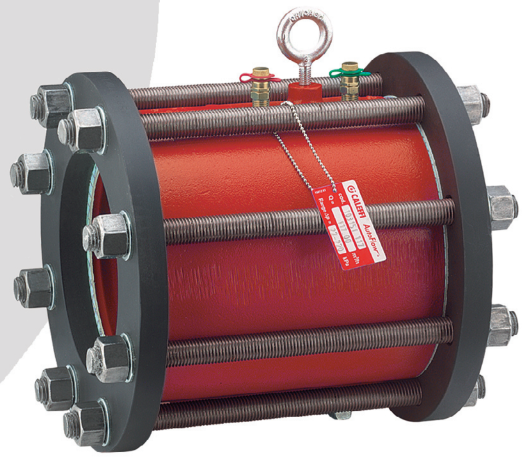
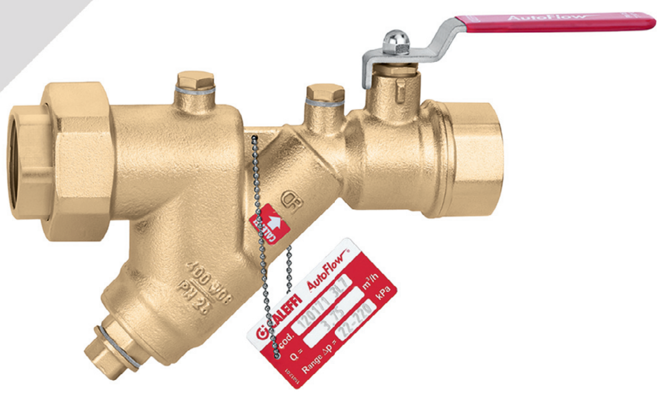
AutoFlow®

dynamic balancing valve





Application Guide

CALEFFI
Hydronic Solutions

altecnic
CALEFFI group

AutoFlow® dynamic balancing valve

System Balancing

The hydronic circuits serving space heating and air conditioning systems must be balanced, meaning that they must be constructed in such a way as to guarantee the design flow rates of the thermal medium are achieved at the terminal units.

The building must be designed and built to ensure the comfort of its occupants.

In addition, the building must be constructed with the aim of achieving fundamental goals including reduced energy demand and environmental protection, with reduced CO_2 emissions.

Controlling the climate of a confined space means creating the necessary conditions to guarantee the thermal comfort of the occupants.

Design

The architect depending upon the size and function of each space/room within the building specifies the temperature requirement for the comfort of the occupants and the type of equipment to be used.

To heat or cool space this can include;

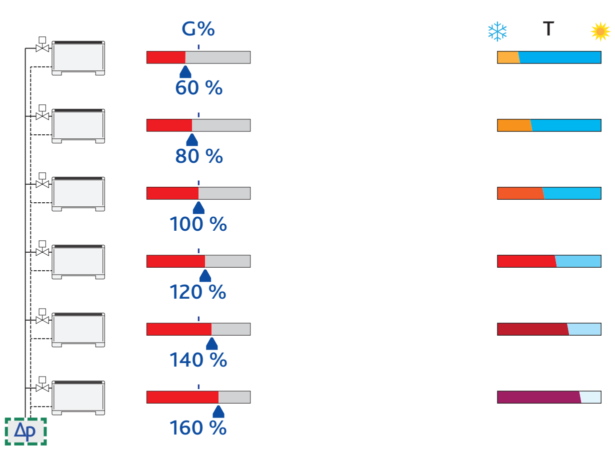
- fancoils
- air handling units
- radiant panels
- chilled beams
- radiators

Static and Dynamic Balancing

Circuits should never be left unbalanced as the characteristics of the system would create problems in distributing the design flow rates to the terminals.

To overcome these problems it is normal practice to fit two types of balancing device:

Unbalanced Circuit



Design Continued

The designer of the mechanical services system uses this information along with established heat loss or gain temperatures, flow and return water temperatures to calculate the water flow requirement to each terminal unit.

The designer also decides if the system will use constant speed or variable speed pumps to move the water around the system. Variable speed pumps are extensively used today in variable volume systems as part of the equipment used to achieve the highest level of efficiency and energy savings.

He will also decide what type and size of control valves will be used to balance the system and where they should be installed.

This guide is intended to cover the progression from constant flow using commissioning sets to variable flow with DPCVs and variable flow using AutoFlow® automatic balancing valves.

- Manual balancing valves - these are conventional valves suitable for use in constant flow rate circuits frequently in conjunction with 3-port regulating valves or downstream of the DPCVs in variable balancing systems.
- Constant flow regulators - modern automatic devices which respond to changes in differential pressure to maintain the design flow rate of the internal flow regulating cartridge.

Water always takes the path of least resistance so with identical circuits the one nearest the pump will receive a much higher percentage of the design flow rate than the one furthest away.

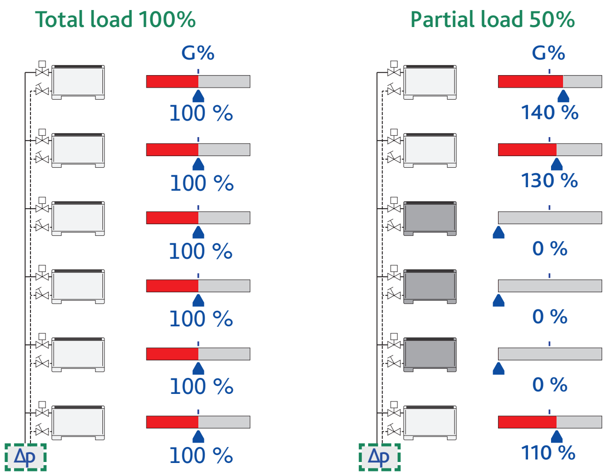
This means the room nearest the pump receiving the most water will be uncomfortably hot whilst the one furthest away will be uncomfortably cool.

If the circuits are identical the differences will be proportional as shown above.

Unbalanced systems have high energy consumption since the total flow rate will be higher than the total of the design flow rates.

Static and Dynamic Balancing Continued

Static Balancing



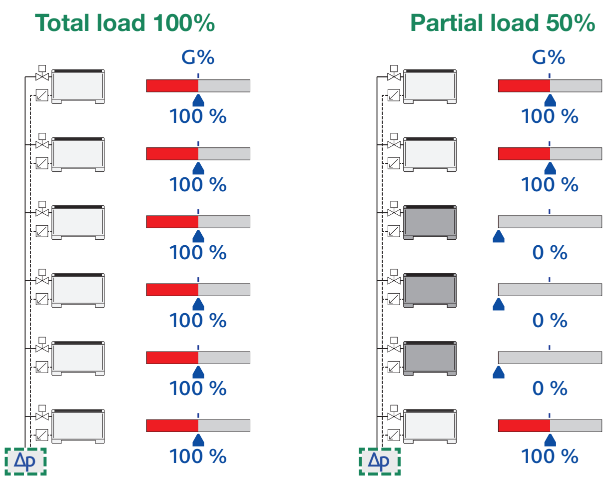
Traditionally, hydraulic circuits are balanced using manual balancing valves.

The system is balanced or commissioned using established procedures by specialised commissioning engineers.

The process is very time consuming as multiple visits to each commissioning valve/double regulating valve are required as each adjustment affects the system as a whole. This dictates multiple visits to the same valve/commissioning set as the engineer moves through the system.

The system is only balanced under one set of conditions and if something changes the system will no longer be balanced

Dynamic Balancing



Dynamic devices balance the hydraulic system automatically, ensuring each terminal receives the design flow rate.

Even in the case of circuit closure by means of the control valve, the flow rates in the open circuits remain constant at the design value.

The system always guarantees the greatest comfort and the highest energy savings.

The commissioning process is also drastically reduced as all that is required is a verification of the correct pressure drop at the dynamic device. No adjustment or rechecking is required.

AutoFlow® Operating Principle

The AutoFlow® automatic balancing valve or constant flow regulator incorporates a flow cartridge which is specifically designed to give a specific flow rate when operating within a speciated differential pressure range.

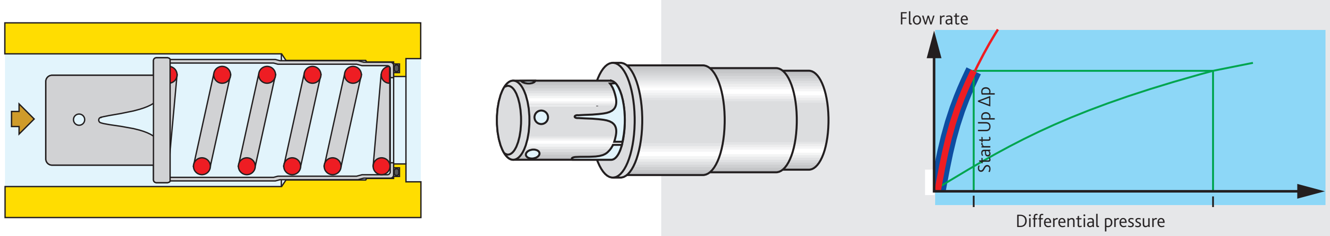
Altecnic are able to offer stainless steel flow cartridges to suit 3 differential pressure ranges, 7 to 100 kPa, 22 to 220 kPa and 35 to 410 kPa and polymer flow cartridges with the differential pressure range 15 to 200 kPa.

The cartridges have 3 distinct differential pressure ranges, prior to start up, the working range and differential pressures above the final pressure.

The differential pressure across the flow cartridge moves a spring loaded piston containing flow ports, the higher the differential pressure the smaller to combined area of the flow ports which continues until the piston cannot retract further into the cartridge body.

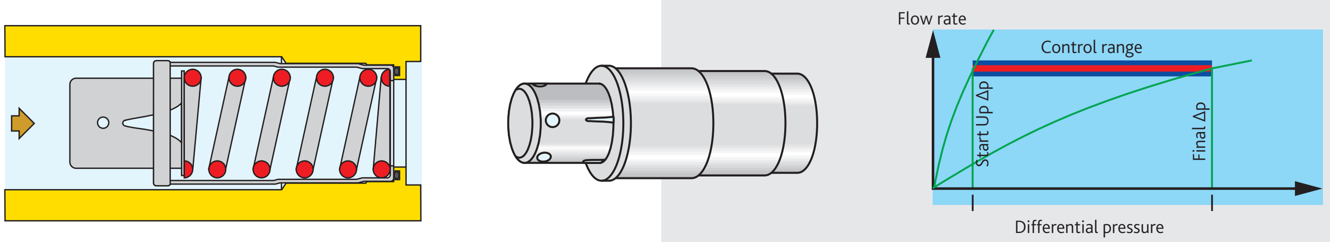
Differential Pressures Below the Operating Range

If the differential pressure is less than start up pressure the flow rate will be lower than the design flow rate of the cartridge since the cartridge acts like a fixed orifice.



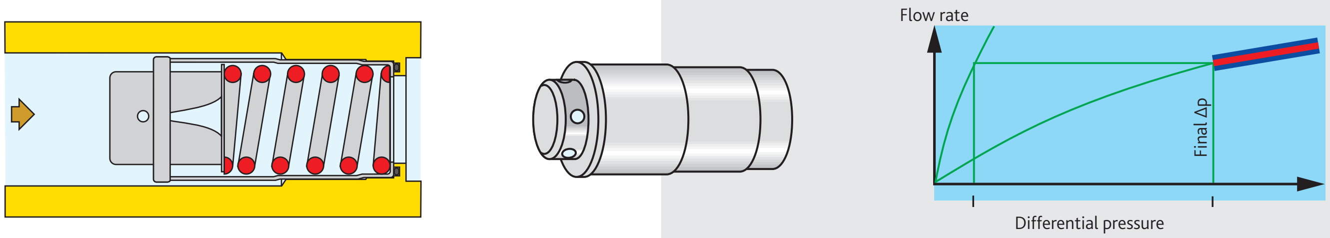
Control Range

If the differential pressure is greater than start up pressure and within the control range, the flow cartridge will control the flow to give the design flow rate of the cartridge within ± 5% accuracy.



Higher than Final Pressure

If the differential pressure exceeds the final pressure the flow rate will be higher than the design flow rate of the cartridge since the cartridge acts like a fixed orifice.



AutoFlow® dynamic balancing valve

Constant Volume System

Constant volume systems, using constant speed pumps were traditional used in building services.

The schematic shows a system using fixed orifice double regulating valves (commissioning set), double regulating valves and 3-port or 4-port regulating valves.

As the name suggests a constant volume of water is always being pumped around the system using a pump set at a fixed speed, the only variation being the pump as it moves along it's characteristic curve.

Periods of maximum demand

For both heating and chilled water systems the requirement for maximum heating or cooling occurs at start up or occasionally under exceptional climatic conditions.

For the majority of the time a reduced heating or cooling output will suffice. During these periods there is a potential to pump less water thereby reducing the energy required.

Diverting the flow

With constant volume systems, when heating or cooling is not required from the fancoil or air handling unit, since the room is at the desired temperature, the 3-port or 4-port valve can only divert the flow down the bypass away from the terminal unit.

Even when used as a mixing valve the same volume of water is being pumped except that it is proportioned between the bypass and the terminal unit.

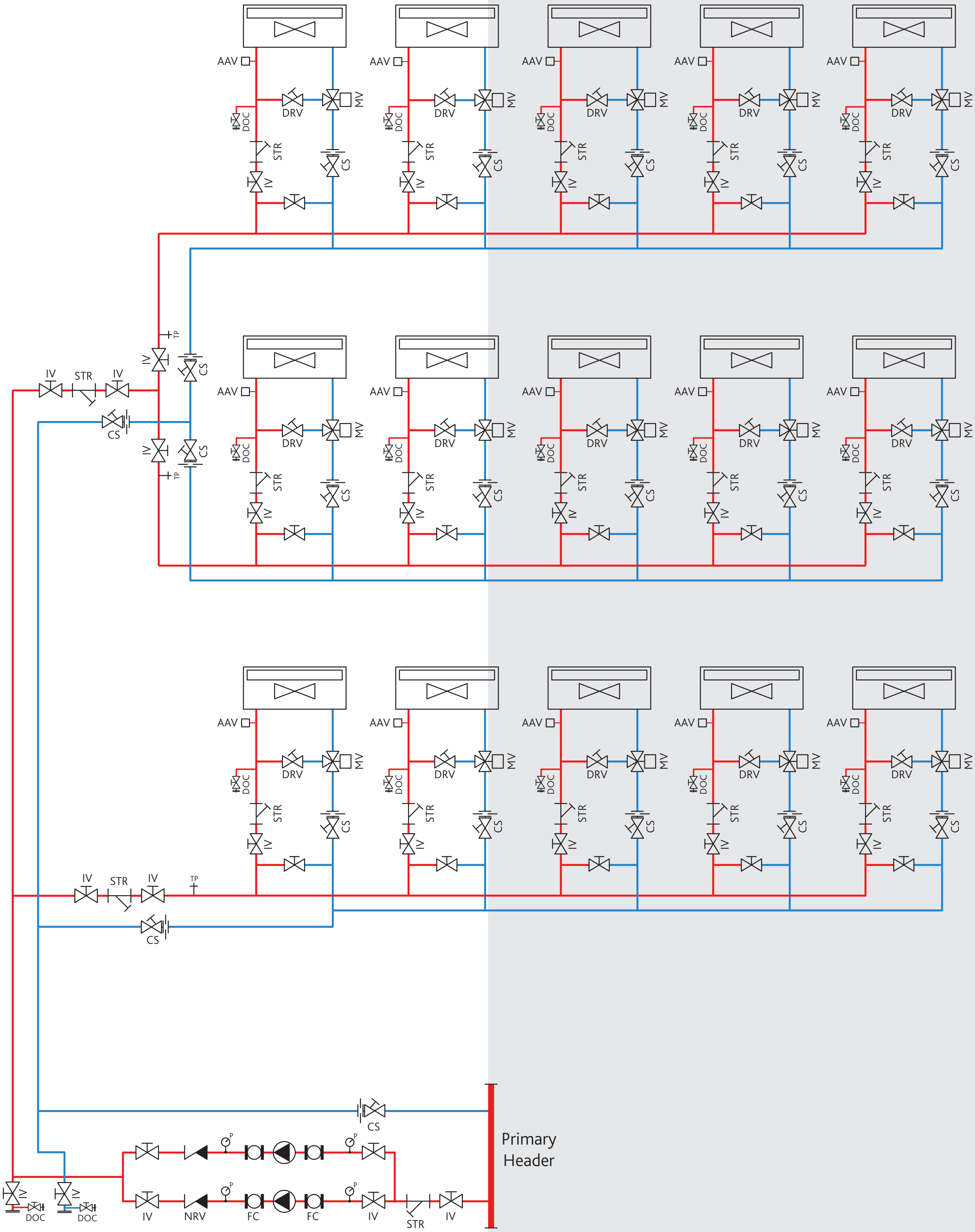
A constant volume system is only in balance when all the circuits are in use passing the design flow rate, straight through to the terminal units or diverted down the bypass

During periods when the 3-port or 4-port valves are changing from one port to the other the resistance through the valve does not remain constant, which can result in overflow and the system being temporarily out of balance.

Disadvantages of constant volume systems

- Not energy efficient due to the pump running at a constant speed, even during periods of low heat or cooling demand.
- Commissioning sets in series between the terminal unit and the pump.
- Double regulating valves required to balance the bypass when 3-port valves are used.
- Commissioning sets must always have at least 5 diameters of straight pipe immediately upstream of the metering station.
- Time consuming commissioning procedure due to:
  - Full system scan required.
  - Continuously monitoring the index circuit.
  - Manual adjustment of the balancing valves.
  - Re-scan of system
  - Noting final setting of balancing valves

Example of a constant speed system



Variable Speed Pumping with Differential Pressure Control

The progression from a constant volume system to a system using variable speed pumps and differential pressure control valves is significant.

The 3-port and 4-port valves have in the main been replaced by 2-port control valves and the bypasses are no longer required.

Differential pressure control valves (DPCV) maintain a set differential pressure for that particular circuit regardless if other circuits in the system regulate the flow or shut off.

The variable speed system pumps are controlled immediately ahead of the furthest DPCV on the system. The commissioning sets downstream of the DPCV, are there as simple flow setting valves to divide the flows required to the individual fan coil units on that particular branch.

All circuits should aim to achieve a potential flow reduction of around 80% i.e. the flow rate at minimum load should be around 20% of the maximum load.

To achieve this target one in five control valves at the end of each circuit should be selected as a 3-port or 4-port valve.

The advantage of doing this is

- There is always an open flow path at minimum load and prevents the pumps 'dead heading' and pumping against a closed system.
- Water treatment chemicals are always circulated throughout the system.
- When a control valve begins to open, there will be a ready supply of hot or cold water in the supply pipework.

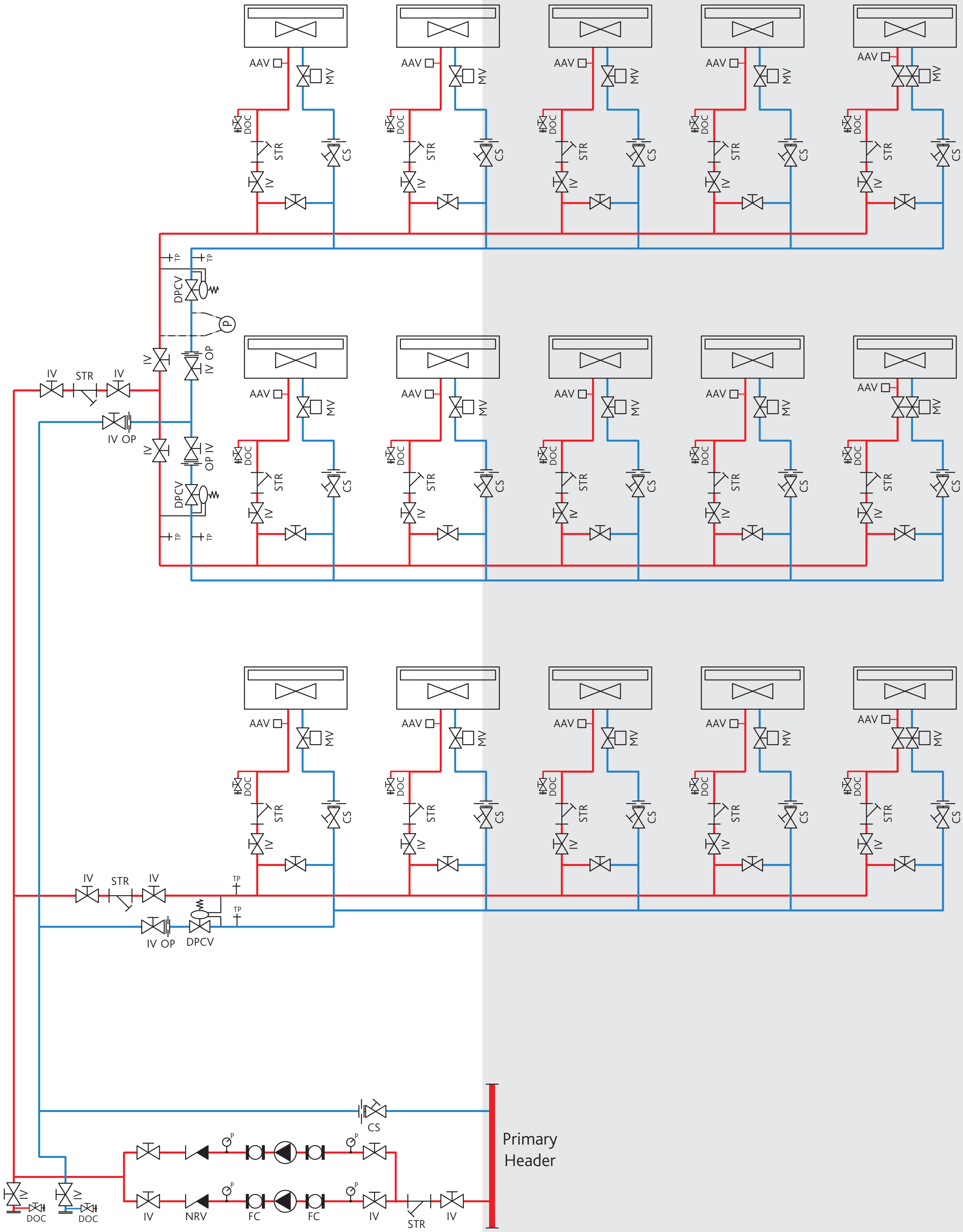
Differential pressure sensing

Some system designs include differential pressure sensing on a number or remote circuit or levels because it is possible that the index circuit could temporarily move to another part of the system as circuits throttle down.

Disadvantages of this type of system

- High cost of differential pressure control valves.
- Cost of commissioning sets
- Cost of double regulating valves
- Time consuming commissioning procedure due to:
  - Manual adjustment of the balancing valves to ensure correct flow to the terminal units
  - Re-scan of system
  - Noting final setting of balancing valves

Example of variable speed pumping with differential pressure control



Variable Speed Pumping with Automatic Balancing Valves

By selecting automatic balancing valves it is possible to remove the differential pressure control valves and commissioning sets from the system.

Automatic balancing valves replace the commissioning sets on circuit of each terminal unit.

The flow cartridge for each automatic balancing valve is selected to achieve the flow rate specified by the system designer for that particular circuit in the system.

The size of the automatic balancing valve body will also be specified by the system designer to correspond to the diameter of pipe required for that flow rate.

It is normal practice to install the body of the valve during pipework installation and then after flushing to remove debris within system to fit the flow cartridges prior to commissioning.

Each flow cartridge is supplied with a tag which contains the valve reference number in the system, the flow code and the flow rate in m^3/h for that particular cartridge.

Depending upon the valve size 3 different pressure ranges are available 7 to 100 kPa, 22 to 220 kPa and 35 to 410 kPa. The high pressure cartridges 35 to 410 kPa are sometimes required for circuits situated close to the pumps.

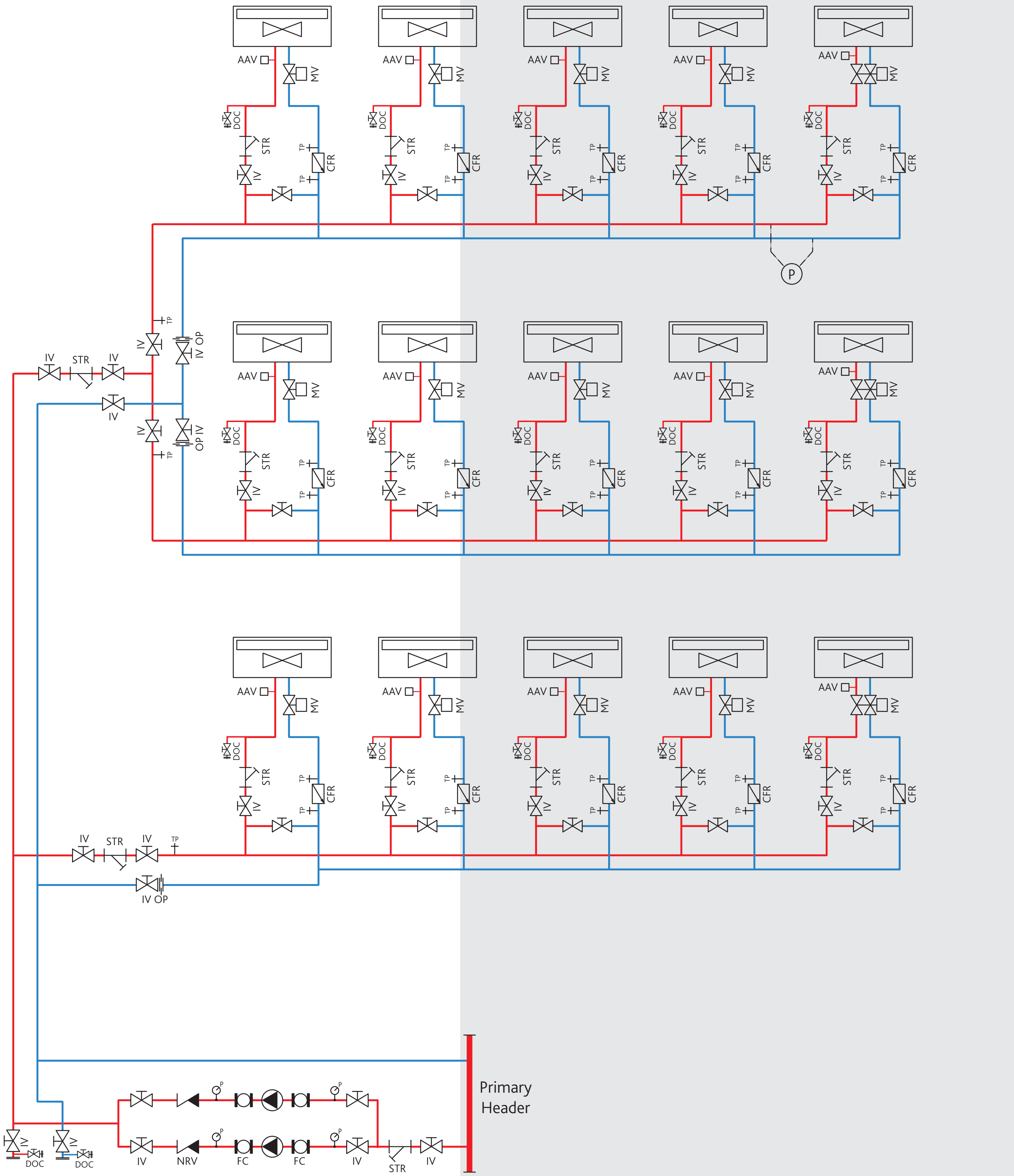
Most valves are suppled with two tapped and plugged bosses which can be fitted with pressure test points which can be using during commissioning to measure the pressure differential across the flow cartridge.

This is normally carried out by the commissioning engineer on a random basis and as long as the differential pressure measured is within the operating range of the cartridge i.e 22 to 220 kPa the cartridge is passing the design flow rate for the cartridge.

Advantage of using automatic balancing valves

- If one or more circuits is shut off by the 2-port control valves, the remaining circuits are never out of balance as the piston in the flow cartridge adjusts its position to compensate for the change and maintain the design flow rate of the cartridge.
- Automatic balancing valves are never installed in series so all commissioning sets installed at any point on the system can be removed.
- Significant saving on the reduced number of balancing valves required.
- Differential pressure control valves are not required with additional significant savings.
- Commissioning time and cost significantly reduced although some checks by commissioning engineer are still required to confirm the system is operating as designed.
- Straight pipe upstream of valve not required.
- Unaffected by different grades of pipe or fittings.
- Available in sizes ½” to DN350
- A wide range of flow cartridges available covering 0.45 m^3/h (0.125 l/s) to 730 m^3/h (202.7 l/s).
- Automatic balancing valve available with integral ball isolating valves saving installing time and eliminating a joint.

Example of variable speed pumping with automatic balancing valves



Variable Speed Pumping with PICVs

By selecting pressure independent control valves (PICV) it is possible to remove the differential pressure control valves and commissioning sets from the system.

The PICV consists of an automatic flow rate regulator and a control valve with actuator.

The PICV can keep the flow rate constant regardless of changes in differential pressure conditions in the system in which it is installed.

The flow rate is adjusted in 2 different ways;

- Manually using the automatic flow rate regulator to restrict the maximum flow rate.
- Automatically by the control valve using a proportional 0-10 V or ON/OFF actuator to reduce the flow rate as the thermal demand changes.

The differential pressure range of the Altecnic 145 PICV is from the minimum between 25 to 30 kPa to the maximum of 400 kPa.

The automatic flow rate regulator is selected to suit the design flow rate of the individual circuit and has 10 positions for manual adjustment to allow the actual design flow rate to be selected.

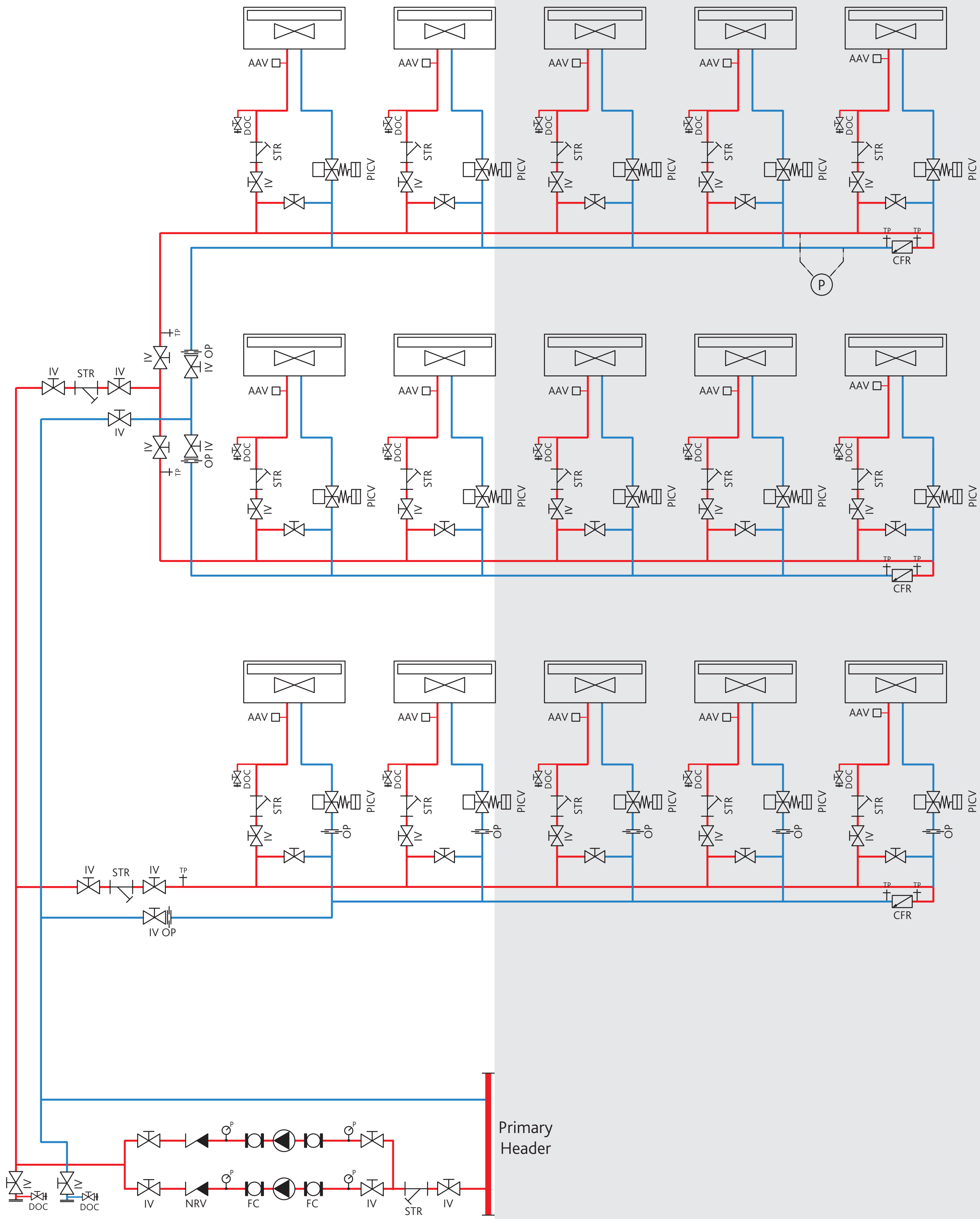
A selection table is available detailing all the available options.

Automatic flow control valves can be used with PICVs in the circuit return to maintain a constant flow rate in the circuit should all the PICVs on the terminal units close down and isolate.

Advantage of using pressure independent control valve

- If one or more circuits is shut off by other PICVs, the remaining circuits are never out of balance as the PICVs adjust automatically to maintain a constant flow rate.
- Significant saving on the reduced number of balancing valves required.
- Differential pressure control valves are not required with additional significant savings.
- Commissioning time and cost significantly reduced although some checks by commissioning engineer are still required to confirm the system is operating as designed.
- Straight pipe upstream of valve not required.
- Unaffected by different grades of pipe or fittings.
- Available in sizes $^3/_8$" to 1"
- A wide range of flow cartridges available covering 0.08 m^3/h (0.022 l/s) to 1.2 m^3/h (0.33 l/s).

Example of variable speed pumping with pressure independent control valves



AutoFlow® dynamic balancing valve

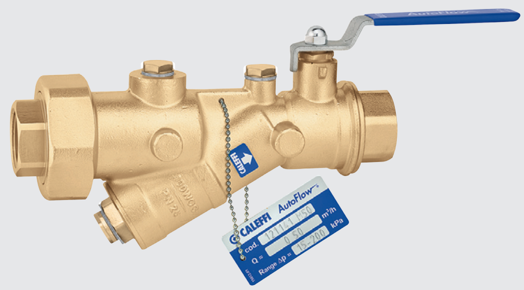
Schematic Symbols

- IV — Isolating valve
- NRV — Non return valve
- CS — Fixed orifice balancing valve
- DRV — Double regulating valve
- OP — Orifice plate
- CFR — Automatic balancing valve
- MV — 2-port control valve
- MV — 3-port regulating valve
- MV — 4-port regulating valve
- DPCV — Differential pressure control valve
- PICV — Pressure independant control valve
- Pump
- STR — Strainer
- AAV — Automatic air vent
- DOC — Drain cock
- FC — Flexible hose
- P — Pressure gauge
- TP — Pressure test point
- P — Pressure sensor

127 Series straight pattern ½" to 1¼" with polymer cartridge
1½" to 2" with satinless steel cartridge

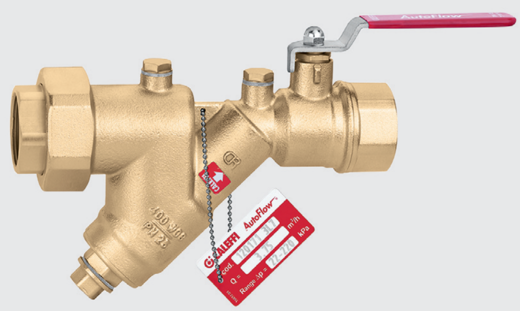
126 Series ½" to 1¼" with high resistance polymer cartridge

121 Series ½" to 1¼" with high resistance polymer cartridge



125 Series ½" to 2½" with stainless steel cartridge

120 Series ½" to 2" with stainless steel cartridge



103 Series wafer pattern 65 to DN350 with stainless steel cartridge

127, 121 & 126 Autoflow® with high resistance **Polymer Cartridge**

Code	Size	Δp range kPa	Flow rates available m^3/hr
127, 121, 126	½" & ¾"	15 to 200	0.12, 0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.5, 06, 0.7 0.8, 0.9, 1.0, 1.2
	1" & 1¼"	15 to 200	0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.2, 1.4, 1.6, 1.8, 2.0

Method of coding Autoflow®

Complete code:

1st	2nd	3rd	4th	5th	6th	7th	8th	9th
			1		1			
Series				Size		Flow rate and Δp range		

The first three digits indicater the series

121	Autoflow® regulator with ball valve
126	Autoflow® regulator
127	Autoflow® straight pattern

The fifth digits indicater size

Size	½"	¾"	1"	1¼"
Code	4	5	6	7

The last three digits indicater the available cartridge flow rates

m^3/hr	0.12	0.15	0.20	0.25	0.30	0.35	0.40	0.50	0.60
Code	M12	M15	M20	M25	M30	M35	M40	M50	M60

m^3/hr	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0
Code	M70	M80	M90	1M0	1M2	1M4	1M6	1M8	2M0

127, 120 & 125 Autoflow® with **Stainless Steel Cartridge**

Code	Size	Δp range kPa	Flow rates available m^3/hr
120, 125	½" & ¾"	7 to 100	0.45, 0.5, 06, 0.7 0.8, 0.9, 1.0
	1"	7 to 100	0.45, 0.5, 06, 0.7 0.8, 0.9, 1.0
	½" & ¾"	22 to 220	0.12, 0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.2, 1.4, 1.6, 1.8
	1" & 1¼"	22 to 220	0.7, 0.8, 0.9, 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.25, 2.5, 2.75, 3.0, 3.25, 3.5, 3.75, 4.0, 4.25
120, 125, 127	1½" & 2"	22 to 220	2.75, 3.0, 3.25, 3.5, 3.75, 4.0, 4.25, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0, 11.0
120, 125	½" & ¾"	35 to 410	0.25, 0.35, 0.45, 0.55, 0.7, 0.9, 1.1, 1.4, 1.6, 1.8, 2.0, 2.25, 2.5, 2.75
	1" & 1¼"	35 to 410	1.4, 1.6, 1.8, 2.0, 2.25, 2.5, 2.75, 3.0, 3.25, 3.75, 4.0, 4.25, 4.5, 5.0, 5.5, 6.0
	1½" & 2"	35 to 410	3.0, 3.25, 3.75, 4.0, 4.25, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10.0, 11.0, 12.0, 13.0, 14.5, 15.5

Method of coding Autoflow®

Complete code:

1st	2nd	3rd	4th	5th	6th	7th	8th	9th
			1		1			
Series				Size		Flow rate and Δp range		

The first three digits indicater the series

120	Autoflow® regulator with ball valve
125	Autoflow® regulator
127	Autoflow® straight pattern

The fifth digits indicater size

Size	½"	¾"	1"	1¼"	1½"	2"	2½"
Code	4	5	6	7	8	9	0

The last three digits indicater the available cartridge flow rates

Δp range 7 to 110 kPa

m^3/hr	0.45	0.50	0.60	0.70	0.80	0.90	1.0
Code	S45	S50	S60	S70	S80	S90	1S0

Δp range 22 to 220 kPa

m^3/hr	0.12	0.15	0.20	0.25	0.30	0.35	0.40	0.50	0.60	0.70	0.80	0.90	1.0	1.2	1.4	1.6
Code	L12	L15	L20	L25	L30	L35	L40	L50	L60	L70	L80	L90	1L0	1L2	1L4	1L6

m^3/hr	1.8	2.0	2.25	2.5	2.75	3.0	3.25	3.5	3.75	4.0	4.25	4.5	5.0	5.5	6.0	6.5
Code	1L8	2L0	2L2	2L5	2L7	3L0	3L2	3L5	3L7	4L0	4L2	4L5	5L0	5L5	6L0	6L5

m^3/hr	7.0	7.5	8.0	8.5	9.0	9.5	10	11	12	13.5	14.5	15.5	16.5	17	18
Code	7L0	7L5	8L0	8L5	9L0	9L5	10L	11L	12L	13L	14L	15L	16L	17L	18L

Δp range 35 to 410 kPa

m^3/hr	0.25	0.35	0.45	0.55	0.70	0.90	1.1	1.4	1.6	1.8	2.0	2.25	2.5	2.75	3.0	3.25
Code	H25	H35	H45	H55	H70	H90	1H1	1H4	1H6	1H8	2H0	2H2	2H5	2H7	3H0	3H2

m^3/hr	3.5	3.75	4.0	4.25	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10
Code	3H5	3H7	4H0	4H2	4H5	5H0	5H5	6H0	6H5	7H0	7H5	8H0	8H5	9H0	9H5	10H

m^3/hr	11	12	13.0	14.5	15.5	16.5	18	19	20.0	21.0	22.0	23.0	24.5	25.5	26.5
Code	11H	12H	13H	14H	15H	16H	18H	19H	20H	21H	22H	23H	24H	25H	26H

103 Autoflow® with Stainless Steel Cartridge

Code	Size	Δp range kPa	Flow rates m³/hr
103	DN65	22 to 200	5 to 18
	DN65	35 to 410	6 to 26
	DN80	22 to 200	18 to 22
	DN80	35 to 410	18 to 22
	DN100	22 to 200	18 to 22
	DN100	35 to 410	18 to 22
	DN125	22 to 200	16 to 61
	DN125	35 to 410	19 to 77
	DN150	22 to 200	16 to 122
	DN150	35 to 410	19 to 154

Code	Size	Δp range kPa	Flow rates m³/hr
103	DN200	22 to 200	32 to 215
	DN200	35 to 410	38 to 270
	DN250	22 to 200	64 to 338
	DN250	35 to 410	77 to 425
	DN300	22 to 200	95 to 460
	DN300	35 to 410	115 to 580
	DN350	22 to 200	160 to 580
	DN350	35 to 410	190 to 730

Method of coding Autoflow®

Complete code:

1st	2nd	3rd	4th	5th	6th	7th	8th	9th
1	0	3	1		1			
Series				Size	Δp range	Flow rate		

The fifth digits indicater size

DN	65	80	100	125	150	200	250	300	350
Code	1	2	3	4	5	6	7	8	9

The sixth digits indicater Δp range

kPa	22 - 220	35 - 410
Code	1	3

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