FRABO

TECHNICAL CATALOGUE

FRABOPRESS H2O SECURFRABO

COPPER AND BRONZE PRESS FITTINGS

FRABOPRESS
H2O SECURFRABO

Copper and Bronze press fittings

CONTENTS

DESCRIPTION

COPPER / BRONZE FRABOPRESS H2O SECURFRABO FITTINGS

High purity copper **Cu-DHP** (CW024A) and high purity cast bronze press fittings with high performance **EPDM** gasket suitable for application with drinking water and suitable to be pressed with "V" type jaws.

ADVANTAGES

- Easy and quick installation
- High hydraulic and mechanical seal ("V" profile with pipe insertion guide)
- Noble (copper) and bacteriostatic material
- Safe installation
- High fitting body durability

TECHNICAL FEATURES

COMPLIANCE FEATURES

FRABOPRESS H2O SECURFRABO fittings are suitable for the realization of pressed junctions on high-quality copper pipes in most thermohydraulic installations (compliant with **EN 1057**).

FRABOPRESS H2O SECURFRABO copper fittings comply with the **UNI 11065** standard, made with a careful choice of raw materials and maximum quality in the internal processing.

The threaded fittings are made of bronze in compliance with the **EN 1982** standard and have threads according to the **UNI EN 10226-1** standard.

CONSTRUCTION FEATURES

Available range: 12, 14, 15, 16, 18, 22, 28, 35, 42, 54 mm

Fitting profile: the type of profile adopted by **FRABO** (for "V" type jaws) for the **FRABOPRESS H2O SECURFRABO** series allows pressing at 3 points and is therefore optimal for guaranteeing seal and solidity at the pipe-fitting junction. The protruding collar of the fitting allows a more secure installation of the pipe without difficulty, preventing any deviations of the connection of the pipe in the fitting, which could damage the gasket.

Fitting structure: the body of the **FRABOPRESS H2O SECURFRABO** fitting features a particularly high wall thickness, hence guaranteeing maximum performance in every application.

In the text of this manual are detailed references to Italian product standards and national installation. References to national rules of other countries (eg Germany) are presented for information purposes.
To get detailed information about consult the Technical Service FRABO

FITTING TECHNICAL FEATURES			
APPLICATION		FRABOPRESS H2O SECURFRABO	
		Pmax (bar)	Tmax °C
	Sanitary water / Heating	16	0°/+110°C
	Drinking water	16	0°/+110°C
	Cooling *	16	-10°/+110°C
	Oil-free compressed air (residual oil <5 mg/m³)	16	30°C
	Compressed air (residual oil >5 mg/m³) (with FKM O-ring)	16	30°C
	Oils (with FKM O-ring) **	16	30°C
	Solar systems (with FKM O-ring) ***	6	160°C
	Steam (with FKM O-ring) ***	1	120°C
	Fire prevention	16	30°C
	Sprinkler		

* any additives contained in the cooling media must be compatible with the EPDM O-rings
** for this application RED FKM O-RINGs must be used
*** for this application GREEN FKM O-RINGs must be used, which can be subjected to temporary temperature peaks of 200°C

MATERIALS

FRABOPRESS H2O SECURFRABO Copper fittings
They are made of high purity deoxidised copper (**Cu-DHP**) in compliance with the EN 1412 standard.

FRABOPRESS H2O SECURFRABO Bronze fittings
They are made of high quality bronze alloy with low lead content in compliance with the EN 1982 standard.

COPPER

Copper is widely used in the realization of many thermohydraulic installation thanks to its physical and technological properties and excellent thermal conductivity and corrosion resistance

Copper is now a highly valuable material, used by designers and installation technicians for thermal systems due to its qualities and has always been one of the most noble metals.

GASKET SEAL – O-RING

For the **FRABOPRESS H2O SECURFRABO** series, the sealing ring is made of black **EPDM**. The high performance and excellent behaviour of this material against ageing allow their safe and durable use in most civil and industrial applications.

The maximum operating temperature that can be handled by the sealing gaskets is 110 °C. The **EPDM** O-Ring complies with the European Standard EN 681-1 and is equipped with the major European certifications regarding its suitability for hygienic food uses, and is suitable for contact with drinking water as determined by the ministerial degree No. no. 174 of 6 April 2004.

The **EPDM** polymer is not resistant to combustible gases, oils, gasoline, turpentine, and hydrocarbons in general. Should it be necessary to transfer fluids containing mineral oils (fuel oil, gas oil, etc.), **FRABO** offers a specific **FKM** red gasket suitable for this type of applications.

For fluids other than drinking water, and water for heating and other requirements, please contact the FRABO technical support office and send an inquiry.

USABLE PIPES

The basis for performing installations with copper pipes is the **UNI EN 1057** standard. The **FRABOPRESS H2O SECURFRABO** fittings are suitable for a safe connection to copper pipes (in rods or rolls) compliant with **EN 1057** regulations.

Table 2.2 shows the mechanical characteristics of copper pipes as per **EN 1057** standard.

STATE	External diameter Nominal size mm		Resistence to Rm Mpa traction	Elongation at breaking A%	Hardness HV5
	Min	Max	Min	Max	
R220 (Annealed)	6	54	220	40	from 40 to 70
R250 (Half hard)	6	66,7	250	30	from 75 to 100
	6	159		20	
R290 (Hard)	6	267	290	3	min 100

Table 2.2

Please remember that only pipes with an internal surface which has been suitably processed can be installed in drinking water installations and, in any case, only high quality pipes which are expressly suitable to transport drinking water can be installed.

When installing sanitary and heating water installations, with the **FRABOPRESS H2O SECURFRABO** system it is possible to press any pipe listed by rule **EN 1057** which has the thickness listed in Table 2.3

PIPE DIAMETER	R220 (Annealed)	R250 (Half hard)	R290 (Hard)
	Min. depth (mm)	Min. depth (mm)	Min. depth (mm)
12	1,0	1,0	1,0
15	1,0	1,0	1,0
18	1,0	1,0	1,0
22	1,0	1,0	1,0
28	X	1,0	1,0
35	X	1,2	1,0
42	X	1,5	1,5
54	X	1,5	1,5

Table 2.3

COPPER PIPES IN ROLLS

To guarantee an excellent seal also in the event of using convenient copper pipes in rolls (a material that is notoriously softer than the version in rods) it is recommended to check the calibration and make sure there are no deformations in the section affected by the pressing. The force exerted by the pressing tool is such as to make the walls of the piping collapse unless high quality pipes free from imperfections are used.

MARKINGS

FRABOPRESS H2O SECURFRABO fittings are recognisable thanks to their light blue mark and the **SECURFRABO** symbol.

FRABOPRESS H2O SECURFRABO fittings are equipped with the new **SECURFRABO** safety system, which allows any un-pressed fittings to be detected. The **SECURFRABO** system is made using an elastomeric gasket whose patented shape allows liquid to leak out if the junction has not been pressed.

Thanks to **SECURFRABO**, when the system is tested, the fitting end not pressed can be quickly identified and action can be taken so as to reduce the possibility of mistakes or oversights that can reduce the system's effectiveness over time.

PRESSING/JAW EQUIPMENT

The installation tools for the **FRABOPRESS H2O SECURFRABO** products comprise a set of electronically controlled electromechanical equipment. You can refer to the paper catalogue or view the updated list of our available equipment and request detailed operating instructions on www.frabo.com.

Thanks to the deformation imposed on the fitting and the pipe, the pressing tools create a permanent junction, which is constantly sealed and not removable.

A clear visual example of the nature of the deformation is provided in the following figures.

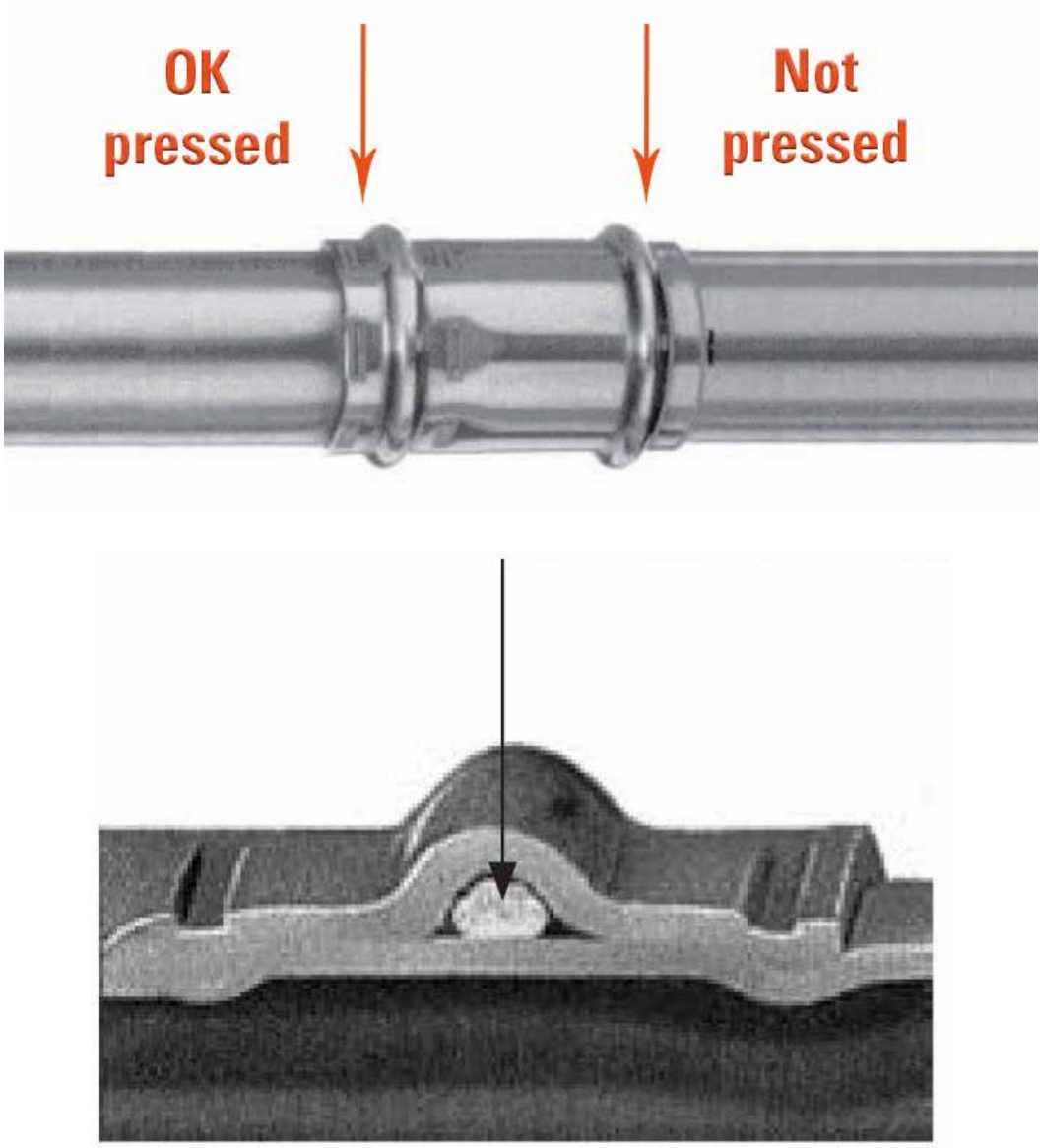


Figure 1 - Chain and its adapter

A notable characteristic of the electric pressing tools provided by **FRABO** is the ability to optimize the pressure force based on the nominal diameter to compress.

For larger diameters (42, 54) the **FRABOPRESS H2O SECURFRABO** system proposes, instead of traditional pressing jaws, chains with the same function. (fig. 1)

COMPATIBLE INSTALLATION EQUIPMENT

Original **FRABO** jaws or jaws with the same profile ("V") are used to install **FRABOPRESS H2O SECURFRABO** fittings.
A good number of pressing tools are available on the market today, which are provided by different tool manufacturers and can be used for the installation of **FRABOPRESS H2O SECURFRABO** fittings.

For the sake of simplicity, we list the minimal characteristics of the pressing tools here below:

- Minimum pressing force of the electric tool: 32kN
- Jaw profile suitable for **FRABOPRESS** fittings
- Jaw fastening pin diameter: 14 mm
- Minimum jaw housing width: 33 mm
- Pressing without stop function – after pressing begins, the pliers cannot be separated (with no special operation, such as the pressing of the emergency stop button) from the piece, which may not yet be connected to pressure.

The chain offers the advantage of a smaller footprint during positioning and pressing and allows the achievement of an installation with excellent concentricity between the pipe and the fitting.

The electric tools provided by **FRABO** can also be used in other press fitting systems

COMPACT PRESSES

Compact presses that provide easier installation thanks to greater manageability are now available on the market. The minimum electric tool pressing force is about 19 kN and they are suitable for fittings with diameters up to 28 mm (metal).

ATTENTION

Except in cases where the manufacturer of the pressing equipment explicitly declares the compatibility of its electric tool with jaws produced by other manufacturers, the use of a brand of jaws different from that of the electric tool is not allowed.

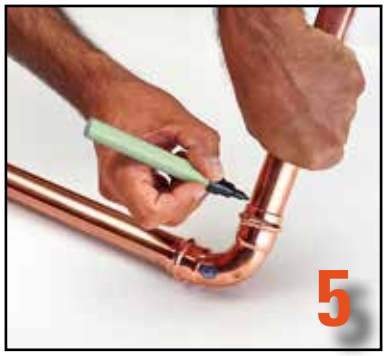
INSTRUCTIONS FOR FRABOPRESS INSTALLATION AND ASSEMBLY

Cut the pipe perpendicularly across its section (by means of a pipe cutter or a fine tooth saw).

Internally and externally bar the pipe.

Make sure the O-Ring is well-inserted.

Fully insert the pipe in the fitting.



Mark the pipe at the stroke position.

Insert the jaw suited for the pressing tool and push the stop pin until it clicks

Open the jaw and position it perpendicularly on the fitting

Begin pressing. It will run completely automatically. The jaw must close completely

After pressing has occurred, the jaw can be opened.

TECHNICAL SOLUTIONS FOR INSTALLATION AND ASSEMBLY

The **FRABOPRESS H2O SECURFRABO** system is an excellent solution for the realization of many types of systems. A good installation depends on the degree of accuracy used for the assembly of the various components and respect for some simple technical rules in addition to the Regulations.

CUTTING OF THE PIPE

The copper pipes used along with the **FRABOPRESS H2O SECURFRABO** fittings, must be cut by using a pipe cutting tool, the efficacy of which has previously been verified. By using this tool, the cut will not have burrs and will be perpendicular to the pipe's axis.

Other cutting systems can of course be used, although Frabo generally discourages the installer from using them . In any case, it is absolutely necessary to deburr the pipe.

DEBURRING THE PIPE

Once the pipe has been cut to the desired size, it is always necessary to carefully deburr its internal and external extremities. This operation is absolutely essential whenever the adopted cutting system can create burrs; for example, with manual and electric saws. The removal of any residual chips prevents the possible damage of the O-ring gasket once the pipe is introduced into the fitting.

DEPTH OF THE CONNECTION

To be absolutely sure of the correct depth of the connection of the pipe inside the fitting, it is sufficient to mark the depth of the connection beforehand, or make sure that the pipe is introduced up to the end stop in the coupling block of the fitting itself.

In the case of passing fittings, i.e. without an arresting block, or for a better quality of work, it is advisable to trace the depth of the connection on the pipe, in order to verify, visually as well, the proper insertion of the pipe.

CONTROL

Before proceeding, it is best to check correct O-ring position beforehand; then check its integrity and cleanliness.

PRESSING

To perform a proper pressing, the appropriate equipment must be used, which can be battery powered or plugged into an electricity supply. For each diameter of pipe utilized, the appropriate deformation jaws must be used to permit the realization of a perfectly airtight junction.

To perform perfect pressing, put the fitting inside the jaw and keep the tool positioned at right angles to the pipe.

Ensure that the toroidal chamber of the fitting (which contains the O-Ring) is properly positioned inside the corresponding groove of the jaw. Then begin pressing the junction; the pliers will automatically perform the deformation until its completion.

PIPE BENDING

The range of **FRABOPRESS H2O SECURFRABO** fittings includes 45° and 90° bends and elbows that allow changes to be made in the route without the need to bend the pipe directly. However, sometimes, the cold shaping of the pipes is necessary. To carry out this type of operation, the use of a special pipe-bending tool is absolutely recommended.

The minimum bending radius (R) is inferred from the following relations:

R = 3,5 x D for D <= 18mm
R = 5,5 x D for D >= 18 mm

where D is the diameter of the pipe

Avoid making bends that have a minimum radius that is lower than that indicated.

Hot pipe bending using an acetylene torch or other tool is absolutely unacceptable.

It is always necessary to respect a minimum distance from the bend made on the pipe to the installation of fittings (fig.4.1).

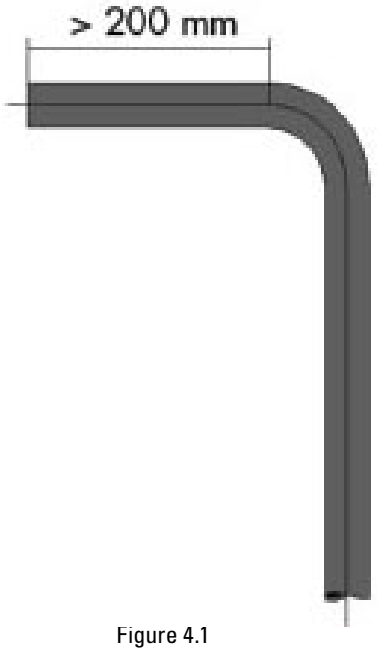


Figure 4.1

FITTING DEPTHS

The installation depths and the coupling tolerances are designed and implemented with the utmost attention to ensure the highest degree of safety of the junction.

The connection depths based on the diameter are reported in following table.

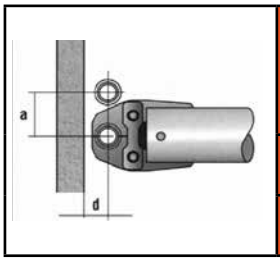
	Nominal Diam. [mm]	12	15	18	22	28	35	42	54
	L mm	18	22	23	24	25	26	35	42

INSTALLATION DEPTHS

The use of the cold pressing technique gives a great advantage in terms of execution time of the connections. To facilitate correct installation, the cases that we report below may prove useful, as they very clearly exemplify the minimum installation depths that allow an installation that is easy and free of annoying complications.

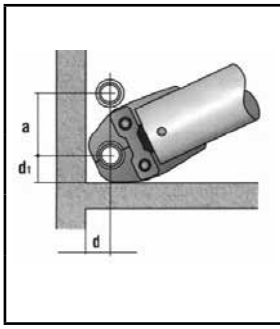
The distances from walls, corners, and cracks in the wall necessary for the installation of pipelines can be deduced from the diagrams and the following tables:

Table 2.1



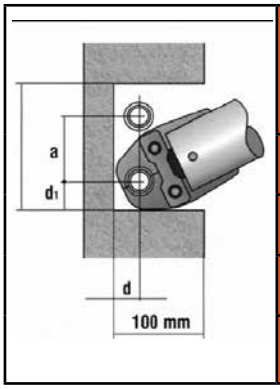
Nom. diam. mm.	12	15	18	22	28	35	42 chain	54 chain
d mm	20	20	22	25	25	30	75	85
a mm	56	56	60	65	75	83	115	120

Minimum depths of the pipelines installed in-wall



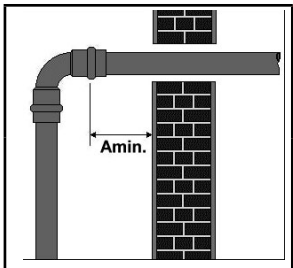
Nom. diam. mm.	12	15	18	22	28	35	42 chain	54 chain
d mm	31	31	31	31	31	31	75	85
a mm	80	80	80	80	80	84	75	85
d1 mm	28	28	28	35	35	44	115	120

Minimum depths of pipelines installed near corners



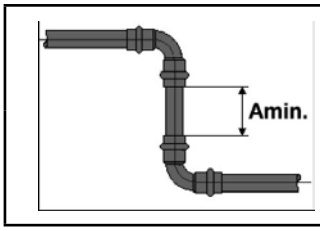
Nom. diam. mm.	12	15	18	22	28	35	42 chain	54 chain
d mm	31	31	31	31	31	31	75	85
a mm	80	80	80	80	80	84	75	85
c mm	155	155	161	173	181	206	265	290
d1 mm	28	28	28	35	35	44	115	120

Minimum depths of pipelines installed inside cracks and crevices



d mm	12-54
A mm	50

Minimum distance from the fitting to the wall for passing through walls



Nom. diam. mm.	12	15	18	22	28	35	42	54
A mm	10	10	15	20	20	25	30	35

Minimum distance between two pressed fittings

NOTE COMPACT PRESSES

Smaller sized pressing tools or tools with specific joints/articulations which allow to easily carry out pressing operations are also available on the market.

APPLICATIONS AND PLANT DESIGN PROBLEMS

TYPE OF APPLICATIONS

FRABOPRESS H2O SECURFRABO fittings are suitable for a wide range of applications:

- DRINKING WATER
- NON-POTABLE WATER
- HEATING / COOLING
- COMPRESSED AIR
- NAVAL CONSTRUCTIONS
- TREATED WATERS
- FIRE PROTECTION

SPECIAL APPLICATIONS

- SOLAR POWER SYSTEMS with green gaskets already assembled on the **SOLARPRESS** series (for solar panels);
- HIGH TEMP. INDUSTRIAL PLANTS (HT) / steam conveyance with optional green gaskets;
- COMBUSTIBLE OILS with red gaskets optional.

DRINKING WATER

The **FRABOPRESS H2O SECURFRABO** fittings are suitable for a safe connection in all applications for drinking water. The fitting has passed all compliance tests for use in systems with drinking water.
The use of **FRABOPRESS H2O SECURFRABO** copper fittings is optimal for these applications since copper is a highly bacteriostatic metal. The O-ring used is certified for drinking water as it meets the suitability requirements according to the provisions of the memorandum of the Ministry of Health Decree 174 of 6 April 2004.

NON-POTABLE WATER AND TREATED WATER

FRABOPRESS H2O SECURFRABO fittings can easily be used in many applications for systems with non-potable water, and guarantee total reliability.

In addition to water transport for building and large civil works, systems for treated, softened, distilled, osmosized, decarbonated, demineralized, and deionized water can be cited.
This product respect the requirements of the DWGW W534.

FRABOPRESS H2O SECURFRABO can also be used for the realization of systems conveying rainwater.

HEATING / COOLING

The advantages of the use of **FRABOPRESS H2O SECURFRABO** fittings in the realization of heating/cooling systems are many. The speed of system implementation, the ease of installation, and the guarantee of a perfect seal are the result of careful planning.

Even near boilers or heaters, the **FRABOPRESS H2O SECURFRABO** fittings guarantee an optimal seal thanks to the use of high quality materials. The **FRABOPRESS H2O SECURFRABO** fittings are also suitable in heating systems with glycols used as antifreeze in standard percentages.

For installations with higher operating temperatures (solar installations, industrial appliances, steam conveyors etc.) a particular **FKM** green O-Ring which resists up to 160° for continuous use (**SOLARPRESS** series).

COMPRESSED AIR

Compressed air is widely used in all industries and its applications are endless. The **FRABOPRESS H2O SECURFRABO** fittings are suitable for the construction of systems routing compressed air with a maximum operating pressure of 16 bar.

NAVAL CONSTRUCTIONS

The **FRABOPRESS H2O SECURFRABO** system can also be used in shipbuilding. In particular, where robustness and ease of installation is necessary, as for example in the internal stretches of ships to convey refrigerated water, water for sanitary uses, or firefighting systems.

FIRE PROTECTION

The **FRABOPRESS H2O SECURFRABO** fittings can be used for the construction of fire protection systems defined by the **UNI EN 12845** (April 2007) – Automatic fire-fighting sprinkler systems, **UNI 10779** – Networks of systems – standards. It is recommended to contact the **FRABO** technical support office to verify suitability for specific cases.

SPECIAL APPLICATIONS

SOLAR SYSTEMS

SOLARPRESS is the line of copper fittings with specific green **FKM** O-rings for high operating temperature applications such as, for example, solar power systems or stoves.
The **SOLARPRESS** fittings withstand up to 160 °C for continuous use and 200 °C for short-term peaks and can be used in systems protected with antifreeze in standard percentages. The **SOLARPRESS** range is made up of the diameters 15, 18, 22, 28, 35mm.

For the other measurements (up to 54) **FRABO** provides green O-Rings. However, it is recommended to take utmost care when inserting O-Rings in fitting housings avoiding the use of potentially sharp tools (for example screwdrivers, scissors, etc.), since the high thermal expansions typical of these systems highlight even the smallest incisions.

HIGH TEMPERATURE INDUSTRIAL SYSTEMS (HT) / STEAM CONVEYANCE

The **FRABOPRESS H2O SECURFRABO** fittings are suitable for the construction of high-temperature industrial systems and the conveyance of steam with the use of the green **FKM** O-Ring available in the **FRABO** catalogue. The resistance to high temperatures (160 °C) of this special O-ring and the optimal design of fittings allows safe use in many industrial applications. The maximum pressure for steam conveying installations is 1 bar and a temperature of 120 °C.

COMBUSTIBLE OILS

In industrial applications where the transport of combustible oils is necessary, the use of **FRABOPRESS H2O SECURFRABO** fittings with a red **FKM** O-Ring is recommended. The special mixture used makes this O-Ring resistant to the common combustible oils.
For special applications it is recommended to consult the FRABO technical support office.

N.B.: THE FKM O-RING IS NOT SUITABLE FOR CONTACT WITH POTABLE WATER.

INSTALLATION WARNINGS AND RECOMMENDATIONS

This manual provides a quick overview of the most common installation problems. The topics covered are principally intended to increase the attention of the designer to the most common installation problems that they can meet to guarantee the realization of plants that are safe and reliable over time.
Therefore the installer has to refer to the current and mandatory full texts of the regulations.

LEGIONELLA

Often in systems for sanitary use, stagnant water can promote the proliferation of the legionella bacterium. Legionella is found in springs, including thermal ones, rivers, lakes, vapours, and soils.
From these environments, it is conducted to artificial ones such as city conduits and hydraulic systems of buildings, such as tanks, pipes, fountains, and pools. Legionella is a bacterium for which over 40 species have been identified.

The most dangerous one, which has been attributed to nearly 90% of cases of legionnaire's disease, causes a serious pneumonia. The name derives from the acute epidemic that affected a group of veterans of the American Legion in 1976 who had met up in a Philadelphia hotel, causing 34 deaths out of 221 infected people. The most favourable conditions for proliferation are stagnant waters with temperatures between 25 and 42 °C, acidic and alkaline environments, and the presence of incrustations and sediments.

Installations that produce nebulized water, such as air conditioning systems and hot water circulation networks in hydro-sanitary systems are favourable sites for the diffusion of the bacterium. Critical areas appear in hydro-sanitary systems inside pipes - particularly if they are obsolete and have sediments inside, or even closed sections - storage tanks, boilers, shower heads and distribution terminals; emergency water systems, such as decontamination showers, eye washing stations and fire prevention sprinkler systems can also be places of proliferation. Legionella has also been found in baths and jacuzzis.

Systems that spray nebulized water at high speed: the bacteria can be released into the air from the bubbles that rise or through a fine aerosol. Some cases of legionnaire's disease have been associated with the presence of decorative fountains where water is sprayed into the air or splashes down onto a base. Fountains that work intermittently have a higher risk of contamination Other systems where the risk of legionella is high are open and closed circuit cooling towers where there are air recovery or suction channels nearby. Air conditioning systems must also be considered, like humidifiers/wet pack coolers, nebulizers and spray systems.

Combating the proliferation of legionella first requires careful design and accurate management/maintenance.

With regard to water systems, the avoidance of pipelines with dead ends or without circulation is recommended, as is the avoidance of stagnation, excessive lengths of piping, contact between air and water, and accumulation in non-sealed tanks. Provide regular and easy cleaning.

It has been observed that legionella has more difficulty proliferating in the presence of copper pipes and fittings.

Areas of stagnant water must be avoided, acting on the correct dimensioning and circulation in the system and if possible, seeing to treatment stations as presented below.
Whenever possible, a heat treatment is recommended, in which the water is maintained at a temperature higher than 60 °C, a condition that inactivates legionella, or a thermal shock in which the water temperature is raised to 60-70 °C for at least 30 minutes a day for three days, up to the taps.

The use of copper (unlike common plastic materials) enables maximum safety in the event of a thermal shock to be used for removing legionella within systems. Other treatments are continuous hyperchlorination: chlorine is added to the system in the form of calcium or sodium hypochlorite, until the residual concentration of the disinfectant is between 1 and 3 mg/L or with chlorine dioxide which enables continuous disinfection, with moderate levels of residual chlorine, leaving the water suitable for drinking, removing the biofilm (natural habitat of legionella), a very prolonged action over time and in terms of the distance from the injection point, recommended levels 0.2-0.4 mg/l, does not produce sub-products (such as THM), is produced on site with special generators with suitable production capacity for the system to be disinfected and with the aforementioned concentrations does not attack the pipes.

With UV rays generated by special lamps, the bacteria are killed, or with copper-silver ionisation, or with hydrogen peroxide and silver, it is possible to reduce the presence of legionella. Finally, we mention ozone and terminal filters: thanks to the properties of ozone, all the macromolecular structures of cells (mould, bacteria, yeast, etc.) are profoundly altered and inactivated and with the use of terminal filters applied directly at the sampling point, a mechanical barrier (0.2_m) to the bacteria is formed (they must be replaced quite regularly).

CONDENSATION

The changing of state from a vapour to a liquid is called condensation: when there is a sudden temperature difference between the substance in the form of a vapour (e.g. water in the air) and a colder wall, it is likely that condensation will form.
Condensation on metal conduits may create rust and corrosive currents that become hazardous to system seals and reliability in time. In the case of the passage of water near heat sources, in order to avoid condensation phenomena, it is preferable to insulate the pipes and fittings in the section concerned.

For refrigerated water systems, pipes and fittings with suitable insulating sheaths should be installed on the appropriate walls in order to reduce condensation phenomena.

FREEZING AND ANTI-FREEZE

It is known that freezing water increases in volume. This can cause breakage of tanks and deformations in the sections of the system where the increase in the volume of the water is hindered.

When using press fittings in systems that can be found at temperatures close to zero with the consequent formation of ice, the drainage of the system is recommended, and in the case of a test of the system in the cold, the use of compressed air or inert gas.
The strong stresses that any frost could give to the pipeline could also negatively affect the seal of the fitting, reducing performance and causing undesired leaks. In many cases, the use of antifreeze systems that are designed to ensure circulation within the system even at low temperatures is recommended.
Even in solar panel systems, the use of an antifreeze system is recommended for the proper protection of the system during winter months.

ADDITIVES

In case of the use of anti-corrosion or antifreeze additives, it is recommended to contact the **FRABO** technical support office to verify their suitability. The chemical composition of the additive could damage the sealing gasket over time, compromising durability and reliability.

COMPRESSED AIR FILTRATION

Compressed air often contains a large amount of contaminants that can damage the machinery, and the final product. Contamination essentially derives from three main sources: the environment (from which it is taken), the compressor (materials, lubrication, etc.), the storage tanks.

The use of **FRABOPRESS H2O SECURFRABO** fittings downstream of the compressor (after the filtering and condensate collection stations) is recommended so as to ensure the transport of compressed air in a protected and safe system with oily traces that do not damage the junction elements. It is always recommended to provide filtering stations to minimize the circulation of contaminants.

The water vapour that is contained in the compressed air is the greatest contaminant of the air and acts as a catalyst: in the form of condensation it is combined with substances in suspension and forms abrasive and corrosive sludges. Whenever oily substances are present at high concentrations oil residue **SUPERIOR** to 5 mg/m^3 (Class 5 according to ISO 8573 - 1:2001), the use of the red **FKM** O-ring available in the **FRABO** catalogue is recommended.

MECHANICAL VIBRATIONS

The mechanical stresses and vibrations that affect a system may make it less reliable in the long run. In these cases, the use of mounting brackets that can cushion and compensate for vibrations as much as possible is recommended. When possible, use mechanical breakers to separate the source of vibrations from the rest of the system.

HEAT

If the operating temperature of the fluid is high or the system is located near heat sources (boilers / solar panels / industrial panels with high temperatures, etc.), it is important to ensure protection against heat. Therefore, whenever the temperature of transported fluids exceeds 95 °C, the use of products with specific high-performance O-rings is recommended.

FRABO offers a green **FKM** O-Ring that can withstand temperatures up to 160 °C for continuous use and 200 °C for short-term peaks. Moreover, if the system is located near heat sources, it is important to prepare insulating sheaths to reduce the formation of any condensation.

PROTECTION FROM CORROSION
GALVANIC CONTACT CORROSION

Directly connecting material with different electro-chemical potential in the presence of an electrolyte such as water, causes contact corrosion to the detriment of the electrochemically less noble metal. In hydrothermal sanitary systems this situation can arise, for example, in junctions between copper and zinc-plated steel. Which, when reacting, acts like an anode.
Copper occupies a position on the electrochemical scale that classifies it between the noble materials. In actual fact, it isn't so simple and immediate that in the junction of these two elements galvanic corrosion can be triggered off since the presence of oxygen 02 in the gaseous phase, which is a fundamental requirement, is insignificant in heating systems (fractions of ppm) and, without oxygen, the phenomenon of corrosion is practically inexistent.

Therefore, the position of copper compared to other metals does not actually have any effect on triggering any corrosion phenomena due to galvanic contact. On the contrary, in sanitary systems the oxygen content of water is high (close to saturation) and governed by precise legal provisions. In these systems the principle of installing the **FRABOPRESS** system copper and copper alloy components is valid after any components made of less noble metals (in the water downflow direction).

For example, it is possible to branch off from a network constructed with the Frabopress C-Steel series, made of zinc-plated steel with copper networks; the opposite should be avoided unless a joint is inserted that introduces a resistance such as to cancel out the corrosion speed of the zinc-plated steel in relation to the conductivity of water, such as, for example, a dielectric joint.

In figures 5.1 and 5.2 two derivation examples between networks made of different materials.

Another important factor is the relationship between the surface of the more noble metal with respect to the surface of the less noble metal; a higher ratio could result in a higher speed of corrosion.

E.g.: a small component, such as a brass valve, assembled on a zinc-plated steel pipe, causes almost insignificant corrosion in terms of damage to the pipe. On the contrary, in a system made with copper pipes, components made with less noble metal corrode quickly causing the water to become discoloured.

Therefore try to avoid the use of galvanized steel extensions or fittings as far as possible and use copper or bronze fittings instead; the direct contact of copper and its alloys with stainless steel (FRABOPRESS 316 series) does not lead to galvanic contact corrosion issues: although the two materials have different potentials they are very close on the electrochemical scale.

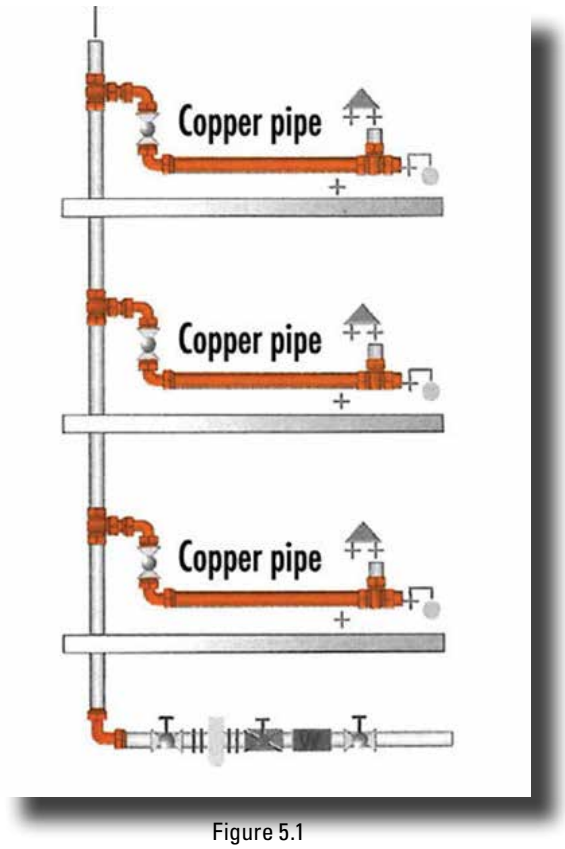


Figure 5.1

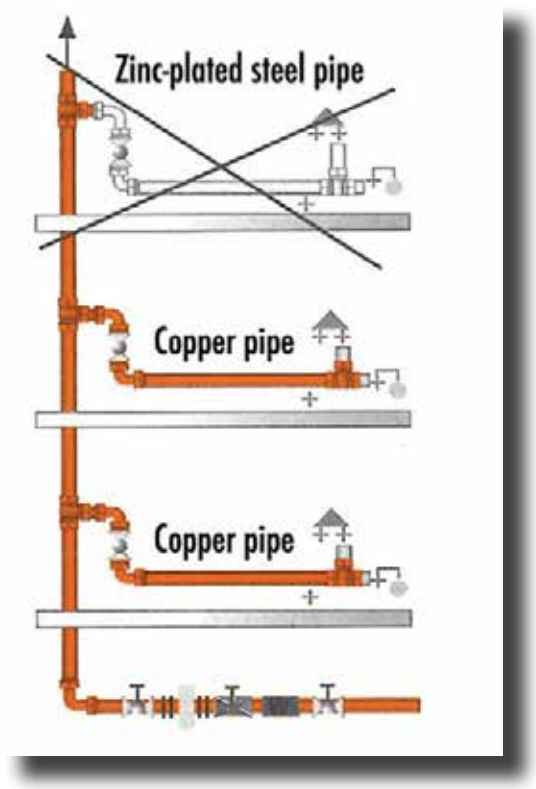


Figure 5.2

INTERNAL CORROSION

The components in the **FRABOPRESS H2O SECURFRABO** system are made of phosphorus deoxidised copper resistant to drinking waters with the characteristics that fall within the physical-chemical limits established by legislation in force.

In water containing oxygen, the action of copper fitting and pipe corrosion mainly depends on internal surface quality.

Due to the anti-corrosion treatment **FRABOPRESS H2O SECURFRABO** press fittings guarantee effective protection against deep corrosion. With the **FRABOPRESS H2O SECURFRABO** fittings that use the press technique it can also be assured that in drinking water installations risks of deep corrosion caused by the welding stage are avoided. In fact, the action of temperatures over 400 °C, which are inevitable in strong brazing, can lead to a clear increase in the risk of corrosion, in the presence of unfavourable conditions.

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With the installation of press fittings, any negative effect due to heat is avoided. In cases of water treatment systems, **FRABOPRESS H2O SECURFRABO** fittings are compatible with all the domestic-use treatment processes (softeners) and are also resistant to corrosion in the presence of decarbonated, demineralized, or distilled water.

Furthermore, to protect the system from corrosion, the salt content must be limited according to the standards and regulations on drinking water:

- Sulphate ions < 240 mg/l
- Nitrate ions < 50 mg/l
- Sodium ions < 150 mg/l

STRAY CURRENTS AND GROUNDING

In reality, corrosion due to stray current phenomena is very rare and immediately recognizable. In these cases the corrosion begins outside the pipeline and creates a conical crater with the top (hole) toward the inside. In order for corrosion from stray currents to occur, a continuous current that acts on the metal, imposing an anodic and therefore sacrificial behaviour, must be present.

The so-called stray currents are, in reality, currents that, through an insulation defect, disperse into the ground and penetrate into other metallic structures that they meet (in this case for example, a sanitary system), use a section as a conductor and therefore exit into the ground again.

In order to penetrate inside a distribution network, the dispersed currents must find a point where the normal protective coating of the pipes and tubing is damaged or missing.

First, metallic systems must be grounded (see CEI regulations) and, consequently, any current must be discharged through the appropriate dispersers and, since corrosion by stray currents occurs through the exit point of the system current, it is here that the disperser itself will eventually suffer.

In general, also, equipment is not used under continuous current in homes and, on the other hand, alternating current does not produce an appreciable effect. The electrical resistance offered by common cement mortars, where pipes are normally housed, is high, in addition to the electrical resistance offered by insulation sheaths...

THERMAL EXPANSIONS

As for all the types of pipes constituting a distribution network, even with the **FRABOPRESS H2O SECURFRABO** system the elongations or contractions due to thermal expansions as a result of the increase or decrease of temperature of the conveyed fluid must be evaluated.

To compensate for these effects, the necessary space for the expansions, the proper placement of fixed sliding support points, and the realization of any line compensators must therefore be provided for.

First of all, it is necessary to determine the extension of a given part of pipe [ΔL] based on a certain thermal jump [ΔT]. The equation used to calculate this variable is: $\Delta L = L \bullet \alpha \bullet \Delta T$

with ΔL: global extension [m]
L: length of the stretch considered [m]
α: linear expansion coefficient of copper (0.0000168 K^{-1} between 25°and 100°C)
ΔT: thermal change [°C] or the difference between the maximum and minimum operating tempera tures

For example: in a rectilinear copper tubing, which is 40 m long and installed at a room temperature of 5 °C and which can reach an operating temperature of 85 °C, the elongation is:

$\Delta L = 40 \bullet 0.0000168 \bullet (85 - 5) = 0.0538$ m which corresponds to 54 mm

If the conduit is found between two fixed pieces of equipment (e.g. a pump and a heat exchange group) and has a limited diameter (e.g. 18 x 1.0), only bending of the pipe would most likely be found as a result of expansion, with harmful consequences for any intermediate bodies (valves or others).

If the pipe has a larger diameter (e.g. 54 x 1.5) and therefore less elasticity, elevated axial effects could occur. The result of the expansion, in fact, is a strain that is expressed by the following formula: $\delta = \varepsilon \bullet E$

with ε: $\Delta L / L = \alpha \bullet \Delta T$
$E = 132.000$ N/mm² for raw copper

Therefore:

$\delta = 0.0000168 \bullet (85 - 5) \bullet 132.000 = 177.41$ N / mm²

Note that this value is not negligible since it is more than 60% of the minimum unit ultimate tensile strength (290 N/mm²).

Finally it is possible to determine the stress exerted by the pipe on the equipment placed at the ends using the following formula: $F = \delta \bullet S$

where S is the section of the pipe calculated with the relationship:

$S = \pi \bullet (D^2 - d^2) / 4 = \pi \bullet (54^2 - 51^2) / 4 = 247.40$ mm²

Consequently we have:

$F = 177.41 \bullet 247.40 = 43.891$ N a significant value.

The above shows that thermal expansions cause deformations and stresses to the pipelines and strains at the ends.

Thus, in the case in which the section considered is not straight, the deformations of the conduit, depending on the geometry of the course, can dangerously stress typical points such as bends, derivations, extremities, etc.

It should be noted that the same stresses calculated for positive ΔT can also be calculated for negative ΔT (e.g. cold water conduits set up for 10 - 15 °C but subject to weather conditions such as cold and frost). In this case the calculated formulas change sign and compressive stresses turn into tensile stresses with a possible danger of disengagement of the pipe from the pressed connection.

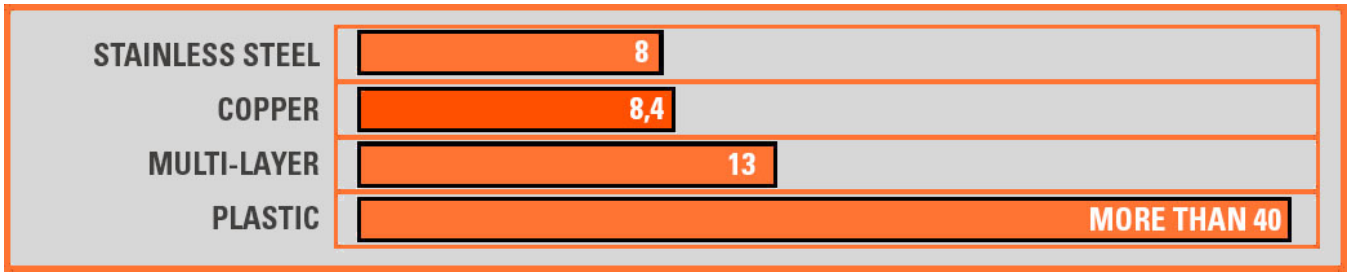

Table 6.1 – Expansion in mm for a 10 metre pipe upon material variation with ΔT 50°

As can be seen in the graph, **FRABOPRESS H2O SECURFRABO** fitting quality combined with reduced copper pipe heat expansions provide for safe and stable system, even with temperature changes.

L [mm]	Δt [°K]									
	10	20	30	40	50	60	70	80	90	100
1	0,17	0,34	0,50	0,67	0,84	1,01	1,18	1,34	1,51	1,68
2	0,34	0,67	1,01	1,34	1,68	2,02	2,35	2,69	3,02	3,36
3	0,50	1,01	1,51	2,02	2,52	3,02	3,53	4,03	4,54	5,04
4	0,67	1,34	2,02	2,69	3,36	4,03	4,70	5,38	6,05	6,72
5	0,84	1,68	2,52	3,36	4,20	5,04	5,88	6,72	7,56	8,40
6	1,01	2,02	3,02	4,03	5,04	6,05	7,06	8,06	9,07	10,08
7	1,18	2,35	3,53	4,70	5,88	7,06	8,23	9,41	10,58	11,76
8	1,34	2,69	4,03	5,38	6,72	8,06	9,41	10,75	12,10	13,44
9	1,51	3,02	4,54	6,05	7,56	9,07	10,58	12,10	13,61	15,12
10	1,68	3,36	5,04	6,72	8,40	10,08	11,76	13,44	15,12	16,80
11	1,85	3,70	5,54	7,39	9,24	11,09	12,94	14,78	16,63	18,48
12	2,02	4,03	6,05	8,06	10,08	12,10	14,11	16,13	18,14	20,06
13	2,18	4,37	6,55	8,74	10,92	13,10	15,29	17,47	19,66	21,84
14	2,35	4,70	7,06	9,41	11,76	14,11	16,46	18,82	21,17	23,52
15	2,52	5,04	7,56	10,08	12,60	15,12	17,64	20,16	22,68	25,20
16	2,69	5,38	8,06	10,75	13,44	16,13	18,82	21,50	24,19	26,88
17	2,86	5,71	8,57	11,42	14,28	17,14	19,99	22,85	25,70	28,56
18	3,02	6,05	9,07	12,10	15,12	18,14	21,17	24,19	27,22	30,24
19	3,19	6,38	9,58	12,77	15,96	19,15	22,34	25,54	28,73	31,92
20	3,36	6,72	10,08	13,44	16,80	20,16	23,52	26,88	30,24	33,60
21	3,53	7,06	10,58	14,11	17,64	21,17	24,70	28,22	31,75	35,20
22	3,70	7,39	11,09	14,78	18,48	22,18	25,87	29,57	33,26	36,96
23	3,86	7,73	11,59	15,46	19,32	23,18	27,05	30,91	34,78	38,64
24	4,03	8,06	12,10	16,13	20,16	24,19	28,22	32,26	36,29	40,32
25	4,20	8,40	12,60	16,80	21,00	25,20	29,40	33,60	37,80	42,00
26	4,37	8,74	13,10	17,47	21,84	26,21	30,58	34,94	39,31	43,68
27	4,54	9,07	13,61	18,14	22,68	27,22	31,75	36,29	40,82	45,36
28	4,70	9,41	14,11	18,82	23,52	28,22	32,94	37,63	42,34	47,04
29	4,87	9,74	14,62	19,49	24,36	29,23	34,10	38,98	43,85	48,72
30	5,04	10,08	15,12	20,16	25,20	30,24	35,28	40,92	45,36	50,40

Table 6.2 – Overall elongations ΔL – [mm] for COPPER (linear expansion coefficient equal to 16,8 10-6)

CALCULATION OF AN EXPANSION ARM

Elongation as an effect of thermal expansion cannot always be compensated for by counting on the normal configuration of the distribution network, where the various path changes can actually act as compensators.

It is sometimes necessary to prepare and calculate expansion arms in a precise way or, in more challenging cases, [Ω] expanders constructed using appropriately shaped pipe or normal fittings.

The expression that permits the determination of the expansion arm of Fig. 6.1 in mm is as follows:

$$Bd = k * \sqrt{(de - \Delta L)}$$

where: k: material constant
de = external diameter of the pipe used
ΔL = extension to be compensated

The extrapolation of the result offered by the aforementioned formula can also be made through the use of charts that relate the pipe diameter, elongation to compensate for, and the value of the expansion arm length [Bd].

The easiest solution is to refer to the expansion arm length values listed in table 6.4.

Here too, the listed length value is a function of the different expansion values to be compensated by the external diameter of the pipe used. In table 6.4, the expansion arm length values of a square omega compensator are represented in fig. 6.2.

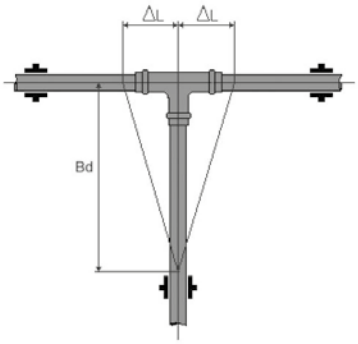

Figure 6.1

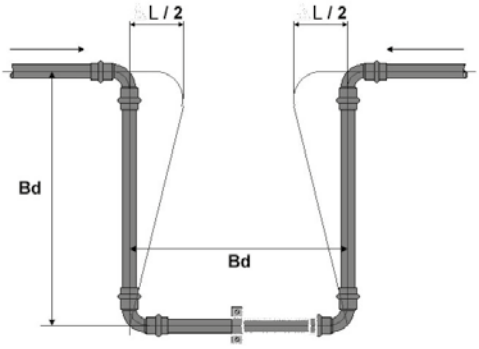

Figure 6.2

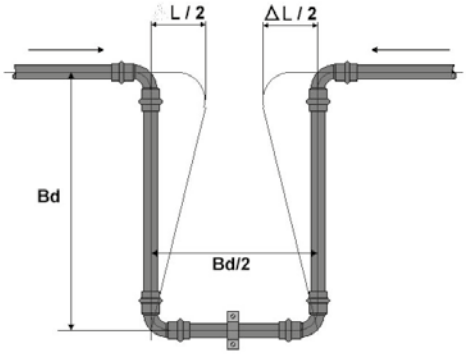

Figure 6.3

EXPANSION ARM LENGTH BD [MM]										
External Copper Pipe Diameter [mm]	Extension to be compensated ΔL [mm]									
	2	4	6	8	10	12	14	16	18	20
12	637	901	1103	1274	1424	1560	1685	1801	1911	2014
15	712	1007	1233	1424	1592	1744	1884	2014	2136	2252
18	780	1103	1351	1560	1744	1911	2064	2206	2340	2467
22	862	1220	1494	1725	1928	2112	2281	2439	2587	2727
28	973	1376	1685	1946	2175	2383	2574	2752	2918	3076
35	1088	1538	1884	2175	2432	2664	2878	3076	3263	3439
42	1191	1685	2064	2383	2664	2918	3152	3370	3574	3768
54	1351	1911	2340	2702	3021	3309	3574	3821	4053	4272

Table 6.4 – Square omega

In table 6.5, the expansion arm values of a rectangular omega compensator are represented in fig. 6.3.

EXPANSION ARM LENGTH BD [MM]										
External Copper Pipe Diameter [mm]	Extension to be compensated ΔL [mm]									
	2	4	6	8	10	12	14	16	18	20
12	735	1039	1273	1470	1643	1800	1944	2078	2205	2324
15	822	1162	1423	1643	1837	2012	2174	2324	2465	2598
18	900	1273	1559	1800	2012	2205	2381	2546	2700	2846
22	995	1407	1723	1990	2225	2437	2632	2814	2985	3146
28	1122	1587	1944	2245	2510	2750	2970	3175	3367	3550
35	1255	1775	2174	2510	2806	3074	3320	3550	3765	3969
42	1375	1944	2381	2750	3074	3367	3637	3888	4124	4347
54	1559	2205	2700	3118	3486	3818	4124	4409	4677	4930

Table 6.5 – Rectangular omega

The expansion compensators mentioned are generally realizable on-site on the basis of the expansion to compensate for, but they are often bulky and sometimes undesirable for aesthetic reasons. Alternatively, there are axial bellows compensators.

To size the bellows compensator, reference should be made to the following data:

- diameter of the pipe
- maximum operating pressure
- system test pressure
- operating pressures (minimum and maximum)
- expansion to absorb
- life desired for the compensator (number of cycles)

For these details, great emphasis should be placed on the installation of the pipe guides and clamps near the expansion joint so that the piece can be freely compensated.
The normal bellows expansion joint in commercial use can be connected to **FRABOPRESS H2O SECURFRABO** fittings through the use of standard threaded connections.
The case-by-case consultation of the publications and manufacturer's technical specifications for these devices is therefore advisable.

ARRANGEMENT OF COLLARS

1. Never place collars that constitute a fixed point near a fitting. (fig. 7.4)
2. It is also important to note that the sliding supports are not positioned to ensure that they behave as if they were fixed points. (fig. 7.5)
3. When there are sections of straight pipe without expansion compensators, only one fixed point can be installed in order to prevent possible deformations. All of the remaining points must be sliding points. It is a good practice to position this point in the intermediate position with respect to the length of the straight section (fig. 7.6) as much as possible; by doing this, the elongation due to expansion in the two directions is shared, thus halving the length of the necessary expansion arm.

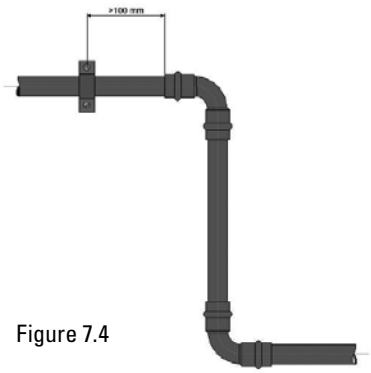

Figure 7.4

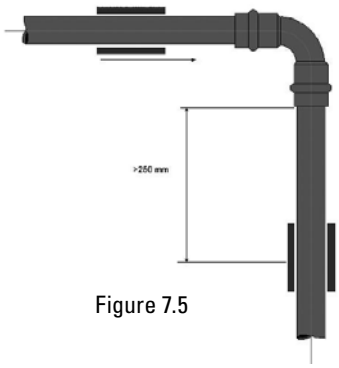

Figure 7.5

Figure 7.6

As a general rule, use copper collars or, if steel, use those with rubber seals; this type of support allows the isolation and dampening of any rustling and vibrations and better behaviour of the combination of stresses.

PRESSURE DROPS

All of the fluids distributed through a network of pipes are hampered in their flow by continuous and localized resistances that are normally defined as pressure drops. First of all we distinguish between continuous and localized drops.

CONTINUOUS PRESSURE DROPS

The calculation of the total resistance of a straight pipe can be simply obtained by knowing the unit resistance value of the pipe and then multiplying it by the total length of the pipeline.

The calculation is normally performed using the appropriate diagrams. With these instruments, the unit pressure drop values [R] and the speed value in [m/s] for a given water flow rate can be determined.

Once the value of R and the length of the network in effective metres or equivalent metres have been determined, the value of the total pressure drop of the section can be obtained.

The unit resistance values [R] change with variations in the temperature and velocity of the fluid conveyed; it is therefore necessary to use the appropriate diagram. Similarly, any additives added to the water, such as common antifreeze, influence the unit resistance value and therefore require appropriate corrections.

LOCAL PRESSURE DROPS

The mathematical formula that allows the calculation of the local pressure drop is as follows:

$\Delta P_{\zeta} = \Sigma\xi \bullet v^2 \bullet \gamma/2g$

where: v: fluid flow velocity [m/s]
g: acceleration due to gravity [m^2]
γ: specific fluid weight [kg/m^3]
ξ: localized resistance coefficient

For convenience, the method of equivalent metres can be used, i.e. considering the value of the fictitious length of a straight pipeline of the same diameter that produces the same pressure drop value. All of the equivalent length values determined for each type of fitting from Table 8.1 should be added to the real length of the network.

EQUIVALENT LENGHT IN METERS							
External Pipe Diameter	Water Temperature [°C]	T joint			Curve	Reduction	
						D1/D2=2	D1/D2=3
							
12	10	0,03	0,43	0,36	0,16	0,09	0,08
	40	0,04	0,53	0,47	0,19	0,11	0,10
	70	0,04	0,57	0,51	0,21	0,12	0,11
15	10	0,04	0,57	0,51	0,22	0,10	0,11
	40	0,05	0,65	0,59	0,24	0,12	0,13
	70	0,05	0,74	0,65	0,27	0,13	0,14
18	10	0,05	0,73	0,63	0,25	0,16	0,15
	40	0,06	0,88	0,75	0,31	0,19	0,18
	70	0,07	0,93	0,82	0,34	0,19	0,18
22	10	0,07	0,97	0,82	0,34	0,20	0,19
	40	0,08	1,10	0,96	0,40	0,24	0,22
	70	0,09	1,20	1,10	0,45	0,25	0,23
28	10	0,10	1,30	1,00	0,47	0,28	0,27
	40	0,12	1,60	1,30	0,56	0,33	0,30
	70	0,12	1,70	1,50	0,61	0,34	0,31
35	10	0,13	1,80	1,50	0,60	0,38	0,35
	40	0,15	2,00	1,70	0,71	0,45	0,42
	70	0,16	2,30	2,00	0,80	0,48	0,44
42	10	0,16	2,20	1,90	0,74	0,54	0,45
	40	0,18	2,50	2,20	0,87	0,57	0,51
	70	0,20	2,90	2,50	0,97	0,75	0,54
54	10	0,22	3,10	2,70	1,00	0,75	0,63
	40	0,24	3,60	3,20	1,20	0,87	0,72
	70	0,26	4,00	3,40	1,30	0,87	0,71

Table 8.1

Inside diameter of copper pipes		8-16 mm	18-28 mm	35-54 mm	>54 mm
Type of localized resistance	Symbol				
Straight shut-off valve		10	8	7	6
Inclined shut-off valve		5	4	3	3
Reduced passage closure		1,2	1	0,8	0,6
Total passage closure		0,2	0,2	0,1	0,1
Reduced passage ball valve		1,6	1	0,8	0,6
Total passage ball valve		0,2	0,2	0,1	0,1
Butterfly valve		3,5	2	1,5	1
Check valve		3	2	1	1
Straight valve for heating body		8,5	7	6	-
Square valve for heating body		4	4	3	-
Straight retainer		1,5	1,5	1	-
Square retainer		10		1	
Four-way valve		10		4	
Three-way valve		10			
Passage through a radiator		3			
Passage through a hot-water heater		3			
Collector		2			
Section enlargement		1			

Table 8.2 localized drop coefficient values Δ (system components)

The total fictitious length determined in this way will be multiplied by the value of the unit pressure drop, thus obtaining the circuit's total resistance.

This operation allows the calculations to be dramatically sped up at the expense of the accuracy of the pressure drop value, which is forced to be approximate.

TESTING

Civil construction technologies are increasingly oriented toward the adoption of in-wall pipes and fittings so that the system and its components are not visible in any way.

The **FRABOPRESS H2O SECURFRABO** fittings can be placed in the wall without any problem with regard to water distribution or heating installations. A preventive test of the system must be carried out before it is integrated into the construction structure.

The test, almost established by the totality of the good practice rules, has two specific objectives:

- to verify that there are no leaks in correspondence with the junctions;
- to ensure that the heat expansions do not cause difficulties.

In relation to this, it is important to define the procedures for verifying the different installation types.

TESTING AND START UP OF HEATING SYSTEMS

The heating systems are typically realized through the installation of in-wall pipes. Before the completion of masonry work, some preliminary tests must be done to verify each junction's seal.
These are described below in detail:

- leakage test immediately after hook-up and subjection to pressure of 10 N/cm² greater than the normal operating pressure; the seal will be verified after the solicitation of the junctions, and a period of time not less than 15 minutes.
- flushing
- circulation test
- expansion test with circulation of water at 95 °C
- second leakage test like the previous one

TESTING AND OPERATION OF SANITARY SYSTEMS

The consideration of the in-wall installation of pipelines as common practice is now also valid for sanitary systems.

However, in this case, special care must be taken since as well as the seal tests on the system, for an installation performed in a workmanlike manner, the following operations must be envisaged:

- pre-washing the pipes, i.e. removing foreign bodies before the taps are installed;
- extensive washing with the taps installed;
- disinfection using gaseous chlorine or a sodium hypochlorite solution;
- final rinsing with drinking water.

As well as these operations which clearly aim to create the best hygiene conditions inside the pipes, the seal tests must be performed on the system, which can be summarised as follows:

1. cold hydraulic test to be performed on the whole distribution of hot and cold water before assembling the taps and before the masonry work, keeping the pipes at a pressure of 1.5 times higher than the operating pressure with a minimum of 6 bar, for no less than 4 hours;
2. hot hydraulic test, to be performed exclusively on distributions of hot water with centralised production, at the operating pressure, for no less than two consecutive hours, at an initial temperature of at least 10°C higher than the maximum operating temperature that can be reached;
3. circulation and insulation tests on the hot water distribution network with no supply, if possible to be performed at the coldest time of year; The test is considered positive when a temperature difference of less than or equal to 2 °C is measured between the start of the hot water production system and the furthest branch;
4. cold water supply test, for 30 consecutive minutes, making all the supply openings envisaged work at the same time;

5. hot water supply test for more than 60 minutes, making all the openings except one work;
6. checking the hot water supply flow rate; the test must be performed with all the supply openings working at the same time.

GUARANTEES

The **FRABO** production line is known for the high level of quality reached through years of experience in thermohydraulic systems.

The **ISO 9001** certification and the numerous quality marks associated with its products are a direct testimony. With relation to its products **FRABO S.p.A.** declares that, in terms of third party liability insurance, it has taken out an insurance policy to cover any hidden product faults for a duration of 10 years.

The proper and professional use of the product according to **FRABO**'s specifications as well as respect for applicable technical regulations are essential conditions for the validity of the guarantee. The guarantee is not valid for those installations that are performed in an incorrect or non-professional way.

This manual provides a quick overview of the most common plant design problems. Therefore the installer has to refer to the full texts of the current and mandatory regulations.

FRABO declares that it has a corporate liability insurance policy through a major insurance company, including responsibility for the extended product.

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