Domestic Water Systems

The Bathroom Academy
in partnership with
Strategic Professionals

Domestic Water Systems
Generic Industry Guide

Welcome to the Domestic Water Systems Generic Industry Guide one in a series of Industry Guides which are available free of charge from the Bathroom Academy Web Site.

We have aimed to make the contents of the Guides both informative and relevant and hope you will consider them a valuable aid to your continuing professional development and that of your colleagues, within the Bathroom Industry.

Each Guide has been written by experts and contains the same five elements:

- Right choice of product for end user needs
- Generic industry design
- Generic industry installation
- Frequently asked questions
- Generic industry terminology

The Domestic Water Systems Generic Industry Guide looks at the vast range of domestic water systems that are available and offers essential information which will allow the Retailer, Merchant and Installer to provide items best suited to the end user needs, whilst the customer's major considerations will be cost, functionality, durability and aesthetics. It is also essential to consider a number of important additional factors; available space, storage requirements and the materials used to manufacture the furniture and its' suitability and compatibility with the bathing and/or showering suite within the bathroom.

Other guides in the series are:

- Baths
- Bathroom Furniture
- Brassware
- Sanitaryware and Fittings
- Shower Controls
- Shower Enclosures
- Shower Trays
- Thermostatic Mixing Valves
- Wetrooms

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Industry Guide to Domestic Water Systems Issue 4/11

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Introduction

This guide outlines how different types of domestic water systems work and gives guidance on suitable products.

In all cases the manufacturer's guidance on plumbing requirements must be followed. Particular attention must be given to ensuring installations are in accordance with Building Regulations, Water Regulations/Bye-laws and BS 8558:2011 (Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. Complimentary guidance to BS EN 806).

The Water Supply (Water Fittings) Regulations (Byelaws 2000 in Scotland) are mainly about ensuring the integrity of the mains supply. In particular, they are designed to prevent misuse, waste, undue consumption, erroneous measurement and, most importantly of all, contamination of drinking water.

Tap, Mixing Valve & Shower Performance

The effective performance of taps, mixing valves & showers require a dynamic pressure of somewhere between 0.1 and 3 bar. Any less than this and the customer will notice poor performance – particularly in a mixer shower or when filling a bath.

Note: As a broad rule consider up to 1 bar as low pressure and anything over as high pressure.

A number of factors will influence the available dynamic pressure, such as the mains water pressure and flow: the water system itself (some gravity fed systems may give less than 0.1 bar in an upstairs bathroom, but an unvented system may provide up to 3.5 bar); the overall demand, (that is, how many people occupy the dwelling and what is their water usage); and finally what is the pattern of use, for example do lots of people need to use showers and bathrooms at the same time early in the morning?

Note: Many consumers find the Rate your bathroom (Designing for Life) fact sheet, available to download free of charge from www.bathroom-association.org/consumer-advice an invaluable tool in assessing their needs.

Before we examine the operating principles of specific water systems let us look at some simple definitions.

Water Pressure

Can be defined as the weight of water above the point of use. A good way to understand water pressure is to imagine a vertical column of water feeding the water system way above the house. Water pressure is measured in 'bar'. A column of 10 metres high is equal to 1 'bar'.

Static Head

The height of water available above the point of use is known as Static Head. So if a storage cistern in the loft is 1.5 metres above the point of use then the Static Head is said to be 1.5 metre which is equal to 0.15 bar.

The Relationship between Pressure and Flow

We need to be clear about the relationship between pressure and flow because the two don't mean the same thing! Imagine a gardener watering his garden. If he opens the supply tap just a little way he will get a dribble of water coming out. If he opens the tap to the maximum, the pressure at the tap inlet changes little, but flow increases, more water comes out of the end of the hose but it still pours out close to his feet. If he wants to water plants that are more than a few inches away he will need to increase the pressure in the nozzle, and he will usually do this by putting his thumb over the end to reduce the nozzle area which turns the flow into a strong jet. Even if the tap is closed a little by further reducing the area of the hose nozzle he can still produce a jet – a high pressure, low flow supply.

The Difference between Static & Dynamic Pressure

There is also the issue of static versus dynamic pressure. An appliance can only use dynamic pressure that is available whilst water is flowing. This is a common mistake to measure static pressure and assume that this same pressure will be available constantly. Pressure does vary from static to dynamic. Whilst a tap is in the closed position, the pressure may be as high as 3 bar, however once the tap is opened the pressure may drop to 0.8 bar or less, as the supply pressure fluctuates.

Static Pressure is the water pressure existing at a fitting when no flow is taking place.

Dynamic Pressure is the maintained pressure, where the water pressure in the pipework to a fitting has flow taking place.

Section 1

Domestic Water Systems

Gravity Fed Hot Water System

Mains cold water is supplied into a storage cistern via a float operated valve. The size of the cistern will depend on the supply requirements within the building. For domestic dwellings the volume of stored cold water is generally more than 230 litres. Connections at the base of the cistern distribute water to supply, in some cases, both hot and cold taps within the property.

Alternatively, the cistern will supply the hot water cylinder only, the cold water taps being connected to the mains cold water supply.

In either case, the domestic hot water circuit is the same. Water from the cistern is delivered into the bottom of the cylinder. When full, water flows out from a connection at the top of the cylinder. Pipework from this point distributes water to the hot taps within the property. A section of pipe also rises above the cistern where it terminates as an open outlet above the waterline. The prime function of the open vent is to maintain stored water at atmospheric pressure with a boiling point of 100°C.

Cylinder capacities vary, in domestic dwellings, the cylinder will usually contain 115 to 230 litres of stored water heated to between 60° and 65°C. It is advisable to store water no hotter than 65 °C to reduce the effects of scaling that occurs in hard water areas.

The most common gravity system consists of a cistern located in the roof space approximately 2 metres above the cylinder, which is usually located in an airing cupboard.

Other arrangements exist in the form of combination cylinders, which consist of a small cold water cistern and hot water cylinder in a single compact unit. This type of arrangement is usually unsuitable for mixing valves and pumped shower products due to the low head of water available.

Suitable Products:

- Manual Mixing Valves
- Venturi Mixing Valve Showers
- Low Pressure & General Purpose Thermostatic Mixing Valves
- Low Pressure & General Purpose Taps & Mixing Valves including Bath and Bath/Shower Mixing Valves
- Twin Ended Pumps
- Integral Pump Power Showers
- Pumped Shower Panels
- Low Pressure Digital and Remote Control Mixer Showers

Tap, Mixer Shower Performance on a Gravity System

Flow rate is determined by three factors:

a) The height of the cold water cistern above the shower head.

b) Restrictions within the system i.e. pipe, fittings, valves, and showerhead.

c) Any flow regulators that have been fitted including aerators.

For water to be forced out of the system, a head of water must exist. Head is the vertical measurement from the base of the cistern to the showerhead or tap outlet. Every 1 metre head achieved will result in a pressure increase of 0.1 bar. 10 metres head = 1 bar = 100kPa. In domestic situations, head of water can be less than 1 metre, therefore minimal pressure exists to force water through the system.

In addition to the low head factor, restrictions within the system will reduce the pressure further. As the water flows through fittings and valves, etc., a pressure loss occurs; if these areas are particularly restrictive, pressure and flow at the showerhead can be significantly reduced.

Pumped Gravity Shower Systems

Note: Electrical installations in domestic dwellings must comply with part P of the Building Regulations. If installation is carried out by anyone who is not registered to issue a Part P certificate for electrical work in bathrooms then the Building Control Office must be notified before work commences.

Installing a booster pump will improve gravity system pressure and the performance of mixer showers.

In domestic situations a pump can be installed to improve flow rate from a number of outlets, but more common is the installation of a pump to boost the pressure and flow from a single mixer shower, bath shower mixing valve or shower panel. It is important to note that shower booster pumps must not be connected to mains fed hot or cold supplies as this contravenes Water Regulations. Also there is high risk that mains pressure will damage the pump. All shower pumps must be installed below the bottom of the cold water cistern so that the pump chamber/s can fill with water. Turning on a pump before it has been primed with water will damage the internal seals.

Pump Products Suitable for Tap and Shower Applications are:

- Single ended pump
- Twin ended pump
- Integral pump mixing valve
- Digital and remote control low pressure (pumped) mixing valves

Single Ended Pump

This pump consists of a single pumping chamber with one or more impellers. Water connections consist of one inlet and outlet.

Water from the gravity hot and cold supplies is delivered to a mixer shower where it is blended to the required temperature. Water at showering temperature is then delivered into the pump, which must be installed between the mixing valve and the showerhead. The pump may be fitted with a flow switch on the outlet to start the pump when the mixing valve is turned on. Blended water is then delivered directly to the showerhead. When the mixing valve is turned off, the flow switch is deactivated and the pump stops running. Some pump units can be wall mounted in the showering area, in which case the pump is turned on and off by a start – stop switch on the unit.

Twin Ended Pump

A twin ended pump has two pumping chambers each with one or more impellers; one chamber is used to pump cold water, the other to pump hot water.

The pump is fitted into the supplies between the stored water and the mixing valve, typical locations being in an airing cupboard or under a bath. A flow or pressure switch on the pump is activated when the mixing valve is turned on; hot and cold water is then supplied to the showerhead at increased pressure.

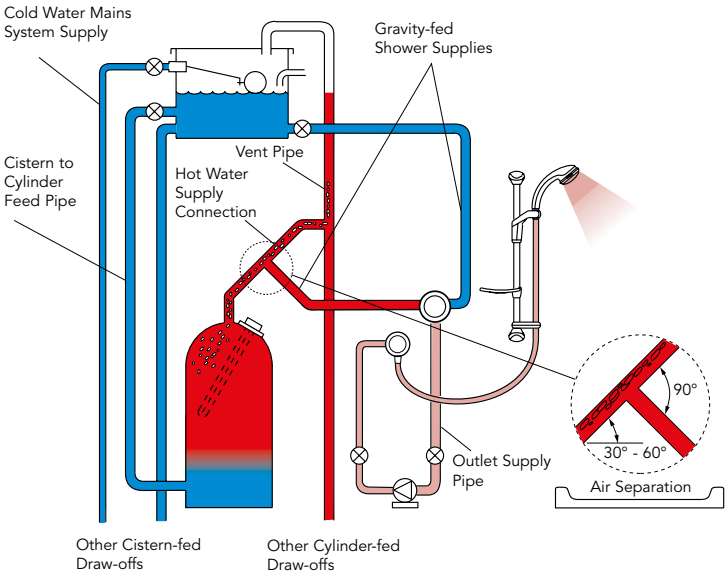
For a flow switch to operate there must be a positive head of water above the showerhead. If the shower manufacturers head requirement cannot be met, or there is a negative head situation then a negative head (pressure) switch, air switch or momentary pull - cord switch will be required to start the pump. Providing that independent supplies of hot and cold water have been taken to the pump, then balanced pressures will be maintained whilst showering.

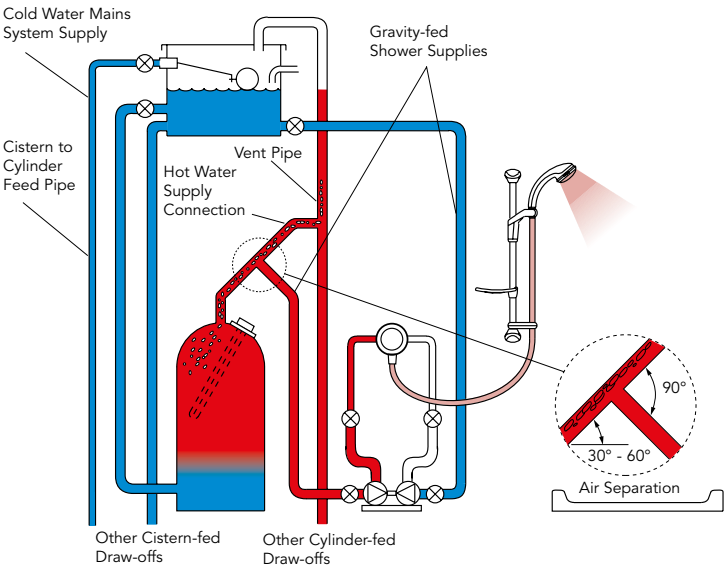
Suitable Shower Products:

- High Pressure & General Purpose Thermostatic Mixing Valves
- Pressure Compensating Mixing Valve
- Manual Mixing Valve
- High Pressure & General Taps & Mixing Valves including Bath and Bath/Shower Mixing Valves
- Shower Panels
- Shower Temples & Steam Cabins

* When using low pressure taps and mixing valves, flow regulators or appropriate aerators may be required to regulate the flow down. Without these, splashing or 'splash-back' may be experienced particularly on washbasin and bidet products.

As previously stated, it is important to remember that the method of delivery of water, whether hot or cold, is a crucial factor in the level of performance of any tap, mixing valve, shower or bath. However, in the examples that follow, showers have been used to illustrate the impact of varying domestic water systems and how they operate.

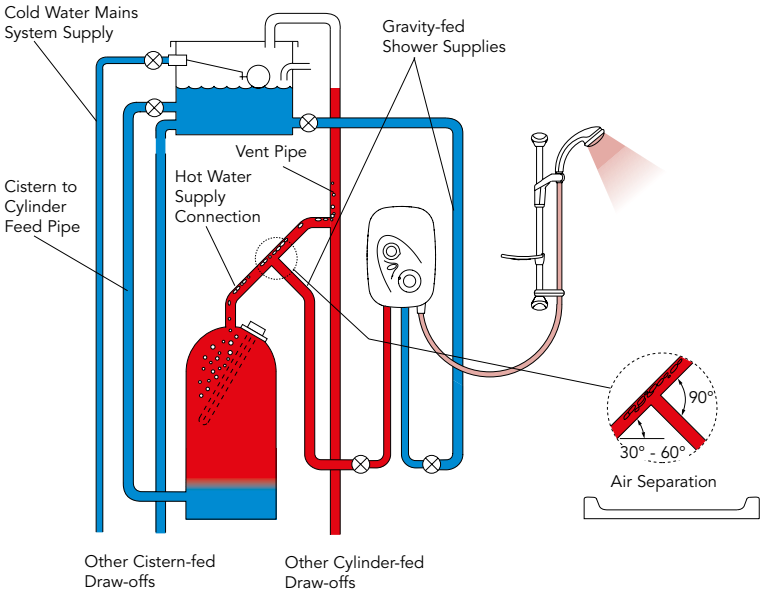




Integral Pump Shower

In this type of shower both the pump and mixing valve are housed within a wall-mounted unit for installation in the showering area. A single ended pump in the unit draws water through a mixing valve, which can be manual or thermostatic in operation, and delivers it to the showerhead at the selected temperature and flow rate.

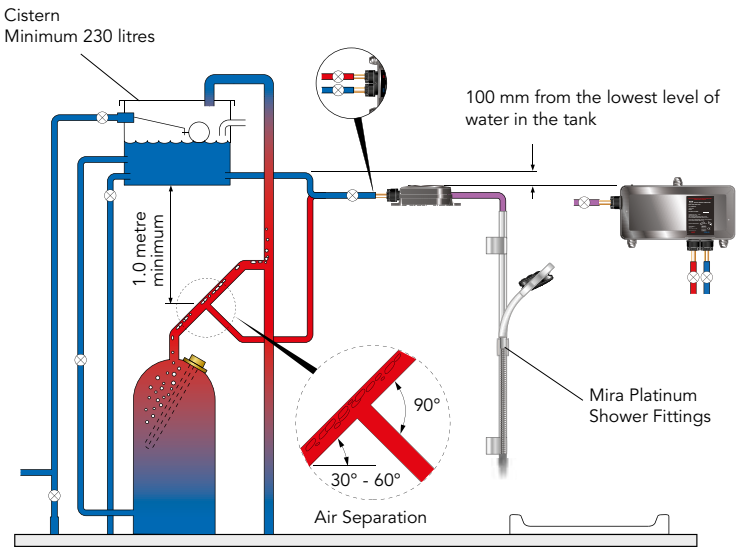
This type of shower does not require a flow or pressure switch to start the pump as it can be operated by a start - stop switch on the unit. Providing the unit is located under the level of the cold water cistern, sufficient to flood the pump chamber, it is possible to position the showerhead above the height of water in the cistern. This can be of benefit in properties where the cold water cistern is in an airing cupboard and there is minimal head of water above the top of the unit. It is best practice to connect this type of shower to independent hot and cold water supplies. Connecting to pipes supplying other outlets can result in the pump being starved of water when the other outlets are in use.



Digital and Remote Control Low Pressure (pumped) Mixing Valves

At the heart of Digital technology is the 'processor box' which blends hot and cold water supplies. This can be installed some distance from the shower i.e. in the loft, in the airing cupboard or under a bath. Mixed (Blended) water is delivered to the shower area either through a supply pipe brought down inside the riser rail or to a ceiling or wall mounted fixed head or a wall outlet fitting. An electronic control panel in the shower area allows the user to control the flow and temperature of water delivered from the LP processor box to their preferred settings. The control panel can be incorporated into the riser rail with a data cable or can be battery operated and mounted remotely.

This type of shower does not require a flow or pressure switch to start the pump/s as the control panel mounted in the shower area controls the function of the pump/s. The processor unit must be located below the level of the cold water cistern, sufficient to flood the pump chamber/s.



Pump Performance Characteristics

Domestic shower pumps are designed to improve gravity fed 15mm or 22mm supplies to showers. Pump performance is such that when very little flow is taking place at the terminal fitting, the pressure inside the pumping chamber will be at or near to the maximum potential. This varies from pump to pump, but an example being 2 bar (20 metres head pressure). This is referred to as deadhead or static pressure. As more water is allowed to flow from the terminal fitting, the pressure within the chamber falls accordingly. This is often illustrated in manufacturer's technical manuals in the form of a graph that shows as more water flows the dynamic pressure falls. The flow and pressure that is maintained will depend on the design of the pumping chamber, speed of pump motor and restrictions within the supplies.

High performance shower pumps usually deliver between 10 and 20 litres per minute at running pressures between 1 and 3 bar.

Gravity System and Pumped System Plumbing Fault Diagnostics

The performance of a tap and mixing valve product can be compromised by incorrect plumbing connections.

Common mistakes are:

a) Connecting a mixing valve to gravity hot and mains cold water supplies resulting in unbalanced pressures. (Always check product specification to ensure it is compatible with unbalanced supplies).

b) Taking the cold supply from the cistern directly beneath the float operated valve. As the cistern fills, air entering the cistern is drawn into the supply to the mixing valve/pump causing erratic flow or air locks.

c) Using restrictive 1/4 turn service valves and stop taps in the supplies to the shower. On gravity systems non-restrictive gate valves or full way lever valves must be used.

d) The use of high pressure taps and mixing valves will result in little or no flow on gravity systems (either hot, cold or both). Ensure low pressure taps are used and restrictions are minimal.

e) When fitting products that incorporate filters such as mixing valves, ensure that the system has been flushed adequately as debris will block filters and again on low pressure gravity systems this can dramatically reduce the flow.

f) Taking the cold supply from the cold feed supplying the cylinder. This bad practice reduces the available amount of hot and cold water to the shower.

g) Taking the supply too low from the expansion/vent pipe. This results in a total loss of flow to the shower when other outlets are in use and introduces air into a supply to a pump.

h) Taking the hot supply pipe to the shower vertically from a T fitting located in the inclined section of pipe from the top of the cylinder. This results in air from the cylinder entering the supply to the shower. When fitting the T at this position it must face downwards to allow air to pass by and escape via the expansion/ vent pipe.

i) Connecting to a cistern that has insufficient capacity and slow filling rate whereby the cistern drains to the level of the take-off connection to the mixing valve/pump, resulting in air locks.

j) Running pipes to the shower through the loft at a height that exceeds the water level in the cistern resulting in a negative head condition.

k) Crossed supplies on the mixing valve i.e. connecting hot water to the cold inlet of the mixing valve. Check whether the mixing valve can accommodate hot on the left and right.

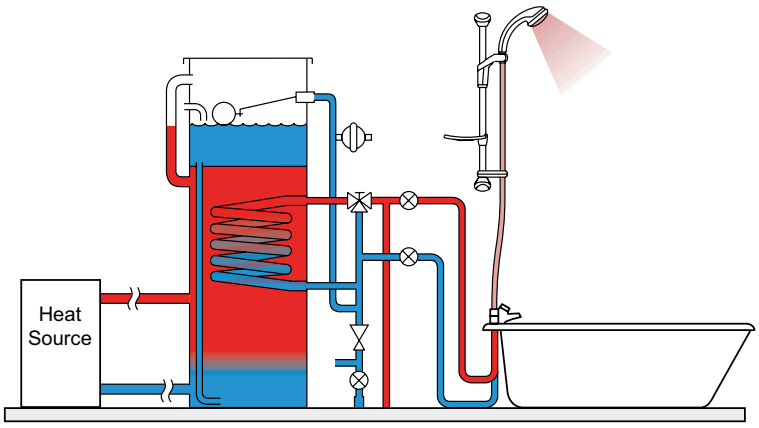
Thermal Heatstore Units

Principles of Operation

Thermal heatstore units consist of a cylinder of hot water stored at low-pressure, which is used to transfer heat into a flow of mains cold water as it passes through the unit.

In their outward appearance, many resemble a gravity fed system, consisting of either a separate cold water cistern and hot water cylinder or a combined cistern and cylinder.

Some models combine gravity flow of hot water with mains fed hot water. In these units water in the cylinder is heated to between 60°C - 65°C; this can be drawn off as required at the various hot taps within the property under gravity pressure.



The cylinder differs internally where a coil of copper tube is wound within the hottest section of stored water. External cold in hot output connections on the coil enable a dedicated water supply to a single mixer shower. Mains cold water is connected to the inlet tapping. When the shower is operated, cold water flows through the coil and is heated by the stored hot water; water to the shower is therefore delivered at mains pressure. The cold feed to the shower mixing valve is also taken from the cold mains supply. Other higher output thermal store units exist where the heated water in the cylinder is not drawn off at taps. In these units the store of hot water is maintained at approximately 80°C.

Domestic hot water delivery to taps, showers etc. is provided at mains pressure as the heat transfer into the cold water takes place via a coil or plate heat exchange process within the unit.

Performance Characteristics

The primary factors that govern performance are:

a) Available temperature of stored hot water in the cylinder

b) Heat transfer characteristics of the coil or plate heat exchange inside the unit

c) Ambient temperature of cold water entering the coil

d) Number of outlets being supplied simultaneously (flow rate through the appliance).

With a number of variations on the principle, performance differs greatly from one make of thermal store to another, some having better heat - transfer characteristics than others.

In addition flow rate from the showerhead can vary throughout the year as water entering the thermal store in winter will be at a much lower temperature than in the summer. It should also be noted that when cold or hot water is being drawn off elsewhere, temperature and pressure fluctuations occur in the supplies to the shower.

When operating at full potential, some thermal store units can provide powerful showers with pressures in excess of 1 bar running pressure and flow rates ranging from 8 to 30 litres per minute.

Suitable Shower Mixing Valves

Pressure compensating valves will operate satisfactorily on models incorporating a thermostatic blending valve on the outlet of the unit.

Thermostatic mixing valves should be specified for units unable to maintain stable hot water temperature.

Suitable Products:

- Manual Mixing Valves
- Low and High Pressure and General Purpose Taps and Mixing Valves including Bath and Bath/Shower Mixing Valves
- High Pressure and General Purpose Thermostatic Mixing Valves
- Pressure Compensating Mixing Valves
- Shower Panels
- Digital and Remote Control High Pressures Mixer Showers

Thermal Heatstore - System issues to be aware of:

a) A Pressure-Reducing Valve (PRV) is required if incoming mains water pressure exceeds the manufacturer's maximum specified running pressure. The PRV must be installed at a point in the cold supply where it provides a balanced pressure of both hot and cold water to the shower.

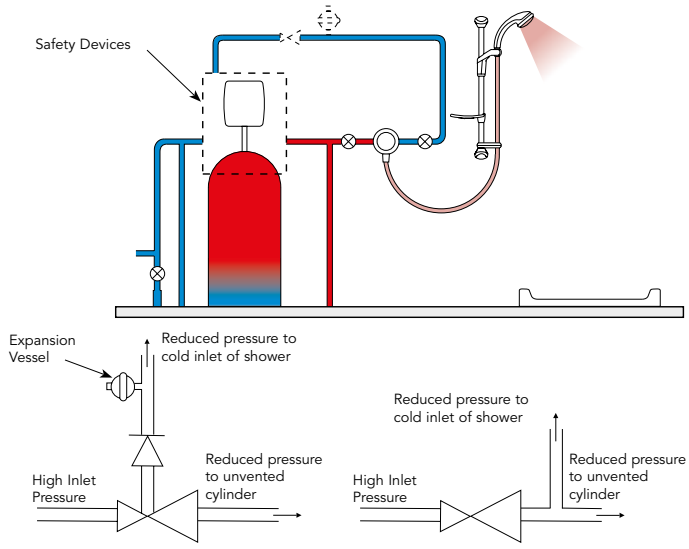
b) The temperature control on the appliance must be set to provide hot water within the temperature range specified for the mixer shower. If too low the required showering temperature will not be achieved if too high the mixer shower may be damaged.

c) If a check valve is present in the cold supply to the thermal store unit, thermal expansion in the supplies to the mixing valve, under no flow conditions will be prevented. Consequently excessive pressure can occur at the inlet to the shower, which may damage internal components. To prevent static pressure damaging the shower a mini expansion vessel must be fitted in the cold supply to the heat exchange unit downstream of the check valve.

Unvented Hot Water System

Principles of Operation

This system consists of a storage cylinder, which can be made from a variety of materials, i.e. copper, stainless steel or glass enamelled s§l. A range of storage capacities is available for both domestic and commercial applications. Some units are similar in appearance to gravity fed hot water storage cylinders.



Combined outlet pressure reducing valve with internal non-return valves, expansion vessel required.

Cold takeoff after pressure reducing valve, expansion pressure taken up by unvented cylinder expansion vessel.

An Unvented cylinder provides a known volume of stored hot water usually at temperatures between 55 to 65°C. Water can be heated by electric immersion heater, central heating indirect coil or gas and oil burner direct flame.

The major difference between an unvented and gravity fed cylinder is the method of supplying cold water into the cylinder.

In the case of a gravity cylinder, cold water is supplied from a cold water cistern at low pressure, whereas an unvented cylinder is connected to the incoming mains cold water supply providing high pressure.

Irrespective of the incoming mains water pressure a pressure-reducing valve must be fitted in the cold supply to the cylinder to restrict pressure to the maximum specified by the cylinder manufacturer. The maximum allowed pressure for any unvented cylinder being 3.5 bar.

An unvented system does not incorporate an open vent/expansion pipe to relieve pressure/air from within the cylinder when water is heated. It is effectively a closed system, until such times as a terminal fitting is opened and hot water is delivered out at high pressure.

An expansion vessel fitted to the cold supply, or alternatively an air gap maintained within the top of the cylinder, caters for natural expansion of water within the cylinder when there is no flow from terminal fittings.

Either method caters for normal operating conditions. However, if thermostats or components regulating the temperature of water fail to stop the heating process then abnormal pressure can occur within the cylinder.

To safeguard the system, expansion and temperature relief valves are present on the cold supply and on the cylinder respectively. Failure of the control of supply pressure, or failure of expansion vessel, or an air bubble, will cause the expansion relief valve to release excess pressure.

Failure of the temperature controls will result in the temperature relief valve discharging hot water faster than steam can be generated. Both valves reset when conditions are normal.

Under abnormal conditions one or both relief valves operate to release excess pressure safely to the atmosphere. The relief valves reset automatically when pressure has reduced.

Performance Characteristics

a) Showering time relative to volume of water stored at 50° to 65°C.

b) Hot and cold delivery at mains pressure up to 3.5 bar.

c) Governed by the available mains cold water pressure to the property.

d) Unbalanced hot and cold supplies to the shower if incorrectly plumbed. The hot and cold delivery should always be reasonably balanced.

As mains water pressure is forcing hot water out of the cylinder, a powerful shower can be achieved. With regard to flow rates that can be achieved, this will depend on the restrictions within the shower equipment; some mixer showers and showerheads being less restrictive than others.

Whilst flow rates above 20 litres can be achieved this is now considered by many to be excessive giving rise to a greater emphasis on controlling flow to a comfortable and economical level.

Suitable Products:

- Manual Mixing Valves
- Low and High Pressure and General Purpose Taps and Mixing Valves including Bath and Bath/Shower Mixing Valves
- High Pressure and General Purpose Thermostatic Mixing Valve
- Pressure Compensating Mixing Valves
- Shower Panels
- Digital and Remote Control High Pressures Mixer Showers
- Shower Temples and Steam Cabins

Unvented System Issues

Common system issues to be aware of:

a) Pressure changes occur in the supplies to the shower when other terminal fittings are in use. Fluctuations can be minimised by taking the hot and cold supplies to the shower from specific areas on the system, i.e. the cold feed should be taken off directly after the pressure - reducing valve on the supply to the cylinder.

If this is not possible a separate pressure - reducing valve must be installed on the cold feed to the shower. This can be set to the same value as that fitted on the supply to the cylinder.

b) If the cold water supply to a mixer shower is taken from a Pressure - Reducing Valve containing a check valve or there is a check valve elsewhere in the cold supply, which prevents thermal expansion returning back into the mains, then static pressure may exceed the specification of the shower. Installing a mini expansion vessel in the cold supply to the shower will prevent excessive pressure damaging the mixing valve.

Gas Combination-Boilers - Multipoint Heaters

Operating Principles

These hot water appliances provide hot water on demand as and when required.

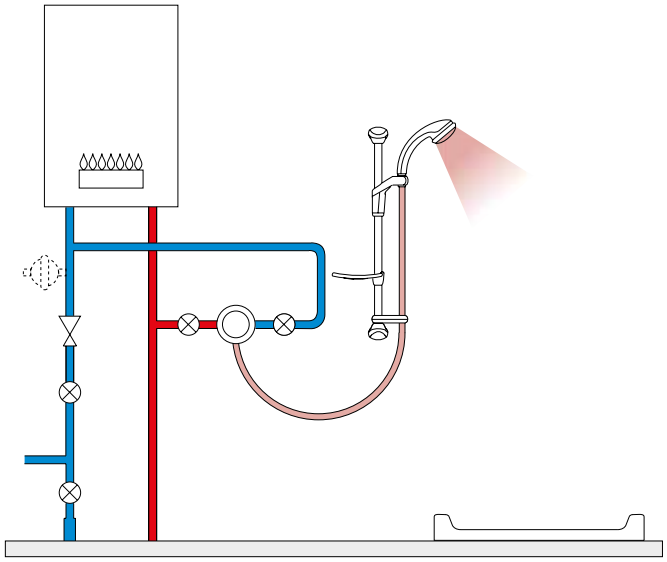
Combination-boilers cater for both central heating and domestic hot water needs, whereas multipoint heaters provide domestic hot water only.

Both types of appliance are available in a range of heating abilities. Sizes are quoted either in B.T.U. ratings e.g. 100,000 BTU/H output or Kilowatt ratings.

1 B.T.U. (British Thermal Unit) = 17.5 watt minutes, 100,000 BTU/H = 29kW

Combination and Multipoints heat mains cold water instantaneously as it flows through a heat exchange unit within the boiler.

Operating pressure for these units is usually between 0.5 to 10 bar. Within this pressure range, sufficient water must flow through the boiler when a tap or shower is turned on to activate a flow sensor in the boiler. When activated, the flow sensor initiates heat transfer to the domestic hot water circuit. The minimum flow to activate the water heating process is normally around 2 to 3 litres/minute.



Performance Characteristics

a) Hot water available on demand.

b) Flow rate is dependent on: boiler rating + ambient temperature of mains cold + required hot water temperature at mixing valve.

c) Reliant on satisfactory mains pressure/flow for operation.

d) Temperature and pressure fluctuations can occur when other outlets are operated.

Although hot water is available on demand, performance will vary throughout the year.

In winter, the cold water entering the boiler will be around 5°C whereas in summer it will be warmer at an average of 15°C. Consequently the flow rate must be reduced in the winter to raise the water temperature to the degree required e.g. on a combination boiler, a fully opened bath tap will allow flow of water too quickly and subsequently reduce the temperature down as it flows through too fast.

Assuming a cold water input of 10°C, a boiler rated at between 90,000 to 100,000 BTU and a shower temperature between 40°C to 42°C, the resultant maximum flow rate through the boiler would be approximately 12 litres/minute. In the worst case flow rate from a combi boiler in the wintertime can be as little as 7 litres per minute at a temperature of 50°C. This is only sufficient to service one hot water outlet at a time.

A number of combi boilers are available that incorporate a store of preheated water, usually around 15 litres volume at 60°C. These appliances can service more than one outlet at a time.

As both hot and cold supplies to a shower mixing valve are from the mains supply, flow variations can occur when other outlets are opened. On very poor sites, this could result in a total loss of one or both supplies to the shower; satisfactory shower performance is therefore very reliant on good site conditions.

The latest combi - boilers and some multipoint water heaters are all of the modulating type. This means that having set the hot water temperature control on the boiler to a preferred temperature e.g. 50°C, automatic adjustment (modulation) of the burner will occur i.e. the gas flame will increase or decrease to maintain a relatively stable hot water temperature. If a boiler is not of the fully modulating type then water temperature will fluctuate when flow rate adjustments occur at terminal fittings.

In the case of a thermostatic mixing valve it will close off against an increasing hot water temperature. This has the effect of water temperature in the boiler steadily increasing to a point where a thermostat in the boiler switches off the gas burner completely. Water to the shower then runs cooler until the boiler thermostat resets and restarts the gas burner. This hot - cold cycling effect will be noticed at the shower.

Suitable Products:

- Low and High Pressure and General Purpose Taps and Mixing Valves including Bath and Bath/Shower Mixing Valves
- High Pressure and General Purpose Thermostatic Mixing Valves
- Pressure Compensating Mixing Valves
- Shower Panels
- Digital and Remote Control High Pressures Mixer Showers

Gas Combination Boilers, Multipoint Heaters - System Issues

Common system issues to be aware of are:

a. Combi and Multipoints are not supplied with a pressure reducing valve therefore it may be necessary to install one in the cold supply if mains pressure exceeds the maximum running pressure specified for the mixing valve.

b. It should be appreciated that when other hot water taps are turned on, flow to the shower will decrease or even stop altogether.

c. Where a check valve is fitted in the cold feed to the boiler it may be necessary to fit a mini expansion vessel to prevent static pressure increasing to a level that can damage the mixing valve.

d. The flow sensor in the boiler must be capable of starting the heating process when a minimum of 3 litres/minute is flowing from a tap or shower valve.

e. At flow rates between 3 and 8 litres/minute the boiler must be capable of maintaining a relatively stable output temperature.

f. If flow rate through the combi boilers and/or cold supply to the mixing valve is excessive then a satisfactory showering temperature may not be achieved.

If the mixer shower is not fitted with a flow restrictor it may be necessary to fit additional flow control devices in the supply pipework to the mixing valve.

Section 2
Frequently Asked Questions

Can a power shower unit be fitted to the mains cold water supply?

A power shower unit contains a pump. The construction of the pump is such that it can only accept a low pressure gravity (cistern fed) supply. Connecting the shower to the mains will subject the pump to excess pressure and result in damage to the pump and leakage from the unit. Water Regulations prohibit the connection of this type of pump to the mains water supply.

Can an integral power shower be installed onto a combi boiler?

All integral power showers incorporate a pump and mixing valve, which can only be connected to low pressure gravity supplies. Connecting to the high pressure mains fed combi boiler will damage the shower unit. This combination also contravenes the Water Regulations.

I am fitting a shower panel and the hot supply is from a combi boiler. How can I be sure there will be enough flow from the combi to satisfy customer needs?

The performance of a combi boiler is determined by its kW rating and temperature can change dependent on season. The boiler specification literature should provide flow rate figures for a given temperature rise, enabling hot water output throughout the year to be established.

As a rough guide each function on a shower panel i.e. the overhead spray, hand held spray and body jets can each deliver from 8 to 14 litres per minute, depending on supply pressure. To satisfy two functions simultaneously effectively requires around 13 litres per minute.

If you are fitting a shower panel to gravity fed water supplies you will need to increase supply pressures by installing a twin impeller pump. Depending on the model of the shower panel and customer preferences the pump should be rated at 1.5 to 4 bar running pressure.

How do you determine the pressure you will get to a showerhead when a mixer shower is connected to gravity supply?

The principle is that for every 1 metre head of water, (as measured from the base of the cold water cistern to the top of the showerhead) there will be a pressure in the showerhead of 0.1 bar. This is a theoretical pressure as restrictions within pipe fittings and the shower mixing valve will reduce the pressure to a degree. Providing only minimal restrictions are present in the supplies and terminal fitting the additional measurement (height) of water within the cistern will usually compensate for pressure losses in the supplies. It can be seen that a shower requiring 1 bar minimum operating pressure would need to be connected to a cistern located 10 metres above the showerhead.

Is it acceptable to install two power showers onto a 115 litre (25 gallon) cold water cistern if they are going to be used simultaneously?

When two power showers are in operation simultaneously they can draw around 30 litres (6 gallons) per minute from the cold water cistern. If the cold water entering the cistern through the float operated valve is less than this amount then the level of water in the cistern may fall to the level of the connections to the showers. Air will then be drawn into the supplies, adversely affecting shower performance and potentially damaging the pumps. It is advisable to increase the cistern capacity to at least 230 litres (50 gallons) and check that the fill rate of the cistern is adequate to cater for all outlets that are likely to be in use simultaneously.

Can I fit an all in one power shower in a loft conversion bathroom?

All in one power showers must be installed below the level of the cold water cistern. In a loft conversion it is unlikely that the cistern can be raised above the shower unit. If a pumped shower is required it is necessary to install a twin impeller pump with some form of negative head switching and a surface mounted or built in mixer shower. The pump must be sited below the level of the water in the cistern. With negative head switching the hot and cold supply from the pump can rise vertically to the shower. The shower can therefore be sited above the level of water in the cistern.

Why is it important to ensure that high pressure taps are not used on a low pressure system?

If a tap requires high pressure it won't perform adequately on a low pressure system. Therefore the flow from the tap will be less than satisfactory. Usually the waterways in the fitting are much smaller in a high pressure tap, so when installing it on a low pressure system, you will frequently see a much reduced flow of water out of the tap, invariably one that is not fit for the purpose you require.

Do I need to use a cylinder flange when installing a mixing valve or power shower?

Most leading shower manufacturers agree it is not necessary to use cylinder flanges when installing a single domestic power shower. T'ing into the inclined section of pipe from the top of the cylinder is the preferred method of connection. Providing the T is pointing down, air released from the heated water in the cylinder will bypass the T and escape out of the expansion pipe. If it is not possible to fit the T in this fashion it can be installed in the falling supply to other outlets, providing it is below the expansion pipe T and is the first take off point before other taps.

Can a mixing valve be installed to unbalanced supplies of mains fed cold water and gravity fed hot water?

Water Supply (Water Fittings) Regulations (By-laws 2000 in Scotland) permit the connection of combination taps and shower mixing valves to mains fed cold water and gravity fed hot water, providing there is a check valve in both supplies to prevent crossflow. Check with the manufacturers' installation instructions that the product can be used to mix mains and gravity supplies.

I have a Thermal Store hot water system in my property. How many mixer showers can be fed from one of these appliances?

The output from a thermal store unit depends on its size (stored volume), heat transfer capability and the water pressure entering the unit. Some are only capable of delivering sufficient hot water to one mixer shower whereas others can supply 3 or 4 showers simultaneously. Always check before selecting any shower that the capacity of the heating appliance is compatible with the shower and required usage.

I have fitted a thermostatic mixer shower to a combi boiler system only to find the shower temperature is fluctuating, I thought a thermostatic mixing valve was supposed to remain at a constant temperature?

The most common reason for this symptom is when the combi boiler is not fully modulating (i.e. the gas flame is not regulated in sympathy with the flow of water through the heat exchange unit) and is therefore not maintaining stable hot water temperature to the shower.

Industry Guide to Domestic Water Systems Issue 4/11

As hot water entering the shower increases in temperature a thermostatic mechanism will adjust to restrict hot water entering the valve. In turn flow through the boiler is reduced and the temperature reaches a point where a thermostat switches off the burner. Water temperature will then reduce before the thermostat resets, this will result in the shower constantly cycling between hot and cool.

The flow from my mixer shower is less than I expected, what is the usual performance of a shower on a gravity system?

Flow rate from mixer showers varies depending on the available head of water and restrictions within the supply and valve. To ensure optimum performance from gravity fed mixer showers the following guidance should be followed.

- Use as few 90° elbows as possible and where possible use pulled bends
- Use full way lever or gate valves, do not fit restrictive stop taps or 1/4 turn service valves
- Follow manufacturer recommendations regarding pipe size
- Ensure the mixing valve is specified for low pressure application
- Always flush out pipes before connecting to avoid debris blocking inlet filters

My thermostatic bath & mixer shower is supplied from a combi boiler and I cannot achieve a hot enough showering temperature. What could the problem be?

The most common causes of this symptom in a bath & mixer shower (and on other outlets) are:

- The flow of water through the shower is too great and the boiler is unable to heat the water to the required temperature. Isolating the cold supply and measuring the hot water flow and temperature through the mixing valve on its maximum hot setting should establish whether this is the case. If so it will be necessary to fit some form of flow limiting device on the inlet or outlet of the shower.

- A blockage has occurred in the hot supply. With a combi boiler it is to be expected that the all cold flow through the mixing valve will be significantly greater than the all hot flow because there will always be more restriction through the boiler than through the cold pipework. To determine whether or not there is sufficient hot flow available, turn the mixing valve to the full hot position and then check that the boiler has ignited and remains so.

I am looking to install a mixer shower onto a thermal store hot water system. Can I fit a pressure compensating mixer shower to this type of system?

Pressure compensating valves can be specified for this type of high pressure system. A pressure compensating mixer shower is designed to maintain the set showering temperature when a pressure change occurs in either the hot or cold supply i.e. when another tap is turned on in the property. However this type of mixer shower does not respond to any changes that occur in the hot water supply temperature. Providing the thermal store unit is capable of maintaining a constant water temperature when other taps are operated, then a pressure compensating valve can maintain comfortable showering temperature. Where there are noticeable fluctuations in thermal store domestic hot water temperature then a thermostatic mixing valve should be specified.

Can I use one twin ended pump to supply water to three mixer showers?

It is possible to supply a number of mixer showers from one pump providing the following guidelines are followed:

- The pump must be suitably rated to provide the flow and pressure that will cater for simultaneous shower use.

Example: Three showers are required to deliver 10 litres per minute at a minimum delivery pressure of 1 bar when operated individually. Therefore a pump capable of delivering 30 litres per minute at 1 bar running pressure is required.

- If a number of showers are supplied by one pump, supply pressures will fluctuate when showers are being operated simultaneously.

- Thermostatic mixer showers should be fitted to ensure a stable showering temperature is maintained.

What is Legionella and Legionnaires' disease? How can I assess the risk?

Legionella are bacteria that are common in natural water (rivers and lakes etc.) and artificial water systems, e.g. hot and cold water systems (storage tanks, pipework, taps and showers). We usually associate legionella with larger water systems, e.g. in factories, hotels, hospitals and museums, and cooling towers, but they can also live in smaller water supply systems used in homes and other residential accommodation. Legionella can survive in temperatures from 20°C up to 60°C and thrive at temperatures around 45°C. High temperatures over 60°C will kill the bacteria.

It should be possible for you to assess the risk yourself, but if you do not feel you have the right skills, you can obtain help and advice from a consultant. When you do the risk assessment, consider the following: Are conditions right for the bacteria to multiply, e.g. is the water temperature between 20°C and 45°C? Are there areas where stagnant water occurs (deadlegs), e.g. pipes to a washing machine that is no longer used? Are there infrequently used outlets, e.g. showers, taps?

Comprehensive information can be obtained from the Health & Safety Executive. They publish an Approved Code of Practice & Guidance that deals with Legionnaires' disease and the control of legionella bacteria in water systems.

Has there been a change to the Building Regulations covering the installation of condensing boilers?

Yes, an important change to the Building Regulations covering the installation of condensing boilers came into force on 6th April 2007. The alteration to the Guidance documents for Part L of the revised Building Regulations requires that any new installation of a condensing boiler, where the water hardness is above 200ppm, some provision must be made to treat the feed water to reduce the rate of accumulation of scale.

The current document is the 2013 edition. For more detailed information go to www.planningportal.gov.uk/buildingregulations/approveddocuments

Section 3
Industry Terminology

Airlock
Section of pipework which, due to its layout, enables a pocket of air to be trapped. This results in zero or very little flow through the pipe.

Air Switch
A manual means of overriding a flow switch for initial energisation of the pump.

All-in-One Power Showers
A product which houses a pump and some form of integrated shower control. It needs a low pressure cistern fed supply of stored hot and cold water.

Anti-Surge
A feature which restricts the possibility of fluctuating volumes of water movement through the system.

Automatic Air Vent
A mechanical device similar to a car carburettor float chamber that is used to remove quantities of air entrapped in plumbing pipework.

Backflow
A flow in a direction contrary to the intended normal direction of flow.

Backsiphonage
A backflow caused by the siphonage of liquid from a cistern or appliance into the pipe feeding it, possibly leading to a contamination of the water supply.

Bar
A unit of measurement of water pressure approximately equivalent to a column of water 10m high or 14.5 lbf/in (or 100 kPa) per bar.

B.E.A.B
BEAB Approved Mark.

Boiler
An enclosed vessel in which water is heated by the direct or indirect application of heat.

Cavitation
Localised boiling of water below 100ºC caused by a reduction in pressure due to flow conditions.

Centrifugal
A type of pump design which draws water in through the eye or centre of the impeller, forcing it out to the external edges of the pump by centrifugal force. Water is then discharged vertically.

Check Valve
A plumbing fitting designed to allow water to flow in one direction only.

Cistern
A fixed container for holding water at atmospheric pressure. It is normally fitted with a float operated valve and warning pipe.

Cold Water Storage Cistern
Fixed container for holding water at atmospheric pressure usually used for providing a feed to a vented domestic hot water cylinder. It can also be used to provide a vented cold supply to terminal fittings.

Cylinder Flange
A plumbing fitting which can be fitted to a hot water cylinder to provide a dedicated hot water supply to a terminal fitting.

Distributing Pipe
Any pipe (other than a flush pipe or warning pipe) conveying water from a Cold Water Storage Cistern.

Diverter
A fitting used to control the direction of water to various outlets.

Double Check Valve (Verifiable)
A device which is designed to prevent back siphonage, consisting of two check valves in series with a test point between the two.

Downstream
Water flowing away from a given point of reference.

Dynamic Pressure
Maintained Pressure. The water pressure in the pipework to a fitting whilst flow is taking place.

E.L.C.B.
Earth Leakage Circuit Breaker. See R.C.D.

Equamatic
A term used to describe a pressure balancing mixing valve.

Expansion Pipe
See Vent Pipe.

Expansion Vessel
See Pressure Accumulator.

Feed Cistern
See Cold Water Storage Cistern.

Float Operated Valve
A valve used to control the flow of water into a cistern, the valve being controlled by the level of water in the cistern.

Flow Rate
Speed at which water flows e.g. through a fitting – usually measured in litres per second or minute.

General Pressure (GP)
Refers to water supplied within a pressure range of between 0.1 bar to 5.0 bar.

Gravity Pressure
Generally refers to water that receives its pressure as it falls from a cistern located in the roof space, or at a point higher than the terminal fitting. The pressure obtained is relevant to the height of the fall or head (1 metre head = 0.1 bar), the greater the fall, the higher the pressure. Generally this refers to low pressure in most domestic dwellings, however if the head is above 10 metres it can be classed as high.

Header Tank
See Cold Water Storage Cistern.

High Pressure (HP)
Refers to water supplied at 1.0 bar to 5.0 bar.

Hot Water Cylinder
A cylindrical closed vessel capable of containing water under pressure greater than atmospheric.

I.E.T.
Institution of Engineering and Technology.

Indirect Cylinder
A hot water cylinder in which the stored water is heated by a primary heater through which hot water is circulated from a boiler. There is no mixing of the primary and secondary water.

Instantaneous Electric Shower
A shower that electrically heats the water whilst the water is passing through it.

Instantaneous Gas Water Heater
An appliance which heats water on demand whilst the water is passing through it.

Integrated Power Showers
See All-in-One Power Showers.

Low Pressure (LP)
Refers to water supplied at 0.1 bar to 1.0 bar.

Maintained Pressure
See Dynamic Pressure.

Manual Mixing Valve
A device which does not compensate for variations in the temperature or pressure of the incoming water supplies and needs to be adjusted manually.

M.C.B.
A Miniature Circuit Breaker is an electrical circuit protection device used as an alternative to rewireable and cartridge type fuses. It trips out when too much current flows in the circuit, typically on fault conditions. Do not confuse with R.C.D.

Mixer Shower
The mixing valve and fittings.

Modulating Instantaneous Gas Water Heater
An instantaneous gas water heater or boiler which is fitted with a gas control mechanism to vary the heat input and produce a relatively stable domestic hot water temperature, often termed fully modulating. Step modulating: Gas controlled heat being less able to maintain a constant output temperature under varying flow rate conditions.

Multi - Point
An instantaneous water heater which can supply water to more than one outlet, but not usually simultaneously.

Negative Head
If the cistern is below the level of the shower head a gravity flow of water will not occur. A pump with special switching can be used to obtain a flow of water.

Non-Return Valve
See Check Valve.

Open Outlet Flow Rate
Maximum potential flow rate from mixing valve without shower fittings attached.

Positive Head
A volume of water held above the highest point on the system, allowing a flow of water through the pipework and out of the discharge point by gravity.

Pressure Accumulator
A pressure vessel inside which is fitted a bladder to accommodate thermal expansion of water or alternatively to absorb the pressure shock waves of water hammer. Also known as expansion vessel.

Pressure Balancing Mixing Valve
A pressure balancing compensatory shower mixing valve designed to maintain a constant shower temperature under variable inlet pressures but maintained inlet temperatures.

Pressure Compensating
See Pressure Balancing Mixing Valve.

Pressure Regulating Valve (drop-tight)
Gives constant downstream pressure when supply pressure is higher and does not allow backflow.

Pressure Relief Device
Safety device fitted to prevent excessive pressure building up within an electric shower heater.

Pressure Relief Valve
Spring loaded relief valve fitted to cold supply on unvented systems to relieve excess pressure safely to atmosphere.

Primed
All air has been exhausted from the system/pump.

Processor Box
Central to digital technology, the processor box blends hot and cold water supplies. This can be installed some distance from the shower i.e. in the loft, in the airing cupboard or under the bath.

Proportioning Valve
A manually or electronically controlled valve that regulates the flow of hot or cold water. Usually used as a pair to mix water to a required temperature.

Pump Hose
A flexible pipe that connects the pump to rigid pipework.

R.C.D.
A Residual Current Device is an accurate electrical balance that measures the electrical loading on the outgoing live and return neutral conductors. If any current leakage exceeds the trip value under a fault condition it turns off the power supply.

Running Pressure
See Dynamic Pressure.

Servicing Valve
A valve for shutting off the flow of water in a pipe connected to a water fitting to facilitate the maintenance or servicing of that fitting.

Shower Controls
Any device that supplies and controls hot and cold water supply for the purposes of showering.

Shower Panel
Easy to install panel with integrate overhead and hand showers, full-body massages from side showers.

Solenoid Valve
An electrically operated valve giving either no flow or full flow.

Static Pressure
The water pressure existing at a fitting when no flow is taking place.

Standing Pressure
See Static Pressure.

Storage Cistern
A cistern, other than a flushing cistern, which is used to store water for subsequent use.

Supply Pipe
A pipe conveying mains cold water around the building.

Supply Stop Valve
A valve used to isolate the mains cold water supply within a building.

Temperature and Pressure Relief Valve (PRV)
A relief valve fitted to unvented cylinders to prevent explosive failure due to excessive temperature. A pressure relief function is included.

Thermal Storage Hot Water System
A hot water system where cold mains pressure water is heated (instantaneously) as it passes through a heat exchanger surrounded by a stored volume of hot water.

Thermostat
A temperature sensitive device, producing a linear or rotary motion, to control the mixing of hot and cold water within a thermostatic mixing valve. Also, thermostat is the generic name for a temperature activated switching device.

Thermostatic Mixing Valve
A device to compensate for variations in the temperature and/or pressure of the incoming water supplies, to maintain a selected blend temperature.

Unvented Domestic Hot Water Cylinder
A plumbing system where the cold feed is taken directly from the mains to provide a high pressure hot water supply. There is no open vent to atmosphere.

Upstream
Water flowing from a given point of reference.

Vent Pipe
An uninterrupted safety pipe which allows air or expansion of water within a hot water system to escape to the atmosphere.

Water Fittings
Includes pipes, taps, ferrules, valves, cisterns, mixing valves and similar apparatus used in connection with the supply of water within a building.

Water Jacketed Tube Heater
See Thermal Storage Hot Water System.

Section 4
References

Water Supply (Water Fittings) Regulations 1999
The Water Fittings Regulations (or Byelaws 2000 in Scotland) are national requirements for the design, installation and maintenance of plumbing systems, water fittings and water-using appliances. Their purpose is to prevent misuse, waste, undue consumption or erroneous measurement of water and to prevent contamination of drinking water. www.legislation.gov.uk/uksi/1999/1148/contacts/made

Water Byelaws
The Water Fittings Regulations replace water byelaws (in governing the prevention of waste, misuse, undue consumption, contamination and erroneous measurement of public water supplies in domestic and commercial plumbing installations) and represent important protection for public health and the environment. The regulations are based on performance standards, e.g. British Standards or those European Standards being mandated under the Construction Products Directive. www.opsi.gov.uk

NSF-WRc Ltd
NSF-WRc Ltd provides analysis, testing and consultancy in the areas of public and environmental health by combining strong laboratory capabilities with expert interpretation. NSF-WRc is a joint venture of WRc plc and NSF International with laboratories in South Wales and the Thames Valley. www.wrcnsf.com

KIWA Watertec
KIWA Watertec provide inspection, testing, technology, training and consultancy of water appliances. Main area of activity is approval and certification to the Water Regulations Advisory Scheme (WRAS). Laboratories are situated in the Netherlands and South Wales. www.kiwa.co.uk

Building Regulations
The Building Regulations are a set of minimum requirements designed to secure the health, safety and welfare of people in and around buildings and to conserve fuel and energy in England and Wales. They are made by the Secretary of State under powers given by Section 1 of The Building Act 1984.
www.planningportal.gov.uk/buildingregulations/approveddocuments

Local Building Control Office
Building Control is an umbrella term covering all Local Authority Building Control Departments in England & Wales. These Departments have a statutory duty to enforce Building Regulations. The Building Regulations are designed to ensure that the highest standards of construction apply to all buildings, and that the health and safety of people using and working in and around buildings is adequately provided for. http:/www.labc.uk.com

I.E.T Wiring Regulations
The IET manages the national committee JPEL/64 which prepares and updates the regulations for the safety of electrical installations in buildings, and publishes the standard BS 7671:2008+A3:2015 (the IET Wiring Regulations). It also provides and publishes extensive guidance upon the standard as well as related codes of practice. http://electrical.theiet.org/wiring-regulations/index/cfm

Part P of the Building Regulations
Part P, brings domestic electrical installation work in England and Wales under the legal framework of the Building Regulations. It will, for the first time, place a legal requirement for safety upon electrical installation work in dwellings, although the sector is highly regarded for its high levels of conformity with its chief standard, BS 7671:2008+A3:2015. www.planningportal.gov.uk/buildingregulations/approveddocuments

BS 7671:2008+A3:2015 - (otherwise referred to as) I.E.T 17th Edition Wiring Regulations
The IET prepares regulations for the safety of electrical installations for buildings, the IET Wiring Regulations (BS 7671) now having become the standard for the UK and many other countries. http://electrical.theiet.org/wiring-regulations/index.cfm

BS 3036:1958 - Semi Enclosed (rewireable) Fuse/ BS HD 60269-2:2010 and BS 88-2:2010 HBC Fuses
The devices used to detect such overloads, and to break the circuit for protection against them, fall into three main categories:

1. Semi-enclosed (rewireable) fuses to BS 3036:1958 and cartridge fuses for use in plugs to BS 1362:1973.
2. Low voltage fuses. Household to BSHD 60269-3:2010+A1:2013 and BS 88-3:2010.
3. Circuit breakers, miniature and moulded case types to BS EN 60898-1:2003+A13:2012 and BS EN 60898-2:2006

Contact Details for Plumbing Organisations

BEAB - Approved Mark

BEAB has been promoting electrical safety for over 40 years. A Notified Body to the UK Department of Trade and Industry, and to the European Union, BEAB plays an active role in the development of standards on a global basis and is an accredited Certification Body under both the European CCA and international CB Schemes. http://www.intertek.com/marks/beab

BS 8558:2011

A guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. Combines requirements and recommendations for systems, pipes, fittings and connected appliances installed to supply buildings with water for drinking and other purposes. Complimentary guidance to BS EN 806.

BS 7942:2011

Performance and material requirements, including test methods, three distinct types of thermostatic mixing valves for use in care establishments.
www.bsigroup.com

BS EN ISO 1456:2009

Metallic and other inorganic coatings. Electrodeposited coatings of nickel, nickel plus chromium, copper plus nickel and of copper plus nickel plus chromium.
www.bsigroup.com

NHS Specification DO8

A thermostatic mixing valve with enhanced thermal performance complying with NHS Estates purchasing specification DO8.
www.buildcert.com/nsf-wrc-tmc.htm

References to Water Regulations apply to England and Wales.

Data may vary for Scotland and Northern Ireland - please check for specific regulations applicable.

The Bathroom Manufacturers Association (BMA) is the trade association that represents the major manufacturers of bathroom products, ranging from sanitaryware, baths, taps, showers, enclosures, accessories and furniture.

Members of the BMA offer products with an outstanding combination of quality, style, design, colour and availability. www.bathroom-association.org.uk

Scottish and Northern Ireland Plumbing Employers Federation (SNIPEF) is the trade association representing businesses involved in the installation and maintenance of plumbing and heating systems. For a list of members telephone 0131 556 0600, or visit the website www.snipef.org

The Association of Plumbing & Heating Contractors (APHC) is the leading Trade Association for the plumbing & heating industry in England & Wales. For a list of members telephone 0121-711 5030 or visit the website www.aphc.co.uk

The Institute of Plumbing and Heating Engineering (IPHE) is the professional body for the UK plumbing industry. For a list of members telephone 01708 472791, or visit the website www.ciphe.org.uk

National Training Group (NTG) – Telephone 0115 921 4865. Website www.kbbntg.org

Construction Industry Training Board (CITB) – Website www.citb.co.uk

KIWA Watertec – Website www.kiwa.co.uk

WRAS – Website www.wras.co.uk