



# PRESSURE KRYOCLIM®

For conveying chilled fluids and air conditioning



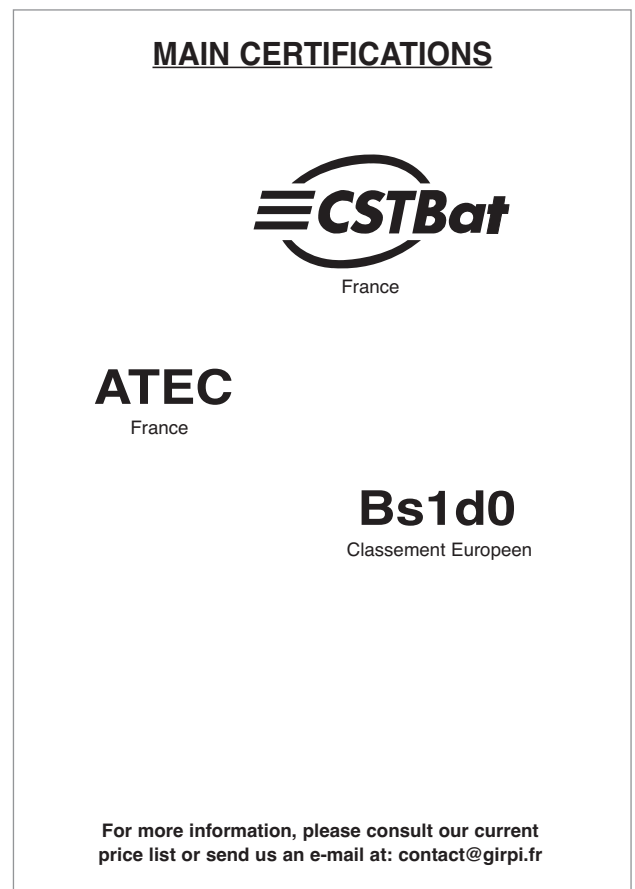
## TECHNICAL DOCUMENTATION

June 2017



*safety for your pipework*

an *OAliaxis* company



**The KRYOCLIM® system is made from H.P.F®, which is totally recyclable** 

\* For more information, visit: [www.vinyl2010.org](http://www.vinyl2010.org)

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**GENERAL RECOMMENDATIONS****1.0**

2017

**■ GENERAL RECOMMENDATIONS**

GIRPI technical documentation can be found on our website, [www.girpi.fr](http://www.girpi.fr).  
It is freely available for consultation and download.

We recommend that you check if any updates are available.

For any questions or clarifications concerning this technical documentation, particularly:

- chemical compatibility between KRYOCLIM® and specific additives or fluids,
- calculations and measures related to compensation for expansion and contraction phenomena affecting KRYOCLIM® systems,
- special parts and/or assemblies,
- KRYOCLIM® installation training,

you can contact GIRPI technical assistance at +33 (0)2 32 79 58 00 or [be.girpi@alixis.com](mailto:be.girpi@alixis.com)

This technical documentation makes references to texts (building code, orders, standards...) which are those in force on the date of publication.

**■ TRANSLATION**

This English translation of our KRYOCLIM® technical documentation has been made in good faith, but the original French version shall prevail under all circumstances.







# HOW TO SELECT THE SYSTEM BEST ADAPTED TO YOUR NEEDS?

**GIRPI**, specialist of pipeworks made from synthetic materials, has developed complete systems to meet today's requirements in the building industry.

In addition to **KRYOCLIM®**, described in this documentation, **GIRPI** offers systems adapted to each application.

## HOW TO SELECT THE SYSTEM BEST ADAPTED TO YOUR NEEDS?

APPLICATIONS	GIRPI SYSTEMS
Comfort cooling/air conditioning, industrial cooling air conditioning in the food industry	<b>KRYOCLIM®</b>
Domestic hot and cold water services	<b>SYSTEM'O® (HTA® + HTA®-F)</b>
Low temperature heating	<b>HTA®</b>
Gravity drainage up to 100°C	<b>HTA®-E</b>
Cold water, swimming pool, irrigation, water treatment	<b>PVC-U K62</b>
Compressed air distribution	<b>GIRAIR®</b>
Acoustic drainage	<b>FRIAPHON®</b>

	SYSTEM'O®		KRYOCLIM®	GIRAIR®	PVC-U K62 pressure fittings
<b>PN: Nominal Pressure rating (at 20 °C)</b>	<b>HTA®</b> PN 25 (ø16 to 63) PN 16 (ø25 to 160)	<b>HTA®-F</b> PN 16 (ø16 to 160)	PN 10 (ø20 to 160) PN 6 (ø200)	PN 12.5 (ø16 to 110)	PN 25 (ø12 to 20) PN 16 (ø25 to 20) PN 10 (ø250 to 315)
<b>Fire classification</b>	Bs1d0		Bs1d0	Bs1d0	NPD
<b>Priming with:</b>					
<b>Welding polymer</b>	RERFIX		HPFIX	GAFIX	RERFAST
<b>Main French certifications*</b>	CSTB technical advice LNE fire certificate		CSTB technical advice LNE fire certificate	LNE Fire certificate	Approval NFP
<b>Drinking water certified*</b>	ACS		not applicable	not applicable	ACS
<b>Non permeable to oxygen</b>	yes		yes	yes	yes
<b>Working temperatures (°C)</b>	<b>HTA®</b> [+5°C ; +90°C] 100°C without pressure	<b>HTA®-F</b> +20°C up to 70°C	[- 30°C ; + 40°C]	[ 0°C ; + 40°C]	+20°C

It is important to verify the chemical compatibility before using specific additives or specific fluids such as anti-freeze, etc...  
(see our technical documentation or ask GIRPI for tests)

\* Please consult us for certifications outside France.

\*\* No Performance Determined

**GENERAL CHARACTERISTICS  
APPLICATIONS**

**GIRPI**, a specialist in technical systems composed of synthetic materials, is part of the international group Aliaxis.

Thanks to its long experience in the fields of air conditioning and refrigeration, **GIRPI** developed the **KRYOCLIM®**, system, which answers the needs of the following applications:

- **Residential/tertiary centralized air conditioning:**

- cold only
- cold circuit of reversible systems (2-pipe, 2-line):
  - cooler unit, underfloor cooling connection
  - chilled beam, fan coil distribution
  - air heater
  - cooling ceiling
  - air handling unit

- **Industrial applications:**

- cooling (processes)
- air conditioning in production workshops, storage warehouses

- **Food industry:**

- refrigeration: refrigerated warehouses, centralized kitchens, medium and large supermarkets...
- food industry processes

**Composed of H.P.F.®**, a material with excellent physicochemical properties at very low temperatures, the **KRYOCLIM®** system offers many advantages for secondary refrigeration and indirect air conditioning applications.

**Thanks to its wide range** of pipes (between  $\varnothing 20$  and  $\varnothing 200$ ), fittings and accessories adapted to existing networks, the **KRYOCLIM®** system enables the installation of any kind of refrigeration or indirect air conditioning networks from  $-30^{\circ}\text{C}$  to  $+40^{\circ}\text{C}$  (chilled water, glycol solutions, brine, etc.).



**Please note:**

**The KRYOCLIM® system must not be used to transport refrigerant fluids** (HFC, HCFC, CFC).

**KRYOCLIM®** is compatible with most coolants on the market (brine, glycol water).

The **KRYOCLIM®** system offers numerous advantages which allow it to meet the requirements of air conditioning networks:

- compliance with regulatory requirements,
- no corrosion,
- low heat loss,
- can be installed on new or renovated premises,
- simple installation on occupied sites,
- minimal maintenance,
- easy extension of the system.



# GENERAL CHARACTERISTICS BENEFITS

## ■ A COMPLETE SYSTEM FOR CHILLED WATER SERVICES:

Pipes, fittings and accessories from ø20 to ø200.

## ■ NO CORROSION:

Being non corrodable by nature, KRYOCLIM® does not require film forming protective treatments inside, and corrosion protective paint outside. Your corrosion-free pipeworks thus remain durable and watertight.

## ■ FIRE CLASSIFICATION:

The KRYOCLIM® is Bs1d0 (Euroclasses classification), an excellent fire reaction for a synthetic material. KRYOCLIM® meets the requirements of CH25 and CH35 (french regulation).

## ■ INSTALLATION TIME UNDER CONTROL

The KRYOCLIM® solution facilitates installation even on occupied sites. Lightweight pipes, easy to handle (6 times lighter than steel), a simple set of tools, no fire permit required, no noisy operations, no dust on site, no pollution of other pipeworks, no need for electricity supply.

## ■ SAFE JOINTS

Easy visual seal quality check, specific application tools, high performance joints.

## ■ REDUCED MAINTENANCE

## ■ EASILY IDENTIFIABLE PIPEWORKS

## ■ EASY TO EXTEND

No risk to deteriorate neighbouring networks (e.g. electric or IT cables).

## ■ HIGH IMPACT RESISTANCE

Even at very low temperatures.

## ■ LIMITED CONDENSATION

Thanks to its higher pipe surface temperature as compared to metals, KRYOCLIM® limits temperature drops below dew point, an ideal asset for air conditioning applications (chilled beams).

## ■ ENERGY SAVINGS

With its low thermal conductivity ( $\lambda$  coefficient = 0.17 W/mK), KRYOCLIM® reduces heat losses up to 30% as compared to non insulated steel.

## ■ REDUCED PRESSURE LOSSES AND FRICTIONAL LOSSES

## ■ NO PERMEABLE

The KRYOCLIM® is non permeable to oxygen, which prevents the formation of sludge deposits.

## ■ DEDICATED BRACKETING

GIRPI offers a wide range of MONOKLIP® pipe brackets and thermal insulation rings, fully appropriate for supporting KRYOCLIM®.

## ■ RECYCLING FRIENDLY

The KRYOCLIM® is made from HPF®, a completely recyclable material.



Choose safety  
French and European  
**CERTIFICATIONS**

• ATEC N° 14/14-1997  
from ø20 to ø160

• Non-flammable: Bs1d0

• A system that meets the demands of  
the High Environmental Quality scheme  
(HQE)



GENERAL PROPERTIES  
CHARACTERISTICS

The physical and mechanical properties below are measured on standard test samples before aging. As for all synthetic materials, these characteristics are likely to drop as the materials age, depending also on the conditions of use of the system.

## 1. PHYSICAL CHARACTERISTICS

Characteristics	Standards	Units	Values
Physical aspect	EN 1452 - 2/3	—	—
Fire classification	EN 13501-1	—	Bs1d0
Density (volumic mass)	ISO 1183 meth A	kg/m <sup>3</sup>	≈ 1350
Linear expansion coefficient	ASTM D 696-70	mm/m °C	0,07
Transversal resistivity (under 1000 V)	ASTM D 257/76	Ohm.cm	10 <sup>15</sup>
Thermal conductivity λ	ASTM C 177-76	W/m°C	0,17
Shrinkage at 150°C (pipes)	EN 743	%	≤ 5

## 2. MECHANICAL CHARACTERISTICS

Characteristics	Standards	Units	Values
Bending under load temperature	NF T 51-005/meth.A - ISO 877	°C	≈ 55
VICAT softening temperature (5 daN load)	NF T 51-021/meth.B - ISO R 306 NF T 54-034 - ISO 2056/2507	°C	≥ 76
Resistance to static pressure • at 20°C time ≥ 1 h	NF EN 921	— bar	4.2 x PN
Resistance to alternating pressure (on fittings) Pressure min 20 bar/max. 50 bar • Diameter 20 to 90 = frequency 1 Hz • Diameter > 90 = frequency 0.42 Hz	NF EN 921 NF T 54-094	Cycles Cycles	≥ 2000 ≥ 1500
Impact resistance at - 20° (pipe)	NF EN 744	J	> 100
Pipe elongation at break • Rr • A %	NF EN ISO 6259-1	MPa %	> 32 120


1 MPa = 10 bar

## 3. PHYSICAL CHARACTERISTICS OF BRASS AND STAINLESS STEEL

ITEMS CONTAINING BRASS	Grades
Items with inserts (FEAL, FMML, FMIL, FTGRL, FTFRL)	CW614N
Nuts (F3F/L, F3G/L)	CW614N or CW617N

The user must check whether the nature of the brass or stainless steel composing our fittings complies with applicable regulations in the country of use, and is compatible with the operating temperature, the specifications of the fluid carried, and any additives.



	KRYOCLIM® SYSTEM	Technical Sheet <b>1.5</b>
	GENERAL PROPERTIES CHARACTERISTICS	

## ■ CHEMICAL RESISTANCE

Any fluids or liquids containing chemical agents, in suspension or solution, other (or in different quantities) than those permitted by the standards and regulations concerning drinking water are considered chemicals. Their compatibility with GIRPI's KRYOCLIM® system should therefore be verified. See the table indicating the behaviour of HPF® in contact with chemical agents in data sheets 9.1 to 9.3. If in doubt, it is recommended that you consult both the product's supplier and GIRPI technical assistance.

## ■ PRODUCT QUALITY

To ensure that its products have a consistent level of quality and to provide its users with assurance that the stated performance levels are attained, GIRPI implements the monitoring regulations imposed by French and international standards.

As part of its quality assurance framework, KRYOCLIM® is monitored by various certifying bodies by regular sampling. This monitoring concerns the physical and mechanical characteristics of the pipes and fittings. However, in addition to these checks, to ensure maximum reliability in real-world usage conditions, GIRPI conducts additional testing under standard NF T 54-094. An alternating pressure test (on the fittings) is regularly conducted, which simulates the stresses placed on the product in a network (pressure surges, variations in speed, etc.). As part of the quality procedure, the fittings are tested to withstand pressure surge cycles (20/50 bar) at a frequency of 1 Hertz (3 600 cycles per hour) for diameters between 20 and 90 and at a frequency of 0.42 Hertz (1 500 cycles per hour) for diameters between 110 and 160.

All of the industrial and logistics processes are certified compliant with the ISO 9001 standard, providing assurance to users of GIRPI's systems regarding the products' technical performance and the quality of the company's services (delivery, technical assistance).

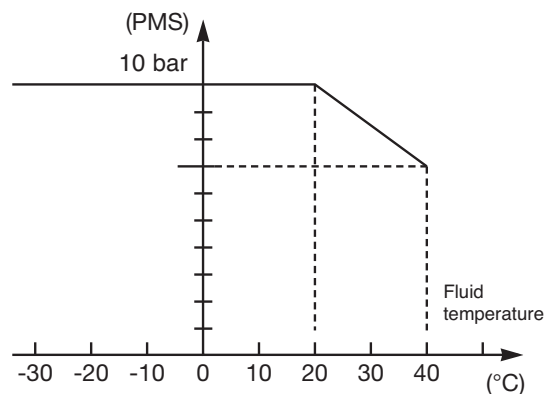
## ■ PRESSURE - TEMPERATURE CURVE

### OPERATING PRESSURE AND TEMPERATURE

ø20 to ø160: 10 bar from -30°C to +20°C  
 ø200 : 6 bar from -30°C to +20°C

During certain cooling operations for plastics processing or during the defrost cycles of certain fan coils, the temperature of the return circuit may be greater than 20°C. As indicated in the diagram, KRYOCLIM® accepts such configurations, between ø20 and ø160mm, as long as the maximum temperature is no greater than 40°C and the operating pressure is no greater than 7 bar.

For ø200, the maximum operating pressure is limited to 4 bar in the same temperature conditions.



## ■ GUARANTEES

• GIRPI guarantees its products for 10 years from the date of delivery to the first buyer, except for parts subject to regular wear. This guarantee only applies when the products are selected, stored, installed and used in strict compliance with the technical documentation, the technical notice and standard practice, and only covers the replacement of defective parts, excluding any other damage.

Uses other than those mentioned in the technical documentation shall not be eligible for the guarantee, particularly with regard to:

- the nature and types of facilities for which the products are intended,
- the modes of attachment,
- the insulation,
- the installation and start-up procedures (flushing, etc.),
- the composition of the fluids to be transported and the temperature-pressure ratios to be respected during operation.

GIRPI is not responsible for a system's hydraulic design, including its sizing.



### ■ HANDLING AND STORAGE

The pipes and fittings will be stored separately on an even area, away from dust and sun. In all cases, take special care to avoid rough handling, impacts and especially with indenting, cutting or heavy objects, particularly in cold weather. Transport and store the pipes with their protection cover. Remove the cover and protection caps or plugs immediately before installation.

**For any operation, use the individual protection equipment adapted and recommended for the installation on the building site.**

### ■ CUTTING

#### • The roller plastic pipe-cutter

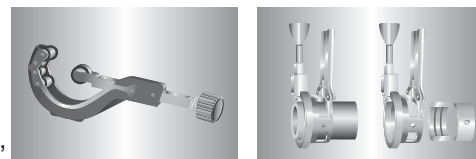
Allows for neat, clean cuts to be carried out.

#### • The chamfering pipe-cutter

This type of tool cuts and chamfers pipes in one single operation.

According to the model and size used, it can cut and chamfer pipes of all diameters, with the help of reducing half-shells.

**• It is strongly advised to avoid using disk saws or shears to cut the pipe.**



### ■ TRIMMING - CHAMFERING

**⚠ Omitting to chamfer the pipe externally may cause leaks, both short term and longer term.**

After cutting, the pipe must be trimmed inside and a chamfer must be made on the outside. **The chamfer shall deflect from the pipe following a 15° angle. That chamfer's dimensions must comply with the following table:**

Pipe Ø	Chamfer length
ø20 - ø50	2 - 3 mm
ø63 - ø200	3 - 6 mm

These operations can be performed by means of the following tools:

#### • Trimming and chamfering cone

This tool can be used to trim the inside of the pipe, and on the other side, it chamfers the outside.

Ref. GIRPI **CONE50U** or pipes ø20 to ø50 mm

#### • Chamfering tool

This tool chamfers the pipe outside from ø50 to ø160.

Ref. GIRPI **CHANF160R** ø50 to ø160 mm

**• Chamfering pipe-cutter** (see "cutting" section)

#### • Trimmer

This reams the inside of pipes of all diameters.

Ref. GIRPI **EBAV1R** ø20 to ø160 mm

**• The use of tools including cutting or abrading disks to chamfer pipes is strictly prohibited.**

### ■ HOLDING TOOLS

#### • Chain vice

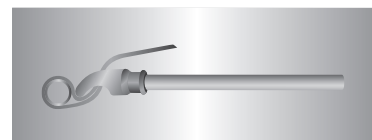
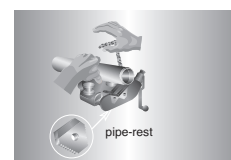
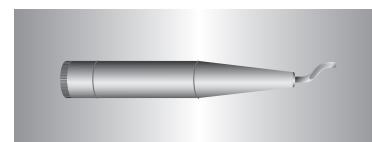
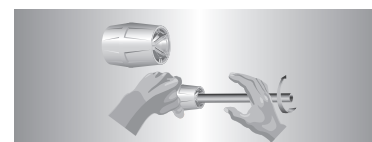
Polyurethane pipe-rests hold the pipe without any scratching.

#### • Strap wrench

Maximum gripping power, with no risk of deforming the pipes or fittings (braided nylon strap).

#### • Bench vice

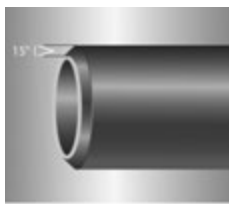
When using such traditional vices, it is mandatory to clamp the pipes by means of wooden notched pipe-rests.



## GENERAL RULES OF INSTALLATION WELDING PROCEDURE



CUTTING



CHAMFERING



CHECKS



PRIMING



WELDING POLYMER  
APPLICATION



PUSH STRAIGHT

### ■ CHECKS PRIOR TO WELDING

Abrading and priming operations are not compulsory.

However, depending on the environment met on each building site, pipes and fittings can be cleaned with a clean, lint-free piece of cloth, and primed with **CLEANER+**, in order to ensure optimal performances for each assembly.

In all cases, pipes and fittings **MUST** be clean and free from any trace of humidity. If that is not the case, the cleaning procedure described above must be carried out.

Before welding it is important to make certain checks:

- on the pipes: check that they are chamfered.

Extract chips produced during cutting or trimming operations, so as to avoid the obstruction of balancing valves and other similar equipment on the network.

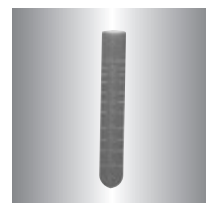
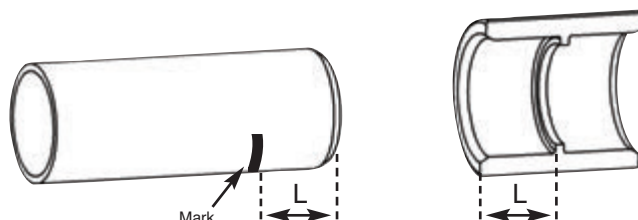
- on the fittings: see that they contain no sign of impact, deep scratches, etc..

- on the welding polymer: it must be fluid, homogeneous, check the maximum date of use on each pot.



### ■ MARKING OF THE SOCKET LENGTH

- Before applying the welding polymer, mark the socket length with the gauge supplied by GIRPI or by a "test" assembly.



ref. : JAUGE

This mark enables the application of the welding polymer over the necessary length, and helps the installer to check whether the penetration length of the male end in the socket is correct. The use of GIRPI's socket gauge is recommended (ref. JAUGE).

### ■ SURFACE PREPARATION

Dulling / abrading the surface to be joined is not necessary. Preparing the surfaces of the male and female parts to be joined is mandatory. That priming operation shall be carried out using **CLEANER+** and a clean, soft, lint-free piece of cloth. Leave the cleaned surfaces to dry, or dry them up using another clean, soft, lint-free piece of cloth.



### ■ WELDING POLYMER APPLICATION

- Once the checks and marking have been done, apply **HPFIX** welding polymer, available in 250 ml or 1 liter pots.

- Check the maximum date of use on each pot.

- To apply the welding polymer, use the brush provided with the pot.

Brushes provided with:

- 250 ml pots are fit for use with sizes 20 to 50 mm.

- 1 liter pots are fit for use with sizes 40 to 200 mm.



As a range addition, the applicators reference PAB1L are recommended for the application of welding polymers for diameters > 110 mm.

# GENERAL RULES OF INSTALLATION

## WELDING PROCEDURE

As a range addition, the applicators reference PAB1L are recommended for the application of welding polymers for diameters > 110 mm.

The use of any other means or method is prohibited, namely: fingers, wood sticks, or any other utensil. Dipping the pipes or fittings directly into the welding polymer pots is prohibited as well (such practices lead to the creation of thick welding polymer deposits, which can cause obstruction of small bore pipeworks).



- Apply the welding polymer moderately (in a thin coat) over the whole socket length (female) and over the whole length of the male end (marked on pipe). The welding polymer should be applied in rotation movements so as to obtain a uniform, homogeneous coat, well spread over the whole interlock surface.

PIPE DIAMETER	ROTATIONS
ø 20 to ø 40	4
ø 50 to ø 90	6
ø 110 - ø 200	8

Due to standardised size tolerances on male and female elements, gaps may need to be filled in order to obtain a reliable weld. Under such circumstances, a double welding procedure is required. That double procedure consists in applying a first layer of welding polymer on the male end, then apply the usual layer of welding polymer on the female end. Finally, apply a second layer on the male end before pushing the two elements together immediately after.



**Modifying the welding polymer's composition by dilution or by any other means is prohibited.**



### ■ JOINTING



**- Immediately after applying the welding polymer, joint the two elements right home (as far as the marks previously traced) by pushing longitudinally and without twisting.**

- Keep held together for 5 to 10 seconds without any movement. In order to secure optimal welding performances, do not submit fresh joints to any mechanical effort during the first minutes that follow joining.

A bead of welding polymer is formed after pushing the elements together. That bead helps check that the weld is done. Excess welding polymer can be wiped off with a clean, soft and lint-free piece of cloth.



**Nota :** In certain cases it is necessary to mark the position of one element in relation to the other. On large sizes, greater than diameter 90, **2 fitters must operate simultaneously**, i.e one fitter will coat the male end, while the other fitter will be coating the female end with welding polymer. This method enables a quick jointing, needed for a strong weld.



### ■ PARTICULAR CLIMATIC CONDITIONS



- Temperature range required for cold welding: +5°C to +35°C. If the welding polymer is stored at 20°C, welding is possible at 0°C.

- The atmospheric conditions (temperature, humidity) considerably affect the curing drying time, (evaporation of solvents of the welding polymer). Therefore:

- At low temperature, the parts when assembled should be held together for 20 to 30 seconds.
- In hot weather, the adhesive should be applied rapidly and the parts immediately jointed. So as to avoid evaporation of the welding polymer, the pot must be closed after each welding operation, and it must be used as quickly as possible once opened, especially under warm climatic conditions.

## ■ DRYING TIMES

The drying times for the HPFIX welding polymer are as follows:

DRYING TIMES BEFORE PRESSURE TESTS:		6 bar			10 bar		
		ø20 - ø63	ø75 - ø110	ø160-ø200	ø20 - ø63	ø75 - ø110	ø160-ø200
Ambient temperature	5 - 10°C 11 - 35°C	4 h 2 h	6 h 2 h	24 h 12 h	6 h 3 h	12 h 4 h	24 h 12 h

## ■ THERMOFORMING

Thermoforming of pipes from the KRYOCLIM® range by use of hot air or any other method, **is strictly prohibited on the work site** and involves cancellation of the GIRPI guarantee. For all direction changes, make use of standard KRYOCLIM® fittings only. Contact GIRPI's Technical Assistance when faced with particular problems at +33 (0)2 32 79 58 00.

## ■ CONNECTIONS BETWEEN KRYOCLIM® AND THREADED METAL COMPONENTS

connections between KRYOCLIM® and metal pipes, fittings and equipment featuring male or female threads (cylindrical/parallel) must be made by means of the KRYOCLIM® couplings provided for this purpose.

It is advised not to connect tapered (conical) male threads onto GIRPI's KRYOCLIM® fittings with female metal threaded inserts.

Fittings that are equipped with threaded metal components: FEAL, FMML, FTFRL, FTGRL, FMIL, can be used when high torque is required for connections to metal threaded components.

The table below indicates maximum torque values:

Diameter (mm)	16	20	25	32	40	50	63	75	90
Maximum torque (N.m)	45	50	60	75	90	110	135	160	190

## ■ SEALING

### General recommendations related to sealing compounds:

The use of anaerobic resins is forbidden. Applying excess anaerobic resin quantities on brass components may result in a contact between the anaerobic paste and the plastic components, and cause the plastic components to crack.

Please contact the sealing paste manufacturers to get their confirmation as to the drying times chemical/compatibility resistance and sealing capacity under pressure of their products.

### Connections between threaded metal components and KRYOCLIM® fittings with metal threaded inserts:

In our current state of our knowledge at the date of publication of this data sheet, the following compounds have proven to be satisfactory for connecting HPF/HPF parts and mixed HPF/metal parts:

- Tangit (Loctite) racoretanch plastique.
- Geb fileplast plastique.

Do not use anaerobic resins (e.g. Filetfix III by Virax). In no case should GIRPI's KRYOCLIM® pipes and fittings be machine threaded inside or outside.


### Connections between threaded metal components and KRYOCLIM® fittings with plastic threads:

The use of tallow, hemp or similar materials is forbidden, as excessive tightening can cause the fittings to break up.

The following sealants will be preferred:

- PTFE (e.g. "Teflon") tape, preferably high density.
- Soft silicon paste.



	<b>KRYOCLIM® SYSTEM</b>	Technical Sheet <b>3.5</b>

# GENERAL RULES OF INSTALLATION COMMISSIONING, TESTS AND PUTTING INTO SERVICE

## ■ GENERAL

KRYOCLIM® pipes and fittings are inspected throughout their manufacture and are guaranteed for a use complying with their design, within the limits indicated.

During the installation and before putting the KRYOCLIM® network into service, it is advisable to make a certain number of checks, as with all other materials.

## ■ INSPECTION

### a) Visual inspection

During installation, the pipes and fittings should be inspected so as to eliminate doubtful elements containing abnormalities such as impacts and deep scores caused by unsuitable handling. Before the tests, the whole network will be visually inspected to eliminate any pipework section containing deep cuts or notches, large deformations due to sudden impacts, traces of blow torch burns, etc...

Any damaged part should be replaced before putting into service. The aim of the visual inspection is also to ensure that the installation complies with the drawings and hence the correct installation of all the components (connection, supports, monitoring and safety mechanisms, etc...).

### b) Leak tests

After installation of the network, a leak test will be carried out (all parts of the network should be visible and accessible during that test).

### c) Cold water pressure test

The network shall be filled with water (purge the air from all high points) and kept under pressure long enough to enable visual control of all joints (for large installations, test by sections). In France, consult DTU 65-10 - (NF P 52-305).

The pressure test is performed at 1.5 times the **Maximum Operating Pressure** with a minimum of 6 bars at a temperature of 20°C.

- In the event of a leak on a glued joint, replace the faulty section and recommence the test.
- In the event of a leak on a screwed joint, tighten the fitting or replace the joint.

## ■ TEST BEFORE PUTTING INTO SERVICE

Once the leak tests have been made, it is advisable, in order to remove all foreign matter, clean the inside of the network. All applicable tests and controls before putting into service must be carried out, according to all relevant regulations, rules and codes of practice.

## ■ OPERATING CONDITIONS

Whatever the use, the safety mechanisms necessary for the traditional protection of networks (regulation, pressure reduction and limitation, temperature regulation and limitation, shut off mechanisms, etc...), should be planned, installed and kept in perfect working order throughout operation.

### a) Vibrations

Vibrations can be a source of disorders on both pipework and supports ; it is highly advisable to install a suitable system preventing vibrations from spreading.

### b) Sources of heat and U.V.

Being made from thermoplastic material, KRYOCLIM® should in no case be installed close to a source of heat causing a rise in temperature greater than its limits of use, and must be protected from exposure to ultraviolet rays.

### c) Prevention of impacts

As with all networks conveying pressurised fluids, KRYOCLIM® pipework systems must be protected from impacts which might occur in passage ways used by handling machinery or suspended loads in movement (use of safety barriers, railings, etc...).

### d) Malfunction

Compliance with the operating Pressure/Temperature conditions must be checked and ensured using regulation and safety devices, such as pressure reducers, safety valves, expansion tanks, anti-hammering or similar devices, in compliance with applicable codes of practice.

Any malfunction must be noted in the maintenance log book of the networks.

### e) Insulation materials

Electric cable insulation materials contain substances that can potentially damage KRYOCLIM® pipes. Therefore, it is advised not to store or install KRYOCLIM® pipes near electric cables.



## EXPANSION - CONTRACTION PHENOMENON - CALCULATIONS

# 4.1

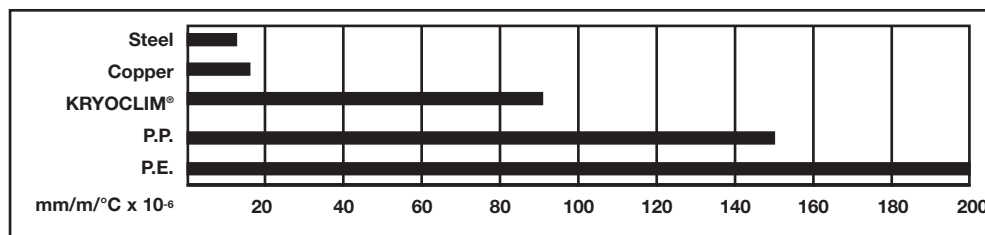
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### ■ THE PHENOMENON

All materials, under the effect of thermal variations:

- contract when the temperature drops,
- expand when the temperature rises.

Comparison between coefficients  $\alpha$



Steel	12,8 x 10 <sup>-6</sup> m/m°C
Copper	16,5 x 10 <sup>-6</sup> m/m°C
KRYOCLIM®	70 x 10 <sup>-6</sup> m/m°C
P.P.	150 x 10 <sup>-6</sup> m/m°C
P.E.	200 x 10 <sup>-6</sup> m/m°C

### ■ CALCULATION PARAMETERS FOR KRYOCLIM®

The linear expansion coefficient of KRYOCLIM® is:

$$\alpha = 0.07 \text{ millimeter per meter per } ^\circ\text{C (mm/m.}^\circ\text{C)}$$

The implementation of the system would take account of the elongation or contraction of the pipe which is calculated by the relation:

$$\Delta L = \alpha \times L \times \Delta T$$

in which  $\alpha$  = expansion-contraction coefficient (linear)

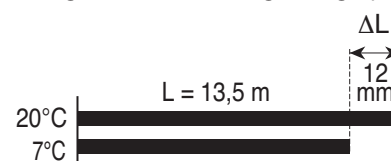
$L$  = length of the piping when installed, in meters

$\Delta T$  = temperature deviation in degrees Celsius ( $^\circ\text{C}$ )  
(difference between the maximum or minimum temperature in service and the installation temperature)

$\Delta L$  = length deviation in millimeter (mm)  
(difference in length between  $L$  on installation and  $L$  in operation, i.e. elongation or shrinkage length).

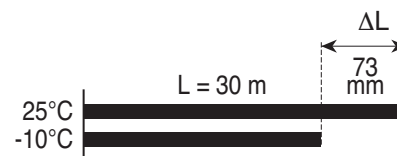
#### Ex 1: Comfort cooling (flow circuit)

- Installation temperature =  $20^\circ\text{C}$
- Chilled water temperature =  $7^\circ\text{C}$
- $L = 5 \text{ levels (1 level} = 2.7 \text{ m)} = 13.5 \text{ m.}$
- $\Delta T = 20 - 7 = 13^\circ\text{C}$
- $\Delta L = 0,07 \times 13.5 \times 13 = 12 \text{ mm contraction.}$



#### Ex 2: Network for industrial kitchen

- Installation temperature =  $25^\circ\text{C}$
- Fluid temperature (glycol) =  $-10^\circ\text{C}$
- Length (at the moment of installation) = 30 m.
- $\Delta T = 25 - (-10) = 35^\circ\text{C}$
- $\Delta L = 0.07 \times 30 \times 35 = 73 \text{ mm contraction.}$



### ■ TECHNICAL ASSISTANCE

GIRPI's installation guide and expansion slide rules will enable you to figure out expansion loop dimensions and bracket positioning in changes of direction. You can obtain then upon simple request from [contact@girpi.fr](mailto:contact@girpi.fr)

For help in calculating expansion, producing the application drawings or training staff on site, contact GIRPI's technical support: **+33 (0)2 32 79 58 00 - [be.girpi@alixis.com](mailto:be.girpi@alixis.com)**

## ■ CONSEQUENCES OF CONTRACTION-EXPANSION AND SOLUTIONS

Under certain conditions, the elongation due to the expansion causes compression of the pipe resulting in buckling. Conversely, the shortening due to the contraction of the pipe cause it to be tensioned. The sketches below illustrate a number of cases of compression or tension, which cause abnormal stress on the material and may cause serious disorders.

The French DTU, ATEC, SINDOTEC handbooks, and various guides all over the world concerning the installation of piping, whatever their nature, generally indicate that “when installing, it is necessary, in order to avoid disorders which may be caused by variations in length, to recognise them and address them”.

### ■ EXPANSION (compression between anchor points).

#### DON'Ts:

- buckling of the pipe between anchors

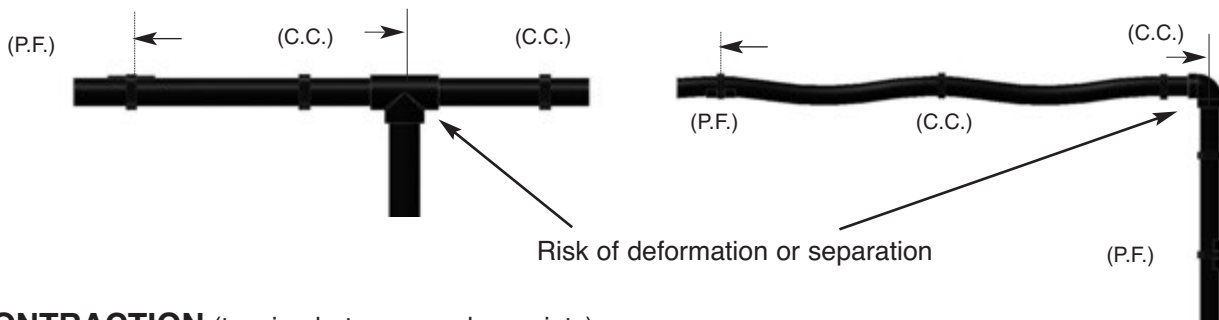


P.F. : Anchor point (1)

C.C. : Guide (bracket) (2)

➔ : Direction of the expansion movement

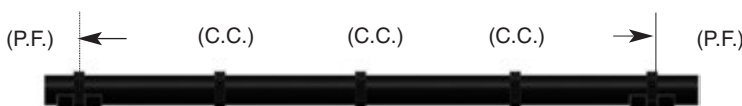
- thrust on the walls, obstacles, jointings or on the materials forming an anchor



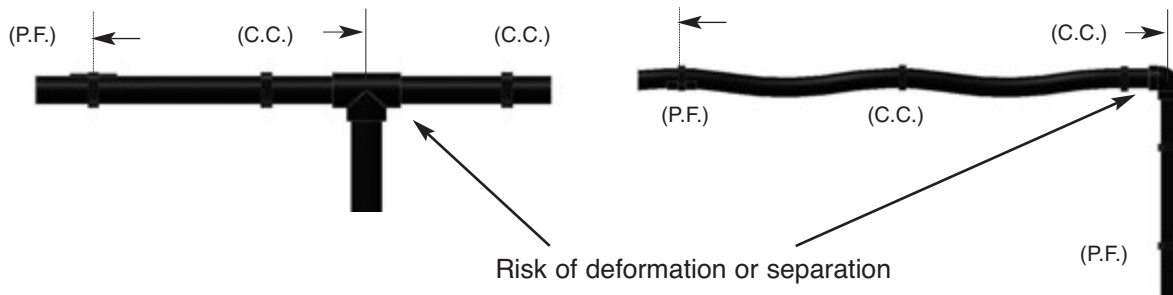
### ■ CONTRACTION (tension between anchor points)

#### DON'Ts

- tensioning of pipes, mechanical couplings, jointings between anchors



- tensioning between walls, obstacles, jointings or material forming an anchor



(1) P.F.: This is a support blocking the pipework system at one point, in order to “orientate” the movements caused by expansion and contraction.

(2) C.C.: They support the pipes while allowing them to expand and contract freely.

# EXPANSION - CONTRACTION CALCULATION OF THE LOOP ARM B

# 4.3

2017

## ■ THE REMEDIES

### TO DO:

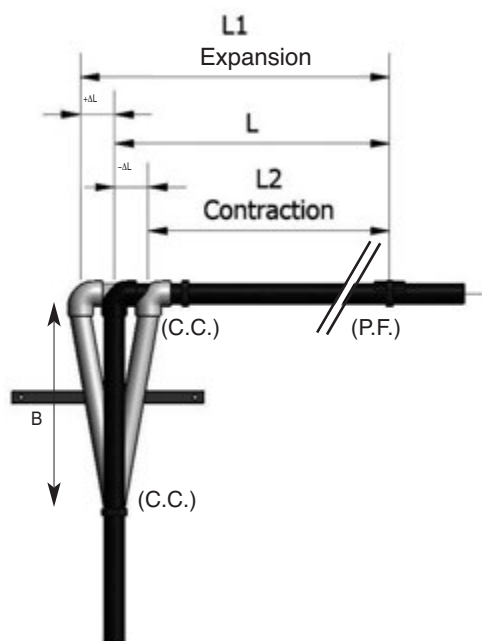
In order to avoid the disorders subsequent to the movements of the pipes, it is necessary to let them expand and contract freely.

It is therefore necessary to:

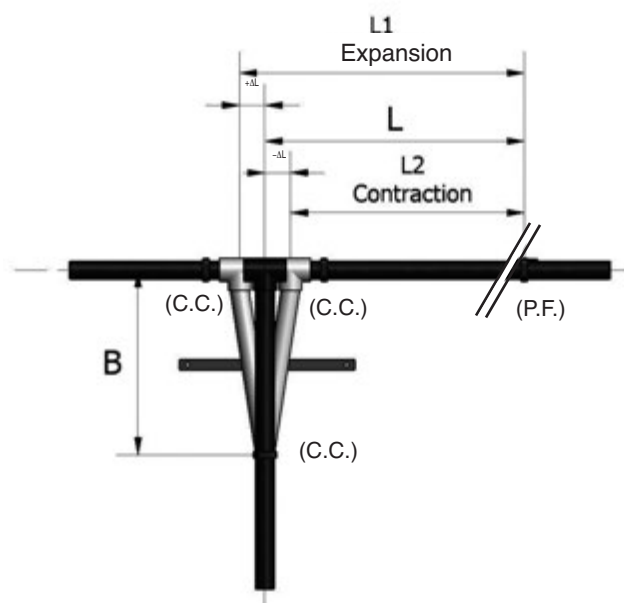
- Use pipe brackets allowing the longitudinal movements of the pipe to be guided.
- See to it that there never is a straight length of pipe between 2 anchors without any expansion compensation, either by using a change in direction, or by making a loop, or by using a flexible expansion joint (see illustrations below).

Change in direction, which is generally efficient in most cases

### CHANGE IN DIRECTION



### BRANCH



- L : Length of pipe section during installation
- L1 : Length at maximum temperature
- L2 : Length at minimum temperature (fluid or room)
- $\Delta L$  : Length difference between L1 (or L2) and L
- B : Length of loop's arm
- C.C. : Guide (bracket)
- P.F. : Anchor point

# EXPANSION - CONTRACTION CALCULATION OF THE LOOP ARM B

Examples referring to Technical Sheet 4.3:

For 20 to 63 mm

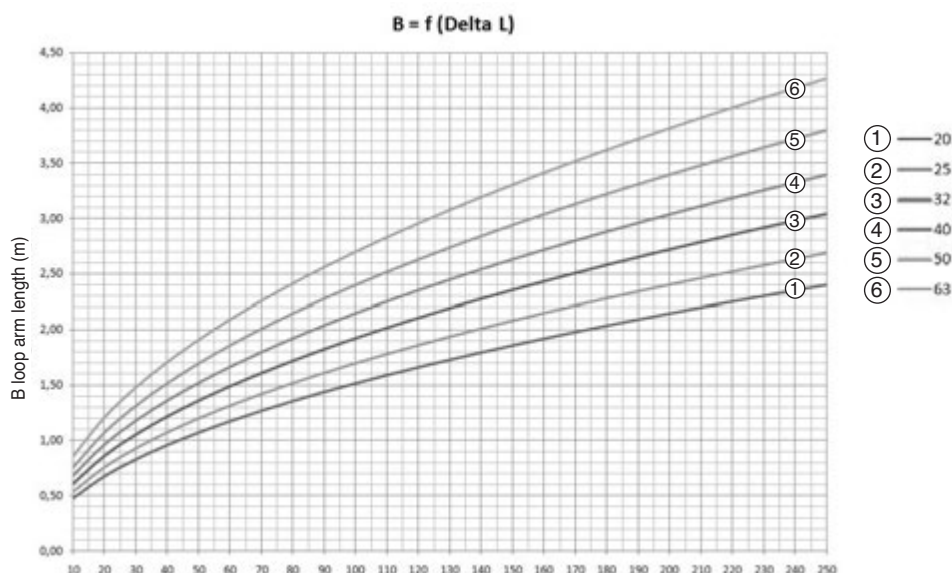
KRYOCLIM®:

Ex 1:

Determine B for a  $\varnothing$  40 mm pipe  
and a  $\Delta L$  of 27 mm.

Result: **B** = 1.12 m.

$\varnothing$  20,  $\varnothing$  25,  $\varnothing$  32,  $\varnothing$  40,  $\varnothing$  50,  $\varnothing$  63 KRYOCLIM®



Calculation formula of loop arm:

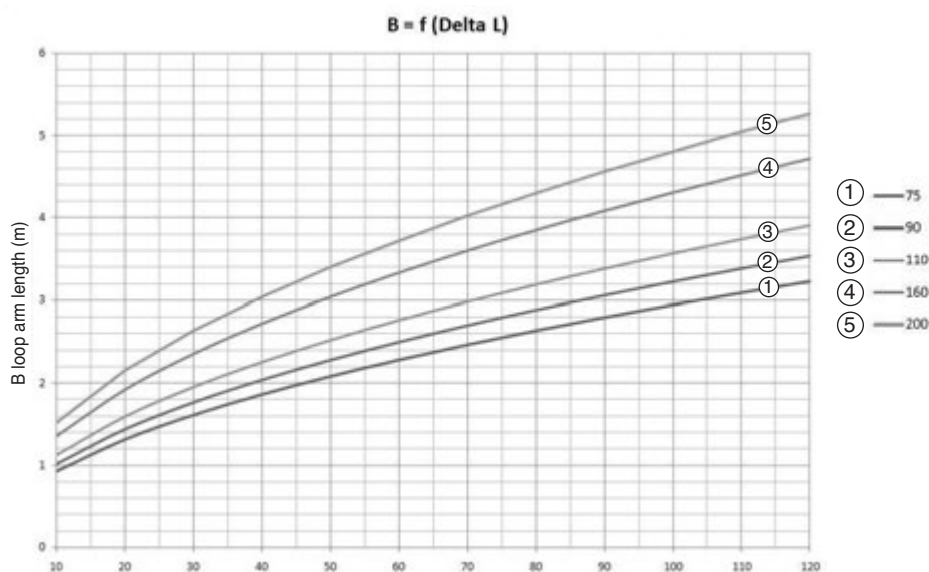
$$B = 34 \sqrt{\varnothing \times \Delta L}$$

with 34: constant for KRYOCLIM®

$\varnothing$ : external diameter

$\Delta L$ : length variation

$\varnothing$  75, 90,  $\varnothing$  110,  $\varnothing$  160,  $\varnothing$  200 KRYOCLIM®



For  $\varnothing$  75 to  $\varnothing$  200 mm

KRYOCLIM®:

Ex 2:

Determine B for a  $\varnothing$  110 mm pipe  
and a  $\Delta L$  of 28 mm.

Result: **B** = 1.88 m

## EXPANSION - CONTRACTION CALCULATION OF THE EXPANSION LOOP

# 4.5

2017

### ■ THE REMEDIES

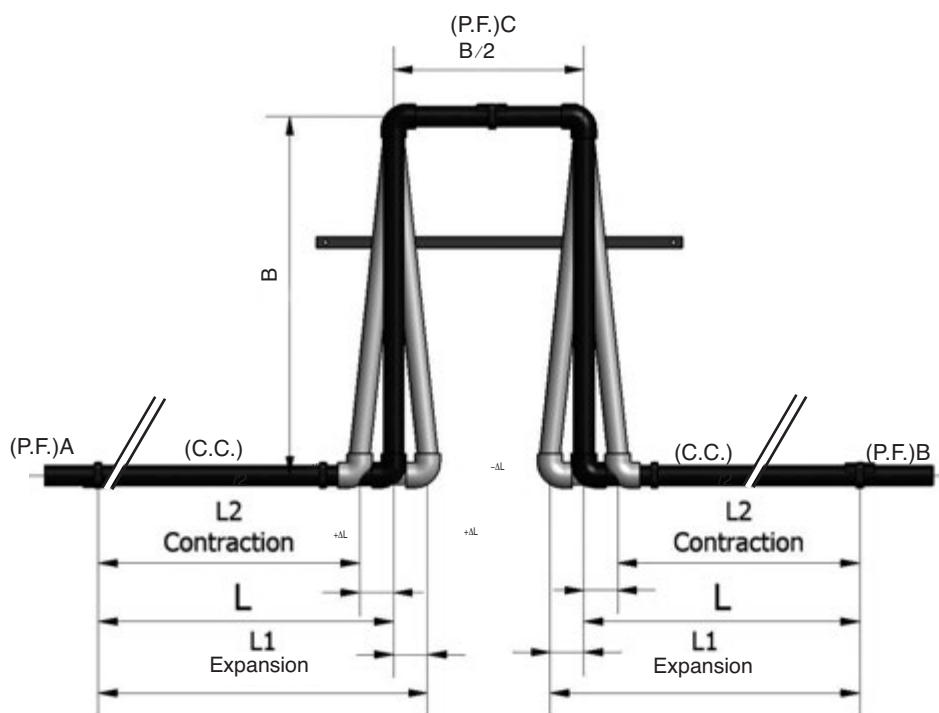
#### TO DO:

In order to avoid the disorders subsequent to the movements of the pipes, it is necessary to let them expand and contract freely.

It is therefore necessary to:

- Use pipe brackets allowing the longitudinal movements of the pipe to be guided.
- See to it that there never is a straight length of pipe between 2 anchors without any expansion compensation, either by using a change in direction, or by making a loop, or by using a flexible expansion joint (see illustrations below).

**Expansion loop** constructed from pipes and fittings usually fitted on long straight sections.



- $L$  : Length of pipe section during installation
- $L_1$  : Length at maximum temperature
- $L_2$  : Length at minimum temperature (fluid or room)
- $\Delta L$  : Length difference between  $L_1$  (or  $L_2$ ) and  $L$
- $B$  : Length of loop's arm
- C.C. : Guide (bracket)
- P.F. : Anchor point

# EXPANSION - CONTRACTION

## CALCULATION OF THE EXPANSION LOOP

# 4.6

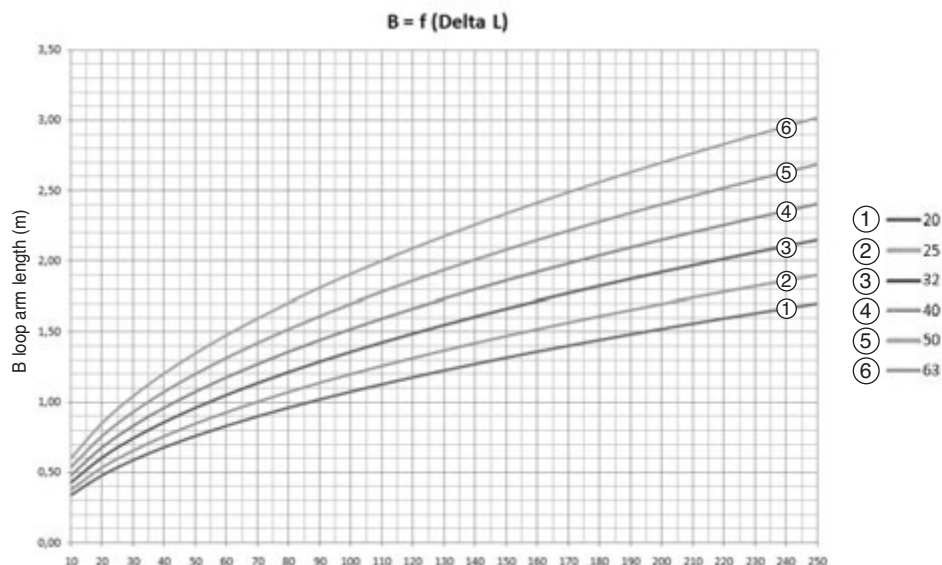
Examples referring to Technical Sheet 4.5:

**For ø 20 to 63 mm KRYOCLIM®:**

Ex 3: Determine B for a ø 40 mm pipe and a  $\Delta L$  of 27 mm.

Result: B = 0.79 m

ø 20, ø 25, ø 32, ø 40, ø 50, ø 63 KRYOCLIM®



Calculation formula of loop arm B:

$$B = 34 \sqrt{\varnothing^* \times (\Delta L/2)}$$

L: length between anchor points

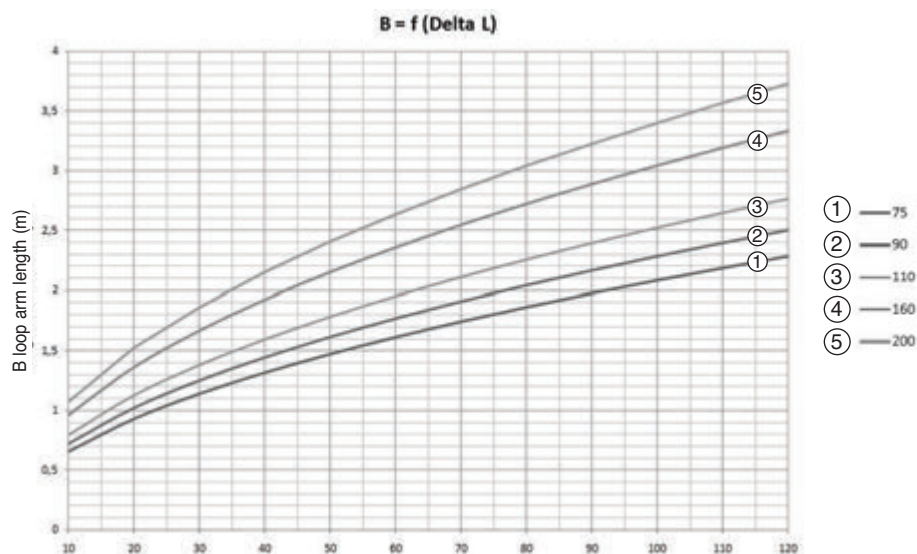
(P.F.)A and (P.F.)B

Place an anchor point (P.F.) C in the intermediate length between the two loop arms.

The latter must measure B/2.

$\varnothing^*$ : external diameter of the pipe

ø 75, ø 90, ø 110, ø 160, ø 200 KRYOCLIM®



**For ø 75 to 200 mm KRYOCLIM®:**

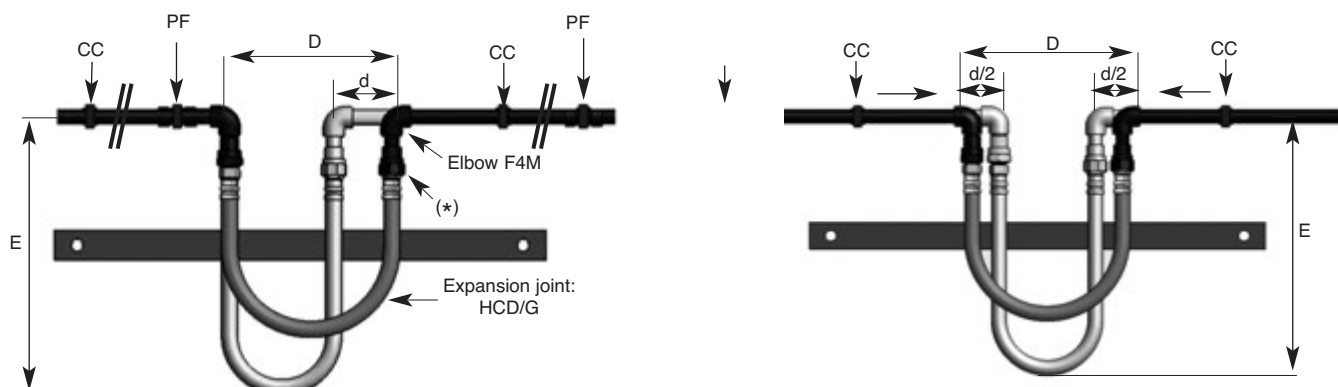
Ex 4: Determine B for a ø 110 mm pipe and a  $\Delta L$  of 28 mm.

Result: 1.33 m

## EXPANSION - CONTRACTION FLEXIBLE EXPANSION JOINTS

# 4.7

2017



\* Depending on the type of flexible:  
male or female threaded adaptor.  
Threaded adaptors: FMML  
Adaptor nipples: FEAL

➔ : Direction of the expansion movement  
D : Distance at time of installation (open position)  
d : Amount of expansion absorbed  
E : Maximum distance between main pipe and end of flexible (closed position)  
PF : Anchor point  
CC : Guide (bracket)

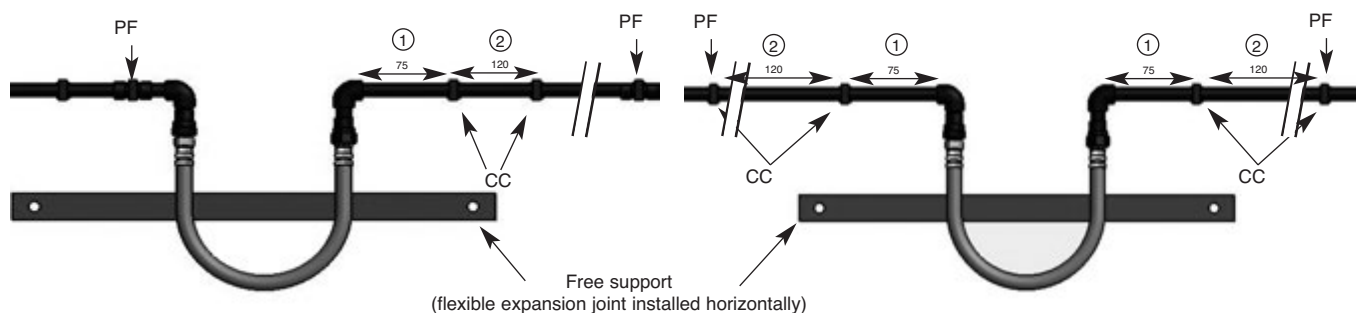
### SUPPORTING FLEXIBLE EXPANSION JOINTS:

- 1) The first guide will be at distance ①  $\approx 75$  mm (maximum distance), the next bracket in line will be at a distance ②  $\approx 120$  mm from the first.
- 2) The surface finish of the free support supporting the expansion joint will be such that the braiding is not deteriorated by friction..

Ø pipe KRYOCLIM®	Reference flexible	D	d	E
20	HCD/G20	220	100	282
25	HCD/G25	280	100	338
32	HCD/G32	350	100	407
40	HCD/G40	420	100	442
50	HCD/G50	500	100	591

GIRPI's silicone flexibles ref. HFS/G are not suitable for chilled water applications.

### EXPANSION JOINTS WITH BRASS THREADS



### IMPLEMENTATION OF FLEXIBLE EXPANSION JOINTS:

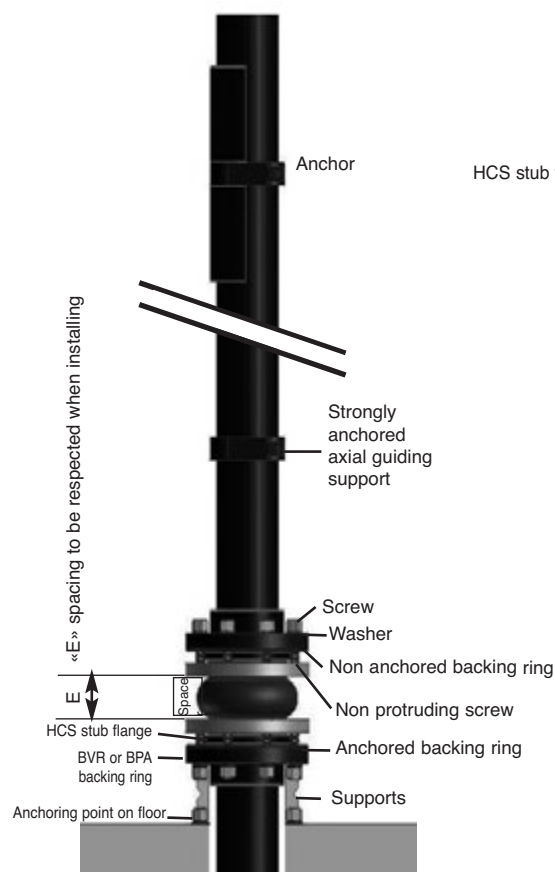
To guarantee correct operation, the following rules must be respected when designing the installation and installing the flexible expansion joints:

- a) respect the clearances defined on sheet 5.1,
- b) ensure that the flexible expansion joint is not subjected to twisting during installation or during operation,
- c) provide appropriate supporting in situations where the flexible expansion joint is overhanging.

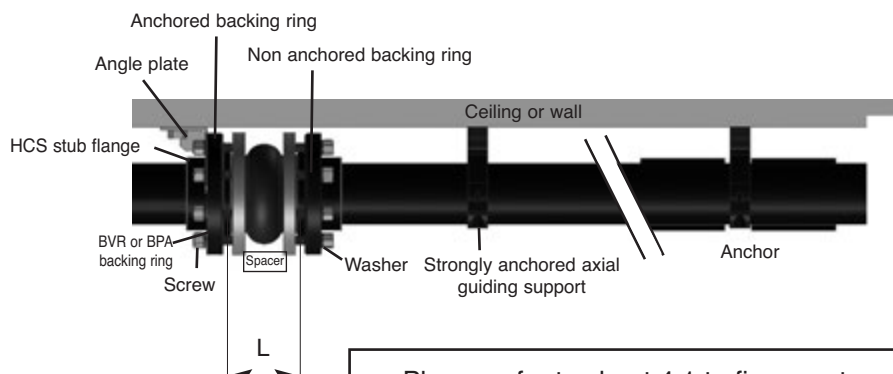


# EXPANSION - CONTRACTION FLANGED LINEAR EXPANSION COMPENSATORS

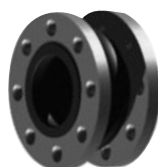
## VERTICAL INSTALLATION



## HORIZONTAL INSTALLATION



Please refer to sheet 4.1 to figure out expansion or contraction.



Expansion joints and hoses do not require maintenance, but are classified as wear parts. As such, they must be inspected at regular intervals (see building code and corresponding NF). They must be accessible, removable and replaceable.



Backing rings must always be assembled onto the components that they flange together with their plain sides oriented in the external (visible) positions. Their uneven sides (with cavities) will face the components to be flanged.

Absorption of expansion/contraction

Ø pipe	Ref. GIRPI	Contraction mm +	Expansion mm -	Length mm	E Spacing mm	Backing ring ref.	Stub flange ref.	Screw dim.
40	COMP40	20	30	100	68	BVR32B	FCS40	M 16x50
50	COMP50	20	30	100	68	BVR40B	FCS50	M 16x50
63	COMP63	20	30	100	68	BVR50B	FCS63	M 16x50
75	COMP75	20	30	100	68	BPA65	FCS75	M 16x50
90	COMP90	20	30	100	64	BPA80	FCS90	M 16x55
110	COMP110	20	30	100	64	BPA100	FCS110	M 16x55
125	COMP125	20	30	100	64	BPA125	FCS125	M 16x60
160	COMP160	20	30	100	60	BVR150	FCS160	M 20x70

See technical sheet 7.8 for flanging kit details.

## ■ INSTALLATION

Never work with sharp tools, which may damage the rubber bellows.

The flange screws must not protrude towards the bellow. Under operating conditions, the spherical bellow rolls on the smooth disks of the flange. All parts must be fully deburred and cleaned (otherwise, there is a risk of damaging the bellows).

Rubber parts must not be painted (solvents and chemical products have a negative effect).

We recommend that you use spacer wedges when you install the compensator. This will maintain the spacing defined at installation temperature.

Torque: refer to sheet 7.10 for backing rings.

## ■ GENERAL DESCRIPTION

MONOKLIP® brackets have been especially designed to support KRYOCLIM® pipeworks. The pipe is allowed to move freely inside the bracket as it expands and contracts. Depending on their size, they are offered with M6, M8 and 7x150 female threaded brass inserts, or with a plain 5.5 mm diameter drilled base.

KRYOCLIM® is a complete system, specially developed to bring global reliability. Therefore, all of the system's elements must imperatively be used. The use of components of external origin will make GIRPI's guarantee null and void, especially the use of other brackets than MONOKLIP®.

Other brackets than MONOKLIP® shall be used under the installer's entire responsibility.

In all cases, the supports:

- shall continue to support their load even under temperature variation effects,
- shall allow the pipeworks to expand freely,
- shall keep the pipeworks which they support at enough clearance from any wall or obstacle so as to allow for the expansion movements and also for the assembly and disassembly of the mechanical couplings and accessories (unions, flanges, valves, pressure limiters, etc...),
- shall in no event either injure or damage the pipeworks,
- shall be free from any chemical substance which could potentially damage the pipeworks (e.g. plasticisers).

## ■ SPACING OF SUPPORTS

The spacing of the supports must be calculated to prevent pipe deformations.

### SPACING BETWEEN MONOKLIPS®

PIPES FILLED WITH FLUID, APPROXIMATE DENSITY OF 1 (T ≤ 20°C)								
Outer diameter (mm)		20 to 32	40 to 50	63 to 75	90	110	160	200*
Spacing between MONOKLIP® (in meters)	Horizontale pipes	1.00	1.25	1.5	1.75	2	2.25	2.25
	Verticale pipes	1.3	1.6	2.00	2.3	2.6	3	3

The maximum distances given in the above table can be used to determine the recommended spacing.

Valves or heavy accessories fitted on a pipe must be independently supported

\* D200: it is possible to use brackets that comply with the specifications given in the previous paragraph. In this event, spacing should be 2.25 m for horizontal pipes and 3 m for vertical pipes. If A9C200 brackets are used, the spacing should be 1 m for vertical pipes and 1.3 m for horizontal pipes.

## ■ CORRECTION FACTORS

- Fluid temperature > 20°C

In this case, the distances between MONOKLIP® brackets must be reduced by multiplying by 0.9 for 30°C and by 0.8 for 40°C.

## ■ WEDGES

MONOKLIP® brackets between ø20 and ø110 can be elevated using 20 mm wedges designed for this purpose.

Ref. CALE 1225 for ø 20

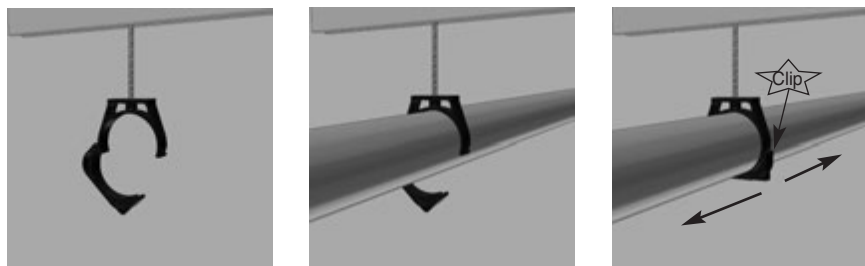
CALE 3263 for ø 25 - 32 - 40 - 50 - 63

CALE 75110 for ø 75 - 110

Using these wedges, the heights of the MONOKLIP® brackets can be changed to ensure a constant pipe axis during reduced flow.

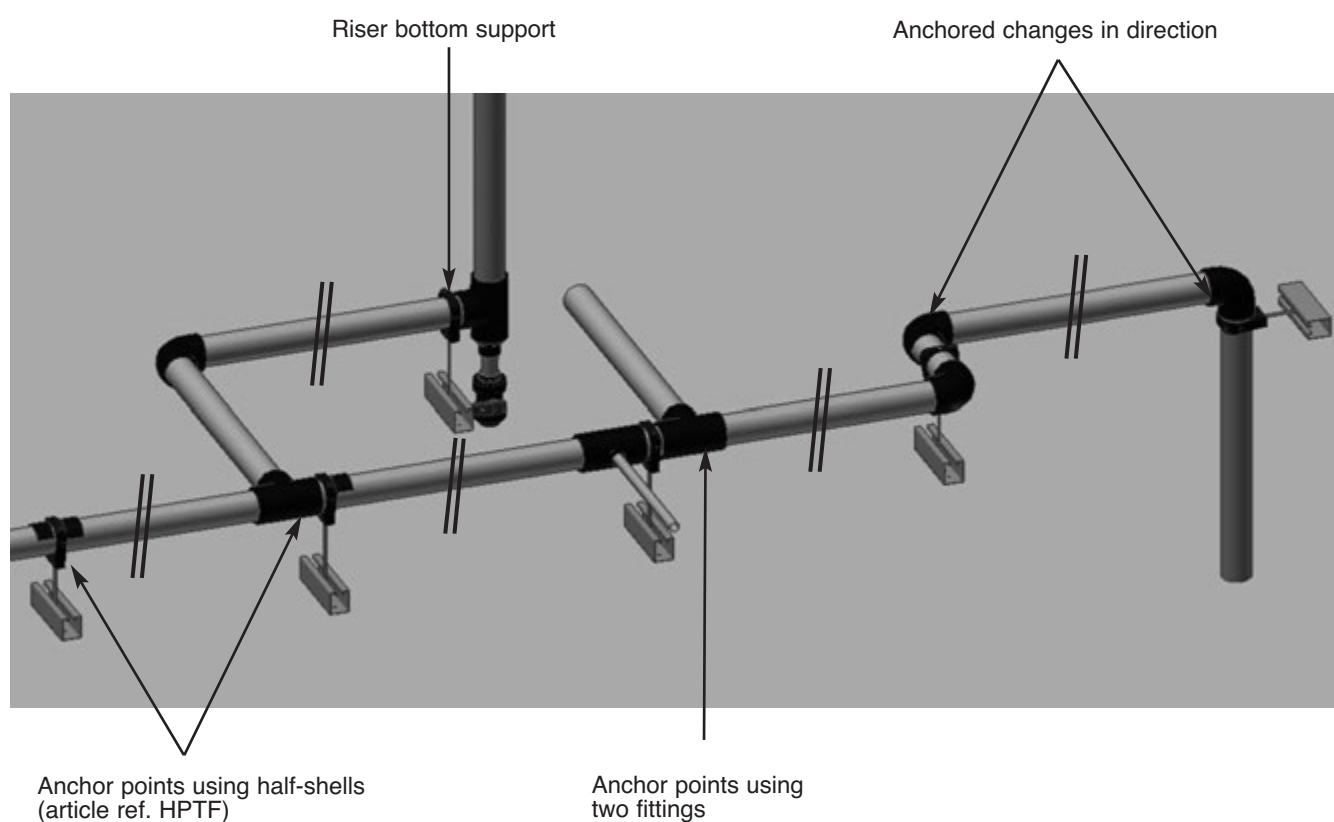
# INSTALLATION: ACCESSORIES AND ANCILLARIES MONOKLIP® BRACKETS

## ■ EXAMPLES OF SUPPORTS: MONOKLIP® BRACKETS



Bracket which works as a guide  
to ensure free movement  
of the pipes

## ■ EXAMPLES OF ANCHORS

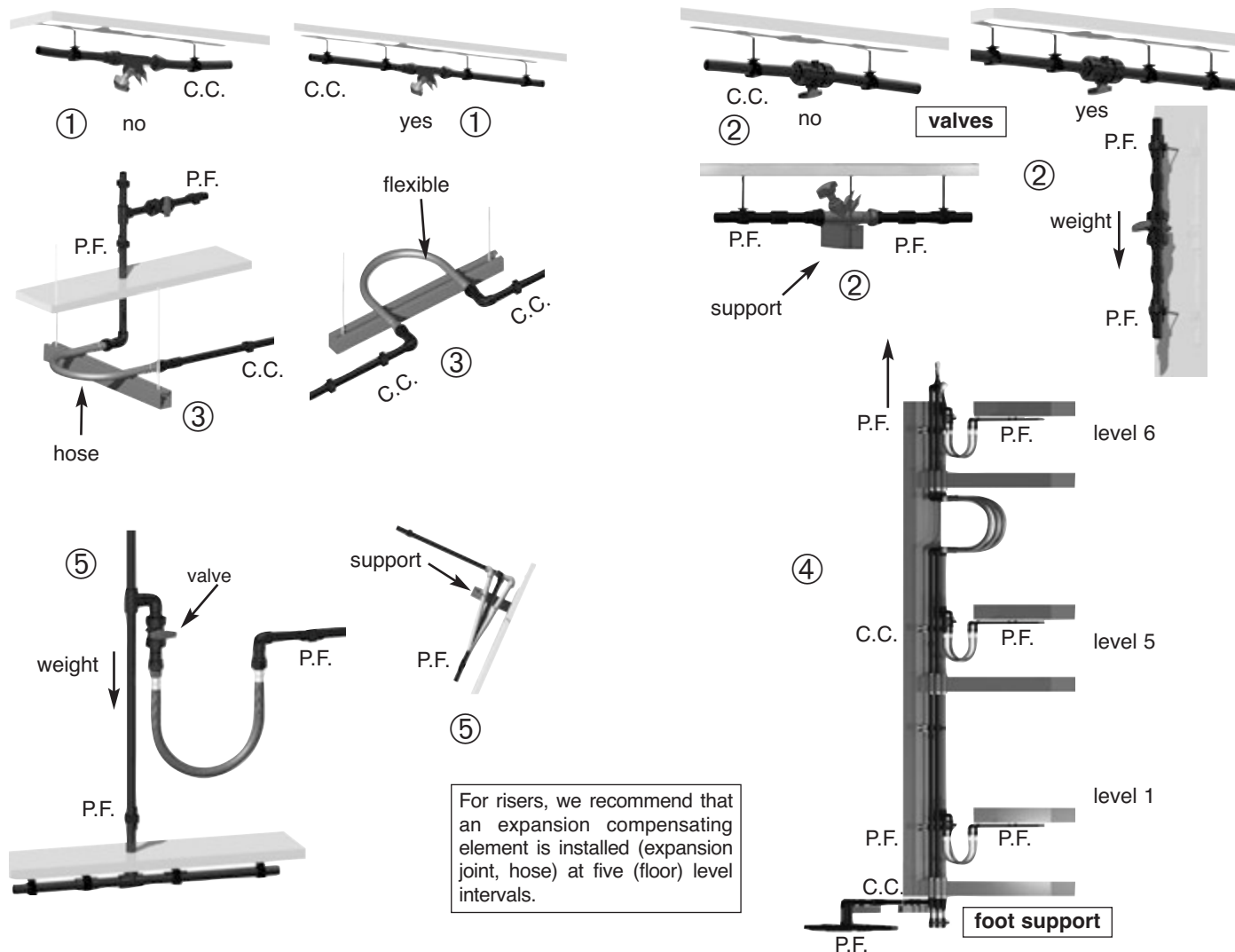



Various accessories or special points require specific supporting: this supporting must be carefully designed in each case, to prevent the pipes from being subjected to mechanical forces.

CASE	TYPES OF SUPPORT	REASONS
① • KRYOCLIM® male and female threaded fittings and tap connectors	Free or fixed on either side (double support)	To avoid tension on threads due to movement out of axis
② • Plastic valves	On either side and often with anchor point (double support)	Weight, must operate without twisting on pipe and threads
③ • Hoses/Expansion joints	(See technical sheet 4.5)	To allow movement without rotation, without moving out of axis and without chaffing
④ • Riser bottom	Free or fixed depending on the case	To support the weight of the riser
⑤ • Direction changes	Forming a right angle	To allow translation of the loop arm, to prevent sag and wear

### IMPORTANT:

- The sliding supports must be positioned in such a way that the couplings or accessories do not come in contact with them when the pipes expand and contract.
- Heavy metallic accessories (e.g. filters, 3-way valves, etc.) require specific, individual supporting



	KRYOCLIM® SYSTEM	Technical Sheet <b>5.4</b>
	INSTALLATION: ACCESSORIES AND ANCILLARIES INSULATION	

## ■ INSULATION

The low thermal conductivity coefficient ( $\lambda = 0.16 \text{ W/mK}$ ) of HPF and the high thermal resistance of KRYOCLIM® helps reduce heat losses and delay the condensation phenomena. Like all other materials, KRYOCLIM® must be insulated to be protected against frost, to reduce heat losses and to avoid condensation when the outside pipe temperature is below dew point.

To limit bacterial growth, the domestic hot and cold water networks must be insulated individually.

Choose an insulation material limiting heat losses and complying with applicable thermal regulations.

Most insulation products can be used (insulation, rubber foam, glass wool, rock wool), except those whose installation requirements (e.g. use of certain adhesives) or chemical composition are not compatible with KRYOCLIM®. See technical sheets 9.1 to 9.3. If in doubt, the user must check the insulation product's compatibility with its manufacturer and with GIRPI.



## ATTENTION :

**Insulation made from phenolic foam can cause brass to crack.**

**If in doubt, please contact the insulation manufacturer for more information.**

■ Calculating the surface temperature at different locations can indicate the secure range with regard to the risk of condensation due to intrinsic resistance in cases where the insulation is insufficient at critical points, poor sealing, accidental tears...

**Example for reference only**

		Surface temperature (not insulated)		
		Metallic pipe	KRYOCLIM® pipe	KRYOCLIM® coupling
$T_{\text{fluid}} = 7^\circ\text{C}$	$\varnothing 25$	$7^\circ\text{C}$	$9^\circ\text{C}$	$11^\circ\text{C}$
$T_{\text{reference ambient temperature}} = 23^\circ\text{C}$	$\varnothing 63$	$7^\circ\text{C}$	$10^\circ\text{C}$	$13^\circ\text{C}$
$h_e = 8 \text{ W/m}^2\text{K}$ $T_{\text{dew point}} = 16.1^\circ\text{C}$	$\varnothing 110$	$7^\circ\text{C}$	$12^\circ\text{C}$	$15^\circ\text{C}$

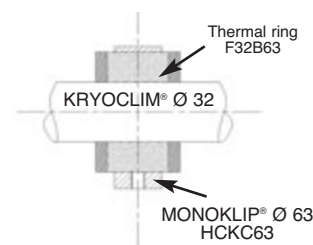
■ The following table gives the heat loss in W/m for KRYOCLIM® pipes with or without insulation:

$T_{\text{fluid}} = 7^\circ\text{C}$ $T_{\text{ref.: ambient}} = 23^\circ\text{C}$ $h_e = 8 \text{ W/m}^2\text{K}$	No insulating material	Insulation material ( $\lambda=0.039\text{W/mK}$ ) Thickness = 13 mm	Insulation material ( $\lambda=0.039\text{W/mK}$ ) Thickness = 19 mm	Insulation material ( $\lambda=0.039\text{W/mK}$ ) Thickness = 32 mm
$\varnothing 25$	8.7	4.1	3.4	2.7
$\varnothing 63$	19.8	7.9	6.4	4.8
$\varnothing 110$	30.5	12.1	9.7	7.1

## ■ THERMAL RINGS

Outside France, observe local rules and standards.

To prevent the insulating material from flattening out at collar level, a thermal ring must be used. They allow the KRYOCLIM® pipe to expand and contract freely.



## ■ IMPLEMENTATION OF RUBBER FOAMS AND EXTRUDED / CUT POLYSTYRENE

Please refer to manufacturer's instructions and to applicable codes of practice.

Thermal ring reference	$\varnothing$ pipe KRYOCLIM® Diameter int.	$\varnothing$ MONOKLIP® Diameter ext.	Theoretical thickness
F16B40	16	40	12
F20B50	20	50	13
F25B50	25	50	13
F32B63	32	63	16
F40B75	40	75	18
F50B90	50	90	20

**INSTALLATION:  
ACCESSORIES AND ANCILLARIES  
INSULATION****■ APPLICATIONS: Cold air conditioning****■ Other indirect expansion applications**

Applications	Example of Temperature of fluid	Type of recommended internal insulating material	Thickness recommended indoor (mm)*
Cooling system	+15°C	Foam rubber	0 - 9
Negative cold circuit (centralized kitchen, warehouse)	-10°C for glycol water	Foam rubber $\mu \geq 7000$ Cut extruded polystyrene and vapour barrier	19 - 32 25 - 30
Indirect expansion cooling chamber	-25°C for glycol water	Cut extruded polystyrene and vapour barrier	30 - 40

\* Thicknesses are given for reference only; they may vary depending on the construction site (dew point, hygrometry, temperature) and depending on the system configuration (length, fluid speed). It is the user's responsibility to check with a specialized consulting firm.

**NB** :  $\mu$ : material permeability.

$h_e$ : the external superficial exchange coefficient (average value = 8).

In France, insulation must be installed in accordance with NF DTU 45.2 P1-1.

The KRYOCLIM® system does not require any anti-corrosion treatment before insulation. The fire resistance of the insulating products must comply with the fire safety regulations for establishments open to the public.

It is better not to directly glue the insulating materials on the KRYOCLIM® pipes and fittings. In other countries, insulation must be installed in accordance with the standards in force.

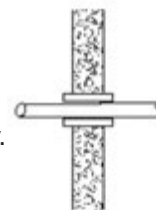
In any case, the thickness of the insulation layer should comply with the local regulations and requirements.

# INSTALLATION: ACCESSORIES AND ANCILLARIES SPECIAL CASES

## ■ PASSING THROUGH PARTITIONS AND FLOORS

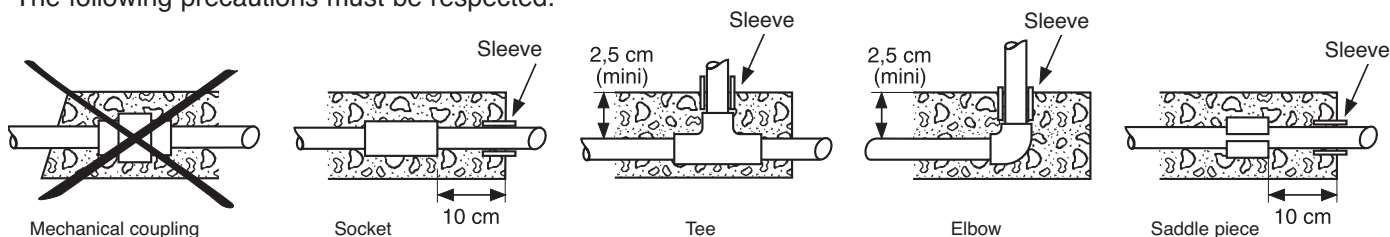
When a KRYOCLIM® pipe goes through a wall or a floor, it must be protected by a rigid sleeve made of synthetic material, and preferably HPF.

The sleeve internal diameter is chosen with enough tolerance to allow the pipes to expand and contract freely. The sleeve must be long enough to protrude on both sides of the finished masonry element.



## ■ BUILT-IN OR EMBEDDED INSTALLATIONS

KRYOCLIM® can be built or embedded in the masonry as long as there is no disconnectable coupling in that pipework section. The following precautions must be respected.



- The pipe must be made integral with the masonry either by means of the couplings making up the system or using half-shells onto the wall of the pipe.
- Each time the pipe enters the masonry it must be protected against shearing by a sleeve which protrudes from the finished surface of the masonry.
- The chase will be filled with a homogeneous material without sharp gravel which could damage the pipe.
- The commissioning tests must be carried out before filling the chase or pouring the concrete.

## ■ BURIED INSTALLATIONS: PRESSURISED PIPING NETWORKS OR CENTRALISED KITCHEN DRAINAGE:

KRYOCLIM® pipeworks can be buried if the following precautions are respected:

- The bottom of the excavation must be levelled and free of large grained materials and have no surface hard spots. A carefully compacted bed of 10 cm minimum will be made of clean sand 0/10 containing less than 10 % of fines..
- The backfill directly in contact with the pipe (comprised of sand containing less than 12 % of fines and free of gravel with diameter greater than 30 mm) will cover the pipe to a depth of 15 cm minimum and will be compacted.
- The covering backfill will be compacted in successive layers comprised of materials removed from the trench and which contain less than 30 % of elements greater than 20 mm.
- The minimum total height of the backfill above the pipe will be:

- general case: 60 cm
- under road/rail traffic: 80 cm
- under concrete slab: 40 cm

### 1 - Belding

- 10 cm on normal ground
- 15 cm on hard or rocky ground
- Clean, lightly fillerised sand (< 5%)

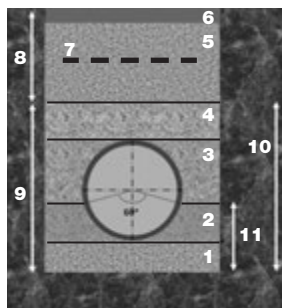
### 2 - Base

- Clean sand with low fine element content (< 5%)
- Installation by mechanical clamping of the grains

### 3 - Lateral embankment

### 4 - Initial embankment

- ≥ 10 cm above the collar
- ≥ 15 cm above the top



### 5 - Roadway embankment or base

- Untreated gravel
- Granularity 0/20 and 0/40
- Minimum code : "Cb" (granulate standard XP P 18-545 march 2008)
- Warning mesh: (NF EN 12 613): 30 cm above pipes

### 6 - Finishing layer

- Topsoil, asphalt overlay, etc...

### 7 - Warning mesh

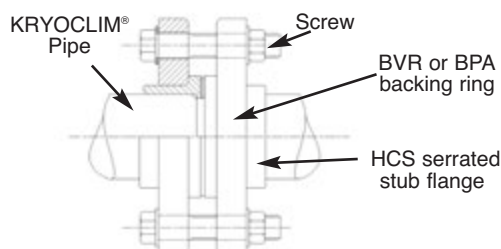
### 8 - Embankment

### 9 - Protective embankment

### 10 - Wrapping area

### 11 - Seating

## ■ ASSEMBLY WITH FLANGES: the screws must be tightened in a "cross" sequence.



Ø pipe	20	25	32	40	50	63	75	90	110	160
Screw length (mm)	70	80	90	100	100	100	110	110	110	130
Nb of screws	4	4	4	4	4	4	8	8	8	8
Screw Ø (mm)	14	14	14	18	18	18	18	18	18	22

\* according to the type of flanges in use



## ■ CALCULATION BASIS

The quality of the internal surface of KRYOCLIM® pipes gives the guarantee of a better flow capacity (for an equivalent cross section) than that of metallic pipes.

To calculate HPF pipes' pressure losses, taking in to consideration a perfect internal surface condition (therefore a low coefficient of roughness which is specific to our pipes), GIRPI has ordered from CATED a nomogram of pressure losses at 7°C (see sheet 6.2).

This nomogram is established using the REEF formula.

## ■ THE REEF FORMULA

J : Pressure losses (mmCE/m) - U : fluid speed (m/s)

D : internal pipe diameter

$$J = k \times U^{1.75} \times D^{-1.25} \quad (\text{mmCE/m})$$

V : kinematic viscosity (m²/s) - W : volumic mass (kg/m³)

g : gravitational acceleration = 9.81 (m/s²)

N.B. :  $\epsilon$  = absolute roughness of the material = 0.001 mm.

$$k = 0.3264 \times V^{0.25} \times \frac{W}{2g}$$

### Correction coefficient

• Following the percentage of NEUTRAGEL® used, the pressure losses increase due to the variation of the kinematic viscosity and the density of the fluid. Therefore, it is necessary to multiply the pressure losses read on the nomogram at 7°C - 0 % by a correction coefficient in case of a regular and smooth fluid circulation.

% NEUTRAGEL volume	0%	10%	15%	25%	30%	35%	40%	45%	50%
Fluid temperature (°C)	7 to 5	4	2	-5	-10	-15	-20	-25	-30
Machine protection* temperature (°C)	-	-2	-5	-10	-15	-20	-25	-30	-35
Pressure losses correction coefficient	nomogramme x 1	x 1.1	x 1.2	x 1.4	x 1.6	x 1.8	x 2	x 2.4	x 2.8
Flow correction	x 1	x 0.95				x 0.9			

\* Estimated values, check with the manufacturer.

• For example: in case of an air conditioning network at 7°C, during winter when the outside pipework does not work, the pipes must be protected against frost. Use one of the following methods:

- 1) Drain the pipework while it is stopped.
- 2) Protect the pipework with a self regulated heating cord covered by a lagging with a big wall thickness. (ex.: 32 mm).
- 3) Using NEUTRAGEL® in sufficient quantity and oversizing some items of the installation.

% NEUTRAGEL	0%	30%	40%
Fluid temperature (°C)	7°C		
Pressure loss correction coefficient	nomogram x 1	x 1.4	x 1.5

• MIXIGEL® is used pure.

Its viscosity at low temperature is much lower than that of Propylene Glycol.

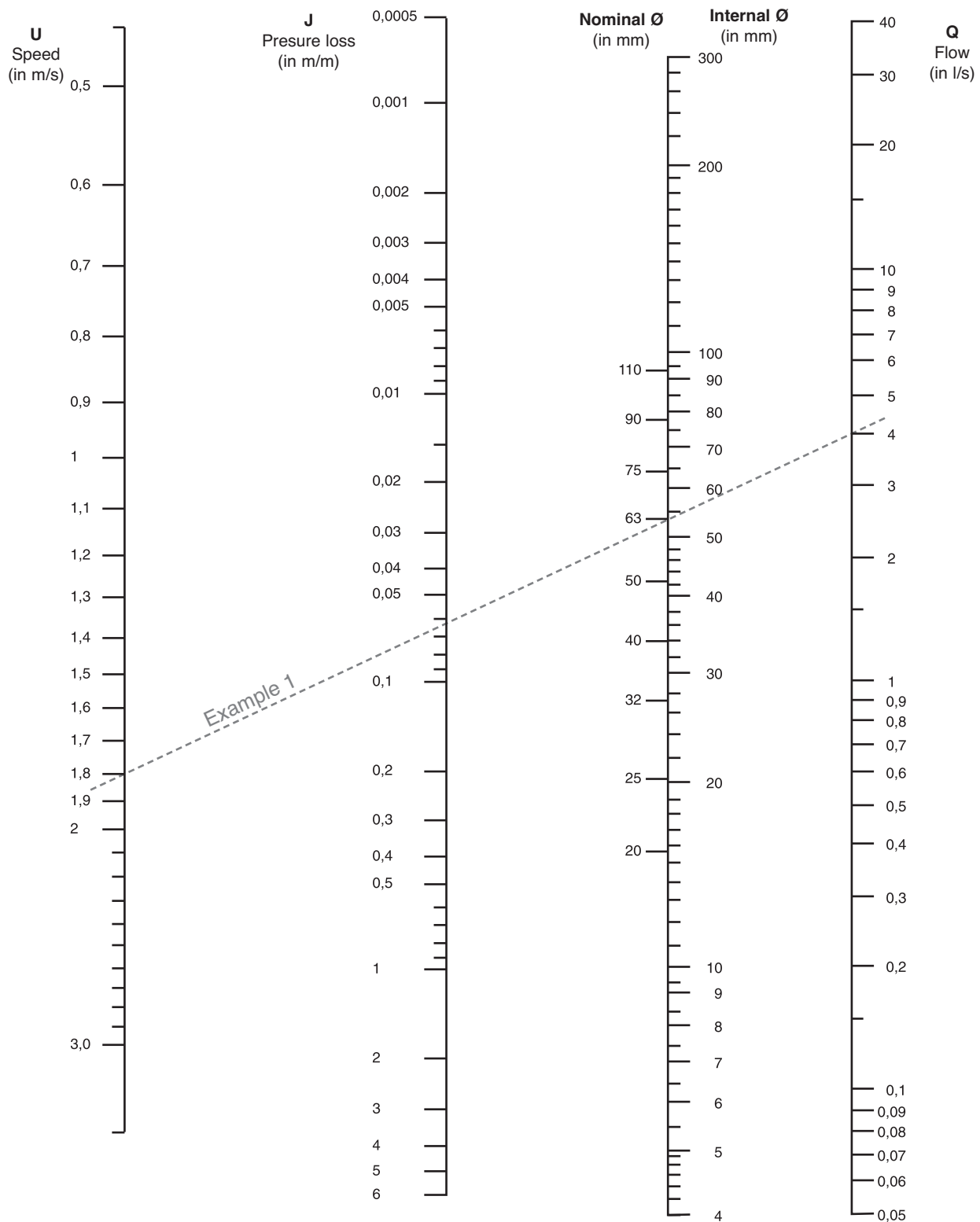
% MIXIGEL	0%	Pur = 100%	
Fluid temperature	7°C	-20°C	-30°C
Pressure losses corrector coefficient	nomogram x 1	x 2.2	x 2.7

- Ex 1 :
- Reading on the nomogram (see sheet 6.2), pure water.  
 Flow rate: 4l/s      ⇒      Pressure losses: 0.06 mCE/m  
 Speed: 1.8 m/s      ⇒      External pipe ø: 63 mm
  - In case of a fluid at -20°C, with 35% of NEUTRAGEL®  
 Flow rate: 4l/s      ⇒      Pressure losses: 0.06 x corrector coefficient = 0.06 x 1.8 = 0.108 mCE/m  
 Speed: 1.8 m/s      ⇒      External pipe ø: 63 mm



# **PRESSURE LOSSES** **NOMOGRAM AT 7°C - FLUID: WATER**

# 6.2



## METHOD:

mark two of the installation's working parameters, trace a straight line between those two points, read missing parameter values on this line.

# DIMENSION SHEET

# 7.1

2017

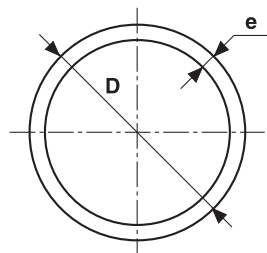
## IMPORTANT NOTE:

With the constant concern to improve the range and quality of its products within the context of the standards used at present, GIRPI reserves the right to modify the dimensional characteristics of its pipes and fittings together with the scope of its ranges, without prior notice

Unless otherwise indicated, the dimensions given below (data sheets 7.1 to 8.2) are expressed in mm and the threading/tapping in inches.

## KRYOCLIM® PIPES

4 m lengths with chamfered ends

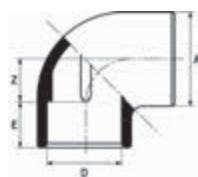


D	Dn	Reference	Pack (*)	PN	mini thickness	Weight kg/ml	Internal Ø	Cont. l/m
20	15	TUBF20	10	10	2.3	0.188	15.4	0.186
25	20	TUBF25	10	10	2.3	0.235	20.4	0.327
32	25	TUBF32	10	10	2.4	0.314	27.2	0.581
40	32	TUBF40	10	10	3	0.490	34.0	0.908
50	40	TUBF50	5	10	3.7	0.756	42.6	1.425
63	50	TUBF63	5	10	4.7	1.210	53.6	2.256
75	65	TUBF75	1	10	5.6	1.680	64.0	3.217
90	80	TUBF90	1	10	6.7	2.430	76.8	4.632
110	100	TUBF110	1	10	8.1	3.640	93.6	6.911
160	150	TUBF160	1	10	11.8	7.800	136.4	14.6
200	200	TUBF200	1	6	11.9	9.900	176.2	24.38

(\*) Quantity of pipes per bundle  
PN10 from ø20 to ø160  
PN6 ø200

## ELBOWS 90°

Soc. x Soc.

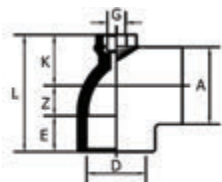


D	Dn	Reference	Z	E	A
20	15	F4M20	11.5	17	26
25	20	F4M25	14.5	19.5	31
32	25	F4M32	18	23	38
40	32	F4M40	23	27	49
50	40	F4M50	27	32	62.5
63	50	F4M63	34	38	77
75	65	F4M75	38.5	46	92.5
90	80	F4M90	49	52.5	112
110	100	F4M110	59.5	62.5	136.5
160	150	F4M160	80	88	190.5
200	200	F4M200	98	107	235



### ELBOWS 90° WITH THREADED BRASS INSERT

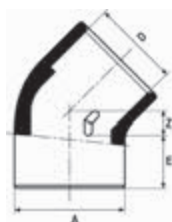
Soc. x Soc. x Female brass thread



D	Dn	Reference	Z	E	L	A	K	G
50	40	F4MI5012	26	32	105	65	30	1/2"
63	50	F4MI6312	32	38	124	80	37	1/2"

### ELBOWS 45°

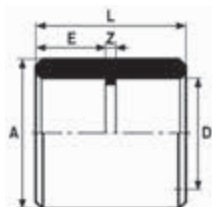
Soc. x Soc.



D	Dn	Reference	Z	E	A
20	15	F8M20	5.5	17	26
25	20	F8M25	6	19.5	31.5
32	25	F8M32	9	23	39.5
40	32	F8M40	9.5	27	49
50	40	F8M50	12	32	58
63	50	F8M63	15	38	72.5
75	65	F8M75	18	44	91.5
90	80	F8M90	19.5	52	109
110	100	F8M110	23	62	136.5
160	150	F8M160	37	87.5	190.5
200	200	F8M200	45	106	235

### COUPLINGS

Soc. x Soc.



D	Dn	Reference	Z	E	A	L
20	15	FMA20	3.5	17.5	26	37.5
25	20	FMA25	3.5	20	31.5	42.5
32	25	FMA32	4	23	38	49.5
40	32	FMA40	3.5	26.5	48	56.5
50	40	FMA50	4	32	59.5	69
63	50	FMA63	4	39	74.5	81
75	65	FMA75	5	44.5	91	94
90	80	FMA90	6.5	51.5	107	109
110	100	FMA110	7.5	61.5	126.5	130
160	150	FMA160	10.5	86.5	188	183
200	200	FMA200	8	106	228	220

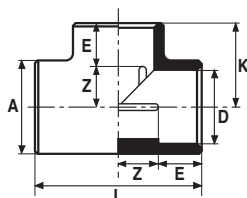
# **DIMENSION SHEET**

# 7.3

2017

## **EQUAL TEES 90°**

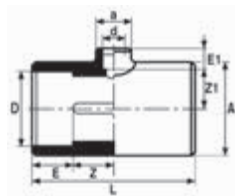
Soc. x Soc.



D	Dn	Reference	Z	E	A	L	K
20	15	FTE20	11.5	17	26	56.5	28.5
25	20	FTE25	14	19.5	31.5	67	33.5
32	25	FTE32	18.5	22.5	39.5	81	40.5
40	32	FTE40	22	27	49.5	97	48.5
50	40	FTE50	26	32	61	114.5	58
63	50	FTE63	32.5	38.5	78	141.5	71
75	65	FTE75	39	45	91.5	167	84
90	80	FTE90	46	52.5	112.5	196.5	98.5
110	100	FTE110	57.5	60.5	132	236	119.5
160	150	FTE160	84	87	191	342	170
200	200	FTE200	101	106	238	413	210.5

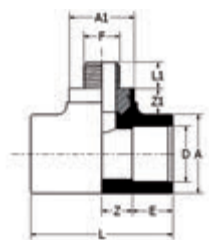
## **REDUCING TEES 90°**

Soc.



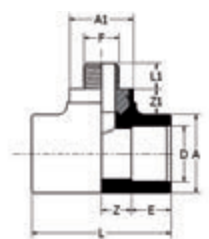
D-d	Dn	Reference	Z	Z1	E	E1	A	a	L
25-20	20-15	FTR2520	14	14,5	19.5	16.5	31.5	26.5	66.5
32-20	25-15	FTR3220	18.5	18	22.5	17	39.5	26.5	81.5
32-25	25-20	FTR3225	18	18	23	19.5	39.5	31.5	81.5
40-20	32-15	FTR4020	22	23	26.5	16	50	26.5	97
40-25	32-20	FTR4025	22	28	27	20	50	31.5	97
40-32	32-25	FTR4032	22.5	22	26.5	23	50	39.5	97
50-20	40-15	FTR5020	26	28,8	32	17	61	33	114.5
50-25	40-20	FTR5025	26	26	31.5	19.5	61	33	114.5
50-32	40-25	FTR5032	26	25.5	31.5	23	61	41	114.5
50-40	40-32	FTR5040	26.5	25,5	31.5	26.6	61	50	114.5
63-20	50-15	FTR6320	34	32.5	38	17.5	80	38	143
63-25	50-20	FTR6325	34	33.5	38.5	19.5	80.5	38	143.5
63-32	50-25	FTR6332	33.5	33.5	38.5	23.5	80	46	143.5
63-40	50-32	FTR6340	33.5	33.5	38.5	26.5	80	54.5	143.5
63-50	50-40	FTR6350	33.5	32.5	38.5	32.5	80	45	144
75-25	65-20	FTR7525	38.5	39.5	37.5	93	92.5	37	167
75-40	65-32	FTR7540	39	39.5	45.5	26.5	93	54	166.5
75-63	65-50	FTR7563	39	39	44.5	39	93	80	166.5
90-25	80-20	FTR9025	46.5	47	52	19.5	114.5	37.5	197
90-40	80-32	FTR9040	46.5	47	52.5	27	115	54.5	198
90-75	80-65	FTR9075	47	46.5	52.5	44.5	115.5	93.5	198
110-32	100-25	FTR1132	57	67.5	62	23.5	135	65	238
110-50	100-40	FTR1150	57	57	62	31.5	135.5	65	237.5
110-90	100-80	FTR1190	57.5	56.5	62	52	135.5	114.5	237.5

### REDUCING TEES WITH MALE TREADED BRASS INSERT 1/2"



D - F	Reference	A	E	Z	A1	L1	Z1	L
32-1/2"	FTFRL3212	45	22.5	18.5	37	15	15	81
40-1/2"	FTFRL4012	54	26.5	22	37	15	15.5	96.5
50-1/2"	FTFRL5012	65	31.5	28	37	15	15	118.5
63-1/2"	FTFRL6312	80	38	34	37	15	14.5	143.5

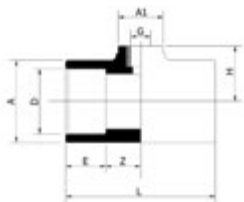
### REDUCING TEES WITH MALE TREADED BRASS INSERT 3/4"



D - F	Reference	A	E	Z	A1	L1	Z1	L
32-3/4"	FTFRL3234	43	23	17.5	46	16.5	21.5	80.5
40-3/4"	FTFRL4034	54.5	27	22	47.5	16.5	18.5	97
50-3/4"	FTFRL5034	65	32	27.5	47.5	16.5	19	118.5
63-3/4"	FTFRL6334	80	38	34	47.5	17	18.5	143.5

### THREADED 90° TEES WITH BRASS INSERT

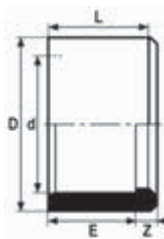
Soc. x Female brass thread branch



D	G	Reference	Dn	Z	E	A	A1	L	Z1	L1
32	1/2"	FTGRL3212	25	17.5	23.5	43	46	80.5	28	47
40	1/2"	FTGRL4012	32	22	27	54.5	47.5	97	28	47
50	1/2"	FTGRL5012	40	28	32	65	47.5	119	28.5	47
63	1/2"	FTGRL6312	50	34.5	38	80.5	47.5	144	35	53.5

**REDUCING BUSHES SHORT PATTERN**

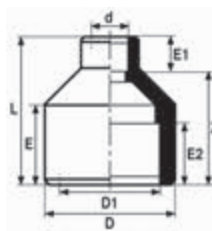
Spig. (Ø) - Soc. (øR)



D-d	Dn	Reference	Z	E	L
25-20	20	FRS25	3.5	17.0	20.5
32-25	25	FRS32	4	19.5	23.5
40-32	32	FRS40	6.5	23	29.5
50-40	40	FRS50	6.5	27	33
63-50	50	FRS63	8.5	30.5	39
75-63	65	FRS75	7.5	37.5	44.5
90-75	80	FRS90	8.5	44	52
110-90	100	FRS110	11	51.5	62.5
200-160	200	FRS200	21	86	107

**REDUCING BUSHES LONG PATTERN**

Spig. (Ø) - Soc. (øR)



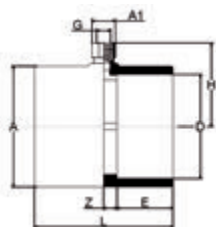
D-d	Dn	Reference	D1	Z	E	E1	E2	L
32-20	25-15	FRD3220	25	31.5	23	17	20	48
40-20	32-15	FRD4020	32	36.5	27.5	17	23.5	53.5
40-25	32-20	FRD4025	32	36.5	27	19.5	23	55.5
50-32	40-25	FRD5032	40	44	32	23.5	27	67.5
63-25	50-20	FRD6325	50	55.5	38.5	19.5	32.5	75
63-32	50-25	FRD6332	50	55.5	38.5	23	32	78.5
63-40	50-32	FRD6340	50	55.5	38.5	27	32	82.5
75-40	65-32	FRD7540	63	62	45	27.5	34	89.5
75-50	65-40	FRD7550	63	62	45	32.5	34.5	94
90-40	80-32	FRD9040	75	74.5	53	27.5	44.5	101.5
90-50	80-40	FRD9050	75	74.5	53	32.5	44.5	106.5
90-63	80-50	FRD9063	75	75	53.5	38.5	44.5	112.5
110-50	100-40	FRD1150	90	91	62	32.5	53	122.5
110-63	100-50	FRD1163	90	90	63	38.5	53	128
110-75	100-65	FRD1175	90	91.5	62.5	43.5	52.5	135
160-75	150-65	FRD1675	140	126	88	44.5	77.5	170.5
160-90	150-80	FRD1690	140	126	87	52.5	76.5	178
160-110	150-100	FRD1611	140	126	87	62	78.5	187.5

**NB :** Reducers large ends for references FRD 32 to 110 (except FRD 7532, 7540 and 7550) can be used as sockets and spigots, with one size interval. Small ends are sockets only - e.g : FRD 9063 = 90 SPIG. + 75 SOC. / 63 SOC.

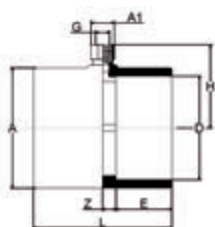
**CONDENSATE RECOVERY COUPLINGS**


D	Reference	d	E	H	L
32	APC32/16	16	22	65	47
40	APC40/16	16	26	69.5	55



**ADAPTORS FOR MEASURING ACCESSORIES****WITH 1/2" THREAD** Soc. x female brass thread branch

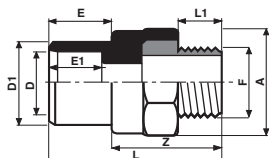
D-G	Dn	Reference	A1	Z	E	L	A	H
110-1/2"	110	FMIL110/12	36	20	61	163	132	100
160-1/2"	160	FMIL160/12	36	20.5	86	213	185	125

**ADAPTORS FOR MEASURING ACCESSORIES****WITH 3/4" THREAD** Soc. x female brass thread branch

D-G	Dn	Reference	A1	Z	E	L	A	H
110-3/4"	110	FMIL110/34	41	20	61	163	132	101
160-3/4"	160	FMIL160/34	41	20.5	86	213	185	126

**ADAPTOR NIPPLES**

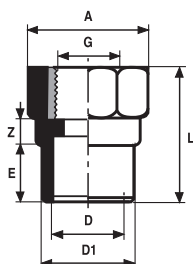
Soc./Spig. x male brass thread



D-F	Reference	D1	Z	E	E1	A	L	L1
20-1/2"	FEAL20	25	40	19.5	17.5	36	60	15
25-3/4"	FEAL25	32	42.5	23	19.5	41	65.5	17
32-1"	FEAL32	40	49	27	23	49.5	76	20
40-1 1/4"	FEAL40	50	54	32	27	60	85.5	22.5
50-1 1/2"	FEAL50	63	53	38.5	32	66	91.5	22.5
63-2"	FEAL63	75	61.5	44.5	38.5	82	106	26.5
75-2 1/2"	FEAL75	90	74	52	45	99.5	126	33
90-3"	FEAL90	110	82	62	52	117	144	35.5

**THREADED ADAPTORS**

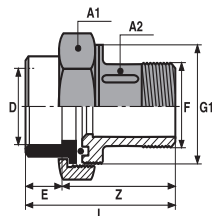
Soc./Spig. x female brass thread



D-G	Dn	Reference	D1	Z	E	L	A
20-1/2"	15	FMML20	25	11.5	19.5	45.5	37
25-3/4"	20	FMML25	32	12	23	49	41.5
32-1"	25	FMML32	40	12	27	56.5	50
40-1 1/4"	32	FMML40	50	13	32	64	60
50-1 1/2"	40	FMML50	63	12	38.5	69.5	66
63-2"	50	FMML63	75	15	44.5	80.5	82
75-2 1/2"	65	FMML75	90	13.5	52	93.5	100
90-3"	80	FMML90	110	18.5	62	108	118

**3 PIECE UNIONS KRYOCLIM® BRASS**

with EPDM gasket - Soc. x Male brass thread

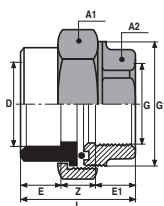


D	F	Dn	Reference	Z	E	A1	G1	A2	L
20	1/2"	15	F3F/L20	34	17	36	1"	24.5	51
25	3/4"	20	F3F/L25	50	19	46	1"1/4	31.5	69
32	1"	25	F3F/L32	54	23	52	1"1/2	37.5	77
40	1"1/4	32	F3F/L40	53	27	67	2"	47	83
50	1"1/2	40	F3F/L50	63.5	32.5	72	2"1/4	53	96
63	2"	50	F3F/L63	70	38.5	89.5	2"3/4	66	108.5

Soc. x male thread

**3 PIECE UNIONS KRYOCLIM® BRASS**

with EPDM gasket - Soc. x Female brass thread

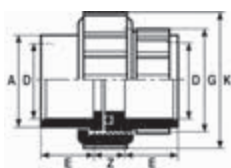


D	G	Dn	Reference	Z	E	E1	G1	A1	A2	L
20	1/2"	15	F3G/L20	8	17	14	1"	36	27	39
25	3/4"	20	F3G/L25	8	19.5	16	1"1/4	46	32.5	43.5
32	1"	25	F3G/L32	10.5	23	16.5	1"1/2	51.5	38.5	50
40	1"1/4	32	F3G/L40	10	27.5	21	2"	67	47	58.5
50	1"1/2	40	F3G/L50	12	32.5	18.5	2"1/4	72	53.5	63
63	2"	50	F3G/L63	11	38.5	22	2"3/4	89	65.5	71.5

Soc. x female thread

**3 PIECE UNIONS**

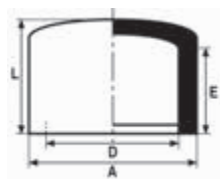
Soc. x Soc. with EPDM gasket




D	Dn	Reference	Z	E	A	G	K
20	15	F3P20	14	17	27	1"	42
25	20	F3P25	14	19	35.5	1"1/4	55
32	25	F3P32	13.5	23	41.5	1"1/2	62.5
40	32	F3P40	17	26.5	52.5	2"	73.5
50	40	F3P50	17.5	32.5	58.5	2"1/4	81.5
63	50	F3P63	22	38.5	74	2"1/2	100.5

**CAPS**

Soc.

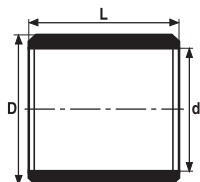


D	Dn	Reference	E	A	L
20	15	FBO20	18	26	22
25	20	FBO25	19.5	31.5	25.5
32	25	FBO32	24	40	30
40	32	FBO40	28	54.5	38.5
50	40	FBO50	32	65	45.5
63	50	FBO63	38.5	80	54
75	65	FBO75	44	90	60
90	80	FBO90	53	110.5	72
110	100	FBO110	62.5	128.5	111
160	150	FBO160	87.5	185.5	154

	KRYOCLIM® SYSTEM	Technical Sheet <b>7.8</b>
	DIMENSION SHEET	

## PLAIN NIPPLES

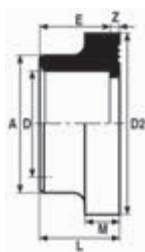
Spig. x Spig.



D	Dn	Reference	L	d
20	15	FMC20	37	15.5
25	20	FMC25	42	19.5

## SERRATED STUB FLANGES

Soc.



D	Dn	Reference	Z	E	A	D2	M	L
32	25	FCS32	3.5	23	41	50.5	7.5	26.5
40	32	FCS40	3.5	27	50	61.5	8.5	30.5
50	40	FCS50	3.5	32	61	73.5	8.5	35.5
63	50	FCS63	3.5	38.5	76	90	9.5	41.5
75	63	FCS75	3.5	44	90	106	10	47.5
90	80	FCS90	5	51.5	107.5	125	11	56.5
110	100	FCS110	5.5	62	131	150.5	12	67
160	150	FCS160	5.5	86.5	187.5	212.5	16.5	91.5
200	200	FCS200	7	106	230.5	273.5	18	113

## FLANGE KITS FOR “COMP” BELLOWS

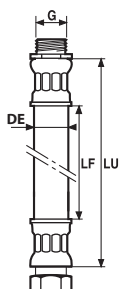
Stub flange + backing ring + bolts + washers



Reference	Quantity			
	stub flanges	backing rings	bolts	washers
FKITCOMP40	2	2	8	8
FKITCOMP50	2	2	8	8
FKITCOMP63	2	2	8	8
FKITCOMP75	2	2	16	16
FKITCOMP90	2	2	16	16
FKITCOMP110	2	2	16	16
FKITCOMP160	2	2	16	16

## EXPANSION JOINTS

with brass threads

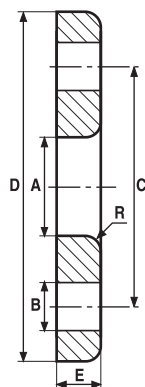


D-G	Dn	Reference	LF	LU	DE	DI
20-1/2"	15	HCD/G20	410	457	22	13
25-3/4"	20	HCD/G25	520	592	28	17
32-1"	25	HCD/G32	640	720	35	22
40-1 1/4"	32	HCD/G40	760	825	42	28
50-1/2"	40	HCD/G50	980	1067	50	34

# DIMENSION SHEET

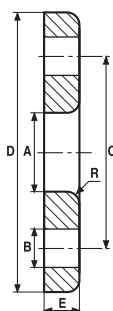
# 7.9

2017

**BACKING RINGS PN16** according to DIN 16-966 (glass fibre reinforced polyester) - color: white


Drilled GN 10/16

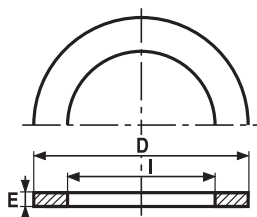
Pipe Ø	Flange Dn	Reference	A	B	C	D	E	R	Nbr of holes	Torque
20	15	BVR15	28	14	65	95	14	1.5	4	0,5 to 1 mkg
25	20	BVR20	34	14	75	105	18	1.5	4	0,5 to 1 mkg
32	25	BVR25	42	14	85	115	20	1.5	4	0,5 to 1 mkg
40	32	BVR32B	52	18	100	140	20	2	4	2 to 4 mkg
40	40	BVR40A	54	18	110	150	20	2	4	2 to 4 mkg
50	40	BVR40B	63	18	110	150	20	2	4	2 to 4 mkg
50	50	BVR50A	65	18	125	165	22	2.5	4	2 to 4 mkg
63	50	BVR50B	78	18	125	165	22	2.5	4	2 to 4 mkg
63	60	BVR60A	78	18	135	175	22	2.5	4	2 to 4 mkg
63	65	BVR65A	81	18	145	185	22	2.5	4	2 to 4 mkg
75	60	BVR60B	92	18	135	175	18	2.4	4	2 to 4 mkg
75	65	BVR65B	92	18	145	185	22	2.5	4	2 to 4 mkg
75	80	BVR80A	94	18	160	200	24	3	8	2 to 4 mkg
90	80	BVR80B	110	18	160	200	24	3	8	3 to 4 mkg
110	100	BVR100	133	18	180	220	26	3	8	3 to 4 mkg
110	110	BVR110A	133	18	190	230	24	3	8	3 to 4 mkg
125	125	BVR125A	150	18	210	250	28	4	8	3 to 4 mkg
160	150	BVR150	190	22	240	285	30	4	8	3 to 4 mkg
200	200	BVR200	235	21	300	340	32	4	8	3 to 4 mkg

**BACKING RINGS PN16** according to DIN 16-966 (glass fibre reinforced polyamide) - color: black


Pipe Ø	Flange Dn	Reference	A	B	C	D	E	R	Nbr of holes	Torque
50	40	BPA40	62.5	18	110	150	18	2.5	4	3 mkg
63	50	BPA50	78.5	18	125	165	19	2.5	4	3 mkg
63	60	BPA60	78.5	18	135	175	19	2.5	4	3 mkg
75	65/60	BPA65	92	18	145	185	22	2.5	8	4 mkg
90	80	BPA80	110	18	160	200	22	2.5	8	4 mkg
110	100	BPA100	133	18	180	218	24	3	8	5 mkg
125	125	BPA125	150	18	210	250	26	3	8	5 mkg
140	125	BPA140	167	18	210	250	28	4	8	5 mkg


## FLAT GASKETS FOR FLANGE ADAPTORS - VITON

Référence	Dn	D	I	E
JPVCS20	15	32	20	2
JPVCS25	20	39	25	2
JPVCS32	25	48	32	2
JPVCS40	32	59	40	3
JPVCS50	40	71	50	3
JPVCS63	50	88	63	3
JPVCS75	65	104	75	3
JPVCS90	80	123	90	3
JPVCS110	100	148	110	4
JPVCS125	125	168	125	4
JPVCS140	125	186	140	4
JPVCS160	150	211	160	4
JPVCS200	200	272	200	4



## FLAT GASKETS FOR FLANGE ADAPTORS - EPDM

Référence	Dn	D	I	E
JPNCS20	15	32	20	2
JPNCS25	20	39	25	2
JPNCS32	25	48	32	2
JPNCS40	32	59	40	3
JPNCS50	40	71	50	3
JPNCS63	50	88	63	3
JPNCS75	65	104	75	3
JPNCS90	80	123	90	3
JPNCS110	100	148	110	4
JPNCS125	125	168	125	4
JPNCS140	125	186	140	4
JPNCS160	150	211	160	5
JPNCS200	200	272	200	4

	KRYOCLIM® SYSTEM		Technical Sheet  <b>7.10</b>
	DIMENSION SHEET MONOKLIP® BRACKETS		

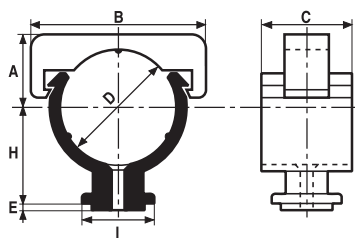
## MONOKLIP® BRACKETS

Specially designed to support pipes. They are highly resistant, corrosion-proof, fitted instantly and allow the pipe to expand freely. Max spacing between supports: see technical sheet no 5.1

Monoklip® brackets with drilled bases can be used with countersunk-head screws  $\varnothing$  4 and 5 mm.

### MONOKLIP® BRACKETS with metal threaded insert

**M6**: references HCK16/6 and HCK20/6 - **M8**: references HCK16/8 et HCK20/8 - **7x150**: references HCK16/7 et HCK20/7  
**without insert, drilled base  $\varnothing$  5.5**: reference HCKP16/5 and HCKP20/5

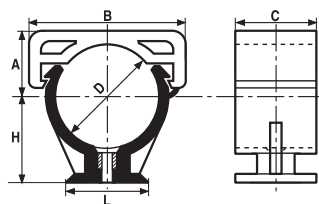


D	Dn	Référence	H	A	B	C	E
with THREADED M6							
20	15	HCK20/6	20	14	32	22	1
with THREADED 7 x 150							
20	15	HCK20/7	20	14	32	22	1
with THREADED M8							
20	15	HCK20/8	20	14	32	22	1
without INSERT drilled base Ø 5,5							
20	15	HCKP20/5	20	14	32	22	1

NB: compatible with wedges ref. CALE1220, 20 mm thickness

### MONOKLIP® BRACKETS with metal threaded insert

**M6**: references HCKC25/6, HCKC32/6, HCKC40/6, HCKC50/6, HCKC63/6  
**7x150**: references HCKC25/7, HCKC32/7, HCKC40/7, HCKC50/7, HCKC63/7  
**M8**: references HCKC25/8, HCKC32/8, HCKC40/8, HCKC50/8, HCKC63/8  
**without insert, drilled base  $\varnothing$  5.5**: reference HCKCP25/5



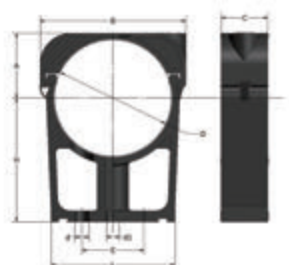
Diameter 25 to 63

D	Dn	Reference	H	A	B	C	L
without INSERT drilled base Ø 5,5							
25	20	HCKCP25/5	22	16	38.5	25	16
with THREADED M6							
25	20	HCKC25/6	22	16	38.5	25	16
32	25	HCKC32/6	28	20	44	24.5	34
40	32	HCKC40/6	32	24	55	24.5	34
50	40	HCKC50/6	35	30	65.6	24.5	52
63	50	HCKC63/6	35	41	79.5	24.5	52
with THREADED 7 x 150							
25	20	HCKC25/7	22	16	38.5	25	16
32	25	HCKC32/7	28	20	44	24.5	34
40	32	HCKC40/7	32	24	55	24.5	34
50	40	HCKC50/7	35	30	65.6	24.5	52
63	50	HCKC63/7	35	41	79.5	24.5	52
with THREADED M8							
25	20	HCKC25/8	22	16	38.5	25	16
32	25	HCKC32/8	28	20	44	24.5	34
40	32	HCKC40/8	32	24	55	24.5	34
50	40	HCKC50/8	35	30	65.6	24.5	52
63	50	HCKC63/8	35	41	79.5	24.5	52

### MONOKLIP® BRACKETS



**Ø 75 to 160**

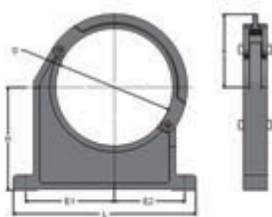


D-dn	Reference	H	A	B	C	L	d	E	J
with THREADED M8									
75-65	HCKC75/8	80	42	96	30	80	9	40	7
90-80	HCKC90/8	80	49	113	30	80	9	40	7
110-100	HCKC110/8	80	60	130	30	80	9	40	7
160-150	HCKC160/8	120	85	194	30	230	9	210	7

# **DIMENSION SHEET** **MONOKLIP® BRACKETS AND WEDGES**

# **7.11**

2017



D	Reference	A	E1	E2	H	L
without INSERT Ø 8 mm drilled base						
200	A9C200	124	151	120	175	311

Ø 200  
drilled base

## **WEDGES FOR MONOKLIP® BRACKETS**



D	Reference	H	d1	H
12 to 20	CALE1220	26	16	20

Ø 12 to 20

## **WEDGES FOR MONOKLIP® BRACKETS**

20 mm high - only compatible with MONOKLIP® brackets HCKC 25 to 63



D	Reference	H	I	L
25 to 63	CALE2563	20	25	52

Ø 25 to 63

## **WEDGES FOR MONOKLIP® BRACKETS**

4 mm high - only compatible with MONOKLIP® brackets HCKC 25 to 63



D	Reference	H	I	L
25 to 63	CALE2563/4	4	25	52

Ø 25 to 63

## **WEDGES FOR MONOKLIP® BRACKETS**

20 mm high - only compatible with MONOKLIP® brackets HCKC 75 to 110



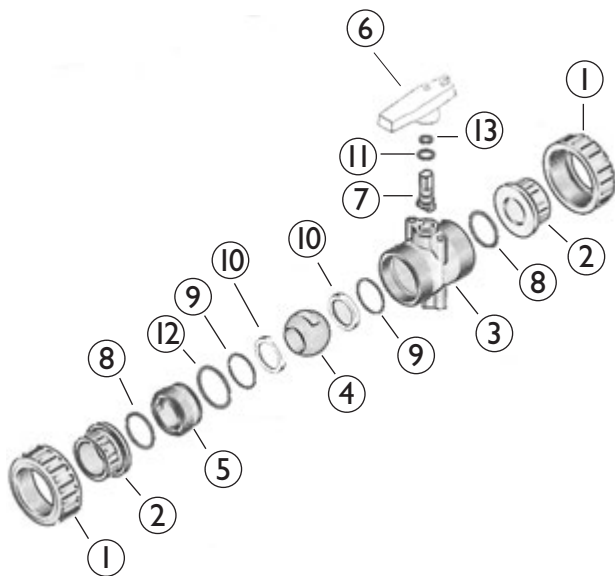
D	Reference	H	I	L
75 to 110	CALE75110	20	30	80

Ø 75 to 110



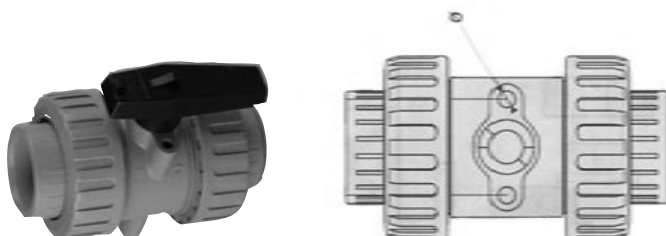
## BALL VALVES Ø 20 to 63

Application: CHW for comfort cooling > 5°C



①	Backing nut
②	Welded stub socket
③	Body
④	Ball
⑤	Ball seat support
⑥	Handle
⑦	Spindle
⑧	Socket o'ring
⑨	Seat gasket
⑩	Ball seat
⑪	Spindle o'ring
⑫	Ball seat support o'ring
⑬	Spindle o'ring

## SUPPORT SYSTEM



• These ball valves have a built-in anchoring system.

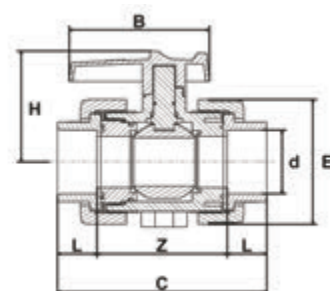
• There are two holes underneath fitted with threaded brass inserts (use screw in accordance with data below).

• These valves are solvent cemented to pipes, and can be dismantled thanks to their double union concept.

• Observe the flow direction.

Ball valve Ø	16	20	25	32	40	50	63
Screw Ø for brass insert (mm)	M4	M4	M4	M5	M6	M6	M6

Reference	d	DN	L	Z	C	E	H	B	weight	Ø
VFCEP20	20	15	16	70	102	47	45	66	160	5.5
VFCEP25	25	20	19	82	120	57	55	78	260	5.5
VFCEP32	32	25	22	87	131	68	67	86	380	6.5
VFCEP40	40	32	26	98	150	86	83	100	655	8
VFCEP50	50	40	31	101	163	98	91	110	925	8
VFCEP63	63	50	38	121	197	122	111	130	1695	8





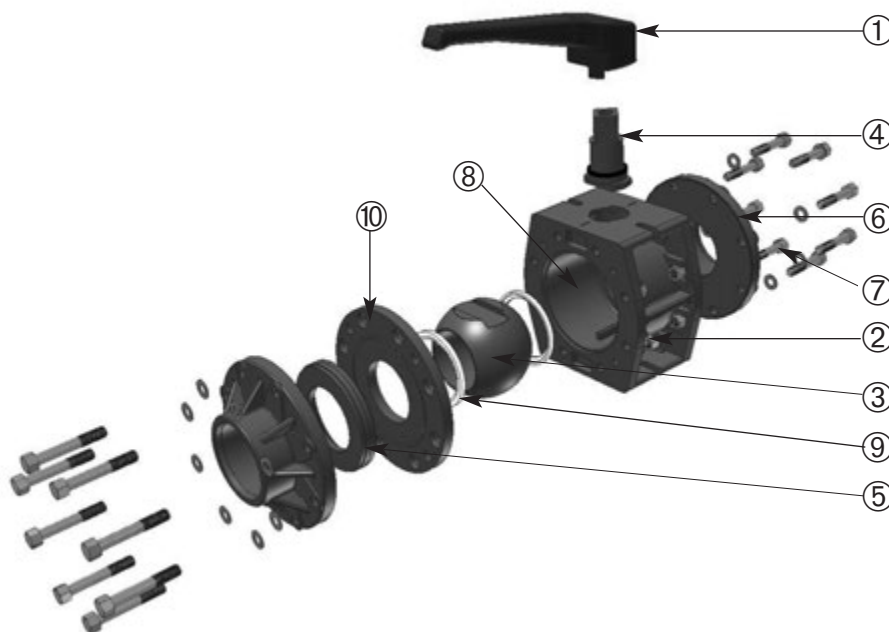
# **TECHNICAL SHEETS** **FLANGED SOCKET KRYOCLIM® BALL VALVES** **CEMENTED SOCKET ENDS**

# **8.2**

2017

## **BALL VALVES** **Ø 75 to 110**

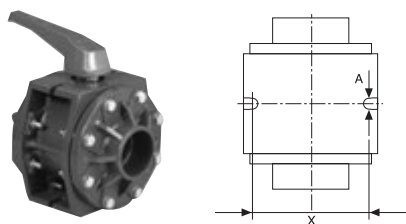
Application: CHW for comfort cooling &gt; 5°C



①	Handle
②	Body
③	Ball
④	Spindle
⑤	Ball seat support
⑥	Cemented socket end
⑦	Nuts bolts
⑧	Ball seat
⑨	O-rings
⑩	Counterplate

**For valves 75/90/110,  
disassembling the  
counterplate is prohibited**

## **SUPPORT SYSTEM**



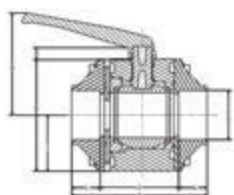
Ø ball valve	75	90	110
A	11	11	11
X (mm)	110	110	135

The valve's weight and proper use require it to be mounted on an appropriate support.


The valve body has two openings on its base, allowing it to be attached to the support with bolts. The above table indicates the width of the openings and their spacing. .

• The Ø 75 - Ø110 valves are factory-configured. It is strongly advised to not disassemble the counterplate ensuring the settings are maintained. The valve connecting flanges can be disassembled..

• Respect the flow direction.



With cemented socket ends		l	z	h	e	b	c	a	i	weight (kg)
d	Ref. EPDM									
75	VFFEP75	43	148	234	211	177	210	25	105	7
90	VFFEP90	52	148	252	211	177	210	25	105	7
110	VFFEP110	63	174	300	252	220	255	30	121	11

	KRYOCLIM® SYSTEM	Technical Sheet <b>9.1</b>
	CHEMICAL RESISTANCE TABLES	

Most current antifreeze liquids are compatible with KRYOCLIM® e.g.: MEG (MonoEthylene Glycol), MPG (MonoPropylene Glycol), potassium Acetate, Potassium Formate, NaCl, CaCl, ammonia-based water solutions.

All additional fluids (e.g. additives) may not be compatible with KRYOCLIM®. Please check with your supplier or the manufacturer.

Any other additive (anti-oxidation, protection films...) must not be used unless its compatibility with KRYOCLIM® has been ascertained with your supplier or the manufacturer.

Elements supplied in the tables below concern HPF®. Other materials used in the KRYOCLIM® system (brass, welding polymer, etc...). require separate compatibility studies.

The indications given in the tables below are extracts from French or foreign documents or the result of our own experiments.

They cannot be considered to be absolute or guaranteed, as they are not valid in all specific operating conditions. It must also be noted that the nature of chemical agents and their mixtures, the presence of impurities, and the degree of vulcanisation of elastomers, can lead to large variations in these indications; only practical tests in these cases can provide valid results.

We cannot be held liable for the indications given.

**SPECIAL NOTE FOR METAL COMPONENTS:** Some of the articles offered in KRYOCLIM® include brass or stainless steel components. These articles were specially designed for chilled fluids. However, some particularly aggressive potable waters might not be compatible with brass and cause brass components to deteriorate. Consequently, the people in charge of a project (contractors, consulting engineers, investors, etc.) need to check the potable water's quality with the water supplying company, and get assurances from them and from the manufacturer that the water is indeed compatible with brass. Also, the compatibility of additives introduced into double purpose air conditioning networks (comfort cooling + heating in one single flow and return pipework) with brass must be checked before use. You are requested to consult the manufacturer for applications other than domestic water services and heating/cooling air conditioning.

The chemical agents are classified in alphabetical order.

**Meaning of symbols:**

**2:** Good resistance, **0:** Not resistant (use not recommended), **-:** Not tested

Please contact: be.girpi@alixis.com

REACTIVE	H.P.F.®	EPDM
	20°C	20°C
Acetaldehyde	0	-
Acetic acid 0 - 20 %	2	2
Acetic acid 20 - 30 %	2	-
Acetic acid 30 - 60 %	2	-
Acetic acid 80 - 100 %	2	-
Acetic anhydride	0	-
Acetone	0	-
Acetylene	2	2
Acid wash water of ore processing	2	-
Adipic acid	2	2
Allyl alcohol 96 %	2	-
Alum	2	2
Aluminium chloride	2	2
Aluminium fluoride	2	2
Aluminium hydroxide	2	-
Aluminium nitrate	2	-
Aluminium oxychloride	2	-
Ammonia (liquid)	-	2
Ammonium bifluoride	2	-
Ammonium carbonate	2	2
Ammonium chloride	2	2
Ammonium fluoride	2	2
Ammonium hydroxide	0	-
Ammonium nitrate	2	2
Ammonium methaphosphate	2	-
Ammonium phosphate (ammoniacal and neutral)	2	2
Ammonium sulphate	2	2
Ammonium sulphite	2	-
Ammonium persulphate	2	-
Ammonium thiocyanate	2	-
Amyl acetate	0	-
Amyl chloride	0	-

REACTIVE	H.P.F.®	EPDM
	20°C	20°C
Amy alcohol	2	2
Anhydrous nitric acid	0	-
Aniline	0	-
Aniline chlorate	2	-
Aniline hydrochloride	0	-
Antimony trichloride	2	2
Anthraquinone	2	-
Aqua regia 50 %	2	-
Aqua regia (nitrohydrochloric acid)	2	2
Arsenic acid 80 %	2	2
Asphalt	2	0
Barium carbonate	2	-
Barium chloride	2	2
Barium hydroxide	2	2
Barium sulphite	2	-
Barium sulphate	2	2
Beetroot (sweet liqueur)	2	-
Benzaldehyde	0	-
Benzene	0	-
Benzoic acid	2	2
Benzol	0	-
Bismuth carbonate	2	-
Borax	2	2
Boric acid	2	2
Boric trifluoride	2	-
Bromic water 10 %	2	2
Bromine liquid	0	-
Bromide sodium	2	-
Bromide water	2	-
Brine	2	2
Butadiene	2	0
Butyl alcohol	2	2
Butylene	2	2

# CHEMICAL RESISTANCE TABLES

# 9.2

2007

REACTIVE		H.P.F.®	EPDM
		20°C	20°C
Butylnediol (erythritol)		2	2
Butylphenol	100 %	2	-
Calcium bisulfite		2	-
Calcium chlorate		2	-
Calcium chlorate		2	2
Calcium hydroxide		2	-
Calcium hypochlorite		2	2
Calcium nitrate		2	2
Calcium sulphate		2	2
Cane sugar melasses		2	-
Carbonate de calcium		2	-
Carbonic acid		2	2
Castor oil		2	-
Caustic potash		2	2
Cellosolve		2	-
Chloral hydrate		2	-
Chlorate potassium		2	2
Chloroacetic acid		2	-
Chloroforme		0	-
Chloride ferric		2	2
Chloride sodium		2	2
Chlorine water	5 %	2	2
Chlorobenzine		0	-
Chlorosulphonic acid	100 %	2	-
Chlorure d'allyle		0	-
Coagulation bath of rayon		2	-
Copper cyanide		2	2
Copper chloride		2	2
Copper fluoride		2	2
Copper nitrate		2	2
Copper sulphate		2	2
Cresol	90 %	2	-
Crude acetic esters		2	0
Crude acetic esters		2	2
Chromic alum		2	2
Chromic acid	10 %	2	-
Chromic acid	30 %	2	-
Chromic acid	40 %	2	-
Chromic acid	50 %	2	-
Citric acid	20 %	2	2
Cyclohexanol		0	-
Cyclohexanon		0	-
Dextrin	18 %	2	2
Dextrose		2	-
Diazotization salts		2	-
Dichloroethylene		0	-
Dichromate sodium		2	-
Diglycolic acid	30 %	2	2
Dimethylamine		0	-
Diocetyl phthalate		0	-
Disodic phosphate		2	-
Distilled water		2	2
Ether		0	-
Ethoxyl		0	-
Ethyl acetate		0	-
Ethyl acrylate		0	-
Ethyl alcohol	5 %	2	2
Ethylene bromide		0	-
Ethyl chloride		0	-
Ethyl chlorohydrine		0	-
Ethyl ether		0	-

REACTIVE		H.P.F.®	EPDM
		20°C	20°C
Fatty acids		2	-
Ferrocyanide sodium		2	2
Ferric nitrate		2	2
Ferrous sulphate		2	2
Ferric sulphate		2	2
Fluoboric acid		2	-
Fluoboric acid		2	-
Formaldehyde		0	2
Formic acid		2	2
Foundry cores oil		2	-
Fresh water		2	2
Fructose		2	-
Furfural		0	-
Gallic acid		2	-
Gelatine		2	2
Glacial acetic acid		2	-
Glucose		2	2
Glycerine		2	2
Glycolic acid		2	2
Greasing oil		2	-
Hexane		2	-
Hydrochloric acid	20 %	2	2
Hydrochloric acid	0 - 25 %	2	2
Hydrochloric acid	25 - 40 %	2	-
Hydrofluoric acid	60 %	2	-
Hydrofluoric acid	40 %	2	-
Hydrocyanic acid		2	-
Hydrofluosilicic acid		2	-
Hydrogen peroxide	30 %	2	-
Hydrogen phosphide		2	-
Hydroquinone		2	-
Hydroxylamine sulphate	12 %	2	2
Hypochlorous acid		2	-
Kerosene		2	-
Lactic acid	28 %	2	-
Lauric acid		2	-
Lauryl chloride		2	-
Lauryl sulphate		2	-
Lead acetate		2	2
Lime sulfide		2	2
Linoleic acid		2	-
Magnesium carbonate		2	-
Magnesium chloride		2	2
Magnesium hydroxide		2	-
Magnesium sulphate		2	2
Magnesium nitrate		2	2
Maleic acid	35 %	2	2
Malic acid		2	2
Melasses		2	2
Mercuric		2	2
Mercuric chloride		2	2
Mercuric cyanide		2	2
Mercaptothiazolate		0	-
Mercurous nitrate		2	2
Methyl alcohol	10 %	2	2
Methyl chloride		0	-
Methyl sulphate		2	-
Methylethylcetone		0	-
Methylene chloride		0	-
Monopropylene glycol		0	-
Naphta		2	-
Naphtalene		0	-
Nickel chloride		2	2



## CHEMICAL RESISTANCE TABLES

REACTIVE	H.P.F.®	EPDM
	20°C	20°C
Nickel nitrate	2	2
Nickel sulphate	2	2
Nicotine	2	2
Nicotinic acid	2	-
Nitric acid 30 - 50 %	2	-
Nitric acid 50 - 60 %	2	0
Nitric acid 60 %	2	0
Nitric acid 68 %	2	0
Ocenol (non-saturated alcohol)	2	-
Oleic acid	2	-
Oleum	0	-
Oxalic acid	2	2
Palmitic acid 100 %	2	-
Peracetic acid 40 %	2	-
Perborate potassium	2	-
Perchloric acid 10 %	2	2
Perchloric acid 70 %	2	2
Permanganate potassium 10 %	2	2
Persulphate potassium	2	2
Phenol	2	0
Phenylhydrazine	0	-
Phenylhydrazine hydrochloride	2	2
Phosgene gas 100 %	2	2
Phosgene liquid	0	-
Phosphoric acid 0 - 25 %	2	2
Phosphoric acid 25 - 50 %	2	2
Phosphoric acid 50 - 85 %	2	2
Phosphorus pentoxide	2	2
Phosphorus trichloride	0	-
Photographic baths	2	2
Picric acid 1 %	0	2
Potassium bicarbonate	2	2
Potassium bichromate	2	2
Potassium bicarbonae	2	2
Potassium bromate	2	2
Potassium bromide	2	2
Potassium carbonate	2	2
Potassium chromate	2	2
Potassium chloride	2	2
Potassium cyanide	2	2
Potassium dichromate	2	-
Potassium ferrocyanide	2	2
Potassium ferrocyanide	2	2
Potassium fluoride	2	2
Potassium hydroxide	2	-
Potassium nitrate	2	2
Potassium perchlorate 1 %	2	2
Potassium sulphate	2	2
Primary butanol	2	2
Propargyl alcohol	2	2
Propyl alcohol 1 %	2	2
Propylene dichloride	0	-
Pure acetic esters	0	-
Pure acetic esters	0	-
Saltwater 90 %	2	-
Secondary butanol	2	2
Secondary butanol	2	2
Selenic acid	2	-
Silinic acid	2	2
Silver cyanide	2	2
Silver nitrate	2	2
Silvering solutions	2	2
Soaps	2	2
Sodium acetate	2	-

REACTIVE	H.P.F.®	EPDM
	20°C	20°C
Sodium acid phosphate	2	2
Sodium arsenite	2	-
Sodium benzoate	2	2
Sodium bicarbonate 36 %	2	2
Sodium bisulphate	2	-
Sodium bisulphite	2	2
Sodium carbonate (soda ashes)	2	2
Sodium chlorate	2	2
Sodium cyanide	2	2
Sodium fluoride	2	2
Sodium fluoride	2	2
Sodium hydroxide	2	2
Sodium hydroxide	2	2
Sodium hypochlorite	2	2
Sodium nitrate	2	2
Sodium nitrate	2	2
Sodium nitrite	0	-
Sodium silicate	2	2
Sodium sulphate	2	2
Sodium sulphite	2	-
Sodium sulphide	2	2
Sodium thisulphate (or hypo-)	2	2
Stannic chloride	2	2
Stannous chloride	2	2
Stearic acid	2	2
Sulphuric acid 0 - 40 %	2	2
Sulphuric acid 40 - 80 %	2	2
Sulphuric acid 80 - 90 %	2	0
Sulphuric acid 95 %	2	0
Sulphurous acid	2	-
Sulphur aluminium sulphate	2	2
Sulphuric anhydride	2	-
Sulphuric anhydride	2	-
Stoddard solvent	2	-
Tannic acid	2	-
Tartaric acid	2	2
Tertiary hexanol	2	2
Tetraethyl lead	2	-
Tetrahydrofurane	0	-
Thionyl chloride	0	-
Titanium tetrachloride	2	0
Toluol or toluene	0	-
Tributyl phosphate	0	-
Trichlorethylene	0	-
Tricresylphosphate	0	-
Triethanolamine	0	-
Triethylamine	2	-
Trimethylolpropane 10 %	2	2
Trisodic phosphate	2	-
Urea 30 %	2	2
Urine	2	2
Iron chloride	2	2
Vinyl acetate	0	-
Xylene or Xylol	0	-
Zinc chloride	2	2
Zinc chromate	2	2
Zinc cyanide	2	2
Zinc nitrate	2	2
Zinc sulphate	2	2

## DESCRIPTION FOR SPECIFICATION

Pipe system made of ductile synthetic material (PVC-H.P.F) between 20 and 200 mm in diameter.

### **FIELDS OF APPLICATION:**

The transport of coolants for use in residential or tertiary centralized cooling, air conditioning or industrial applications.

### **IDENTIFICATION - RANGE:**

The system must include:

- PVC-H.P.F pipes and fittings 20 - 160 in diameter for size PN10 and 200 in diameter for size PN6. They will be self-coloured green to simplify construction work and prevent errors.
- A tinted welding polymer serving as a welding indicator (dark green).
- Pipes delivered capped and in plastic covers to ensure they are kept clean until assembly.
- A wide range of PVC-H.P.F fittings with brass inserts to secure connections with metal threading.
- Fittings permitting the installation of a contact or immersion temperature probe to allow the system temperature to be easily monitored.
- Sliding mounting brackets that take expansion and contraction requirements into account and meet the manufacturer's recommendations.

### **QUALITY - CERTIFICATIONS:**

- The system will be produced by a company that is ISO 9001, ISO 14001, and OHSAS 18001 certified.
- The system will be quality certified: an ATec by CSTB for the pipes and fittings for diameters between 20 and 160 "Cooling and air conditioning facility circulating cool and chilled air for temperatures between - 30°C and + 20°C and a maximum admissible pressure of 10 bars."
- CSTBat certification and the manufacturer's written guarantee.
- The polymer composition must comply with the EU positive lists, with a certificate attesting this, issued by an independent European organization.
- A Euroclasses reaction to fire classification of M1 and B-s1-d0 according to standard EN 13501-1 in order to comply with the fire safety regulations for buildings open to the public (Ministry of the Interior's order of 29 July 2003).

The pipes will be marked with the product quality certifications and information ensuring the traceability of manufacturing.

In addition to the tests under the standard, the fittings will be submitted to static and 20/50 bar alternating pressure tests for 2000 cycles (1Hz) for diameters between 20 and 90, and for 1500 cycles (0.42Hz) for diameters between 110 and 160, in accordance with standards NF T 54-094 and NF T 54-016.

The pipes must be highly resistant to impacts at low temperatures (>100 J at 20°C under standard NF EN 744).

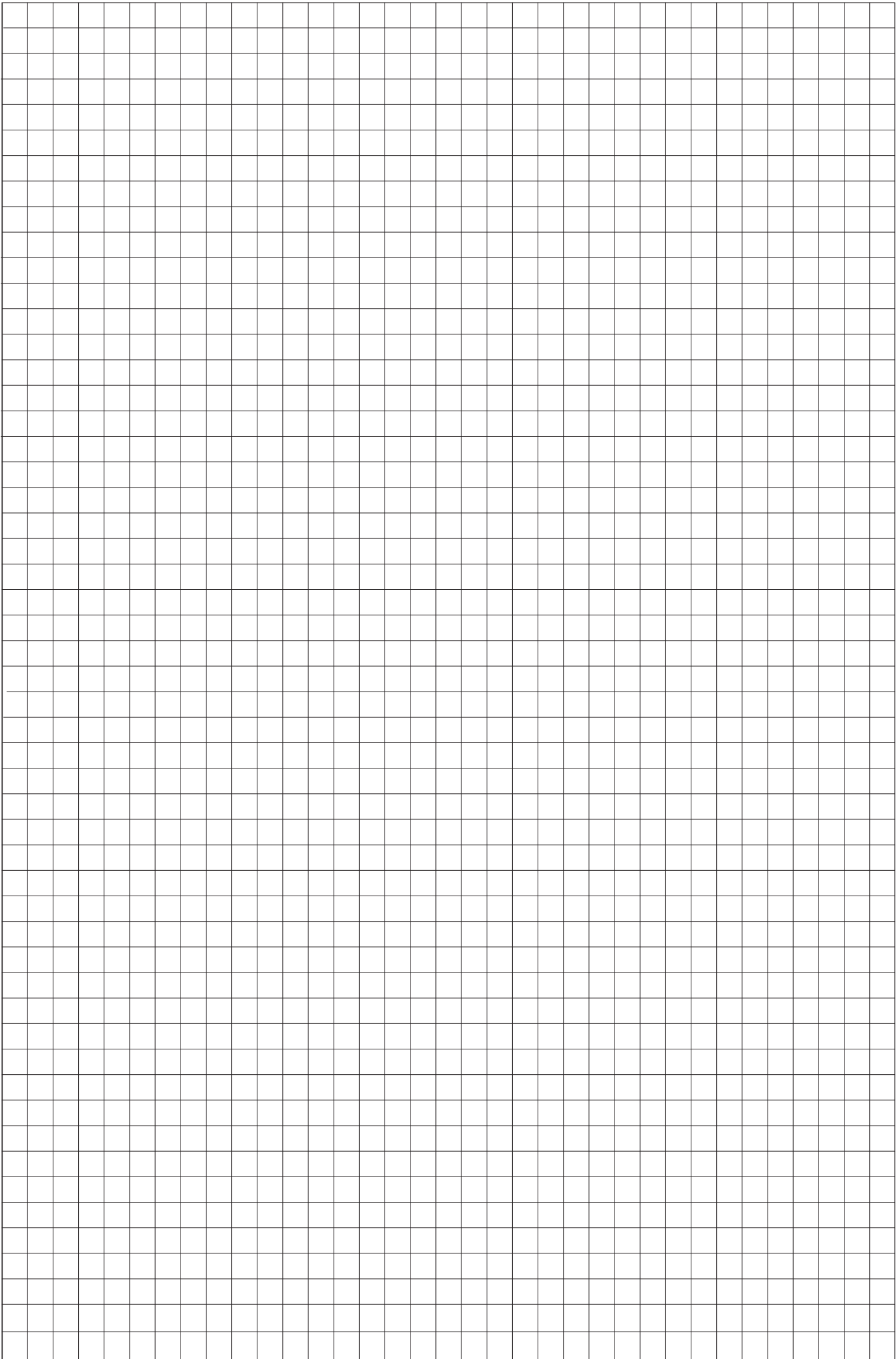
The system must be compatible with commonly used coolants.

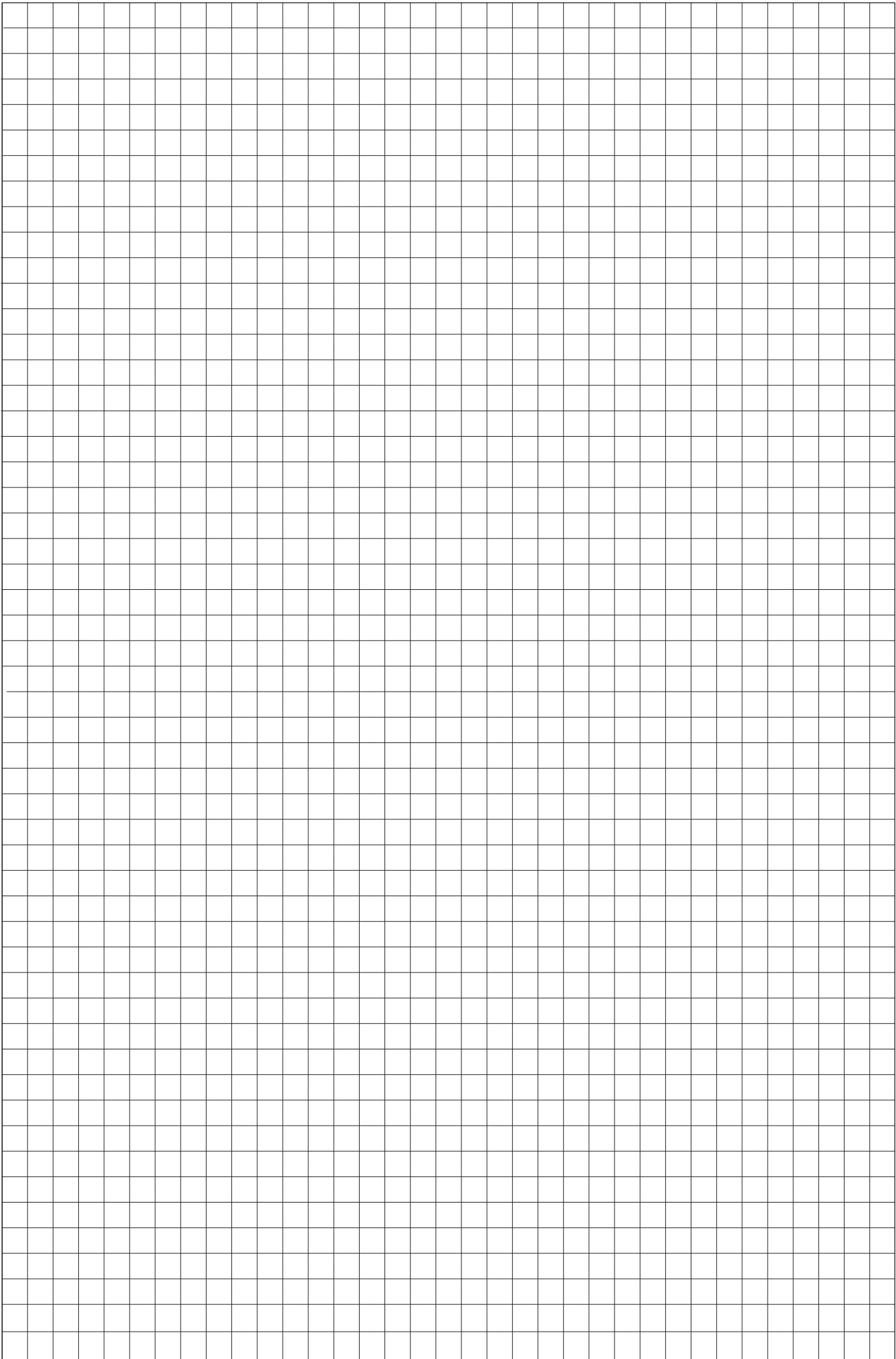
### **ASSISTANCE:**

The manufacturer must be able to provide its BIM product library, develop an implementation plan based on the site plan provided by the contracting company and provide on-site or in-factory professional training on the implementation of its system.

### **ENVIRONMENT:**

The system must be recyclable, with the existence of a recycling channel.







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