



Válvulas de Flujo Equilibrado : CRANE Balancing Valves

CRANE

FLUID SYSTEMS

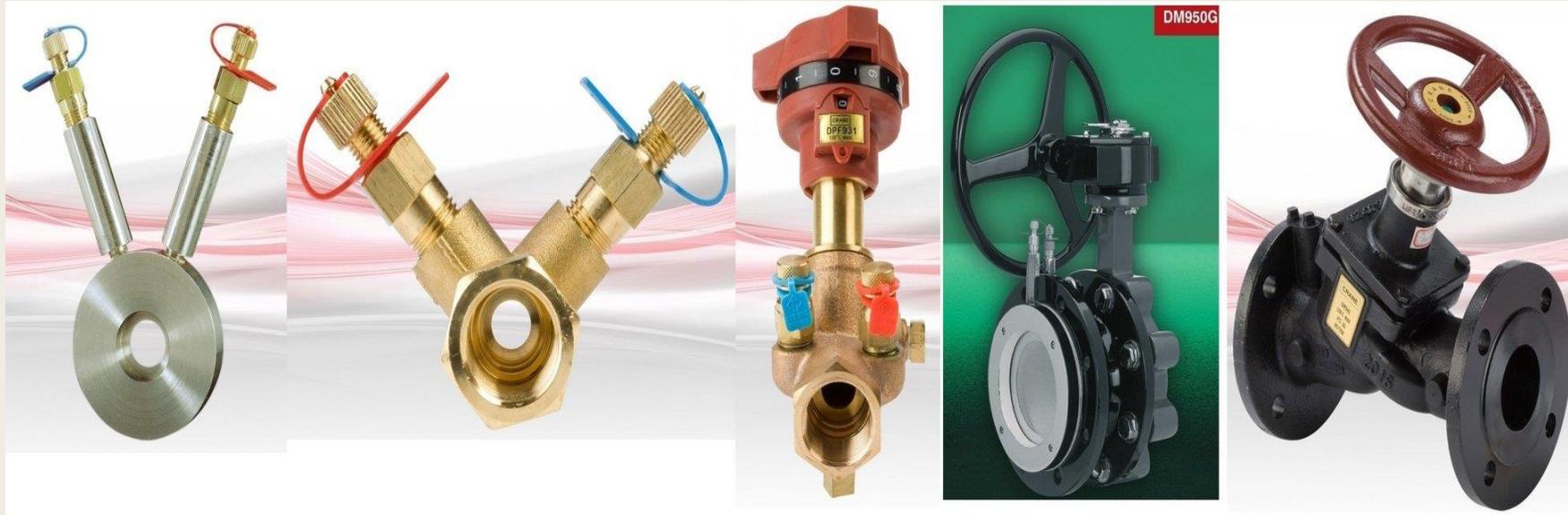


E-PICV

Connected
SOLUTIONS



Modbus Actuator



Control Modulante : satisfacen un equilibrio hidráulico en las instalaciones

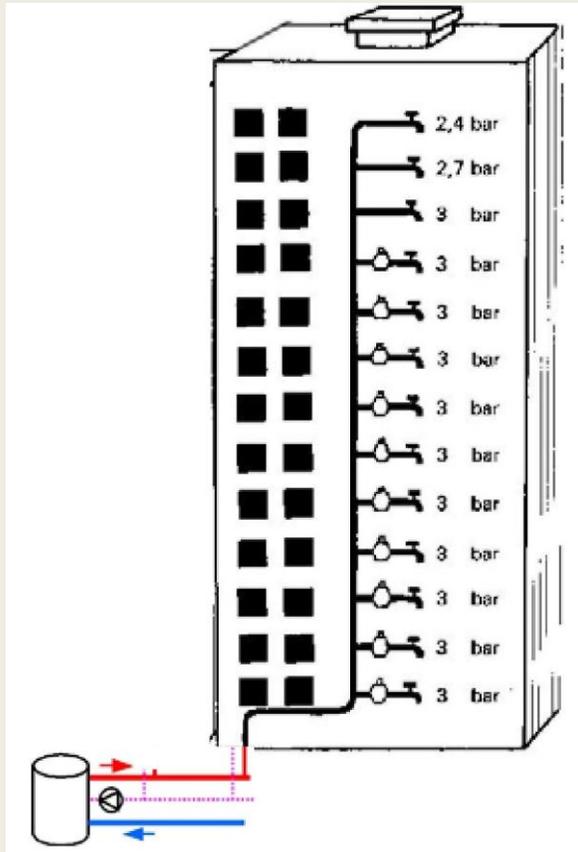
Climatización (HVAC = Heating – Ventilation – Air Condition)

Sistemas de calefacción

Sistemas de refrigeración

Generación de energía

Por qué reemplazar el uso tradicional de una reductora de presión por cada piso



El paradigma tradicional de controlar los fluidos mediante la reducción de presión conlleva que las bombas deban inicialmente proporcionar una presión diferencial de al menos una Presión Total que garantice un suministro suficiente a los pisos superiores generando una presión diferencial excesiva en los pisos inferiores.

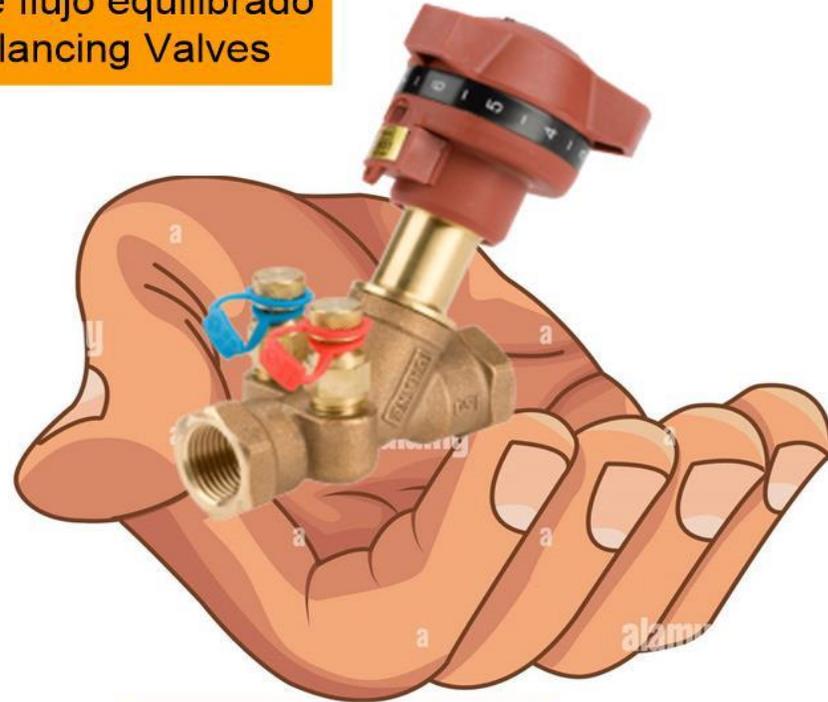
Esta presión diferencial tan elevada provocará un aumento del caudal en dichas unidades y, por lo tanto, un aumento en el consumo energético.

Para evitarlo reemplazamos el control de presión (válvulas reductoras) por válvulas de control de flujo : balancing valves ó válvulas de flujo equilibrado.

Por qué cambiar la válvula reductora de presión de agua por válvula de flujo equilibrado CRANE Balancing Valves



Válvula Reductora de Presión de Agua



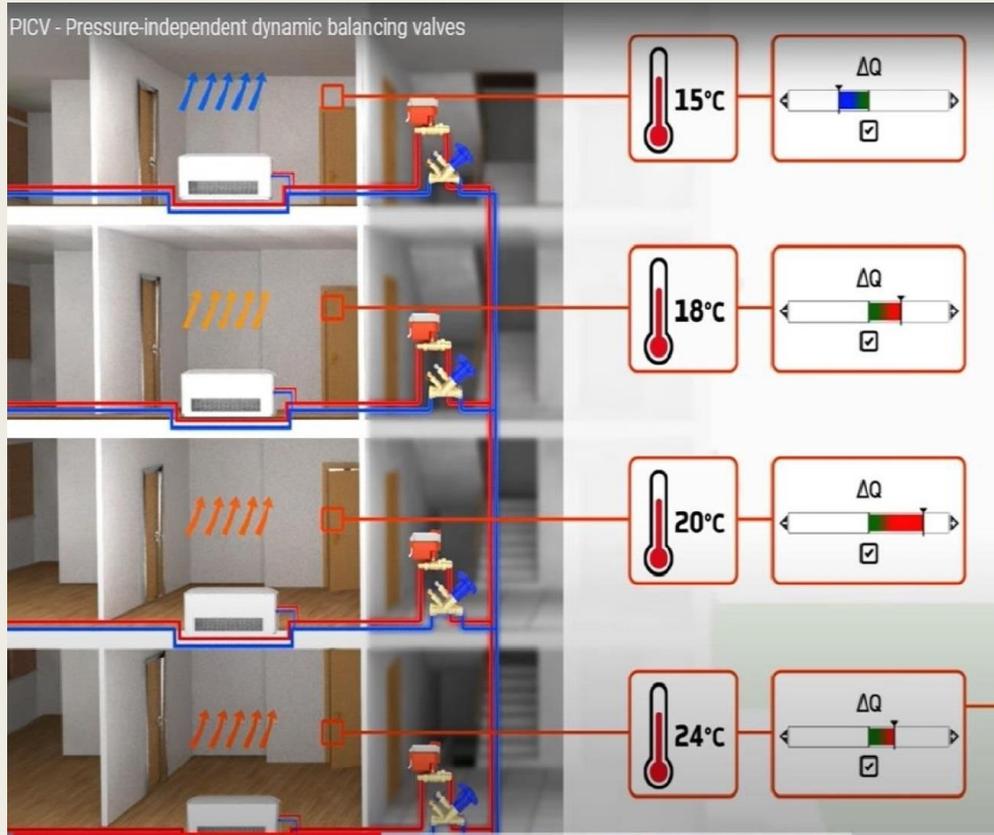
CRANE Válvula de Flujo Equilibrado = Balancing Valves



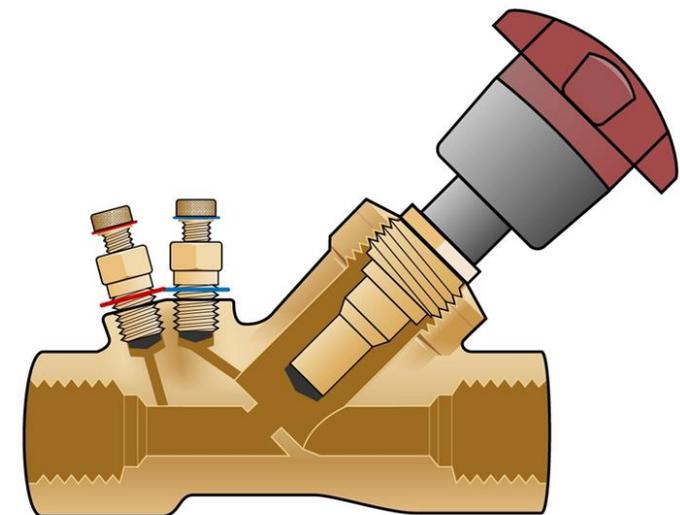
Curvas de consumo de electricidad



¿Cómo funcionan las BALANCING VALVES ?



Todas las válvulas de flujo equilibrado (balancing valves) utilizan alguna forma de regulación para crear una salida constante a partir de un entrada variable.



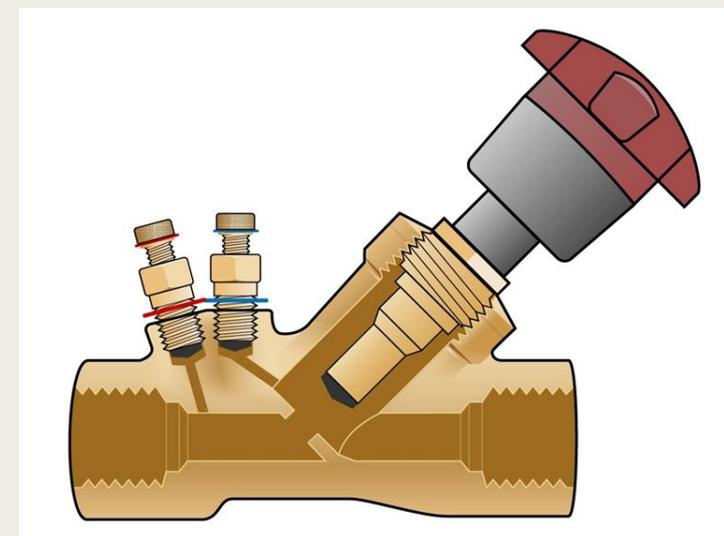
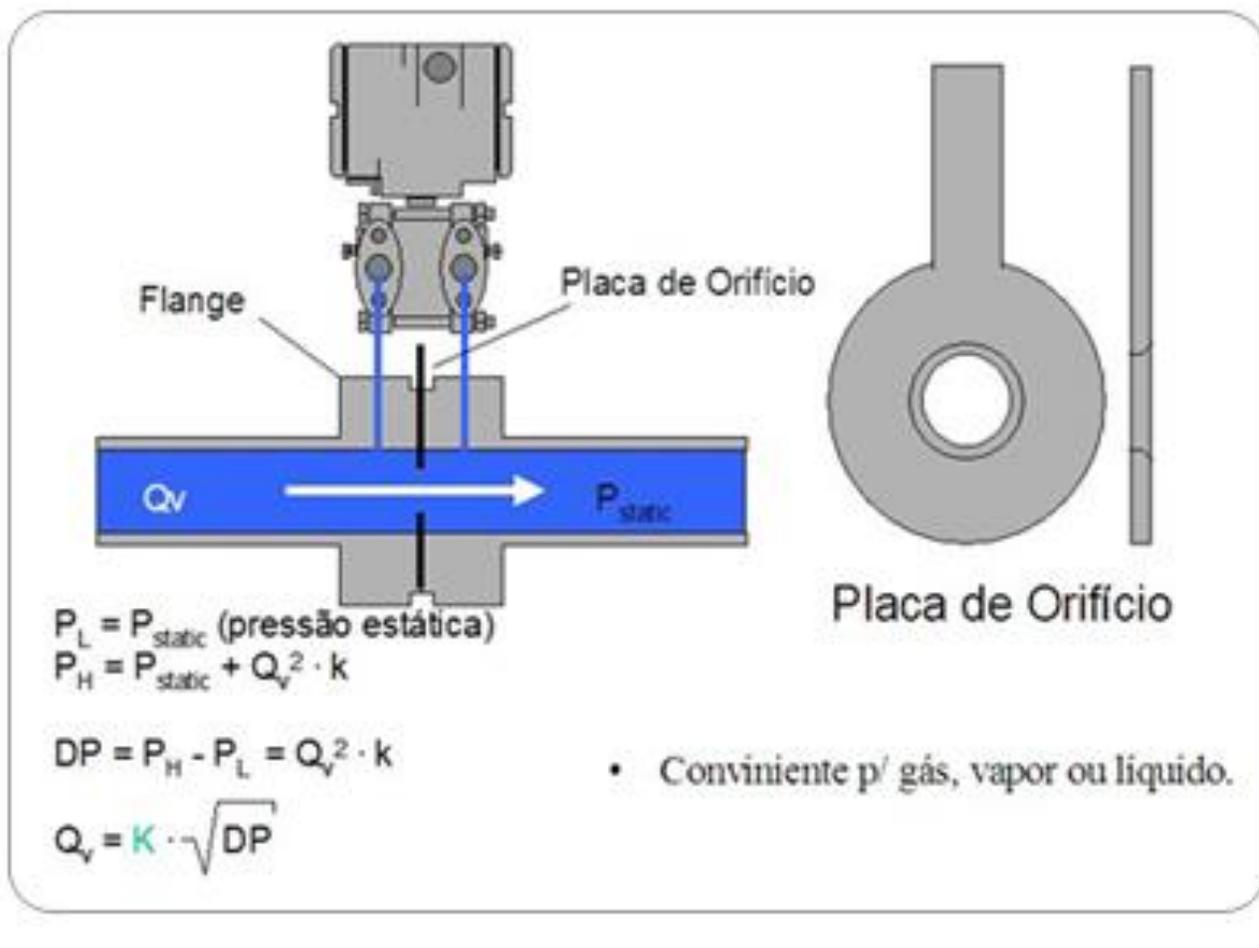
Mercados de Balancing Valves

- Centros comerciales
- Centros financieros
- Supermercados
- Aeropuertos
- Clínicas privadas
- Edificios públicos y corporativos
- Establecimientos de servicios múltiples



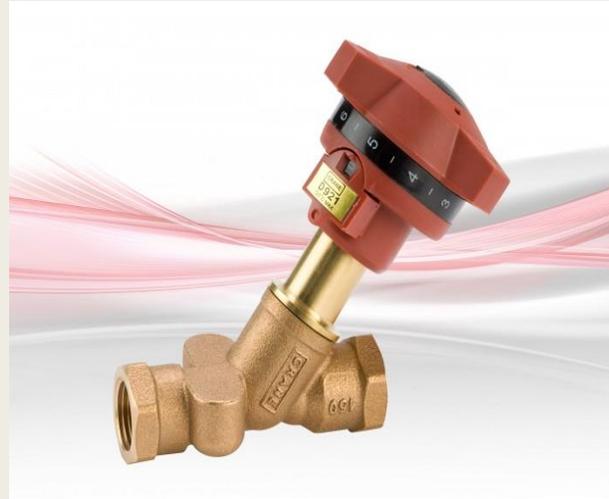
El flujo (caudal) es directamente proporcional a la raíz cuadrada del diferencial de presión.

$$Q_v = K \cdot \sqrt{DP}$$



Modelos básicos de CRANE Balancing Valves

CRANE D921 Double Regulating Valve



DM 941



CRANE D931-Fixed-Orifice-Double-Regulating-Valve .

COMMISSIONING VALVES (Fixed Orifice Double Regulating Valve - Crane D931)

SIZE (mm)	15	20	25	32	40	50
Kv	1.87	3.14	5.59	10.8	18.1	29.1

Kv : el flujo de agua a través de una medición de flujo, dispositivo o válvula de doble regulación a una temperatura entre 5 y 40°C y medido en metros cúbicos por hora, que inducirá una pérdida de presión de 1 bar.

Kv = factor Kv de la válvula (m³ / h)

Q = caudal (m³ / h)

ρ = densidad del medio (kg / m³)

ρ₀ = densidad del medio para el valor Kv (kg / m³)

Δp = pérdida de presión (bar)

$$K_v = Q * \sqrt{\frac{1 \text{ bar} * \rho}{\Delta p * \rho_0}}$$



Handheld



FIXED ORIFICE DOUBLE REGULATING VALVE

BALANCING VALVES

D931 / D933 / D934

Fixed Orifice Double Regulating Valve (FODRV)



Features & Benefits

- D933 size 1/2" low flow FODRV combines the functions of regulation and flow measurement in a unit of high authority making it particularly suitable for low flow applications in the range of 0.03 to 0.07 l/s
- D934 size 1/2" ultra-low flow FODRV combines the functions of regulation and flow measurement in a unit of high authority making it particularly suitable for ultra-low flow applications in the range of 0.016 to 0.04 l/s.
- The Double regulating valve, with its integral fixed orifice design offers an accuracy of $\pm 5\%$ on all settings, for precise flow regulation and measurement
- The Double Regulating feature allows the valve to be used for isolation and to be reopened to its pre-set position to maintain required flow rate
- Y-Pattern globe valves having characterised throttling disc tending towards equal percentage performance
- Integral square edged entrance orifice plate and P84 insertion test points fitted Double regulating feature allows valve opening to be set with an Allen key
- Operation of the valve is by means of the Microset handwheel

Materials

PART	MATERIAL	SPECIFICATION
Body	Bronze	BS EN 1982 CC491K
Bonnet	DZR Copper Alloy	BS EN 12165 CW602N
Stem	DZR Copper Alloy	BS EN 12164 CW602N
Disc	DZR Copper Alloy	BS EN 12164/5 CW602N
O-Ring Seal	EPDM Rubber	
Orifice Insert	DZR Copper Alloy	BS EN 12164 CW602N
P84 Test Valve	DZR Copper Alloy	BS EN 12164 CW602N
Handwheel	Plastic	

Dimensions, Coefficients & Weights

FIG. NO.	SIZE	DIMENSIONS (mm)		FULLY OPEN			WEIGHT (kg)
		A	B	FLOW (Kv)	HEAD LOSS (K)	KVS	
D931	1/2"/DN15	87	105	1.87	30.27	2.2	0.61
	3/4"/DN20	96	106	3.14	34.55	4.7	0.65
	1"/DN25	100	127	5.59	27.85	8.6	0.95
	1 1/4"/DN32	114	128	10.80	22.60	16.6	1.13
	1 1/2"/DN40	125	143	18.10	14.76	24.5	1.52
	2"/DN50	146	144	29.10	14.62	46.1	1.98
D933	1/2"/DN15	87	105	1.06	94.20	1.1	0.61
D934	1/2"/DN15	87	105	0.57	325.80	0.58	0.61

SPECIFICATION: Conforms to BS 7350*:1990

END CONNECTIONS: Sizes 1" to 2" taper threaded to BS EN 10226-2 (ISO 7-1) formerly BS 21.

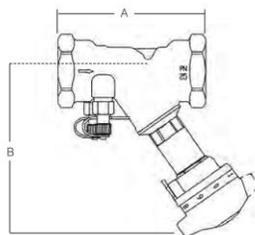
Sizes 1/2" & 3/4" DN15 & DN20 BS 2779 (ISO 228) parallel. Adaptor kits for use with copper tube also available.

Also available threaded to ANSI B1.20.1AT.

Order code D931AT/D933AT/D934AT.



Dimensional Drawing



Pressure/Temperature Ratings

Threaded			
TEMPERATURE (°C)	-10 to 100	110	120
PRESSURE (BAR)	25	23.4	21.8

Compression

TEMPERATURE (°C)	-10 to 30	65	120
PRESSURE (BAR)	16	10	5

Intermediate pressure ratings shall be determined by interpolation.

Maximum temperature 120°C.

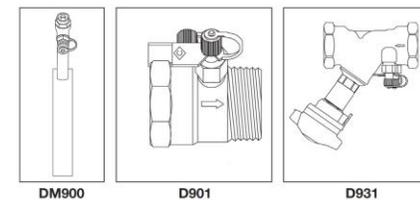
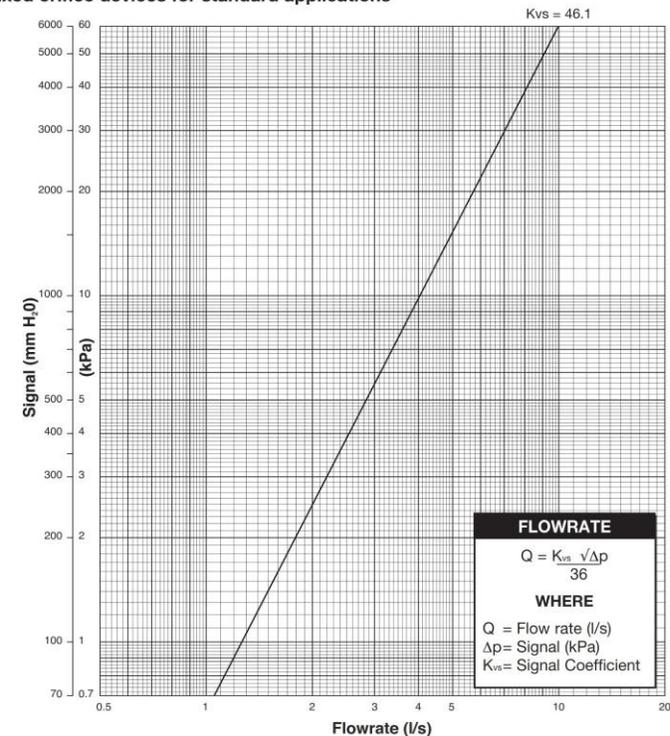
Note: In line with BS EN 1254/2, the maximum pressure must not exceed 16 bar when using compression adaptors.

WRAS approved -10 to 85 °C

FLOW MEASUREMENT GRAPHS FODRV SIZES 1/2" - 2" (DN15-DN50)

D901-D931-DM900-DM950G Size 2 (DN50)

Fixed orifice devices for standard applications



Head / Pressure Loss

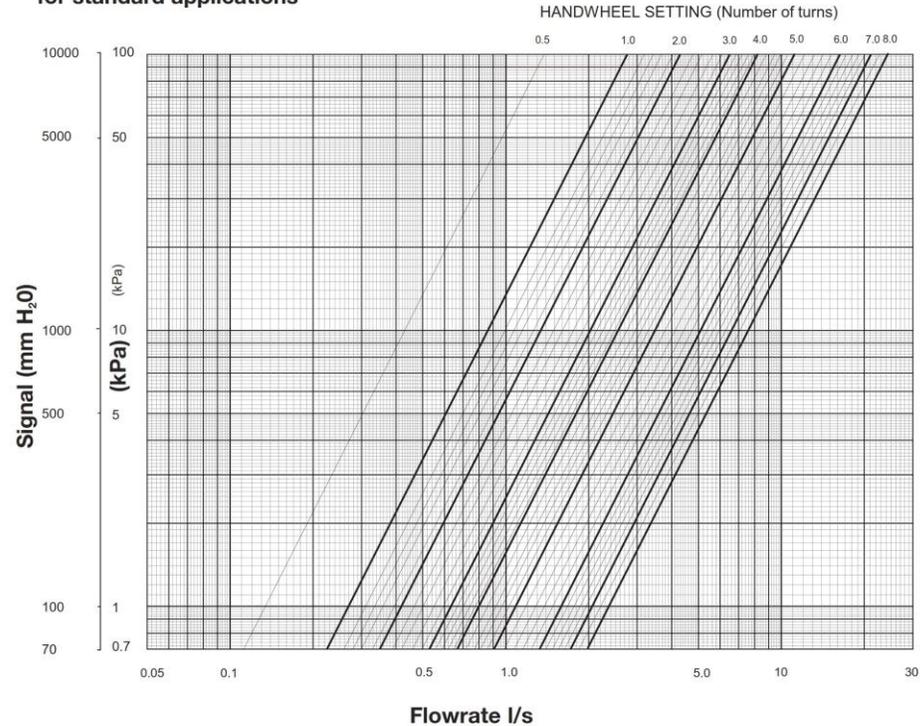
The loss resulting from the insertion of the device in the pipeline may be calculated by multiplying the signal by the appropriate factor.

Fig No.	Factor
D901	0.41
D931 (Fully open)	2.50
DM900	0.41
DM950	0.57

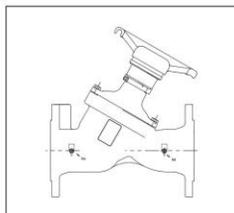
DM931-DA931
Size 2 1/2 (65mm)



Variable orifice double regulating valve
for standard applications



Handwheel position	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	6.0	7.0	8.0
Kv Value	5.0	10.0	12.5	15.0	19	23	29	39	57	74	85



DM931/DA931

Head / Pressure Loss

DM931/DA931: The loss resulting from the insertion of the valve in the pipeline equates to the signal measured at the pressure test valves.

DM921: The loss for DM921 and DM931 is identical

DM931 / DA931



Variable Orifice Double
Regulating Valves (VODRV)

PN16 / CLASS 125



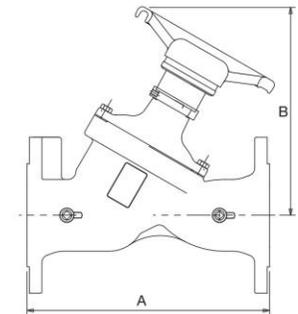
Features & Benefits

- These are Y-Pattern globe valves supplied with two pressure test points P84 to provide flow measurement, regulation and isolation
- The Double Regulating feature allows the valve to be used for isolation and to be reopened to its pre-set position to maintain required flow rate
- Primarily used in injection or other circuits requiring a double regulating valve for system balancing
- Accuracy of flow measurement is $\pm 10\%$ at the full open position of the valve
- Some reduction in accuracy occurs at partial openings of the valve in accordance with BS 7350

Materials

PART	MATERIAL
Body	Ductile Iron - BS EN 1563 GJS-450-10
Bonnet	Ductile Iron - BS EN 1563 GJS-450-10
Bonnet Gasket	Non-asbestos
Disc (All sizes)	EPDM Coated Cast Iron
Disc Bush	Bronze
Stem	410 SS
Gland (65 to 150mm)	Brass
Gland (200 to 300mm)	Cast Iron
Gland Nut	Brass
Packing	Non-asbestos
Seat Ring	Bronze

Dimensional Drawing



Pressure/Temperature Ratings

TEMPERATURE (°C)	-10 to 120
PRESSURE (BAR)	16.0

Ratings align with BS EN 1092-2 PN16 (formerly BS 4504)

Dimensions & Weights

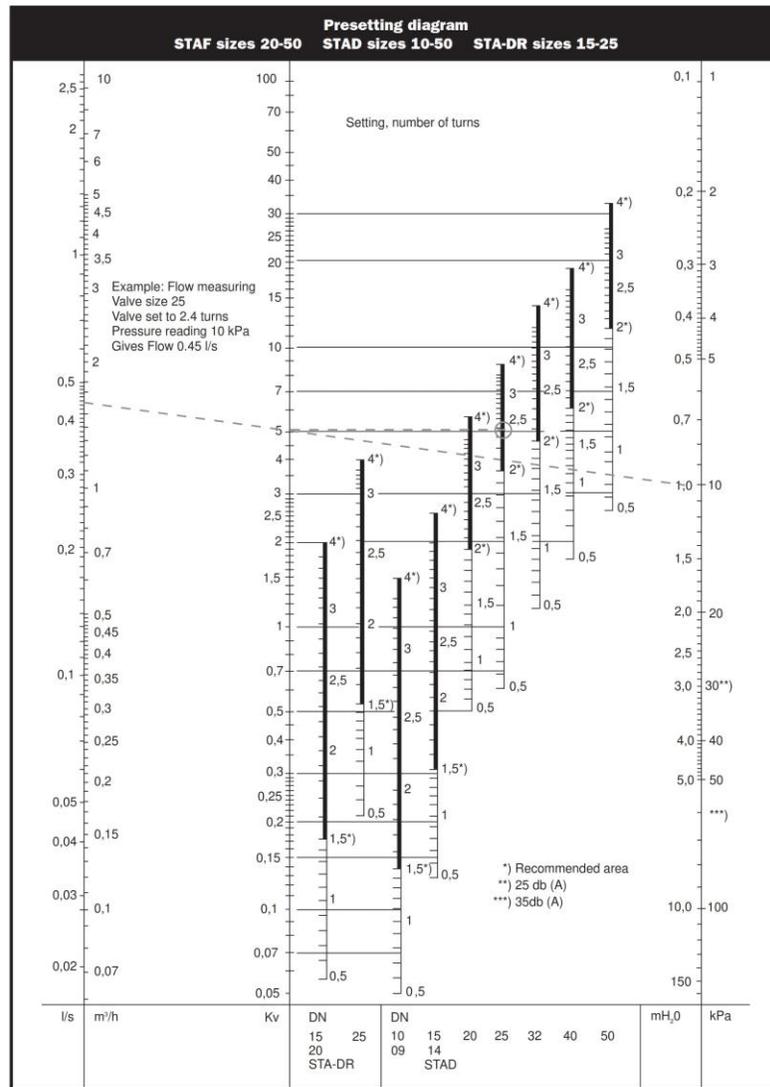
SIZE (DN)	FACE-TO-FACE A (mm)	CENTRE-TO-TOP B (mm)	WEIGHT (kg)
65	290	262	15.8
80	310	267	19.5
100	350	300	28.0
125	400	325	37.5
150	480	340	50.5
200	600	525	123.0
250	730	575	192.0
300	850	645	251.0

Coefficients*

SIZE (DN)	FLOW (Kv)	HEAD LOSS (K)
65	85	4.9
80	111	5.5
100	146	9.2
125	250	7.3
150	380	6.5
200	600	7.8
250	1211	4.6
300	1521	6.0

*Fully open position.

Flow Diagrams

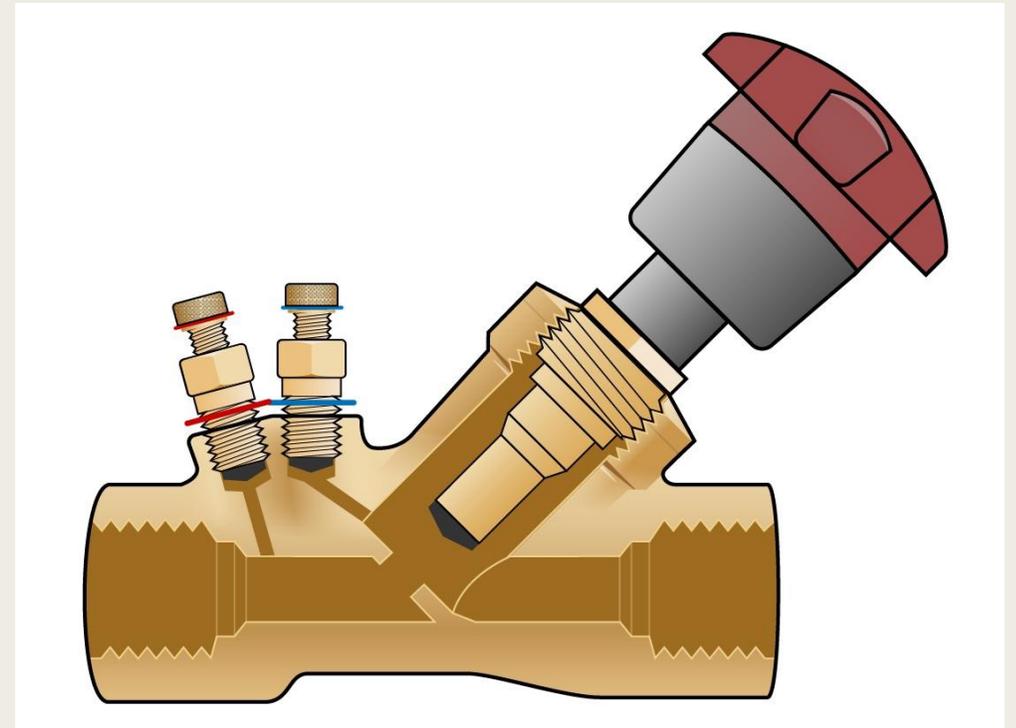


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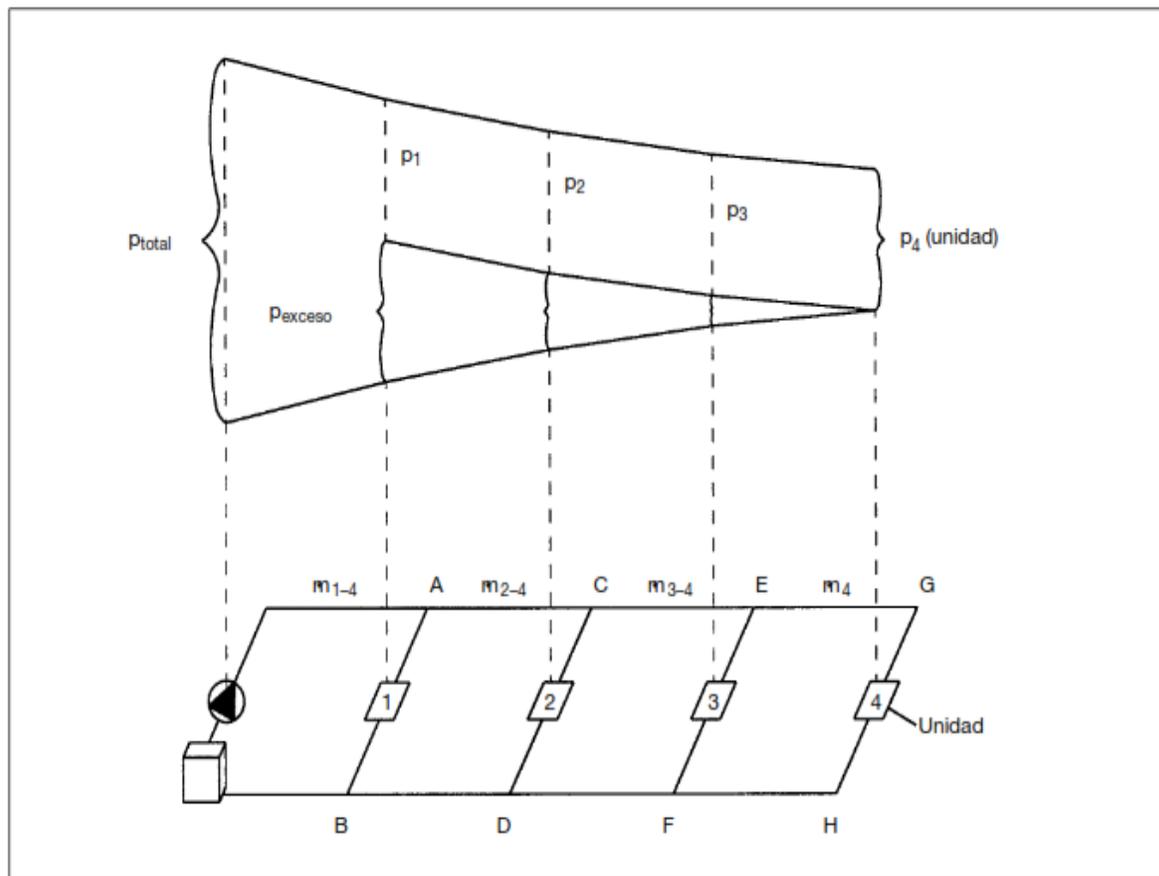
TOUR & ANDERSSON Moorabbin Business Park Unit 25/148 Chesterville Road MOORABBIN VIC. 3189, PO Box 154 Highbett Victoria 3190
Telephone (03) 9553 3366 Facsimile (03) 9553 3733 email david.penny@bigpond.com

July 2003

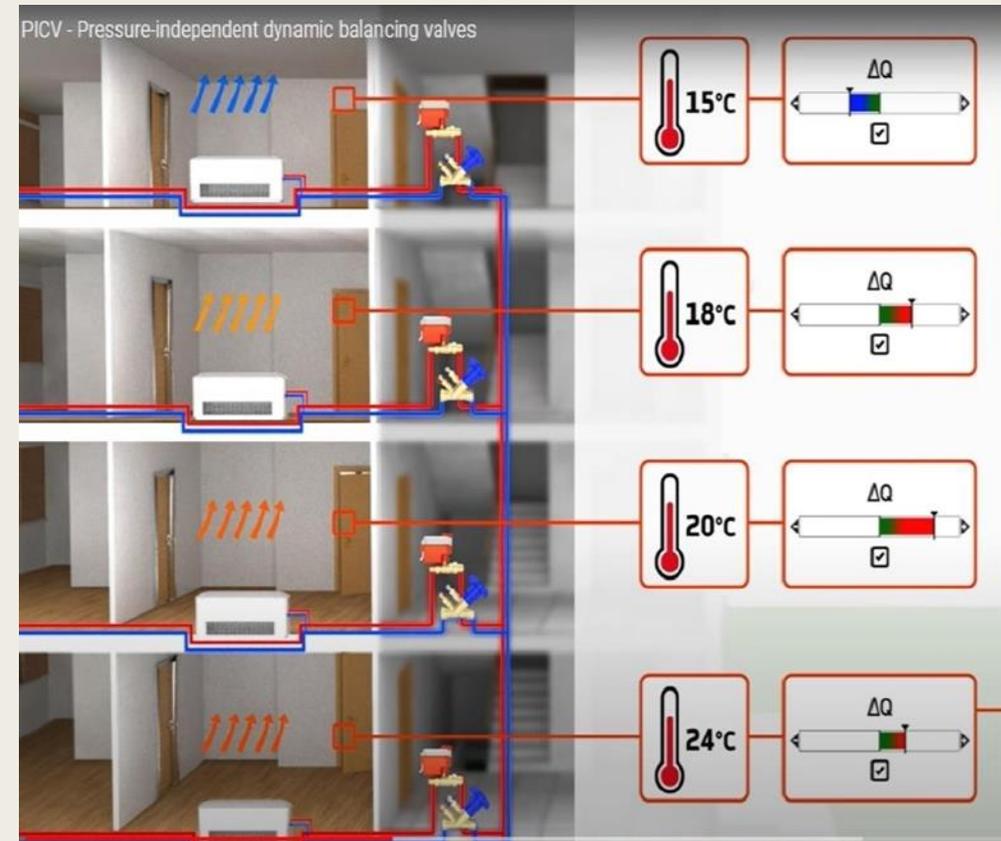
an Indoor Climate business of IMI plc



NºGiros / Turns	Caudal / Flow (m ³ /h)					
	1/2"	3/4"	1"	1"1/4	1"1/2	2"
0,50	0,20	0,14	0,32	0,42	0,66	0,90
1,00	0,30	0,28	0,52	0,61	1,16	1,55
1,50	0,38	0,38	0,72	0,82	1,50	1,95
2,00	0,49	0,48	0,92	1,00	1,80	2,35
2,50	0,58	0,56	1,10	1,20	2,10	2,75
3,00	0,69	0,82	1,30	1,38	2,35	3,45
3,50	0,86	1,12	1,48	1,52	2,65	4,50
4,00	1,11	1,42	1,67	1,70	3	6,20
4,50	1,32	1,62	1,85	1,90	3,80	7,60
5,00	1,55	1,85	2,08	2,10	5,20	9
5,50	1,75	2,12	2,50	2,62	6,80	10,60
6,00	2	2,48	3,00	3,32	8,40	12,20
6,50	2,32	2,78	3,70	4,00	10,20	14
7,00	2,69	3,18	4,45	4,80	11,40	15,90
7,50	3,06	3,50	5,35	5,82	12,50	17,50
8,00	3,35	3,80	6,30	6,98	13,50	19
8,50	-	4	7,40	7,98	15	20,60
9,00	-	-	8,40	8,90	16	22,40
9,50	-	-	9,40	10,00	17	23,70
10,00	-	-	10,20	10,98	18	25
10,50	-	-	11,20	12,00	19	26,25
11,00	-	-	-	12,60	-	27,30
11,50	-	-	-	13,40	-	28,40



Gráfica de la presión en un circuito



El paradigma tradicional de controlar los fluidos mediante la reducción de presión conlleva que las bombas deban inicialmente proporcionar una presión diferencial de al menos una Presión Total que garantice un suministro suficiente a la unidad terminal 4 generando una presión diferencial excesiva en las unidades 1 a 3.

Esta presión diferencial tan elevada provocará un aumento del caudal en dichas unidades y, por lo tanto, un aumento en el consumo energético.

Para evitarlo reemplazamos el control de presión (válvulas reductoras) por válvulas de control de flujo : balacing valves ó válvulas de flujo equilibrado.

El exceso de presión diferencial es absorbido ahora por las válvulas de flujo equilibrado.

El caudal deseado puede ser controlado y ajustado garantizándose el suministro correcto a cada unidad de la instalación.

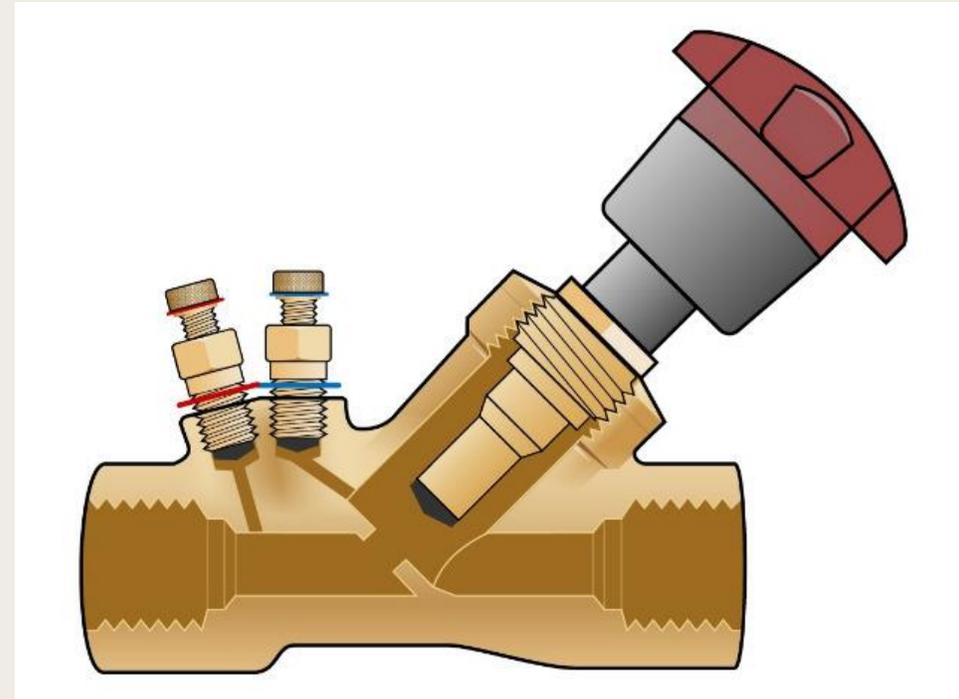
Tipos de Válvulas Equilibradas

Válvulas manuales estáticas

Reguladores de doble posición

Forma fácil de regular el flujo

Implementan obturadores

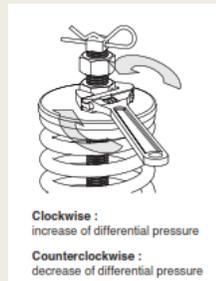


Válvula equilibradora estática típica; tenga en cuenta que la entrada está a la izquierda y la salida a la derecha.

DP971F Válvulas Dinámicas

Válvula de control de presión diferencial de alto rendimiento que puede ser instalada en la tubería de suministro o retorno, regulando diferenciales presión y caudales.

Indicador de posición de válvula integrado para inspección visual.



Cómo funcionan las válvulas CRANE PICV : válvulas de control independientes de las fluctuaciones de la presión de entrada

Controlando la Presión Diferencial

A medida que los caudales en las tuberías de distribución fluctúan para satisfacer la demanda, la presión disponible en cada unidad terminal varía. Esta variación en la presión disponible modifica el caudal a través del subcircuito terminal; es decir, un aumento de presión produce un mayor caudal. Para contrarrestar estas fluctuaciones de presión, la válvula PICV mantiene una caída de presión constante en su asiento (P1 a P2), manteniendo así un caudal constante hacia la terminal.

Regulando el caudal

Al modificar el espacio abierto por el que fluye el agua dentro de la válvula, se puede ajustar y configurar el caudal. El controlador de presión diferencial mantiene constante la presión en el asiento de la PICV. Durante el ajuste, el área abierta alrededor del disco cambia, lo que modifica el caudal. El nuevo caudal ajustado recrea la presión diferencial constante en el asiento (P1 a P2). Una vez ajustado el nuevo caudal, este se mantendrá constante en el nuevo valor establecido.

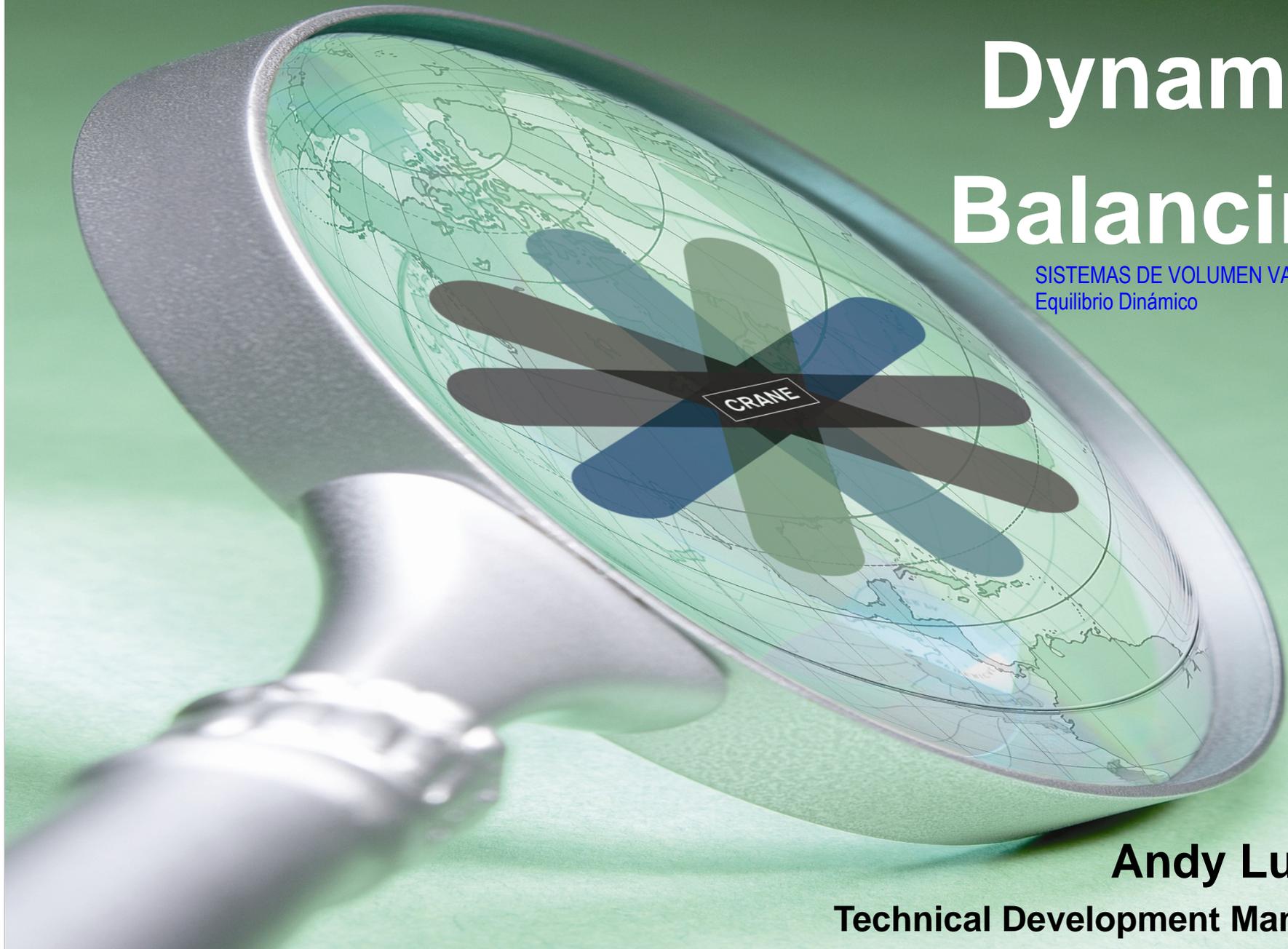
Las válvulas de control PICV de CRANE Fluid Systems vienen con actuadores eléctricos con protocolo de comunicación Modbus.



VARIABLE VOLUME SYSTEMS

Dynamic Balancing

SISTEMAS DE VOLUMEN VARIABLE
Equilibrio Dinámico



Andy Lucas

Technical Development Manager

The Bigger Picture

La imagen más impactante : el asunto energético
Medio Ambiente Cambio climático Emisiones de CO2
Quién es el mayor culpable ?
Autos, camiones, ómnibus, aviones
En realidad son las edificaciones.

Energy Issue

- Environment
- Climate change
- CO₂ emissions
- Who is the biggest culprit
 - Cars
 - Planes
 - Actually, it's buildings



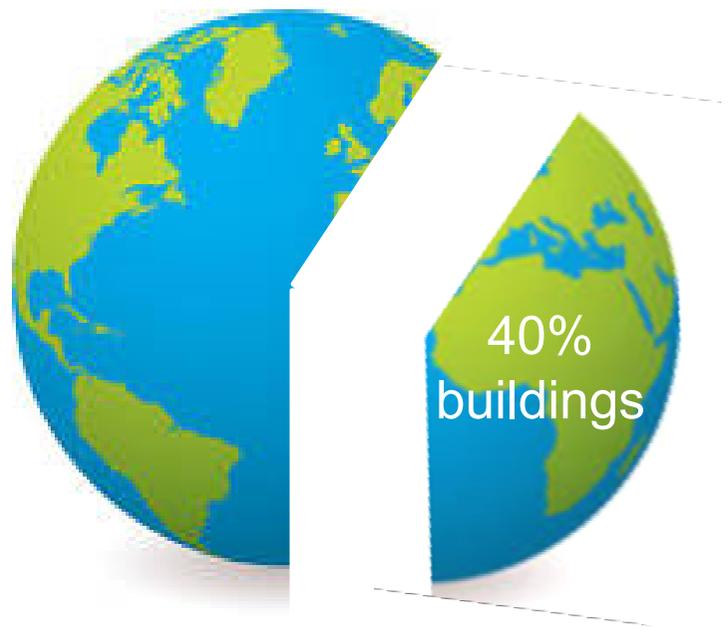
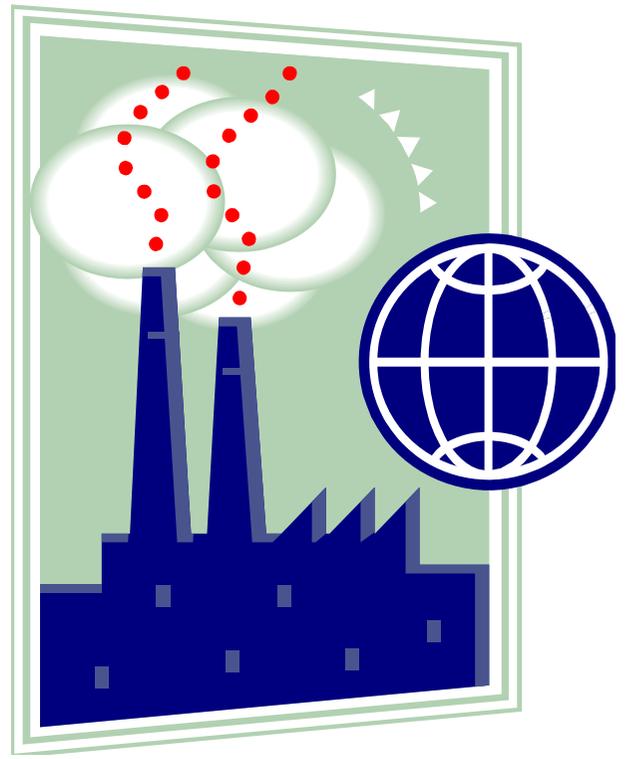
CRANE

BUILDING SERVICES & UTILITIES

Dynamic Balancing

Consumo mundial de energía
El 40% del consumo energético mundial se destina a los edificios

World Energy Consumption



40% of world energy consumption goes into buildings

OUR GENIUS IS VALVES

ProBalance

World Energy Consumption

Consumo energético mundial del 40% utilizado en edificios.
HVAC : Calefacción Ventilación Aire Acondicionado = 20% de la energía mundial total.

of the 40%
used in buildings

HVAC = 20% of total world energy



UK Stringent Carbon Emission Targets

Objetivos estrictos de emisiones de carbono en Reino Unido

Reduction commitment

- 2050 80%



Shaping Policy

- CIBSE
- SoPHE
- BSRIA
- CSA



OUR GENIUS IS VALVES

ProBalance

Política de configuración :

CIBSE Institución de Ingenieros de Servicios de Edificio

SoPHE Estrategia de investigación, traducción e innovación en Salud Pública

BSRIA Asociación de Información e Investigación de Servicios de Construcción

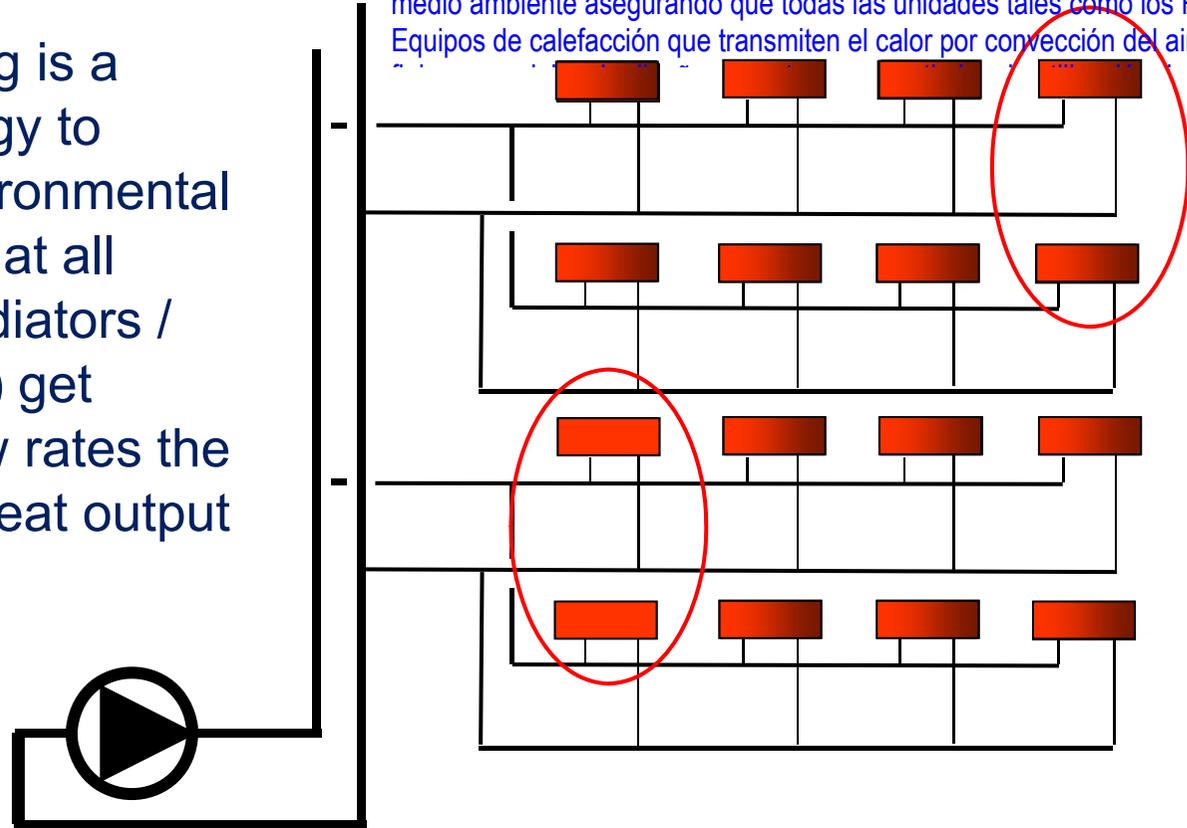
CSA Agricultura climáticamente inteligente enfoque para transformar y reorientar el desarrollo agrícola ante las nuevas realidades del cambio climático.

What is Dynamic Balancing?

Dynamic Balancing is a design methodology to achieve good environmental control ensuring that all terminal units (Radiators / Fan Coil Units etc) get correct design flow rates the therefore design heat output

El equilibrio dinámico es una metodología de diseño para lograr un buen control del medio ambiente asegurando que todas las unidades tales como los Radiadores y Equipos de calefacción que transmiten el calor por convección del aire, obtengan los

unbalanced
balanced



Why do we need Dynamic Balancing?

Moved from Constant Volume to Variable Volume systems

- driven by Government legislation
- energy conservation
- subsequent CO₂ emissions

Por qué necesitamos el Equilibrio Dinámico

Se pasó de sistemas de volumen constante a sistemas de volumen variable

• impulsados por legislación gubernamental

• conservación de energía

• emisiones de CO₂ subsecuentes

El paso del diseño de flujo constante al variable permite que las bombas de gran tamaño obtengan ahorros de energía alrededor del 6 á 8% del total de energía.

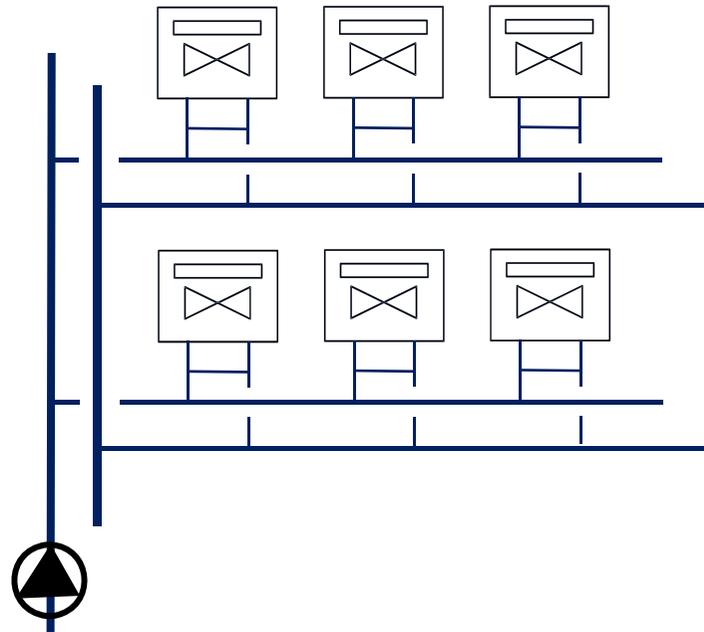
The move from constant to variable flow design enables large pump energy savings; about 6 - 8% total energy saving

Why do we need Dynamic Balancing – *constant volume*

inherently very *stable*

constant pressure drops in distribution pipework

constant pump head

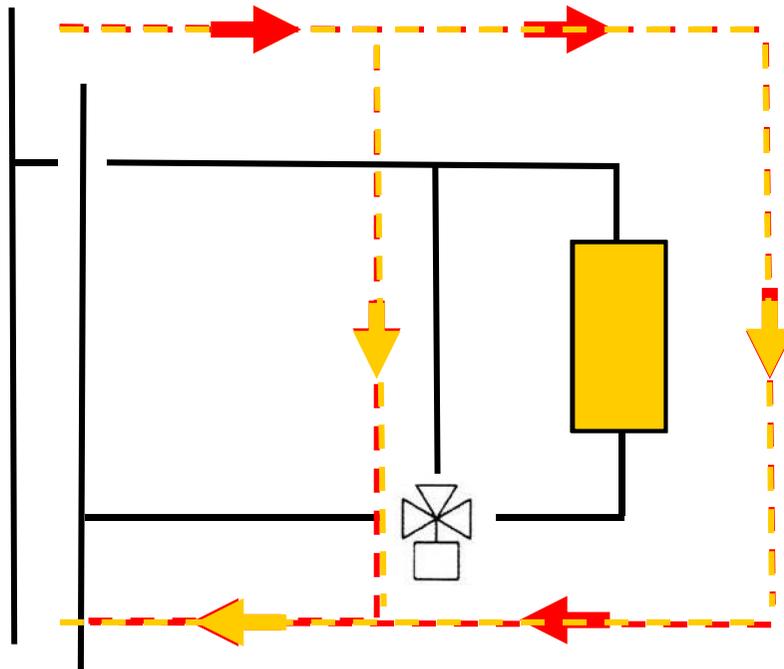


constant pressure drops in circuits at part load

constant control valve authority

Control valves easy to size with constant authority

Why do we need Dynamic Balancing – *constant volume*



constant amount of water pumped around a system controlled by 3 or 4 port control valves and would be

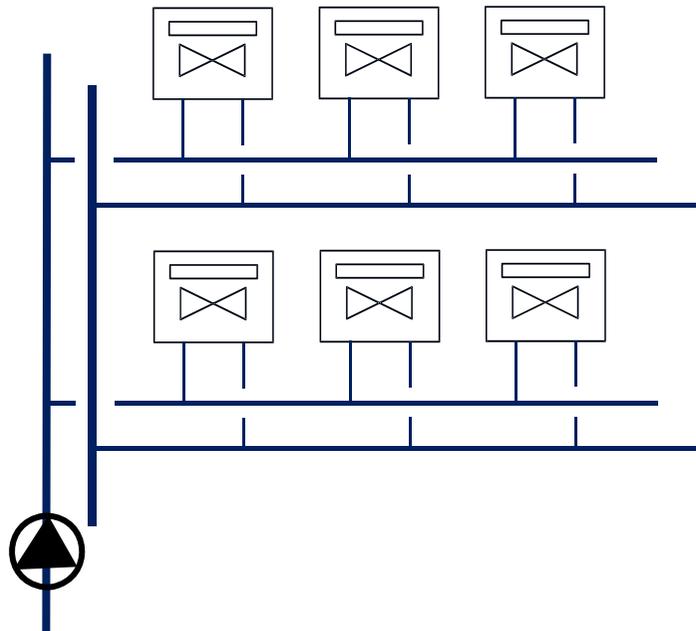
- through terminal
- split between terminal and by-pass
- diverted back if not required

Why do we need Dynamic Balancing – *variable volume*

inherently very *unstable*

variable pressure drops in distribution pipework

variable pump head



variable pressure drops in circuits at part load

variable control valve authority

Control valves difficult to size with variable authority

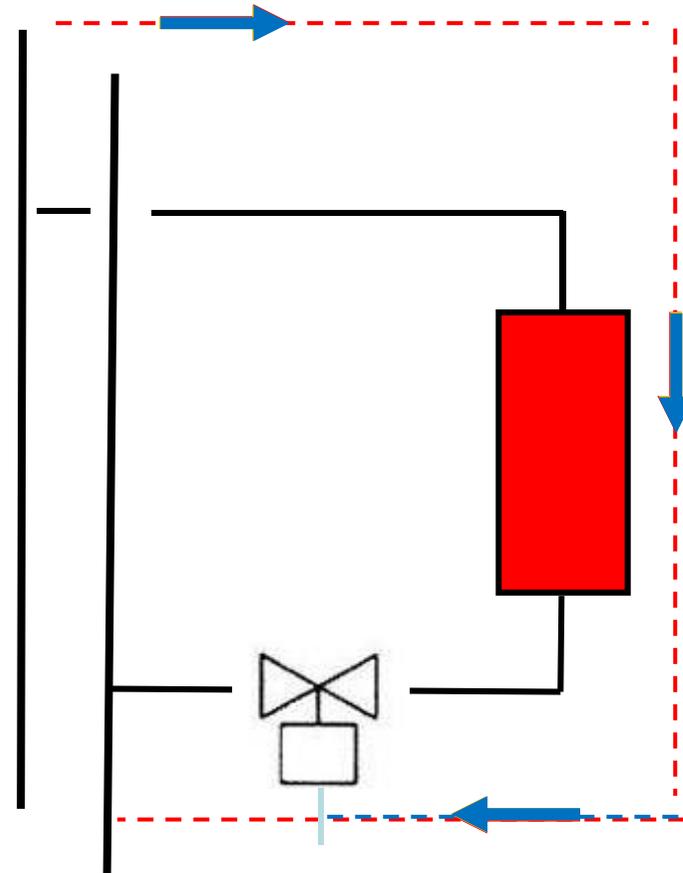
Why do we need Dynamic Balancing – *variable volume*

variable amount of water pumped around a system now controlled by 2 port control valves

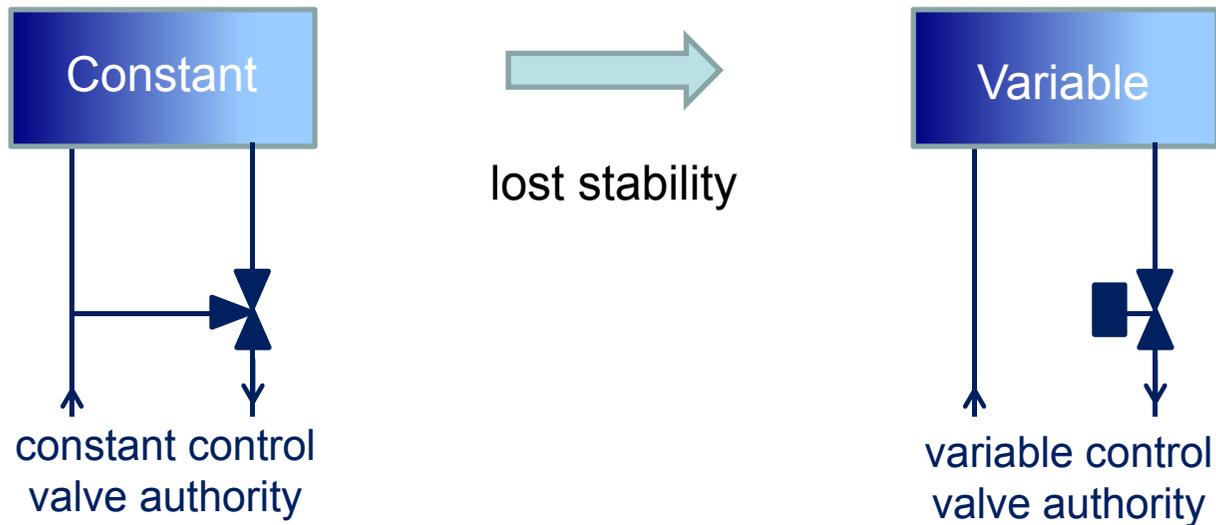
open

modulating between open and closed

closed



Why do we need Dynamic Balancing Valves



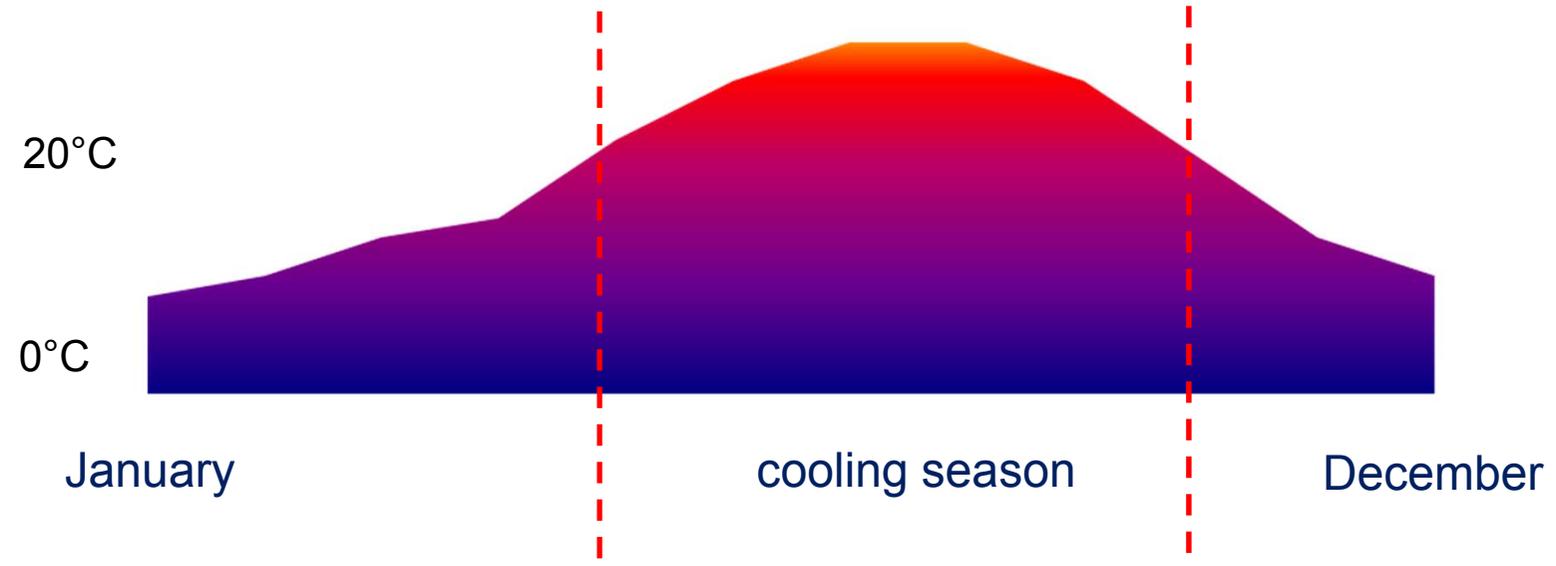
DPCV installed to protect 2 port control valve authority

or

PICVs installed to replace commissioning / control valves

Why do we need Variable Volume Systems

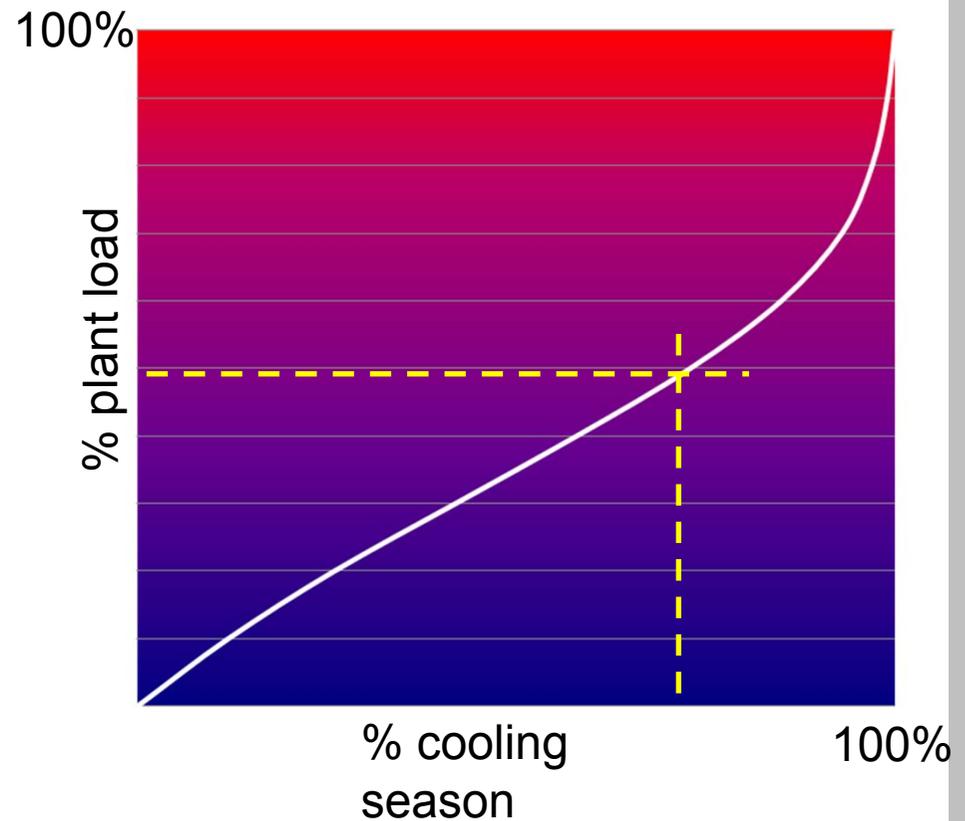
UK average temperature variations



Why do we need Variable Volume Systems

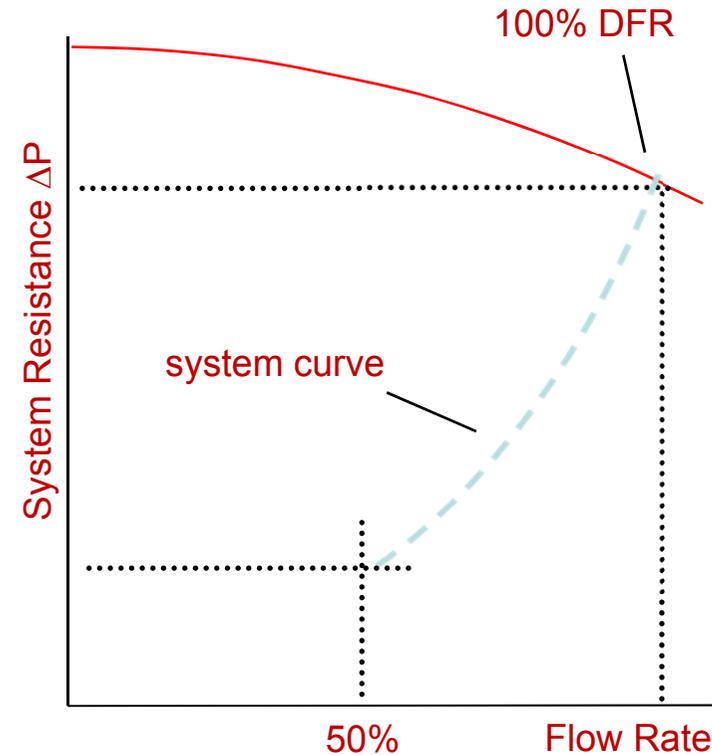
UK temperature variations

- over 70% of cooling season
- load is less than 50%



Variable Volume Pump Energy Savings

- as system demand change, flow rate changes
- direct relationship between pump speed and flow rate
- 50% pump speed = 50% flow rate



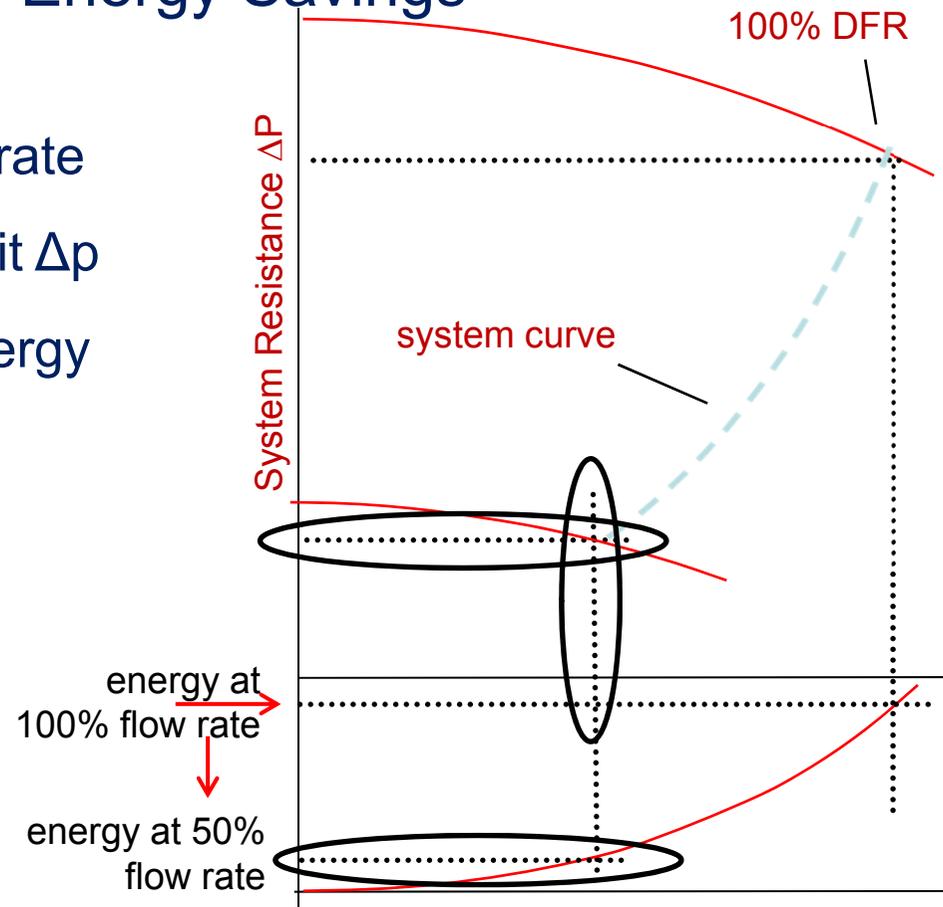
50% flow rate = 25% System Resistance

Variable Volume Pump Energy Savings

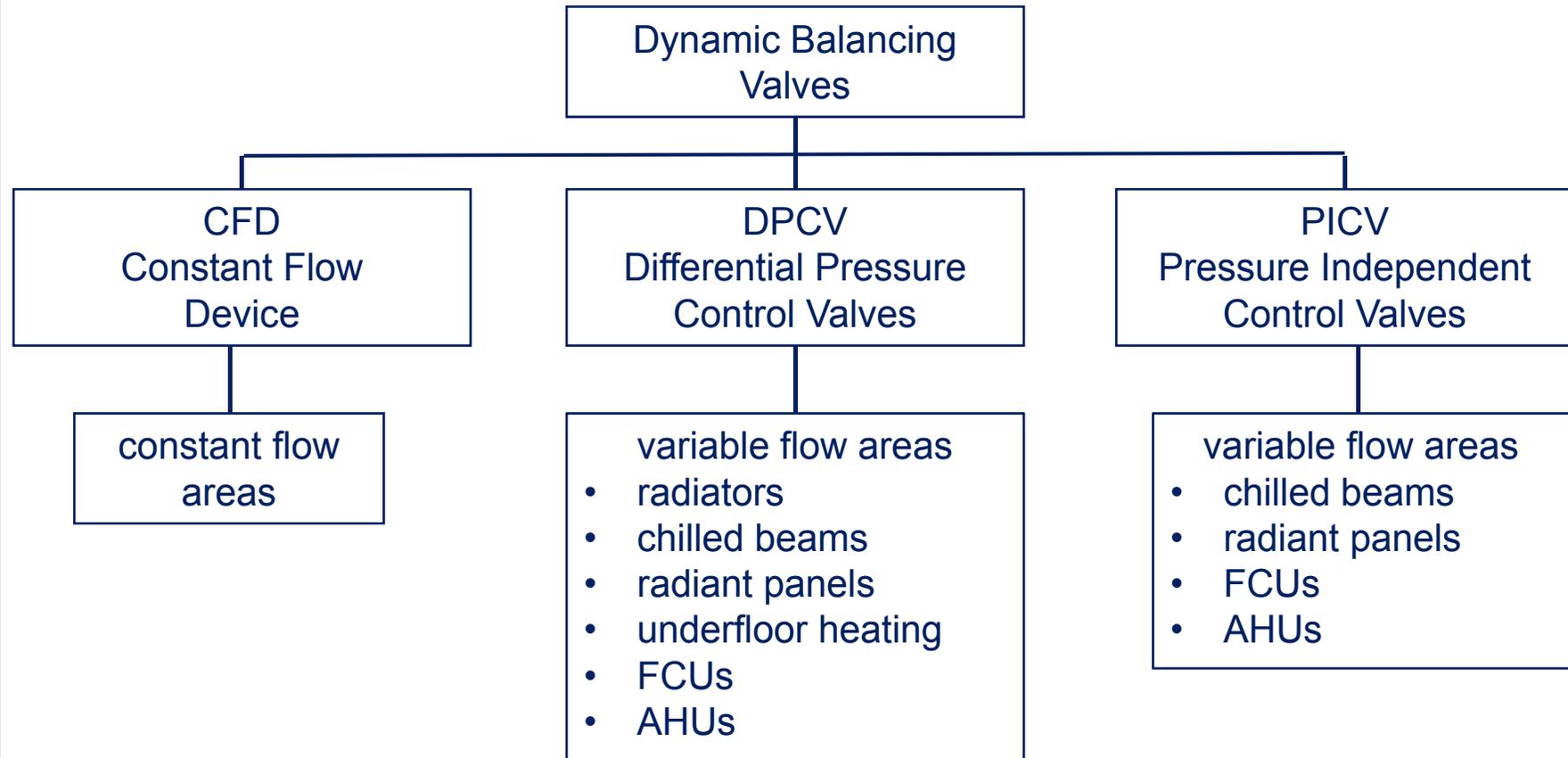
- 50% speed = 50% flow rate
- 50% flow rate = 25% circuit Δp
- 25% circuit Δp = 12.5% energy

*50% flow rate = over 70%
pump energy saving*

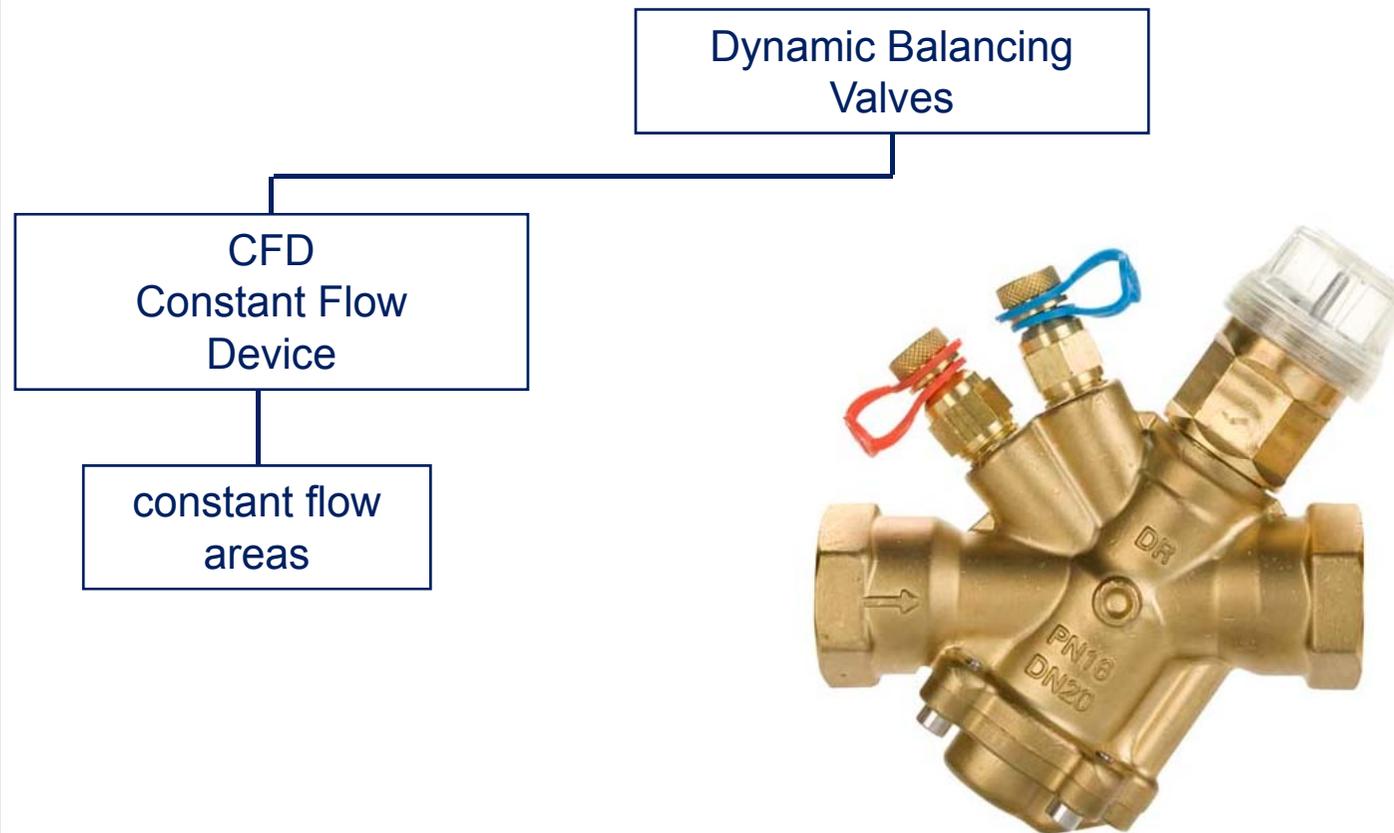
*Loses due to pump
efficiency reducing*



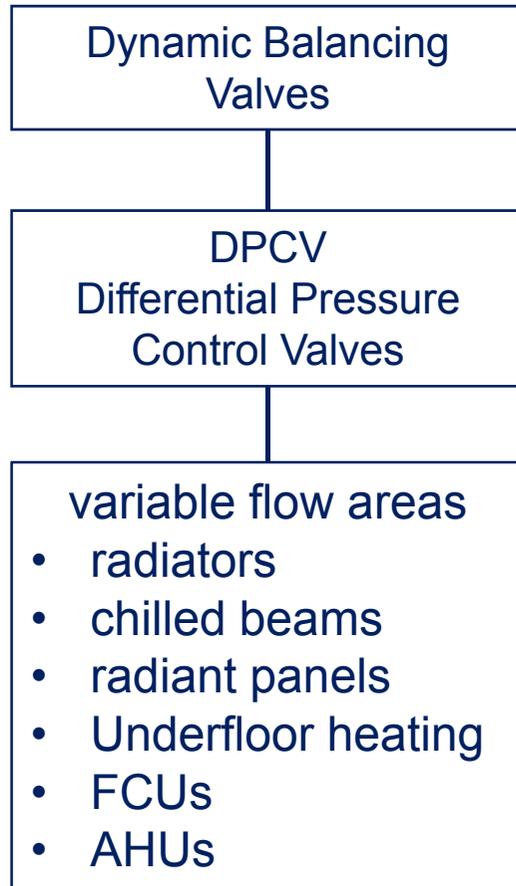
What are Dynamic Balancing Valves?



What are Dynamic Balancing Valves?



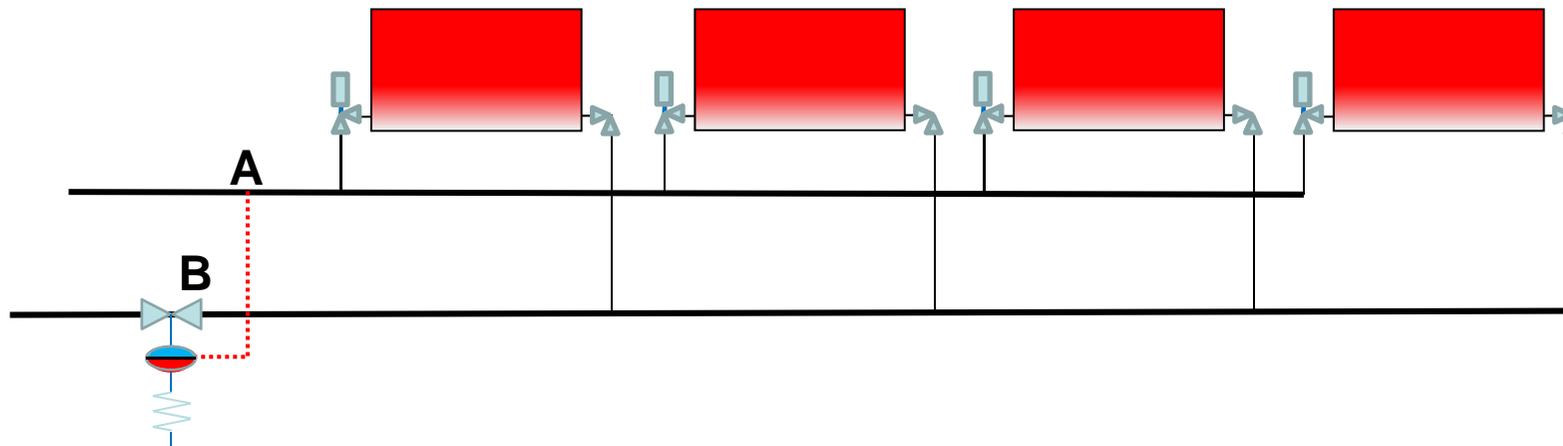
What are Dynamic Balancing Valves?



Why do we need Dynamic Balancing – *radiators circuits*

to enable TRV (Thermostatic Radiator Valves) to correctly operate, a DPCV is installed to limit the radiator sub-circuit pressure differential

the installation of DPCVs in sub-circuits with TRVs reduces the pressure that the TRV has to close against thus reducing the possibility of noisy valves

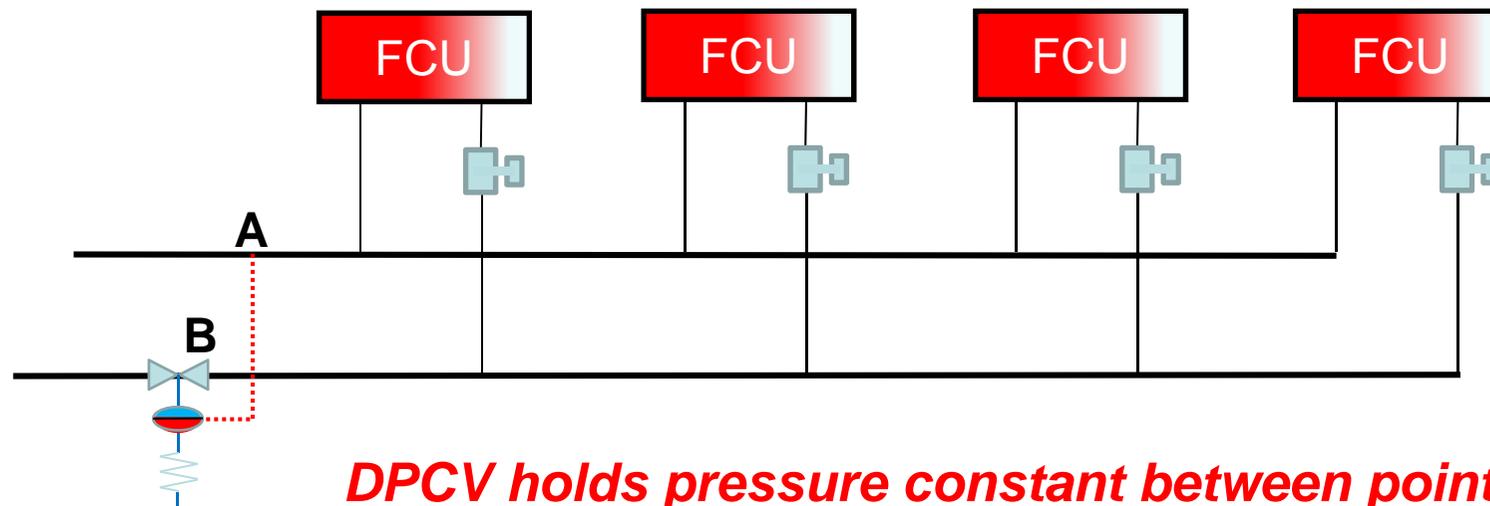


DPCV holds pressure constant between points A and B

Why do we need Dynamic Balancing – *DPCVs for FCU*

to enable modulating 2 port control valves to operate with an acceptable authority, a DPCV is installed to limit the circuit pressure differential

the installation of DPCVs on sub-branches with 2 port control valves is therefore essential to achieve good control



DPCV holds pressure constant between points A and B

Why do we need DPCVs - control valve authority

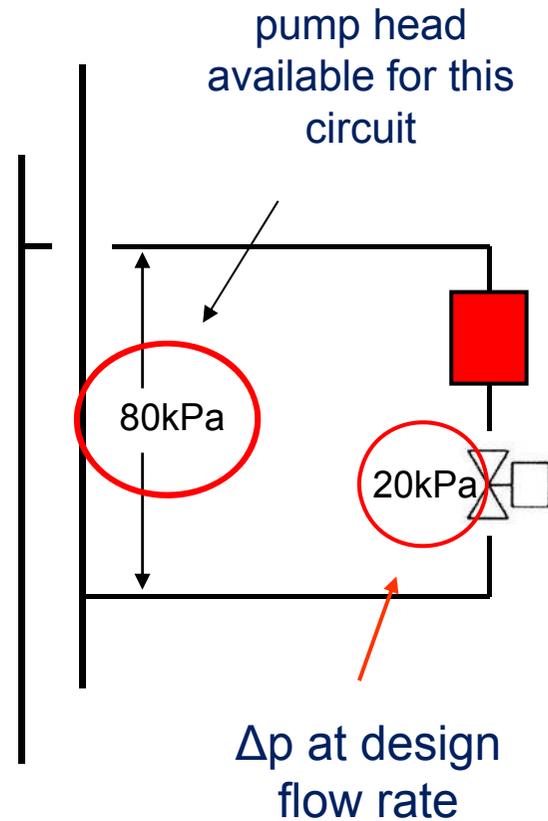
example without DPCV

$$\text{valve authority } \beta = \frac{\Delta p \text{ across 2 port}}{\Delta p \text{ across circuit}}$$

$$\beta = \frac{20 \text{ kPa}}{80 \text{ kPa}}$$

$$\beta = 0.25$$

too low - unacceptable



Why do we need DPCVs - control valve authority

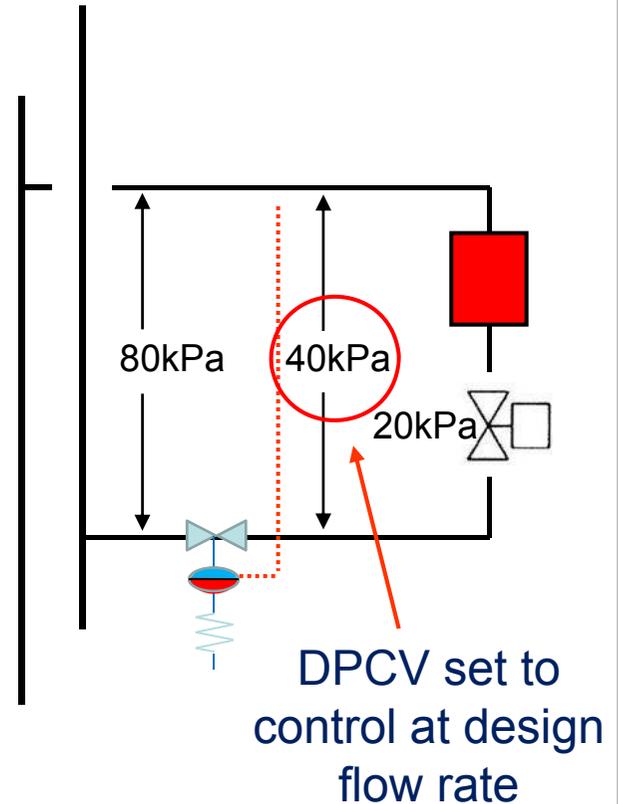
example with DPCV fitted

$$\text{valve authority } \beta = \frac{\Delta p \text{ across 2 port}}{\Delta p \text{ across circuit}}$$

$$\beta = \frac{20 \text{ kPa}}{40 \text{ kPa}}$$

$$\beta = 0.5$$

acceptable



Why do we need DPCVs - control valve authority

position of DPCV?

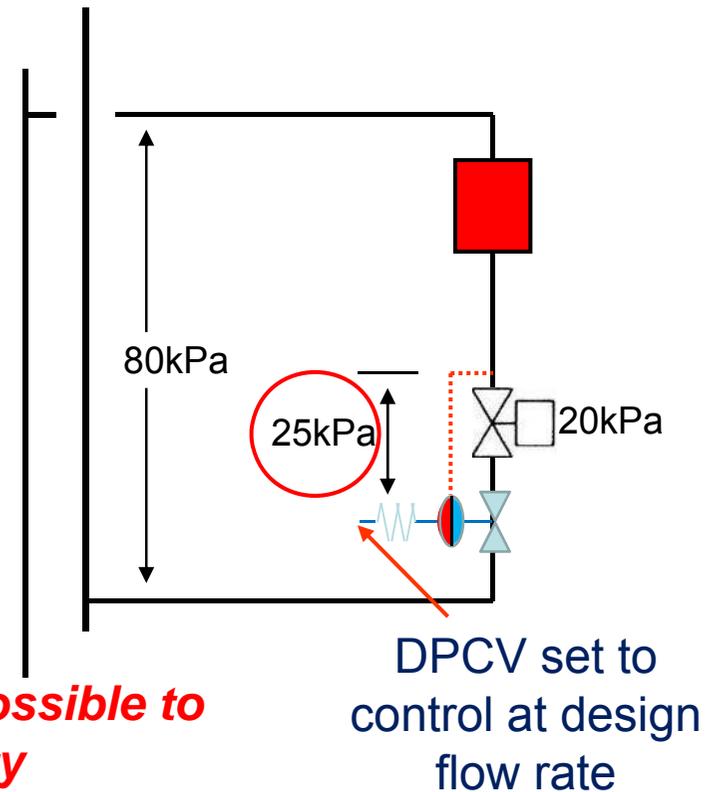
$$\text{valve authority } \beta = \frac{\Delta p \text{ across 2 port}}{\Delta p \text{ across circuit}}$$

$$\beta = \frac{20 \text{ kPa}}{25 \text{ kPa}}$$

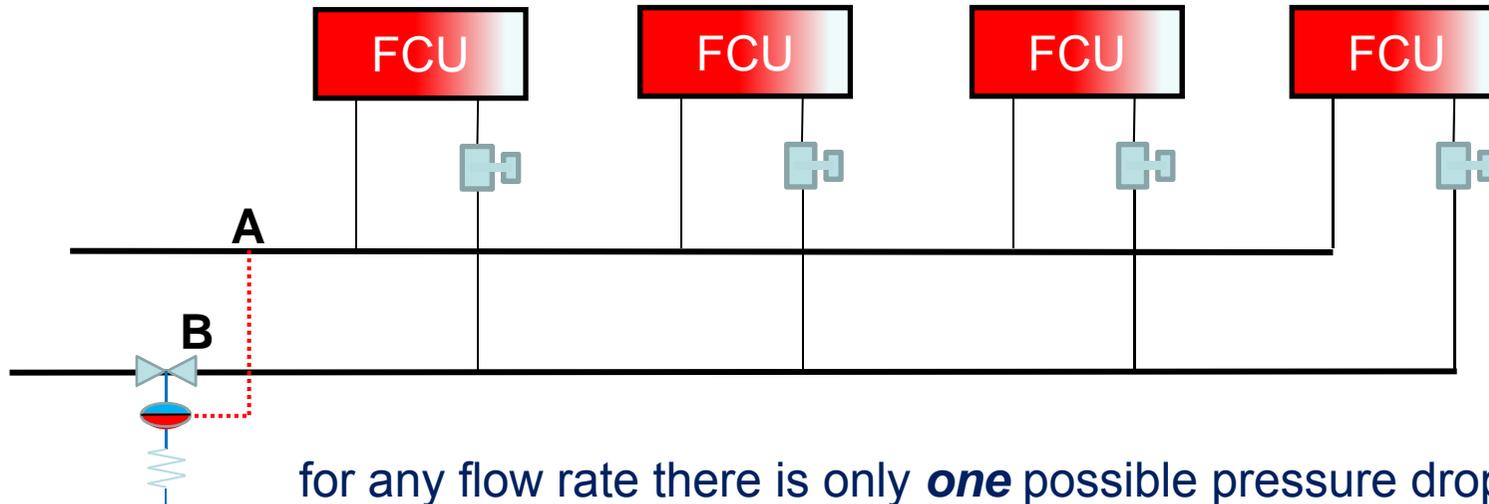
$$\beta = 0.8$$

position can influence authority

on single terminal circuits – as closes as possible to control valves gives higher authority



How do DPCVs work



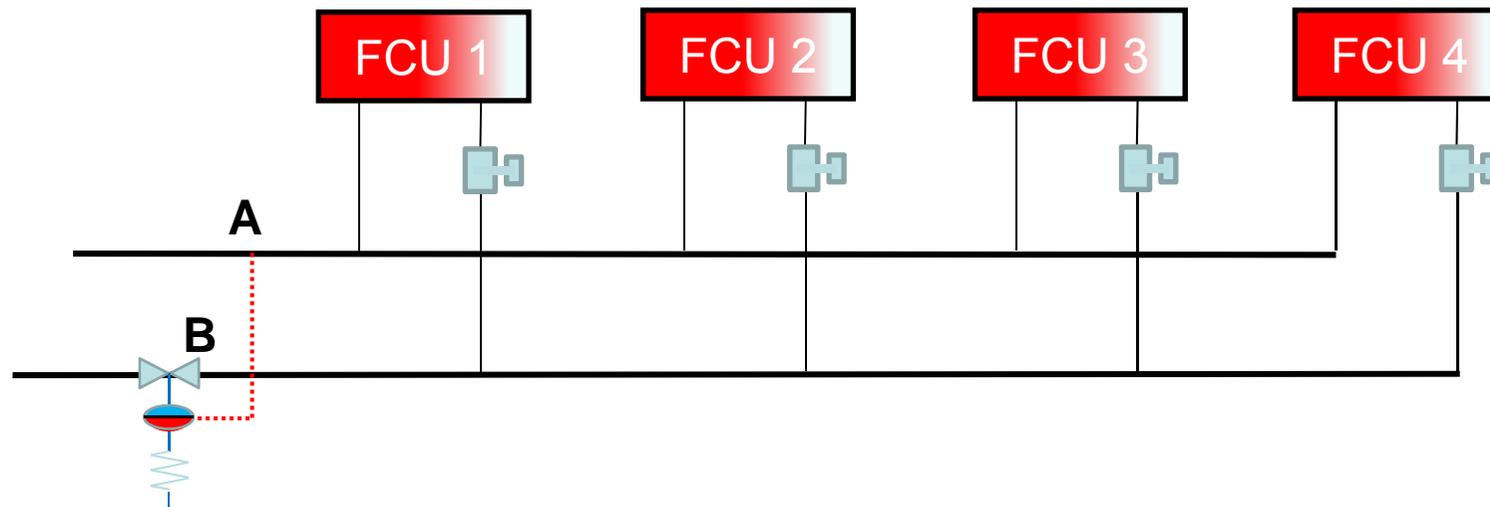
for any flow rate there is only **one** possible pressure drop between any 2 points

as flow rate changes Δp changes – squared change

10% in flow = 21% in Δp

DPCV holds pressure constant between points A and B

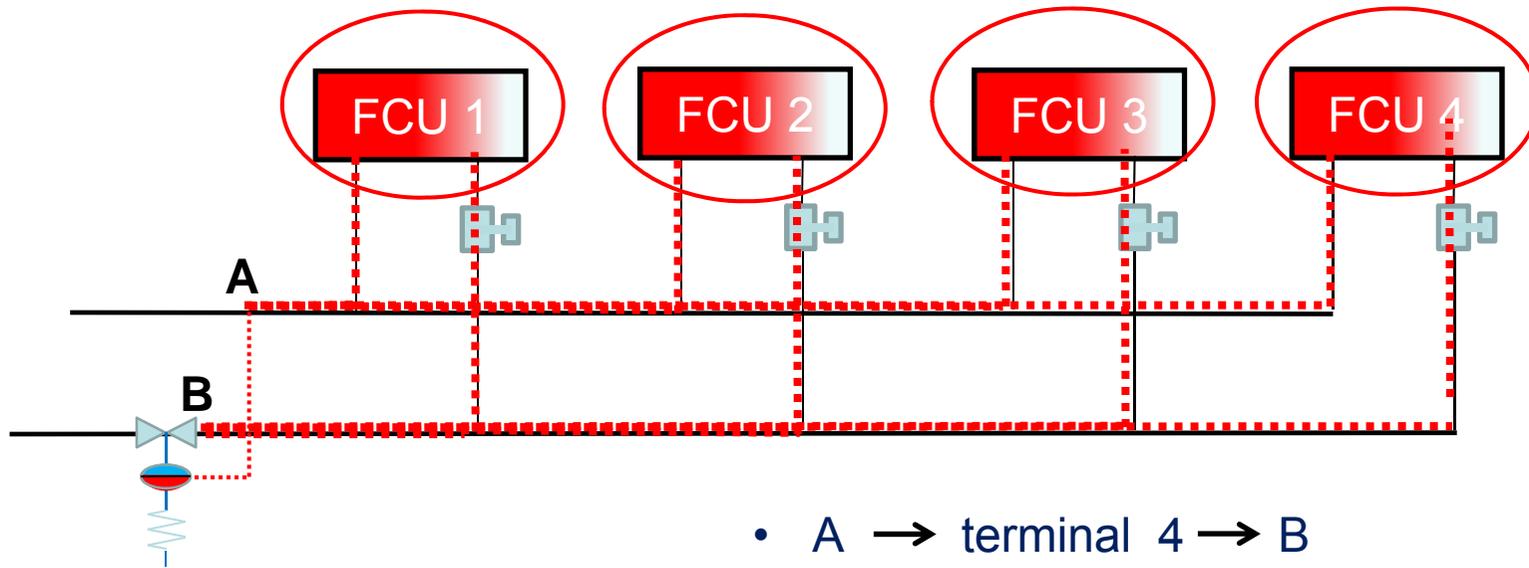
Why a DPCVs work



Kirchhoff's 2nd law states

'head loss in parallel circuits must be equal'

Why a DPCVs work



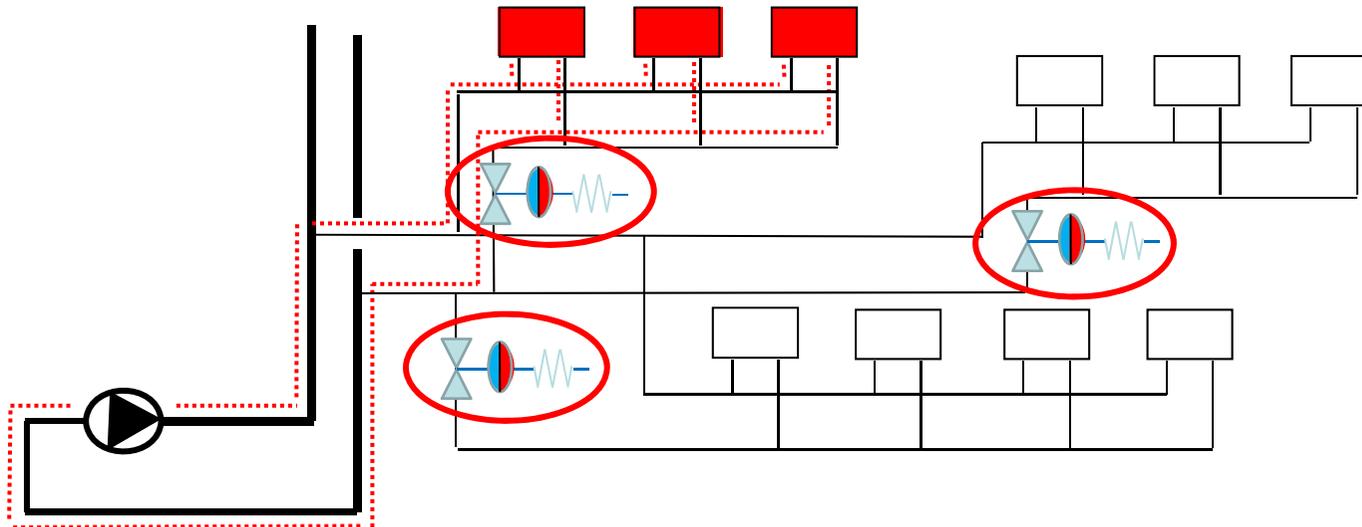
applying Kirchoff's law

- A → terminal 4 → B
- A → terminal 3 → B
- A → terminal 2 → B
- A → terminal 1 → B

all have the same pressure drop irrespective of flow

Where do DPCVs go

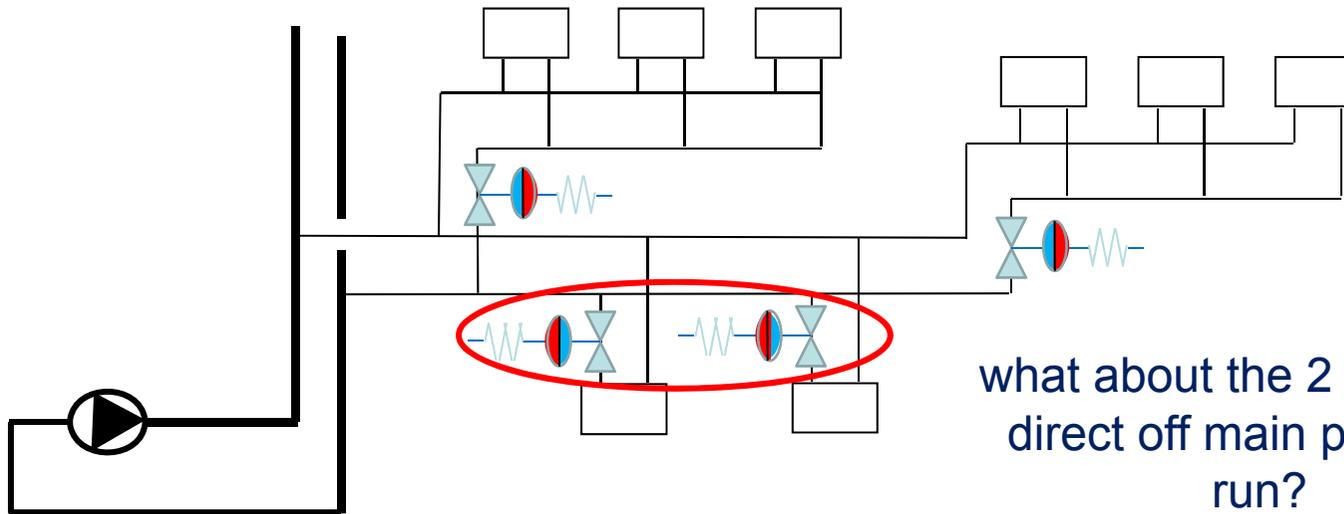
branches are broken down into sub-circuits,
each controlled by a DPCV



each circuit must only flow through a single DPCV

Where do DPCVs go

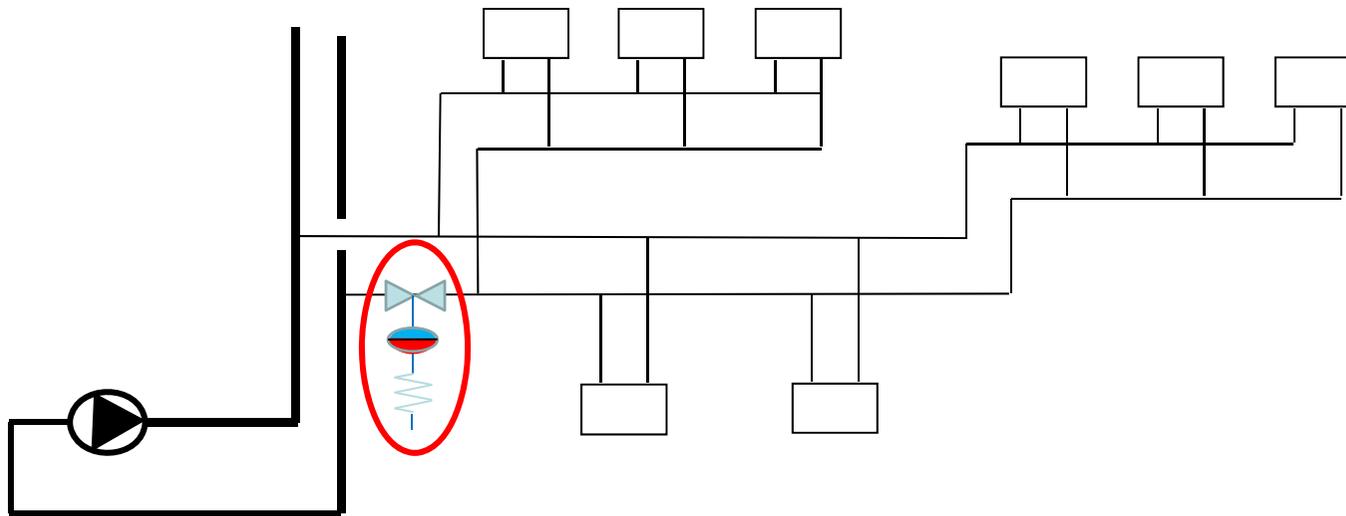
branches are broken down into sub-circuits,
each controlled by a DPCV



each circuit must have some protected from over flow

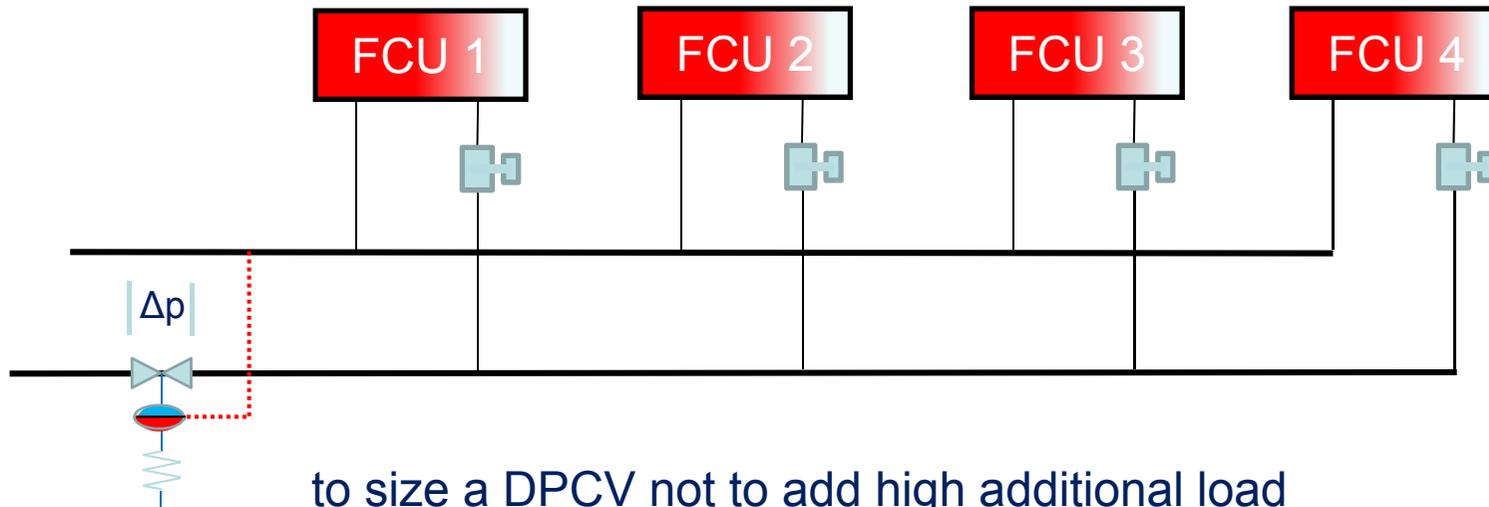
Where do DPCVs go

alternative approach

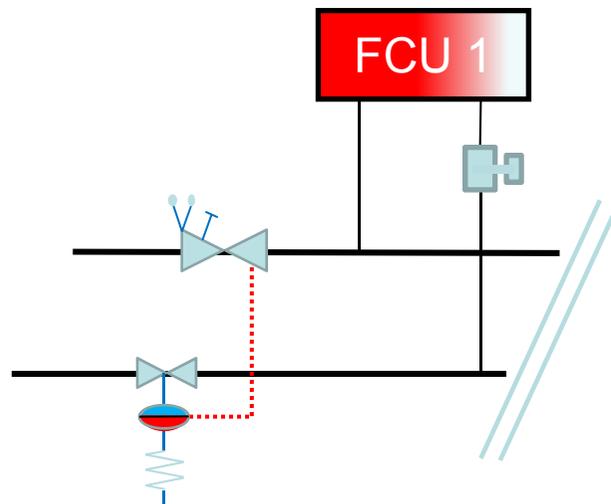


complete circuit protected by a single DPCV

How are DPCVs selected



Other Valves associated with DPCVs - Companion Valve



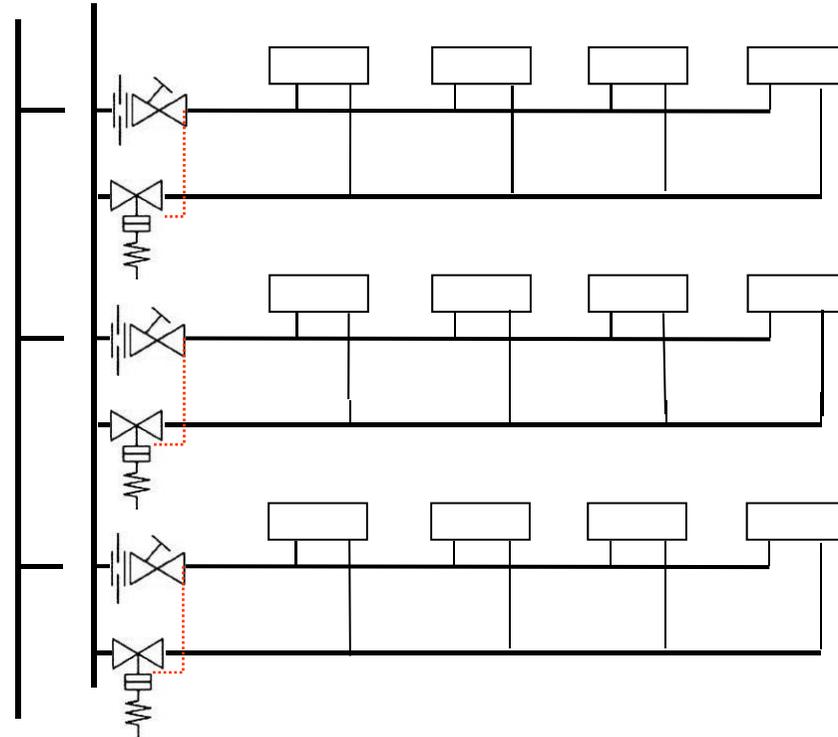
Companion Valve offers

- flow measurement
- isolation
- DPCV connection
- bosses for test points



Dynamic Balancing of the System

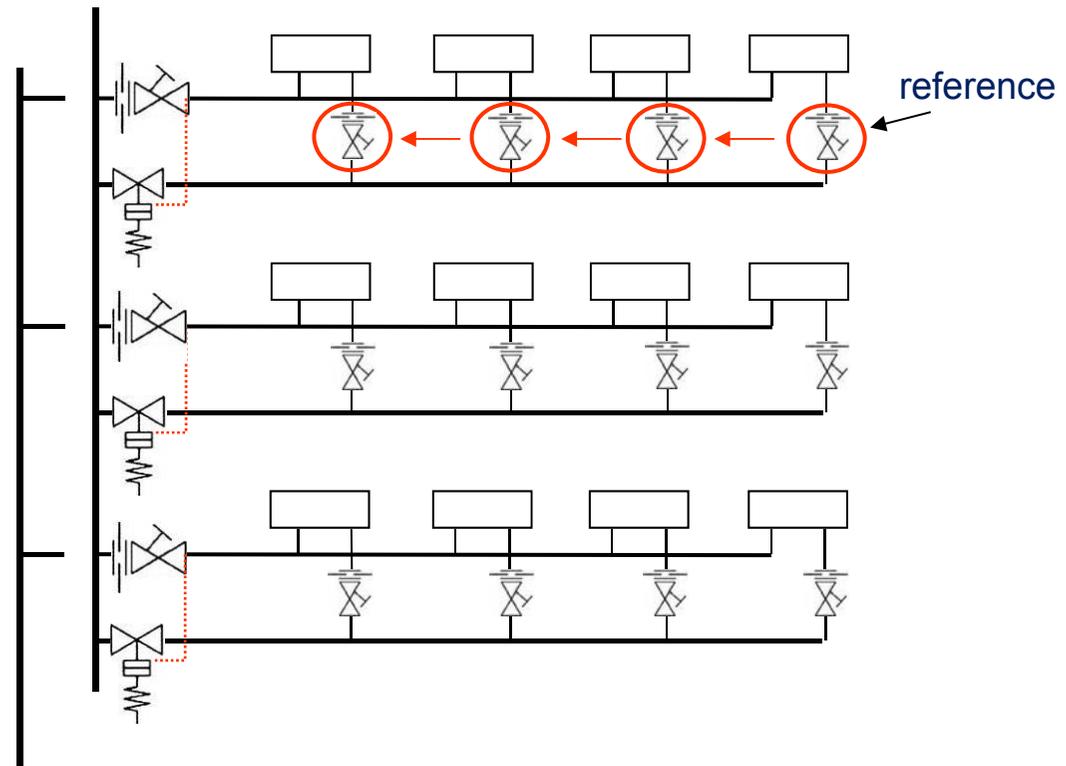
because each sub-circuit is separated by a DPCV from fluctuating system pressure & therefore holds a constant pressure within the sub-circuit, commissioning sub-circuits can be carried out totally independently



sub-circuits are independent of each other

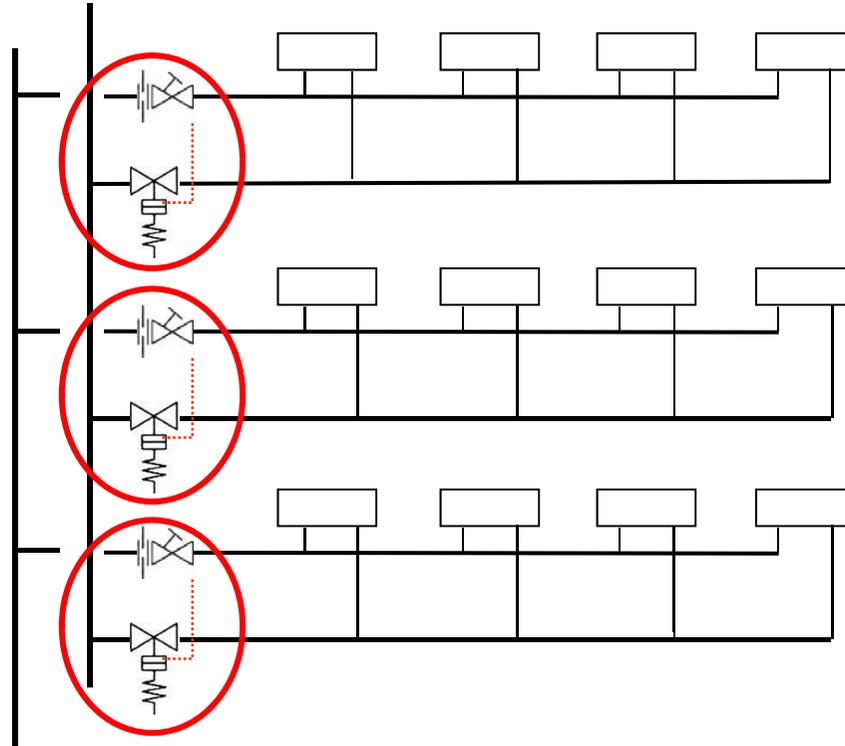
Dynamic Balancing of the System

commissioning within the sub-circuits is carried out by 'proportional balancing' in the conventional manner



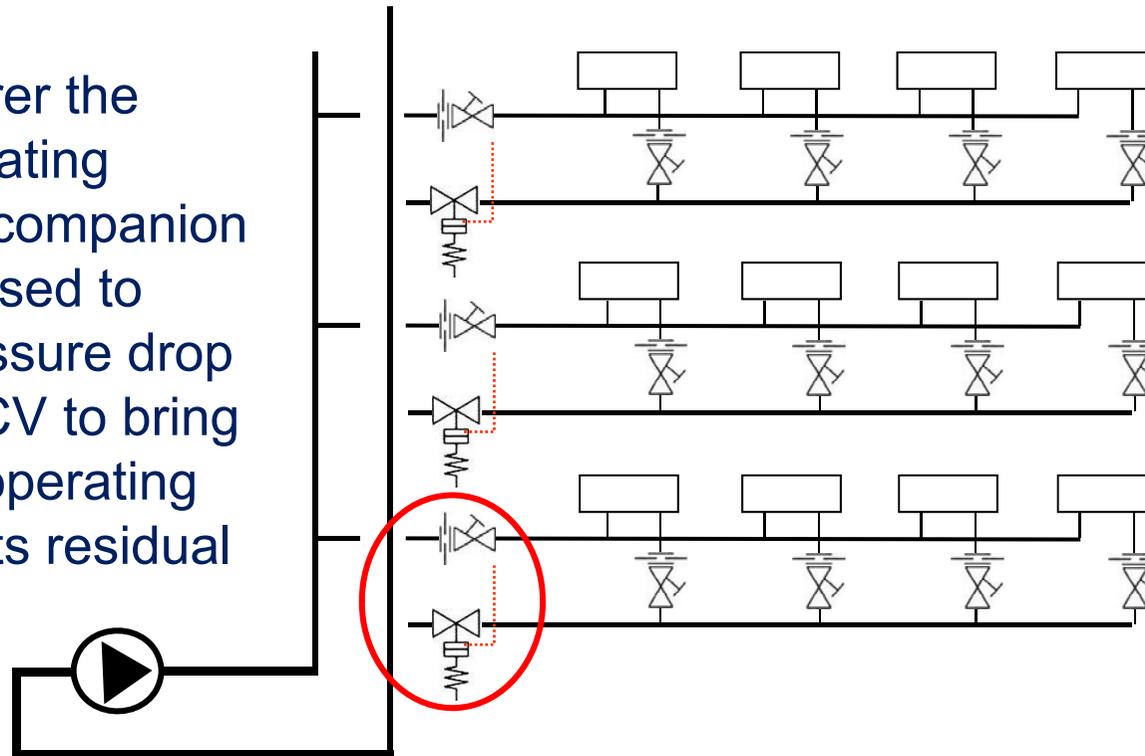
Dynamic Balancing of the System

each sub-circuit is balanced by measuring flow thro the 'Companion Valve' and adjusting DPCV to regulate flow

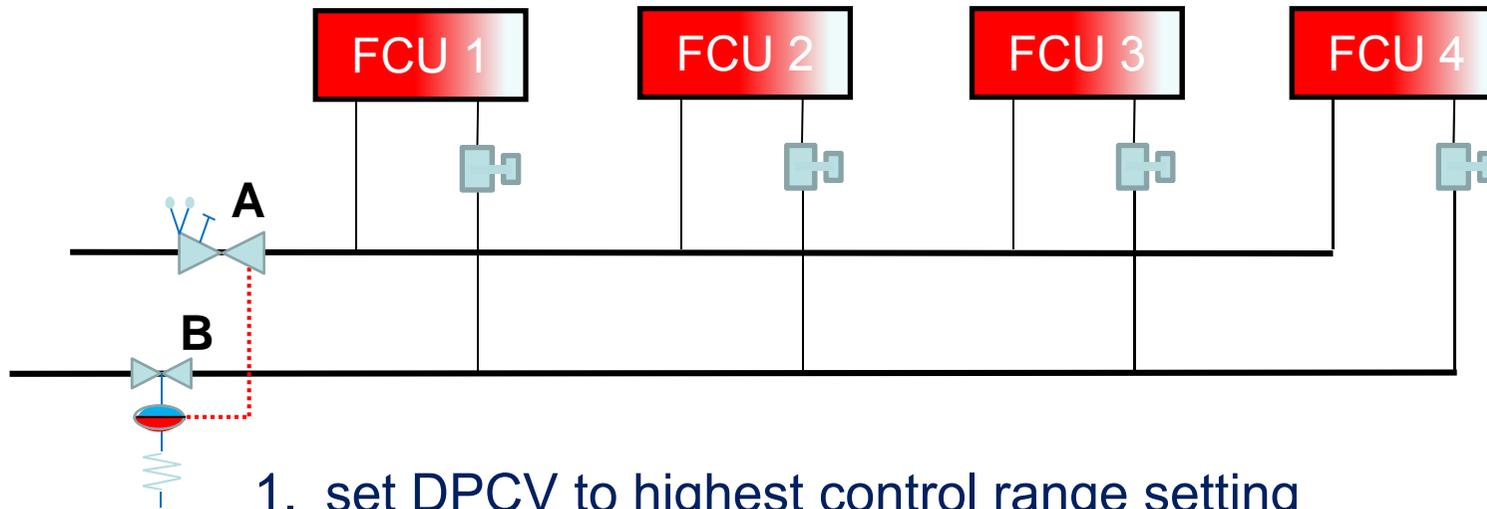


Dynamic Balancing of the System

for circuits nearer the pump the regulating function of the companion valve may be used to reduce the pressure drop across the DPCV to bring it into a better operating position, ie splits residual pressure

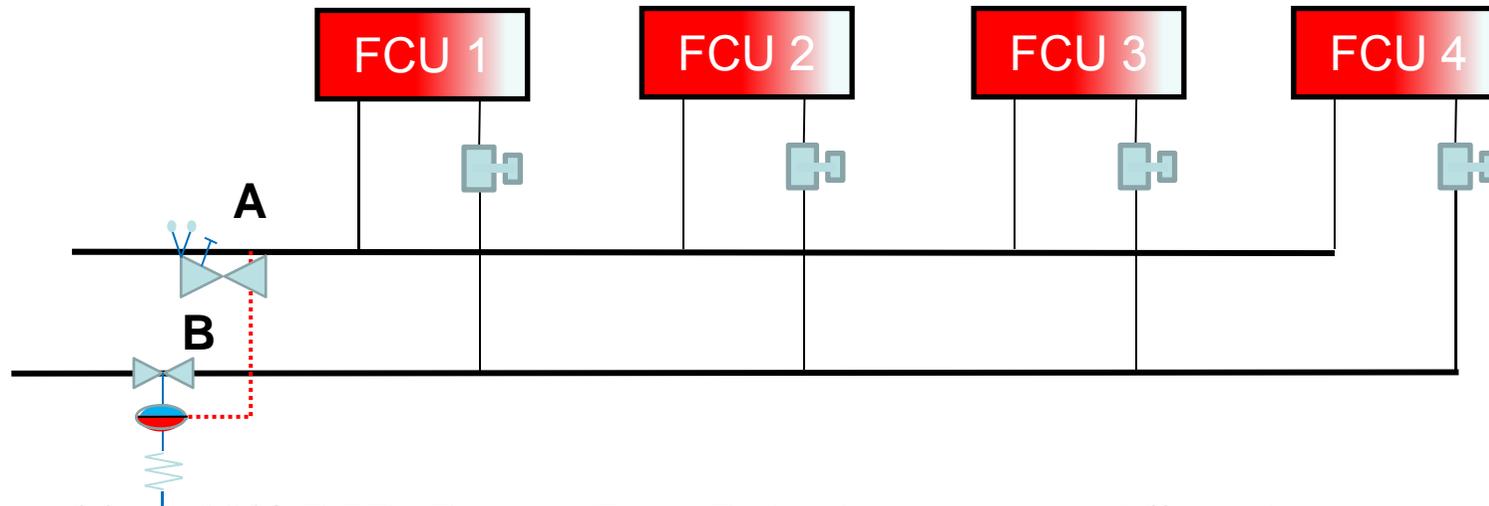


Dynamic Balancing of the System



1. set DPCV to highest control range setting
 - highest pressure difference gives highest flow rates
2. measure flow rate at companion valve
3. adjust DPCV until design flow rate achieved

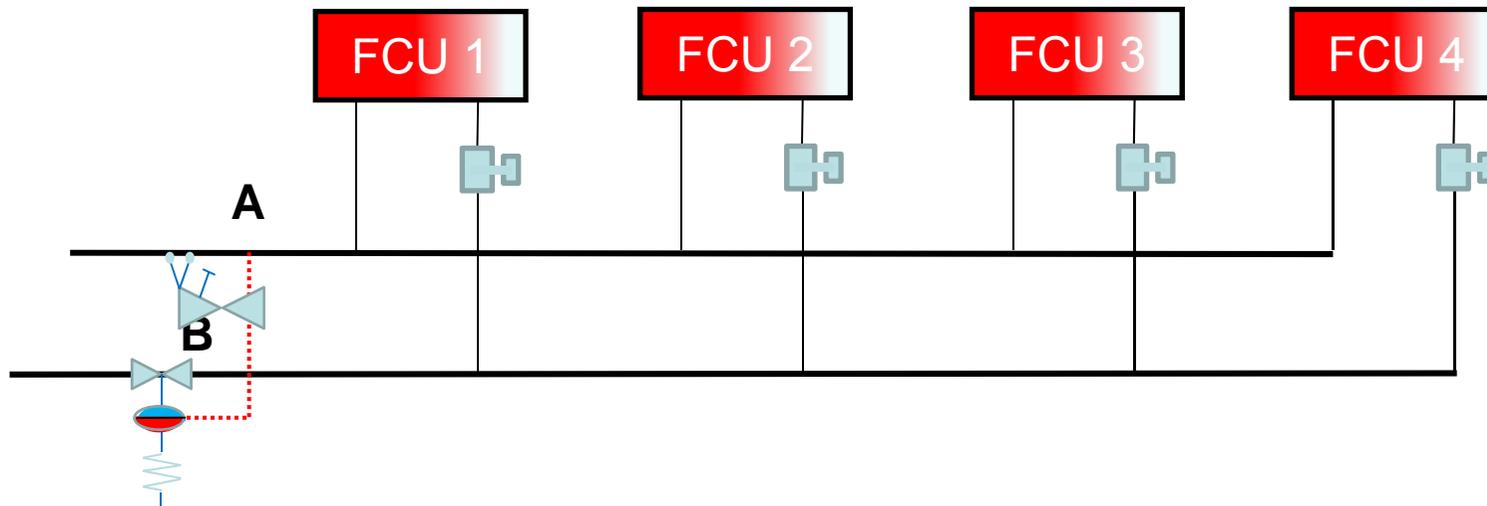
Dynamic Balancing of the System



if for 100% DFR (Design Flow Rate) the required differential pressure drop between **A** & **B** is greater than the highest Δp setting on the DPCV 100% DFR can never be achieved – flow rate will always be lower

- the DPCV will absorb any additional pump head trying to increase flow rate you will have to;
 1. accept lower flow rate achieved
 2. change DPCV actuator to increase Δp setting

Dynamic Balancing of the System



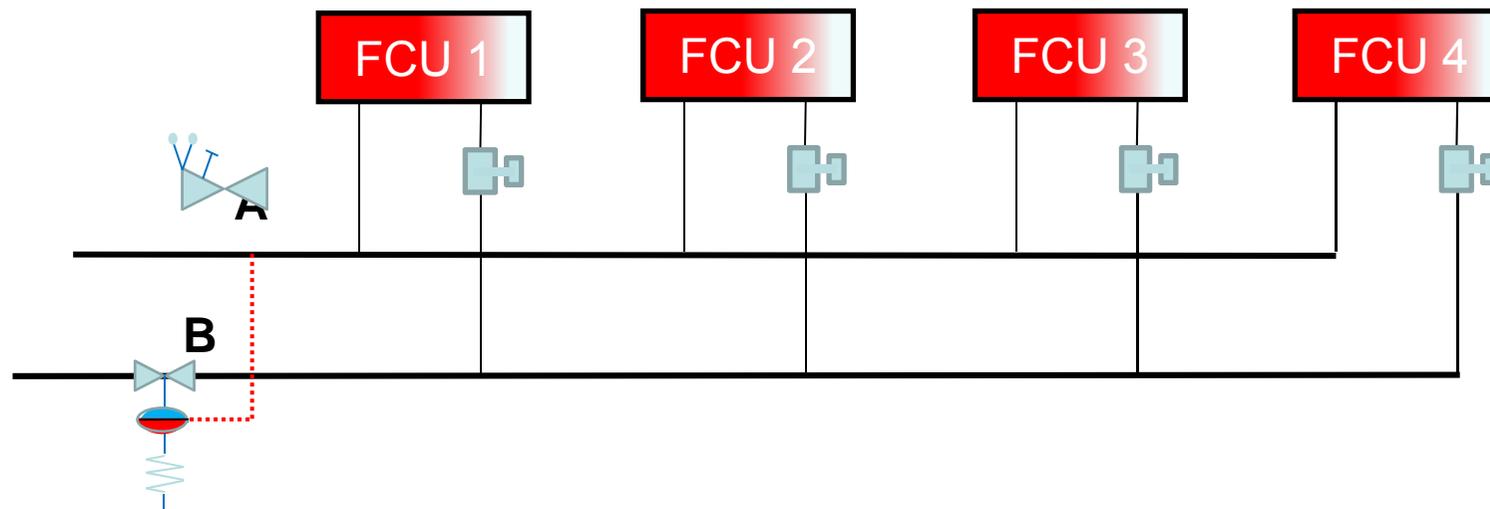
if for 100% DFR (Design Flow Rate) the required differential pressure drop between **A** & **B** is *lower* than the *lowest* Δp setting on the DPCV

- 100% DFR will never be stable – flow rate will *increase with pressure*

there are 3 options;

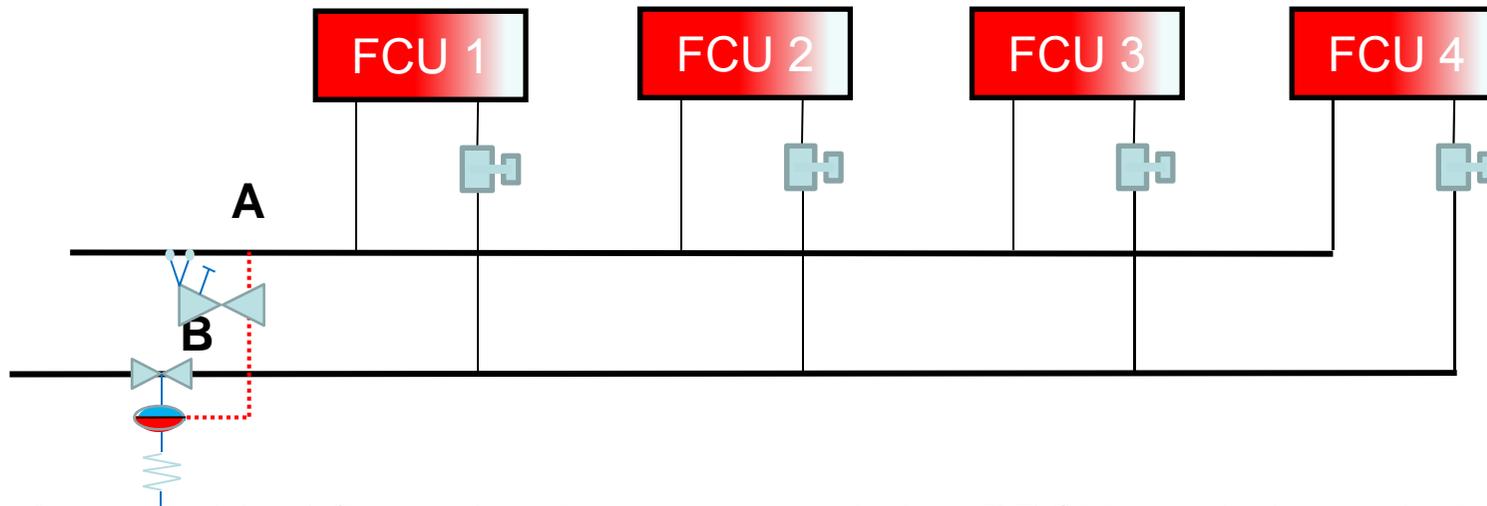
1. change actuator
2. accept that flow rate will increase until the DPCV reacts to control Δp
3. increase Δp through circuit

Dynamic Balancing of the System



1. change the actuator
 - for smaller valve its integral
 - for larger valves it can be changed

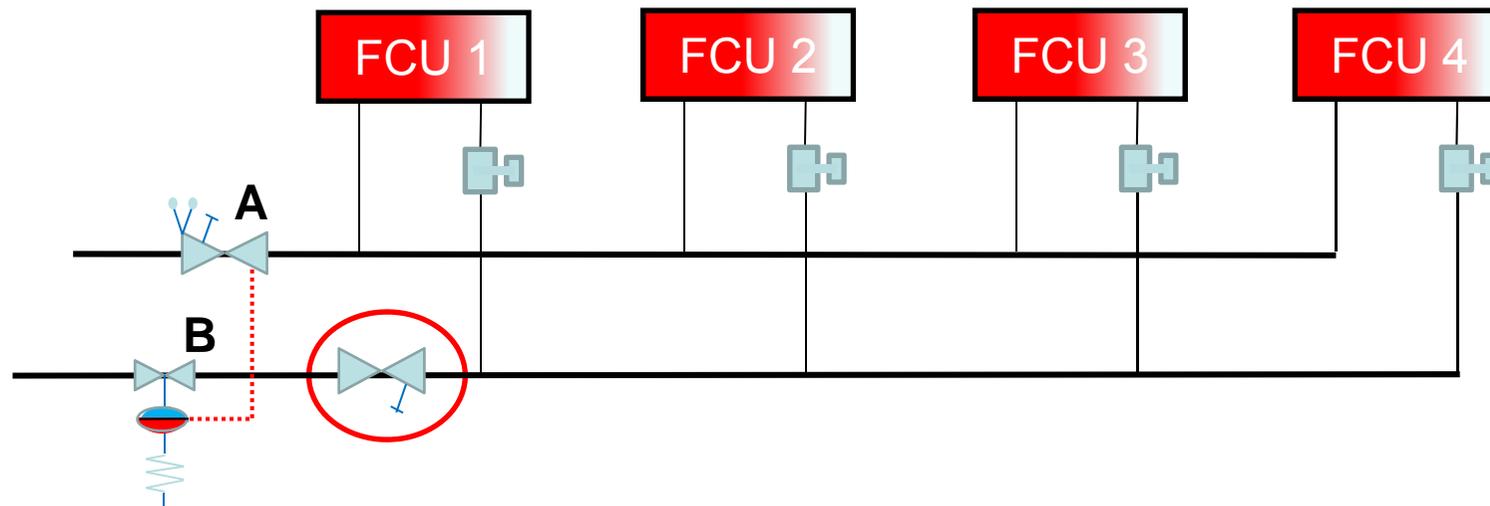
Dynamic Balancing of the System



2. accept that flow rate will increase until the DPCV reacts to control Δp
example

- minimum DPCV set point = 20kPa
- actual Δp though circuit = 12kPa at 100% DFR
- the actual Δp will increase from 12 to 20 = 67% increase
- flow rate will increase by $\sqrt{\% \Delta p}$, ie 100% + 67% = 167%
- flow rate % = $\sqrt{1.67} = 1.30$, ie 30% increase over 100% DFR

Dynamic Balancing of the System



3. increase Δp through circuit

- with DPCV set to minimum set point
- increase Δp using a *common DRV if fitted*
 - this increases Δp through all circuits

Variable Volume System

at maximum pump turndown, typically 10 - 20%,
consideration needs to be given to branches to ensure

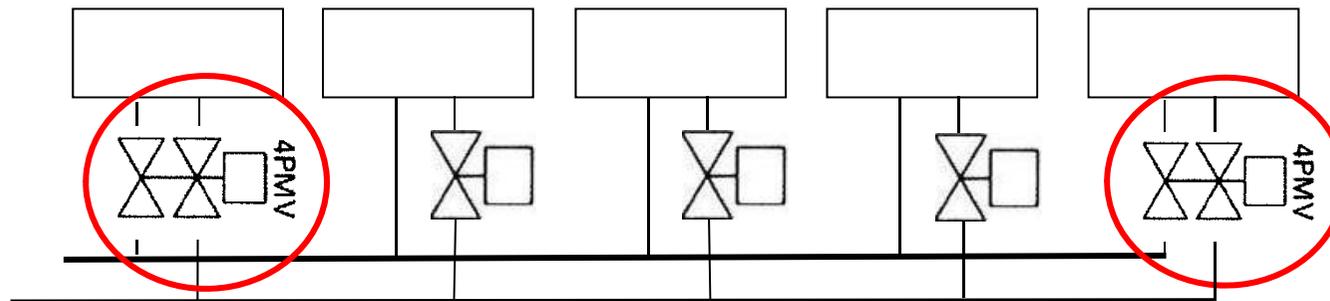
- pump flow at minimum load
- circulation of water treatment
- ready supply of heating / chilled water

Dynamic Balancing of the System

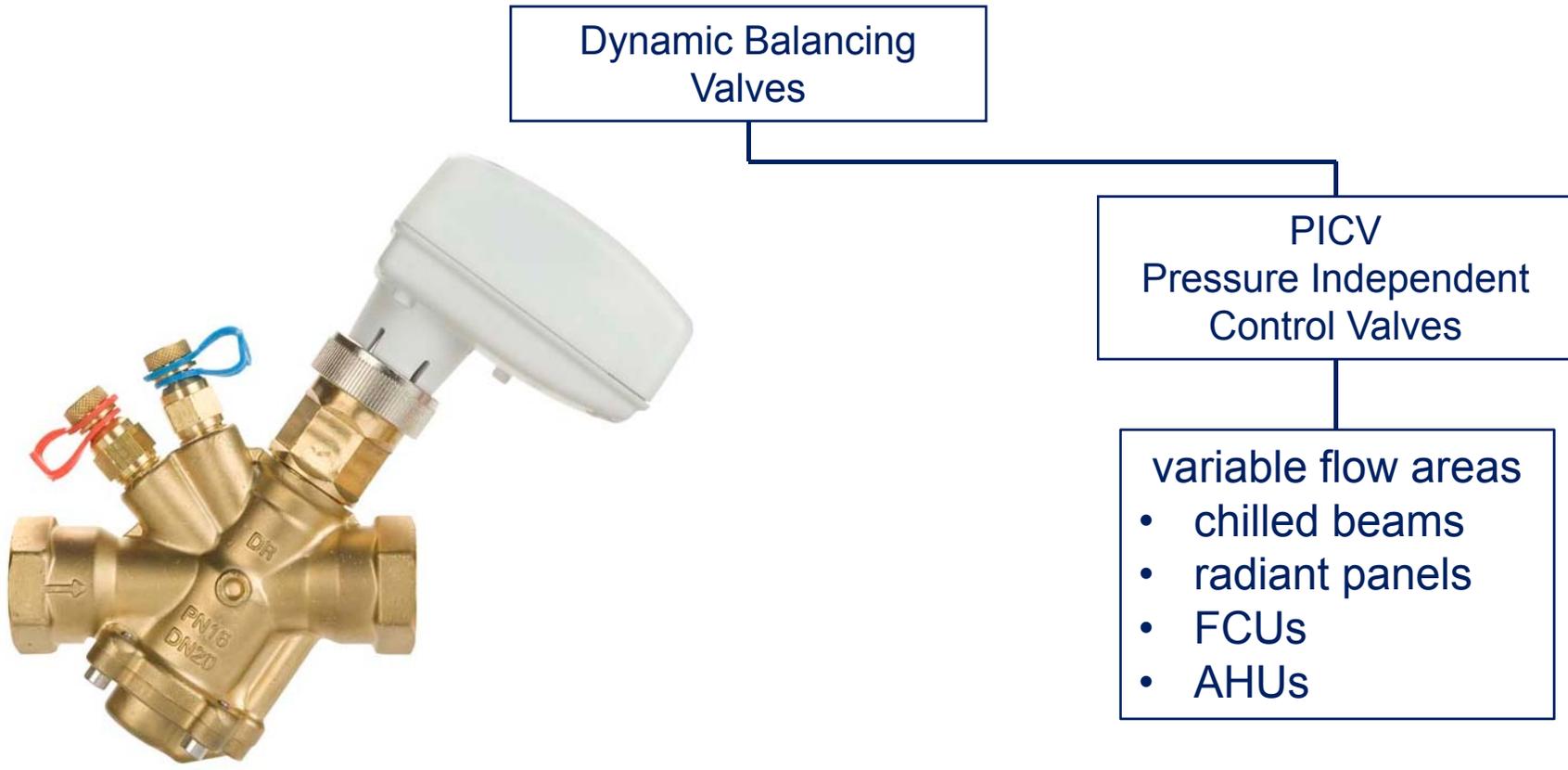
possible solution

end terminal could have a 3 or 4 port control valve

- on larger circuits additional 3 or 4 ports could be added



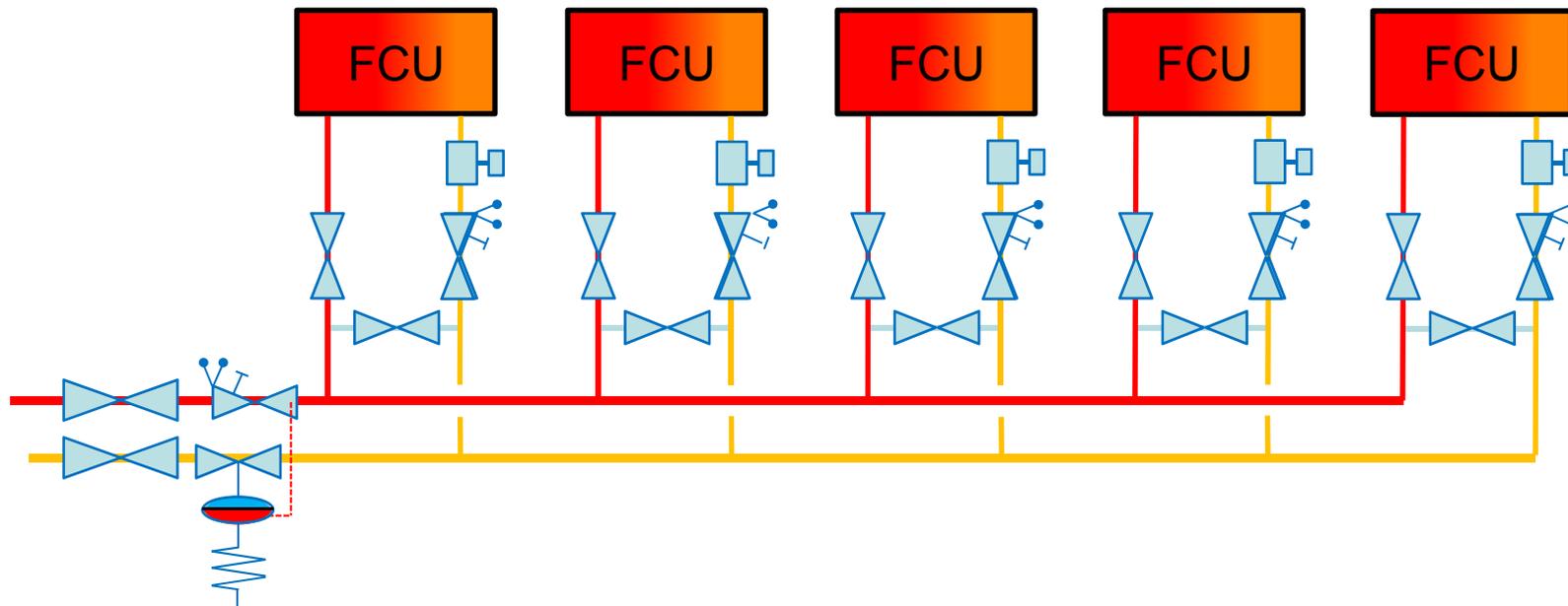
What are Dynamic Balancing Valves?



Controlling Fluctuating System Pressures

following the move to *variable volume* system design

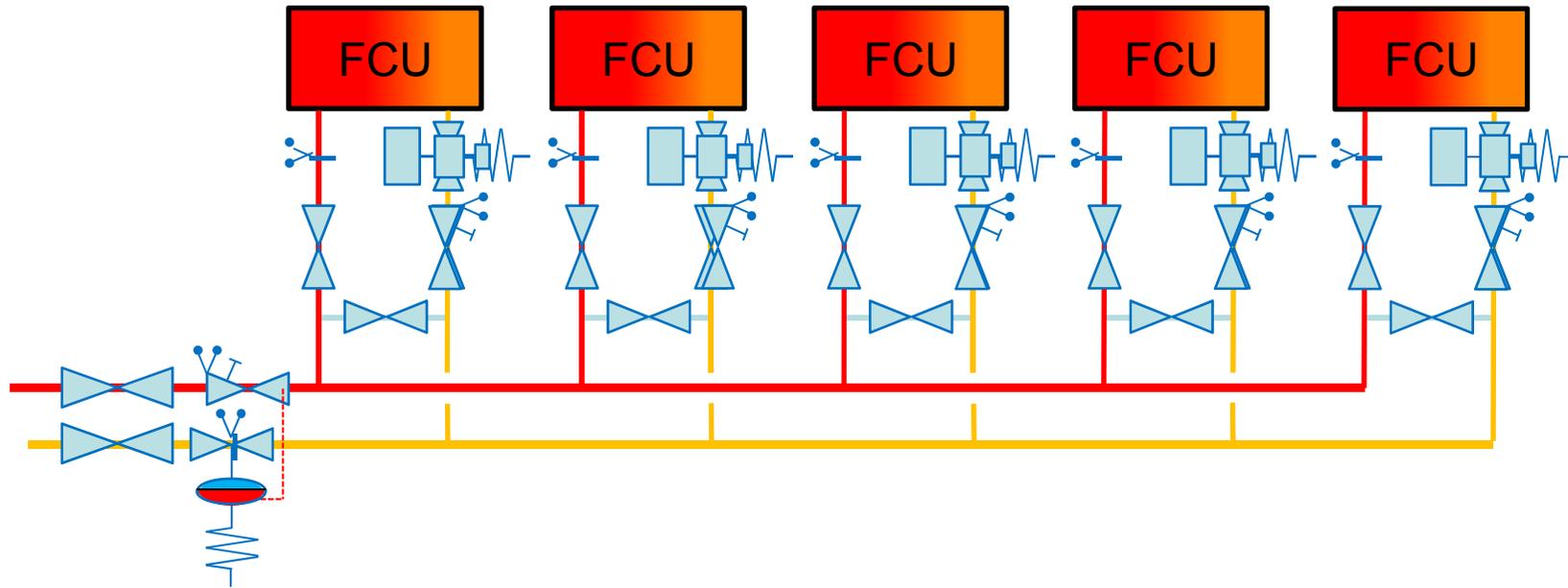
- DPCVs were used to create areas with stable pressures



Controlling Fluctuating System Pressures

PICVs replacing DPCVs

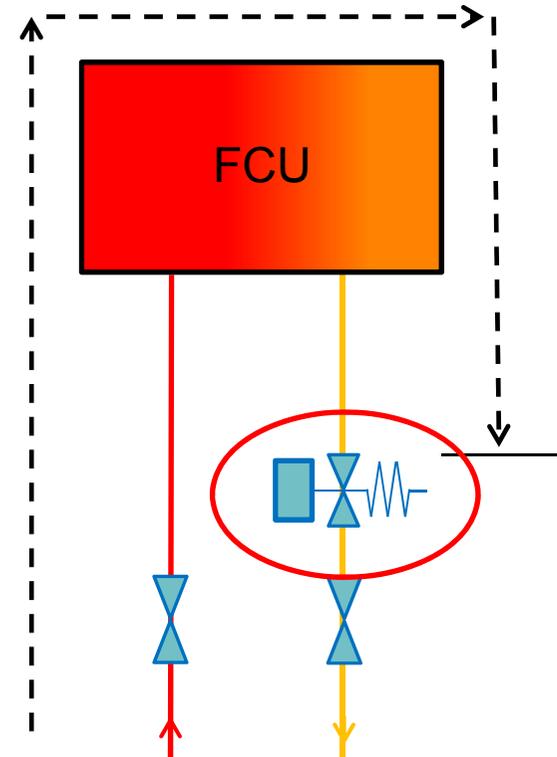
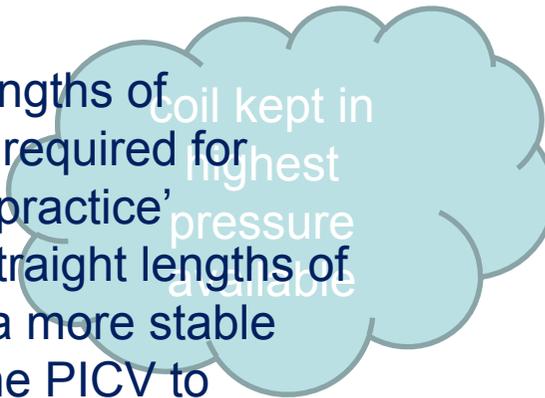
other valves required?



the PICV is fitted instead of – not as well as

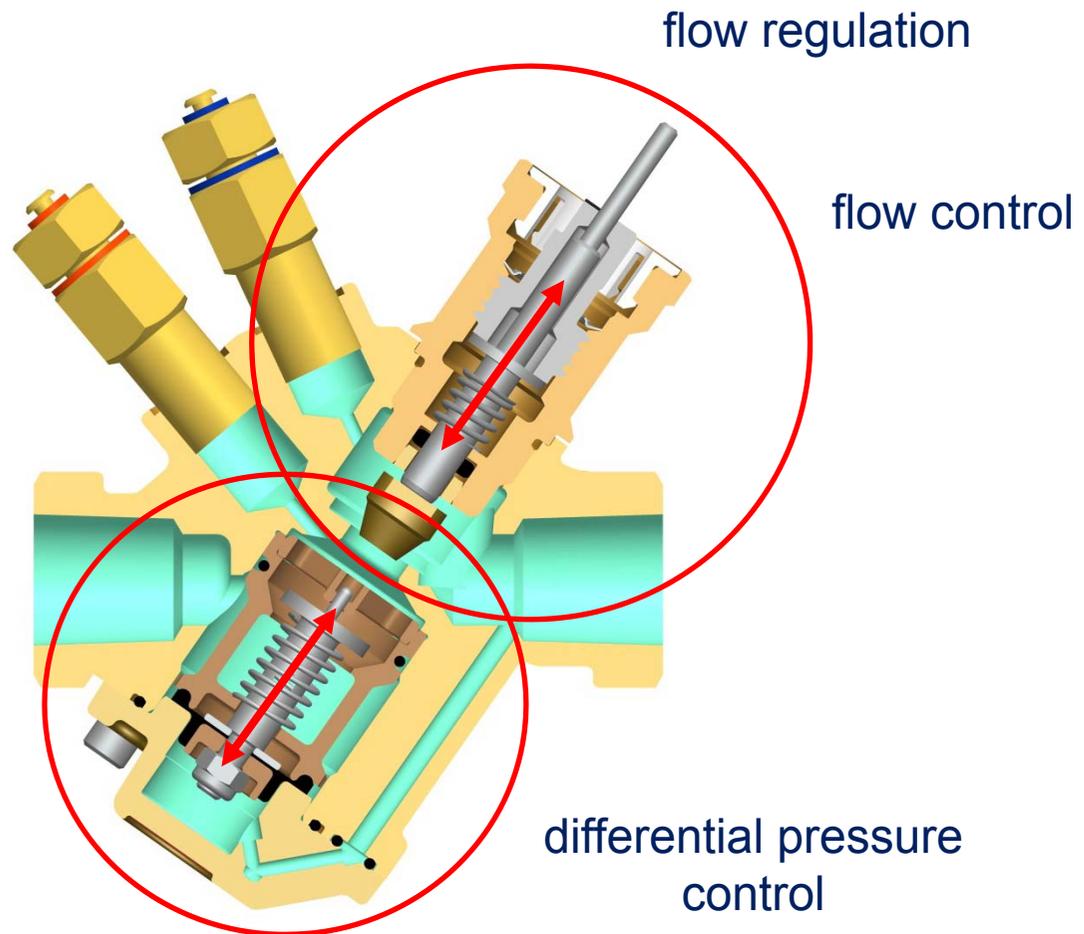
Controlling Fluctuating System Pressures

- Normally fitted to each terminal unit
- Return pipework is the preferred position
- Clear / straight lengths of pipework are *not* required for PICVs but 'good practice' suggests some straight lengths of pipework create a more stable flow pattern for the PICV to control



What is a PICV?

three functions in one

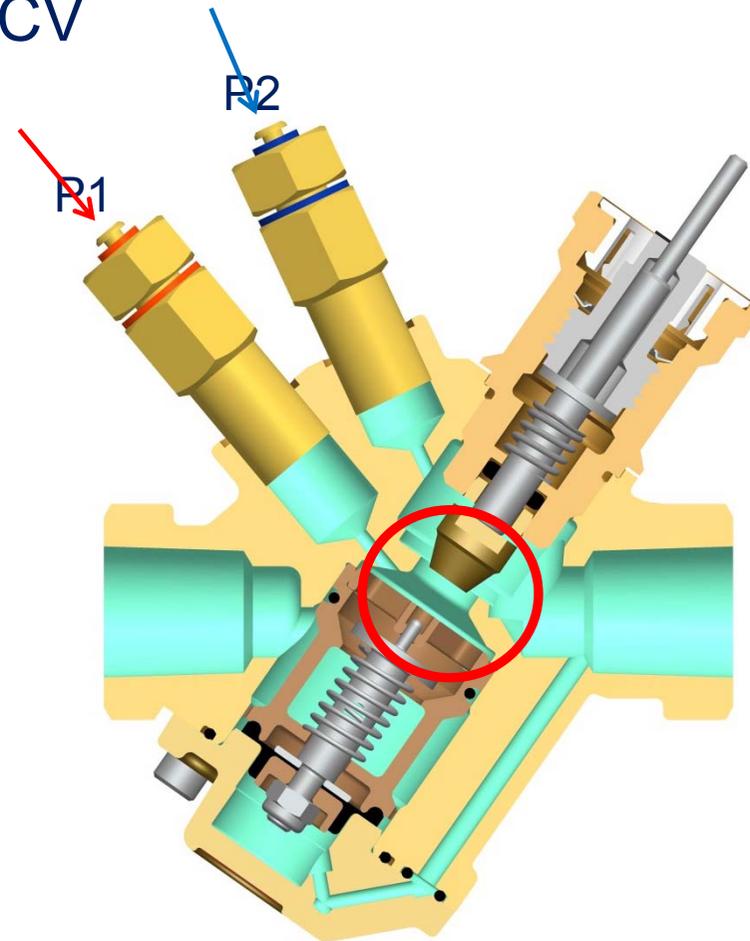


Pressure Drops Across PICV

differential pressure controller holds the Dp across the seat constant

Dp confirmed by test points

Often referred to as P1 – P2

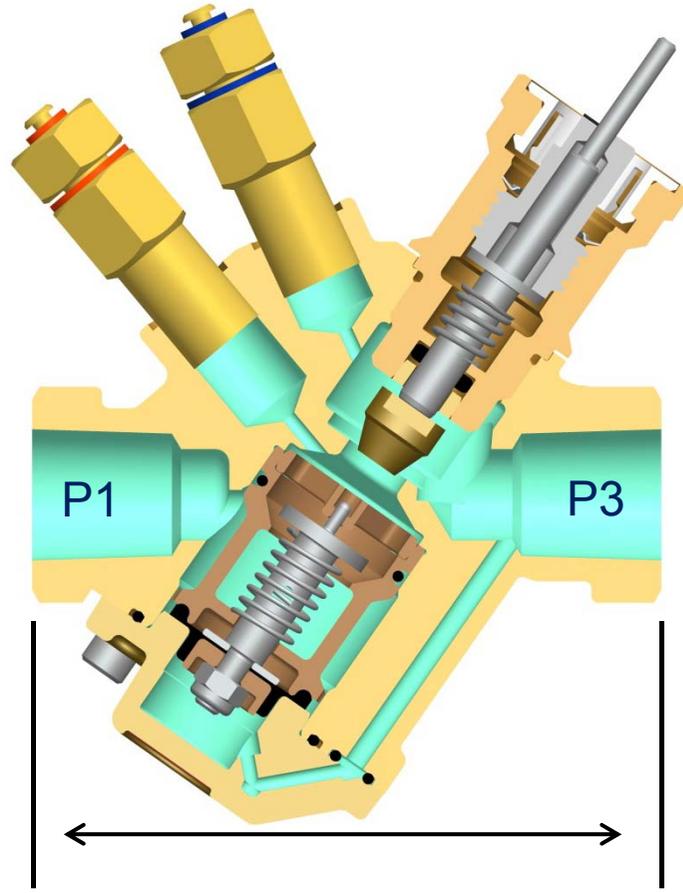


Pressure Drops Across PICV

differential pressure
across the PICV
varies

On smaller sizes
total Dp
NOT
confirmed by test
points

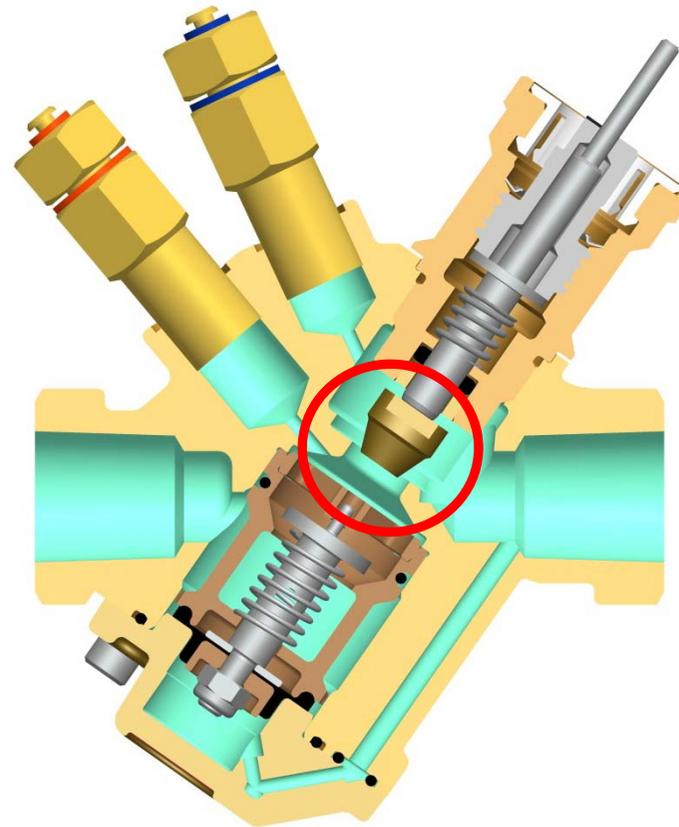
*Often referred to
as P1 – P3*



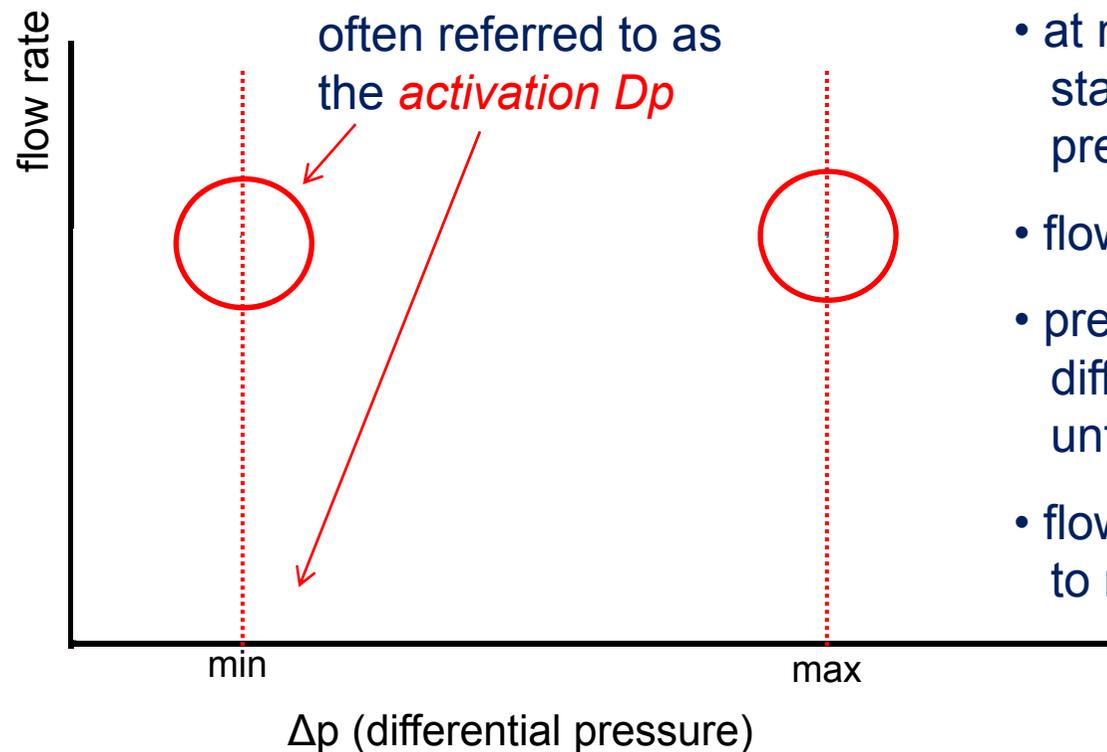
PICV Authority

$$\text{authority } \eta = \frac{\text{Dp across circuit}}{\text{DP across PICV seat}}$$

Considered to be '1'



PICV Activation

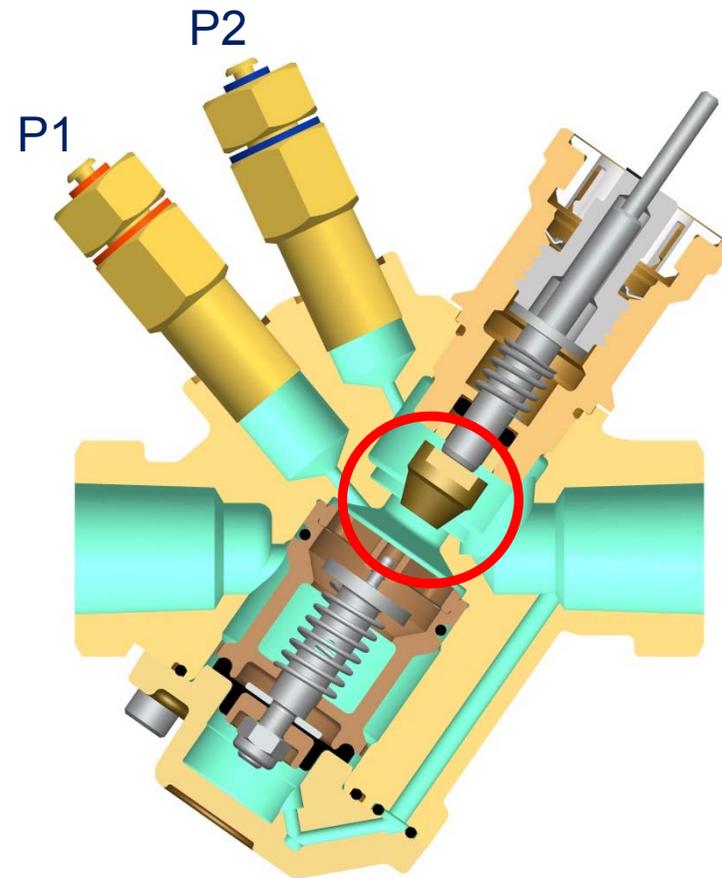


- as flow increases Δp increases
- at min Δp , pressure controller starts to hold differential seat pressure constant
- flow rate remains constant
- pressure controller controls seat differential pressure at *min Δp* until *max total Δp* is reached
- flow rate will rise as Δp continues to rise

PICV Activation

P1 to P2
the activation Δp
always constant
measured by integral
test points

Where test points measure
P1 – P3
 Δp will vary
between min & max

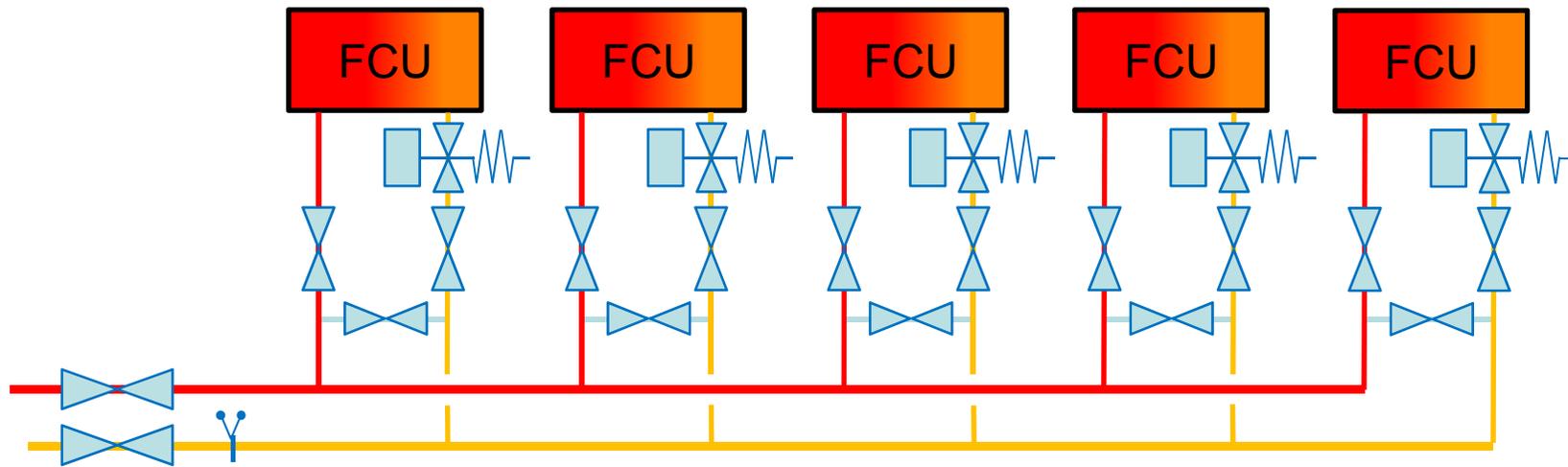


PICV Selection

flow rate is the *main* selection criteria

other considerations could be

- minimising pressure drop
- matching line sizes



almost always it is flow rate that determines selection

PICV Selection

DN15 Low Flow			DN15 Standard Flow		
setting position	flow rate l/s	total Δp kPa	setting position	flow rate l/s	total Δp kPa
2	0.008	15	2	0.04	15
3	0.010	15	3	0.060	15
4	0.020	15	4	0.080	20
5	0.030	15	5	0.105	20
6	0.040	20	6	0.120	20
7	0.050	20	7	0.140	20
8	0.060	20	8	0.155	25
9	0.070	20	9	0.175	25
10	0.080	20	10	0.200	25

selection charts are available

- flow rates
- set position
- minimum Δp (differential pressure) *total loss at activation*

PICV Selection – *activation point*

- *activation* Δp lower than *total* Δp
- activation Δp constant
- total Δp varies

DN15 tandard Flow			
setting position	flow rate l/s	total Δp kPa	activation Δp kPa
2	0.040	15	12
3	0.060	15	12
4	0.080	20	12
5	0.100	20	12
6	0.120	20	12
7	0.140	20	12
8	0.160	25	12
9	0.180	25	12
10	0.200	25	12

PICV Selection

DN15 Low Flow			DN15 Standard Flow			DN20 Standard Flow		
setting position	flow rate l/s	total Δp kPa	setting position	flow rate l/s	total Δp kPa	setting position	flow rate l/s	total Δp kPa
2	0.008	15	2	0.04	15	2	0.065	15
3	0.010	15	3	0.060	15	3	0.100	20
4	0.020	15	4	0.080	20	4	0.130	20
5	0.030	15	5	0.105	20	5	0.160	20
6	0.040	20	6	0.120	20	6	0.190	25
7	0.050	20	7	0.140	20	7	0.220	25
8	0.060	20	8	0.155	25	8	0.240	25
9	0.070	20	9	0.175	25	9	0.260	25
10	0.080	20	10	0.200	25	10	0.280	25

example
required flow rate 0.160l/s

between setting 8 & 9
8.3ish

setting 5

PICV Selection

DN15 Low Flow			DN15 Standard Flow			DN20 Standard Flow		
setting position	flow rate l/s	total Δp kPa	setting position	flow rate l/s	total Δp kPa	setting position	flow rate l/s	total Δp kPa
2	0.008	15	2	0.04	15	2	0.065	15
3	0.010	15	3	0.060	15	3	0.100	20
4	0.020	15	4	0.080	20	4	0.130	20
5	0.030	15	5	0.105	20	5	0.160	20
6	0.040	20	6	0.120	20	6	0.190	25
7	0.050	20	7	0.140	20	7	0.220	25
8	0.060	20	8	0.155	25	8	0.240	25
9	0.070	20	9	0.175	25	9	0.260	25
10	0.080	20	10	0.200	25	10	0.280	25

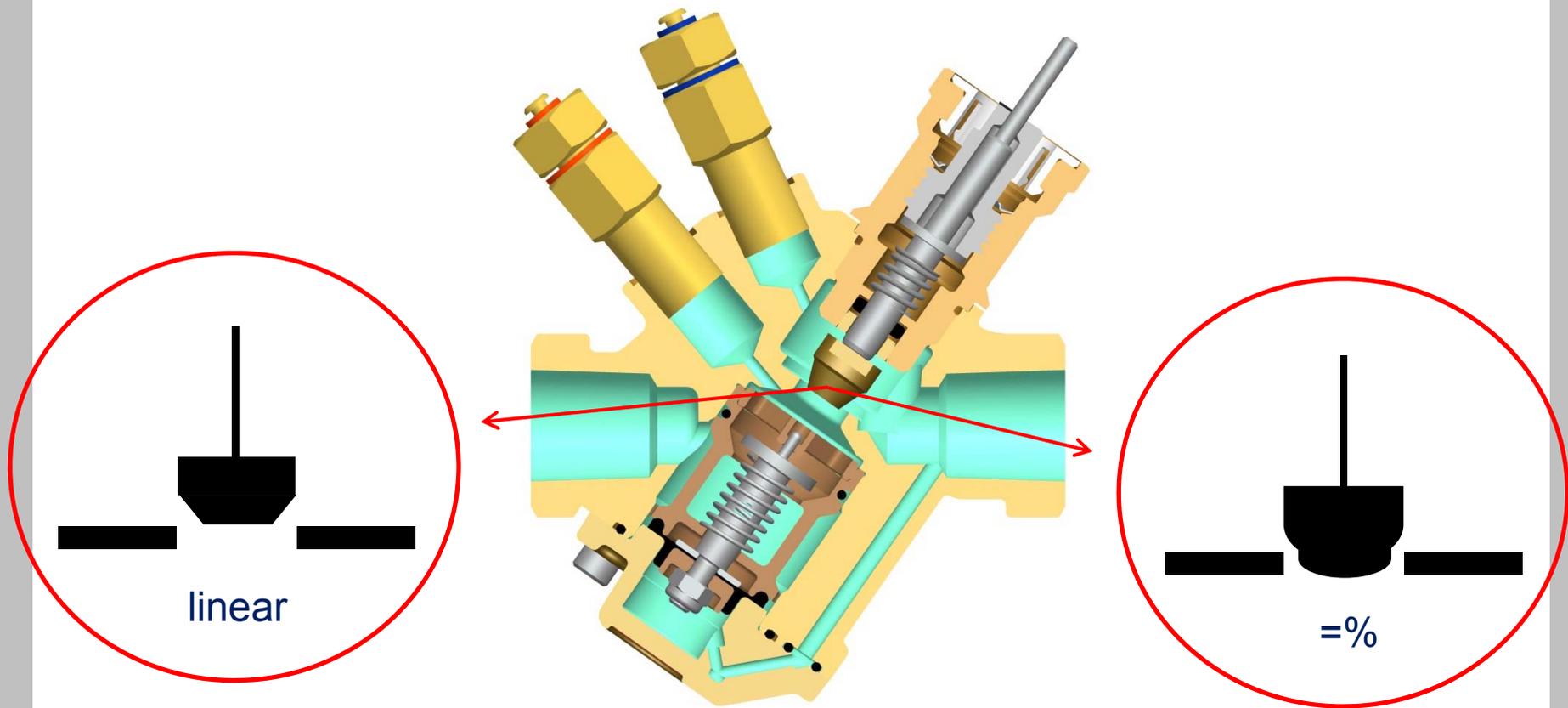
example
required flow rate 0.160l/s

total Δp (P1 – P3)
25 kPa

total Δp (P1 – P3)
20 kPa

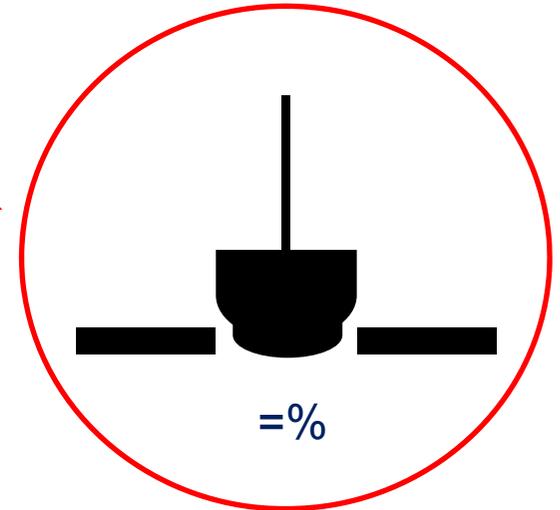
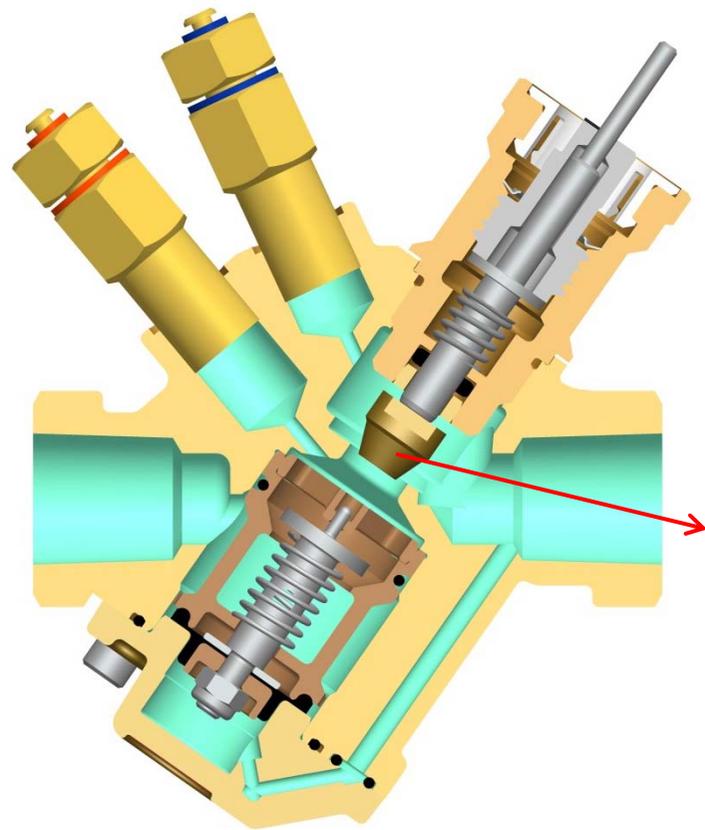
total Δp could rise to max Δp – 350 kPa

PICV Control Characteristic

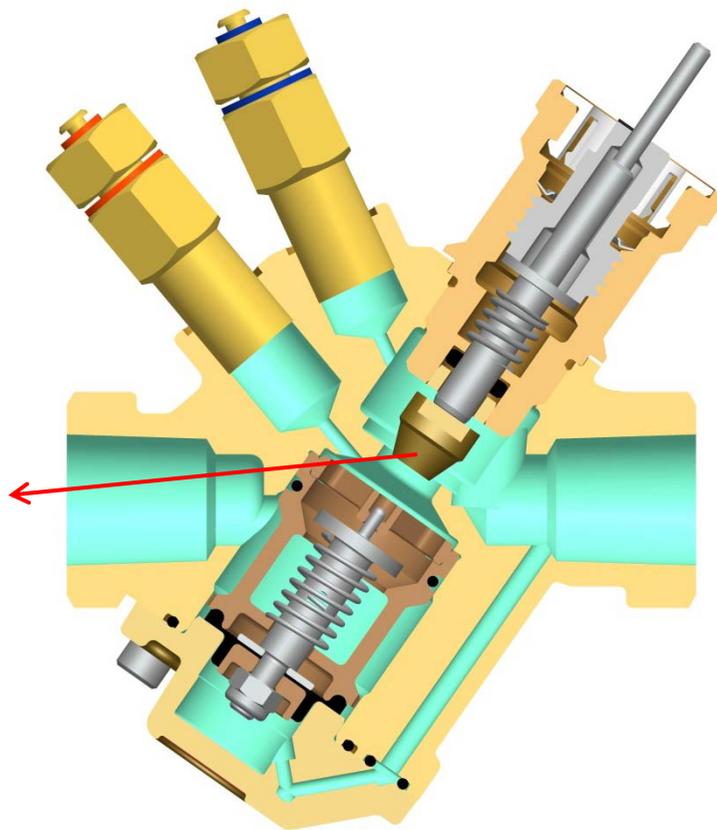
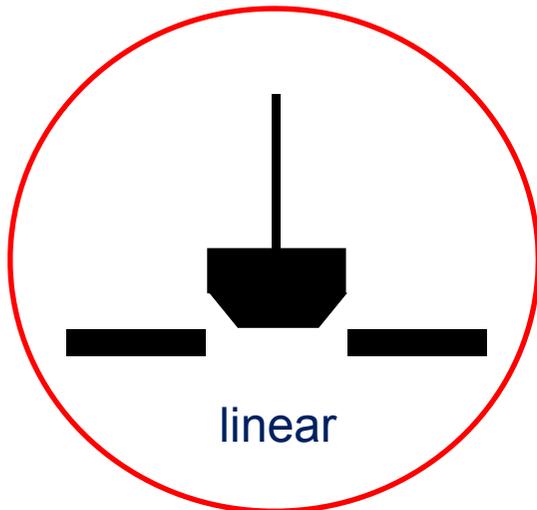


PICV Control Characteristic - =%

if stem it used to regulate flow rate
Control Characteristic
is changed at lower settings



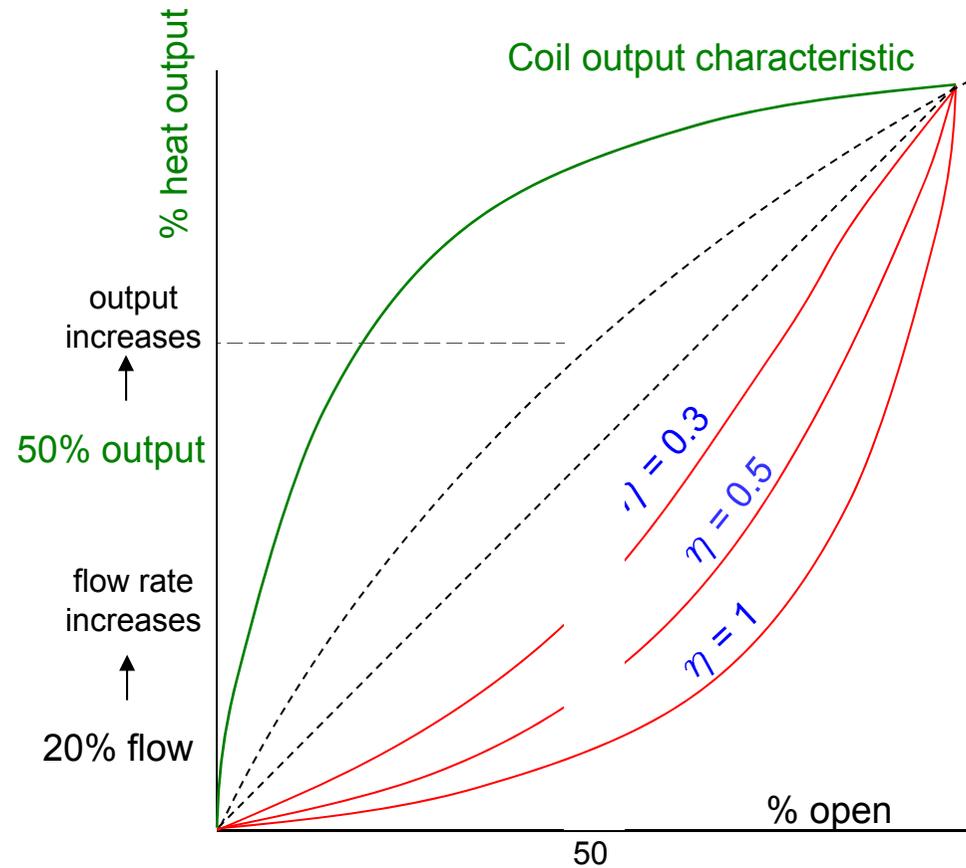
PICV Control Characteristic - *linear*



if stem it used to regulate flow rate
Control Characteristic is **NOT** changed at lower settings

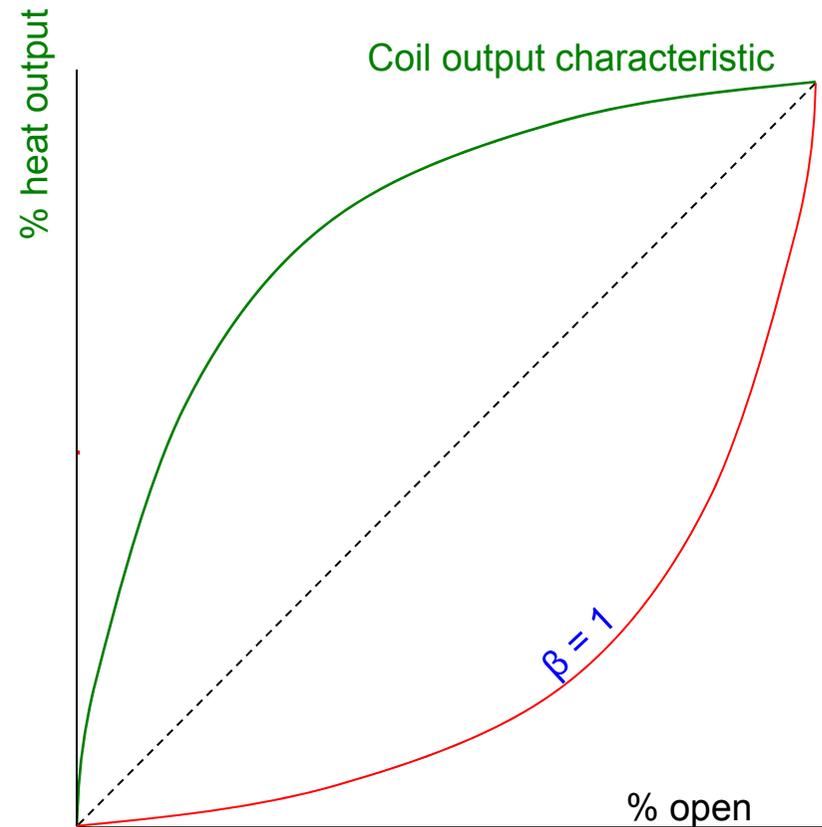
PICV Control Characteristic

equal percentage control valves
are designed with a
 $\eta = 1$
mirror image of coil characteristic



PICV Control Characteristic - $\beta = 1$

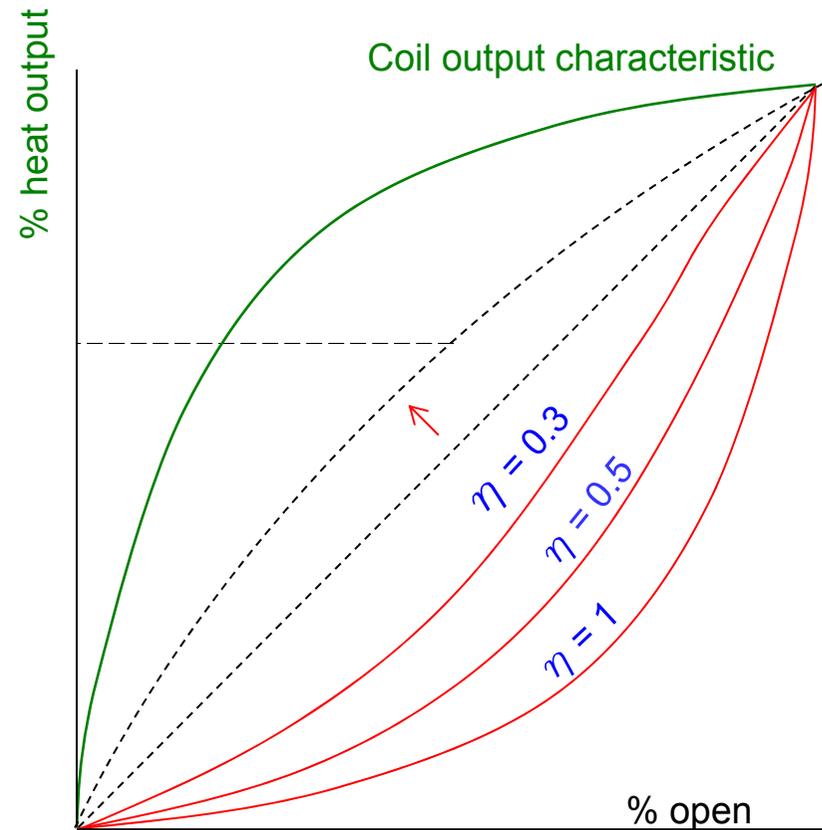
- establish a direct relationship between open position & *heat output*
- 50% valve opening = 50% heat output



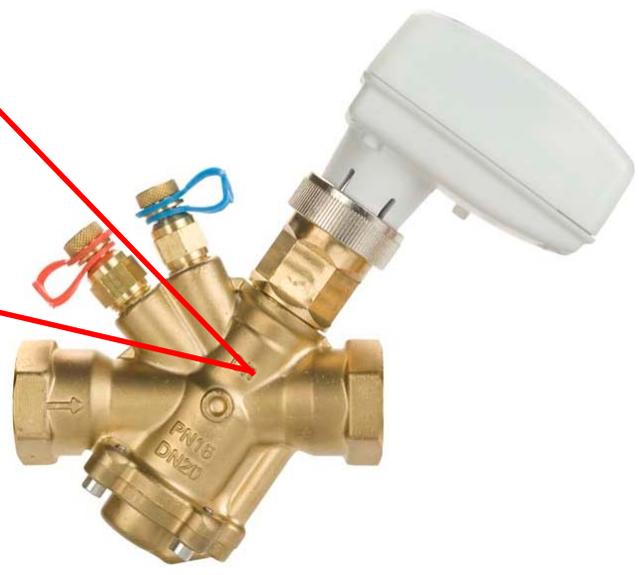
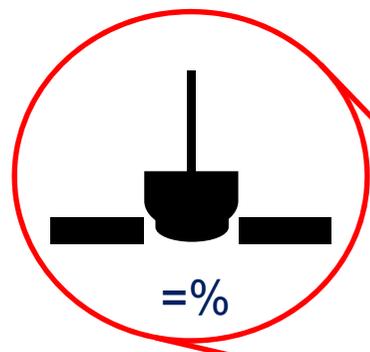
PICV Control Characteristic - $\eta = \%$

- where stem used to regulate flow rate
- changes control characteristic

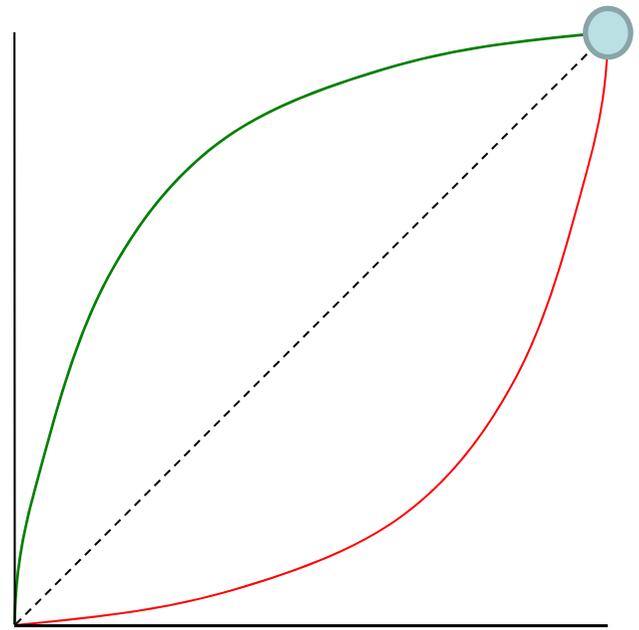
combined 'linear' position moves due to effect of valve characteristic



PICV Control Characteristic - =%

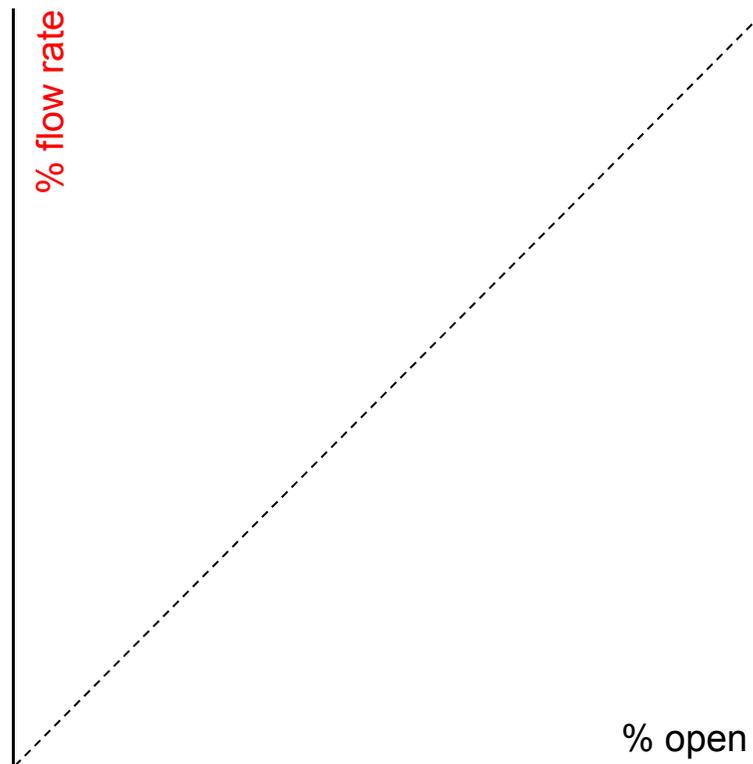


'linear' control actuator giving equal percentage characteristic

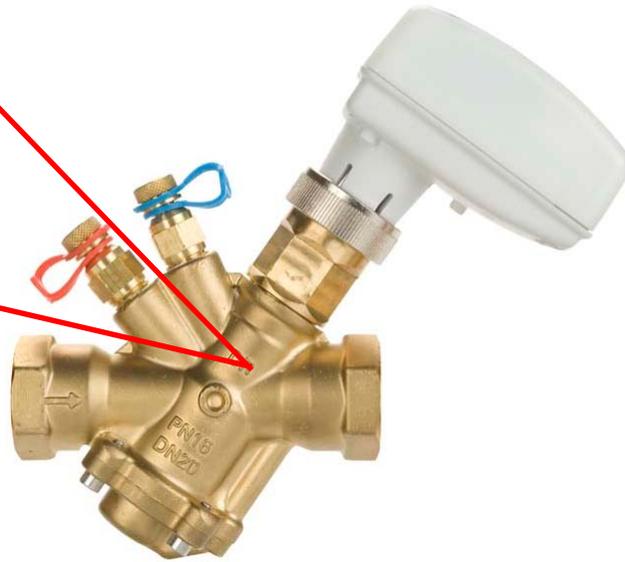
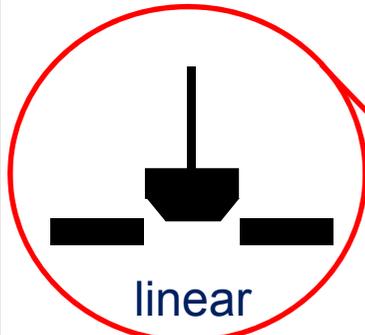


PICV Control Characteristic - *linear*

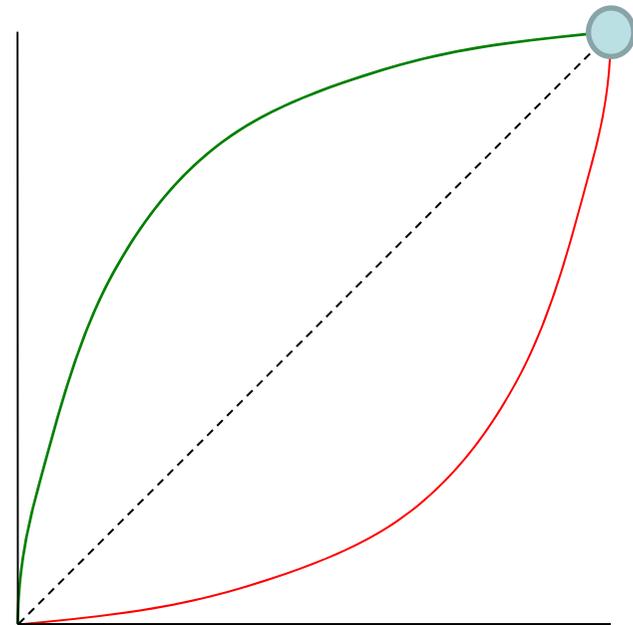
- establish a direct relationship between open position & *flow rate*
- 50% valve opening = 50% *flow rate*
- not effected by flow regulation



PICV Control Characteristic - *linear*



'equal percentage' control actuator giving equal percentage characteristic



Variable Volume System

at maximum pump turndown, typically 10 - 20%,
consideration needs to be given to branches to ensure

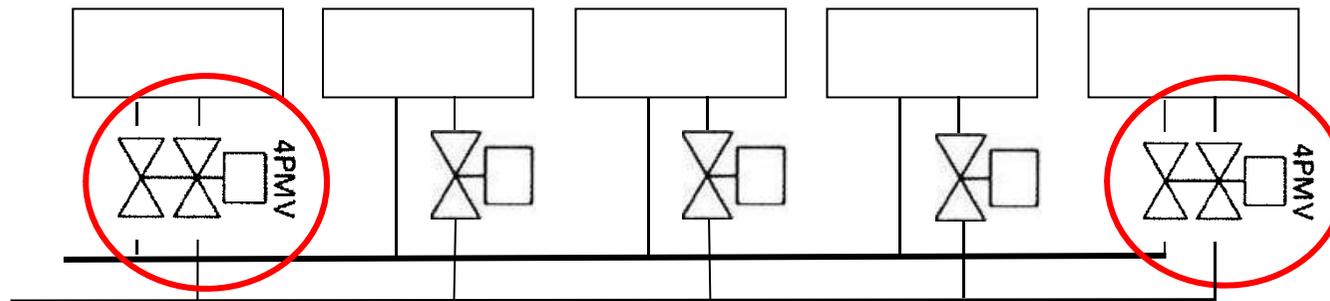
- pump flow at minimum load
- circulation of water treatment
- ready supply of heating / chilled water

Dynamic Balancing of the System

possible solution

end terminal could have a 3 or 4 port control valve

- on larger circuits additional 3 or 4 ports could be added



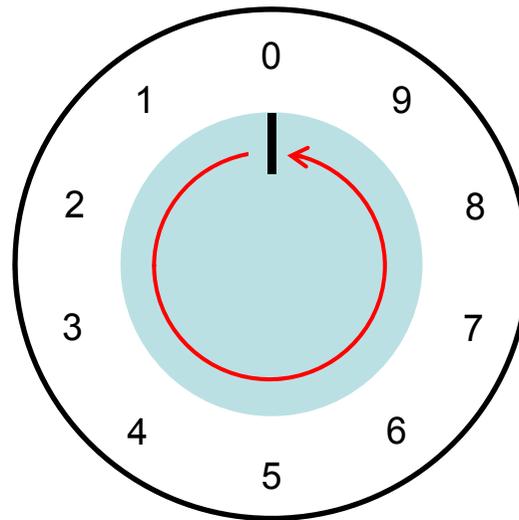
Flow Accuracy

different factors affect accuracy

- pre-set position
- available pump pressure
- actuator control

Accuracy is a combination of all factors

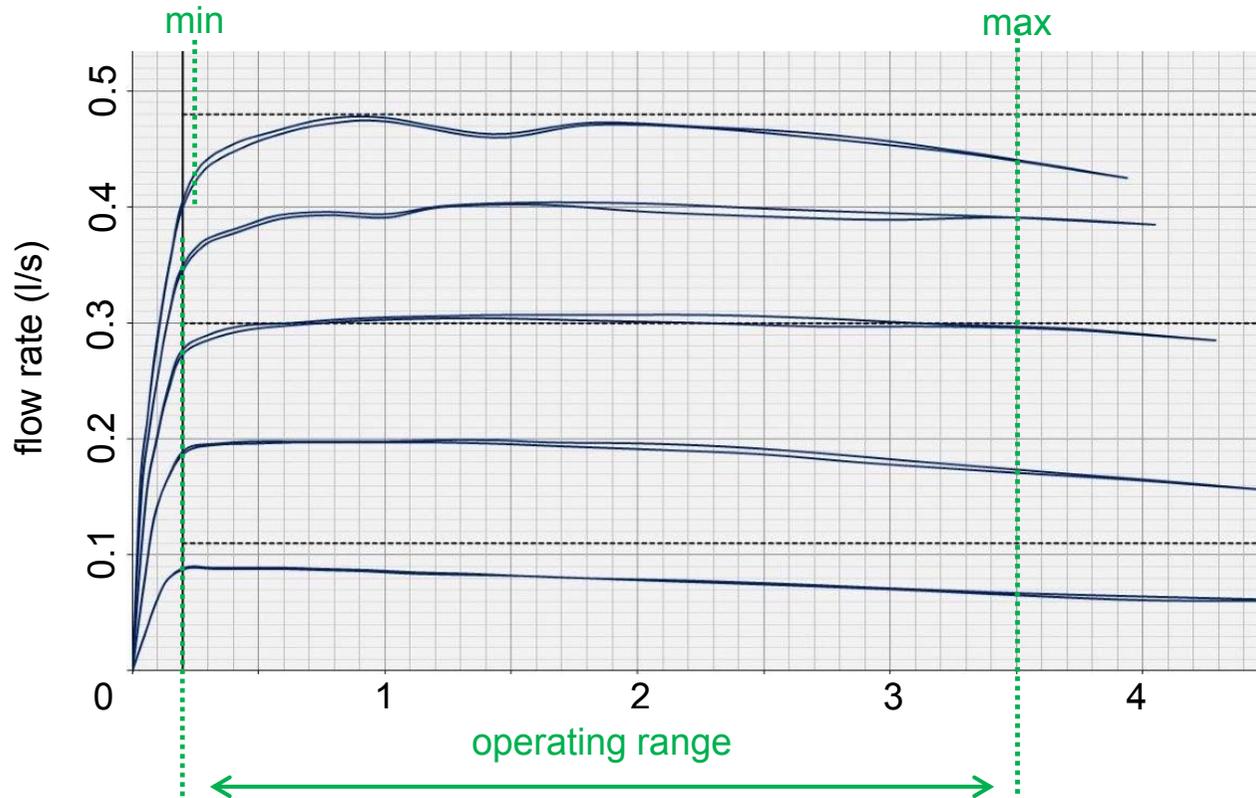
Flow Accuracy – *Pre-set Position*



aligning
dial with
scale

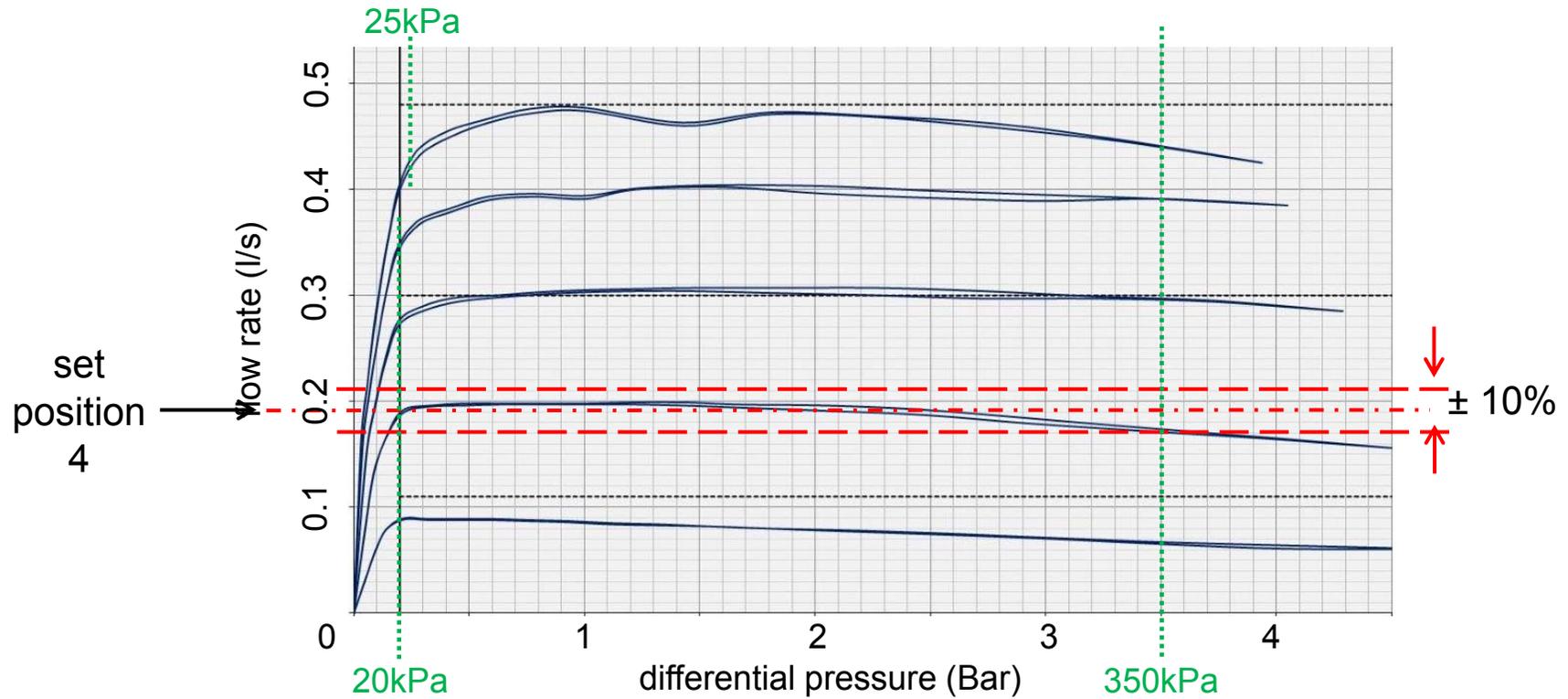
*pre-set position accuracy can be improved by the
installation of a FMD*

Flow Accuracy – *Available Pump Pressure*



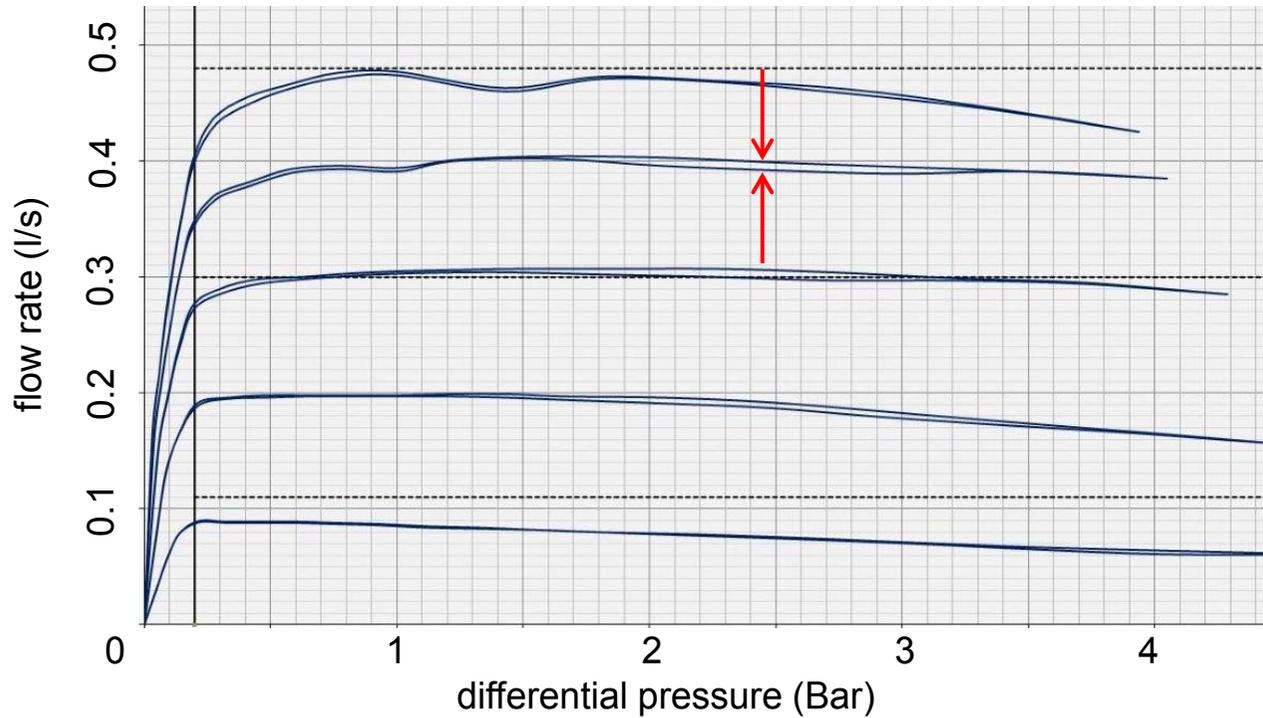
as pump pressure varies flow rate varies

Flow Accuracy – *Available Pump Pressure*



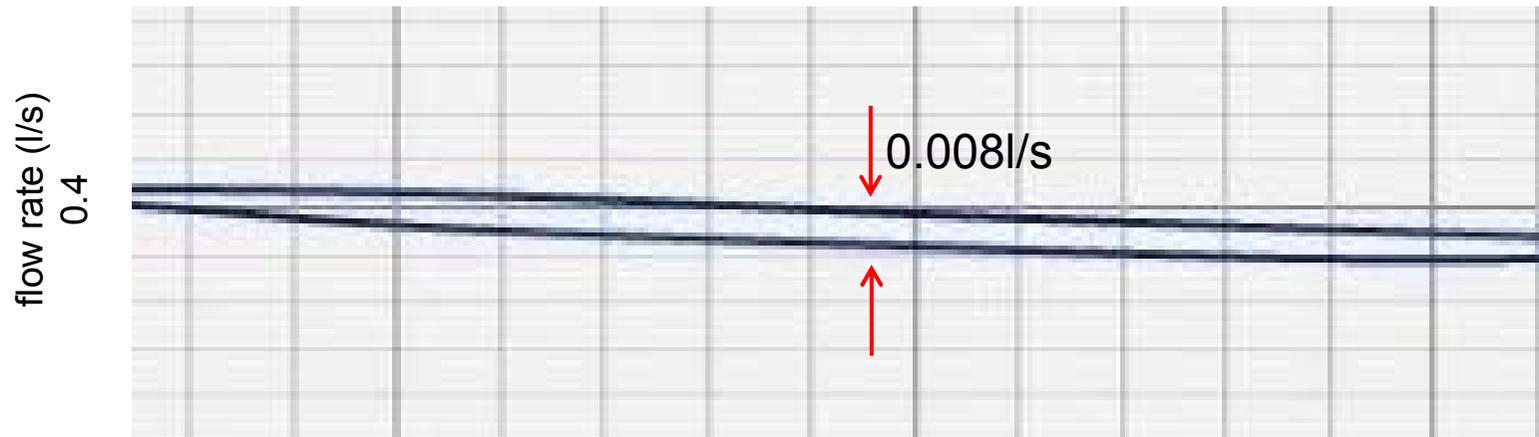
as pump pressure varies flow rate varies

Flow Accuracy – *Rising / Falling Pressure*



almost no hysteresis

Flow Accuracy – *Rising / Falling Pressure*



*worst case at higher differential pressures
about 2.0% max hysteresis*

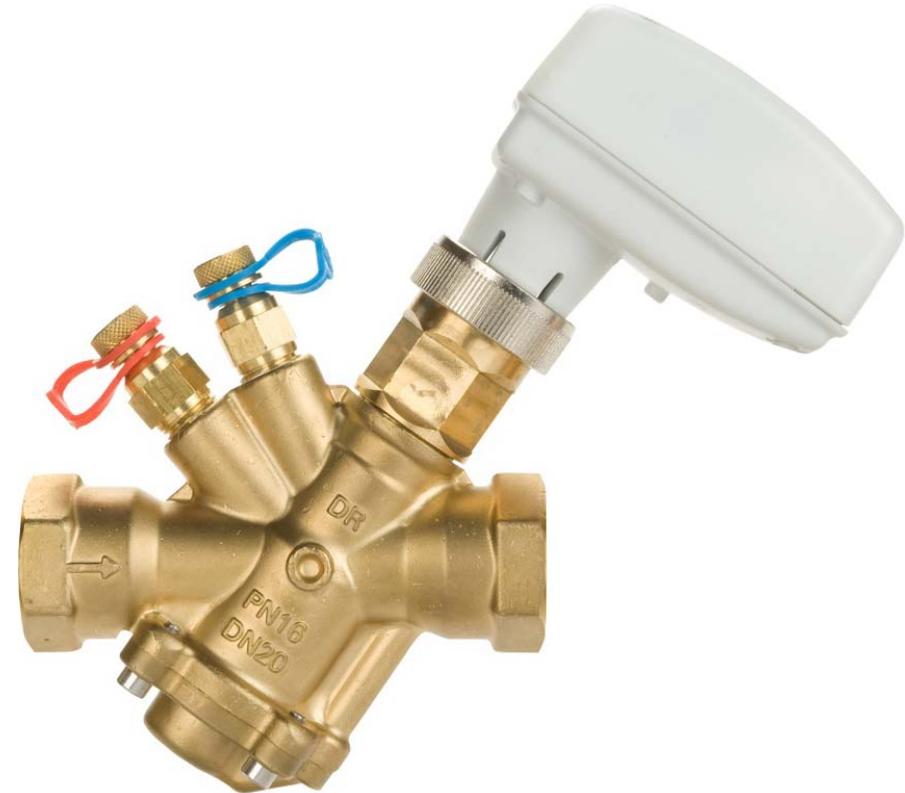
Flow Accuracy – *Actuator*

installed PICVs are a combination of

- PICV
- Actuator

so we should consider the assembly and not the standalone PICV

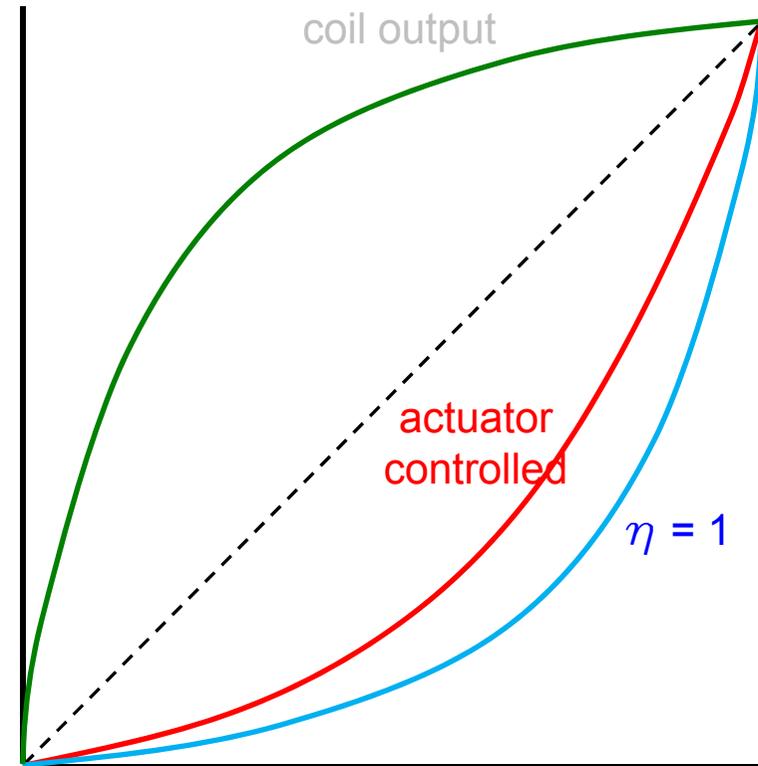
consider as a 'matched' pair



Flow Accuracy – *Actuator*

PICV can perform well as a stand alone valve

but when actuator is fitted performance of valve can be undermined



Actuators

actuators are divided into 2 types

- thermal
- electro-mechanical

and then by control characteristic

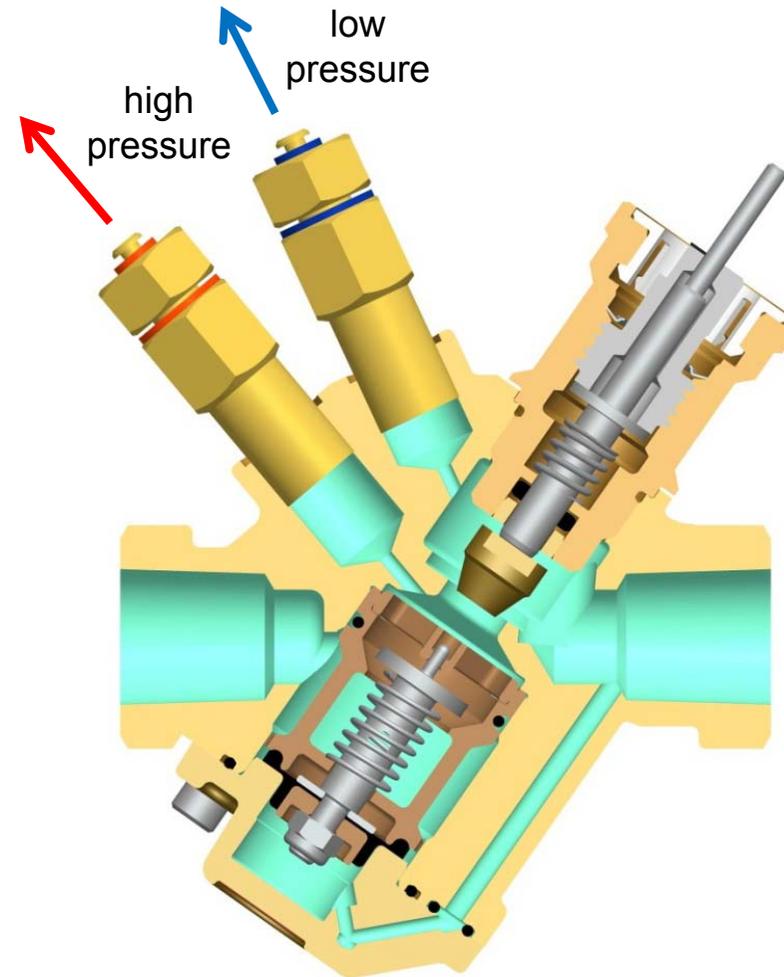
- on / off
- modulating

PICV Commissioning

PICVs are set to give the required flow rate, there is no commissioning required for the PICV

Commissioning Engineers are required to set the pump speed to ensure that the *'least favoured'* (index) PICV generates at least the minimum required differential pressure

if the least favoured PICV has sufficient different pressure, all other PICVs must have greater differential pressure



Summary

- change in system design to variable flow controlled by 2 port control valve resulting in pump energy saving
- fluctuation in system pressure undermines control valve authority
- DPCV installed into sub-circuits to 'protect' control valves from fluctuating pressure to maintain control valve authority
 - terminal units commissioned by conventional proportional method
 - branches commissioned by use of 'Companion' Valve & DPCV
 - branches commissioned independently of each other
- PICVs installed on terminal unit
 - replacing static commissioning valves / 2 port control valve / DPCV

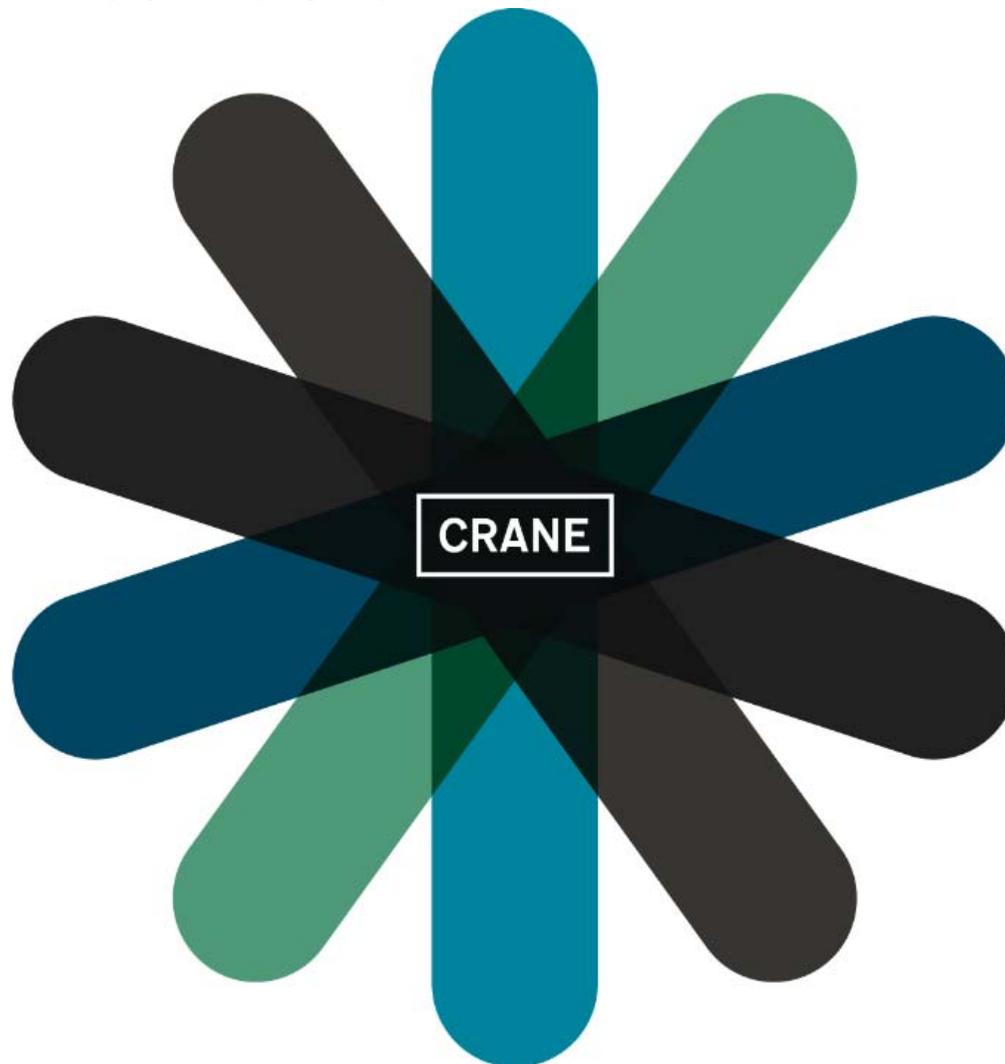
**be efficient
save energy**



*thank you for listening
questions please?*

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ProBalance



Measuring Water Flow Rate at Circuit Balancing Valves

**Bob Blanchard of the Ontario Sheet Metal
youtube.com**

[https://www.youtube.com/watch?
v=x3CsknzR4bg](https://www.youtube.com/watch?v=x3CsknzR4bg)

12:22 p.m. ✓✓



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