



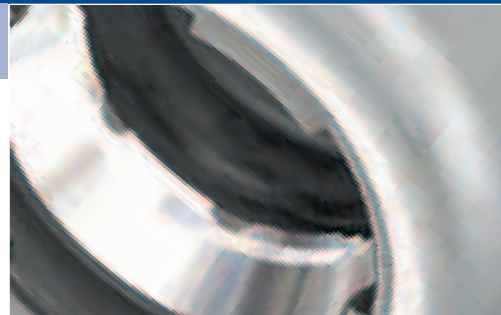
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June 2007

# equator<sup>o</sup>

The hot and cold plumbing system

## Design and Installation Guide





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## Introduction

Equator is the culmination of extensive world-wide research into fitting and system design, material composition and performance capabilities. The result is a uniquely designed fitting, patent pending, offering the following benefits:

- Fitting is fully de-mountable and reusable
- Fitting is tamper proof. Only through use of the de-mounting tool can the system be disassembled
- Excellent chemical resistance
- PE-X gives good temperature resistance, more so than many other non-thermosetting plastics used in the building industry
- Long term durability

Manufactured from cross-linked polyethylene (PE-X), which is a high engineering grade polymer, Equator offers excellent performance capabilities, and its benefits, both practical and financial, present a real alternative to copper systems.

For over 30 years PE-X pipe has been dominant in underfloor heating applications throughout Europe. Excellent chemical resistance, long term durability and performance capabilities make PE-X an ideal material for hot & cold and central heating installations.

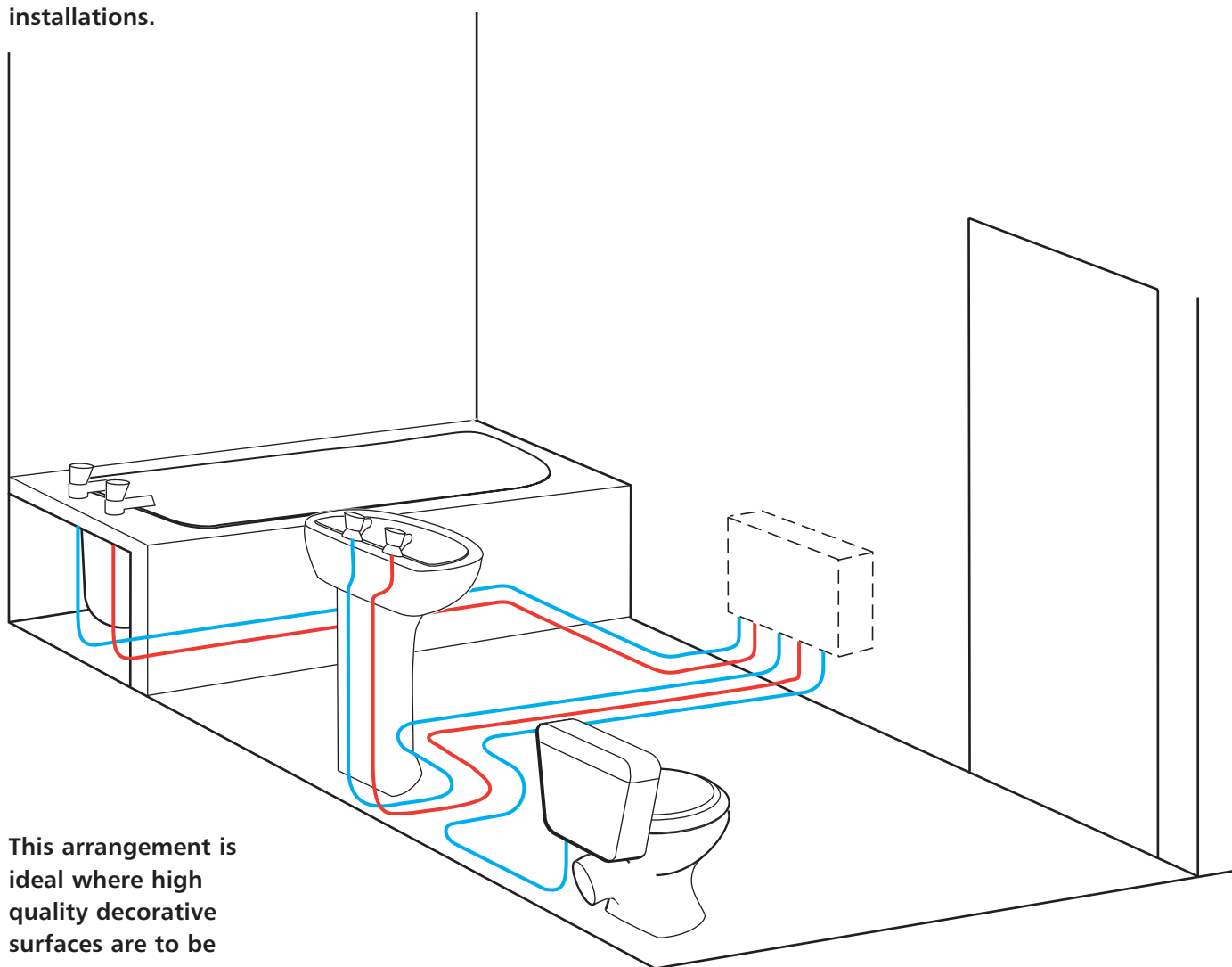
Equator has been designed to meet, and in many cases exceed the requirements of BS 7291: Parts 1 & 3: Class S.

Marley Plumbing and Drainage offers a complete all PE-X system to professional installers backed by a 30 year guarantee.



Equator is ideally suited for all types of domestic, commercial and light industrial applications.

This bathroom layout highlights the use of a manifold system. The manifold provides a central connection point for the whole bathroom installation, thus, reducing the number of connections typically associated with traditional installations.



This arrangement is ideal where high quality decorative surfaces are to be used. It is then possible to avoid having hidden joints, and to form a retractable piping system, by running pipes within conduit. This would provide good accessibility in compliance with Water Regulations or Byelaws.

**Table 1 Normal operating temperature and pressure limits for Equator pipe and fittings**

Application	Nominal system flow temperature °C	Max system service temperature °C	System malfunction temperature °C	System max working pressure bar
Cold water system	20	20	–	12.5
Vented hot water systems	65	83	100	3.5
Unvented hot water systems including instantaneous heaters and/or incorporating storage (excludes discharge pipes from temperature and/or pressure relief valves)	65	95	100	6.0
Vented central heating systems	82	95	100	3.5
Sealed central heating systems (excludes discharge pipes from pressure relief valves)	92	105	114	3.0

**Notes**

- 1 BS 5449 states that the central heating design flow temperature shall not exceed 82°C
- 2 Pipe circuits prone to repeated high level over heating such as found in gravity solid fuel and solar heating systems are not suitable for Equator
- 3 The above performance criteria is classified as having a pressure rating of PN12 within BS 7291. Marley Plumbing and Drainage produce an additional version of Equator for export markets meeting the higher pressure rating of PN16. This version holds KIWA certification. Contact [export@marleyext.com](mailto:export@marleyext.com) for further details.

**Table 2 Warm water operating temperature test limits for Equator**

Operating water temperature, °C	Maximum pressure rating, bar
30	11.5
40	11
50	10.5

## Composition

The materials used in the Equator system are listed and accepted by WRAS – Water Regulations Advisory Scheme for conveyance of drinking water by installations in all the UK’s regional water authorities.

Under test conditions PE-X shows excellent impact resistance and strength within the -20°C to 120°C range.

The inherent composition of plastic pipe makes the system very light in weight, roughly one quarter that of equivalent copper pipework. Scale build up and noise from water hammer are virtually eliminated with Equator pipe.

## Classification

Equator is classified in accordance with BS 7291: Parts 1&3 Class S.

The design life of Equator is at least 50 years when used for the applications and operating conditions listed in Table 1.

Equator may also be used in hot climates and in applications such as grey water systems. For this type of application, where the cold water will become warm, without the use of a heating appliance, the maximum warm water operating limits are shown in Table 2.

## Pipe

Equator pipe offers high performance pressure and temperature ratings and is resistant to most chemicals, see Appendix B for further guidance.

Marley use the Silane method (B) to cross-link the polyethylene used to form Equator. This method was chosen because it offers good surface finish, good uniformity of cross-linking, ease of co-extrusion (allowing production of good quality 5-layer barrier pipe), and low energy processing; thus causing less environmental impact.

Pipes are available in the sizes and lengths as detailed in Table 3.

Dimensional data on Equator pipe can be found in Table 4.

All outside diameters meet the requirements as set out in BS 7291: Part 3 2001: Table 1 and therefore are consistent with metric sized copper tube.

**EQUATOR PIPE MUST NOT BE USED FOR GAS, OIL OR HIGH PRESSURE AIR SUPPLIES.**

### Barrier pipe

Designed originally for central heating and underfloor heating systems, barrier pipe incorporates an oxygen barrier located centrally within the pipe wall to inhibit oxygen permeation.

Barrier pipe is also suitable for hot & cold water applications.

In order to gain optimum system performance, Marley Plumbing & Drainage only offer Barrier pipe

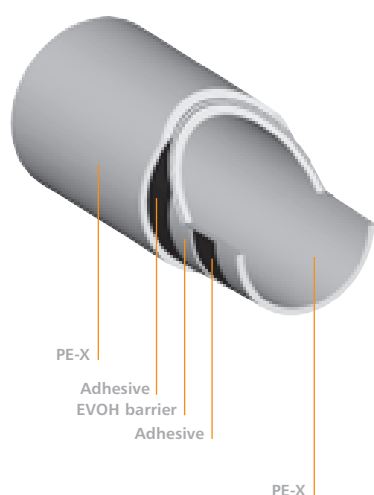
For information on chemical resistance see Appendix B or contact the Technical Hotline on 01622 852695.

### CDM Regulations

Use of the Equator system can help to reduce the risk of injury during construction when compared with other systems such as rigid copper with soldered joints.

The following should be considered when carrying out an assessment of the risks in accordance with the Construction Design and Management Regulations (UK).

- Flexible piping allows services to be cabled from below a joisted floor, obviating the need to work on open joists.
- Jointing does not require the use of a naked flame, which thereby reduces fire risk.
- The jointing system does not require the use of flux which may be helpful in confined areas where exposure to vapour from some fluxes can cause irritation to eyes, nose, throat and respiratory tract. For more information refer to the flux manufacturer’s safety data sheets.



## Electrical bonding

### New installations

Plastic pipes are non-conductive and therefore do not need to be bonded to earth.

Where the incoming water main is plastic and where Equator products are used throughout, any metal components, such as radiators and short lengths of copper pipe at final connections to appliances, will not normally need to be earth bonded.

On such installations supplementary bonding of the electrical appliances within rooms containing a bath or shower would still be required, but there would be no need to make supplementary bonding to metal taps, metal radiators or a metal bath, providing the bath is not connected to the metallic building structure.

Any metal gas pipe, oil pipe or unvented water heater discharge pipes must be earth bonded in accordance with electrical regulations.

On the typical new installation outlined above the use of a plastic system will reduce the need for earth bonding compared to a full copper system.

### Existing installations

For existing metal pipework systems, the installer needs to be aware that if Equator pipe or a moulded fitting is inserted into a metal pipe, the electrical continuity of the existing pipe

will be broken. The electrical continuity can be maintained by fixing a permanent earth wire to link both ends of the metal pipe before the pipe is cut.

### Further advice

For installation methods and applications beyond the scope of the above guidance, installers should refer to regulations, guides and advice which can be obtained from organisations such as:

- Institution of Electrical Engineers, London. Tel 020 7240 1871
- National Inspection Council for Electrical Contracting, London. Tel 020 7564 2323

### Insulation

Equator has a lower thermal conductivity than copper, however for practical application of frost protection and energy conservation to comply with Building Regulations, pipework should be lagged to the same standard as required for copper. This will provide a slightly higher standard of insulation than given by an insulated copper system.

### Freezing

Equator pipework maintains a good degree of flexibility down to -20°C. It is this flexibility that significantly reduces the threat of burst pipes. A length of PE-X pipe clear of pipe fittings will normally accept the increase in volume created when the water freezes, without bursting.

Equator pipe can be frozen by pipe freezing equipment for maintenance to water filled pipes. The freezing process will take slightly longer than normally expected for copper pipe. Always follow the freezing equipment manufacturers' advice.

### Thermal expansion

Equator pipe will expand more than copper piping, however no special provision is usually necessary in domestic applications as the pipe will flex between fixed points and Equator joints will remain secure. On projects where long straight pipe runs apply e.g. on commercial buildings, provisions to maintain correct pipe alignment during thermal expansion will be required. This may involve the use of proprietary brackets, pipe anchors and/or offset bends. For further advice refer to BS EN 806 or contact the Technical Hotline on 01622 852 695.

### Noise reduction

Unlike metal pipes which are rigid and are prone to generate noise from thermal movement or water hammer, Equator pipe is flexible and therefore runs virtually silent.

For detailed technical data on Equator pipe please refer to Appendix C.

**Table 3 Pipe sizes and lengths**

Diameters (mm)	10	15	22	28
Lengths				
3m Straight		•	•	•
6m Straight		•	•	•
25m Coil		•	•	
50m Coil	•	•	•	
100m Coil	•	•		

**Table 4 Dimensions of Equator pipe**

Nominal size (mm)	Mean outside diameter (mm)		Wall thickness (mm)	
	Minimum	Maximum	Minimum	Maximum
10	9.9	10.1	1.5	1.8
15	14.9	15.1	1.5	1.8
22	21.9	22.1	2.0	2.3
28	27.9	28.1	2.6	2.9

**Equator fitting specification**

Body	Cross linked polyethylene (PE-X)
O-ring seal	Ethylene propylene dien monomer (EPDM)
Spacer washer	Acetal
Grip ring	301 stainless steel toothed grip ring in a moulded glass filled acetal support
Support collar	Glass filled Acetal
End cap	316 marine grade stainless steel
Pipe support sleeve (not shown)	316 marine grade stainless steel

## Fittings

A comprehensive range of fittings is produced to cover most domestic and small commercial central heating, and hot & cold water systems up to 28mm size.

A range of manifold fittings and accessories complements the design flexibility of the Equator system.

The body of the basic fitting is made from cross-linked polyethylene, the same heat resistant and tough material as for the pipe. The socket ends are reinforced with a marine grade 316 stainless steel end cap enabling the fitting to withstand the effects of pressure and end loading.

The bodies of BSP screwed adaptors, valves and drain taps are manufactured in DZR quality brass.

Equator push-fit joints should not be used on chrome plated copper tube, stainless steel tube or plain brass spigot ended fittings not within the Equator range.

## Fitting design

Each socket incorporates a pre-lubricated O-ring and a grip ring.

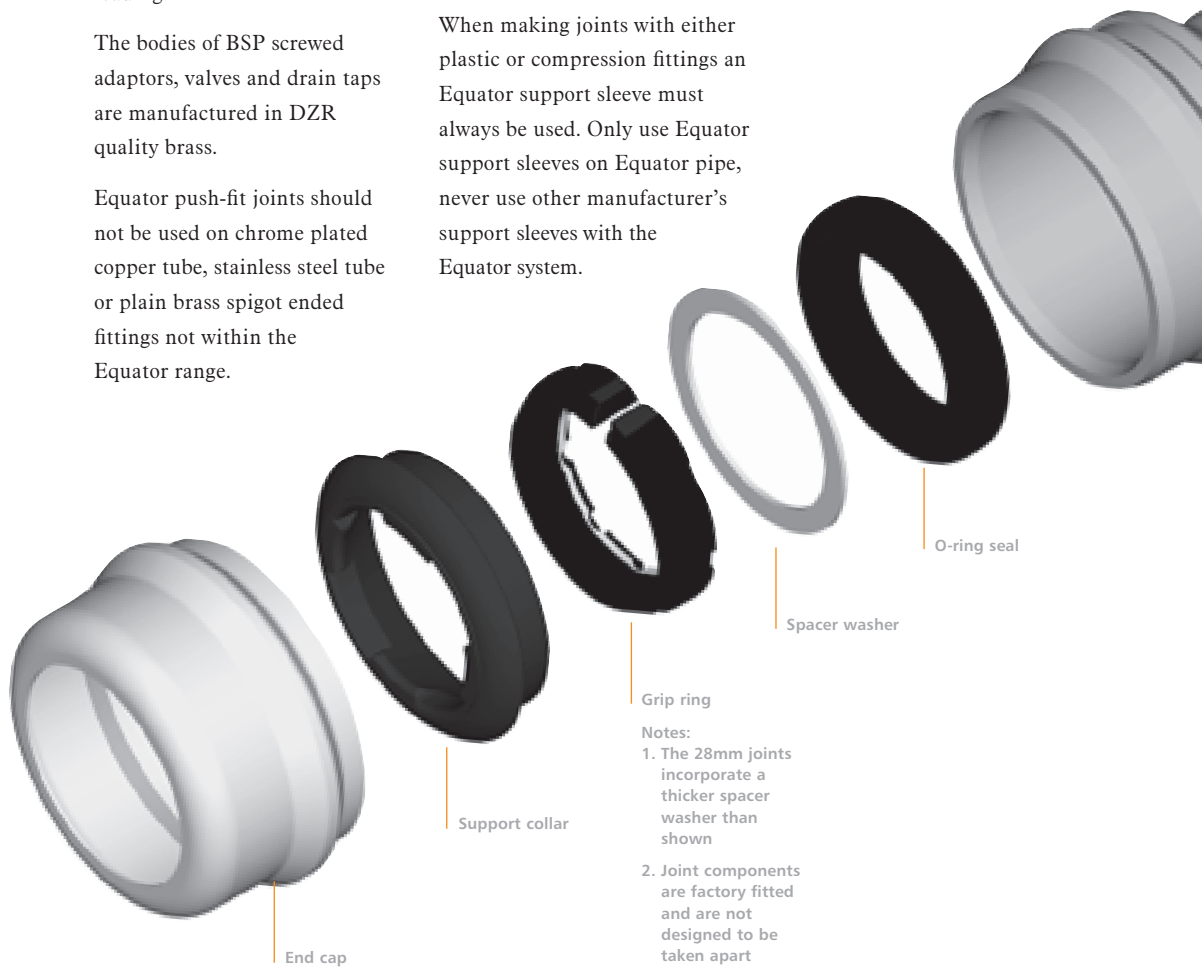
When pipe is pushed into the socket it first passes through the grip ring and then through the O-ring. The pipe is fully home when it meets the pipe stop in the bottom of the socket.

The grip ring is a unique design which allows it to be 'relaxed' or open during pipe insertion. When tugging back on the joint after insertion, or when filling the system with water, the grip ring moves to engage the support collar which closes the grip ring locking it tightly onto the pipe.

When making joints with either plastic or compression fittings an Equator support sleeve must always be used. Only use Equator support sleeves on Equator pipe, never use other manufacturer's support sleeves with the Equator system.

Marley Plumbing and Drainage advise against the mixing of other proprietary push-fit products. Where necessary or where it is unavoidable, i.e. in renovation work, connection to other push-fit systems is possible providing the fittings or pipe is manufactured to BS 7291. Particular care is needed when using spigot fittings, as the position of any grip ring groove varies with each push-fit system manufacturer.

For dimensional information on the basic Equator fittings please refer to Appendix D.



## System design

Hot and cold water systems should be designed using the methods detailed in BS 6700: 1997.

Central heating systems should be designed using the methods detailed in BS 5449: 1990, BSEN 12828 & 12831.

Further design information can be obtained from either of the following sources:

- BS 5955: Part 8
- Plumbing Engineering Services Design Guide – published by the Institute of Plumbing
- Publications by the Chartered Institute of Building Services Engineers.

Although the inside diameter of Equator pipe is slightly less than that of copper, the effect on frictional resistance can be reduced due to the following:

- Fewer elbows and couplers are required
- There is no build up of solder or burrs to impede the rate of flow
- The PE-X pipe and fittings significantly reduce scale build up.

Pressure loss due to water flow rates may be estimated using one of the tables in Appendix E. The tables are based on the Colebrook-White Equation for smooth pipes. Some designers use cold water head loss data when sizing metal piping for domestic hot water supply, on the basis that this safety factor will offset any scale build up. However, as Equator pipe is scale resistant, hot water head loss data may be used.

Allowances for any pipe fittings should be made as normal within the industry.

Pressure loss through Equator valves can be calculated using the tables found in Appendix F.

## Service design conditions

All systems must be designed to operate within the limits in Tables 1 and 2.

### Cold water systems

No special precautions are necessary for Equator pipe and moulded fittings as the system is suitable for working pressures up to 12 bar and mains water supplies are typically much less.

### Vented hot water systems

No special precautions are necessary for Equator in this type of system.

### Unvented hot water systems

For unvented hot water systems including domestic hot water fed from combi boilers or instantaneous heaters, no special precautions are necessary for Equator where the system working pressure is below 6 bar.

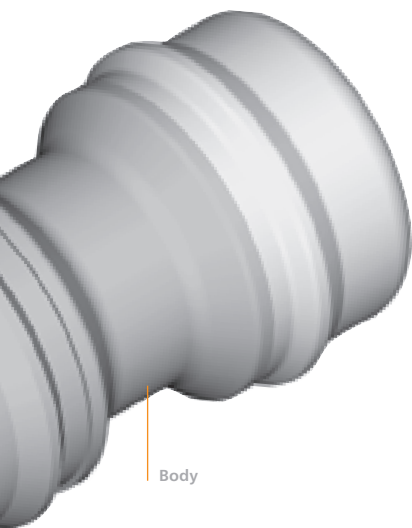
Where this is not so, a pressure reducing valve should be fitted on the cold feed to the heater.

Some heaters must operate at pressures much less than 6 bar, and therefore pressure-reducing requirements of the heater manufacturer should then be followed.

### Central heating systems

Central heating systems will operate within the limits contained in Table 1 when properly designed, installed, commissioned, and operated in accordance with BS 5449, and the boiler manufacturer's recommendations. Equator is suitable for many types of systems such as combi-boiler, condensing boiler, thermal storage unit etc.

See Appendix B for corrosion inhibitors.



Body

## Boilers

Equator pipe may only be fitted to gas and oil fired boilers where the point of connection is more than 350mm above or below the boiler casing. See Fig 1.

Equator is not suitable for gravity primary circuits on solid fuel boilers or solar heating systems as it is not usually possible to adequately control temperatures to ensure the long term longevity of the pipe.

For back boilers, copper pipe should be used in the boiler recess, and extending to outside of the chimney breast.

Marley Equator barrier pipe and fittings are subjected to testing to confirm their ability to withstand all normal operation conditions. In addition they are tested under malfunction conditions which are defined in BS 7291, to ensure that they are capable of withstanding the conditions generated when the control thermostats of a boiler (or other heat generating source) fail or malfunction and subject the pipework to a temperature of up to 114°C +/- 2°C for a short period of time.

Marley Equator pipes and fittings are certified to BS 7291/3 and will withstand the Class S malfunction test of 1000 cycles between 114°C and 20°C at 3.5 bar pressure without failure occurring.

It should be noted, however, that the use of Marley Equator pipes and fittings with any heat source which can generate higher temperatures or pressures than 114°C and 3.5 bar during either normal operation or malfunction could result in the failure of the Marley Equator pipes and fittings. Such conditions will almost certainly result in the release of superheated steam and boiling water which could result in serious injury to any person in close proximity.

Further information can be obtained from the Technical Services department of Marley Plumbing & Drainage.

Fig 1 Boiler connections

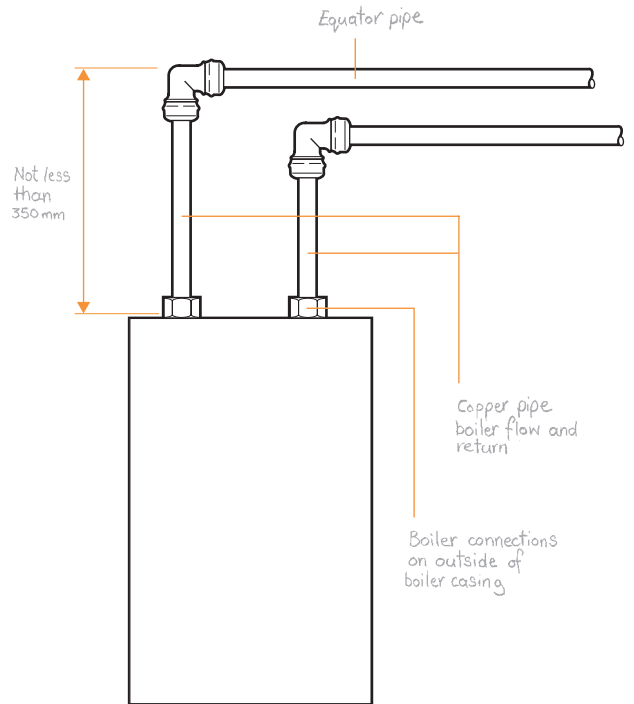
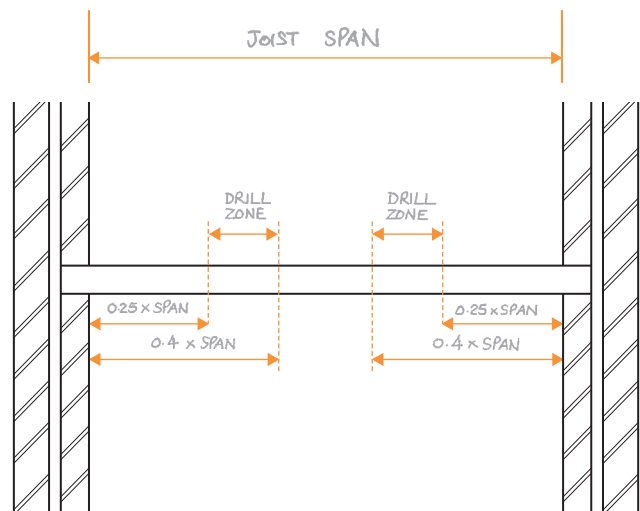


Fig 2 Location of drilling zone on joist span



## Pipe layouts – general advice

The Equator system is ideal for routing services through:

- floor voids
- ceiling voids
- lofts
- conduit piping

Where surface mounted pipework must be used it may be preferable to use rigid pipes, i.e. copper. Equator fittings joint to copper pipe without the need for any special adaptors.

## NHBC pipe detection requirements

To comply with the NHBC requirement to detect plastic pipework behind or in wall surfaces, apply Equator pipe detection tape (ET100) to the pipework.

## Pipe layouts through floor joists

Equator's flexibility permits easy cabling through floor joists, notching is not necessary. This method of fixing means that pipework can be installed after the floor has been laid, working from below.

This method of installing pipework presents several distinct advantages:

- No risk of damage to pipework when fixing floor boards
- Larger pipe sizes can be routed across joist spans by drilling compared to notching
- There is adequate space around the pipe for correct thickness of thermal insulation to be fitted in accordance with Building Regulations or where required by the clients specification

The flexible nature of Equator pipework makes it ideally suited to be cabled through proprietary timber 'I' joists, such as TJI joists used in the Silent Floor System manufactured by TJM Europe where semi punched holes are provided, or through perforated steel beams.

## Guidelines for drilling traditional timber joists

The correct location for drilling joists is different to the notching zone.

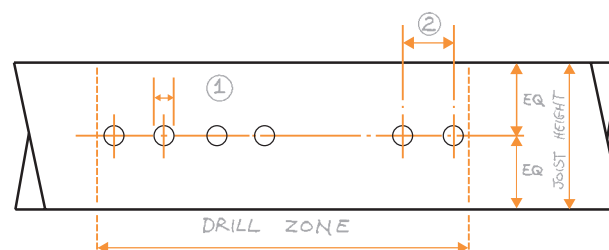
Holes should be drilled in accordance with BS 6700, BS 5449 and NHBC regulations. Figs 2 and 3 give guidance on the regulations.

To assist in calculating the 0.25 and 0.4 factors for a particular joist span, Fig 4 may be used on page 10.

**Table 5 Recommended minimum hole size for pipes through joists**

Pipe size	Hole diameter
10	15
15	20
22	28
28	32

Fig 3 Drilling limits within the drilling zone

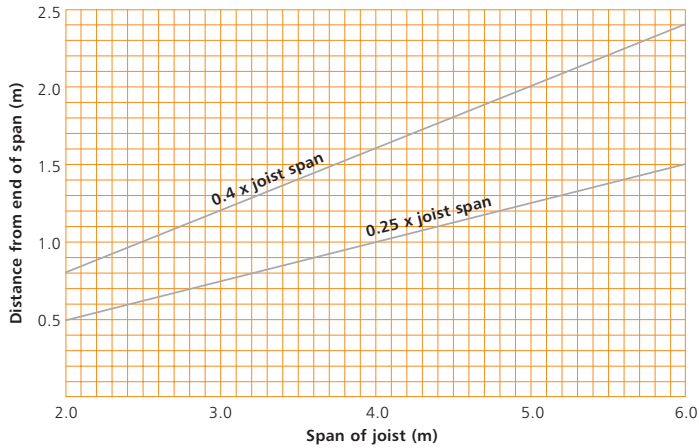


① MAXIMUM DIA OF HOLE = JOIST HEIGHT  $\times$  0.25

② MINIMUM DISTANCE BETWEEN HOLE CENTRES =  $3 \times$  LARGEST HOLE DIA.

## Pipe layouts using 10mm Equator pipe

Fig 4 Graph to aid location of drilling limits



### Central heating

The use of 10mm flow and return radiator connections are very popular with house builders as the smaller pipes can be concealed behind plasterboard (refer to Installation Section for more details).

Equator pipe is ideal for this application and has the advantage over copper of being resilient to impact damage which can sometimes be caused by following trades.

Several boiler manufacturers and heating designers recommend the use of a 'high head' circulating pump whenever minibore size pipe (pipe with diameter less than 15mm), is to be installed. Whatever pump is specified, it is advisable to check that the circulating head of the pump will be adequate to overcome the resistance of 10mm piping plus all other resistances of the index run.

To easily estimate the frictional loss of 10mm Equator pipework based on the design load at 11°C temperature drop, Table 6 may be used.

Table 6 Frictional loss (kPa) for 10mm heating pipes

Design load of circuit (KW) for 11°C temp drop	Circuit length in metres (flow plus return pipe)			
	5m	10m	15m	20m
0.6	1.825	3.650	5.475	7.300
0.8	2.980	5.960	8.940	11.920
1.0	4.405	8.810	13.215	17.260
1.2	6.030	12.060	18.090	24.120
1.4	7.910	15.820	23.730	31.640
1.6	9.965	19.930	29.895	39.860
1.8	12.720	25.440	38.160	50.880
2.0	15.640	31.280	46.920	62.560

#### Notes

Add an allowance for pipe fittings to the measured circuit length before using this table

To check the system pump head requirement, add the allowance from this table to other flow resistances such as, heating main runs, boiler, valves, radiators etc.

### Hot and cold water

On mains water fed systems, where pressure is 'lively', the use of 10mm pipework to supply a wash basin, bidet or WC has been found to be adequate.

Equator pipe is ideal for this application. The system designer should consider the running pressure loss through the system and the minimum head required at the appliance to determine that 10mm pipe will be adequate.

## Pipe layouts using the manifold and conduit system

**Table 7 Operating data for manifolds**

Operational detail	bar
Maximum operating pressure at 20°C	10

*Note*  
Maximum operating pressure for heating and hot water as Table 1 & 2 in this guide

The Equator range includes a complete manifold and conduit system that allows piping to run within floor screeds and masonry walls. This method enables the future withdrawal of the pipe and thus complies with Water Regulations access requirements.

### Manifolds – General

Equator manifolds are ideal for central heating plus hot and cold water systems. The Equator manifold system can be close coupled to make-up manifolds having any number of outlets, as required. Table 7 details operational data for Equator manifolds.

The maximum number of manifold ports which can be fitted in the manifold box is stated in Appendix H.

### Valved manifolds

These are mainly designed for hot and cold water supply. As the valves are not full bore they are not suitable for gravity low pressure hot and cold water systems, refer to flow performance data in Appendix G.

Each valve head incorporates a twin disc label system. The top disc can be fitted with either the red or blue side facing the user and is slotted to display the appropriate wording on the bottom disc. The choice of wording on the bottom disc is given in Appendix H.

### Plain manifolds

These are mainly for central heating, but can also be used for hot and cold water supply where full isolation is not required.

For a complete listing of the fittings and accessories associated with this range please refer to the Equator Product Range at the back of this guide.

Installation details for this system can be found in the Installation section of this guide.

Manifold dimensions can be found in Appendix H. Pressure loss data can be found in Appendix G.

## Piping layout – special advice

### Legionella

All materials within the Equator range are classified as safe for use in contact with water for human consumption. The main risk of colonisation by legionella bacteria relates to the system operating temperatures and stagnation of water within the system, as detailed in current UK publications such as BS 6700: 1997, HSC Doc L8, HSE Doc HS(G) 70 and CIBSE Doc TM13.

Equator push-fit joints reduce the risk of contamination as installation requires no use of flux, solder or joint sealing compound, which could form a nutrient for bacteria. Equator piping is far less prone to scale build-up than metal piping, which helps to promote a cleaner system.

### Vermin

Materials within the Equator range do not attract vermin. However, any materials that are softer than rodent's teeth are liable to be gnawed, including PVC covered electrical conduit.

As vermin are known to carry pathogens and spread diseases, buildings should be constructed and maintained to exclude such pests.

## Appendix A

### Approvals and standards

All plastics pipe and fittings in the Equator product range comply with the recommendations of BS 6920: 1990 – suitability of non-metallic products for use in contact with water for human consumption, with regard to their effect on the quality of the water.

Equator complies with BS 7291: Part 1 2001 which covers the general requirements of thermoplastic pipes and BS 7291: Part 3: 2001 – specification for cross-linked polyethylene (PE-X) pipes and associated fittings.

Equator complies with the highest rating, which is Class S.

Most products in the Equator range are certified by WRAS and BBA. Full details and copies of certificates are available by request or via [www.marley.co.uk](http://www.marley.co.uk)

The Equator system is designed to meet most international test standards; for current approvals contact the Technical Hotline on: 01622 852695.

Equator is accepted for 3 Star Service Cover by British Gas and Scottish Gas throughout the U.K.

The Equator range is manufactured within a Quality Management System which complies with BS EN ISO 9000: 2000.

In addition to compliance with packaging legislation introduced in 1997, Marley places great emphasis on ensuring that all manufacturing processes and practices are environmentally responsible.

Marley Plumbing and Drainage also play an active role at industry level with the British Plastics Federation where broader industry wide environmental issues are addressed.

according to manufacturer's design and installation guidelines and providing the installation is operated within the pressure and temperature limits as stated in the Equator Design and Installation Guide. The scope of this guarantee is limited to the replacement of defective products and all consequential losses of any nature are excluded. Normal 'wear and tear' and all brass or valved assemblies are excluded.

### Guarantee

Marley Extrusions Limited guarantees the Equator product range for 30 years against defects in design or manufacture, or against defective materials. This guarantee is only valid when Equator is installed correctly



## Appendix B

### Chemical resistance

#### Water

Equator PE-X pipework is suitable for the conveyance of all potable water whether hard or soft, and may be used to convey other aqueous media such as distilled water, brackish (salty) water, and 'grey' (ablutionary) waste water.

#### Chlorine

Potable water which contains chlorine at levels which is safe for human consumption will not adversely affect Equator pipework. Where disinfection is required, systems formed by Equator pipework may be disinfected with chlorinated water using the concentration level, contact period, and procedure described in BS 6700:1997. Applications which require the continuous maintenance of a high concentration level of chlorine, such as display water systems, are not suitable for Equator pipework.

#### Central heating corrosion inhibitor

Companies such as Fry Technology UK – 'FernoX' (tel: 0870 601 5000) and Betz Dearborn Ltd – 'Sentinel' (tel: 0151 420 9563) manufacture central heating corrosion inhibitor which they have tested and found to be suitable for all materials within the Equator product range. There is currently no British Standard for corrosion inhibitor, and reputable

manufacturers conduct their own tests to verify that the chemicals will not adversely affect pipework materials.

#### Household chemicals

PE-X gives good resistance to most household chemicals. In the event of accidental spillage, it is recommended that Equator pipework should be washed with clean water. Avoid contact between Equator pipework and paint thinners, paint stripper, acid based descalents and aggressive cleaning agents.

#### Soldering flux

The transfer of flux traces by handling with contaminated hands is not detrimental to Equator pipework, however:-

- Do not allow flux to run onto Equator pipe or fittings
- Keep Equator products away from any sources of naked flame, wrap a damp cloth around the copper pipe during soldering to control conductive heat
- Do not allow hot solder to come into contact with any Equator products.

#### Painting

Equator pipework may be painted with either emulsion or oil based gloss paint. Cellulose based paints must not be used.

#### Wood preservative

Apply treatment to timber and allow for absorption of chemicals prior to installing Equator pipework in the same location.

#### Antifreeze

Equator pipework is suitable for heating systems in which antifreeze based on ethylene glycol has been mixed with the water.

#### Trace heating

The use of Equator pipe with trace heating is not recommended as the source of the heat is uncontrolled.

## Appendix C

### Technical data for Equator pipe

Thermal conductivity	0.37w/m °C
Expansion coefficient	1.9 x 10 <sup>-4</sup> m/m °C
Modulus of elasticity	670N/mm <sup>2</sup>
Vicat softening point	126°C (min)
Density	0.94g/cm <sup>3</sup>

Note: The above data is typical for the PE-X polymer used to extrude Equator pipe, and should not be regarded as a performance guarantee.

### Pressure conversion

1m head = 9810Pa = 9.81kPa
1bar = 10.2m head
1m head = 1.422psi

































































