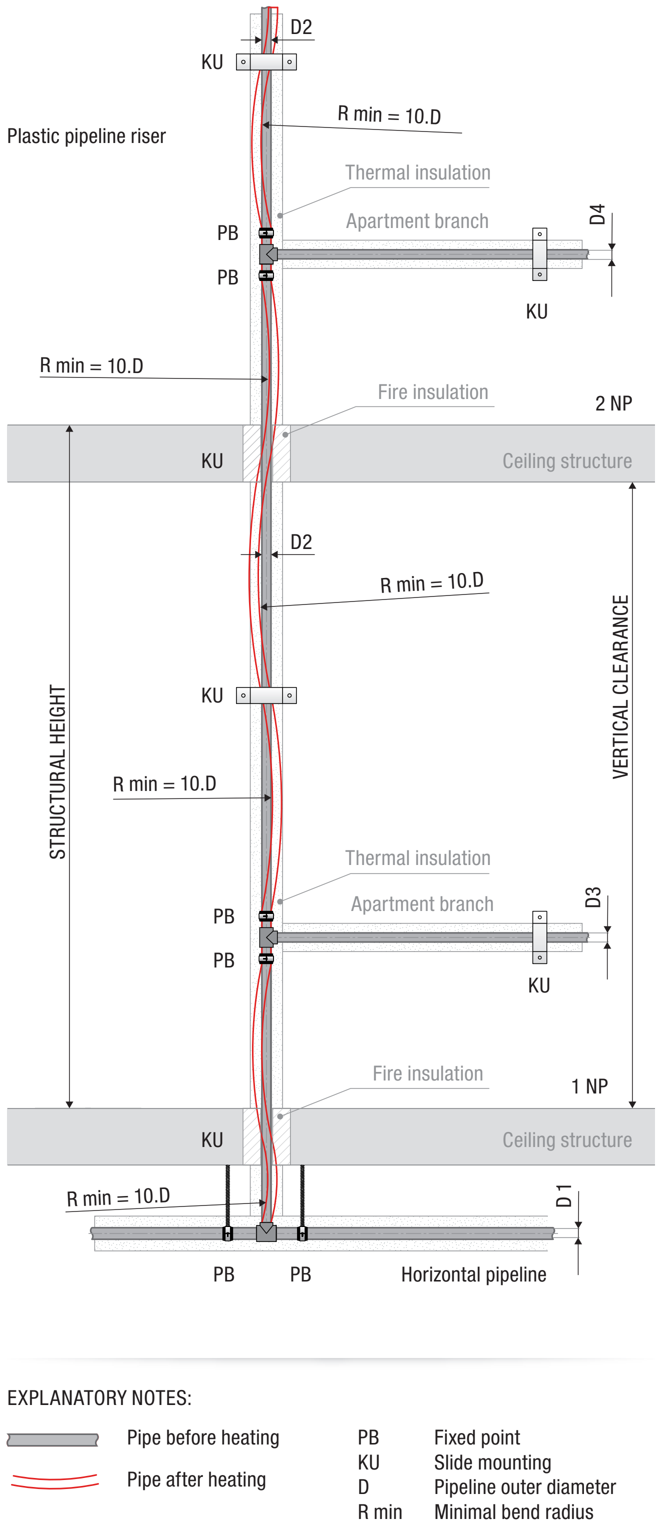
Should it be necessary to divide a rising pipeline into multiple dilatation sections, this is executed by an appropriate layout of individual fixed points. Fixed points on rising pipelines are installed below and above T-pieces by a given split or mouthpiece at the spot where the pipes are connected. This measure also prevents the risers from falling. Pipeline dilatation has to be made possible between individual fixed points.

When implementing connection pipe splitters, dilatation of the rising pipeline has to be taken into account:

PIC. 11 By a sufficient distance of the given riser from the corresponding wall passage



PICTURE 12 Solid pipeline assembly



The FV PPR FASER, FV PP-RCT FASER COOL, FV PP-RCT FASER HOT and FV PP-RCT STABIOXY pipes have three times smaller expandability and greater strength than all-plastic pipes. That is why the pipes can be installed using the same, above described method as the all-plastic pipes, i.e. by following the classic procedure for implementing compensations, when the possibility to use longer distances between individual supports will be utilized and when the dilatation and compensation lengths will be significantly shorter. When the lines are installed in a groove, the so-called solid assembly method can be used as well – fixed points are mounted on the pipeline in a way that the thermal expandability is transferred to the pipe material and does not become evident – see PICTURE 12. When this installation method is used, the used clamps have to be able to hold the pipeline and they have to be sufficiently anchored.

16. Pipeline pressure test / Pipeline pressure test protocol

Pipeline pressure tests are conducted after the given interior water main is inspected. The length of a single section of the assembled tested pipeline should not exceed 100 m. All defects determined during such an inspection have to be corrected. Pressure tests of plastic water main pipelines are conducted using drinking water with a size of the particles < 150μm (this can be ensured by using mechanical filters). The subject of the test is the uncovered pipeline prior to the installation of the given accessories, furnishings, machines and devices (discharge and safety valves, pumps, heaters, etc.). Individual pipes can be furnished with sleeve insulation and/or placed in protective pipes.

Prior to the pressure test

All sections of the interior water main have to be rinsed with water prior to the pressure test. The desludging discharge valves have to be open during the rinsing process. Prior to the commencement of the pressure test, all passage and regulation valves within the tested section must be open, the tested pipeline air--bled and filled with water with the highest permitted operation excess pressure (MOP) for a period of at least 12 hours (for 7 days, at the most). Moreover, all outlets have to be closed using pressure plugs, lids or blind flanges. The pipeline can be filled with water at least 2 hours after the latest weld was implemented.

Pressure test

The actual pressure test in described in ČSN 75 5409 and ČSN EN 806-4, depending on the pipeline type and diameter. Within the frame of the warranty and a simplified process, FV-Plast also accepts the below described pressure test, deep-rooted among the professional public.

Pressure test procedure:

- The tested pipeline has to be air-bled prior to the commencement of the pressure test.
- Fill the pipeline with water, make sure that it has been air-bled and tightly close all air-bleeding and discharge valves.
- The specified excess pressure is created by adding water. Generally speaking, this excess pressure is 1.5 times greater than the maximal operation excess pressure (MOP). The value of the maximal operation excess pressure stated in the standard for the water main interior parts during regular operation amounts to 1,000 kPa (10 bar) for hot as well as cold water. The test excess pressure is thus 15 bar.
- Apply the test excess pressure for 60 minutes.
- Record the current excess pressure from the manometer upon the expiry of the 60-minute period and calculate the corresponding pressure loss.
- The pipeline can be considered tight if the maximal permitted drop of the excess pressure during the test amounts to 0.2 bar.
- Should the pressure drop more than that, you need to locate the leakage spots, fix them and repeat the test.
- A record on the conducted pressure test should be prepared in the form of a protocol (Interior water main pressure test protocol), which forms an appendix to this technical manual (page 22).

The conditions stated in the following TABLE 23 apply to the pressure test of assembled pipelines within the FV AQUA PPR system.

TABLE 23 - Pipeline pressure test conditions*

1	Filling the system with water	1 hour after the last implemented weld, at the earliest
2	Pressurizing the system with water	To the maximal operation excess pressure (MOP)
3	Leaving the pressurized system as it is	At least 12 hours, max. 7 days
4	Odvzdušnění systému a opětovné dotlakování	min. 15 bar (1,5 MPa)
5	Test commencement	Manometer pressure value recorded
6	Test duration and measuring the corresponding pressure drop	60 minutes
7	Test completion after 1 hour	Manometer pressure value recorded
8	Max. permitted pressure drop at the beginning and end of the test	0,2 bar (0,02 MPa)

When exercising any warranty claim, the pipes that are subject of such a claim have to be collected from the construction site and submitted to the manufacturer. Such a warrant claim should include a description of the given pipe.

Moreover, a properly completed pipe pressure test protocol needs to be submitted as well.

* Should you provide a corresponding pressure test protocol pursuant to the valid ČSN EN 806-4, we accept that as a proof of the fulfilment of the warranty conditions as well.

17. Pipeline installation errors and their consequences

- Not respecting thermal expandability of plastics and not implementing the appropriate compensations cause an enormous increase of the tugging and pressure tensions in the pipe walls and thus, due to an unfavorable increase of the overall surface tension, to a significant shortening of the lifespan of the given pipeline system.
- Incorrect distances between the pipeline route supports. When the distances in between the supports are longer, the pipeline sags and the consequences are similar to the situation mentioned in the previous paragraph.
- Concreting pipelines in at passages – the pipes have to be able to move from the dilatation perspective, i.e. the pipes in passages have to be furnished with insulation or the so-called "protectors", and only after that they can be concreted in.
- Not insulating cold water pipelines against dewing and heating and not insulating hot water and circulation pipelines against thermal losses.
- Not complying with the specified welding conditions (cleanliness, climatic conditions, temperature, heating and cooling times, etc.) causes a significant deterioration of the weld quality, which can result in possible and future leaks at the connection points.
- Using reductions with plastic outer threads at locations where the length of the internal thread of the counter-piece is smaller than 2/3 of the length of the given plastic thread – possibility of leaks.
- Using unsuitable sealing materials (hemp can only be used for plastic threads; for sealing outer or inner metal threads, a Teflon tape or sealant should be used).
- Unsuitable way of tightening a reducer with a metal threat into a counter--piece (for example, using a pipe wrench or pliers), which causes separation of its plastic part from the metal thread.
- Not conducting sufficient pressure tests can result in a situation when bad--quality connections and possible system leaks are not detected in a timely manner.
- Unsuitable storage and transportation conditions.
- Not ensuring sufficient pressure and thermal regulations from the perspective of water overheating and overpressure in hot water systems. This can result in a situation when the maximal plastic material parameters are exceeded, thus causing degradation and system breakdowns.

18. Pressure losses caused by friction

The table of pressure losses caused by friction in pipelines in kPa/m pursuant to ČSN 75 5455 are specified in a separate document called Pressure losses in pipelines.

... more than pipes

PROTOCOL

on pipeline pressure test of an interior distribution system

1. Identification data:

Building / structure: ....

Building location: ....

Marking of the tested part of the water main:...

Installation description: ....

Builder / customer: ....

Contractor / supplier:..

Responsible representative of the contractor: ....

2. Pipeline inspection information

The pipeline was inspected and all determined defects fixed prior to the actual pipeline pressure test. The pipelines and valves have to be uncovered during the inspection (for example, in installation shafts or grooves). The pipeline can be laid in protective pipes during the inspection. Furthermore, the pipeline has to be free of insulation, apart from sleeve pipe insulation, during the inspection.

3. Pressure test information:

Date of the pipeline pressure test	
Manometer – type, serial number	
Test substance	Drinking water
Highest operation excess pressure (MOP)	MPa
Test excess pressure	**MPa**
Date and time the pipeline was filled with water prior to the test	
Date and time of the test commencement	
Excess time at the beginning of the test (test excess pressure)	kPa
Excess time at the end of the test	kPa
Total test duration time	min

Result of the pipeline pressure test: SATISFACTORY - UNSATISFACTORY*

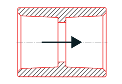
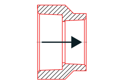
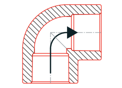
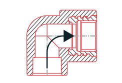
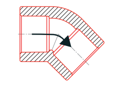
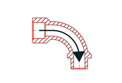
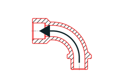
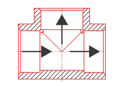
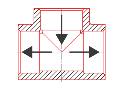
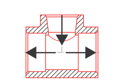
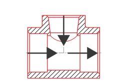
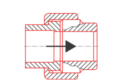
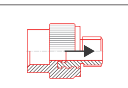
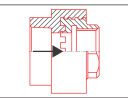
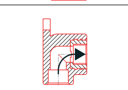
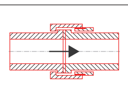
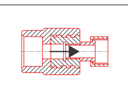
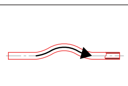
This protocol has been read, approved and signed. Location and date:

Investor: .... Signature: ....

Implementation Company: .... Signature: ....

19. Local resistance in the fittings

TABLE 24 - Local resistance coefficient

Fitting		Local resistance	Local loss coefficient ξ [Pa . s^2 . m^{-2}]
		Mouthpiece (joint)	0.2
		Reduction by 2 dimensions Reduction by 3 dimensions	0,6 0,9
		Elbow 90°	1.5
		Elbow 90° with a metal thread	1.6
		Elbow 45°	0.6
		Arch 90°	1.5
		Arch 90°	4.7
		T - piece passage – unambiguous	1.5
		T - piece – unambiguous	1.15
		T - piece split – reduced	4.8
		T - kus odboč-ka - redukovaný	3.7
		Reducer plastic - metal	0.6
		Reducer with outer reduction	0.9
		Reducer with inner reduction	0.6
		Elbow 90° with an inner thread, reduced	2.2
		Dismountable joint	1.5
		Reduced reducer with a cap nut	8.3
		Crossing	0.8

20. Chemical resistance of the PPR and PP-RCT materials

To verify the material chemical resistance in relation to various liquids, please contact the FV-Plast technical department.

21. Certificates*

AUTORIZOVANÁ OSOBA č. 224
Institut pro testování a certifikaci, a. s., tř. T. Bati 299, Louky, 763 02 Zlín,
Česká republika
Rozhodnutí o autorizaci č. 2/2014 ze dne 10. března 2014

CERTIFIKÁT VÝROBKU
č. 04 0787 V/AO/f

V souladu s ustanoveními §5, odst. 2, nařízení vlády č. 163/2002 Sb., kterým se stanoví technické požadavky na vybrané stavební výrobky, ve znění Nařízení vlády č. 312/2005 Sb. a Nařízení vlády č. 215/2016 Sb., Autorizovaná osoba č. 224 potvrzuje, že u stavebního výrobku

Trubky, kompletační prvky a armatury z polypropylenu PP-R na polyfuzní svařování (Borealis RA 130E, Hostalen 5216/34, Vestolen P 9421, INNOPOL CS 4-8000 G), d 16 – 110 mm, PN 10, PN 16 a PN 20 pro tlakové rozvody pitné vody a teplé užitkové vody, ústředního a podlahového vytápění

uváděného na trh společnosti
FV-PLAST, a.s.
Bártlova 2791/17 A, 193 00 Praha 9 – Horní Počernice, Česká republika
DIČ: CZ26167654

výrobce
FV-PLAST, a.s.
Bártlova 2791/17 A, 193 00 Praha 9 – Horní Počernice, Česká republika

přezkoumala podklady předložené výrobcem, provedla počáteční zkoušku typu výrobku na vzorku a posoudila systém řízení výroby a zjistila, že uvedený výrobek splňuje základní požadavky nařízení vlády, konkretizované ve stavebním technickém osvědčení č. **STO-AO 224-1699/2004/f**
Autorizovaná osoba č. 224 zjistila, že systém řízení výroby odpovídá příslušné technické dokumentaci a zabezpečuje, aby výrobky uváděné na trh splňovaly požadavky stanovené shora uvedeným stavebním technickým osvědčením a odpovídaly technické dokumentaci podle §4, odst. 3.
Certifikát byl vydán na základě Závěrečného protokolu č. **793501503/2016** ze dne 22. 12. 2016, která obsahuje závěry zjišťování a ověřování, výsledky zkoušek a základní popis výrobku, nezbytný pro jeho identifikaci.
Tento Certifikát zůstává v platnosti po dobu, po kterou se požadavky stanovené v technických předpisech nebo stavebním technickém osvědčení, na které byl uveden odkaz, nebo výrobní podmínky v místě výroby či systém řízení výroby výrazně nezmění.
Autorizovaná osoba č. 224 provádí nejméně jedenkrát za 12 měsíců dohled nad řádným fungováním systému řízení výroby v místě výroby, odebírá vzorky výrobků, provádí jejich zkoušky a posuzuje, zda vlastnosti výrobku odpovídají stavebnímu technickému osvědčení podle ustanovení §5, odst. 4, výše uvedeného nařízení vlády. Pokud autorizovaná osoba č. 224 zjistí nedostatky, je oprávněna zrušit nebo změnit tento certifikát.

Vydáno ve Zlíně: **07-12-2004**
Změna f): **22-12-2016**
(Nahrazuje certifikát č. 04 0787 V/AO/e ze dne 09-10-2014)

RNDr. Radomír Čevelík
představitel Autorizované osoby č. 224

AUTORIZOVANÁ OSOBA č. 224
Institut pro testování a certifikaci, a. s., tř. T. Bati 299, Louky, 763 02 Zlín,
Česká republika
Rozhodnutí o autorizaci č. 2/2014 ze dne 10. března 2014

CERTIFIKÁT VÝROBKU
č. 11 0819 V/AO/c

V souladu s ustanoveními §5, odst. 2, Nařízení vlády č. 163/2002 Sb., kterým se stanoví technické požadavky na vybrané stavební výrobky, ve znění Nařízení vlády č. 312/2005 Sb., Autorizovaná osoba č. 224 potvrzuje, že u stavebního výrobku

Vícevrstvé kompozitní trubky FASER z polypropylenu PP-R/PP-R+GF/PP-R (Vestolen P 9421, Borealis RA 130E), d 16 mm – d 110 mm, PN 16, PN 20 pro tlakové rozvody pitné vody, teplé vody a ústředního vytápění

uváděného na trh společnosti
FV-PLAST, a. s.
Bártlova 2791/17 A, 193 00 Praha 9 – Horní Počernice, Česká republika
DIČ: CZ26167654

z místa výroby
FV-PLAST, a. s.
Kozovazská 1049/3, 250 88 Čelákovice, Česká republika

přezkoumala podklady předložené výrobcem, provedla počáteční zkoušku typu výrobku na vzorku a posoudila systém řízení výroby a zjistila, že uvedený výrobek splňuje základní požadavky nařízení vlády, konkretizované ve stavebním technickém osvědčení č. **STO – AO 224 – 360/2011/c**.
Autorizovaná osoba č. 224 zjistila, že systém řízení výroby odpovídá příslušné technické dokumentaci a zabezpečuje, aby výrobky uváděné na trh splňovaly požadavky stanovené shora uvedeným stavebním technickým osvědčením a odpovídaly technické dokumentaci podle §4, odst. 3.
Certifikát byl vydán na základě Závěrečného protokolu č. **793501323/2014** ze dne 22. 9. 2014, který obsahuje závěry zjišťování a ověřování, výsledky zkoušek a základní popis výrobku, nezbytný pro jeho identifikaci.
Tento Certifikát zůstává v platnosti po dobu, po kterou se požadavky stanovené v technických předpisech nebo stavebním technickém osvědčení, na které byl uveden odkaz, nebo výrobní podmínky v místě výroby či systém řízení výroby výrazně nezmění.
Autorizovaná osoba č. 224 provádí nejméně jedenkrát za 12 měsíců dohled nad řádným fungováním systému řízení výroby v místě výroby, odebírá vzorky výrobků, provádí jejich zkoušky a posuzuje, zda vlastnosti výrobku odpovídají stavebnímu technickému osvědčení podle ustanovení §5, odst. 4, výše uvedeného nařízení vlády. Pokud autorizovaná osoba č. 224 zjistí nedostatky, je oprávněna zrušit nebo změnit tento certifikát.

Vydáno ve Zlíně: **29. 09. 2011**
Změna c): **22. 09. 2014**
(Nahrazuje certifikát č. 11 0819 V/AO/b ze dne 20. 03. 2013)

RNDr. Radomír Čevelík
představitel Autorizované osoby č. 224

AUTORIZOVANÁ OSOBA č. 224
Institut pro testování a certifikaci, a. s., tř. T. Bati 299, Louky, 763 02 Zlín,
Česká republika
Rozhodnutí o autorizaci č. 2/2014 ze dne 10. března 2014

CERTIFIKÁT VÝROBKU
č. 14 0045 V/AO/a

V souladu s ustanoveními §5, odst. 2, nařízení vlády č. 163/2002 Sb., kterým se stanoví technické požadavky na vybrané stavební výrobky, ve znění Nařízení vlády č. 312/2005 Sb. a Nařízení vlády č. 215/2016 Sb. (NV 163), Autorizovaná osoba č. 224 potvrzuje, že u stavebního výrobku

Vícevrstvé kompozitní trubky FASER z polypropylenu PP-RCT/PP-RCT+GF/PP-RCT (Borealis RA 7050), d 16 mm – d 250 mm, S 8 (SDR 17), S 5 (SDR 11), S 4 (SDR 9), S 3,2 (SDR 7,4) pro tlakové rozvody pitné vody, teplé vody a ústředního vytápění

uváděného na trh společnosti
FV-PLAST, a.s.
Bártlova 2791/17 A, 193 00 Praha 9 – Horní Počernice, Česká republika
DIČ: CZ26167654

z místa výroby
FV-PLAST, a.s.
Kozovazská 1049/3, 250 88 Čelákovice, Česká republika

přezkoumala podklady předložené výrobcem, provedla počáteční zkoušku typu výrobku na vzorku a posoudila systém řízení výroby a zjistila, že uvedený výrobek splňuje základní požadavky nařízení vlády, konkretizované ve stavebním technickém osvědčení č. **STO – AO 224 – 606/2014/a**.
Autorizovaná osoba č. 224 zjistila, že systém řízení výroby odpovídá příslušné technické dokumentaci a zabezpečuje, aby výrobky uváděné na trh splňovaly požadavky stanovené shora uvedeným stavebním technickým osvědčením a odpovídaly technické dokumentaci podle §4, odst. 3 NV 163.
Certifikát byl vydán na základě Závěrečného protokolu č. **793501510/2017** ze dne 24. 1. 2017, který obsahuje závěry zjišťování a ověřování, výsledky zkoušek a základní popis výrobku, nezbytný pro jeho identifikaci.
Tento Certifikát zůstává v platnosti po dobu, po kterou se požadavky stanovené v technických předpisech nebo stavebním technickém osvědčení, na které byl uveden odkaz, nebo výrobní podmínky v místě výroby či systém řízení výroby výrazně nezmění.
Autorizovaná osoba č. 224 provádí nejméně jedenkrát za 12 měsíců dohled nad řádným fungováním systému řízení výroby v místě výroby, odebírá vzorky výrobků, provádí jejich zkoušky a posuzuje, zda vlastnosti výrobku odpovídají stavebnímu technickému osvědčení podle ustanovení §5, odst. 4, výše uvedeného nařízení vlády. Pokud autorizovaná osoba č. 224 zjistí nedostatky, je oprávněna zrušit nebo změnit tento certifikát.

Vydáno ve Zlíně: **31-01-2014**
Změna a): **24-01-2017**
(Nahrazuje certifikát č. 14 0045 V/AO ze dne 31-01-2014)

RNDr. Radomír Čevelík
představitel Autorizované osoby č. 224

í

AUTORIZOVANÁ OSOBA č. 224
Institut pro testování a certifikaci, a. s., tř. T. Bati 299, Louky, 763 02 Zlín,
Česká republika
Rozhodnutí o autorizaci č. 2/2014 ze dne 10. března 2014

CERTIFIKÁT VÝROBKU
č. 07 0591 V/AO/c

V souladu s ustanoveními §5, odst. 2, nařízení vlády č. 163/2002 Sb., kterým se stanoví technické požadavky na vybrané stavební výrobky, ve znění Nařízení vlády č. 312/2005 Sb. a nařízení vlády č. 215/2016 Sb., Autorizovaná osoba č. 224 potvrzuje, že u stavebního výrobku

Trubky STABI z polypropylenu PP-R (Borealis RA 130E, Vestolen P 9421), d 16 mm – d 110 mm, PN 20 pro tlakové rozvody pitné vody, teplé vody, ústředního a podlahového vytápění

uváděného na trh společnosti
FV-PLAST, a. s.
Kozovazská 1049/3, 250 88 Čelákovice, Česká republika
DIČ: CZ26167654

z místa výroby
FV-PLAST, a. s.
Kozovazská 1049/3, 250 88 Čelákovice, Česká republika

přezkoumala podklady předložené výrobcem, provedla počáteční zkoušku typu výrobku na vzorku a posoudila systém řízení výroby a zjistila, že uvedený výrobek splňuje základní požadavky nařízení vlády, konkretizované ve stavebním technickém osvědčení č. **STO-AO 224-147/2007/c.**
Autorizovaná osoba č. 224 zjistila, že systém řízení výroby odpovídá příslušné technické dokumentaci a zabezpečuje, aby výrobky uváděné na trh splňovaly požadavky stanovené shora uvedeným stavebním technickým osvědčením a odpovídaly technické dokumentaci podle §4, odst. 3.
Certifikát byl vydán na základě Závěrečného protokolu č. **793501511/2016** ze dne 28. 11. 2016, který obsahuje závěry zjišťování a ověřování, výsledky zkoušek a základní popis výrobku, nezbytný pro jeho identifikaci.
Tento Certifikát zůstává v platnosti po dobu, po kterou se požadavky stanovené v technických předpisech nebo stavebním technickém osvědčení, na které byl uveden odkaz, nebo výrobní podmínky v místě výroby či systém řízení výroby výrazně nezmění.
Autorizovaná osoba č. 224 provádí nejméně jedenkrát za 12 měsíců dohled nad řádným fungováním systému řízení výroby v místě výroby, odebírá vzorky výrobků, provádí jejich zkoušky a posuzuje, zda vlastnosti výrobku odpovídají stavebnímu technickému osvědčení podle ustanovení §5, odst. 4, výše uvedeného nařízení vlády. Pokud autorizovaná osoba č. 224 zjistí nedostatky, je oprávněna zrušit nebo změnit tento certifikát.

Vydáno ve Zlíně: **17-10-2007**
Změna c): **28-11-2016**
(Nahrazuje certifikát č. 07 0591 V/AO/b ze dne 22-10-2013)

RNDr. Radomír Čevelík
představitel Autorizované osoby č. 224

AUTORIZOVANÁ OSOBA č. 224
Institut pro testování a certifikaci, a. s., tř. T. Bati 299, Louky, 763 02 Zlín, Česká republika
Rozhodnutí o autorizaci č. 30/2006 ze dne 30. srpna 2006

CERTIFIKÁT VÝROBKU
č. 14 0076 V/AO

V souladu s ustanoveními §5, odst. 2, nařízení vlády č. 163/2002 Sb., kterým se stanoví technické požadavky na vybrané stavební výrobky, ve znění Nařízení vlády č. 312/2005 Sb., Autorizovaná osoba č. 224 potvrzuje, že u stavebního výrobku

Trubky STABIOXY z polypropylenu PP-RCT (Borealis RA 7050), d 16 mm – d 110 mm, S 4, pro tlakové rozvody pitné vody, teplé vody a ústředního vytápění

uváděného na trh společností
FV-PLAST, a.s.
Bártlova 2791/17 A, 193 00 Praha 9 – Horní Počernice, Česká republika
DIČ: CZ26167654

z místa výroby
FV-PLAST, a.s.
Kozovazská 1049/3, 250 88 Čelákovice, Česká republika

přezkoumala podklady předložené výrobcem, provedla počáteční zkoušku typu výrobku na vzorku a posoudila systém řízení výroby a zjistila, že uvedený výrobek splňuje základní požadavky nařízení vlády, konkretizované ve stavebním technickém osvědčení č. **STO – AO 224 – 608/2014**.
Autorizovaná osoba č. 224 zjistila, že systém řízení výroby odpovídá příslušné technické dokumentaci a zabezpečuje, aby výrobky uváděné na trh splňovaly požadavky stanovené shora uvedeným stavebním technickým osvědčením a odpovídaly technické dokumentaci podle §4, odst. 3.
Certifikát byl vydán na základě Závěrečného protokolu č. **793501249/2014** ze dne 21. 2. 2014, který obsahuje závěry zjišťování a ověřování, výsledky zkoušek a základní popis výrobku, nezbytný pro jeho identifikaci.
Tento Certifikát zůstává v platnosti po dobu, po kterou se požadavky stanovené v technických předpisech nebo stavebním technickém osvědčení, na které byl uveden odkaz, nebo výrobní podmínky v místě výroby či systém řízení výroby výrazně nezmění.
Autorizovaná osoba č. 224 provádí nejméně jedenkrát za 12 měsíců dohled nad řádným fungováním systému řízení výroby v místě výroby, odebírá vzorky výrobků, provádí jejich zkoušky a posuzuje, zda vlastnosti výrobku odpovídají stavebnímu technickému osvědčení podle ustanovení §5, odst. 4, výše uvedeného nařízení vlády. Pokud autorizovaná osoba č. 224 zjistí nedostatky, je oprávněna zrušit nebo změnit tento certifikát.

Vydáno ve Zlíně, 21. 2. 2014

AUTORIZOVANÁ OSOBA 224 ZLÍN

RNDr. Radomír Čevelík
představitel Autorizované osoby č. 224

AUTORIZOVANÁ OSOBA č. 224
Institut pro testování a certifikaci, a. s., tř. T. Bati 299, Louky, 763 02 Zlín, Česká republika
Rozhodnutí o autorizaci č. 2/2014 ze dne 10. března 2014

CERTIFIKÁT VÝROBKU
č. 12 0870 V/AO/b

V souladu s ustanoveními §5, odst. 2, nařízení vlády č. 163/2002 Sb., kterým se stanoví technické požadavky na vybrané stavební výrobky, ve znění Nařízení vlády č. 312/2005 Sb., Autorizovaná osoba č. 224 potvrzuje, že u stavebního výrobku

Trubky z lineárního polyetylenu HDPE, typ PE 100 RC (BorSafe 3494-LS-H, BorSafe 3490-LS-H), d 20 mm – d 63 mm, PN 10 (SDR 17), PN 12,5 (SDR 13,6) a PN 16 (SDR 11)
pro tlakové rozvody pitné vody, vody pro všeobecné účely, pro geotermální sondy a zemní kolektory

uváděného na trh společností
FV-PLAST, a.s.
Bártlova 2791/17 A, 193 00 Praha - Horní Počernice, Česká republika
DIČ: CZ26167654

z místa výroby
FV-PLAST, a.s.
Bártlova 2791/17 A, 193 00 Praha - Horní Počernice, Česká republika

přezkoumala podklady předložené výrobcem, provedla počáteční zkoušku typu výrobku na vzorku a posoudila systém řízení výroby a zjistila, že uvedený výrobek splňuje základní požadavky nařízení vlády, konkretizované v určených normách **ČSN EN 12201-2.**
Autorizovaná osoba č. 224 zjistila, že systém řízení výroby odpovídá příslušné technické dokumentaci a zabezpečuje, aby výrobky uváděné na trh splňovaly požadavky stanovené shora uvedeným stavebním technickým osvědčením a odpovídaly technické dokumentaci podle §4, odst. 3.
Certifikát byl vydán na základě Závěrečného protokolu č. **793501373/2015** ze dne 27. 2. 2015, který obsahuje závěry zjišťování a ověřování, výsledky zkoušek a základní popis výrobku, nezbytný pro jeho identifikaci.
Tento Certifikát zůstává v platnosti po dobu, po kterou se požadavky stanovené v technických předpisech nebo normách, na které byl uveden odkaz, nebo výrobní podmínky v místě výroby či systém řízení výroby výrazně nezmění.
Autorizovaná osoba č. 224 provádí nejméně jedenkrát za 12 měsíců dohled nad řádným fungováním systému řízení výroby v místě výroby, odebírá vzorky výrobků, provádí jejich zkoušky a posuzuje, zda vlastnosti výrobku odpovídají normám podle ustanovení §5, odst. 4, výše uvedeného nařízení vlády. Pokud autorizovaná osoba č. 224 zjistí nedostatky, je oprávněna zrušit nebo změnit tento certifikát.

Vydáno ve Zlíně: **26-10-2012**
Změna b): **27-02-2015**
(Nahrazuje certifikát č. 12 0870 V/AO/a ze dne 23-08-2013)

AUTORIZOVANÁ OSOBA 224 ZLÍN

RNDr. Radomír Čevelík
představitel Autorizované osoby č. 224

AUTORIZOVANÁ OSOBA č. 224
Institut pro testování a certifikaci, a. s., tř. T. Bati 299, Louky, 763 02 Zlín, Česká republika
Rozhodnutí o autorizaci č. 2/2014 ze dne 10. března 2014

CERTIFIKÁT VÝROBKU
č. 14 0744 V/AO

V souladu s ustanoveními §5, odst. 2, nařízení vlády č. 163/2002 Sb., kterým se stanoví technické požadavky na vybrané stavební výrobky, ve znění Nařízení vlády č. 312/2005 Sb., Autorizovaná osoba č. 224 potvrzuje, že u stavebního výrobku

Vícevrstvé trubky FV Therm z polyetylenu PE-RT/EVOH/PE-RT, typ II (Dowlex 2388), d 15 x 1,8 mm, d 16 x 2,0 mm, d 17 x 2,0 mm, d 20 x 2,0 mm pro rozvody podlahového vytápění

uváděného na trh společností
FV-PLAST, a.s.
Kozovazská 1049/3, 250 88 Čelákovice, Česká republika
DIČ: CZ26167654

z místa výroby
FV-PLAST, a.s.
Kozovazská 1049/3, 250 88 Čelákovice, Česká republika

přezkoumala podklady předložené výrobcem, provedla počáteční zkoušku typu výrobku na vzorku a posoudila systém řízení výroby a zjistila, že uvedený výrobek splňuje základní požadavky nařízení vlády, konkretizované ve stavebním technickém osvědčení č. **STO – AO 224 – 682/2014**.
Autorizovaná osoba č. 224 zjistila, že systém řízení výroby odpovídá příslušné technické dokumentaci a zabezpečuje, aby výrobky uváděné na trh splňovaly požadavky stanovené shora uvedeným stavebním technickým osvědčením a odpovídaly technické dokumentaci podle §4, odst. 3.
Certifikát byl vydán na základě Závěrečného protokolu č. **793501223/2014** ze dne 22. 12. 2014, který obsahuje závěry zjišťování a ověřování, výsledky zkoušek a základní popis výrobku, nezbytný pro jeho identifikaci.
Tento Certifikát zůstává v platnosti po dobu, po kterou se požadavky stanovené v technických předpisech nebo stavebním technickém osvědčení, na které byl uveden odkaz, nebo výrobní podmínky v místě výroby či systém řízení výroby výrazně nezmění.
Autorizovaná osoba č. 224 provádí nejméně jedenkrát za 12 měsíců dohled nad řádným fungováním systému řízení výroby v místě výroby, odebírá vzorky výrobků, provádí jejich zkoušky a posuzuje, zda vlastnosti výrobku odpovídají stavebnímu technickému osvědčení podle ustanovení §5, odst. 4, výše uvedeného nařízení vlády. Pokud autorizovaná osoba č. 224 zjistí nedostatky, je oprávněna zrušit nebo změnit tento certifikát.

Vydáno ve Zlíně, 22. 12. 2014

AUTORIZOVANÁ OSOBA 224 ZLÍN

RNDr. Radomír Čevelík
představitel Autorizované osoby č. 224

* The certificates can be downloaded from our website:

FV - Plast, a.s.

Kozovazská 1049/3
250 88 Čelákovice
Česká Republika

T: +420 326 706 711
F: +420 326 706 721
@: fv-plast@fv-plast.cz

WWW.FV-PLAST.CZ

ENG 10-2018