FLOWING EXPERTISE

PRESSURE REDUCING VALVES FOR DOMESTIC WATER SYSTEMS

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PROTECTING WATER AND PEOPLE'S HEALTH

PRESSURE REDUCING VALVES FOR DOMESTIC WATER SYSTEMS

The best pressure control in domestic water systems allows the system to work in optimal conditions.

The consumption of potable water by users is therefore reduced and the ultimate precious resource conserved.

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PURPOSE OF THE GUIDE

Correct design of domestic water distribution systems is essential to ensure adequate cold and hot water supply for the utilities at every draw-off point, in terms of both temperature and pressure.

In this guide we will look at pressure control. The aim is to provide useful information on choosing, sizing, installing and maintaining pressure reducing valves. Different installation types will be illustrated, analysing the main aspects that must be considered when designing the entire system.

When the water system pressure is higher than required, it may lead to malfunction, noise and water waste issues. Moreover, the system pressure may vary at different times of the day. For these reasons, it is important to install devices capable of reducing the pressure to the desired value. In other cases, however, the system pressure may be too low, and it will therefore be necessary to install pressure boosting units.

It is essential to know the characteristics and operation of these devices, so that they can be sized correctly and installed at the optimal point in the system. Moreover, installation and maintenance aspects will also be analysed to prevent and identify potential faults and malfunctions.

NORMATIVE REFERENCES

Pressure reducing valves must be made in accordance with specific product standards in relation to both performance and materials. Since these components are in contact with potable water, it is essential that the materials comply with the standards and laws that set out the hygienic requirements, in order to guarantee water quality and protect human health. There is increasing focus on these issues and the evolution of new rules highlights this.
Therefore, there is a tendency to use alloys with very low lead content and with dezincification resistant properties (low lead-DR). Products made with these materials are perfectly in line with the new regulatory provisions concerning contact with potable water.
Each country adopts specific rules regarding permissible materials and the performance that pressure reducing valves must guarantee.

Materials

Europe	Directive (EU) 2020/2184 (recast of Directive 98/83/EC)	“Directive (EU) 2020/2184 of the European parliament and of the council of 16 December 2020 on the quality of water intended for human consumption” *(Drinking Water Directive)*. *The new European directive on potable water aims to improve the quality of tap water by updating the pollutant limit requirements and adding new substances to the safety standards. The new standards therefore include increasingly stringent hygiene requirements for materials in contact with potable water (positive lists) in order to ensure that only safe substances are used in pipes and taps. Each Member State transposes the Directive with its own national regulation.*
North America	NSF 61	“Drinking water system components – Health effects”.
	NSF 372	“Drinking water system components – Lead Content”.
Australia	AS/NZS 4020	“Testing of products for use in contact with drinking water”.

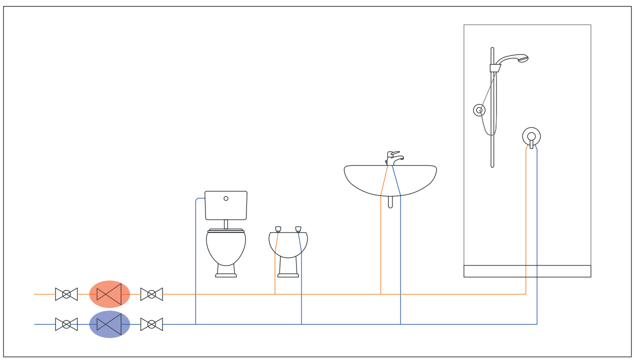
Performance requirements

Europe	EN 1567	“Water pressure reducing valves and combination water pressure reducing valves – Requirements and test”. *This standard specifies the dimensions, materials, performance requirements and hydraulic testing requirements of pressure reducing valves for both cold and hot water applications.*
North America	ASSE 1003	“Water pressure reducing valves for potable water distribution systems”.
	CSA B356	“Water pressure reducing valves for domestic water supply systems”.
Australia	AS 1357.2:2005	“Valves primarily for use in heated water systems - P. 2: Control valves”.

Certification

Cold and hot water applications

The product standards specify the performance requirements and characteristics that pressure reducing valves must have when used with both cold and hot water.
Especially in very large distribution systems, where domestic hot water production is centralised, it is necessary to reduce and control the pressure of the cold and hot water near the utilities (at the floor or single unit level).
There are products certified to the EN 1567, AS 1357.2 and ASSE 1003 standards on the market for such applications, which have been specially made with components and materials that can withstand temperatures up to 80 °C.



PRESSURE REDUCING VALVE TYPES

Pressure reducing valves serve to reduce the pressure of water from the water mains to the desired value as it is often high and erratic. Their action eliminates the pressure fluctuations that can occur in pipes, typically between daytime and night-time due to the difference in water demand.
Serving utilities with almost constant pressure ensures that the components retain their efficiency over time, prevents noise and also contributes to considerable water savings.
In this chapter, will give an overview of the operating principle of pressure reducing valves and their various features, comparing their advantages and disadvantages.

Diaphragm pressure reducing valve

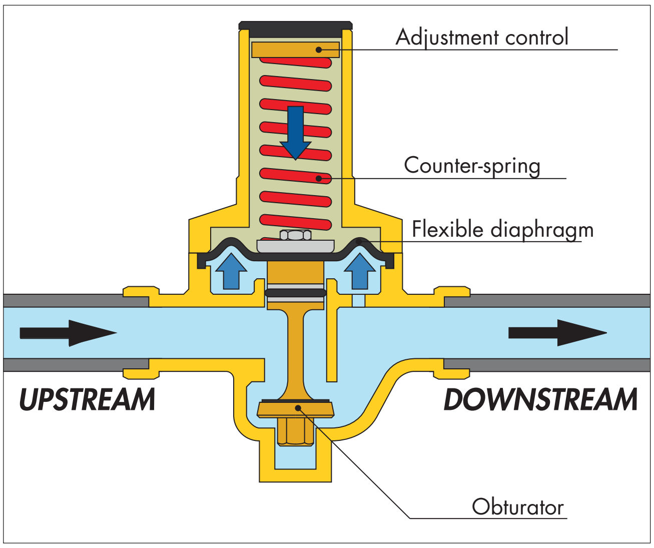
Diaphragm pressure reducing valves are composed of:

- Adjustment control;
- Counter-spring;
- Flexible diaphragm;
- Obturator connected the diaphragm via a stem.

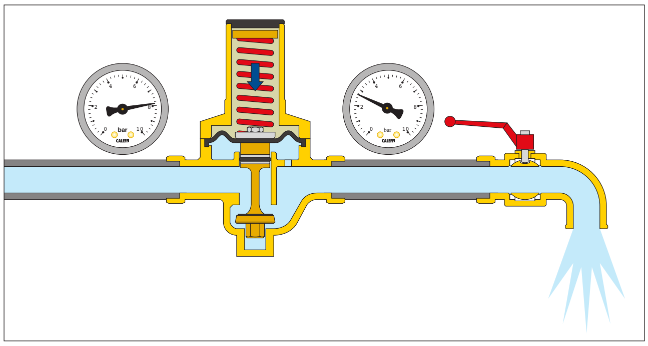
The operating principle of the pressure reducing valve is based on balancing two opposing forces:
1. The thrust of the spring to open the flow through the cross section;
2. The thrust of the diaphragm to close the flow through the cross section.

The spring pushes the obturator downwards to open the pressure reducing valve, while the downstream pressure acting on the diaphragm creates a counter force that tends to return the obturator upwards to close the valve.
The pressure reducing valve operates both during supply and when the taps are closed.

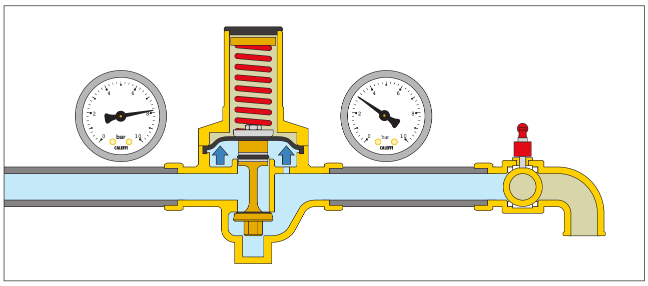
The adjustment control, which only some models have, can be used to change the initial spring compression (i.e. change its preloading) and thereby give it a different thrust force. This special feature means the pressure reducing valve can be set to the desired pressure.



Operation with water flow
Opening a tap on the circuit downstream of the pressure reducing valve causes a reduction in pressure below the diaphragm.
The force of the spring becomes greater than that of the diaphragm; the obturator moves downwards to open the valve to the flow of water.
The greater the demand for water, the lower the pressure under the diaphragm, resulting in a greater flow of medium through the cross section.

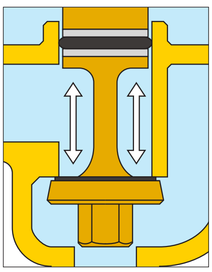


Operation without water flow
When the draw-off outlet is closed, the downstream pressure rises and pushes the diaphragm upwards.
As a result, the obturator closes the cross section to the passage of water and maintains the pressure constant at the setting value. If the diaphragm exerts even a slightly greater force than the spring, the device closes.

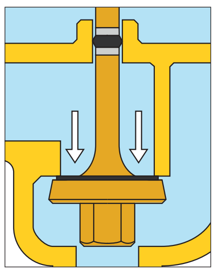


Pressure reducing valve seat

Compensated seat
In pressure reducing valves with a compensated seat, the setting pressure remains constant regardless of variations in the upstream pressure. The opening thrust is counterbalanced by the force created by the closing pressure acting on the compensating piston. Since the piston has a surface area equal to the obturator one, the two forces cancel each other out.

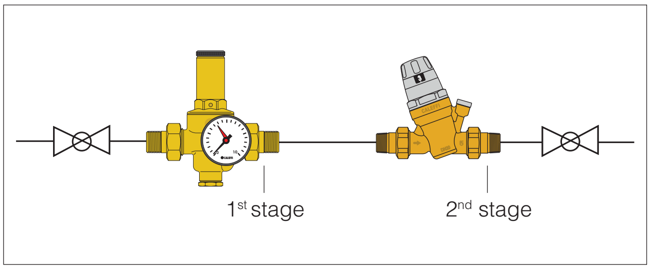


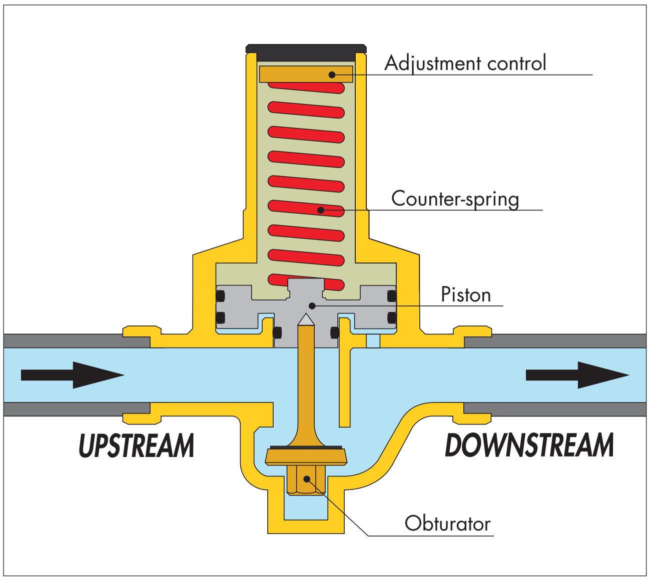
Uncompensated seat
With an uncompensated seat, the pressure thrust acts on the obturator alone, which tends to lower when the upstream pressure increases, further opening the valve to flow.
The obturator movement is therefore affected by the upstream pressure, leading to worse pressure control.



Piston pressure reducing valve

The operating principle of piston pressure reducing valves is similar to that of diaphragm pressure reducing valves.
The difference is that the thrust created by the downstream pressure acts on the surface of a piston in these devices. Also in this case, the thrust is counterbalanced by a spring on the opposite side of the piston. The spring is preloaded according to the setting requirements.



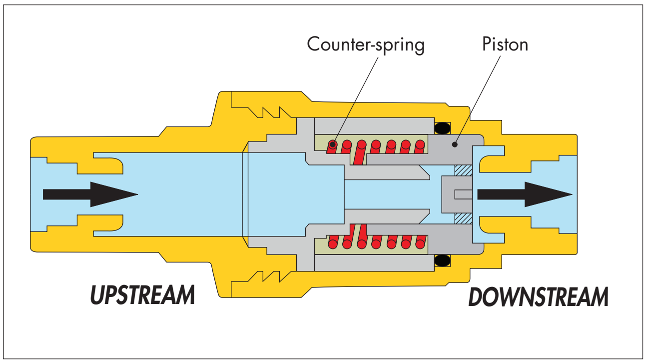


Comparison between diaphragm and piston

Pressure reducing valve	✓	✗	Typical applications
Diaphragm	• Very sensitive to pressure variations; • Responsive and accurate control.	• Less resistant to pressure changes or water hammer; • More susceptible to dirt and temperature changes.	• Installations where pressure control must be as accurate and as responsive as possible, for example in very large buildings that require floor-level pressure control.
Piston	• Robust against stresses (pressure changes or water hammer); • Suitable for first-stage installation; • More economical, depending on the model.	• Less sensitive to pressure variations; • Less accurate pressure control; • Only available with fixed setting in some cases.	• As a first stage or where the water mains pressure tends to have abrupt variations; • Installations in which high accuracy control is not required, for example irrigation systems, or where the pressure control accuracy is less important than the strength and reliability of the component.

Pressure limiting valve

Pressure limiting valves are fixed setting devices used to limit the pressure in a simple manner.
They usually have no strainers and are less reliable and accurate than pressure reducing valves. Pressure limiting valves are often in-line devices and are inserted directly into appliances that do not require accurate pressure control.

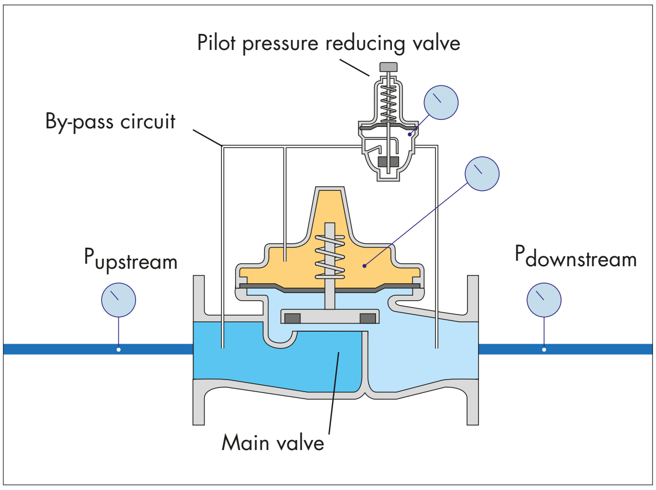


Pilot operated pressure reducing and stabilising valve

Pressure reducing/regulating valves with pilot circuit can maintain the downstream pressure at a fixed value even when the flow rate varies. They are composed of:

1. **Main valve**, which contains an obturator connected to a diaphragm via a special stem;
2. **By-pass circuit;**
3. **Pilot pressure reducing valve**, i.e. a direct acting pressure reducing valve installed in the by-pass circuit.

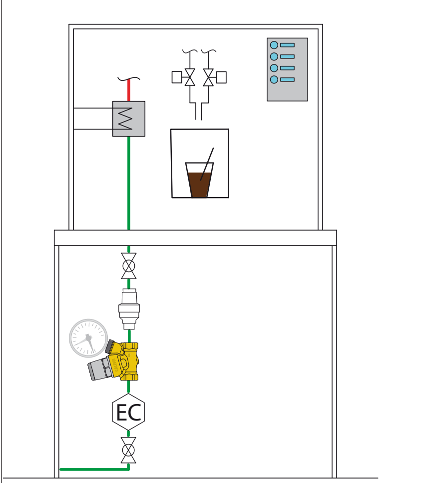
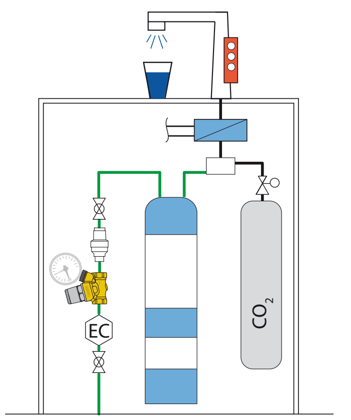
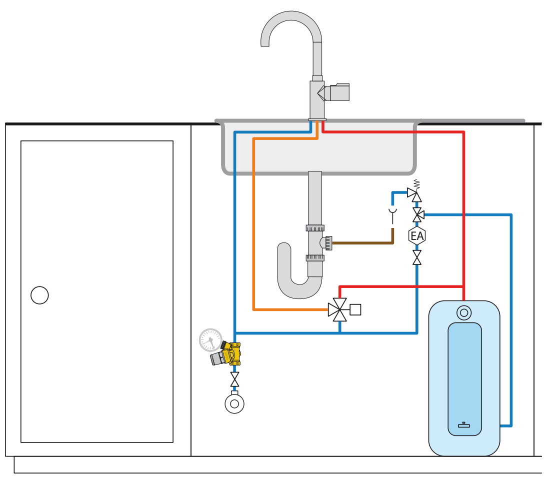
The main valve replicates what happens on the pilot pressure reducing valve, so operation is controlled by the pilot pressure reducing valve. Pressure reducing valves with different functions can be made, depending on the connections.



Pressure reducing valve	✓	✗	Typical applications
Pilot	• Continuous regulation by the pilot ensures accurate downstream pressure control; • Pressure stabilisation with high and very variable flow rates.	• Higher cost; • More components (more frequent checks and maintenance).	• Installations where pressure must be controlled accurately with high water flow rates, for example in industrial and fire-fighting applications; • Water distribution systems with downstream or upstream pressure control (pressure maintenance).

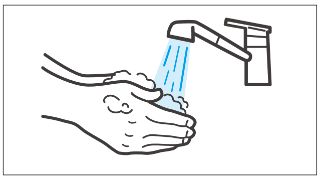
Micro pressure reducing valve

Micro pressure reducing valves are for applications where it is necessary to reduce the mains inlet pressure and stabilise it with low flow rates. They are typically installed for service in large appliances with intermittent operation. Typical applications of these micro pressure reducing valves are coffee machines or water and beverage dispensers. In addition to these applications, micro pressure reducing valves can be used in systems where pressure control is essential, especially with low flow rates.

HOT BEVERAGE PRODUCTION MACHINES	WATER DISPENSERS/REFINERS	UNDER-SINK COLD, HOT AND BOILING WATER STATIONS
		

SIZING

In order to ensure that domestic water is supplied correctly to the utilities, the supply system must be sized to guarantee the design pressure and flow rate at every point. Correct design is essential to ensure and maintain the necessary pressure at the supply point. When the supply pressure is too low, the required flow rate to each utility is not guaranteed. Conversely, if the pressure is too high, noise and damage to the drawing devices and distribution system may occur.



The national technical standards propose various calculation methods for choosing the flow rates.
It should be noted that the design flow rate is not the sum of the flow rates of all the installed appliances. Simultaneous supply from all draw-off points is unlikely, and is related to the system type and application.

Normative references for designing domestic water systems

EUROPE	**EN 806-3:2008** Specifications for installations inside buildings conveying water for human consumption. Part 3: Pipe sizing - Simplified method.
ITALY	**UNI 9182:2014** Hot and cold water supply and distribution installations. Design, installation and testing.
FRANCE	**NF DTU 60.11 P1-1** Building works — Calculation rules for sanitary installations and rainwater draining off. Part 1-1: Cold and warm sanitary networks.
GERMANY	**DIN 1988-300:2012** Codes of practice for drinking water installations. Part 300: Pipe sizing; DVGW code of practice.
UNITED KINGDOM	**BS 8558:2015** Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. Complementary guidance to BS EN 806.
U.S.A.	**IPC** (International Plumbing Code); **UPC** (Uniform Plumbing Code); **ASHRAE** Handbook.
AUSTRALIA	**AS/NZS 3500.1** Plumbing and drainage. Part 1: Water services.

Design flow rate calculation

To size the distribution system correctly, the design flow rate must be calculated carefully to avoid the issues associated with oversizing the pipes and various system components, such as pressure reducing valves. In fact, it should not be based on all the supply points being active simultaneously, but only a fraction of them.

The following steps are required for correct sizing:

1. Calculate the total flow rate in relation to the number of appliances in the system and their types, referring to the technical standards and manufacturers' data;
2. Choose the simultaneity factor, or read the diagrams in the technical standards;
3. Define the design flow rate using the diagrams or factors chosen in the previous step.

The simultaneity factor calculation takes the following into account:
- Utility type and intended use of the building;
- Type and number of draw-off points (appliances);
- Duration of the peak time.

Usually, the more utilities there are, the lower the percentage of appliances open simultaneously.

These days, calculation methods tend to select lower design flow rates than in the past.
Main reasons:
- Saving water;
- User behaviour;
- Hygiene;
- New appliances with a limited flow.

Once the flow rate has been defined, the permissible speeds within the pipes must be taken into account in order to size the distribution system. The pressure at the supply points must be guaranteed to meet the manufacturers' instructions or the technical standards.

Appliance	FLOW RATES according to EN 806-3	
	Draw-off flow rate (l/s)	Minimum flow rate (l/s)
Washbasin	0.1	0.1
Bidet	0.1	0.1
WC with cistern	0.1	0.1
Bathtub	0.4	0.3
Shower	0.2	0.15
Kitchen sink	0.2	0.15
Washing machine	0.2	0.15
Dishwasher	0.2	0.15

MAXIMUM SPEED according to EN 806-3	
Part of system	Maximum design speed (m/s)
Primary distribution	2
Connecting end sections	4

RECOMMENDED PRESSURE according to EN 806-3	
Type	Limit
Maximum static pressure at the draw-off point	500 kPa (5 bar)
Minimum dynamic pressure at the draw-off point	100 kPa (1 bar)
Recommended operating range at the draw-off point	*150—300 kPa (1,5—3 bar)*

Selection criteria for pressure reducing valves (speed and pressure drop)

When choosing the most suitable pressure reducing valve, it is advisable to consider a flow speed range of 1–2 m/s. This range is based on the need to prevent noise and consequently also rapid wear of the components and supply appliances.
The flow speed depends on the pass-through flow rate and the pipe cross section as follows:

$$V = \frac{10^3 * 4}{\pi} * \frac{G_{design}}{(DN)^2}$$

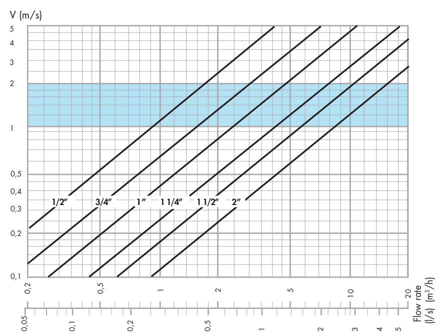
Where:

- V = flow speed (m/s);
- G_{design} = medium flow rate (l/s);
- DN = nominal diameter (mm).

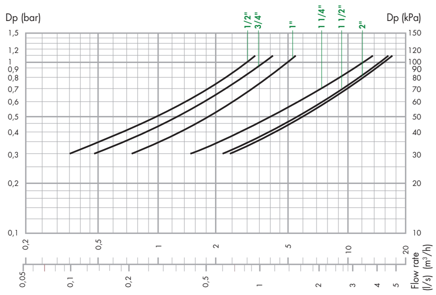
Note that the size of the pressure reducing valve must be selected to obtain a flow rate within the specified range (1–2 m/s). Alternatively, the appropriate diagrams in the technical product documentation can be used.

The pressure drop is obtained from the graphs in the technical documentation by intersecting the design flow rate with the curve for the diameter chosen previously. With respect to the set pressure with a flow rate of zero, the downstream pressure therefore decreases by a value equal to the pressure drop.
It is important to have a progressive pressure drop; a sudden pressure drop can cause problems with some flow rates.

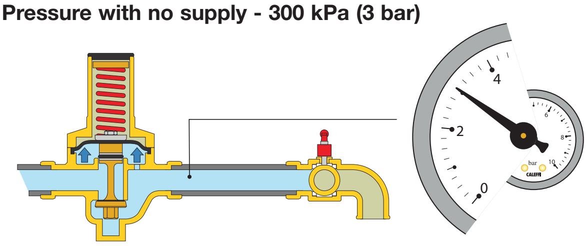
Circulation speed



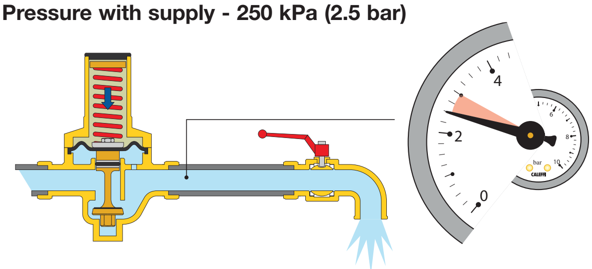
Pressure drop



Pressure with no supply - 300 kPa (3 bar)



Pressure with supply - 250 kPa (2.5 bar)



The pressure drop at the design flow rate must always be taken into account when choosing the pressure reducing valve. In addition to verifying the speed, it is always necessary to check that the pressure drop is not too high, otherwise a larger size or a different type of pressure reducing valve must be chosen.

Oversizing

Oversizing occurs when the chosen pressure reducing valve is too large in relation to the flow rate through it under nominal operating conditions. An error of this type causes the pressure to be regulated incorrectly.

Design errors	**Choice of simultaneity** Error due to choosing simultaneity factors that are incorrect or in any case not in line with the characteristics and intended use of the building.
	Selection according to pipe size Error due to choosing a pressure reducing valve based on the system pipe diameter alone, especially when retrofitting in older, often oversized systems.

Always make appropriate design flow calculations before choosing the pressure reducing valve and other components to be installed.

Parallel installation (by-pass)

Sizing the pressure reducing valve according to the design flow rate sometimes leads to operating problems when there is low flow rate demand. This condition may arise because of the time of use during the day or due to a specific system uses.

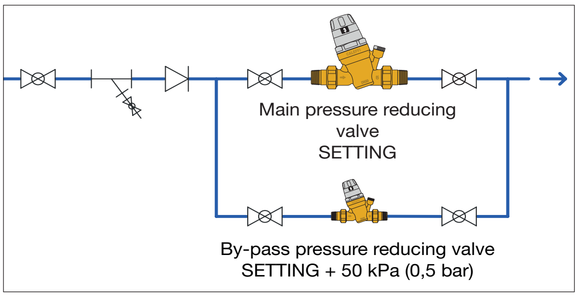
Operation out-side the working range	The pressure reducing valve operates with the obturator almost fully closed, and may be unable to regulate the outlet pressure correctly, causing it to fluctuate. The diaphragm becomes unstable resulting in erratic behaviour at low flow rates. This can lead to noise and vibration problems, which are then transmitted to the whole system.

The solution to this issue is to install two pressure reducing valves in parallel (by-pass) to ensure a stable downstream pressure, even at low flow rates. System operation is fully automatic, based on the actual supply flow rate.

Installation logic with parallel pressure reducing valves

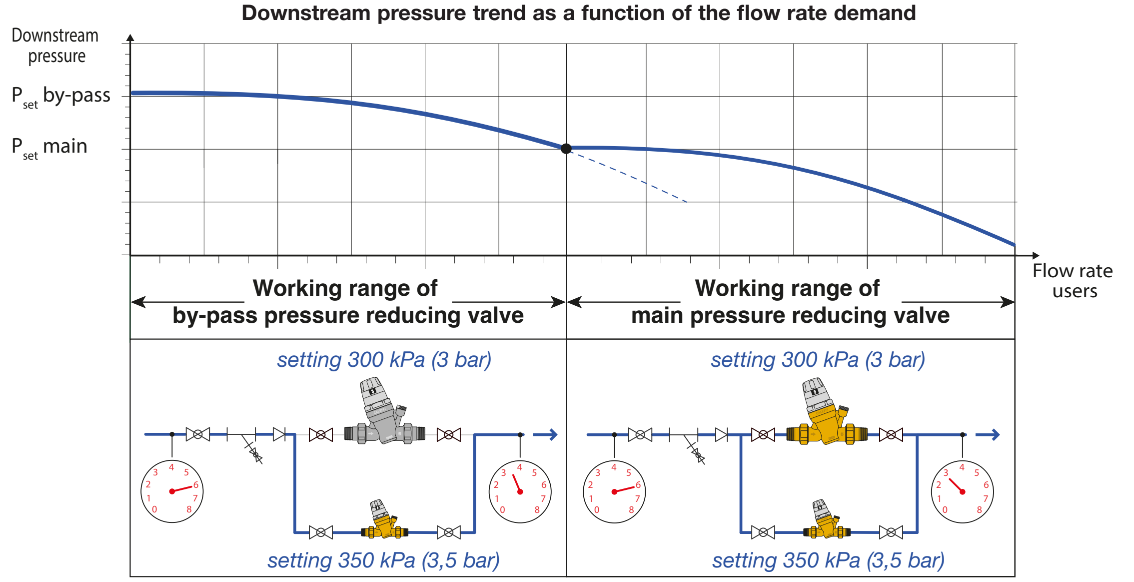
- Main pressure reducing valve:
  Sized according to the design flow rate.

- By-pass pressure reducing valve:
  Set to approximately 50–70 kPa (0,5–0,7 bar) higher than the setting of the main pressure reducing valve, and sized according to the minimum flow rate demand of the system. The minimum flow rate demand can be assumed to be 20–30 % of the design flow rate.



Operating phases

Downstream pressure trend as a function of the flow rate demand



Low flow rate demand Only the by-pass pressure reducing valve intervenes as it is set to a higher pressure than the main valve. As the flow rate increases, the downstream pressure decreases resulting in an increased pressure drop in the pressure reducing valve.	**High flow rate demand** The main pressure reducing valve also intervenes, i.e. the one sized for the design flow rate and set to a lower pressure. It starts to open when the downstream pressure reaches the setting value.

With this system solution, the pressure is fully regulated when the system is operating with a low flow rate. At the same time, the correct pressure is also guaranteed when the design flow rate is used. It is a very useful solution for systems with high flow rate demands during the day or at specific times, and significantly lower flow rates at other times.

Examples of selecting pressure reducing valves

RESIDENTIAL CASE (according to EN 806-3)

Below are some examples of calculations according to the EN 806-3 standard for:
- **Single house**, composed of 2 bathrooms and 1 kitchen;
- **Apartment block** composed of:
  - 10 apartments (bathroom and kitchen);
  - 20 apartments (bathroom and kitchen).

To calculate the total flow rate, the installed appliances are considered, with the flow rates of each appliance.

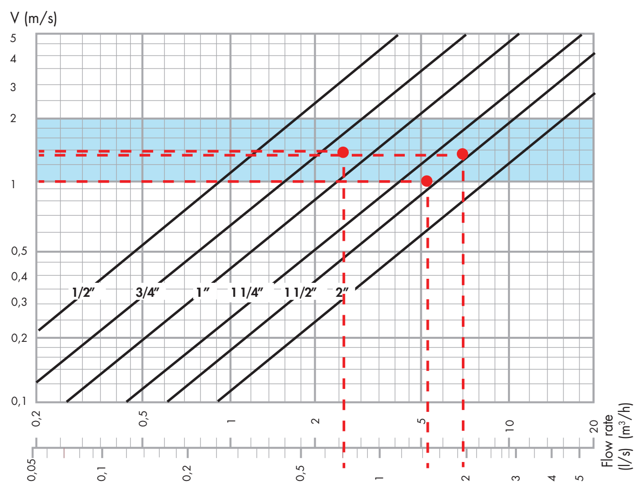
$$G_{total} = n * G_{sink} + n * G_{bidet} + n * G_{wc} + n * G_{bath} + n * G_{hower} + n * G_{dishwasher} + n * G_{washing\_machine}$$

Where n is the number of appliances of each type.

		SINGLE HOUSE	APARTMENT
Appliance	Unit flow rate	No. of appliances	No. of appliances
Sink	0,2 l/s	1	1
Washbasin	0,1 l/s	2	1
Bidet	0,1 l/s	2	1
WC with cistern	0,1 l/s	2	1
Bathtub	0,4 l/s	1	1
Shower	0,2 l/s	1	0
Washing machine	0,2 l/s	1	1
Dishwasher	0,2 l/s	1	1
TOTAL FLOW RATE		1,8 l/s	1,3 l/s

	SINGLE HOUSE	APARTMENT BLOCK	
		10 APART-MENTS	20 APART-MENTS
Total flow rate	1,8 l/s	13 l/s	26 l/s
Design flow rate	0,65 l/s	1,3 l/s	1,6 l/s
Simultaneity factor	36,1 %	10 %	6,2 %

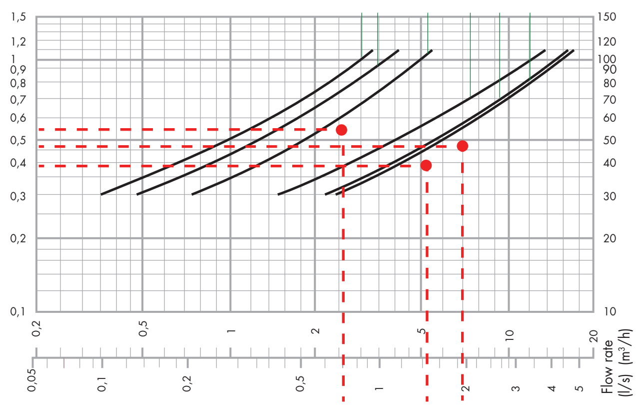
Circulation speed



Selecting the pressure reducing valve (according to the medium flow speed and pressure drop chart)

	SINGLE HOUSE	APARTMENT BLOCK	
		10 APART-MENTS	20 APART-MENTS
DN	20	32	32
Δp	70 kPa (0,7 bar)	55 kPa (0,55 bar)	60 kPa (0,60 bar)

Pressure drop



COMMERCIAL CASE (according to DIN 1988-300)

Below are some examples of calculations according to the DIN 1988-300 standard for:

- **Hotel** composed of:
  - 10 rooms;
  - 25 rooms;
  - 50 rooms.

		HOTEL ROOM
Appliance	**Unit flow rate**	**No. of appliances**
Washbasin	0,07 l/s	1
Bidet	0,07 l/s	1
WC with cistern	0,13 l/s	1
Bathtub	0,15 l/s	0
Shower	0,15 l/s	1
TOTAL FLOW RATE		0,57 l/s

	HOTEL		
	10 ROOMS	**25 ROOMS**	**50 ROOMS**
Total flow rate	5,7 l/s	14,25 l/s	28,5 l/s
Design flow rate	1,48 l/s	2,38 l/s	3,36 l/s
Simultaneity factor	26 %	16,7 %	11,8 %

Selecting the pressure reducing valve (according to the medium flow speed and pressure drop chart)

	HOTEL		
	10 ROOMS	**25 ROOMS**	**50 ROOMS**
DN	32	40	50
Δp	60 kPa (0,60 bar)	65 kPa (0,65 bar)	80 kPa (0,80 bar)

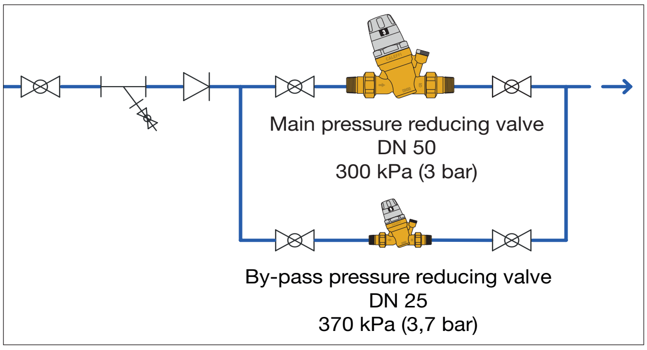
Choice of by-pass pressure reducing valve

Proceeding with the example of the 50-room hotel, we define how to choose and set the by-pass regulator based once again on the speed. Since this application requires high flow rates at specific times and significantly lower ones at other times, it is necessary to install a by-pass pressure reducing valve.

The main pressure reducing valve is DN 50. The parallel pressure reducing valve is sized for a lower flow rate than the design flow rate; we assume a flow rate of 25 % in the example.
We always recommend adjusting it on site during commissioning to ensure all devices operate in the best condition.

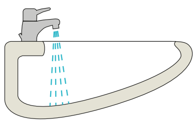
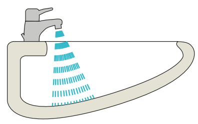
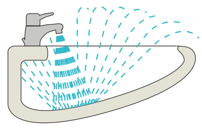
HOTEL 50 ROOMS	
Total flow rate	28,5 l/s
Design flow rate	3,36 l/s
Simultaneity factor	11,8 %
MAIN PRESSURE REDUCING VALVE DN Set to 300 kPa (3 bar)	50 (2”)
Δp	80 kPa (0,80 bar)

BY-PASS PRESSURE REDUCING VALVE - Set to 370 kPa (3,7 bar)	
Minimum flow rate demand is 25 % of the design flow rate	0,84 l/s
By-pass pressure reducing valve DN	25 (1”)
Δp	65 kPa (0,65 bar)



PRESSURE CONTROL

Pressure reducing valves serve to maintain the pressure and ensure that it is correct at the supply point, usually in the range 150 to 300 kPa (1,5 to 3 bar). Always refer to the technical data sheets provided by the appliance manufacturers to verify if they have different working ranges.

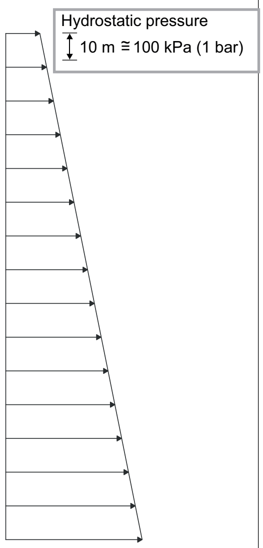
LOW PRESSURE	OPTIMAL PRESSURE	EXCESSIVE PRESSURE
0 kPa < P < 150 kPa (0 bar < P < 1,5 bar)	150 kPa ≤ P ≤ 300 kPa (1,5 bar ≤ P ≤ 3 bar)	P > 300 kPa (P > 3 bar)
		

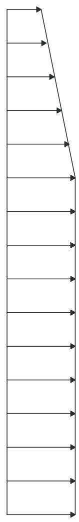
Two main conditions can occur in domestic water systems:

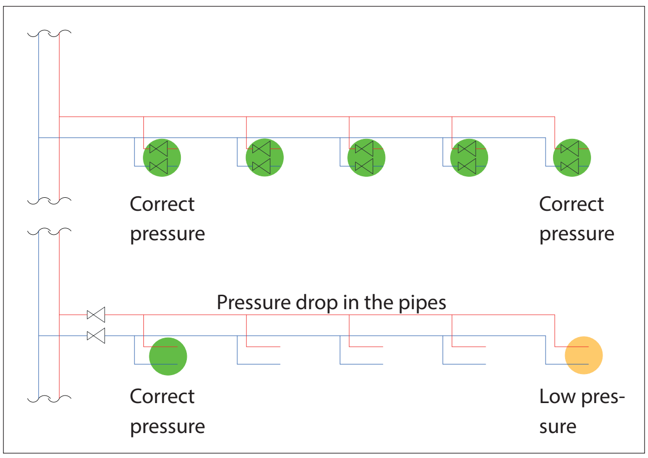
1. The mains pressure is too high and therefore must be reduced at the inlet;
2. The mains pressure is too low and must be increased with pressure boosting units.

In high-rise buildings, the thrust needed to ensure the required pressure at the higher floors may be too high for the lower floors, so the best compromise has to be found between the pressure boosting unit setting and the locations of the pressure reducing valves.
In buildings with several floors, the hydrostatic height results in an equivalent decrease in the pressure available at the taps.
The hydrostatic pressure trend is shown below, considering each floor to be 3 metres high, therefore with a ΔP of 30 kPa (0,3 bar) from one floor to the next.

Building specifications		Pressure trend without pressure reducing valves	Pressure trend with pressure reducing valves
floor 15	45 m	150 kPa (1,5 bar)	150 kPa (1,5 bar)
floor 14	42 m	180 kPa (1,8 bar)	180 kPa (1,8 bar)
floor 13	39 m	210 kPa (2,1 bar)	210 kPa (2,1 bar)
floor 12	36 m	240 kPa (2,4 bar)	240 kPa (2,4 bar)
floor 11	33 m	270 kPa (2,7 bar)	270 kPa (2,7 bar)
floor 10	30 m	300 kPa (3 bar)	300 kPa (3 bar)
floor 9	27 m	330 kPa (3,3 bar)	300 kPa (3 bar)
floor 8	24 m	360 kPa (3,6 bar)	300 kPa (3 bar)
floor 7	21 m	390 kPa (3,9 bar)	300 kPa (3 bar)
floor 6	18 m	420 kPa (4,2 bar)	300 kPa (3 bar)
floor 5	15 m	450 kPa (4,5 bar)	300 kPa (3 bar)
floor 4	12 m	480 kPa (4,8 bar)	300 kPa (3 bar)
floor 3	9 m	510 kPa (5,1 bar)	300 kPa (3 bar)
floor 2	6 m	540 kPa (5,4 bar)	300 kPa (3 bar)
floor 1	3 m	570 kPa (5,7 bar)	300 kPa (3 bar)
floor 0	0 m	600 kPa (6 bar)	300 kPa (3 bar)





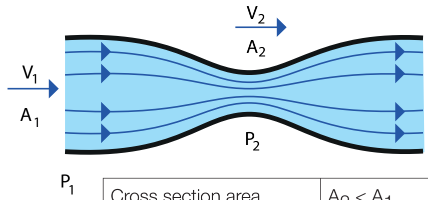


When choosing the correct location for the pressure reducing valves, it is also important to consider the pressure drops due to dynamic effects. In particular, we must prevent the most used areas from subtracting pressure from the farthest areas. When the pipes are undersized and long, the pressure drops due to dynamic effects become considerable, especially in the farthest units. The pressures are lower at these points and may be insufficient for the user.

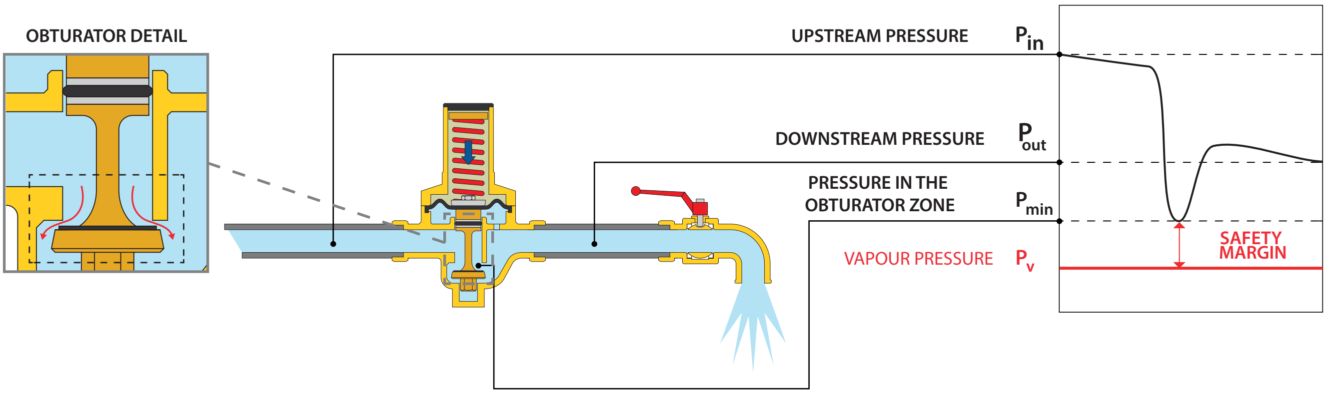
When choosing the pressure reducing valve, it is necessary to consider that it can vibrate and cause noise in certain operating conditions.
In some systems, to avoid problems related to cavitation and noise, specific solutions have to be adopted to ensure that the pressure reducing valves can operate correctly within their working range.

Cavitation and noise

A key consideration when choosing and locating pressure reducing valves is cavitation, the cause of many noise and vibration issues.
It is typical of hydraulic systems and consists of the formation of small vapour bubbles, which can damage pipes and components as a result of rapid collapse. Noise in pressure reducing valves may be a clear indication that they are operating in improper working conditions.
If the pressure reduction ratio, i.e. the ratio of upstream pressure to lower downstream pressure, is too high, the water becomes very fast in the restricted cross section. This generates a local pressure drop (according to Bernoulli's equation) until the vapour pressure of the liquid is reached.



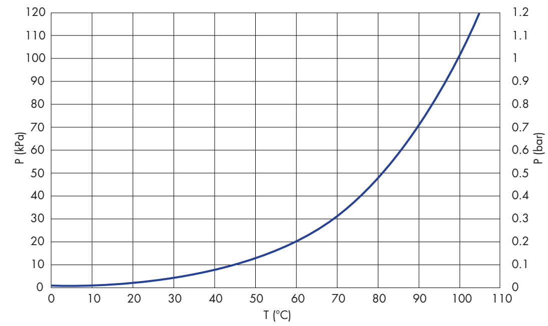
Cross section area	$A_2 < A_1$
Velocity	$V_2 > V_1$
Pressure	$P_2 < P_1$



This condition causes the liquid to change to the gaseous phase, forming bubbles that contain vapour.
When the bubbles implode, it causes pressure fluctuations charged with impact energy. Together with the high water speed in the gap between the seat and obturator, this can compromise the components in the pressure reducing valve, creating mechanical vibrations, noise and material erosion. The phenomenon is increased if the water contains dissolved air.

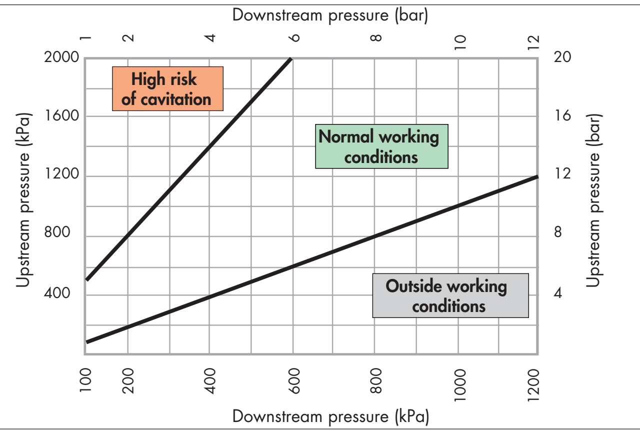
Vapour pressure varies with water temperature. There is a much greater risk of cavitation in hot water as the vapour pressure is higher. For example, the vapour pressure (P_V) at 60 °C is about 20 times greater than at 10 °C.

Vapour pressure of water as a function of temperature



Cavitation diagram

To minimise the risk of cavitation in the pressure reducing valve, we strongly recommend referring to the working conditions specified in the cavitation diagram.



HIGH RISK OF CAVITATION:
The reduction ratio between upstream and downstream is too high and therefore the onset of cavitation is very likely.

NORMAL WORKING CONDITIONS:
The pressure reducing valve works with the correct reduction ratio, and therefore without cavitation.

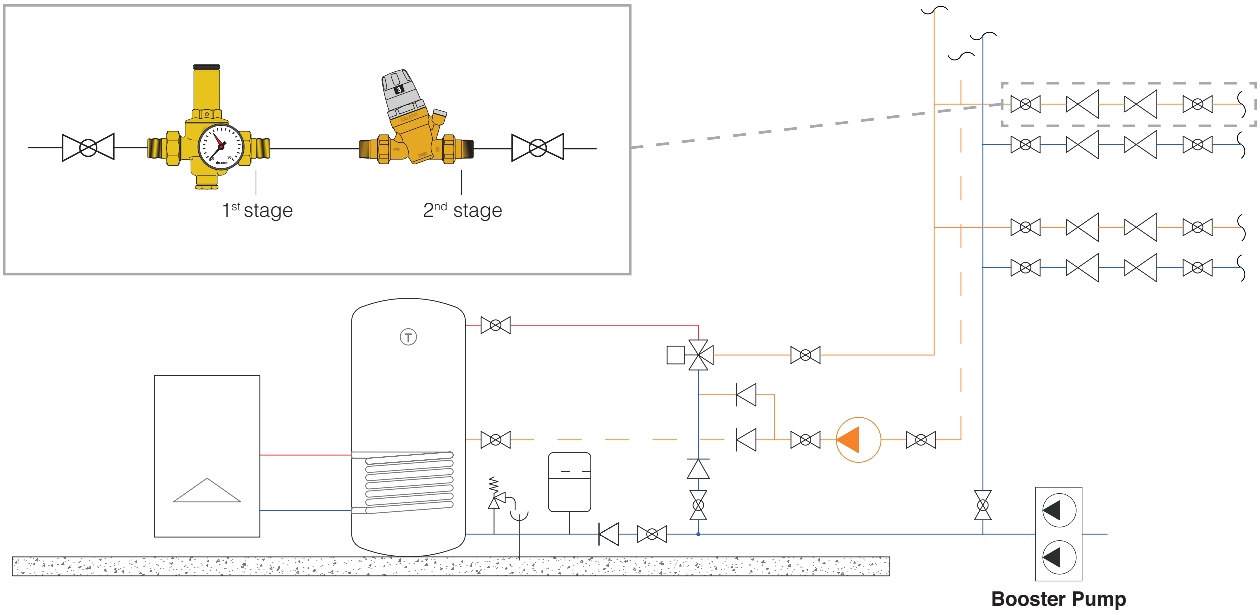
OUTSIDE THE WORKING CONDITIONS:
The pressure reducing valve cannot operate as the upstream pressure is lower than the downstream pressure.

Numerous factors and variable conditions can affect the behaviour of pressure reducing valves, including system pressure, temperature, presence of air, flow rate and speed. We recommended keeping the ratio between the upstream and downstream pressures ideally at 2:1 and no higher than 3:1 (maximum recommended pressure reduction ratio). In such conditions, the risk of cavitation is reduced to a minimum, nevertheless this does not completely exclude potential effects due to the other numerous factors present inside the system during operation.

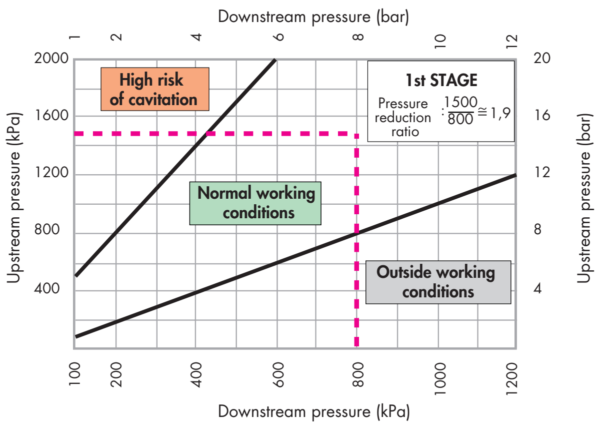
Pressure reducing valves in series (first and second stage)

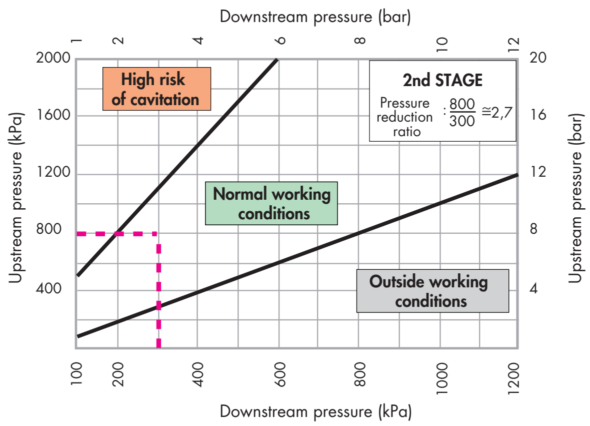
In system applications for which a high pressure must be guaranteed in order to supply the utilities at the top floors, some measures must be taken to ensure that the pressure reducing valves at the bottom floors do not work in conditions at risk of cavitation.
This situation can also occur when the mains pressure is already very high. One of the solutions that can be adopted is to install several pressure reducing valves in series so that they share the pressure drop.
Assuming an inlet pressure of 1500 kPa (15 bar) and a desired pressure of 300 kPa (3 bar) at the utilities, the reduction ratio is too high (5:1). Therefore the following must be installed:

- a **first stage** pressure reducing valve to perform an initial pressure reduction: generally it can be a less sophisticated device with less accurate regulation, but with high mechanical resistance since it is subject to the mains pressure peaks and variations;
- a **second stage** pressure reducing valve installed in series with the first to reach the desired pressure: generally it must be able to guarantee accurate regulation to the utilities, and is also less subject to pressure peaks and fluctuations since its operation is protected by the first stage.

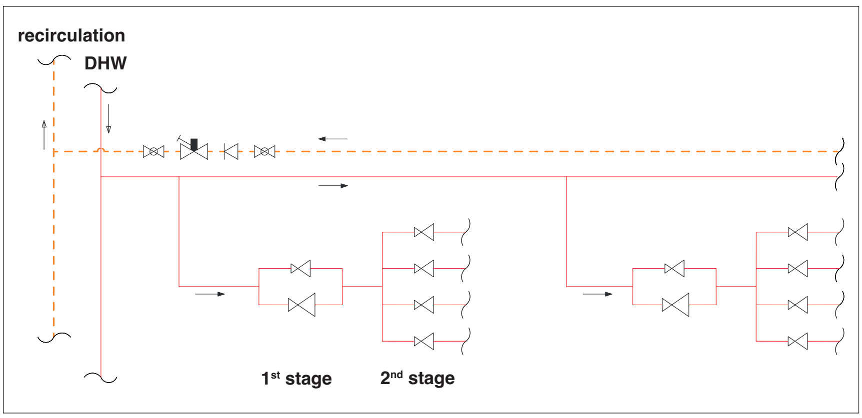


Reduction ratio





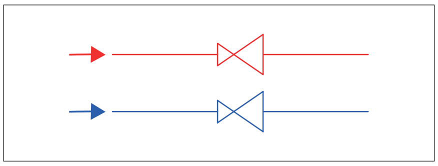
Combined by-pass/series application
In some installations, it is also possible to opt for more sophisticated system solutions, consisting of pressure reducing valves in parallel and pressure reducing valves in series. This ensures that the pressure is controlled optimally in both design flow rate conditions and low flow rate conditions. Series installation also allows low reduction ratios. For the sake of simplicity, the diagram shows only the domestic hot water circuit, but the same considerations can also be applied to the cold water circuit.



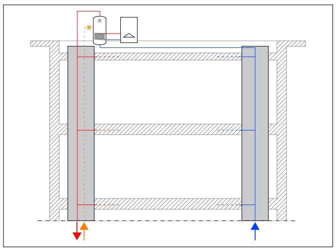
APPLICATION DIAGRAMS

It is important to define the best points for installing the pressure reducing valves at the design stage. In general, local control is the optimal solution as it can ensure correct pressure regulation at the individual utilities. However, for reasons of simplicity and cost, this solution is not always feasible, and so pressure control by zone is used. The installation and maintenance aspects of these devices must also be assessed, especially in very complex buildings.

Below are some typical installation diagrams for pressure reducing valves: small domestic applications, medium-sized multi-storey buildings and high-rise buildings.
The advantages and disadvantages of each application are highlighted, focusing on pressure management, operation and installation of the pressure reducing valves.



NOTE:
for hygiene and design reasons, the cold water pipes must be installed in separate cavities from the hot water and recirculation pipes.
In the diagrams below, the pipes will be shown in shared cavities to make reading easier.



Low-rise buildings

Installation that generally feature distribution networks that are not too large, typically serving two or three floors, in which fairly limited pressures are reached.

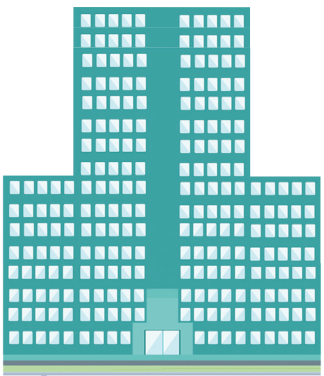
- DIAGRAM 1: Two-floor residential building.

Multi-storey buildings

Buildings from 10 to 15 floors in which it is necessary to assess the pressure variation due to the height differences between the various floors. In the diagrams below, the pressure variation is assumed to be 30 kPa (0,3 bar), considering each floor to be 3 m high.
It is necessary to verify that the pressure on the top and bottom floors remains within the optimal range of 150 kPa < P < 300 kPa (1,5 bar < P < 3 bar).

- DIAGRAM 2: Multi-storey without pressure boosting unit;
- DIAGRAM 3: Multi-storey with pressure boosting unit.

High-rise buildings



Buildings over 15 floors in which there may be multiple solutions. A first choice concerns the distribution system, which can be from the bottom or from the top, exploiting gravity tanks or generators in the plant rooms at the top floors. Buildings of this type usually require pressure boosting systems, which can create excessive pressure at some points in the system. Series pressure reducing valves are installed to prevent cavitation. Regulations in some countries require operating pressures of up to 1000 kPa (10 bar). In these cases, the solution is to divide the building into zones at different pressures.

- DIAGRAM 4: 40 floors with a single plant room;
- DIAGRAM 5: 40 floors with separate plant rooms;
- DIAGRAM 6: 40 floors with separate plant rooms and storage tank;
- DIAGRAM 7: 40 floors with pressurised DHW production on the roof;
- DIAGRAM 8: 40 floors with pressurised DHW production on the roof and floor-level recirculation;
- DIAGRAM 9: 40 floors with tanks at atmospheric pressure.

Low-rise buildings

DIAGRAM 1	TWO-FLOOR RESIDENTIAL BUILDING
SYSTEM FEATURES	• Plant room with DHW storage; • Single riser distribution from the bottom and recirculation circuit in the main riser.
FOCUS OF REDUCING VALVES	• Pressure reducing valves installed at the delivery point; • Setting pressure generally kept between 250 kPa and 300 kPa (2,5 and 3 bar).
ADVANTAGES	• Simple, economical solution with single control over cold and hot water. Balanced cold and hot water pressures; • Boiler and all installed components protected against excessive mains pressures.
DISADVANTAGES	• Overall control, not local.

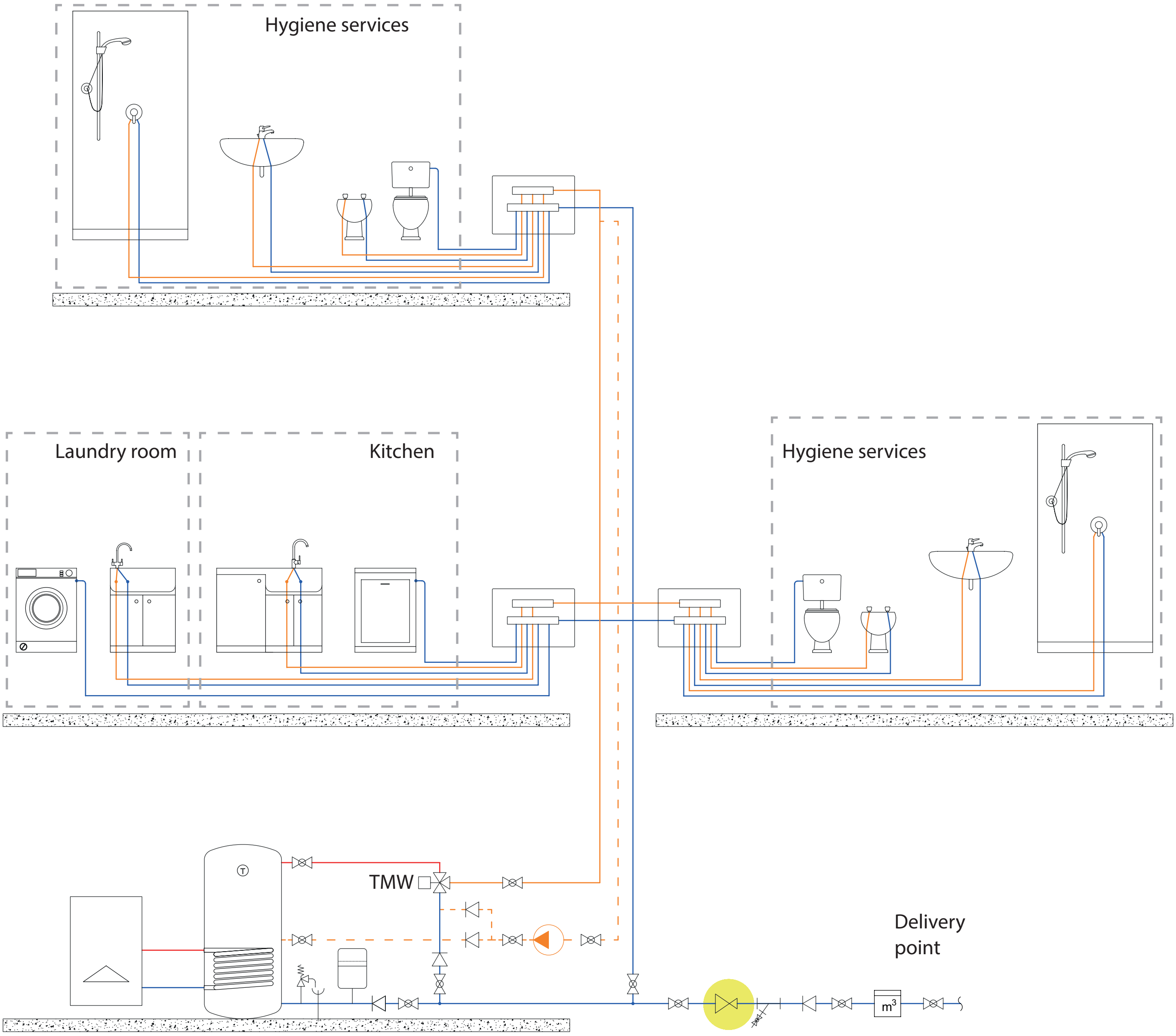
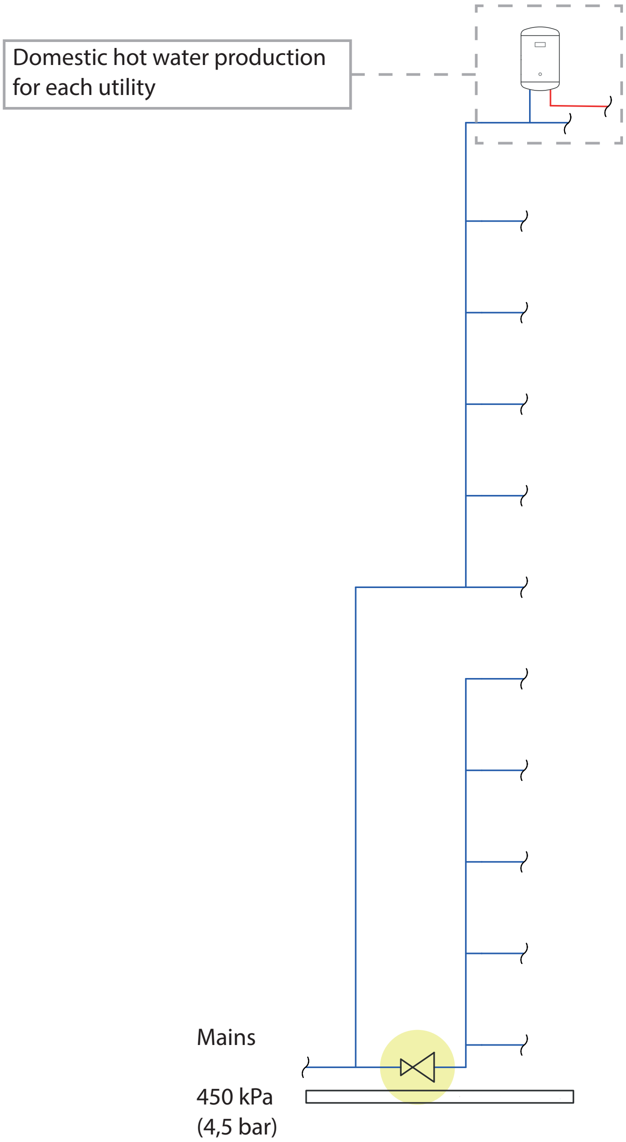


DIAGRAM 2	MULTI-STOREY WITHOUT PRESSURE BOOSTING UNIT
SYSTEM FEATURES	• Sufficient mains pressure available; • Multi-riser distribution; • DHW production within each unit.
FOCUS OF REDUCING VALVES	• Pressure reducing valve installed only on the riser supplying the lower floors. Pressure reducing valve sized for the design flow rate of the units on the riser.
ADVANTAGES	• Simple, economical solution with single pressure reducing valve.
DISADVANTAGES	• Pressure varies from floor to floor, 300 kPa (3 bar) at the bottom floors and 150 kPa (1,5 bar) at the worst-case floor; • Pressures at higher floors are not controlled and are subject to the water mains pressure variations; • Single pressure reducing valve, which may work outside the design conditions for which it was chosen at low flow rates.



Floor	Upstream pressure	Height
Floor 10	150 kPa (1,5 bar)	30 m
Floor 9	180 kPa (1,8 bar)	27 m
Floor 8	210 kPa (2,1 bar)	24 m
Floor 7	240 kPa (2,4 bar)	21 m
Floor 6	270 kPa (2,7 bar)	18 m
Floor 5	300 kPa (3 bar)	15 m
Floor 4	180 kPa (1,8 bar)	12 m
Floor 3	210 kPa (2,1 bar)	9 m
Floor 2	240 kPa (2,4 bar)	6 m
Floor 1	270 kPa (2,7 bar)	3 m
Floor 0	300 kPa (3 bar)	0 m

DIAGRAM 3	MULTI-STOREY WITH PRESSURE BOOSTING UNIT
	• Insufficient mains pressure available, e.g. mains pressure of 250 kPa (2,5 bar); • Installation of a pressure boosting unit; • Central DHW production; • Single riser distribution from the bottom and recirculation circuit in the main riser.
FOCUS OF REDUCING VALVES	• Pressure reducing valve at each floor, on both cold and hot water.
ADVANTAGES	• Floor-level pressure control, inlet pressure reduced to 300 kPa (3 bar); • Single distribution risers for cold and hot water.
DISADVANTAGES	• More devices to maintain and check, in special plant rooms.

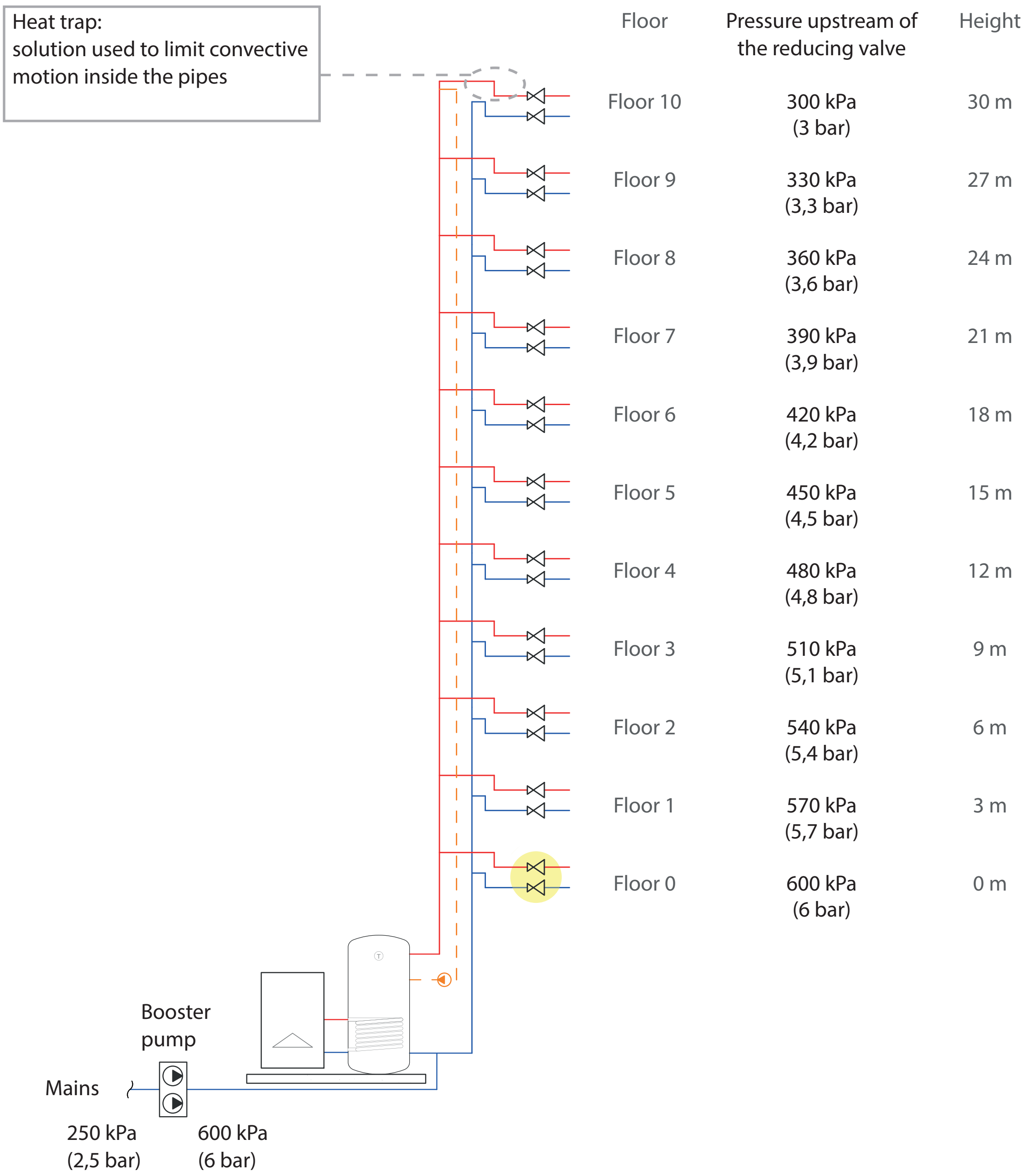


DIAGRAM 4	40-FLOOR BUILDING WITH A SINGLE PLANT ROOM	
SYSTEM FEATURES	• Plant room at the base; • Central DHW production by means of a heat exchanger; • Single riser distribution from the bottom and recirculation circuit in the main riser.	
FOCUS OF REDUCING VALVES	• **Pressure reducing valve per zone**	• **Pressure reducing valves for floor**
ADVANTAGES	• Simple, economical solution with a single riser; • Single recirculation circuit, no balancing required; • Single plant room at the base. No intermediate floors/plant rooms.	
	• Simple, economical solution with single pressure reducing valve per zone.	• Floor-level pressure control, inlet pressure reduced to 3 bar.
DISADVANTAGES	• High maximum pressures, lower floors subject to the entire hydrostatic head; • Need for pressure reducing valves in series at the lower floors (reduction ratios higher than the established limits); • Components suitable for working at high pressures, in some countries pressures must not exceed 1000 kPa (10 bar); • Pressure too high for a boiler, a heat exchanger is required.	
	• Zone pressure varies (300 kPa (3 bar) at the bottom floors and 180 kPa (1,8 bar) at the top floor).	• More devices to maintain and check, in special plant rooms.

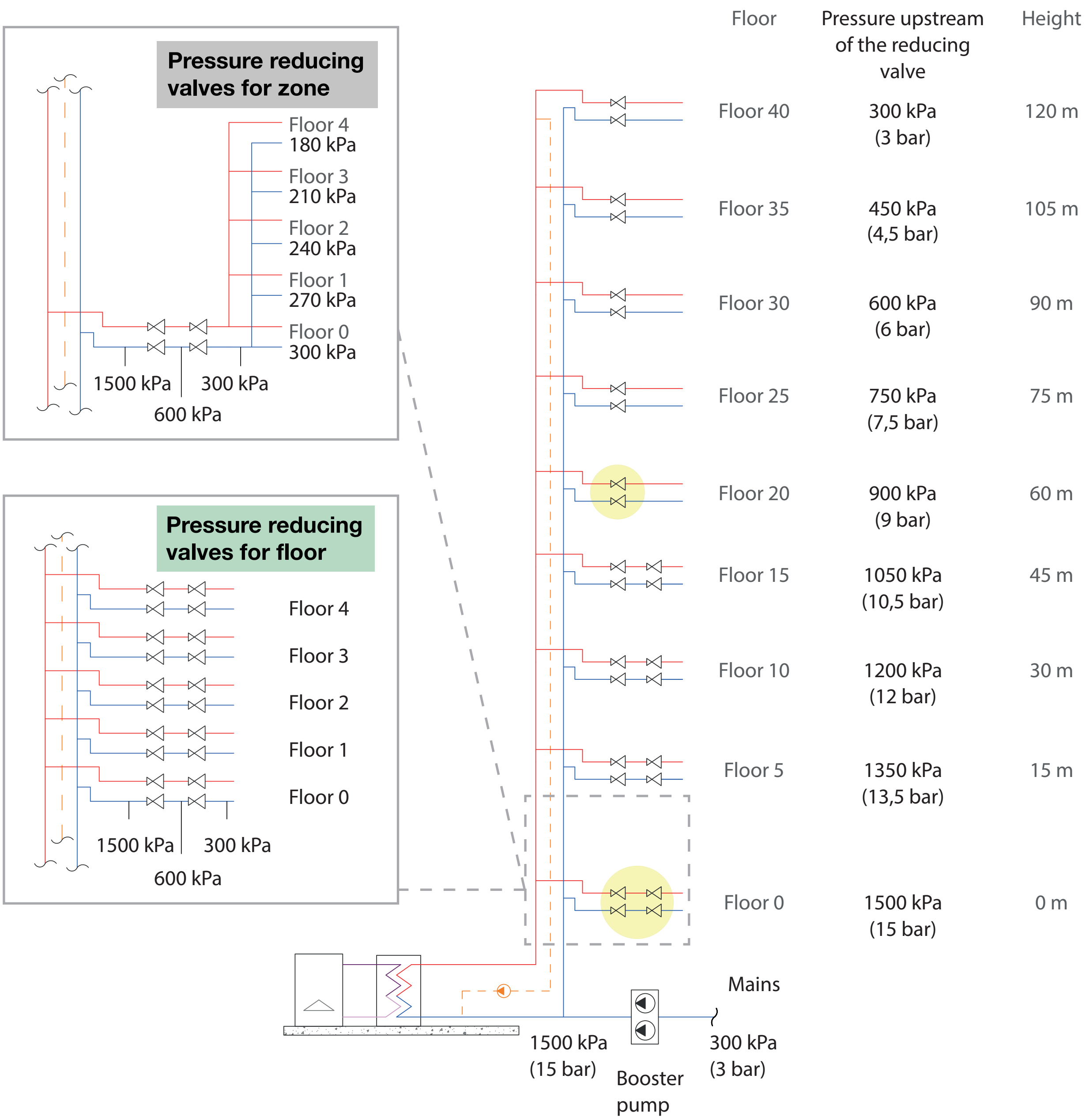


DIAGRAM 5	40-FLOOR BUILDING WITH SEPARATE PLANT ROOMS
SYSTEM FEATURES	• Multi-riser distribution from the bottom; • Two plant rooms for DHW production.
FOCUS OF REDUCING VALVES	• Pressure reducing valves for zone, no need for double stage.
ADVANTAGES	• Double riser limits the pressures acting on the components and storages; • Limited number of pressure reducing valves; • Double stage not required as the reduction ratios are within the established limits.
DISADVANTAGES	• Zone pressure varies (300 kPa (3 bar) at the bottom floors and 180 kPa (1,8 bar) at the top floor); • Use of two pressure boosting units for the two distribution risers; • Two plant rooms and recirculation circuits with dedicated circulation pumps.

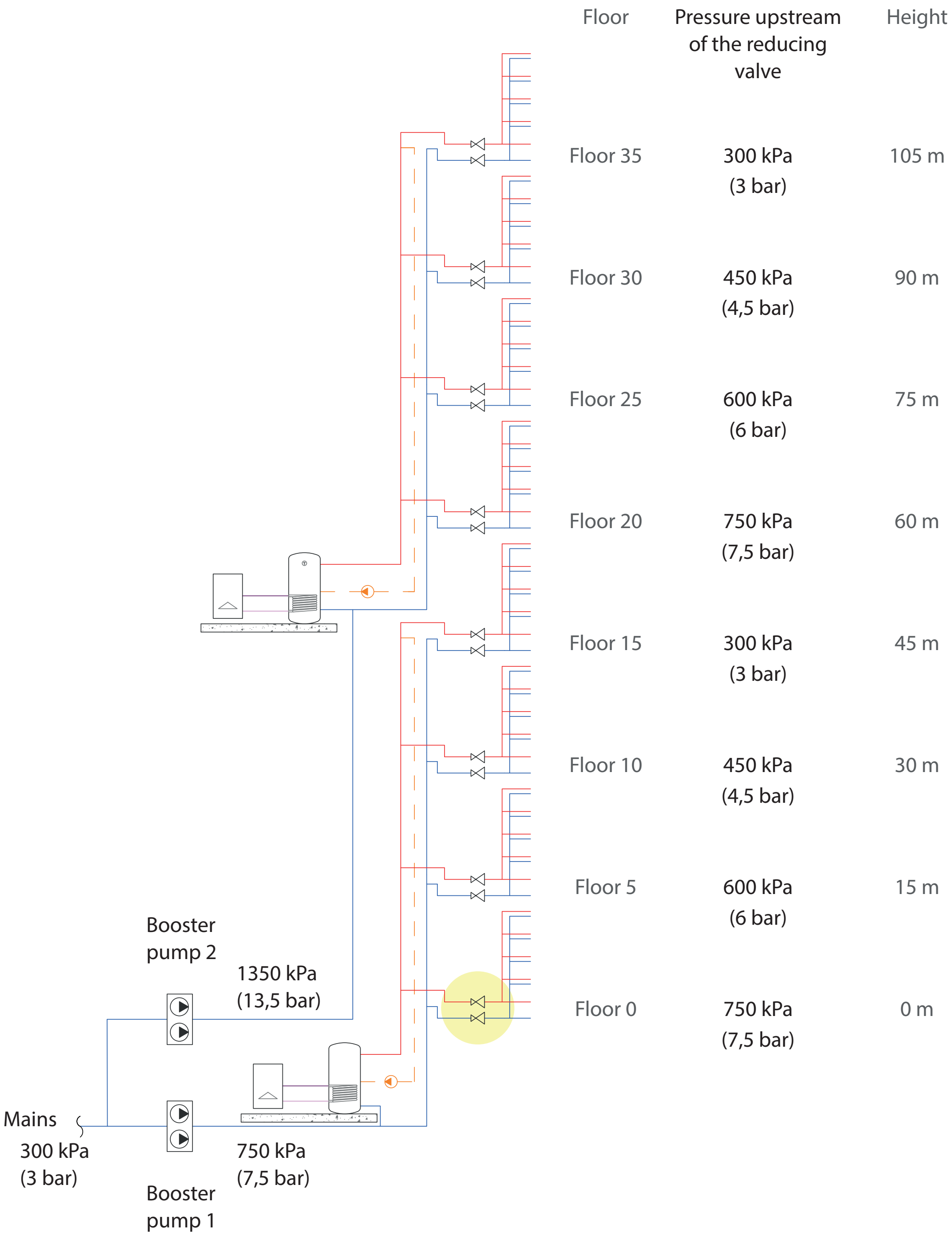


DIAGRAM 6	40-FLOOR BUILDING WITH SEPARATE PLANT ROOMS AND STORAGE TANK
SYSTEM FEATURES	• Multi-riser distribution from the bottom; • Storage tank at atmospheric pressure and heat exchanger for DHW production; • Transfer pump to fill the tank with water.
FOCUS OF REDUCING VALVES	• Pressure reducing valves for zone, no need for double stage.
ADVANTAGES	• Double riser limits the pressures acting on the components and heat exchangers; • Limited number of pressure reducing valves; • Double stage not required as the reduction ratios are within the established limits; • Tank with reserve function and transfer pump (no need for a high-performance pump); • Central thermal medium production.
DISADVANTAGES	• Zone pressure varies (300 kPa (3 bar) at the bottom floors and 180 kPa (1,8 bar) at the top floor); • Use of two pressure boosting units for the two distribution risers; • Plant floor for tank and DHW production heat exchanger; • Very high footprint and load, need for dedicated spaces (floor unavailable for commercial use).

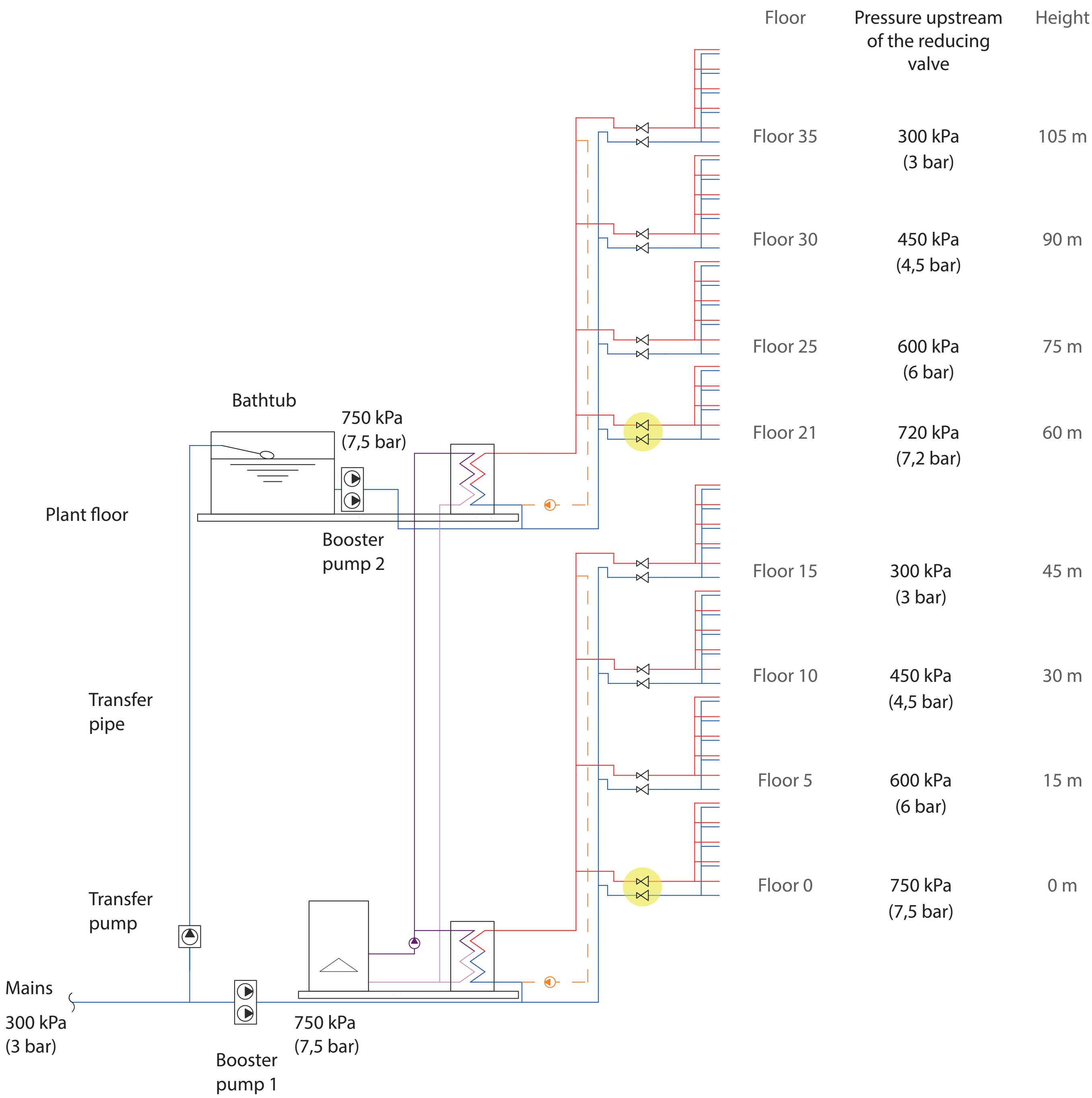


DIAGRAM 7	40-FLOOR BUILDING WITH PRESSURISED DHW PRODUCTION ON ROOF
SYSTEM FEATURES	• Plant floor on the roof; • Cascaded generators with pressure build-up of about 200 kPa (2 bar); • Single riser cold water distribution from the bottom; • Single riser hot water distribution from the top and recirculation circuit in the main riser.
FOCUS OF REDUCING VALVES	• Pressure reducing valves per floor, with double stage at the lower floors; • Pressure reducing valves not required at the top floors.
ADVANTAGES	• Pressure control at 300 kPa (3 bar) floor level, except for the higher floors; • Limited pressure to storages for DHW production and to related components (not subject to the hydrostatic head); • Single plant floor with simple installation and maintenance; • Single distribution risers for cold and hot water.
DISADVANTAGES	• Need for pressure reducing valves in series at the lower floors; • More devices to maintain and check, in special plant rooms; • Pipes and components suitable for working at high pressure; in some countries pressure must not exceed 1000 kPa (10 bar).

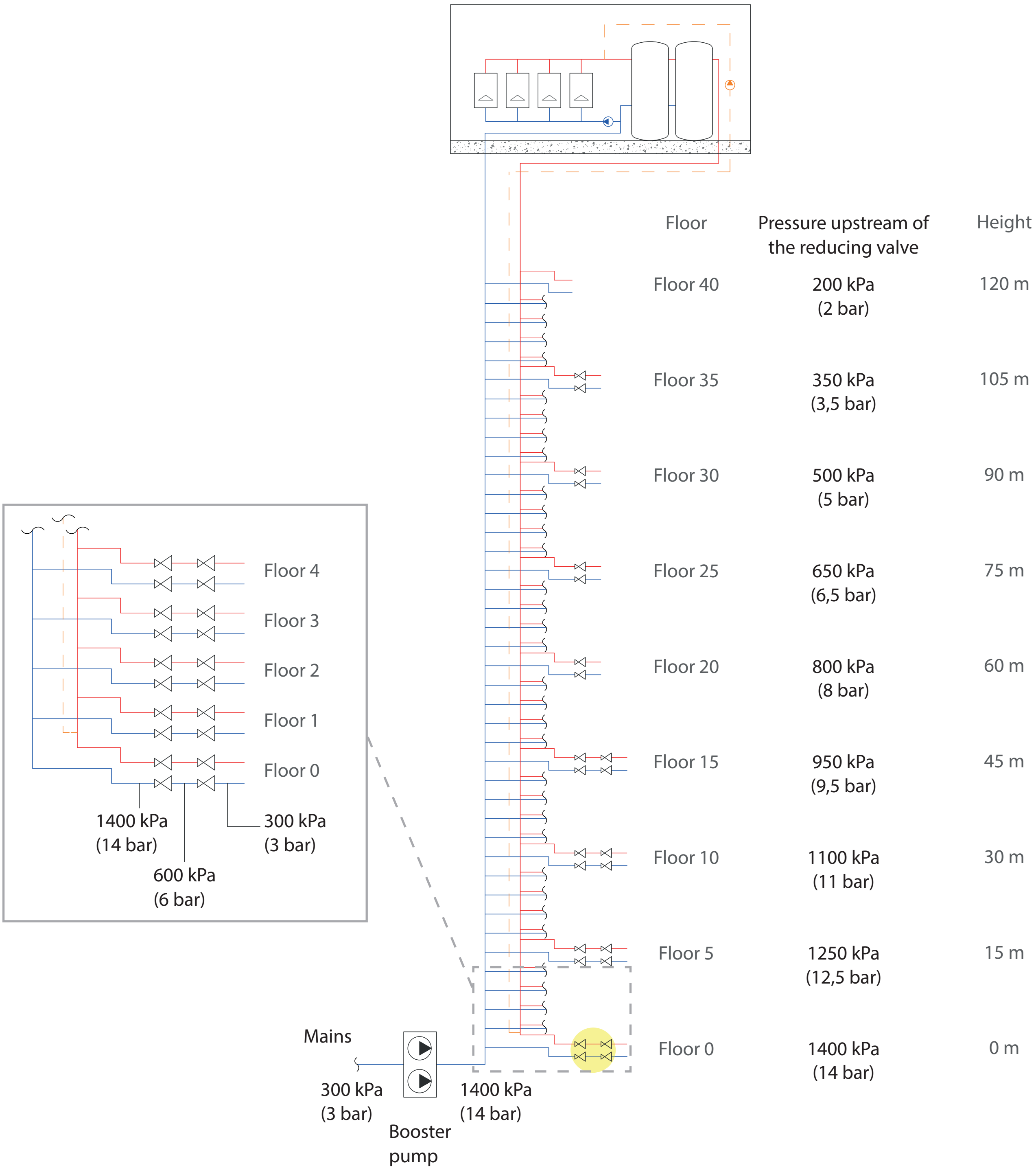


DIAGRAM 8	40-FLOOR BUILDING WITH PRESSURISED DHW PRODUCTION ON ROOF AND FLOOR-LEVEL RECIRCULATION
SYSTEM FEATURES	• Plant floor on the roof; • Cascaded generators with pressure build-up of about 200 kPa (2 bar); • Very wide horizontal distribution; • Single riser cold water distribution from the bottom; • Single riser hot water distribution from the top and floor-level recirculation circuit.
FOCUS OF REDUCING VALVES	• Pressure reducing valves for each unit, with double stage on the lower floors.
ADVANTAGES	• Local pressure control, inlet pressure at each unit reduced to 300 kPa (3 bar); • Limited pressure to boilers for DHW production and to related components (not subject to the hydrostatic head); • Single plant floor and single distribution risers for cold and hot water; • Balanced floor-level recirculation.
DISADVANTAGES	• Need pressure reducing valves in series at the lower floors; • More devices to maintain and check, in special plant rooms; • Pipes and components suitable for working at high pressure; in some countries pressure must not exceed 1000 kPa (10 bar).

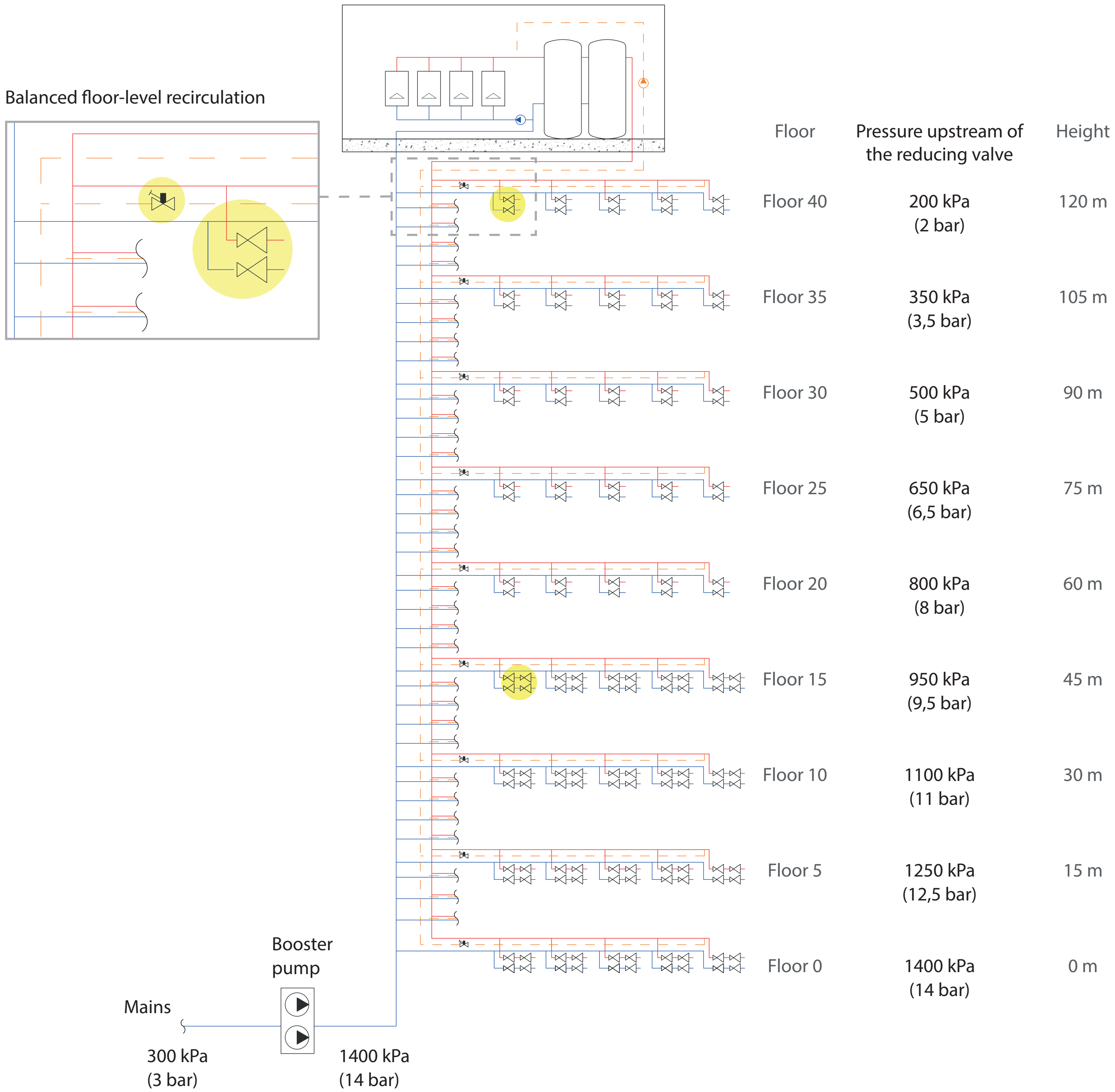
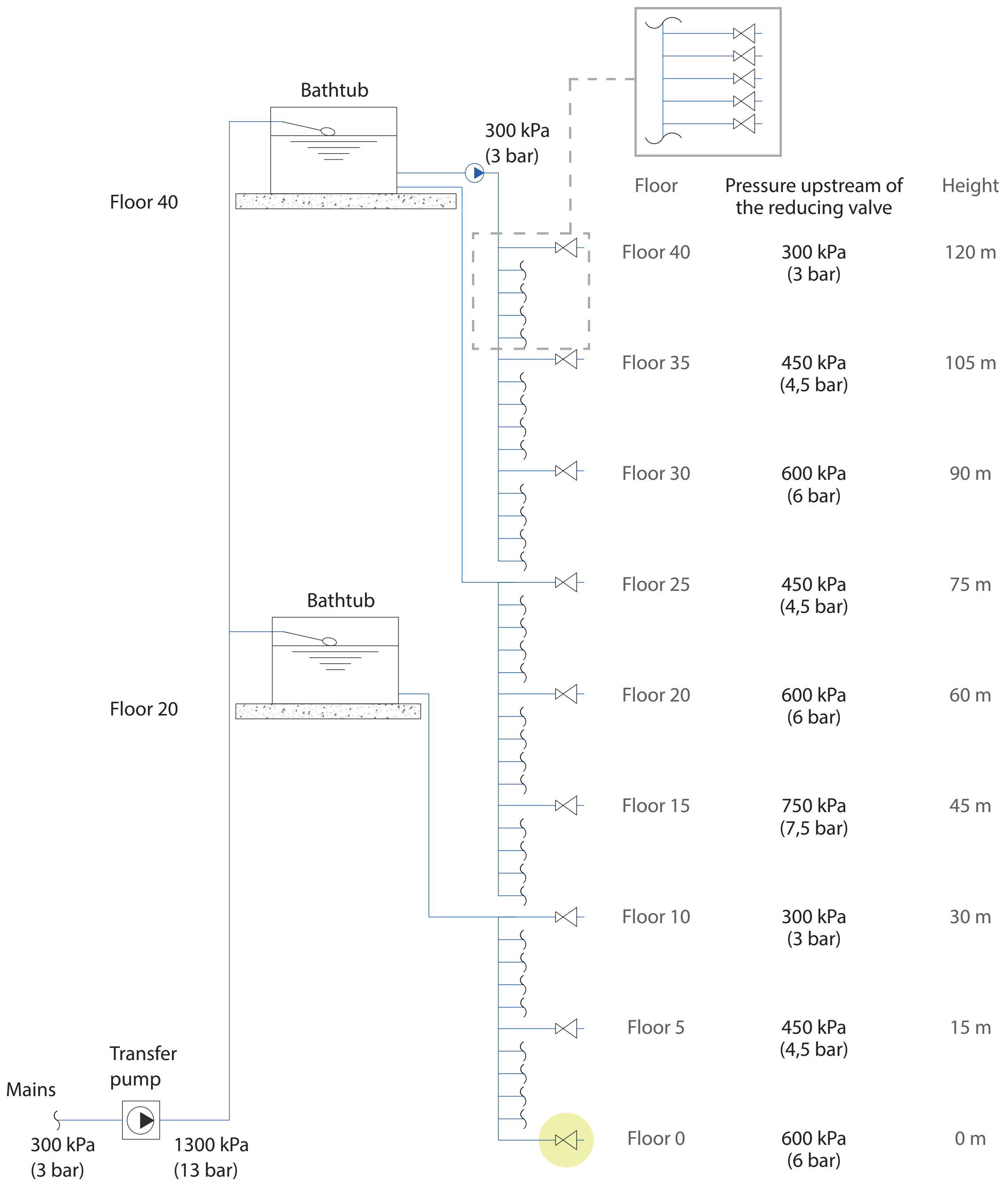


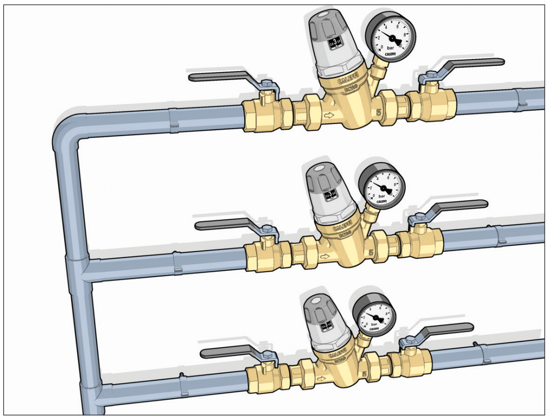
DIAGRAM 9	40-FLOOR BUILDING WITH TANKS AT ATMOSPHERIC PRESSURE
SYSTEM FEATURES	• Intermediate plant floor and on the roof; • Tank at atmospheric pressure with reserve function; • Pressure pump for the top floors; • Transfer pump to fill the tanks with water; • Independent DHW production for each home.
FOCUS OF REDUCING VALVES	• Pressure reducing valves for floor.
ADVANTAGES	• Floor-level pressure control, inlet pressure reduced to 300 kPa (3 bar); • Gravity distribution ensures pressure stability; • Double stage not required as the reduction ratios are within the established limits; • Tanks with reserve function and transfer pump (no need for a high-performance pump).
DISADVANTAGES	• Very high footprint and load, need for dedicated spaces (spaces unavailable for commercial use); • DHW production within each unit, more components and spaces used; • More devices to maintain and check, in special plant rooms.



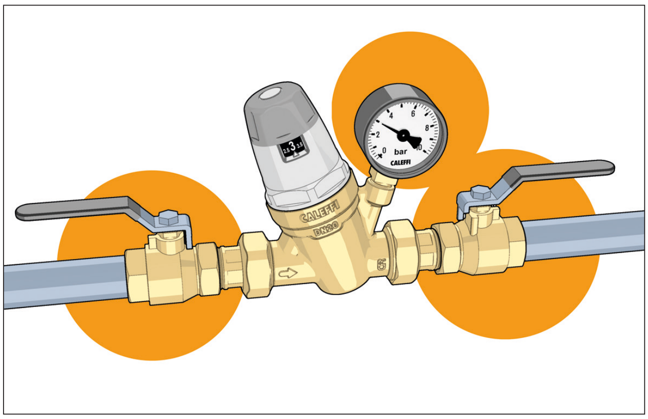
INSTALLATION RECOMMENDATIONS

General information

Accessibility of the pressure reducing valve
To install a pressure reducing valve correctly, it is essential to choose a place that is easily accessible for maintenance and check operations, as well take system-level measures to facilitate such procedures. Moreover, it is not advisable to install these devices in places where cold, frost and weather could damage them.

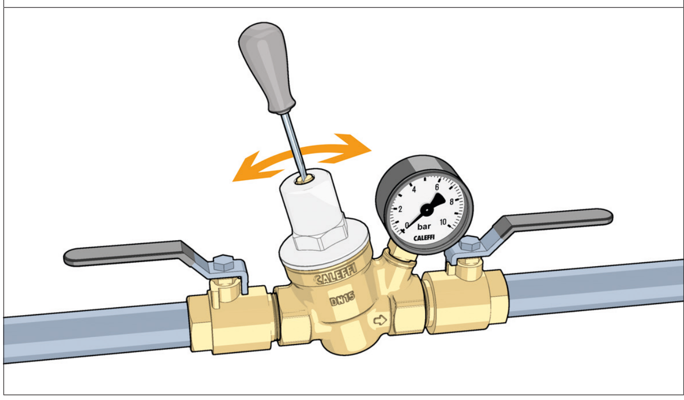
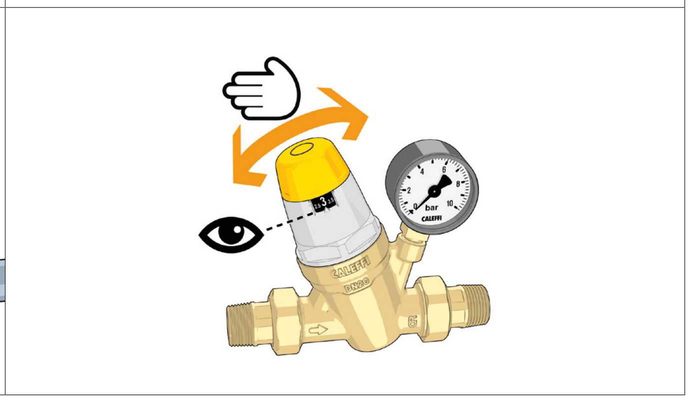


Shut-off valves and pressure gauge
When installing pressure reducing valves, it is important to add shut-off valves to facilitate maintenance and a pressure gauge to check the pressure downstream of the device.
Some models of reducing valves have a pressure gauge connection, while others have them fitted as standard.

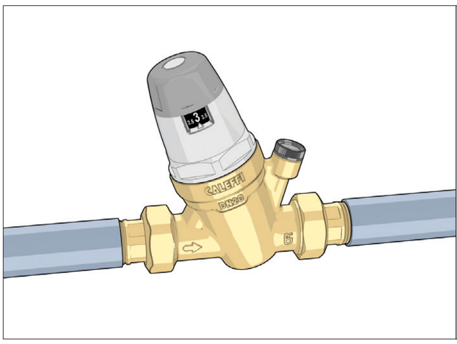
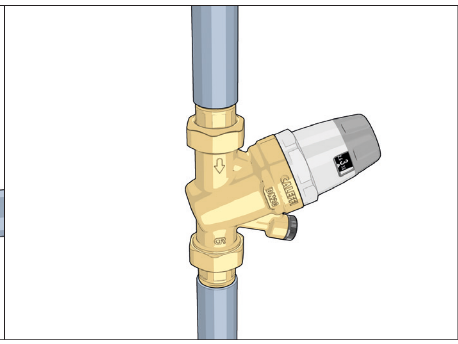
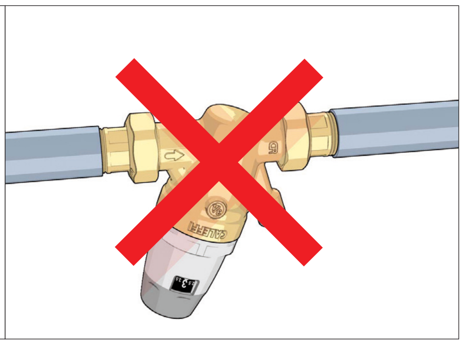


Setting the pressure reducing valve
Pressure reducing valve setting after closing the downstream draw-off points. The pressure must always be checked with the pressure gauge to verify the setting.

The pressure reducing valve can be:

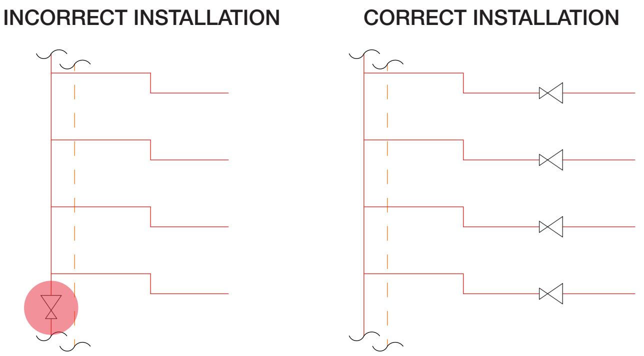
Adjustable This must be set after it has been installed in the system. Turn the spring locking nut with a spanner or screwdriver; turning it clockwise increases the setting, or counter-clockwise decreases it.	**Presettable** This can be preset with a knob that has an indicator to show the setting. To increase the setting, just turn the knob clockwise. After installation, the system pressure will automatically adjust itself to the set value.
	

Location of the pressure reducing valve
The pressure reducing valve may be installed with either vertical or horizontal pipes. However, to avoid dirt build-up problems and consequent obturator malfunction, it must not be upside down.

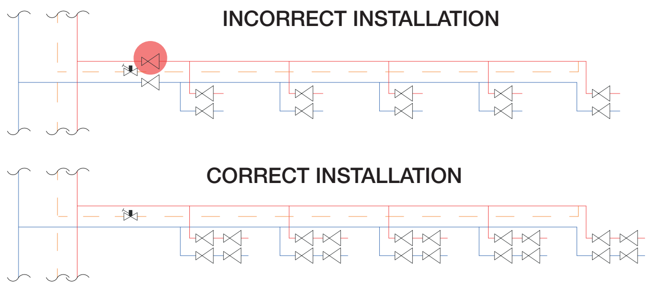




Installation when there is a recirculation circuit

In medium-large systems that require a hot water recirculation network, the pressure reducing valve locations must be carefully assessed.
The pressure reducing valves must not be installed on sections of the network in which hot water recirculates. The operating mechanism of the pressure reducing valve prevents it from being installed in this way because, when all the draw-off taps are closed, the downstream pressure is equal to the hydrostatic pressure at the installation point, so the obturator moves to the closed position, thus stopping the recirculation.
The pressure reducing valves must therefore be installed outside the recirculation network.

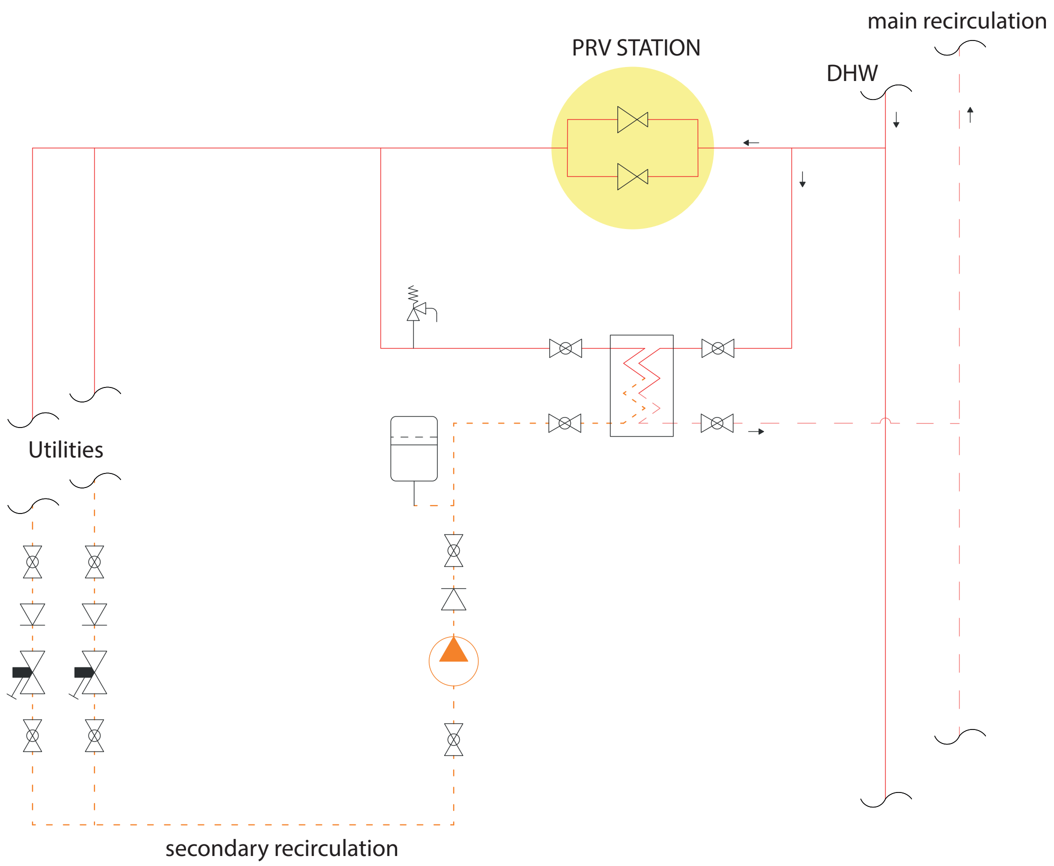


Floor-level recirculation with pressure reducing valves in series
When recirculation is closed at the floor level, a typical error is to insert the first stage pressure reducing valve at the start of the distribution line. The pressure reducing valve on the hot water line is in the recirculation circuit and cannot operate. For this reason, the first and second stage pressure reducing valves must be inserted outside the recirculation circuit, at the inlets to the individual units.



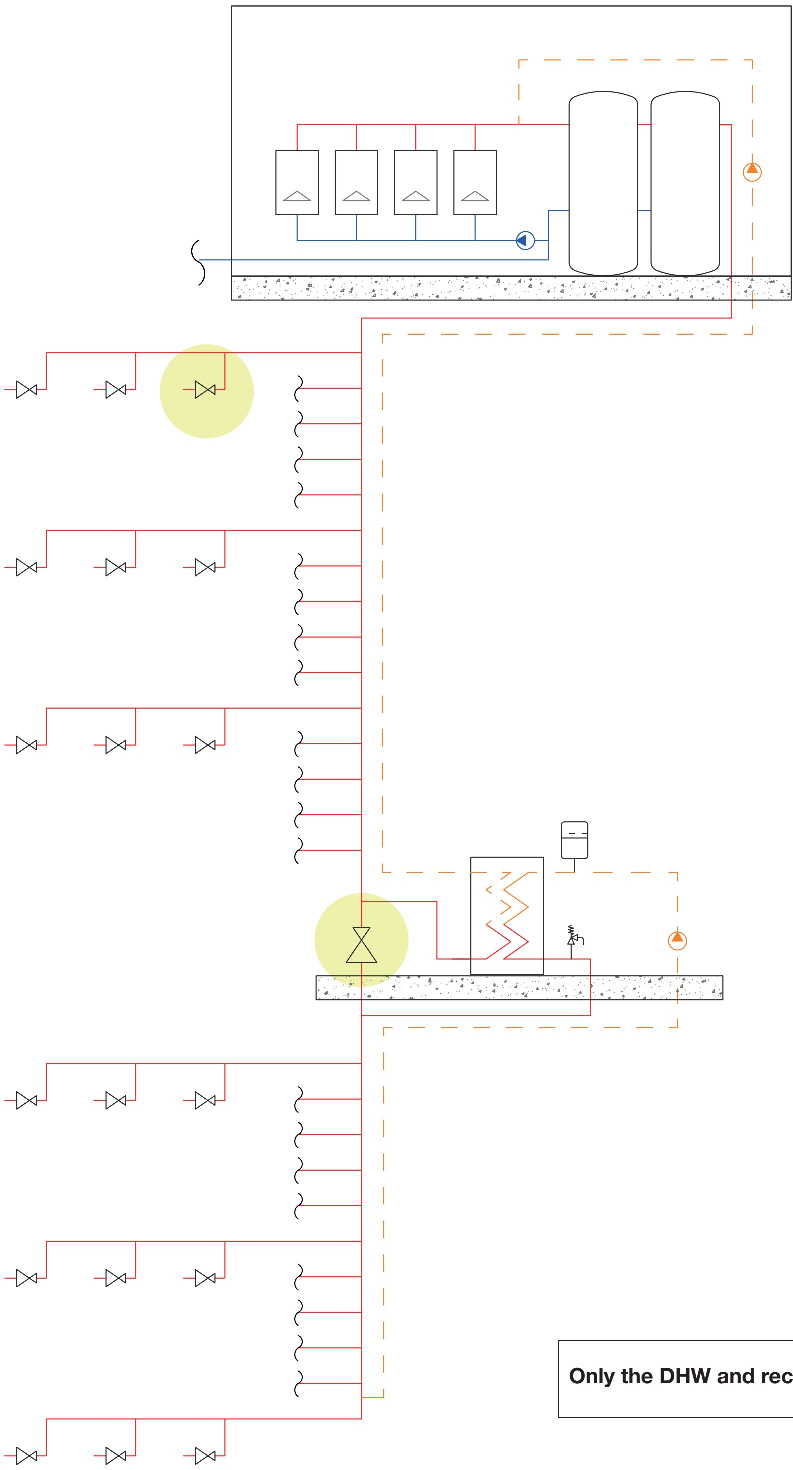
Installation with heat exchanger and recirculation circuit
A system solution that allows the use of pressure reducing valves even when there is a recirculation circuit consists of installing a plate heat exchanger. The secondary recirculation system is kept at temperature by a heat exchanger with hot water from the generator/storage circulating in its primary.
Once the water in the primary circuit has passed through the heat exchanger, it then returns to the central heating system to be heated. This system solution consists of a main high-pressure recirculation network and a secondary low-pressure recirculation network.

The secondary circuit is controlled by a pressure reducing station, which can consist of several pressure reducing valves in a by-pass or series configuration. The secondary network has a dedicated pump, an expansion vessel and all the safety and protection devices.



This solution provides hot water at the correct pressure on the secondary circuit, without having to install a pressure reducing valve for each utility outside the recirculation circuit. The pressure is controlled by means of the pressure reducing valves at the inlet to the secondary circuit (PRV station), so that there is no need to keep the entire distribution network at high pressures up to the utilities. This is a useful solution for high buildings where there is a considerable hydrostatic pressure. The PRV station controls the pressure during operation with supply and without supply alike.

	BUILDING WITH INTERMEDIATE HEAT EXCHANGER FOR THE RECIRCULATION CIRCUIT
SYSTEM FEATURES	• Intermediate plant floor and on the roof; • Cascaded DHW generators at a pressure of about 200 kPa (2 bar); • Intermediate heat exchanger for recirculation at the lower floors.
FOCUS OF REDUCING VALVES	• Pressure reducing valve per single unit; • Pressure reducing valve on the main riser.
ADVANTAGES	• Local pressure control; • Pressure reducing valve on the main riser as a first reduction stage for the lower floors; • Fewer pressure reducing valves installed because there is no need to install pressure reducing valves in series at the inlet of each unit.
DISADVANTAGES	• Intermediate plant room for the heat exchanger and related distribution and safety components; • Need for dedicated spaces (spaces unavailable for commercial use).



Only the DHW and recirculation is shown for simplicity

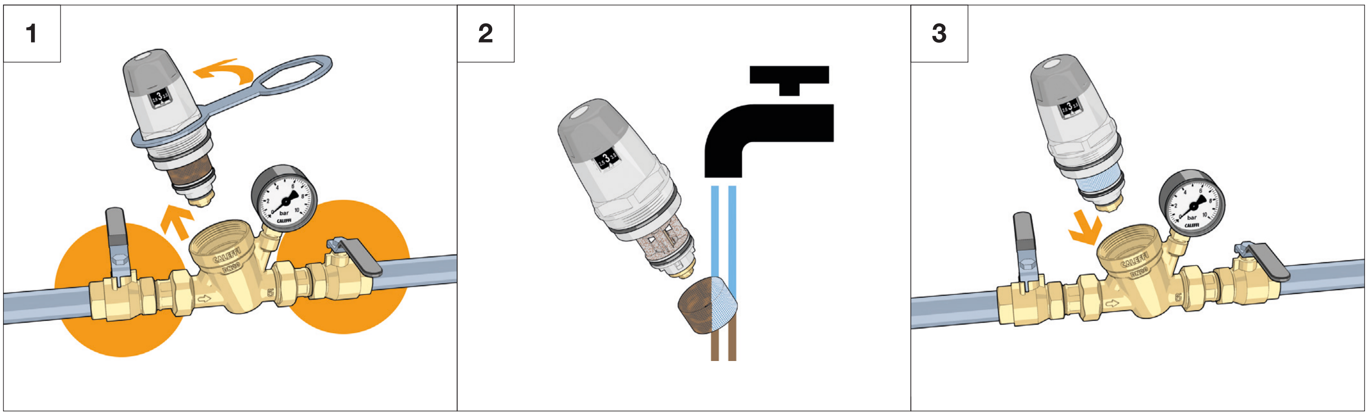
MAINTENANCE

General rules

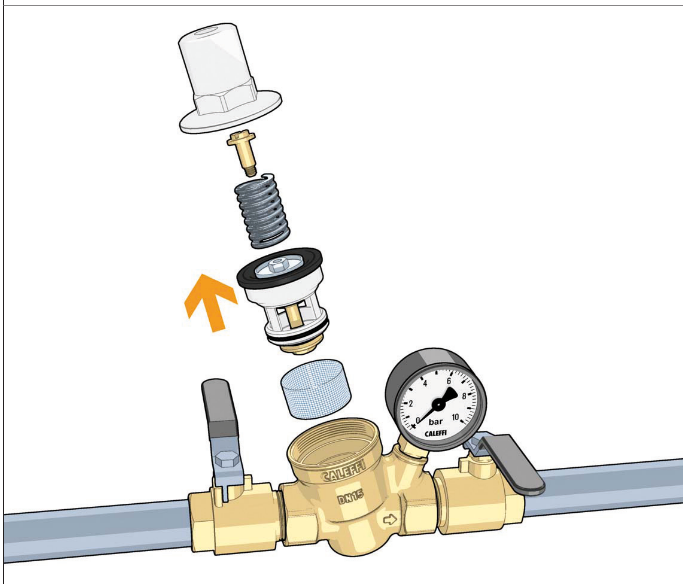
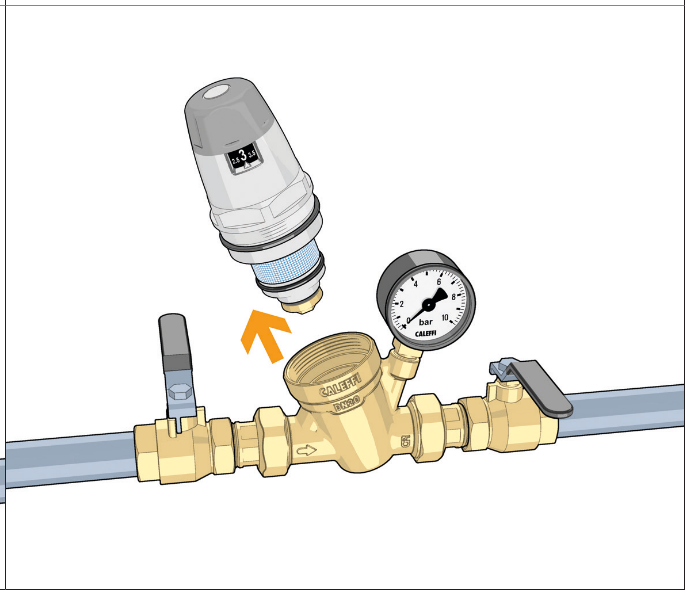
The checking and maintenance of pressure reducing valves must be carried out in accordance with specific national technical standards and with the instructions provided by device manufacturers.

Check frequency
The technical regulations prescribe system-level measures to be considered during design in order to facilitate access to the appliances and maintenance operations thereon.
Information is provided on inspection and maintenance frequencies for the various components in potable water systems. Maintenance and inspection operations must be carried out once a year for pressure reducing valves (in accordance with EN 806-5).
Each country and intended use may have different requirements in terms of inspection and maintenance frequency and methods.

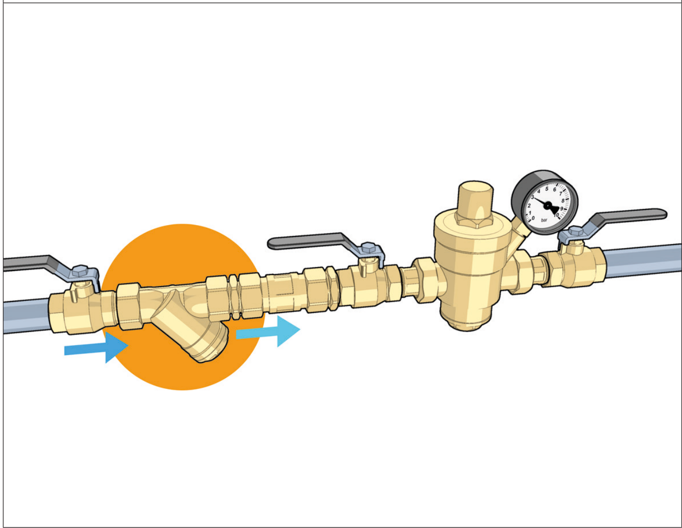
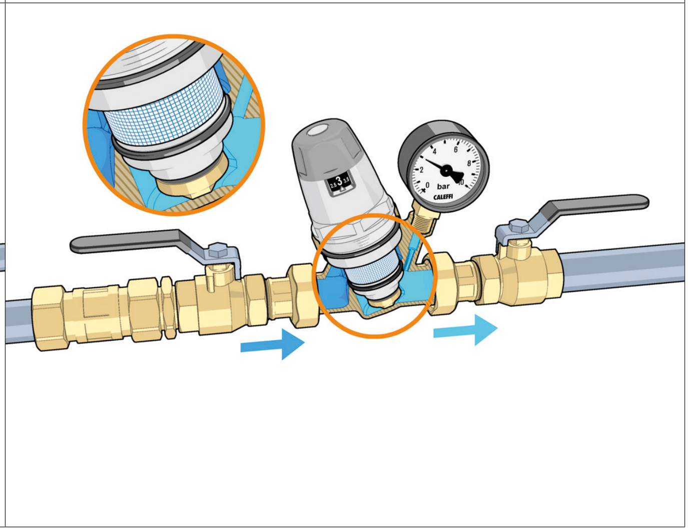
Maintenance operations
The following steps are necessary for the cleaning, inspection and replacement of the entire cartridge:
1. Shut off the pressure reducing valve and remove the cartridge;
2. Clean the strainer and check the condition of the cartridge;
3. Reassemble everything and put it back into operation.



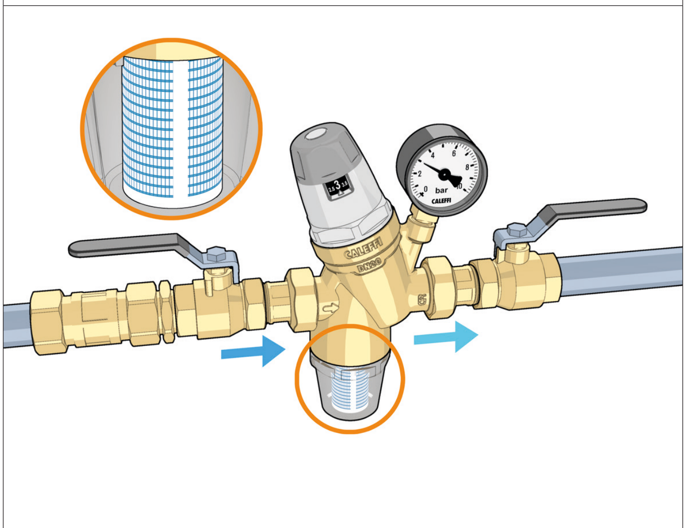
Cartridges and strainers

Conventional cartridge	Self-contained cartridge
The internal cartridges in pressure reducing valves can be removed for regular cleaning and maintenance. When removing the cartridge, be careful of the individual parts that are pulled out.	The cartridge containing the diaphragm, strainer, seat, obturator and compensation piston is a pre-assembled self-contained unit with a cover, and can be removed to facilitate inspection and maintenance operations.
	

A strainer must always be installed to protect the pressure reducing valve. There are several configurations:

Inspectable strainer upstream	**Strainer built into the cartridge**
	

In systems with a high impurity content, it is advisable to install an inspectable strainer upstream of the pressure reducing valve, even if it already has a built-in strainer, in order to perform double filtration.

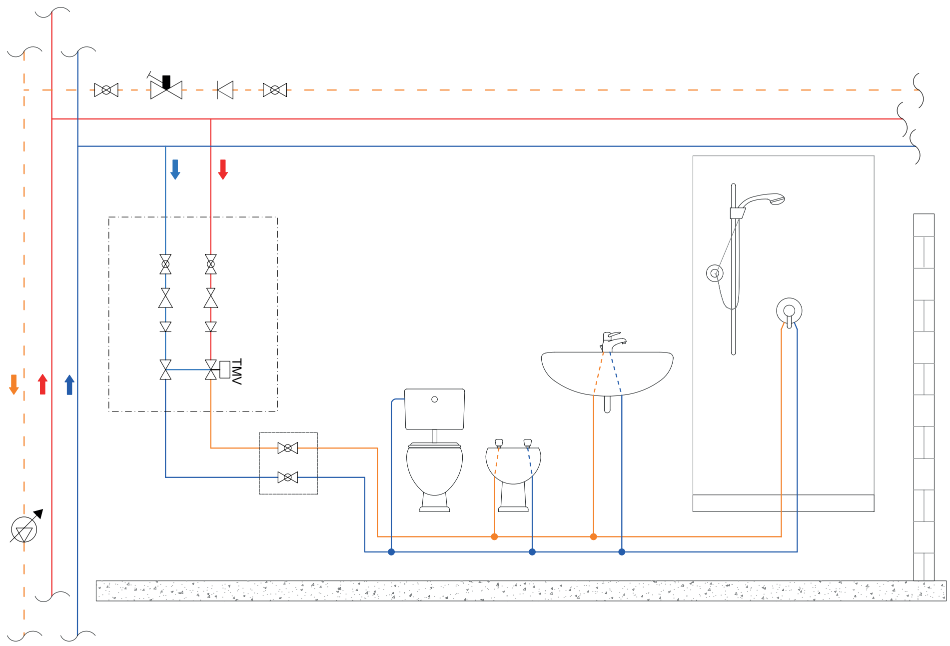
Inspectable strainer built into the body


Some pressure reducing valve models are fitted with a high-capacity inspectable strainer, located in a special transparent container. In this way, the pressure reducing valve is a single compact component with protection against impurities that could compromise its operation.

The strainers must undergo periodic maintenance, be installed in an inspectable location and allow quick access for cleaning and replacement.

PRESSURE CONTROL AND COMBINATION WITH OTHER COMPONENTS

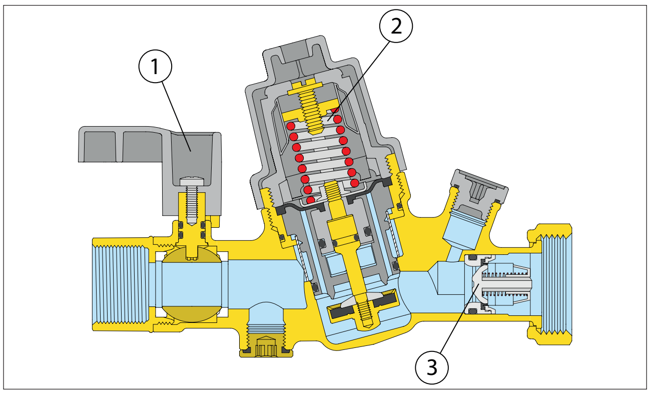
Compact kits have been developed to control the pressure at the inlets of individual property units, hotel rooms or hospital rooms. They combine different functions, reduce space and facilitate component installation and maintenance.



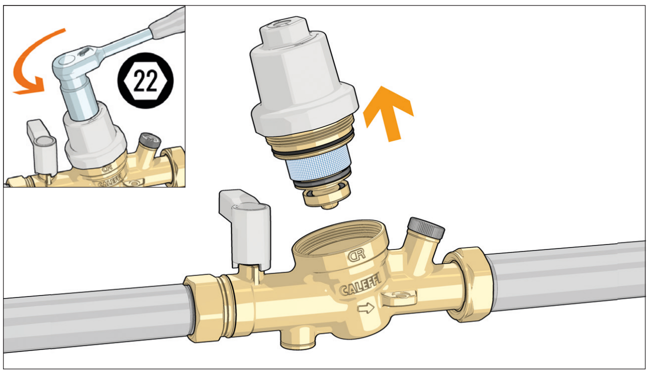
Combined unit for pressure control in domestic water systems
The combined pressure control unit for domestic water systems unites three different devices in a single component:

1. Ball shut-off valve;
2. Pressure reducing valve with strainer;
3. EA type anti-pollution check valve.

Installed on the hot or cold water distribution pipes in domestic water systems, it reduces the mains water inlet pressure, prevents water backflow into the mains and allows utilities to be shut off during testing and maintenance operations.
The check valve in the combined unit serves as water protection and is required in some States (refer to the national regulations on backflow prevention devices).

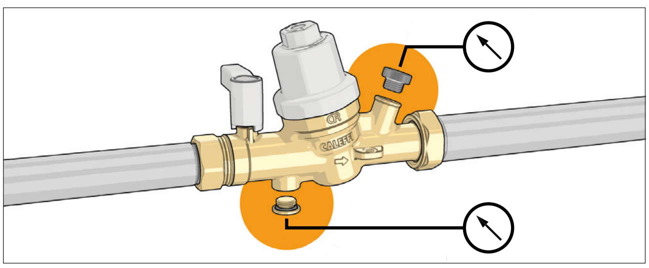


Removable self-contained cartridge
The pressure reducing valve cartridge is a pre-assembled self-contained unit with a cover. It is easy to remove, simplifying inspection and maintenance procedures. The internal strainer is part of the cartridge and cannot be removed.

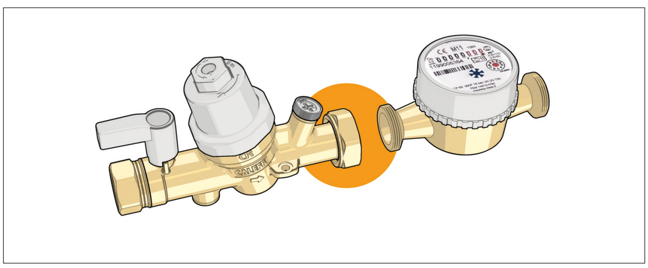


Compact design and versatility
The assembly is designed to be compact, in order to make hydraulic installation easier where space is limited. As it consists of a single body, it limits the number of connections and installation time required.

Pressure test ports
The unit has an upstream pressure test port which can be used for pressure control at the inlet. It is also fitted with a downstream pressure test port for installation of a pressure gauge or inspection of the check valve.

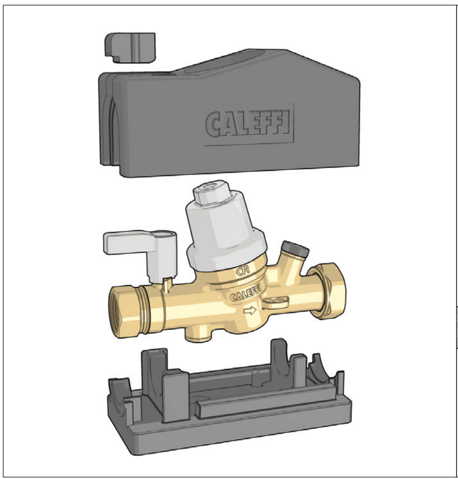


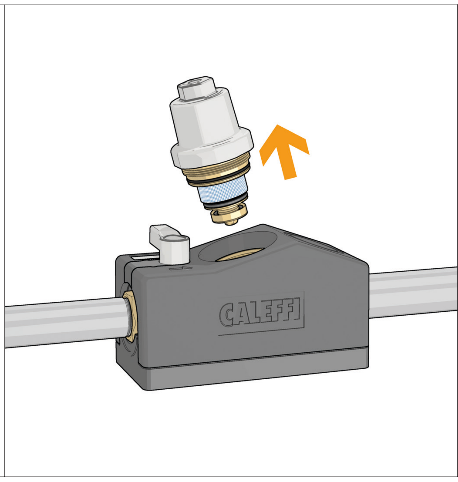
Component connection
The unit is constructed to make installing a water meter and other downstream equipment easier.

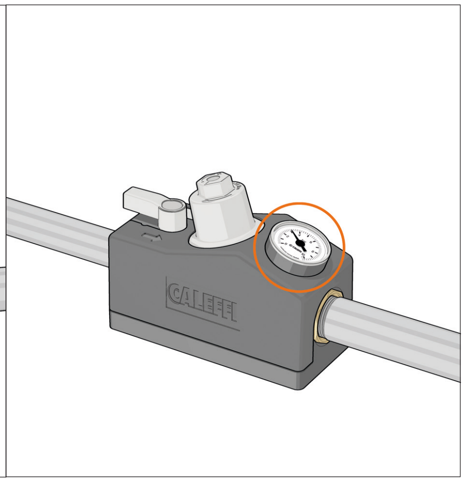


Insulation

The combined unit can be provided with insulation sized to limit heat loss, especially when used on the domestic hot water line. The unit allows insulation to be applied without having to remove the lever. It is also designed for installation of a pressure gauge in the dedicated housing.
The cartridge can be taken out without the need to remove the insulation.

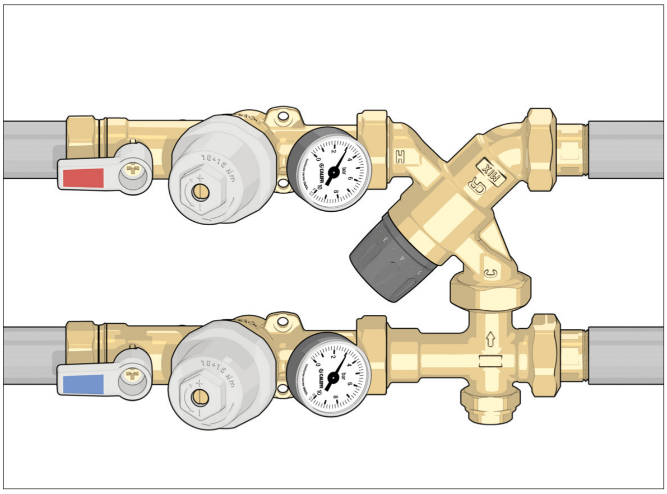




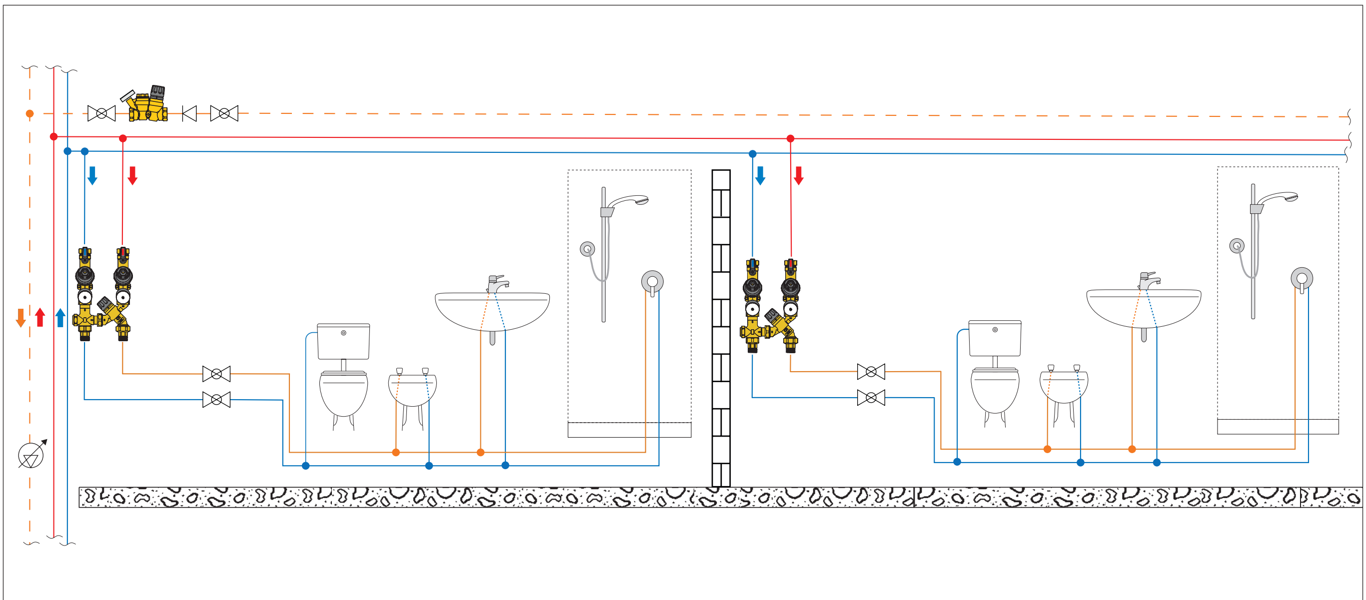


Combined unit for pressure and temperature control in domestic water systems

The combined pressure control unit can be coupled with a thermostatic mixing valve using the appropriate connection tee.
To ensure full pressure and temperature control at the inlet to a property unit, hotel room or hospital room, two combined pressure control units can be installed followed by a mixing valve.
Its compact size and ease of installation make it the ideal solution for all applications that require local temperature and pressure control. It offers the great benefit of being easily installed and maintained, and is suitable for a range of installation types.



Installation in individual bathrooms and floor-level recirculation



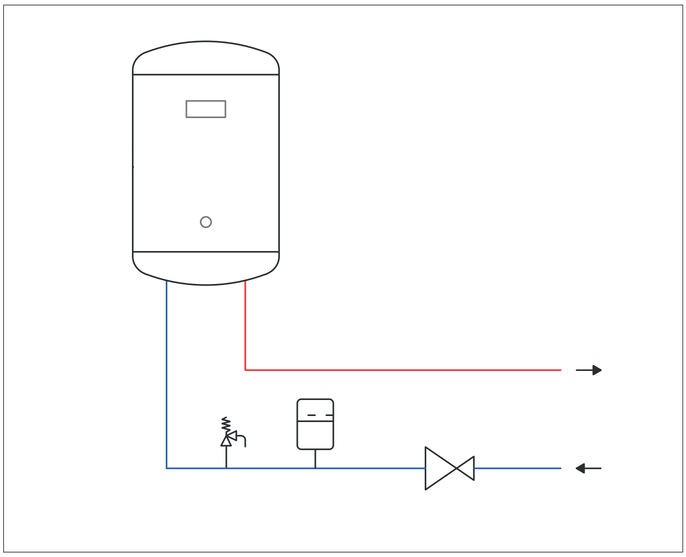
TROUBLESHOOTING

Some typical malfunctions may occur in a system equipped with pressure reducing valves.
Certain types of fault are often attributed to pressure reducing valves, but are actually due to a lack of certain system-level measures. This can compromise normal pressure reducing valve operation, or even damage it irreversibly, causing further problems to the whole system.

Pressure rise downstream of the reducing valve

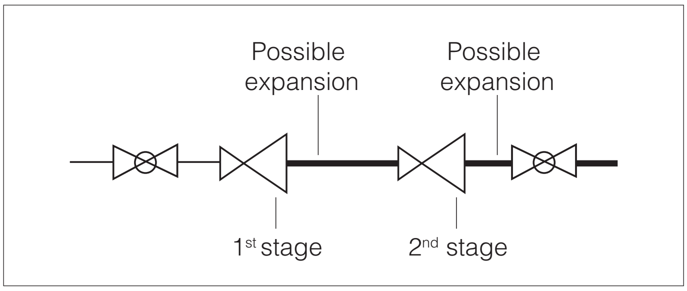
Overheating of the water downstream of the pressure reducing valve causes a pressure increase. There is no pressure relief because the reducing valve is correctly closed.
This condition can be recognised when the downstream pressure exceeds the setting pressure. Sometimes the values reached may be higher than the upstream pressure.

The solution consists of installing an expansion vessel (between the pressure reducing valve and the storage) or another device, such as an expansion valve, to absorb the increase in downstream pressure.
Without this system-level measure, the pressure reducing valve could be damaged if the pressures reach high values, compromising the diaphragm and therefore device operation.



To limit the pressure increase due to thermal expansion in particularly large systems, it is advisable to limit the length of the pipes downstream of the pressure reducing valves.
For series pressure reducing valves, the length of the pipes between the first and second stages must also be limited as much as possible in order to reduce the expansion.

Thermal expansion and overpressure can be amplified if the pipes are close to heat sources (nearby hot pipes, hot environments, heat from direct sunlight).



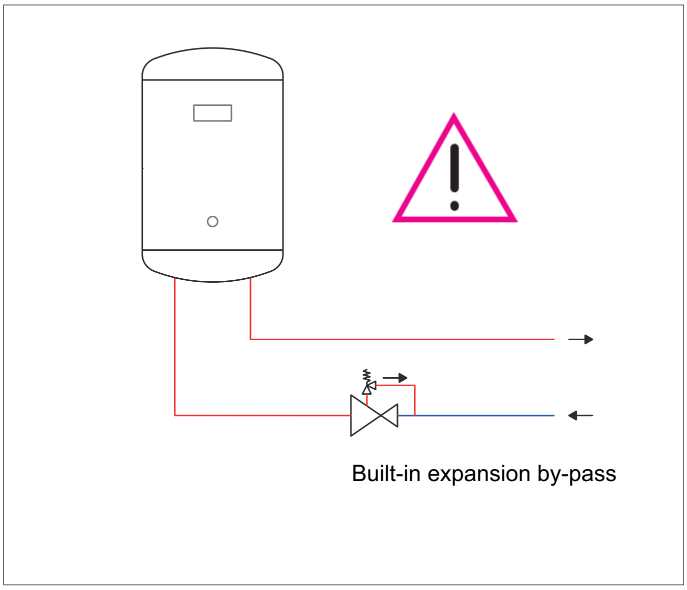
The expansion vessel helps control the system pressure, but is not a safety device.
It is therefore necessary to install safety devices as required in the country of installation, which intervene if the vessel is damaged.

Built-in expansion by-pass device

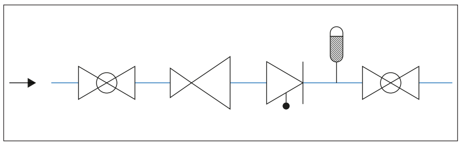
Some manufacturers have developed solutions with an expansion by-pass device built into the pressure reducing valve. This built-in by-pass allows the water to expand from downstream to the upstream main network through an internal device. However, when choosing these components, attention must be paid to the pressure limits imposed by the device manufacturers.

If the by-pass device becomes dirty, the pressure reducing valve can no longer regulate the pressure correctly.
It is not the task of the pressure reducing valve to control/absorb the water expansion in a system. It is advisable to provide devices such as expansion vessels and safety valves to prevent damage to the pressure reducing valve and other system components.

Moreover, in some systems the regulations do not allow the expansion and consequent backflow of water from downstream to upstream. For this reason, the use of these types of products must be assessed carefully.

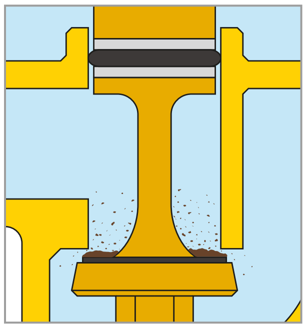


Water hammer



Water hammer is caused by valves opening or closing quickly. It can cause dangerous pressure increases in the system, well above the allowable working pressure, and is one of the main causes of failure in components and pressure reducing valves.
It is best to fit special devices to absorb water hammer when installing pressure reducers in at-risk systems. we recommend installing a check valve when required for correct system operation.

Presence of impurities



Impurities that settle on the seal seat often cause issues in pressure reducing valves related to stabilisation at the setting value due to leakage. This results in the pressure being regulated incorrectly.

The preventive solution is to install a strainer upstream of the reducing valve and then to ensure that the removable cartridge is properly cleaned and maintained.
An upstream strainer can therefore prevent malfunctions that are often wrongly attributed to the pressure reducing valve.

This condition results in the downstream pressure being equal to the upstream pressure since the two zones are connected via the imperfect seal.

Troubleshooting typical problems on pressure reducing valves

PROBLEM	CAUSE	ACTION TO BE TAKEN
The downstream pressure does not remain stable at the setting and tends towards the upstream pressure (creeping)	Impurities on the seal seat leading to leakage.	Install a strainer upstream of the pressure reducing valve. Carry out maintenance on the cartridge and clean it.
The downstream pressure increases above the setting	Water overheating inside the pipes due to hot water storage, especially when not in use for long periods.	Install an expansion vessel between the pressure reducing valve and the hot water storage.
Recirculation circuit malfunction	Pressure reducing valve installed incorrectly.	Move the pressure reducing valve out of the recirculation circuit.
Water leakage from the cover	Broken diaphragm.	System-level measures to manage possible water hammer and sudden pressure increases. If necessary, use a piston pressure reducing valve, which is more robust than the diaphragm type.
Noise and vibration	Incorrect sizing or cavitation.	Replace the pressure reducing valve with one of a different size. Install pressure reducing valves in series or in parallel.
Pressure between cold and hot domestic water differs too much at the point of use and the mixed water temperature is unstable.	Pressure between cold and hot water is unbalanced.	Check the location, setting and installation of the pressure reducing valves. Adjust the system accordingly. Install thermostatic mixing valves.

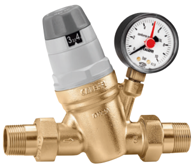
CALEFFI PRODUCTS

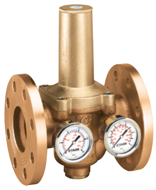
Type	INCLINED BODY				MICRO PRESSURE REDUCING VALVE
Series	5330	5332	5331	5334	533..H
					
Body	Brass EN 12165 CW617N, chrome plated				Dezincification resistant alloy CR EN 12165 CW724R LOW LEAD
Strainer cartridge	Removable				
Upstream Pmax	1600 kPa (16 bar)				
Adjustment range	100–600 kPa (1–6 bar)				80–400 kPa (0.8–4 bar)
Working Tmax	40 °C				80 °C
Sizes and maximum recommended flow rates	DN 15 (*1/2”*) 0,3 l/s DN 20 (*3/4”*) 0,36 l/s		DN 15 (*3/4” M x 3/4” nut*) 0,3 l/s	DN 15 (*1/2”*) 0,3 l/s DN 20 (*3/4”*) 0,36 l/s DN 20 (*1”*) 0,36 l/s	DN 8 (*3/8”*) 0,1 l/s
Certification	ACS				ACS, SVGW, DVGW, WRAS, KIWA, KIWA REG4
Typical utilities	Small utilities Hotel room Small property unit				Coffee machines, water and beverage dispensers

Type	INCLINED BODY			
Series	5336	5337	5338	5335 AUS
				
Body	Dezincification resistant alloy CR EN 12165 CW602N, chrome plated			Dezincification-resistant alloy CR EN 12165 CW602N
Strainer cartridge	Removable			
Upstream Pmax	1600 kPa (16 bar)			
Adjustment range	100–600 kPa (1–6 bar)			
Working Tmax	40 °C			
Sizes and maximum recommended flow rates	DN 15 (*Ø 15*) 0,3 l/s DN 20 (*Ø 22*) 0,36 l/s			DN 15 (*1/2”*) 0,3 l/s DN 20 (*3/4”*) 0,36 l/s
Certification	WRAS, KIWA REG4			WATERMARK
Typical utilities	Small utilities Hotel room Small property unit			

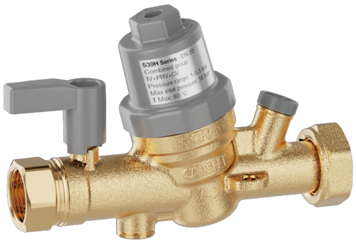
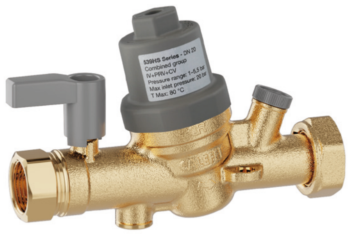
Type	INCLINED BODY for high temperatures			
Series	5330 H	5332 H	5334 H	5331 H
				
Body	Brass EN 12165 CW617N, chrome plated	Brass EN 12165 CW617N, chrome plated LTC Version Dezincification resistant alloy CR EN 12165 CW602N, chrome plated		Dezincification resistant alloy CR EN 12165 CW602N
Strainer cartridge	Removable			
Upstream Pmax	1600 kPa (16 bar)			
Adjustment range	100–550 kPa (1–5,5 bar)			
Working Tmax	80 °C			
Sizes and maximum recommended flow rates	DN 15 (*1/2”*) 0,36 l/s DN 20 (*3/4”*) 0,5 l/s		DN 15 (*1/2”*) 0,36 l/s DN 20 (*3/4”*) 0,5 l/s DN 20 (*1”*) 0,58 l/s	DN 20 (*Ø 22 for 3/4” nut*) 0,5 l/s
Certification	ACS, DVGW, SVGW, KIWA	ACS, DVGW, SVGW, KIWA, (LTC version) WRAS, KIWA REG4		WRAS, KIWA REG4
Typical utilities	Small utilities Hotel room Small property unit			

Type	INCLINED BODY for high temperatures				
Series	5336 H	5337 H	5338 H	5335 H AUS	5335 HS AUS
					
Body	Dezincification resistant alloy CR EN 12165 CW602N, chrome plated			Dezincification resistant alloy CR EN 12165 CW602N	
Strainer cartridge	Removable				Piston type, removable
Upstream Pmax	1600 kPa (16 bar)			2000 kPa (20 bar)	
Adjustment range	100–550 kPa (1–5,5 bar)			100–600 kPa (1–6 bar)	
Working Tmax	80 °C				
Sizes and maximum recommended flow rates	DN 15 (*Ø 15*) 0,36 l/s DN 20 (*Ø 22*) 0,5 l/s	DN 15 (*Ø 15*) 0,36 l/s DN 20 (*Ø 22*) 0,5 l/s DN 20 (*Ø 28*) 0,58 l/s		DN 15 (*1/2”*) 0,36 l/s DN 20 (*3/4”*) 0,5 l/s DN 25 (*1”*) 0,58 l/s	DN 15 (*1/2”*) 0,36 l/s DN 20 (*3/4”*) 0,5 l/s
Certification	WRAS, KIWA REG4			WATERMARK	
Typical utilities	Small utilities Hotel room Small property unit				High-rise buildings

Type	WITH PRESET			WITH PRESET for high temperatures	
Series	5350	5350	5351	5350..H	5350..H AUS
					
Body	Dezincification resistant alloy CR EN 1982 CC770S	Dezincification resistant alloy CR EN 12165 CW602N	Brass EN 12165 CW617N	Dezincification resistant alloy CR EN 1982 CC768S LOW LEAD	
Strainer cartridge	Removable self-contained		Removable self-contained, strainer in transparent container	Removable self-contained	
Upstream Pmax	2500 kPa (25 bar)			2500 kPa (static) (25 bar) 1600 kPa (working) (16 bar)	2000 kPa (20 bar)
Adjustment range	100–600 kPa (1–6 bar)				
Working Tmax	40 °C			80 °C	
Sizes and maximum recommended flow rates	DN 15 (*1/2"*) 0,5 l/s DN 20 (*3/4"*) 0,66 l/s DN 25 (*1"*) 0,83 l/s DN 32 (*1 1/4"*) 2 l/s DN 40 (*1 1/2"*) 2,66 l/s DN 50 (*2"*) 2,83 l/s	DN 20 (*Ø 22*) 0,66 l/s	DN 15 (*1/2"*) 0,41 l/s DN 20 (*3/4"*) 0,58 l/s DN 25 (*1"*) 0,83 l/s	DN 15 (*1/2"*) - DN 15 (*Ø 15*) 0,5 l/s DN 20 (*3/4"*) - DN 20 (*Ø 22*) 0,83 l/s DN 25 (*1"*) - DN 25 (*Ø 28*) 1,16 l/s DN 32 (*1 1/4"*) 2,16 l/s DN 40 (*1 1/2"*) 3 l/s DN 50 (*2"*) 3,83 l/s	DN 15 (*1/2"*) 0,5 l/s DN 20 (*3/4"*) 0,83 l/s DN 25 (*1"*) 1,16 l/s DN 32 (*1 1/4"*) 2,16 l/s DN 40 (*1 1/2"*) 3 l/s DN 50 (*2"*) 3,83 l/s
Certification	DVGW, ACS, SVGW, WRAS, KIWA REG4	WRAS, KIWA REG4	DVGW, ACS, SVGW,	WRAS, ACS, DVGW, SVGW, KIWA, SINTEF, KIWA REG4	WATERMARK
Typical utilities	Medium utilities				

Type	STRAIGHT BODY for high temperatures					FIRST STAGE for high temperatures
Series	539	5360 (5360.1/0)	5362 (5362.1/0)	5365	5366	5360 AUS
						
Body	Dezincification resistant alloy CR EN 1982 CC770S			Bronze EN 1982 CB499K		Dezincification resistant alloy CR EN 1982 CC770S
Strainer cartridge	Removable					Piston type, removable
Upstream Pmax	2500 kPa (25 bar)				1600 kPa (16 bar)	2500 kPa (25 bar)
Adjustment range	100–550 kPa (1–5,5 bar)	50–600 kPa (0,5–6 bar)				600–1000 kPa (6–10 bar)
Working Tmax	80 °C					
Sizes and maximum recommended flow rates	DN 20 (*3/4"*) 0,83 l/s	DN 15 (*1/2"*) 0,36 l/s DN 20 (*3/4"*) 0,75 l/s DN 25 (*1"*) 0,83 l/s DN 32 (*1 1/4"*) 1,5 l/s DN 40 (*1 1/2"*) 2,33 l/s	DN 15 (*1/2"*) 0,36 l/s DN 20 (*3/4"*) 0,75 l/s DN 25 (*1"*) 0,83 l/s	DN 40 (*1 1/2"*) 2,33 l/s DN 50 (*2"*) 3,33 l/s	DN 65 4,41 l/s	DN 15 (*1/2"*) 0,36 l/s DN 20 (*3/4"*) 0,75 l/s DN 25 (*1"*) 0,83 l/s DN 32 (*1 1/4"*) 1,5 l/s DN 40 (*1 1/2"*) 2,33 l/s
Certification	ACS, NF	WRAS, ACS, KIWA REG4				WATERMARK, WRAS, KIWA REG4
Typical utilities	Medium utilities					First stage

Type	PRESSURE REDUCING AND REGULATING VALVES	
	DIRECT ACTING	WITH PILOT CIRCUIT
Series	576	578
		
Body	Cast iron	
Cartridge	Piston	Diaphragm
Strainer	Not present	Y strainer on pilot circuit
Upstream Pmax	1600 kPa (16 bar) 2500 kPa (25 bar) on request 4000 kPa (40 bar) on request	1600 kPa (16 bar) (DN 65 – DN 150, PN 16) (DN 200 – DN 300, PN 10)
Adjustment range	200–1400 kPa (2–14 bar)	200–1400 kPa (2–14 bar)
Working Tmax	60 °C	65 °C
Sizes and maximum recommended flow rates	DN 65 5,8 l/s DN 80 9,2 l/s DN 100 14,2 l/s DN 125 21,7 l/s DN 150 31,8 l/s	DN 65 10 l/s DN 80 15 l/s DN 100 28 l/s DN 125 38 l/s DN 150 50 l/s DN 200 110 l/s DN 250 190 l/s DN 300 300 l/s
Certification	ACS	ACS, WRAS
Typical utilities	Large utilities, water distribution networks	

Type	COMBINED UNIT FOR PRESSURE CONTROL	
Series	539 H	539 HS
		
Body	Dezincification resistant alloy CR EN 12165 CW724R LOW LEAD	
Strainer cartridge	Removable self-contained	Self-contained piston type, removable
Upstream Pmax	1600 kPa (16 bar)	2000 kPa (20 bar)
Adjustment range	100–550 kPa (1–5,5 bar)	
Working Tmax	80 °C	
Sizes and maximum recommended flow rates	DN 20 (Rp *3/4" for 1"* nut) 0,41 l/s	
Certification	KIWA REG4, WRAS, ACS	
Typical utilities	Small utilities Hotel room Small property unit	

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