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PRANDELLI®

SYSTEM FOR HEATING AND WATER SUPPLY SYSTEM

tuborama®

EDITION 1: 04/09

INTRODUCTION

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***TUBORAMA* is a crosslinked polyethilene pipe available both as PE-Xc (electronbeam method) and PE-Xb (silane crosslinking) suitable for the construction of modern heating and water supply installations.**

*The high quality standard of the raw material used, the reliability of the technological process and the crosslinking method used make **TUBORAMA** a product which responds extremely effectively to the most widely varying installation requirements. What's more, the use of screw-on mechanical brass fittings to form the joints makes the installation technique especially simple, with no specific working equipment needed.*

CONTENTS

CHARACTERISTICS OF CROSSLINKED POLYETHYLENE

PROPERTY	TEST METHOD	TEST TEMPERATURE	UNIT OF MEASUREMENT	TEST VALUE
Density	ISO-DIS 1872	-	g/cm³	~ 0.95
Ultimate tensile strength	DIN 53455	+23°C +100°C	Kg/mm² Kg/mm²	2.0 ÷ 2.9 1.0 ÷ 1.9
Ultimate elongation	DIN 53455	+23°C +100°C	% %	170 ÷ 250 300 ÷ 500
Modulus of elasticity	DIN 53457	0°C 80°C	Kg/cm² Kg/cm²	15.000 5.000
Impact resistance	B.S.	-150°C 20°C	Kgm/cm² Kgm/cm²	no breakage no breakage
Field of use	-	-	°C	-100 +110
Linear expansion coefficient	-	(20°C) (100°C)	$°C^{-1}$	1.5×10^{-4}
Softening temperature	-	-	°C	135
Thermal conductivity coefficient (□)	-	-	Kcal/hm°C	0.38
Volume resistivity	BS2782-202B	20°C	ohm • cm	$> 1 \times 10^{16}$

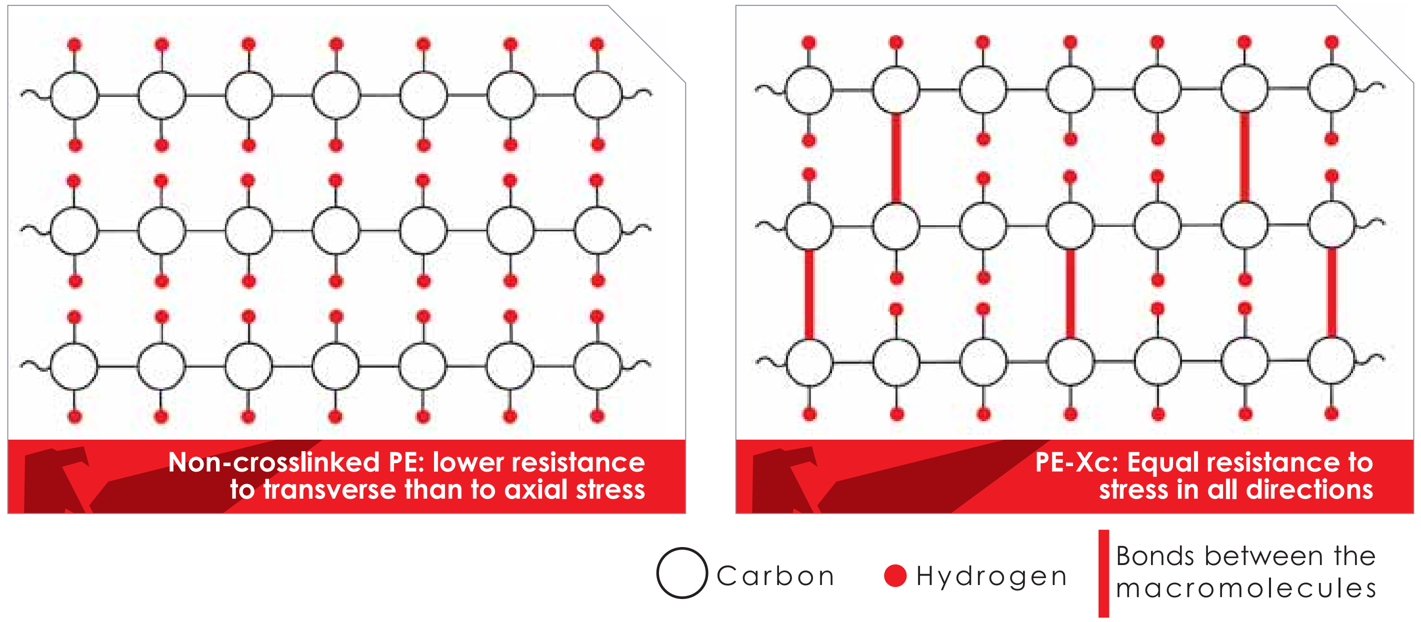
CROSSLINKING

Polyethylene consists of long macromolecules, which are linked together by transverse bonds in the "crosslinking" process.

Depending on the crosslinking process adopted, the current UNI EN ISO 15875 norm requires the following values for the minimum degree of crosslinking:

PE-Xa	Peroxide method	≥ 70%	
PE-Xb	Xylan method	≥ 65%	
PE-Xc	Electron beam method	≥ 60%	TUBORAMA

Compliance with these limits guarantees high mechanical, thermal and chemical resistance values, and ***TUBORAMA* is thus able to transport hot and cold water under pressure** for long periods of time.



Crosslinking also gives the pipe a property known as THERMAL MEMORY, a specific, exclusive feature of crosslinked polyethylene pipes. This property allows correction of any errors made when bending the pipe, with the aid of hot air generators.

2. TUBORAMA MAIN CHARACTERISTICS

TUBORAMA has many characteristics which make it an ideal system for constructing modern plants at the technological state of the art.

RESISTANCE TO ELECTROCHEMICAL CORROSION

TUBORAMA is chemically inert and highly resistant to a wide range of acids and bases. This makes it suitable for contact with the materials normally used in the construction sector, such as lime or cement, with no need for specific protection (except for the metal fittings). For transport of or contact with special substances, you are urged to check the chemical resistance of the polypropylene, consulting the table provided on page 31 of Chap. 9.

Volume resistivity (at 20°C) of TUBORAMA and the metals normally used in the heating and water supply sector

TUBORAMA	$\square_{20} > 1 \cdot 10^{16}$	Ω cm
Steel	$\square_{20}$ □ $0.10 \div 0.25 \cdot 10^{-4}$	Ω cm
Pure iron	$\square_{20}$ □ $0.0978 \cdot 10^{-4}$	Ω cm
Pipe grade industrial copper	$\square_{20}$ □ $0.017241 \cdot 10^{-4}$	Ω cm

LOW THERMAL CONDUCTIVITY

Thanks to the nature of the raw material used for producing ***TUBORAMA***, one of its main properties is its low thermal conductivity coefficient. Naturally, this factor is very important in keeping energy consumption down, as it reduces the loss of heat from the fluid transported.

Thermal conductivity of TUBORAMA and the metals normally used in heating and water supply systems

TUBORAMA	□ = 0.38	kcal h^{-1} m^{-1} °C^{-1}
Steel	□ = 40 ÷ 50	kcal h^{-1} m^{-1} °C^{-1}
Iron	□ = 40 ÷ 50	kcal h^{-1} m^{-1} °C^{-1}
Copper	□ = 260 ÷ 340	kcal h^{-1} m^{-1} °C^{-1}

The low thermal conductivity coefficient also attenuates the formation of condensation on the outside of the pipes and prolongs the time which the water takes to change to ice, in contrast with the use of metal pipes.

RESISTANCE TO STRAY CURRENTS

TUBORAMA is a bad electric conductor and is therefore unaffected by stray currents. This phenomenon, common in rooms with high electrostatic charges (e.g. scientific and industrial research laboratories) or close to high voltage lines, also generates big problems in residential buildings, on both water supply and heating systems constructed from metal materials. The formation of holes in pipes caused by stray currents is even more frequent when household appliances are grounded to the piping network.

LOW NOISE

Due to the material's characteristics and high insulation value, the system noise level is considerably reduced, even when water hammers are present.

HYGIENIC AND NON-TOXIC

The raw material used for production of the ***TUBORAMA*** system is completely non-toxic and complies with current standards at international level.

LOW LOSS OF PRESSURE

The superficial structure of PE-X is very homogeneous, due to the absence of cracking, porosity or splitting, all typical of the metals normally used for water pipelines. ***TUBORAMA*** therefore has a very low friction coefficient (physically, PE-X is defined as a smooth body). This characteristic allows very high speed flow-rates, and therefore low loss of pressure, as shown by the graphs on pages 34 - 35 - 36.

LINEAR EXPANSION

The coefficient of linear expansion is $\alpha = 1{,}5 \times 10^{-4}$ ° $C.^{-1}$.

THERMAL MEMORY

This characteristic is only obtained thorough crosslinking. This property means that after heating to the softening temperature, ***TUBORAMA*** always returns to its original shape. This is very important in case of bending errors or crushing, which can easily be corrected by heating the pipe and restoring it to its initial state.

HIGH RELIABILITY OVER TIME

In view of the temperature and pressure values normally found in heating and water supply systems, and the characteristics of PE-X, systems constructed using ***TUBORAMA*** have a long life, comparable to that of the masonry itself.

3. FIELDS OF APPLICATION

Requirements of life behaviour for pipe-connection systems in Pe-X conforming to the UNI EN ISO 15875-1 normative are specified for four Classes of Application as shown in Prospect n° 1. Each Class is connected to a Typical Field of Application for a project of an operative life span of 50 years. Each Class must be associated to a 4 bar, 6 bar, 8 bar or 10 bar operating pressure. A part from affiliation Classes and Fields of Application, water channelling at 20°C and for a period of 50 years has an operating pressure of 10 bar. For different Fields of Application direct consultation of the afore-mentioned normative or with Prandelli SpA for Technical Assistance is advisable.

Prospect 1 - Classification of conditions of service

Application Class	Temperature of Project T_D °C	Life-span of T_N years	T_{max} °C	Life-span at T_{max} years	T_{mal} °C	Life-span at T_{mal} h	Typical Field of Application
1[1]	60	49	80	1	95	100	Hot-water supply (60°C)
2[1]	70	49	80	1	95	100	Hot-water supply (70°C)
4[2]	20 Followed by 40 Followed by 60 Followed by (see following column)	2,5 20 25	70 Followed by (see following column)	2,5	100	100	Underfloor heating and radiators at low temperature
5[2]	20 Followed by 60 Followed by 80 Followed by (see following column)	14 25 10	90 Followed by (see following column)	1	100	100	Radiators at high temperature

1) A country can choose either class 1 or class 2 in order to conform to their country's rulings.
2) Where there is more than one temperature for each class times must be aggregated (eg. The temperature profile for the 50 year project for class 5 is: 20°C for 14 years, followed by 60°C for 25 years, 80°C for 10 years, 90°C for 1 year and 100°C for 100 h).

4. DIMENSIONS OF PIPES

As foreseen by the normative UNI EN ISO 15875-2 the following Prospect 2 shows available pipe dimensions and the pertaining series S.

Prospect 2 – Dimensions

Nominal diameter DN	Min. Thic-kness en	Internal diameter	Series Scale	Packages in Rolls (m) Bare	with sheathing	with oxygen barrier
15	2,5	10,0	2,5	50-100	50	
16	2,0	12,0	3,5	120-200		120-240-500
16	2,2	11,6	3,14	100	50	
17	2,0	13,0	3,75	120-200		120-240-500
18	2,0	14,0	4,0	120-200		120-240-500
18	2,5	13,0	3,1	50-100	50	
20	2,0	16,0	4,5	120-200		120-240
22	3,0	16,0	3,17	50-100		
28	3,0	22,0	4,17	50		
32	3,0	26,0	4,83	50		

4. DIMENSIONS OF PIPES

Choice of pipe dimensions (series S)

The UNI EN ISO 15875 1-2 normative fixes the series S by calculating it in function with nominal DN diameter and nominal en thickness in the following way:

Scalc = (DN – en)/2en

It appears evident from this formula that, at an equal diameter, if the thickness increases, the S value decreases.

The ratio between the pressure of the PD project, the Application Classes, the Temperature of the TD project and the maximum series calculated Scalc max is shown in the following Prospect 3.

Prospect 3 – Scalc max for Pe-X according to UNI EN ISO 15875 1-2

PD bor	Class 1 TD=60°	Class 2 TD=70°	Class 4 TD=60°	Class 5 TD=80°
4,0	7,6	7,6	7,6	7,6
6,0	6,4	5,9	6,6	5,4
8,0	4,8	4,4	5,0	4,0
10,0	3,8	3,5	4,0	3,2

From further observations it can be seen that systems belonging to a series S with minor values can be substituted with those belonging to a series S with major values; the opposite is not possible.

From this prospect it can be seen that the preferential applications are:

S3.8	Class 1	PD=10 bar - TD = 60°
S3.5	Class 2	PD=10 bar - TD = 70°
S5	Class 4	PD= 8 bar - TD = 60°
S5	Class 5	PD= 6 bar - TD = 80°

The pipe dimensions chosen by Prospect 1 must be made with a series S minor or a maximum equal to that stemming from Prospect 3, in accordance with foreseen conditions.

5. FIELDS OF APPLICATION

FIELDS OF APPLICATION

Thanks to its resistance to mechanical and thermal stresses and its outstanding flexibility which simplifies its installation, ***TUBORAMA*** is used in systems of a wide variety of types.

The main applications are:

- pipe-in-pipe water supply systems with manifold;
- water supply systems with manifold;
- traditional water supply systems;
- traditional heating systems;
- floor heating heating systems;
- other systems.

WATER SUPPLY SYSTEM • pipe-in-pipe with minifold

This type of system allows lengths of pipe to be inspected and if necessary repaired without significant building works.

The single lengths of pipe, which lead from the manifold to supply the users, are housed in a sheathing of suitable diameter, which allows the pipe to be replaced if necessary.

This operation also requires a suitable pipe layout, with no sharp changes in direction or accidental crushing of the sheathing.

The basic element: the PE-X pipe

The fundamental item which has made this type of system possible is the pipe, which must be extremely easy to handle and offer optimum flexibility.

TUBORAMA fulfils these requirements to a high degree thanks to the intrinsic properties of the raw material from which it is made and the extrusion and crosslinking technologies used to produce it. ***TUBORAMA*** PE-X is manufactured from a high density polyethylene with excellent performance characteristics, already approved by the leading institutes in Europe and beyond.

The sheathing

The task of the **plastic sheathing** in which the pipe is inserted is no less important.
It has to be very elastic, since if squashed by accidental loads it must spring back into its original shape as soon as the load is removed.

Its dimensions are designed to allow easy insertion of the pipe, and to enable laying under floors or in walls.

The sheathing also has the important role of protecting the pipe from any sharp-edged bodies.

DIAMETER Pipe mm	THICKNESS Pipe mm
16	2.2

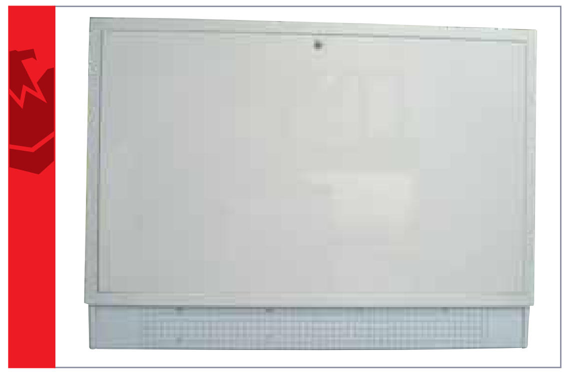
sheating diameter mm 24.5

The distribution manifold

Correct system construction requires a **distribution manifold** to which each single branch of piping is connected.
This allows better control of the water flow-rate required by the users, since even in case of simultaneous use the individual delivery rates do not drop as in conventional systems.
The manifold used also allows a single section of pipe to be shut off if necessary for repair, with no need to put the entire system out of use.
Available in three different versions (with 3, 4 and 5 outlets) which can be combined to construct modular assemblies, the manifold used in the system is also specially styled; in addition to its minimal depth, it is shaped to keep the passage cross-sections suitably proportioned in every point along its length.

The boxes for flush mounting

Special mounting boxes have been designed to allow the manifold to be installed sunk into the wall. They are complete with a metal cover panel and can be equipped with a special kit for installation standing on the floor.



Connecting boxes

Special **connecting boxes** have been developed for pipe ends; for installation in concrete, they are designed to contain the union to which the pipe is connected.

Correct positioning of the union is assured by the ring-nut, screwed onto the front of the box to keep it clamped in place.
The bottom of the box is fitted with a guide to take and secure the sheathing containing the pipe.

The dual function handle

Box accessories include **a dual function handle,** which can be used either as a tool for **tightening and unscrew the ring-nut (a)** which holds the union in place in the box, or as **a cap for system testing (b).**

INSTALLATION

As already mentioned, to make full use of the features this type of system is able to offer, it must be installed in accordance with clearly defined procedures.

The manifold ①

The first operation is to install the **distribution manifold** in the wall, inside the special **mounting box**.
The manifold installation site must meet specific requirements: first of all, the routes leading to all the users to be served must be as straight as possible, or at least free from sharp changes in direction, which might make any future replacement work difficult.

Secondly, as far as possible **the manifold should be located centrally** in relation to all the various outlets (connecting boxes) so that the various lengths of pipe are more or less the same length (excessively long pipes lead to increased loss of pressure and wasted heat in pipes carrying hot water).

Finally, if compatible with the two requirements stated above, which take priority, the manifold should be installed at a point where it can easily be concealed, to guarantee that the system makes the best possible aesthetic impression.

The connecting boxes ②

Once this phase is complete, the next step is to install the **connecting boxes,** which are placed near to the users to be served.

The boxes are fixed to the walls, using metal brackets if necessary, in the positions they will occupy when the system is complete.

The unions ③

The pipe is passed into the box and connected to the union, which is then placed in the box. The pipe is then laid along the ground (or in the wall) to the corresponding manifold connection.

During this phase, care must be taken to assure that **the pipes take the STRAIGHTEST POSSIBLE ROUTE, ensuring that no radius of curvature is less than 8 times the outside diameter of the pipe.**

Cutting the pipe ④

Whenever a pipe branch reaches its manifold connection, cut the pipe and sheathing to the appropriate length and make the connection.

5. FIELDS OF APPLICATION

ADVANTAGES OFFERED BY THE PIPE-IN-PIPE SYSTEM

The installation of pipe-in-pipe ***TUBORAMA*** in systems using manifolds therefore offers the following advantages:

- the flow-rate of water to the individual users is maintained constant even if several taps are turned on simultaneously;
- hot water supply times are reduced;
- there are fewer joints; one at the manifold and another at the user, for each length of pipe;
- no joints under concrete;
- quick, easy installation;
- pipe is protected against any sharp-edged bodies;
- pipes are replaceable;
- any leaks are easily identified and replaced; if a pipe is accidentally punctured, the independence of each section makes it easier to identify, cut off and replace the damaged pipe.

WATER SUPPLY SYSTEMS • manifold type

This type of system offers the same advantages as pipe-in-pipe systems with manifold, except that each individual length of pipe can no longer be removed.
Since the sheathing and connecting boxes are no longer used, pipe replacement becomes more difficult.

WATER SUPPLY SYSTEMS • traditional

Obviously, ***TUBORAMA*** can also be used for the construction of conventional water supply systems. In this case, while ***TUBORAMA*** maintains its advantages over metal pipes, suitable metal fittings must be used to construct the various branches.

This type of system is unable to offer all the advantages of the pipe-in-pipe system, but is very inexpensive since the numerous accessories necessary for the pipe-in-pipe system are no longer required.

HEATING SYSTEMS • traditional

Its outstanding resistance to thermal stresses allows ***TUBORAMA*** to be used to construct traditional heating systems of all kinds. The installation personnel will find the pipes easier to lay thanks to the excellent handling and flexibility of ***TUBORAMA***.
One further advantage offered by this pipe, for transporting hot water, derives from the low thermal conductivity of PE-X (see table on page 7). This allows the reduction of heat losses along the distribution network, below the level of a similar system constructed with metal pipes.

In all cases, it should be remembered that although the thermal conductivity of ***TUBORAMA*** is very low (λ = 0.38 kcal h^{-1} m^{-1} $°C^{-1}$), it does not meet the conductivity value required, for instance, by Italian law on the limitation of energy consumption, which is λ = 0.035 kcal h^{-1} m^{-1} $°C^{-1}$.
Suitable insulation must therefore be fitted where required.

HEATING SYSTEMS • floor heating system

As well as in conventional heating systems, ***TUBORAMA*** can also be used to construct under-floor floor heatings.

The excellent flexibility of PE-X is an essential ingredient in proper, troublefree construction of a system of this kind.

PRANDELLI S.p.A. has developed a complete system, known as THERMORAMA, which comprises all the components needed for construction of this type of installation.

Here we will only underline the important advantages, in terms of both physiological well-being and quality of life in the heated rooms, and in terms of economical operation, offered by these systems; for full information, refer to the relative THERMORAMA System GUIDE.

The oxygen impermeability of the material used for production of the pipe is particularly important in floor heating applications.

TUBORAMA PE-Xc offers a certain degree of permeability to this gas, although in very limited quantities. However, to overcome this phenomenon our company has developed a type of pipe with the same basic characteristics as ***TUBORAMA***, with the addition of oxygen impermeability. This product has been given the name of ***TUBORAMA*** O_2Stop PE-Xb.

floor heating system with TUBORAMA PE-X

TUBORAMA O_2 Stop

TUBORAMA O_2Stop is a polyethylene pipe crosslinked by the electron beam method, coated with a special film to block the passage of oxygen.

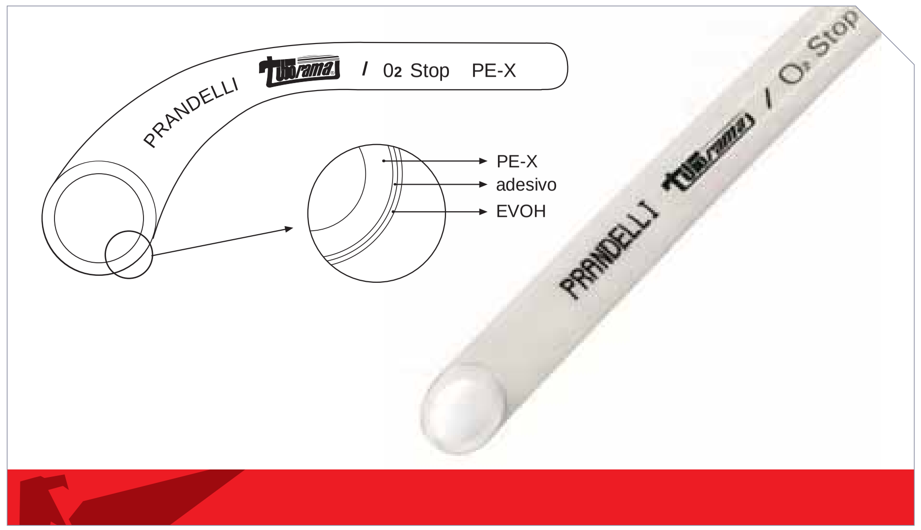
This considerably limits the enrichment of the water with this element, believed to be the main cause of the corrosion of metal components of the system, by precluding one of the ways in which, theoretically, oxygen may gain access to a system conveying water. The oxygen barrier is particularly important in case of under-floor floor heating systems, in which the long length of the pipeline might increase the risks linked to the oxygen enrichment of the fluid transported.

TUBORAMA O_2 Stop PE-X DIMENSIONAL TABLE

OUTSIDE diameter mm	THICKNESS mm	INSIDE diemeter mm	SUPPLIED IN rolls of m
16	2.0	12	120 - 240
17	2.0	13	120 - 240
18	2.0	14	120 - 240
20	2.0	16	120 - 240

The oxygen barrier function is obtained by coating the outside of ***TUBORAMA*** PE-X with a special plastic film: EVOH.

This barrier is applied by means of a co-extrusion process, using a special adhesive which prevents it from separating from the pipe surface.

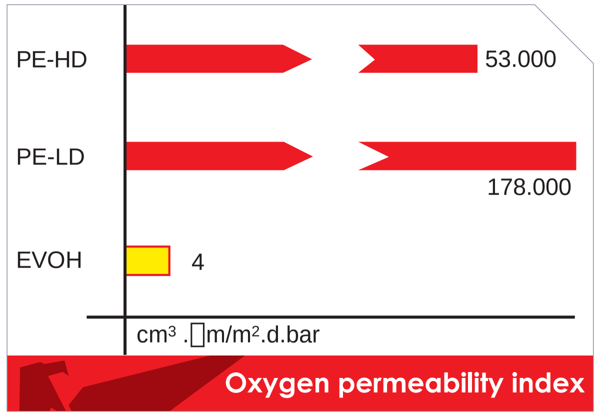


5. FIELDS OF APPLICATION

TUBORAMA O_2 Stop PE-X TECHNICAL DATA

key:

PE-HD = High density polyethylene
PE-LD = Low density polyethylene
EVOH = Barrier material



Permeability of EVOH to various substances

PRODUCT	PERMEABILITY (23°C, 0% UR) (in cm^3 .m/m^2.d.bar)
Oxygen (O_2)	4
Azoto (N_2)	3,7
Helium (He)	2.520
Argon (Ar)	1,1
Hydrogen (H_2)	450
Carbon monoxide (CO)	5,1
Carbon dioxide (CO_2)	12
Butan (C_4H_{10})	2
Methane (CH_4)	8
Chlorine (Cl_2)	0,44
Ethylene (C_2H_4)	2
Sulphur dioxide (SO_2)	6
Freon 12	2,8
Ammonium (NH_3)	90

OTHER SYSTEMS

As well as the systems already mentioned, ***TUBORAMA*** is also suitable for use in the following types of installation:

- **Air-conditioning**
- **Conveying compressed air**
- **Conveying edible liquids**
- **Conveying industrial liquids**

Naturally, regardless of the system constructed, first it is necessary to check that the operating conditions NEVER exceed the maximum levels permitted for the material. Furthermore, when special fluids are conveyed it is essential to check that ***TUBORAMA*** is suitable for transporting these substances, referring to the table on page 31.

6. PIPE FITTINGS

The ***TUBORAMA*** pipe fittings are made from brass. The pipe fittings' seal works through compression and consequential distortion of the pipe on the fittings' rubber holder - the same manner as a mechanical joint. Compression of the pipe onto the rubber holder is obtained by screwing a stop nut onto the body of the pipe fittings. This movement tightens a metallic ogive on the pipe and, therefore, on the pipe fittings' rubber holder which is specifically designed to give a perfect mechanical and hydraulic hold.

7. GUARANTEE

GUARANTEE

The following GUARANTEE is provided for the ***TUBORAMA*** system when used for heating and water supply installations, in a manner compatible with the technical characteristics of the product and in accordance with the installation instructions in the relative publication:

1. Through insurance cover with a leading insurance company, Prandelli, manufacturer of the ***TUBORAMA*** system, will compensate injury or damage caused by breakage of pipes and fittings due to obvious manufacturing defects up to a maximum of 500.000 €, for a period of 10 YEARS after the date marked on the pipe.

2. The conditions governing this GUARANTEE are:

a) the pipe and fittings must be installed in accordance with the installation instructions provided by us, further to checking for possible faults or tampering which have occurred after production due to accidental causes.
b) The operating conditions (pressure and temperature) must be within the technical limits stated by the latest ***TUBORAMA*** Guide.
c) The product must carry the ***TUBORAMA*** identification mark.

3. The GUARANTEE DOES NOT APPLY in the following cases:

a) failure to comply with our recommended installation instructions.
b) Connection of the pipe and fittings to heat sources with even accidental temperature and pressure limits not compatible with the characteristics of the pipe and fittings.
c) Use of obviously unsuitable material (pipes and fittings which are old, scratched, etc.).
d) Use of one or more components not manufactured by us in construction of the system.

4. INSTRUCTIONS FOR REQUESTING AFTERSALES SERVICE UNDER GUARANTEE

In case of a breakage of the ***TUBORAMA*** system due solely to obvious manufacturing defects, users must send us a registered letter, sending a copy to their local agent.
This letter must contain:

- date and place of installation;
- specifications and identification mark of the pipe and fittings;
- information about the operating conditions (pressure and temperature);
- sample of the pipe or fitting on which the breakage has occurred;
- name and address of the installer who constructed the system.

We will send a technician to check the causes of the breakage within a reasonable period of time after receipt of this registered letter. If the breakage is covered by the terms of the GUARANTEE, we will put the matter in the hands of our insurance company, which will pay compensation after checking the cause and amount of the damage. If the breakage is not covered by the GUARANTEE, we will charge the expenses we have incurred to the customer.

Prandelli S.p.A.

EQUIPMENT

One of the advantages of using ***TUBORAMA*** is that no special equipment is required for its use.

The tools needed for working with ***TUBORAMA*** are:

- a cutter for cutting the pipes
- spanners for tightening the fittings

Processing TUBORAMA: cutting

1) As well as the special cutter, ***TUBORAMA*** can be cut to the desired length using other bladed tools, taking care that the cut is at right angles to the pipe's axis and free from burrs on the edges. This will allow a good joint to be made to the unions.

bending

2) In view of its excellent flexibility, ***TUBORAMA*** can easily be bent into shape to make the necessary changes in direction during installation.

There are two alternatives:

a) cold bending
b) hot bending

a) COLD BENDING

TUBORAMA can easily be bent cold, taking care to comply with the minimum recommended radius of curvature:

Rmin ≥ 8 D

where D = outside diameter of the pipe.

For small diameter pipes, the special **pipe bending elbows**, available for sizes ø15, ø18 e ø22 mm, should be used.


Bending by hand


Bending with elbows

b) HOT BENDING

When bending larger pipes, and to ensure maintenance of the bend produced, a heat source (hot air) must be used.

Direct a jet of hot air at the zone of the pipe to be bent, turning it slowly so that the jet reaches the whole of its surface.
Wait until the pipe heats to softening temperature, and then bend as required.
To maintain the bend produced, the pipe must be cooled with a sponge or cloth soaked in cold water.
This procedure can also be used to restore a pipe which has accidentally been crushed to its initial shape.

Do not continue heating a section of pipe for too long without moving it, as the heated part may burn.
If this occurs, the damaged section of pipe must not be used.

NEVER use FLAMES to heat the pipes.


Heating TUBORAMA with hot air


Bent pipe after heating

JOINTING

Since PE-X does not melt, it is not possible to make pipe-to pipe or pipe-to-fitting joints by welding. Joints are made using fittings; the mechanical compression and deformation of the pipe ensures tightness and mechanical resistance.

A complete range of brass fittings have been specially designed for ***TUBORAMA***, to provide perfect joints, giving particular consideration to the forces discharged on the fittings when the pipe expands and subsequently contracts.

Therefore, to obtain a perfect joint between the pipe and the fitting, proceed as follows:

- **cut the pipe at right angles to its axis;**
- **make sure that there are no burrs on the edge of the pipe;**
- **slip:**
  a) the locking nut
  b) the sealing washer onto the pipe
- **fit the end of the pipe onto the hose connection and push it right down;**
- **tighten the locking nut, using two spanners.**

Note that the sealing washer must be fitted the right way round. After mounting, it not only applies radial pressure to the pipe, ensuring a seal, but also ensures that the pipe cannot become disconnected by the stresses applied when it contracts.

The sharp edges of the indentation inside the washer must therefore be facing towards the hose connection.

There is a groove around the circumference of the outside washer surface, close to the bevel.

JOINTING

This side of the washer carrying this groove must be pointing towards the body of the fitting (see illustrations below).


Assembly sequence

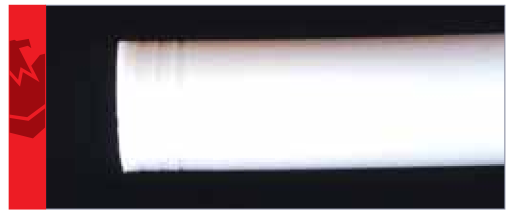

Tightening the nut

Cross-section of a joint

TYPICAL ASSEMBLY MISTAKES

A) Insufficient tightening

In this case, the washer is not able to apply the necessary radial pressure to the pipe. Since the end of the pipe is already deformed (see photograph below), tightening the nut further will not solve the problem. Remove the nut, cut off the deformed part of the pipe and reassemble all parts.



B) Sealing washer incorrectly fitted

When the sealing washer is not fitted correctly, the system will leak in the way typical of hot water systems with poor seals, with leaks appearing when the temperature falls. This occurs because the indentations on the washer are not facing so that they resist the pull of the contracting pipe. In this case, if the nut is tightened further the problem is only eliminated temporarily; once the washer is completely closed, tightening the nut again can only break it.

The follow procedure must therefore be followed:

- **remove the nut;**
- **cut off the deformed part of the pipe;**
- **replace the sealing washer with a new one if damaged, and reassemble all parts correctly.**


Sealing washer INCORRECTLY fitted


Sealing washer CORRECTLY fitted

8. PROCESSING

At this point, it is very important to test the tightness of the completed system, as described on page 52.

C) Fitting breakage

In spite of the quality of the raw material used and the construction criteria adopted, in case of stresses which exceed the characteristics of the material and the appropriate application requirements breakages may occur, due for example to:

- **deformation due to dynamic stress (hammering);**
- **excessive nut tightening;**
- **excess hemp, especially on female threads.**

If too much hemp has been applied, the technician has forgotten that since the fitting has been produced by machining, its tolerances are much lower than those of the equivalent galvanized fittings. Since the tolerance gaps are smaller, less hemp is required to obtain a seal.

Excess hemp will stress the part concerned beyond its limits, which may break some time after installation, due to fatigue.

To avoid this problem, installation personnel must take care over the amount of hemp used, or use alternative materials such as teflon, sealant pastes, etc.

In addition, in threaded connections the male part must always have more turns of thread than the female part.

9. RESISTANCE TO CHEMICALS

The tables below show the compatibility and incompatibility of the most common reagents with high density polyethylene, as stated in Document ISO/TC 138 (Secretariat 351) n. 556 E-December 1976.

Note that since crosslinking increases the average molecular weight, the chemical resistance of PE-X is not lower than that of non crosslinked PE HD, and can actually be considered higher.

Remember that when special fluids, such as combustible and other fluids, are to be conveyed, any legal requirements in force must be complied with.

TABLE OF RESISTANCE TO CHEMICAL

Fluids that can be ducted, at atmospheric pressure and up to a temperature of 60°C, in HD PE pipes not subject to external stress

FLUIDS	CONCENTRATION
Acetic, acid	10%
Vinegar	-
Adipic, acid	sol.sat.
Allylic, alcohol	96%
Alum	sol.
Aluminium, chloride	sol.sat.
Aluminium, fluoride	sol.sat.
Aluminium, sulphate	sol.sat.
Ammonia, gas	100%
Ammonia, liquefied	100%
Ammonia, water	sol.dil.
Ammonium, chloride	sol.sat.
Ammonium, fluoride	sol.
Ammonium, nitrate	sol.sat.
Ammonium, sulphate	sol.sat.
Ammonium, sulphite	sol.
Antimony, thrichloride	90%
Arsenic, acid	sol.sat.
Hydrogen, peroxide	30%
Water	-
Silver, acetate	sol.sat.
Silver, cyanide	sol.sat.

sol. = solution
sol.sat. = satured solution
conc.lav. = working concentration
conc. = concentrated
sol.dil. = diluted solution

9. RESISTANCE TO CHEMICALS

FLUIDS	CONCENTRATION	FLUIDS	CONCENTRATION
Silver, nitrate	sol.sat.	Hydrofluoric, acid	4%
Barium, carbonate	sol.sat.	Photograph, acid	conc.lav.
Barium, chloride	sol.sat.	Glucose	sol.sat.
Barium, hydroxide	sol.sat.	Glycerol	100%
Barium, sulphate	sol.sat.	Glycolic, acid	sol.
Bromic, acid	50%	Hydrogen	100%
Bromic, acid	100%	Hydrogen, sulphide	100%
Benzoic, acid	sol.sat.	Hydroquinone	sol.sat.
Beer	-	Milk	-
Borax	sol.sat.	Lactic, acid	100%
Boric, acid	sol.sat.	Lievito	sol.
Butane, gas	100%	Magnesium, carbonate	sol.sat.
Butyl, alcohol	100%	Magnesium, chloride	sol.sat.
Calcium, carbonate	sol.sat.	Magnesium, hydroxide	sol.sat.
Calcium, chlorate	sol.sat.	Magnesium, nitrate	sol.sat.
Calcium, chloride	sol.sat.	Maleic, acid	sol.sat.
Calcium, hydroxide	sol.sat.	Mercuric, chloride	sol.sat.
Calcium, hypochlorite	sol.	Mercuros, cyanide	sol.sat.
Calcium, nitrate	sol.sat.	Mercuros, nitrate	sol.
Calcium, sulphate	sol.sat.	Mercury	100%
Carbon, dioxide (dry)	100%	Methanol	100%
Carbon, monoxide	100%	Malasses	conc.lav.
Hydrochloric, acid	10%	Nickel, chloride	sol.sat.
Hydrochloric, acid	conc.	Nickel, nitrate	sol.sat.
Chloaretic, acid	sol.	Nickel, sulphate	sol.sat.
Citric, acid	sol.sat.	Nitric, acid	25%
Cyclohexanol	sol.sat.	Ortophosphonic, acid	50%
Hydrocianic, acid	10%	Oxalic, acid	sol.sat.
Dextrine	sol.	Potassium bromate	sol.sat.
Dioxane	100%	Potassium, bromide	sol.sat.
Ethylene, glycol	100%	Potassium, carbonate	sol.sat.
Ferric, chloride	sol.sat.	Potassum, chlorate	sol.sat.
Ferric, nitrate	sol.	Potassium, chloride	sol.sat.
Ferric, sulphate	sol.sat.	Potassium, chromate	sol.sat.
Ferrous, chloride	sol.sat.	Potassium, cyanide	sol.
Ferrous, sulphate	sol.sat.	Potassium, dichromate	sol.sat.
Fluosilicic, acid	40%	Potassium, ferrocyanide	sol.sat.
Formaldehyde	40%	Potassium, fluoride	sol.sat.
Formic, acid	50%	Potassium, bicarbonate	sol.sat.
Formic, acid	98-100%	Potassium, disulphate	sol.sat.
Phenol	sol.	Potassium, bisulphite	sol.sat.

FLUIDS	CONCENTRATION	FLUIDS	CONCENTRATION
Potassium, hydroxide	10%	Sodium, hypochloride	15% chlorine
Potassium, hydroxide	sol.	Sodium, nitrate	sol.sat.
Potassium, nitrate	sol.sat.	Sodium, nitrite	sol.sat.
Potassium, orthophosph.	sol.sat.	Sodium, orthophosphate	sol.sat.
Potassium, perchlorate	sol.sat.	Sodium, sulphate	sol.sat.
Potassium, permanganate	20%	Sodium, sulphide	sol.sat.
Potassium, persulphate	sol.sat.	Sulphuric, acid	10%
Potassium, sulphate	sol.sat.	Sulphuric, acid	50%
Potassium, sulphide	sol.	Stannic, chloride	sol.sat.
Propionic, acid	50%	Stannoso, cloruro	sol.sat.
Salicylic, acid	sol.sat.	Sulphur, dioxide (dry)	100%
Sodium, benzoate	sol.sat.	Sulphurous, acid	30%
Sodium, bromide	sol.sat.	Photograph, developer	conc.lav.
Sodium, carbonate	sol.sat.	Tannic, acid	sol.
Sodium, chlorate	sol.sat.	Tartaric, acid	sol.
Sodium, chloride	sol.sat.	Yeast	sol.
Sodium, cyanide	sol.sat.	Urine	-
Sodium, ferrocyanide	sol.sat.	Wine	-
Sodium, fluoride	sol.sat.	Zinc, carbonate	sol.sat.
Sodium, bicarbonate	sol.sat.	Zinc, chloride	sol.sat.
Sodium, bisulphite	sol.	Zinc, oxyde	sol.sat.
Sodium, hydroxide	40%	Zinc, sulphate	sol.sat.
Sodium, hydroxide	sol.		

Fluids that can be ducted, at atmospheric pressure and up to a temperature of 20% C, in HD PE pipes not subject to external stress.

FLUIDS	CONCENTRATION	FLUIDS	CONCENTRATION
Acetaldehyde	100%	Cycloheanone	100%
Glacial acetic, acid	>96%	Decahydronaphtalene	100%
Acetic, anydride	100%	Dioctylphthalate	100%
Amyl, acetate	100%	Heptane	100%
Amyl, alcohol	100%	Ethanol	40%
Aniline	100%	Ethyl, acetate	100%
Hydrogen, peroxide	90%	Furfurilic, alcohol	100%
Benzaldehyde	100%	Fluoridrico, acido	60%
Petrol (Aliphatic Hydrocarbons)	-	Phosphorous, trichloride	100%
Butyric, acid	100%	Nicotinic, acid	sol.dil.
Chromic, acid	20%	Oils and Fats	-
Chromic, acid	50%	Oleic, acid	100%

9. RESISTANCE TO CHEMICALS

FLUIDS	CONCENTRATION	FLUIDS	CONCENTRATION
Orthophoshoric, acid	95%	Propionate, acid	100%
Oxygen	100%	Pyridine	100%
Piric, acid	sol.sat.	Sulphuric, acid	98%
Lead, acetate	sol.sat.	Triethanolamine	sol.
Potassium, hypochlorite	sol.		

Fluids non to be ducted in HD PE pipes

FLUIDS	CONCENTRATION	FLUIDS	CONCENTRATION
Acqua, regia	HCl/HNO_3=3/1	Nitric, acid	da 50% a 100%
Dry bromine, gas	100%	Ozone	100%
Liquid, bromine	100%	Sulphuric, acid	fuming
Carbon, disulphide	100%	Sulphuric, anhydride	100%
Carbon, tetrachloride	100%	Thionyl, chloride	100%
Dry chlorine, gas	100%	Toluene	100%
Chlorine, water	sol.sat.	Trichloroethylene	100%
Chloroform	100%	Xylene	100%
Fluorine, gas	100%		

FLOW RESISTANCE DIAGRAM

To use the monogram, at least two quantities will have to be established, one of which is the size of the pipe and the second generally the flow rate or speed.

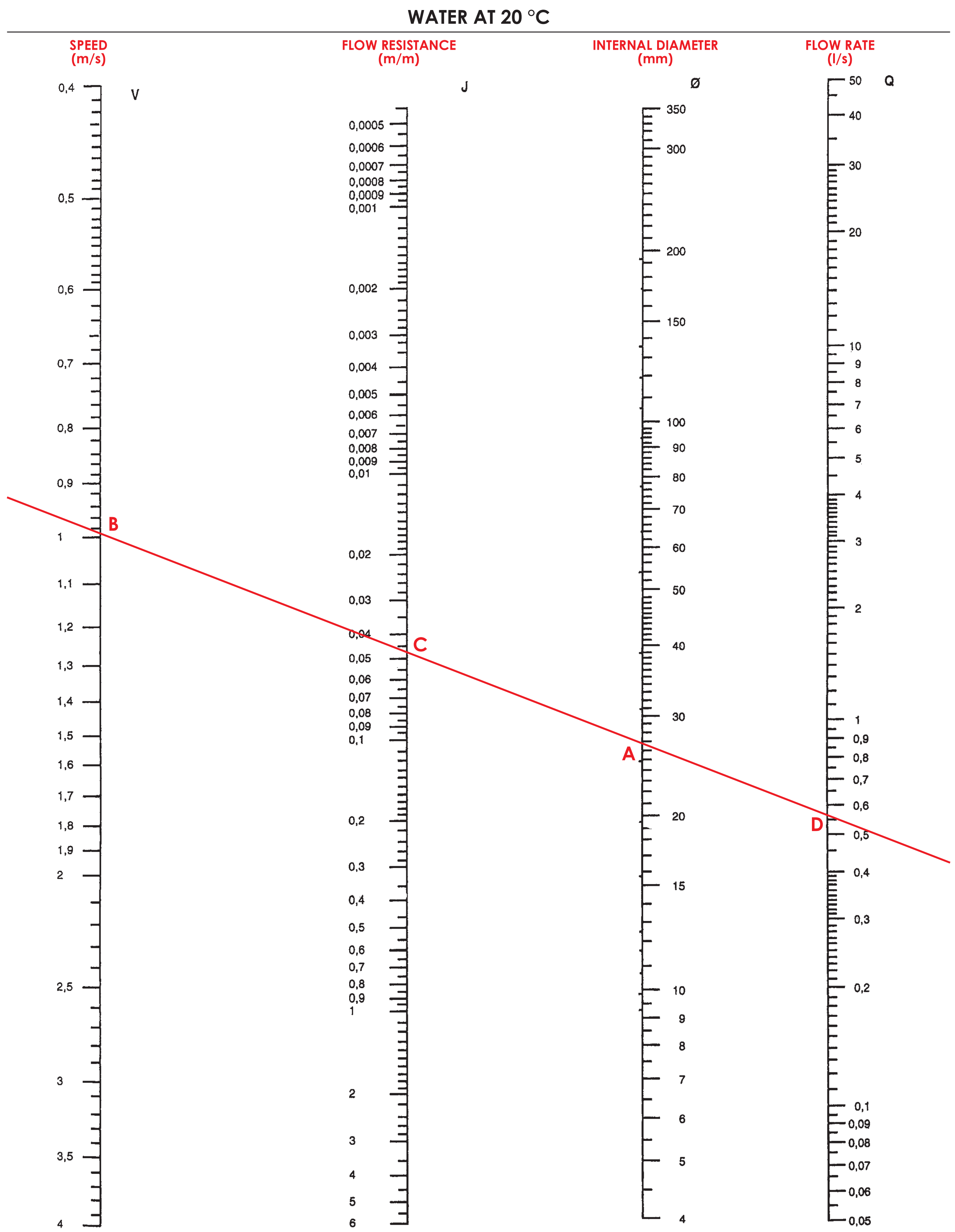
Tube: ø 32 x 3

ø int. = mm 26 (point **A**)

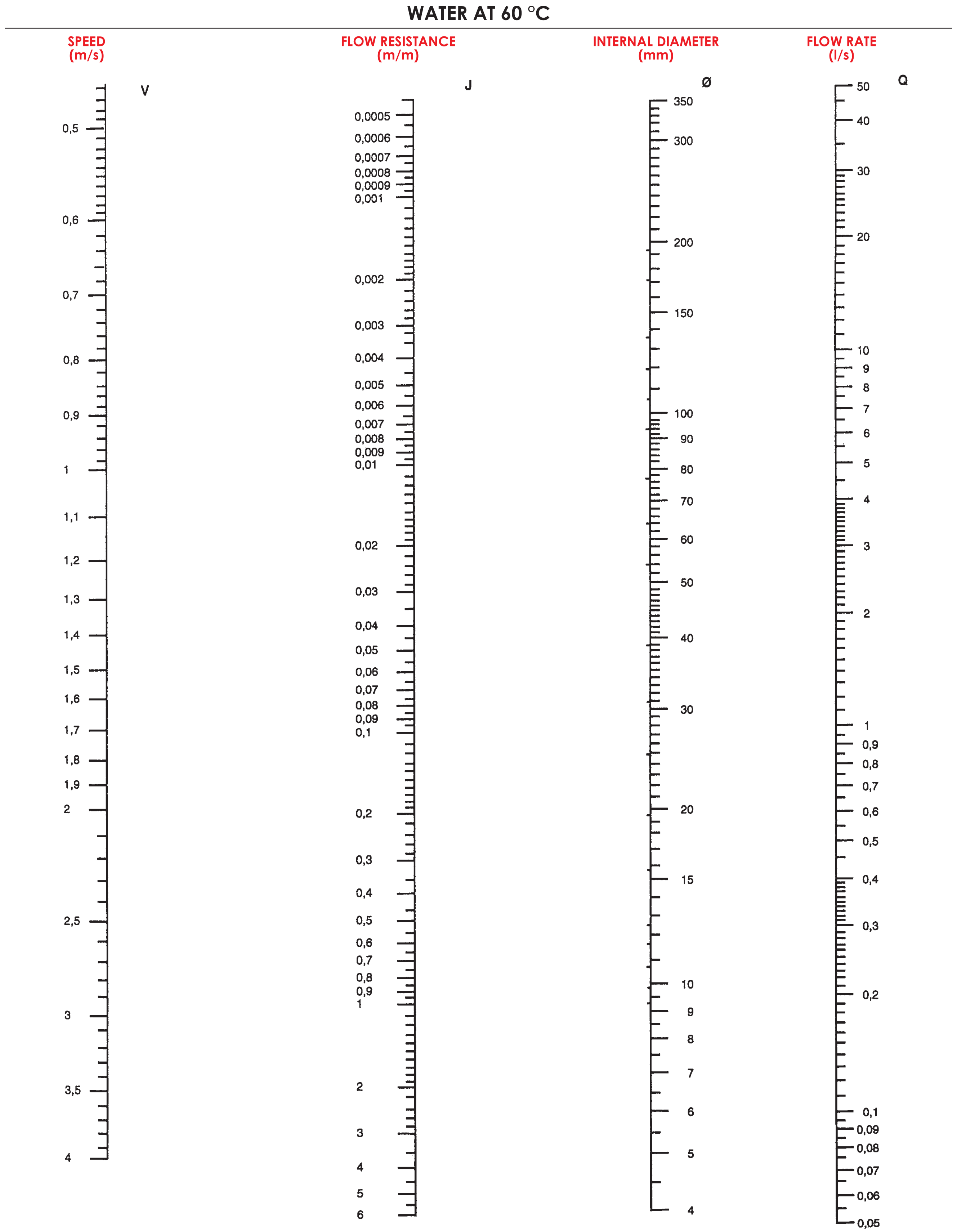
speed 1 m/s (point **B**)

By joining points A and B with a straight line, points **C** and **D** are found which indicate a flow resistance J = 0,5 m/m e and flow rate Q = 0,54 l/s.

10. FLOW RESISTANCE DIAGRAM



10. FLOW RESISTANCE DIAGRAM



11. THERMAL INSULATION

Thermal insulation for heating and air-conditioning systems, plumbing and sanitary fittings

Ruling n° 10/91 relating to containment of energy consumption and the implemental decree DPR 412/93 imposes that the pipes used for constructing heating circuits have suitable insulation protection. Obviously, in cases of heating and/or in the hot water (sanitation) systems, insulation is the most important factor in avoiding dispersion, whilst in air-conditioning systems it is not only to avoid temperature rises in channelled fluid, but also to impede formation of condensation on the pipe's surface due to humidity in the air. For equal depth of insulation, consequent energy saving will be just as high, the more major the heating power of the insulation is and how minor the surface area of heat exchange is. The DPR n° 412/93 sets the minimum values of the insulation thickness in function with its thermal conductivity and from the diameter of the pipe to be insulated; moreover, it establishes that the thickness shown on the following table are to be applied:

CASE A for sections placed in unheated areas (eg. Garages, cellars, etc.)
CASE B multiplied by a 0,5 reductive co-efficiency for sections of columns to be placed inside the building's wall perimeters
CASE C multiplied by a 0,3 reductive co-efficiency for sections placed in structures neither facing externally nor adjacent to un-heated areas.

Minimum thickness of insulation

thermal conductivity of insulation w / m ° K	External diameter of pipes <20	from 20 to 39	from 40 to 59	from 60 to 79	from 80 to 99	>100
0,030	13	19	26	33	37	40
0,032	14	21	29	36	40	44
0,034	15	23	31	39	44	48
0,036	17	25	34	43	47	52
0,038	18	28	37	46	51	56
0,040	20	30	40	50	55	60
0,042	22	32	43	54	59	64
0,044	24	35	46	58	63	69
0,046	26	38	50	62	68	74
0,048	28	41	54	66	72	79
0,050	30	44	58	71	77	84

The pipe systems and ***TUBORAMA*** pipe-fittings can be installed under tracks, by following a preferential installation technique according to the type of system to be installed.

As a general line it is, however, not only best to comply with the normative stated in the rule book for installing, but above all to follow that foreseen by the Law on containment of energy consumption with regard to heating systems (L.10 dated 9th January, 1991 and relevant DPR n° 412 dated 26/08/93).

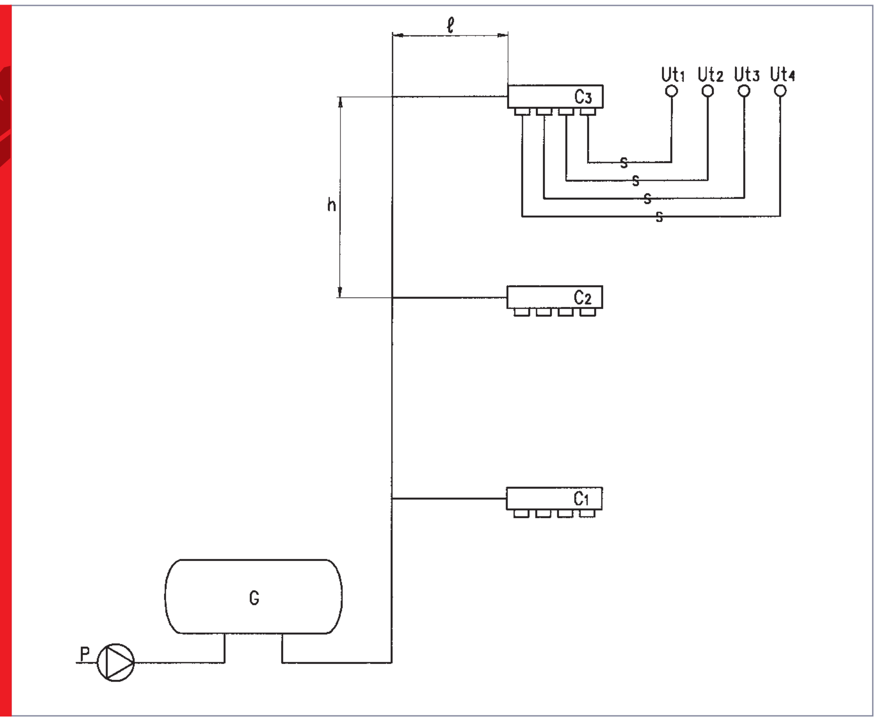
For installing outside tracks protection of the pipe from UV rays is fundamental as these can damage them.

EXAMPLES

As mentioned previously, the particularly smooth inner surface which so characterizes ***TUBORAMA*** permits that a low loss of distributed flow is maintained. This is advantageous above all where iron pipes are compared due to the fact that on an equal inner diameter, a superior flow can be obtained. On pages 34-35-36 diagrams show losses of ***TUBORAMA*** flows for the various temperatures of the transported water.

We wish to demonstrate below an example of scaling relative to interlocking the hot water branch, for sanitation, of a building with three apartments all on different levels. For scaling we will follow the indications given under the UNI 9182-87 normative.

We presume that the systems are installed using the manifold technique. This is given below.



Key:

P =	pump (supposing that this is necessary to provide the necessary head);
G =	heat generator;
h =	3 m: distance between floors;
l =	5 m: distance between the mounting column and the manifolds;
C1 ... C3 =	manifolds on each floor;
Ut1 ... Ut4 =	users to be served.

Flow-rates required by the users (UNI 9182-87)

Bath	Ut1 = 0.2 l/s
Bidet	Ut2 = 0.1 l/s
Washbasin	Ut3 = 0.1 l/s
Sink	Ut4 = 0.2 l/s
Total flow-rate	**Utot = 0.6 l/s**

Total and simultaneous flow-rates

Total and simultaneous flow-rates to the individual floors:

FLOOR	TOTAL FLOW-RATE (l/s)	* MAXIMUM SIMULTANEOUS FLOW-RATES (l/s)
3°	0.6	0.30
2°	1.2	0.45
1°	1.8	0.66

*** Determined with the Load Unit (L.U.) method.**

- Data available (valid for the specific example):

- the head available at the pump is 400 kPa;
- the minimum dynamic pressure required at the user is 50 kPa;
- the loss of pressure in the heat generator are 100 kPa;
- we will not consider the loss of pressure relating to the fittings and the manifold.

N.B.: the unit of measurement for pressure is kPa
(1 kPa = 100 mm of water column).

Let us suppose that the connecting lengths between the manifold and the user are constructed using ***TUBORAMA*** ø. 16x2.2, in which case we obtain:

USER	DISTANCE FROM MANIFOLD m	PIPE DIMENSIONS mm	FLOW-RATE l/s	* UNITARY LOSS OF PRESSURE kPa/m	TOTAL LOSS OF PRESSURE kPa
Ut1	4	16x2.2	0.2	3.6	14.4
Ut2	5	16x2.2	0.1	1.1	5.5
Ut3	6	16x2.2	0.1	1.1	5.5
Ut4	8	16x2.2	0.2	3.6	28.8

*** The losses of pressure have been obtained from the graph on page 48 relating to water at 50°C.** From this calculation, the user receiving lowest priority is Ut4, for which there is a continuous loss of pressure of 28.8 kPa.

Head available

Determination of the head available:

Head available at pump	400	kPa
Loss of pressure in generator	- 100	kPa
Dynamic pressure at users	- 50	kPa
Level difference	- 88.3	kPa
(9.81 kPa/m x 3 m x 3 = 88.3 kPa)		
Head available	**161.7**	**kPa**

Considering the maximum length of the supply line to the most distant manifold (3rd floor), we have:

$$L = 3 \times h + l = 14 \text{ m}$$

therefore:

$$\frac{161.7 \text{ kPa}}{14 \text{ m}} = 11.55 \text{ kPa}$$

This value provides us with an indication of the continuous loss of pressure of the supply line (column) and assists in the choice of diameter. Considering this approximate loss of pressure and the maximum flow-rate value required, in case of simultaneity (0.66 l/s), the pipe which satisfies these conditions must be chosen for construction of the mounting column. In our case, we choose ***TUBORAMA*** ø 22x3.0, for which we obtain:

SIMULTANEOUS FLOW-RATE l/s	*CONTINUOUS LOSS OF PRESSURE kPa/m	DISTRIBUTED LOSS OF PRESSURE x h kPa
0.30	1.6	4.8
0.45	3.2	9.6
0.66	6.1	18.3

*** The losses of pressure have been obtained from the graph on page 48 relating to water at 50°C.** **32.7 kPa**

Total loss of pressure

Finally, we consider the total loss of pressure:

Loss of pressure in the heater	100	kPa
Dynamic pressure to the outlet	50	kPa
Level difference	88.3	kPa
Loss of pressure: manifold-outlet	28.8	kPa
Loss of pressure: mounting column	32.7	kPa
Total loss of pressure	**299.8**	**kPa**

Check

Since the head available at the pump (= 400 kPa) is higher than the total loss of pressure (= 299.8 kPa), the pipe chosen (***TUBORAMA*** ø 22x3.0) is sufficient to ensure the flow-rates required at the users.

EXPANSION

Like every pipe which transports hot and cold fluids, if not constrained and if significant differences in temperature occur, ***TUBORAMA*** will expand or contract.

The size of this variation in dimensions depends on the linear expansion coefficient, which in the case of ***TUBORAMA*** is α = 0.15 mm/m °C.

When the pipe is installed outside the walls and exposed to considerable variations in temperature, it is necessary to establish the variation in length which will occur in sections of pipe free to expand, so that any damage can be prevented using suitable supporting brackets.

Calculating the expansion

The variation in length is calculated using the following formula:

$$\Delta L = \alpha \cdot L \cdot \Delta T$$

where:

ΔL =	variation in pipe length	mm
α =	linear expansion coefficient of the material	mm/m°C
L =	length of the section of pipe free to expand	m
ΔT =	temperature variation	°C

EXAMPLE: Expansion

When calculating ΔL we must consider the temperature difference ΔT between the moment of installation and the maximum operating temperature:

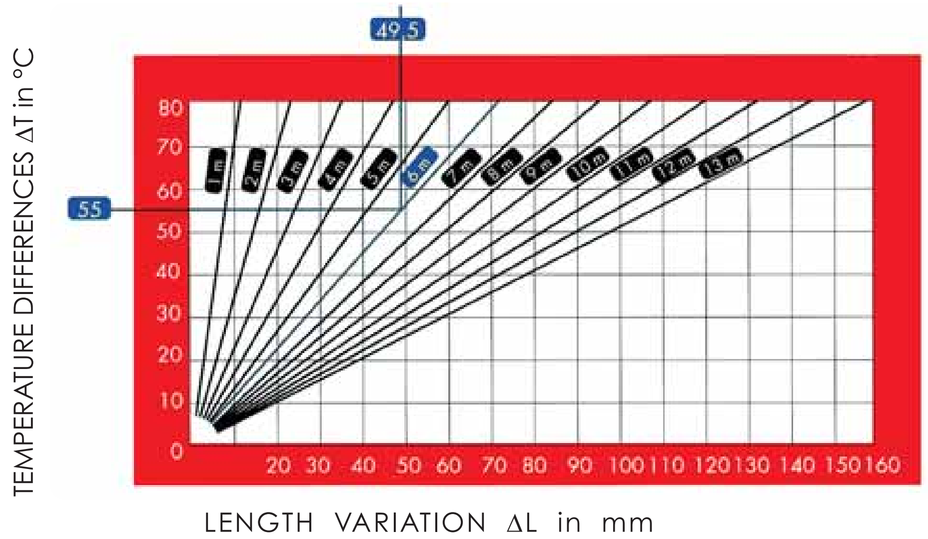
Tamb	= 20°C (ambient temperature);
Tmax	= 75°C (maximum operating temperature);
L	= 6 m;
ΔT	= ?

from which we obtain

$\Delta L = \alpha \cdot L \cdot \Delta T = 0.15 \cdot 6 \cdot 55 = 49.5$ mm

Also see the graph in the near page.

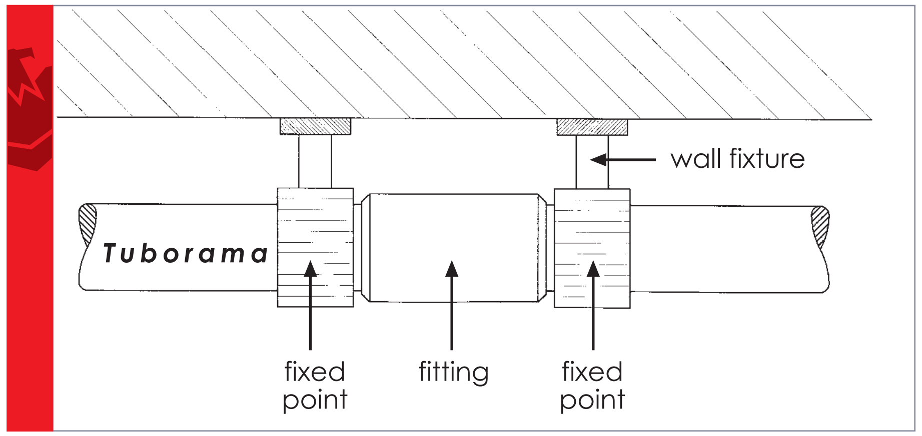
Expansion calculation graph



N.B.: For parts of systems installed in concrete, the effect of the expansion is negligible, since the pipe is unable to expand and therefore absorbs the effect independently.

The fixed points are there to prevent movement of pipes and for this reason a rigid link must be made between the system and the wall. This is done through the use of rigid collar ties, mesh and generally metal, with the part of the pipe covered in rubber material and from a component to be fixed to the wall from the opposite side. Naturally, the rubber part (or similar material) functions as a preventive agent against danger of damage to the pipes' surface. The fixed points are placed, usually, in correspondence with changes in the system's direction (branch, elbow, etc.) to impede any damage caused by expansion in those points.
It is good practice to always have the fixed point covered by a pipe joint, by using pipe coupling or any other welded joint.
It is easy to understand that the presence of fixed points limit the length of the pipe tracks free to expand, by diminishing as a consequence the relevant ΔL value.

Example of fixed point



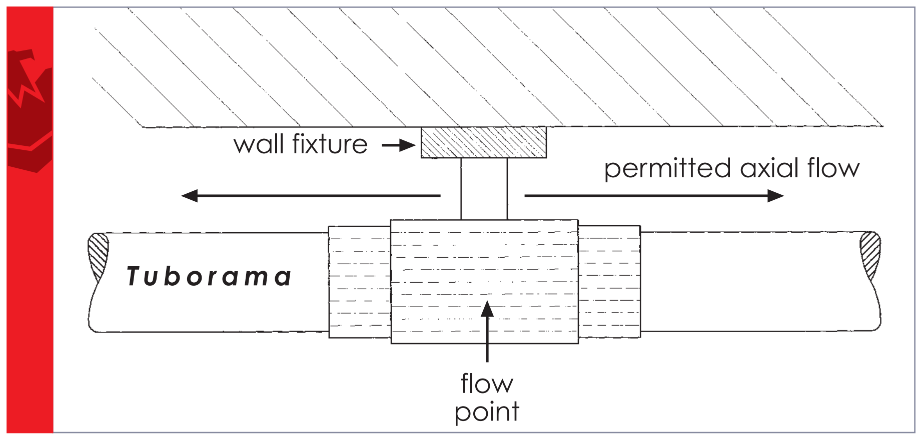
Flow points

The flow points permit axial flow (in both directions) in the pipe. Because of this they must be positioned away from the joint area with the pipe fittings, on a track free from the pipe's surface. The collar tie functioning as a flow point must in no way hold parts which could damage the external surface of the pipe.

The flow points also act as a support and guarantee (if sufficient in number) maintenance of the geometrical rectilinear of the system in the presence of thermal stress.

Usually the distance is 1.2-1.4 m for pipes with a diameter of between 16 to 32 mm.

Example of flow point



COMPENSATION BY WAY OF EXPANDER ARMS

By using this technique the system has a geometrical set-up which permits absorption of the expansion. For this purpose, in correspondence with changes in direction (elbows, tees, etc.) **expanding arms** are used, whereby the pipe has the possibility to expand in the presence of thermal stress. Calculation of these expander arms is made through the following formula:

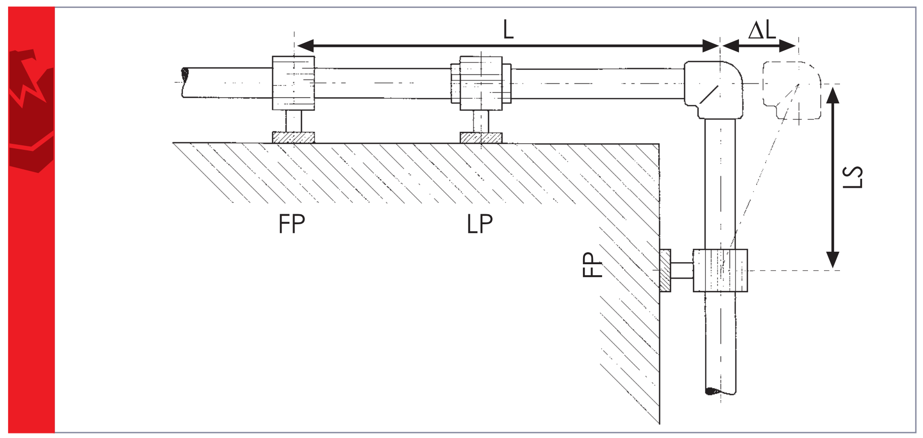
$LS = F \cdot \sqrt{d \cdot \Delta L}$ where:

LS = length of expander arm (mm)
F = material constant of the pipe (mm)
d = external diameter of pipe (mm)
ΔL = variation in length of pipe (mm)

EXAMPLE

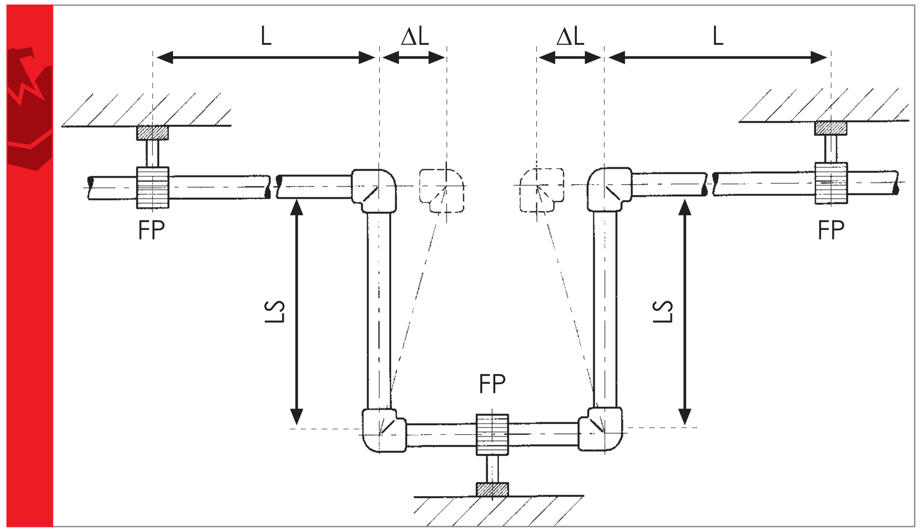
How to calculate the expanding arms relevant to a TUBORAMA pipe track where:		
d	=	40 mm (external diameter);
L	=	6 m;
ΔT	=	55°C
As previously calculated one obtains a ΔL = 49.5 mm		
Thereby:		
$LS = F \cdot \sqrt{d \cdot \Delta L} = 30 \cdot \sqrt{(40 \cdot 49.5)} = 1335$ mm		

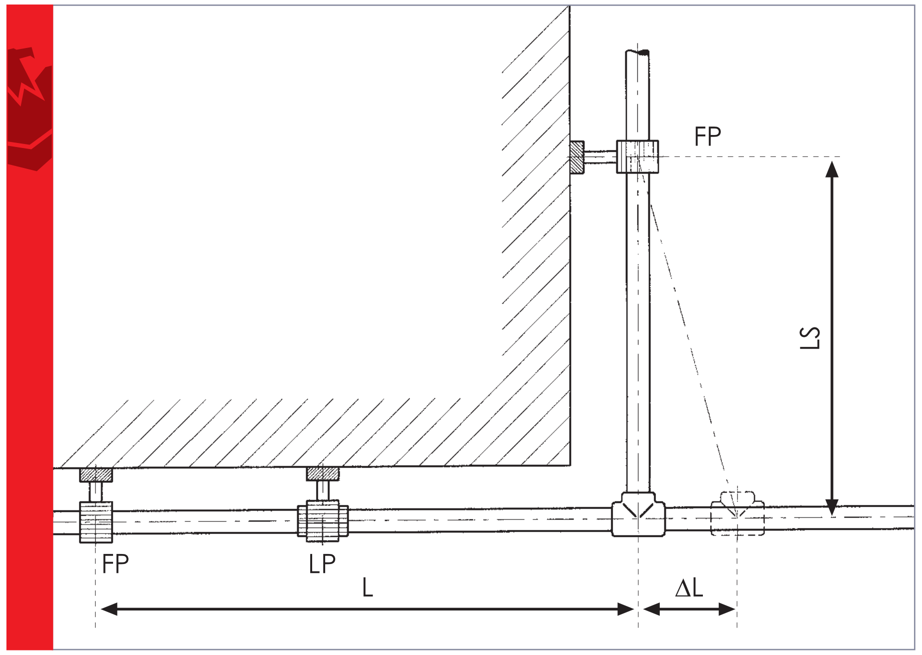
Example of expander arm

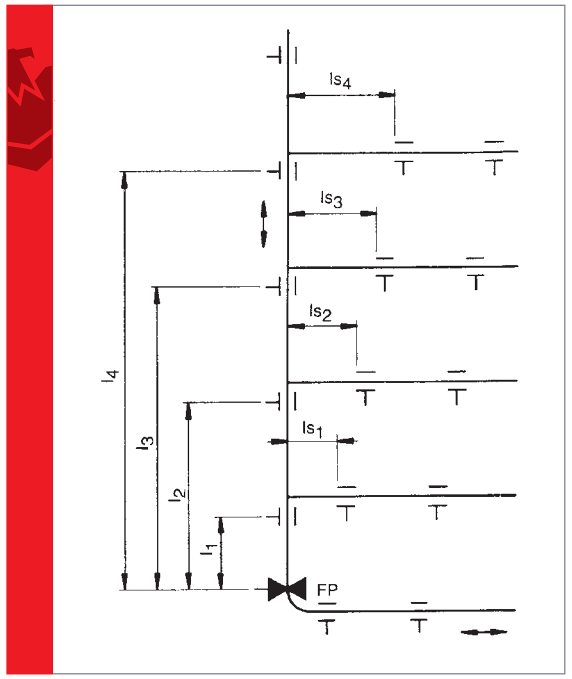


Graphic examples

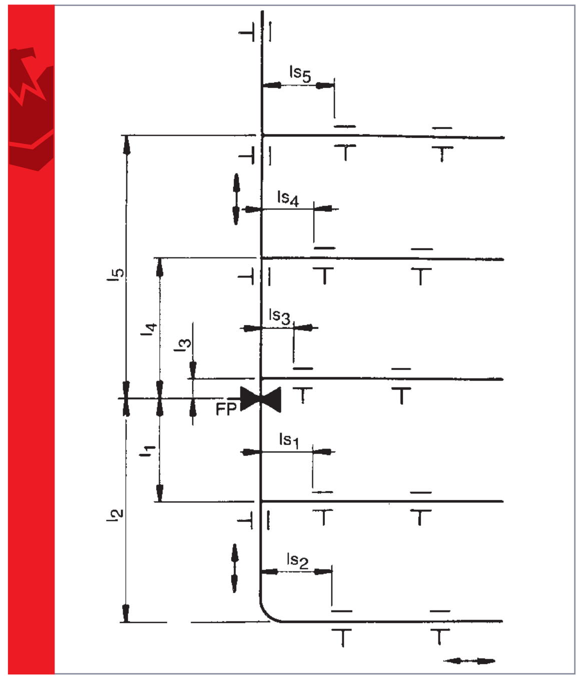
We are showing some examples of a correct outer track installation of ***TUBORAMA*** system, through the adoption of diverse techniques in controlling thermal stress on the material.



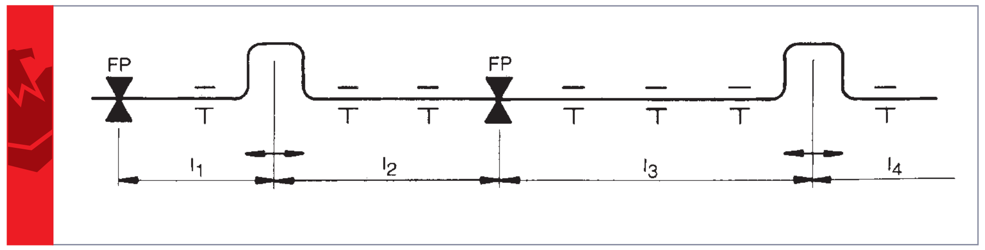




Fixed point at the base of the mounted column



Fixed point in an intermediary area of the mounted column



Absorption of length with compensation ring in a straight conductor

13. PRECAUTIONS

INTRODUCTION

Use of ***TUBORAMA*** for the construction of heating and hot water systems offers many advantages, already illustrated in this Guide.

However, in order to enjoy all the benefits of these properties, the user must be well aware of every aspect relating to the product to be used. To assist the ***TUBORAMA*** system user, we have prepared a number of important recommendations, set out below.

OPERATING CONDITIONS

The use of ***TUBORAMA*** in the stated operating conditions creates absolutely no problems for the material.
However, **exceeding the limit conditions for use may impair the product's resistance.**
All precautions must therefore be taken to ensure that this does not occur; this not only protects the system itself, but frequently also its user.

ULTRAVIOLET LIGHT

TUBORAMA **must never be installed or stored where it is subject to direct ultraviolet light.**
Exposure to ultraviolet light causes ageing in the material, leading to loss of its initial chemical-physical characteristics.

CONTACT WITH SHARP-EDGED BODIES

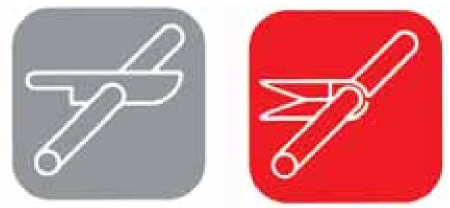
Care must be taken to ensure that the pipe surface does not come into contact with sharp edges which may cut its surface and lead to shearing.

This factor must be born in mind during both installation and storage.

Pipes which have been accidentally scratched or scored must not be used.

CUTTING PIPES

Users are advised to use tools which allowing cutting without burrs and perpendicular to the pipe's axis.



BENDING

For very wide radius curves, the pipe may be bent cold (see page 25).

For radii close to, but not below, 8 times the diameter of the pipe concerned, the pipe should be heated with hot air (see page 32).

FITTINGS WITH FEMALE THREAD

When using fittings with female thread, do not apply excessive tightening torques when connecting to male fittings.

Also, take care not to place too much hemp between the parts to be assembled, or use alternative materials such as teflon or similar products.

In addition, check that the male part is long enough for a proper connection; generally, at least one turn of thread should be left free.

If installation requirements mean that a ***TUBORAMA*** fitting must be connected to an iron pipe or union, the connection should be made using ***TUBORAMA*** fittings with male thread.

SYSTEMS AT AMBIENT TEMPERATURE ≤ 0°C

Remember that if the fluid conveyed is water, at this temperature the following change in state takes place:

$$\text{liquid (water)} \xrightarrow{T \leq 0°C} \text{solid (ice)}$$

and is accompanied by an increase in volume which leads to greater stress on the pipe. This stress may reach levels incompatible with the properties of PE-Xc.

For this reason, freezing should be prevented by adopting one of these precautions:

1) for heating systems:

- empty when not in use
- add anti-freeze agents (as in air-conditioning systems)
- insulate as appropriate

2) for water supply systems:

In this case, health requirements mean that the freezing point cannot be lowered by adding additives, and so the main precautions are to increase the level of pipeline insulation, and to create recycling loops for the most exposed sections.

N.B.
It is a common mistake to think that insulating pipes will eliminate all risk of freezing.

Remember that insulation is a barrier, designed essentially to delay the onset of freezing, and can never make it impossible.

14. INSPECTION OF SYSTEM

PROCEDURE

The inspection of the system (pursuant to ENV12108:2001 normative) is fundamental to the work having been carried out correctly. It permits, in fact, ascertainment that for no reason whatsoever, are there any leakage points in the system.
The following tests are shown below:

- Inspection of pipes and joints
This verifies that the installation of pipes has been correctly executed and that no parts have been accidentally damaged by sharp edges.

- Hydraulic hold test
Is executed on the system still directly accessible, by filling it with water at room temperature and taking care of releasing the air present.

1. Once filled and with the system closed, it is placed at a pressure established for testing for 30 minutes (where a decrease in pressure is registered due to settlement of pipes, reset pressure at 10 minute intervals).
2. Read the pressure value by using the apparatus at a precision of 0,1 bar after 30 minutes, read the pressure value after a further 30 minutes; if the variation is inferior to 0.6 bar the installation is without leaks. Continue inspection for a further two hours.
3. Read the pressure value after 2 hours, if the pressure drops by over 0.2 bar there is a leak in the system, otherwise the inspection is positive.

For certain tracks in the system it is possible to omit the tests stated in point 3.

INSPECTION OF PRESSURE – MAXIMUM PRESSURE OF TEST x 1.5

An appropriate use of ***TUBORAMA*** and its joints, together with a careful inspection will avoid any problems regarding tracks or systems destined to channel hot water.

Note:
On completion of inspection the test pressure is removed; sometimes it is best to totally empty the system, especially where it has been carried out in areas subject to temperatures close or inferior to 0°C.

This advice is given to avoid any eventual, unexpected breakage and due to formation of ice on systems which are presumed to have been inspected and, therefore, absent of any inconvenience.

NOTES