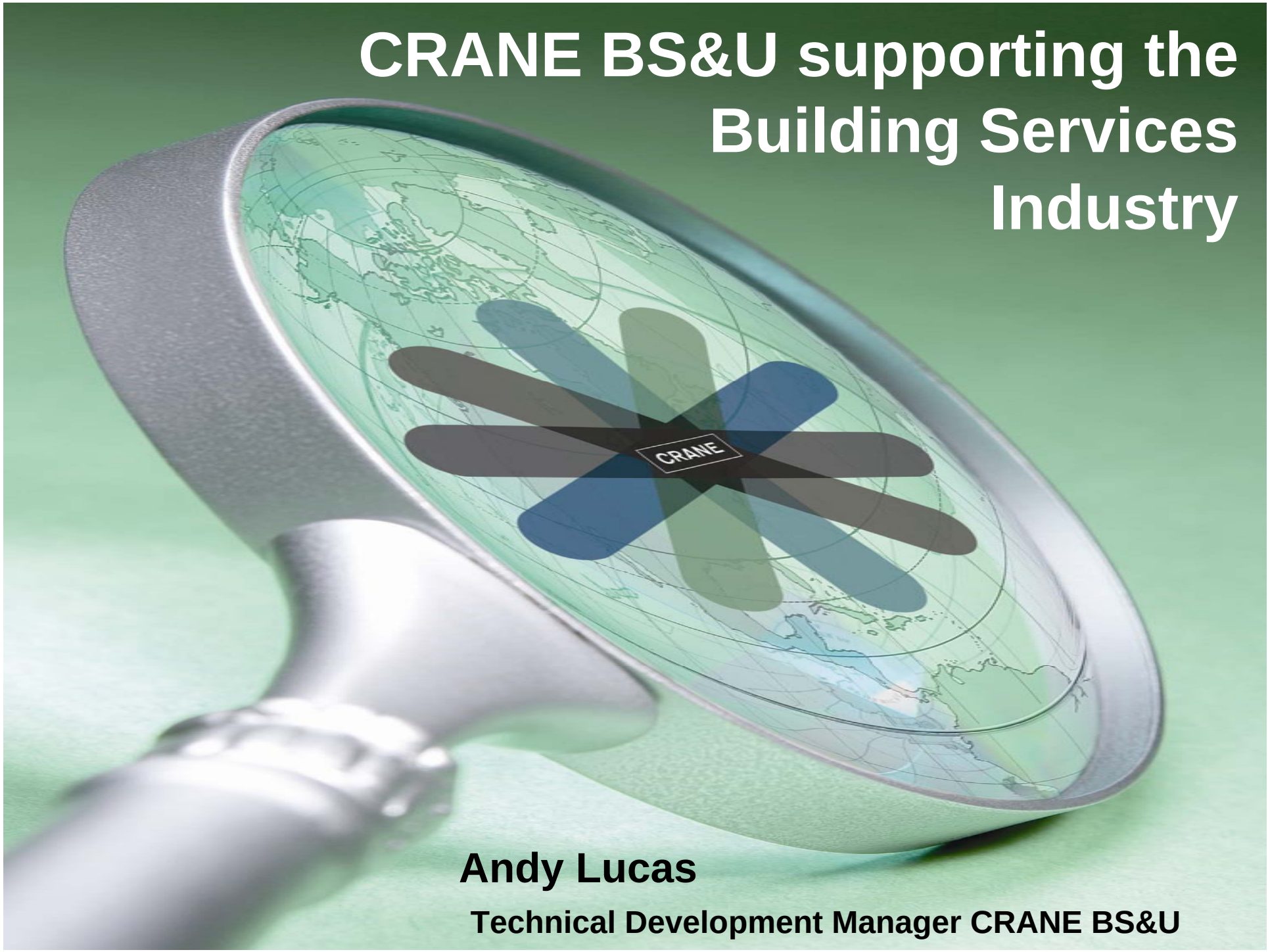
# CRANE BS&U supporting the Building Services Industry




**Andy Lucas**

**Technical Development Manager CRANE BS&U**

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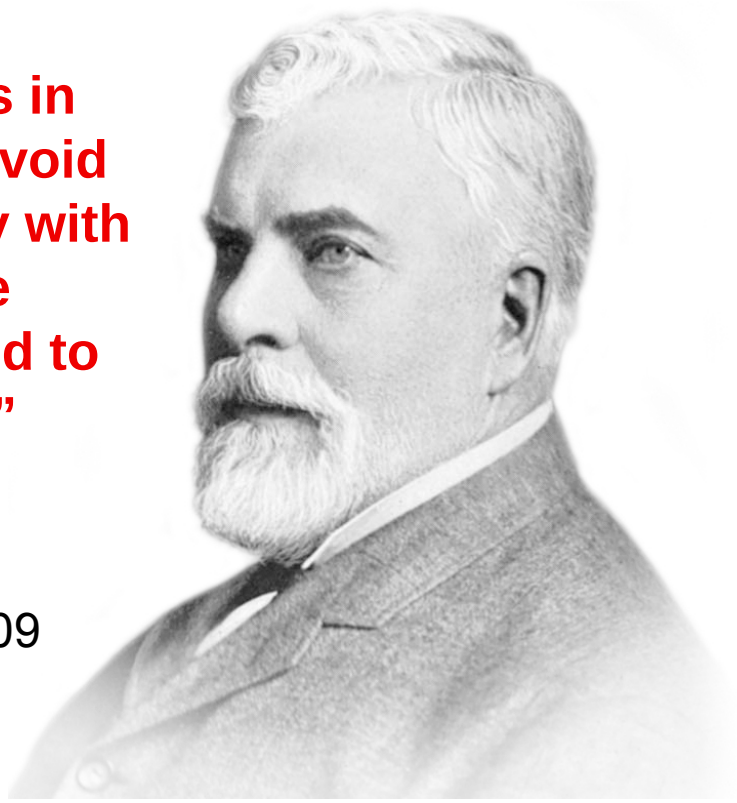
Crane Co founded in 1855 by Richard Teller Crane who made the following resolution -

**“I am resolved to conduct my business in the strictest honesty and fairness; to avoid all deception and trickery; to deal fairly with both customers and competitors; to be liberal and just towards employees; and to put my whole mind upon the business”**



Crane Limited founded in Ipswich in 1919

Crane Building Services & Utilities created 2009

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## Building Services

CRANE FLUID SYSTEMS

brownall™ RHODES™

NABIC™ Wade™

iat™ INGOLSTADT ARMATUREN TECHNOLOGIE

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## Gas Utilities

WASK™ Specialist fittings and equipment for the utilities industry

SPERRYN GAS CONTROLS

## Water Utilities

VIKING JOHNSON™ Leaders in pipe joint, repair & flow control products

POSIFLEX™ Total pipe expansion solutions

Helden

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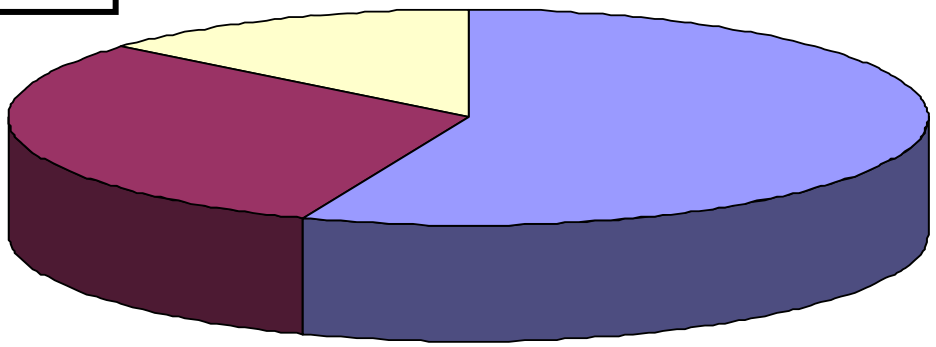
# CRANE BS&U 2010 sales £110m



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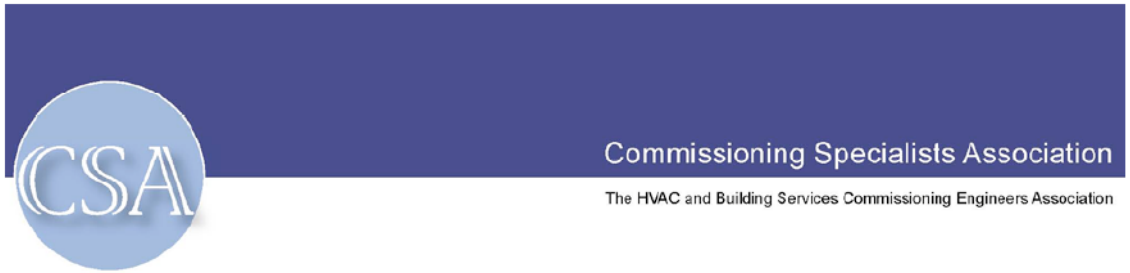
industry organisations

- CIBSE
  - SoHPE
- BSRIA
- CSA





# VARIABLE FLOW SYSTEMS

## incorporating

## DPSVs

CIBSE approved CPD

**Andy Lucas**

**Technical Development Manager CRANE BS&U**

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**Title** **VARIABLE FLOW SYSTEMS**

**Objective** **To give an overview of Variable Flow System design and commissioning using Differential Pressure Control Valves**

***this applies to both heating and chilled water systems***

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# Drivers of Change

- driven by Government legislation
- energy conservation
- subsequent $CO_2$ emissions

The move from constant to variable flow design can give up to 80% pump energy savings; about 6 - 8% total energy saving

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# Constant volume flow systems

- fixed speed pumps – no energy saving for part load
- constant volume of water is pumped around the system
- 3 or 4 port control valve diverts water through by-pass
- commissioned by **proportional balancing** or by the use of constant flow regulators – ABV (Automatic Balancing Valves)

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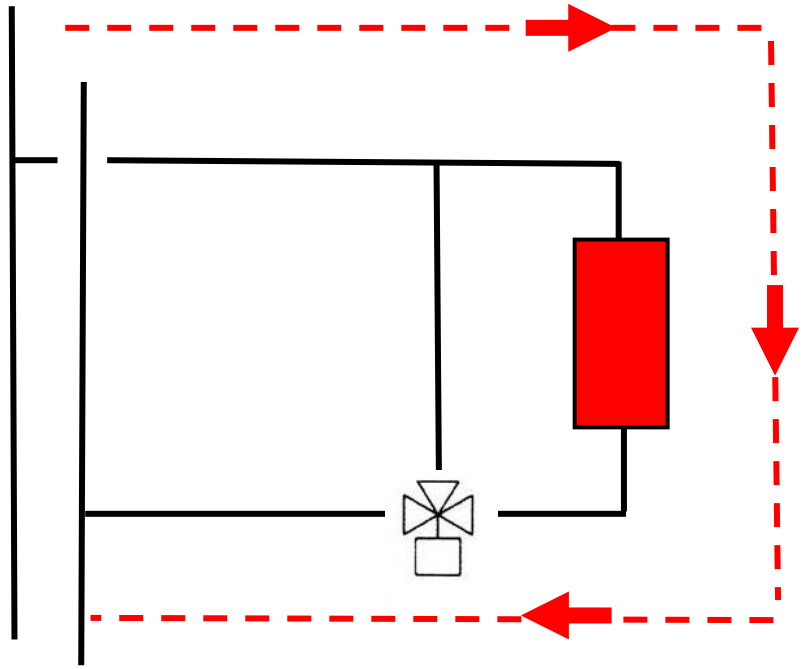
# Constant flow



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

- through terminal

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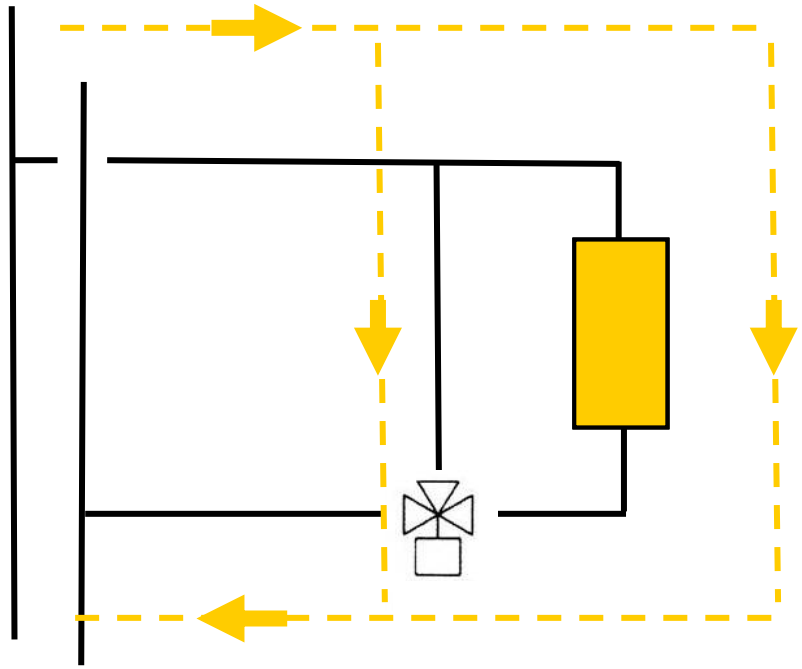
# Constant flow



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

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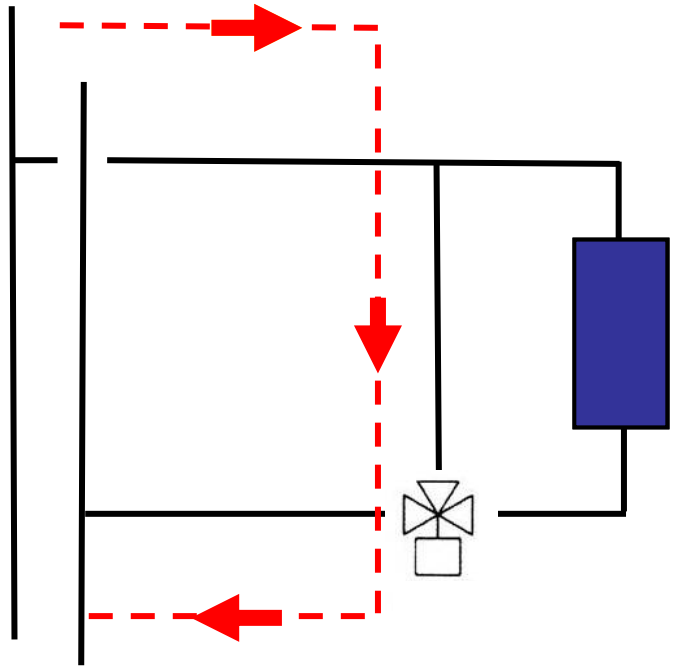
# Constant flow



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

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# Variable volume flow systems

- variable speed pumps – energy saving for part load
- variable volume of water to match demand
- diversity factor
- 2 port control valve
- commissioned by combination of;
  - **proportional balancing**
  - **DPCV – Differential Pressure Control Valves**

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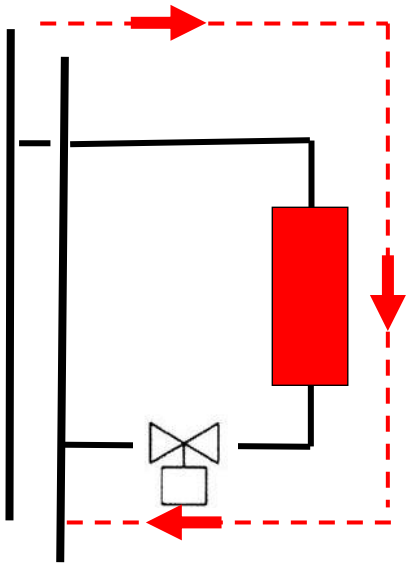
# Variable flow



open

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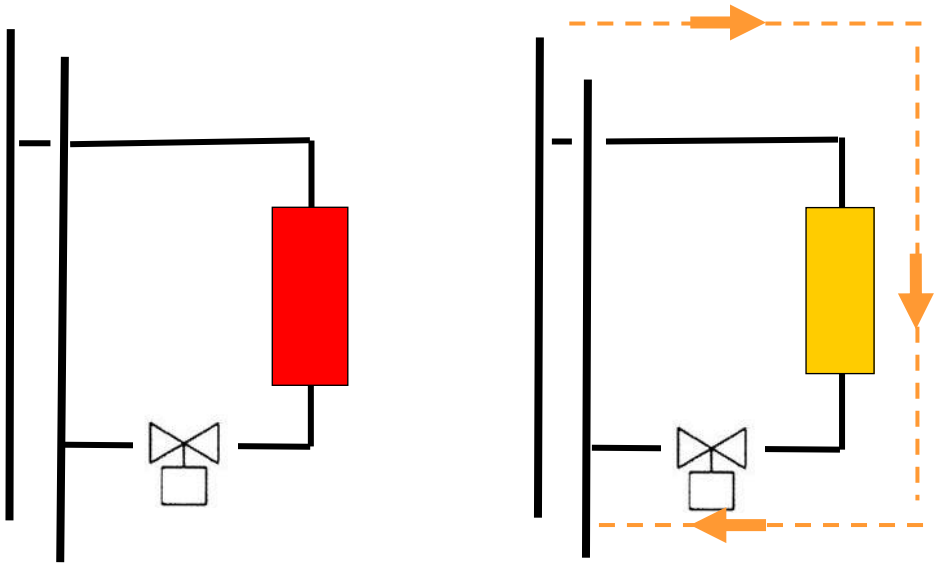
# Variable flow



open

modulating between
open and closed

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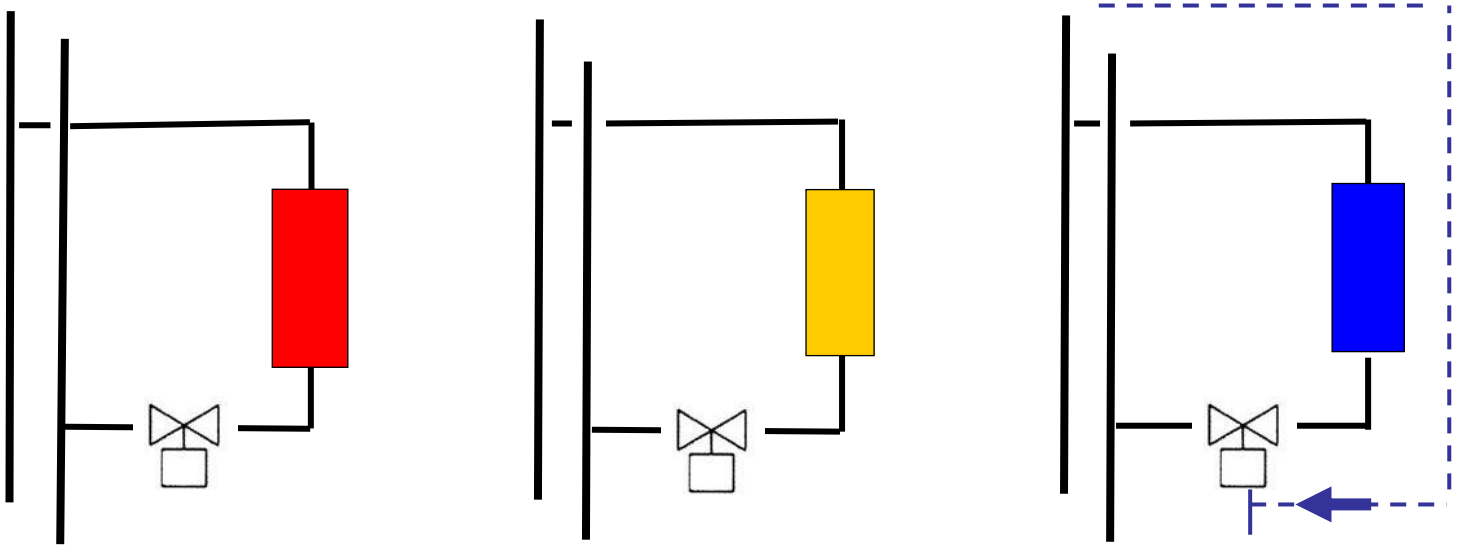
# Variable flow



open

modulating between open and closed

closed

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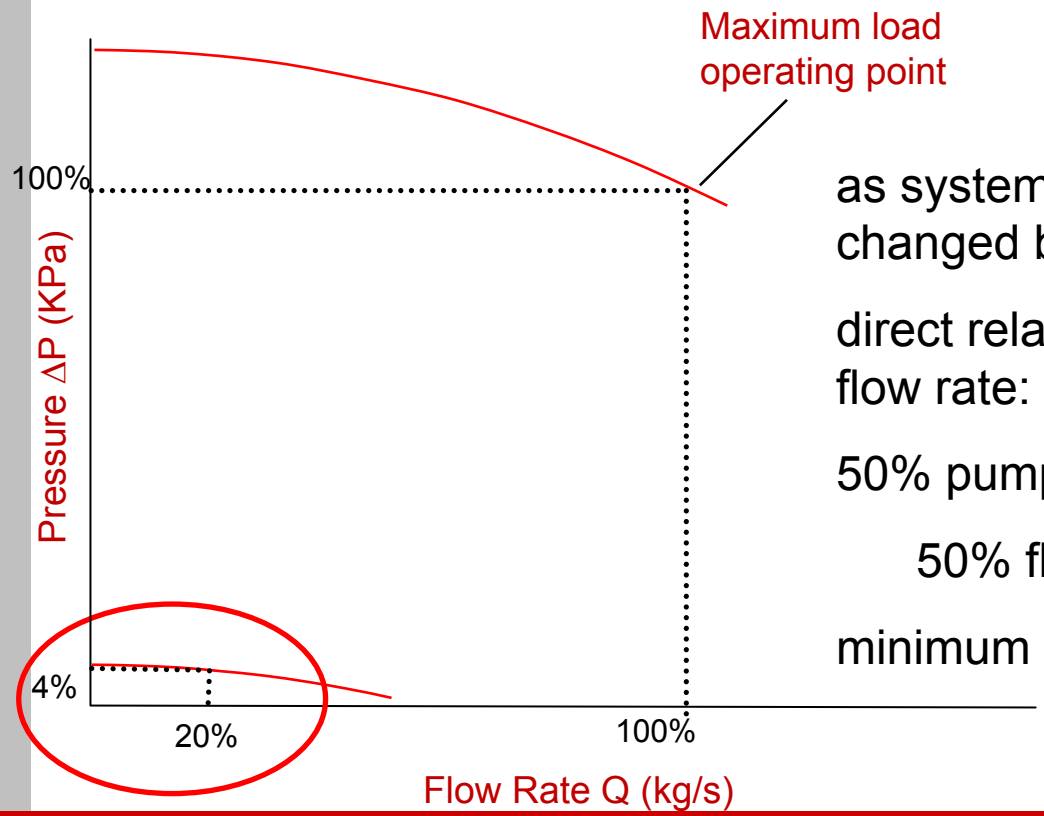
# Pump energy saving




as system demand change, flow rate is changed by varying speed of pump

direct relationship between pump speed and flow rate:

50% pump speed = 50% flow rate

50% flow rate = over 85% energy saving

minimum flow rate approx 20%

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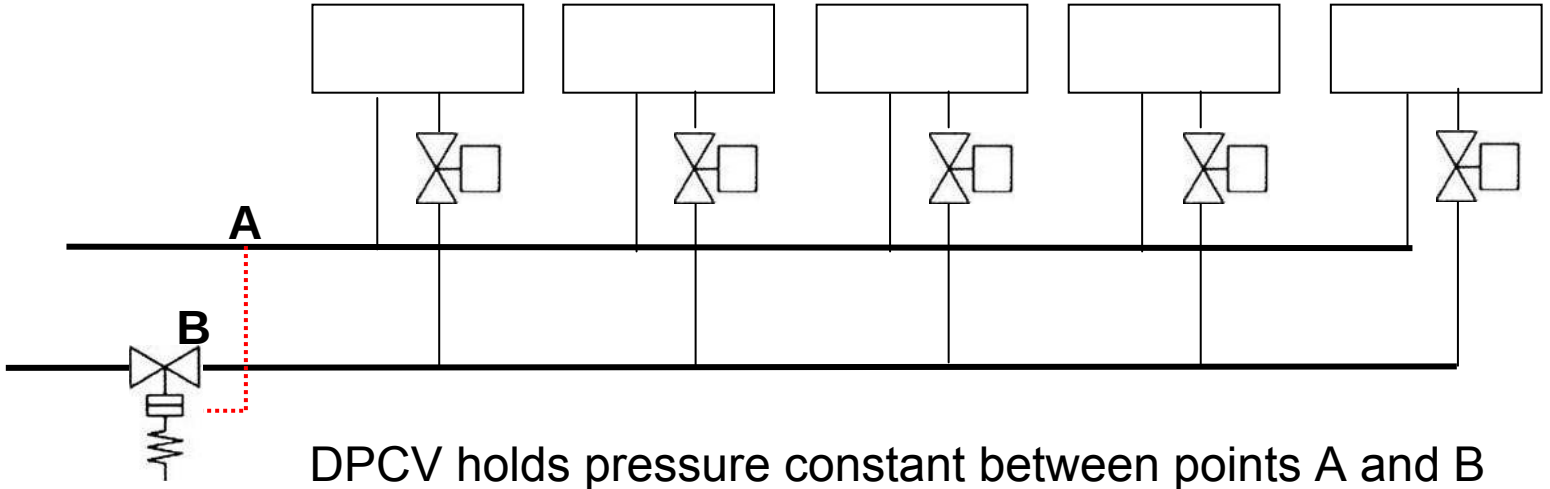
# DPCVs to protect 2 port control valves

to enable modulating 2 port control valves to operate with an acceptable authority, a DPCV is installed to limit the pressure differential against which the 2 port valves have to close. The installation of DPCVs on sub-branches with 2 port control valves is therefore essential to achieve good control, as well as to avoid noise or cavitation.




DPCV holds pressure constant between points A and B

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# Installation of 2 port control valves

due to fluctuating system pressures created by the 2 port control valves opening & closing, consideration needs to be given to valve authority.

valve authority is;

- is ability of the control valve to control flow
- is calculated by dividing the pressure drop across the 2 port at design flow by the pressure drop at no flow
- should not be below 0.3
- higher authority gives better flow control

**the installation of Differential Pressure Control Valves (DPCV) protects the 2 ports from the fluctuating/rising pressures**

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# Installation of 2 port control valves

example without DPCV

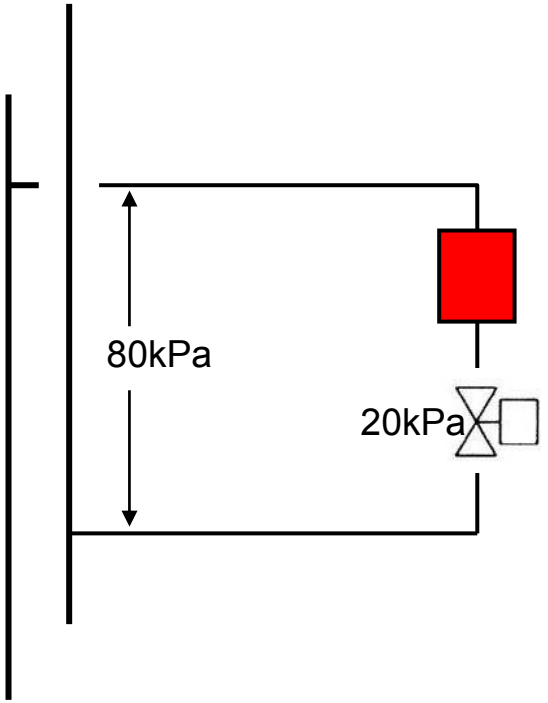
$$\text{valve authority } ß = \frac{\Delta p \text{ across 2 port}}{\Delta p \text{ across circuit}}$$

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

$$ß = 0.25$$

always given as a decimal

**too low - unacceptable**




at design flow rate

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# Installation of 2 port control valves

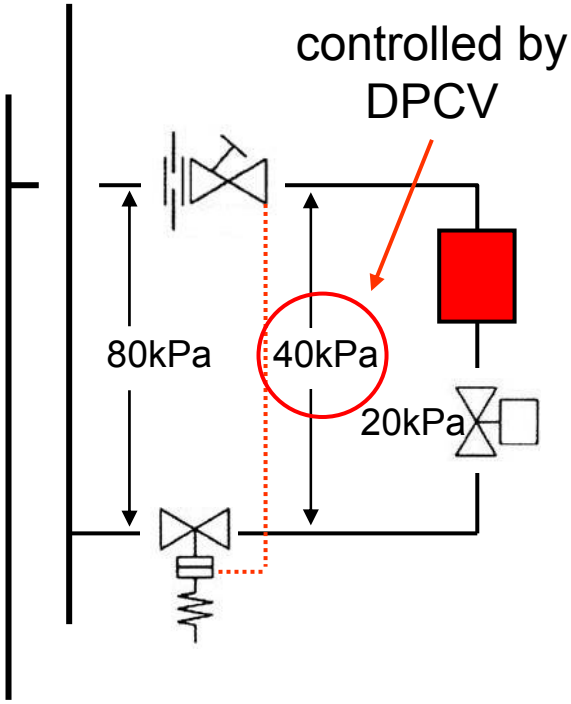
example with DPCV fitted

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

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

$$ß = 0.5$$

**acceptable**




at design flow rate

Hattersley™
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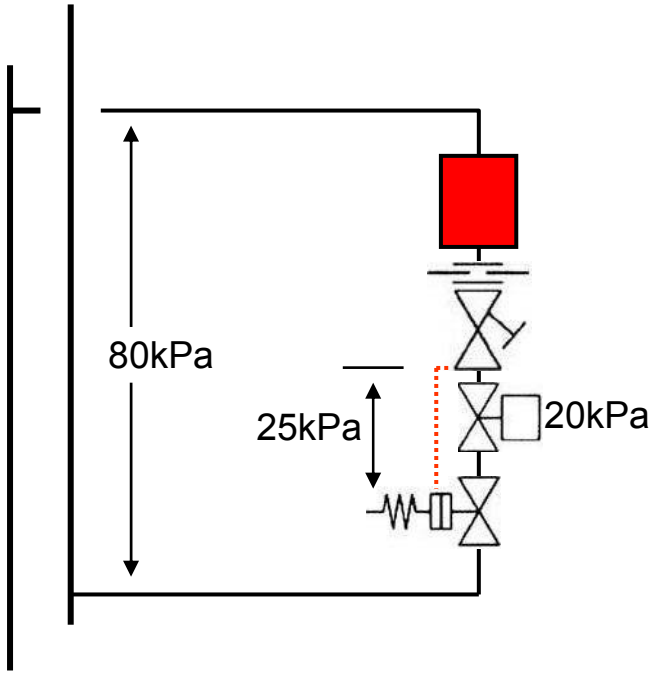
# Installation of 2 port control valves

position of DPCV?

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

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

$$ß = 0.8$$




***position can influence authority***

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

at design flow rate

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# Installation of 2 port control valves

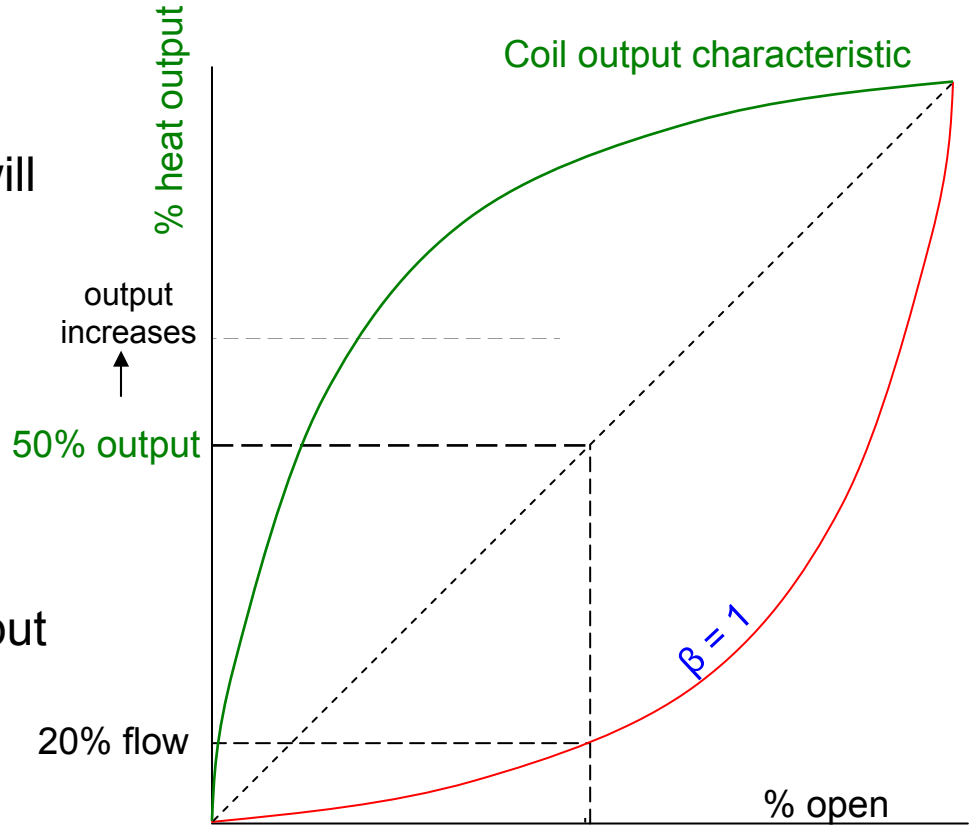
equal percentage control valves will only operate with near to an equal percentage characteristic where authority, β, is greater than 0.3

with β = 1

mirror image of coil characteristic

50% valve opening = 50% heat output

flow rate reduces to 20%



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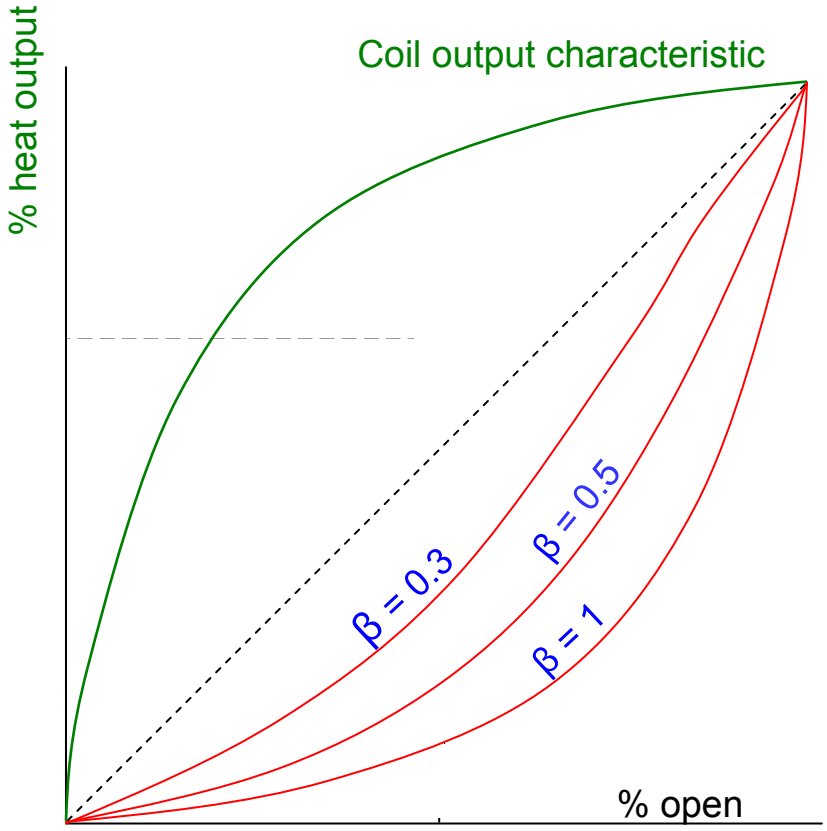
# Installation of 2 port control valves

equal percentage control valves will only operate with near to an equal percentage characteristic where authority, β, is greater than 0.3

with β = 1

mirror image of coil characteristic

authority is reduced as pressure drop increases



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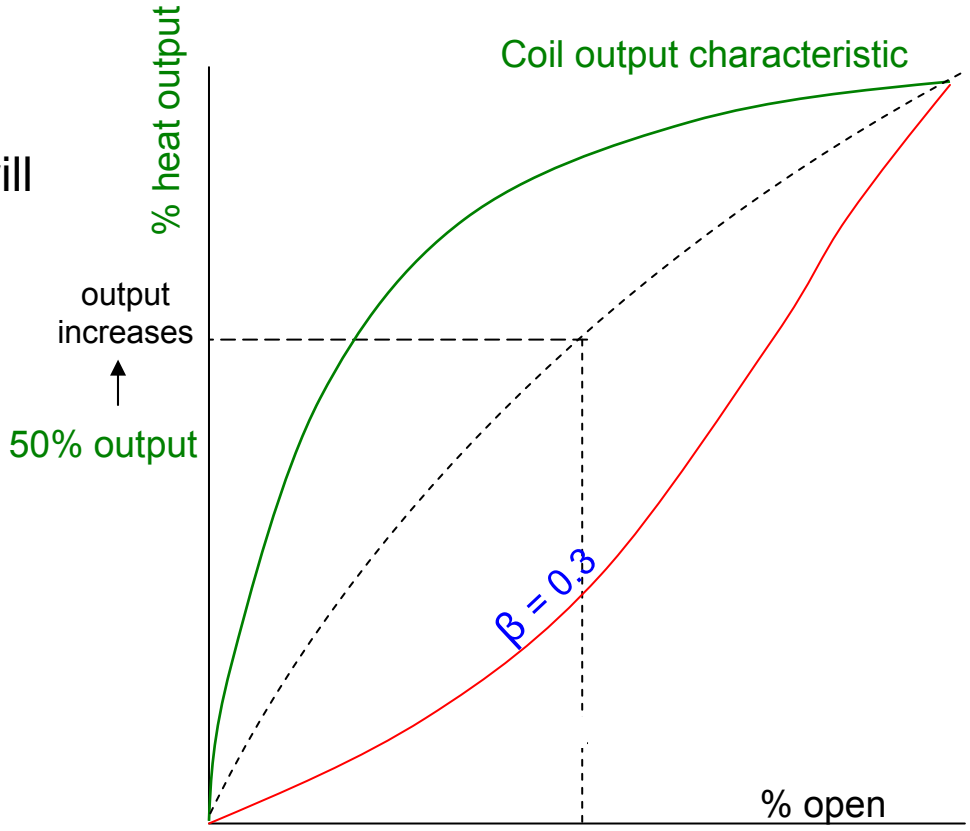
# Installation of 2 port control valves

equal percentage control valves will only operate with near to an equal percentage characteristic where authority, β, is greater than 0.3

with β = 1

mirror image of coil characteristic

effect of reduction in β to 0.3



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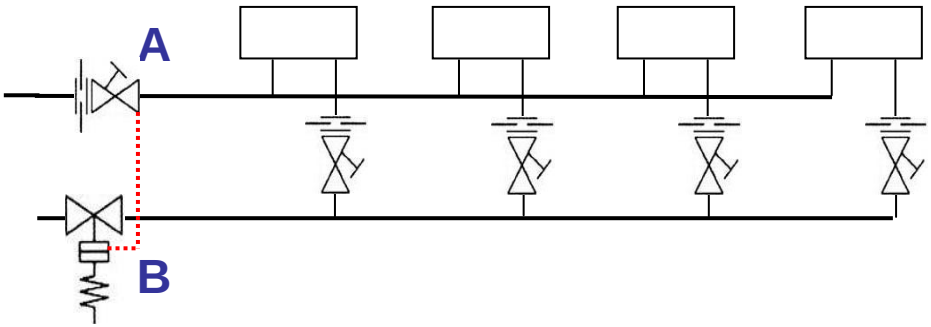
# DPCV – operating principle




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

the DPCV identifies the 2 points by the connecting impulse tube

setting the DPCV to control Δp (pressure drop) between **A** & **B** at 100% DFR controls flow rate between these 2 points

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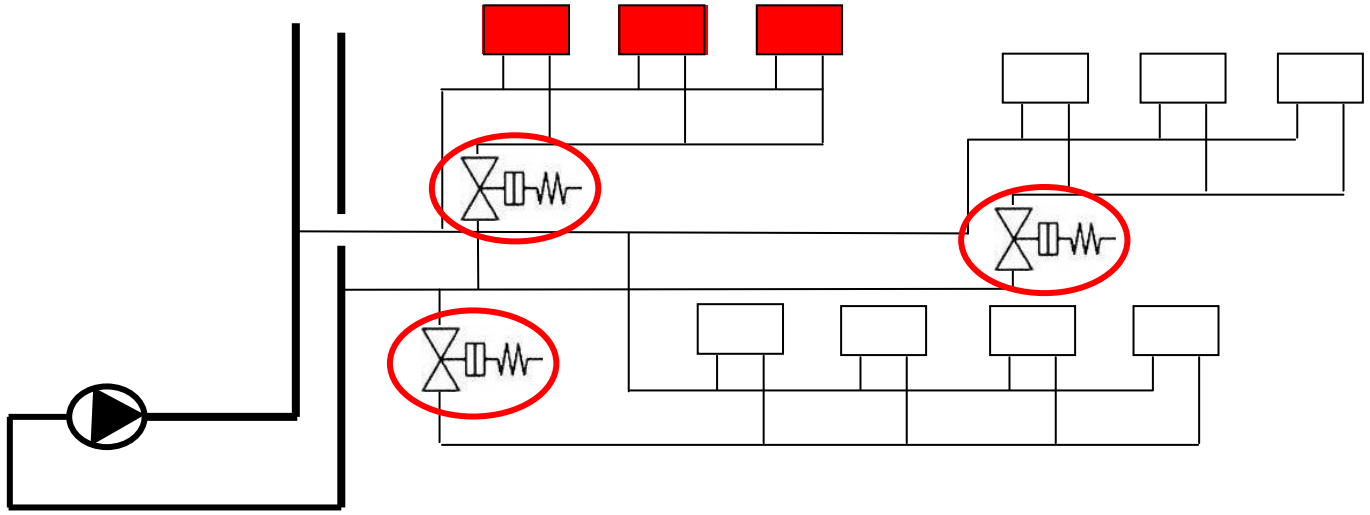
# System layout – position of DPCV

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



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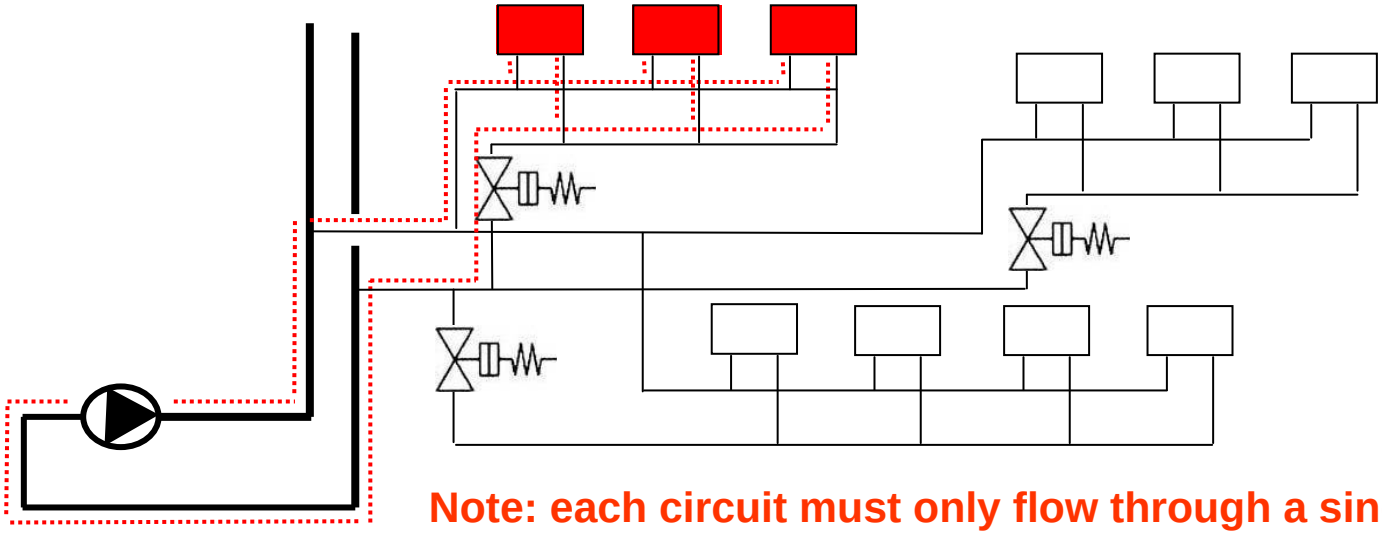
# System layout – position of DPCV

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



**Note: each circuit must only flow through a single DPCV**

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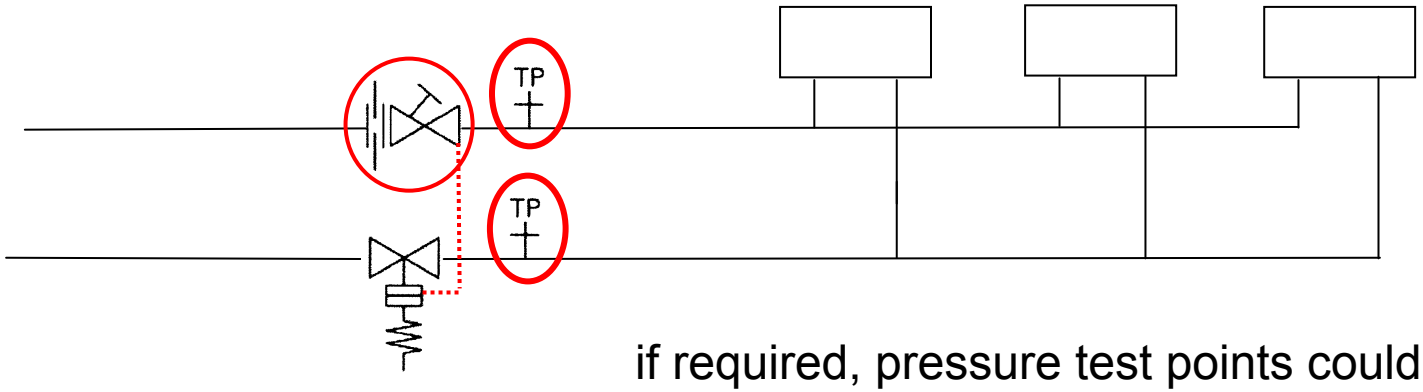
# Commissioning features around DPCVs

a ‘Companion Valve’ (FODRV) should be installed so that the DPCV can be adjusted until the required design flow rate is achieved.




if required, pressure test points could be installed so that the pressure controlled by the DPCV can be measured and recorded.

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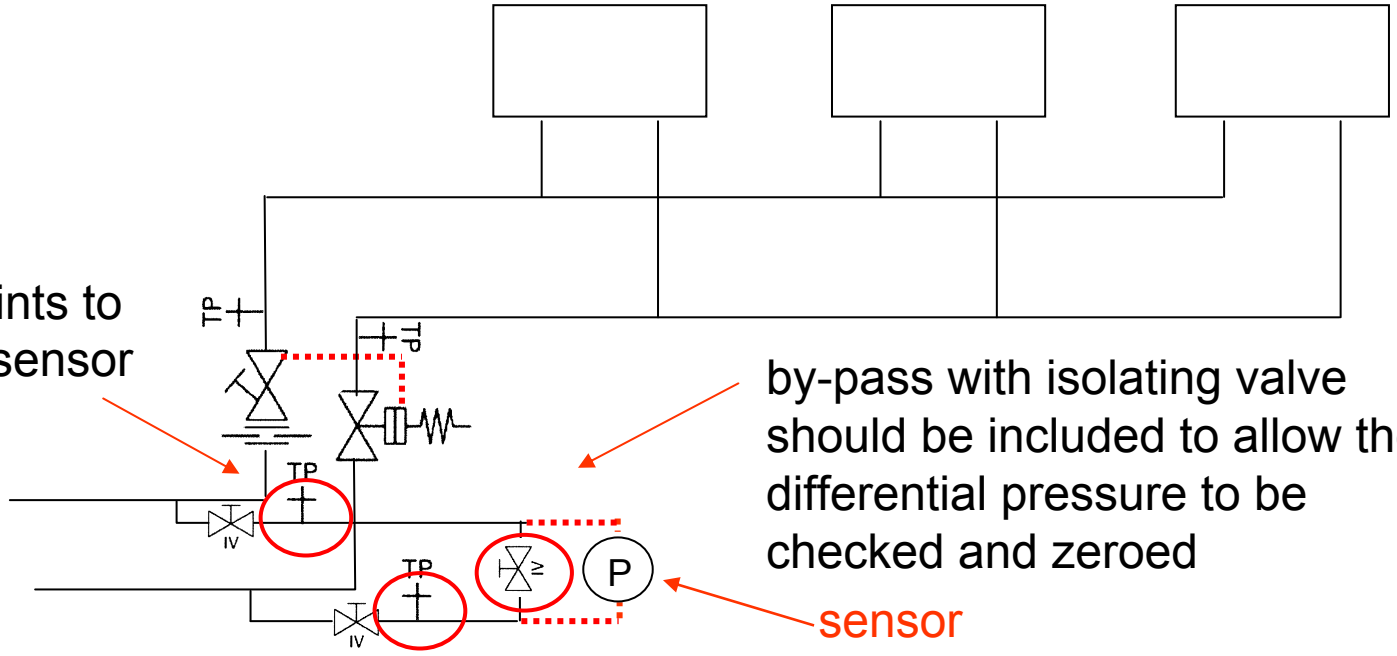
# Differential pressure sensors

to control pump speed, differential pressure sensor should be located across the most remote DPCV controlled sub-branch with additional sensors on branches that might become the index circuit under part load conditions.




test points to check sensor

by-pass with isolating valve should be included to allow the differential pressure to be checked and zeroed

sensor

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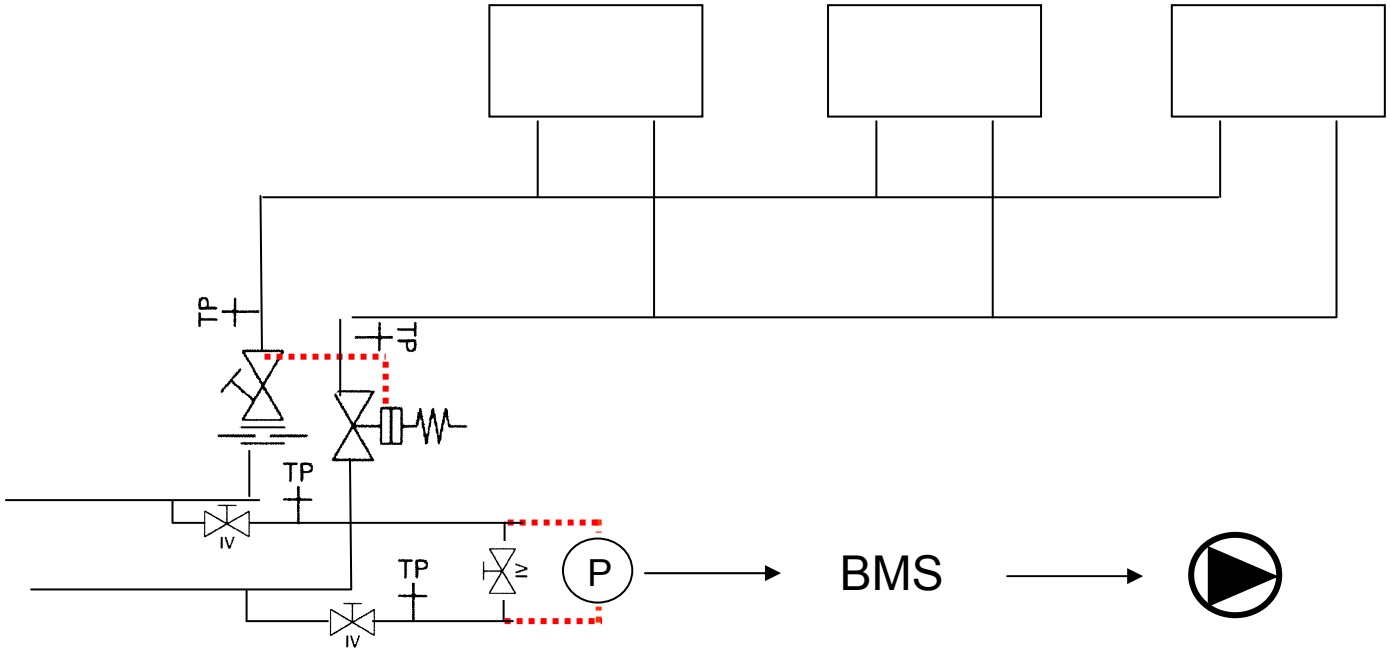
# Differential pressure sensors

to control pump speed, the differential pressure sensor sends signal to BMS which varies pump speed



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# Minimum flow

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

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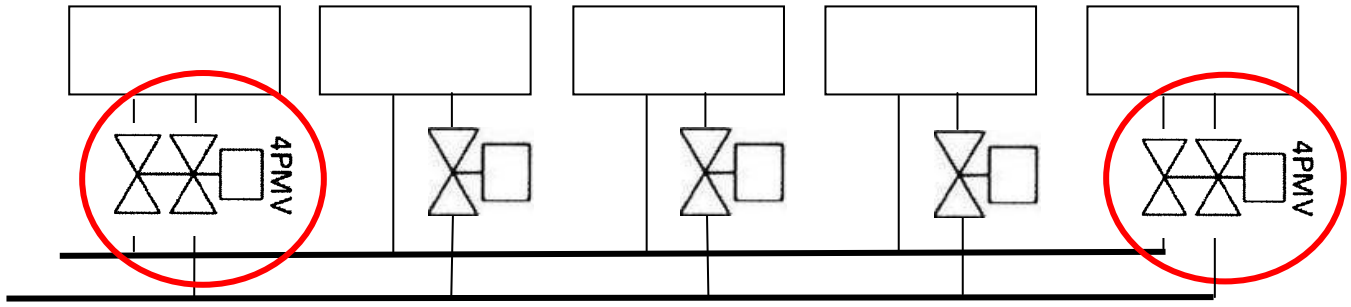
# Minimum flow

possible solution

end terminal could have a 3 or 4 port control valve

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



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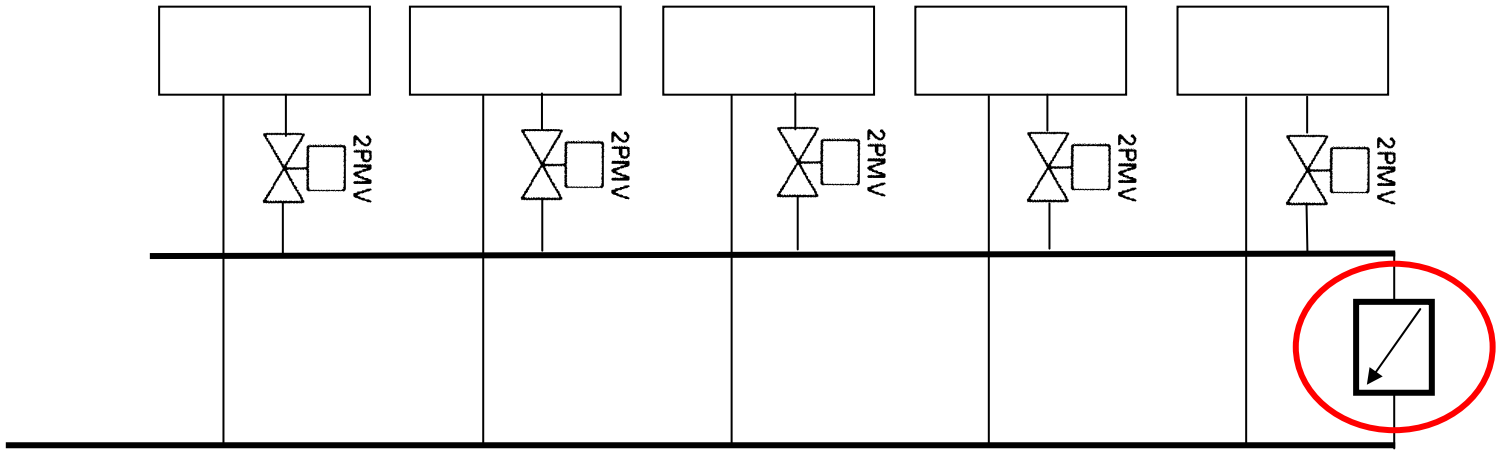
# Minimum flow

possible solution

a constant flow regulator (ABV) could be used



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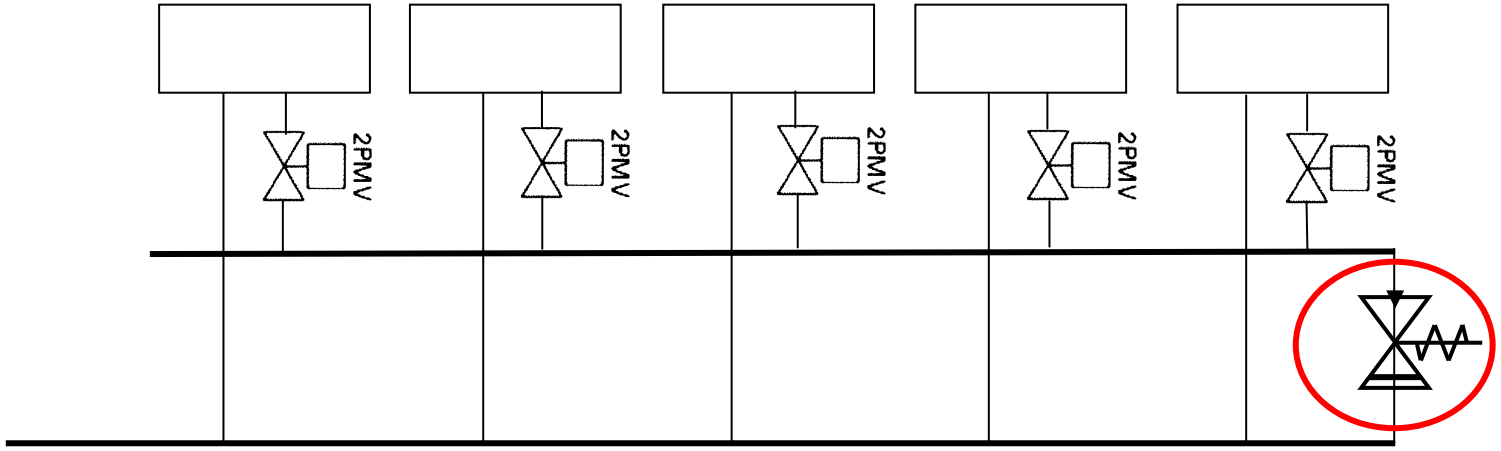
# Minimum flow

possible solution

a pressure relief valve could be installed



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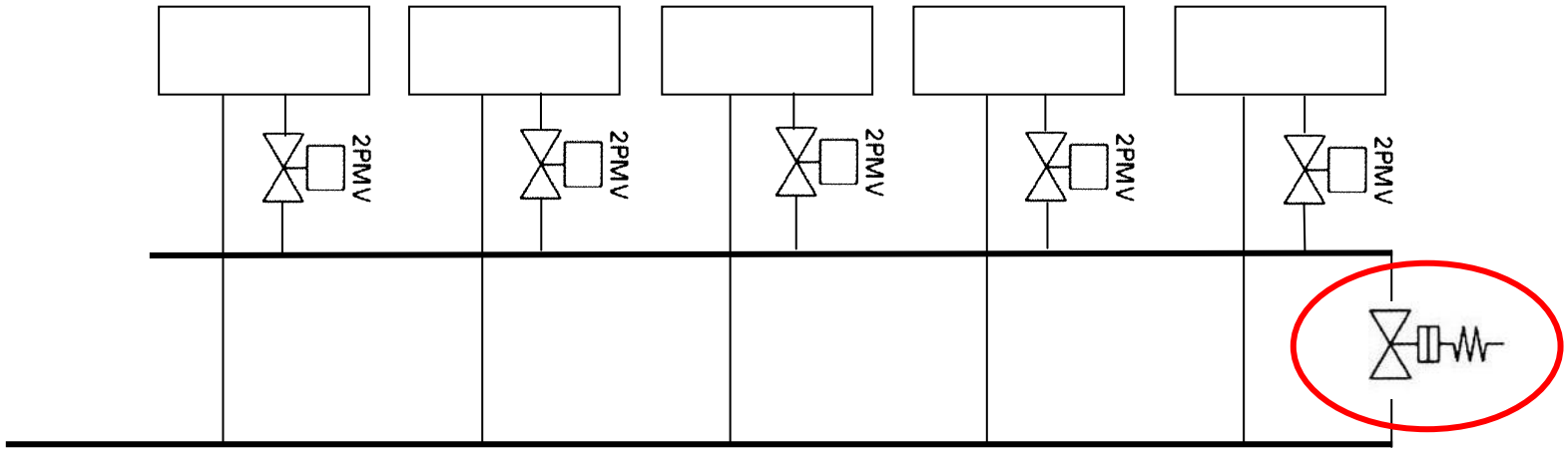
# Minimum flow

possible solution

a RADPCV (Reverse Acting DPCV) could be used



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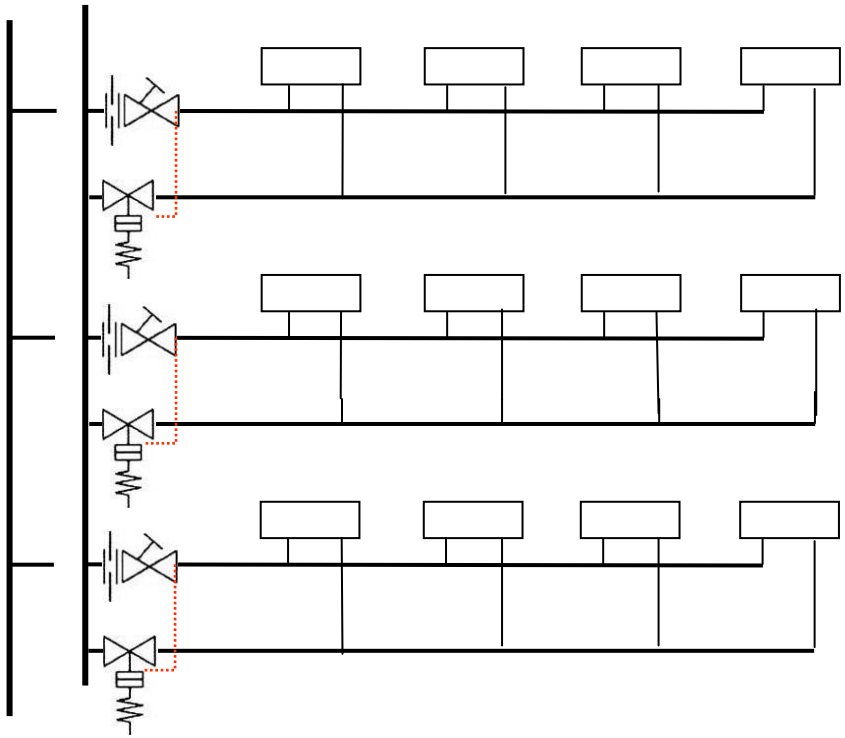
# Commissioning Variable Flow Systems

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***

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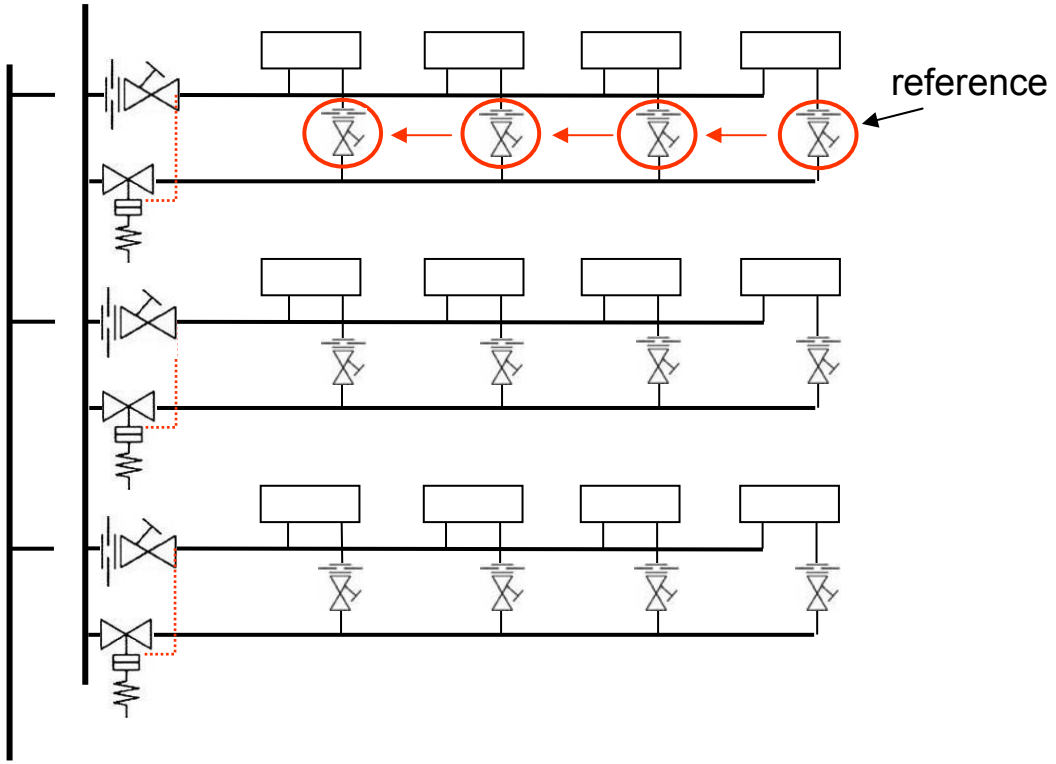
# Commissioning Variable Flow Systems

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



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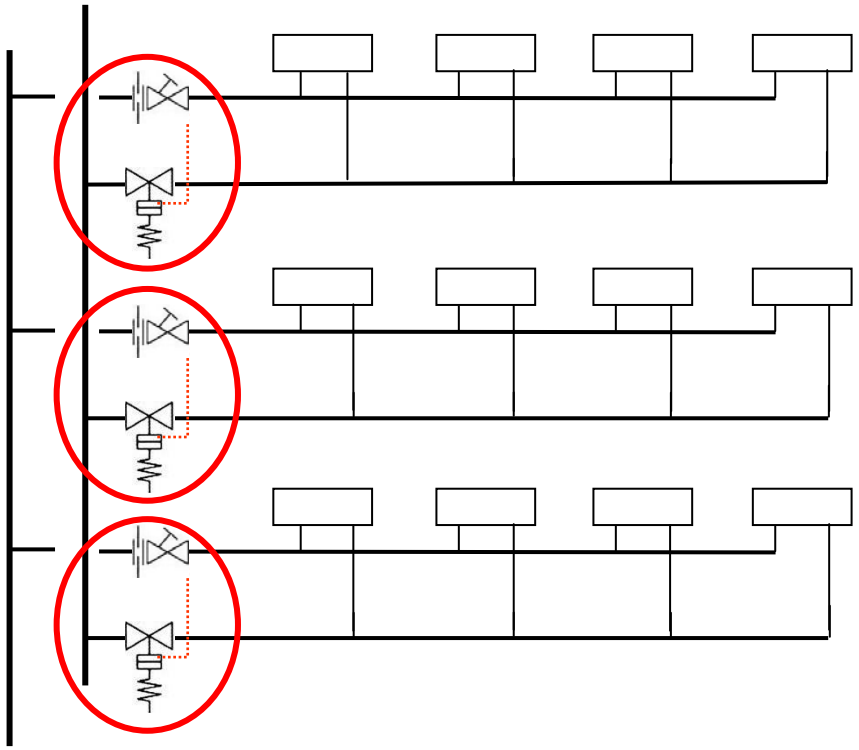
# Commissioning Variable Flow Systems

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



***commissioning valve normally fully open***

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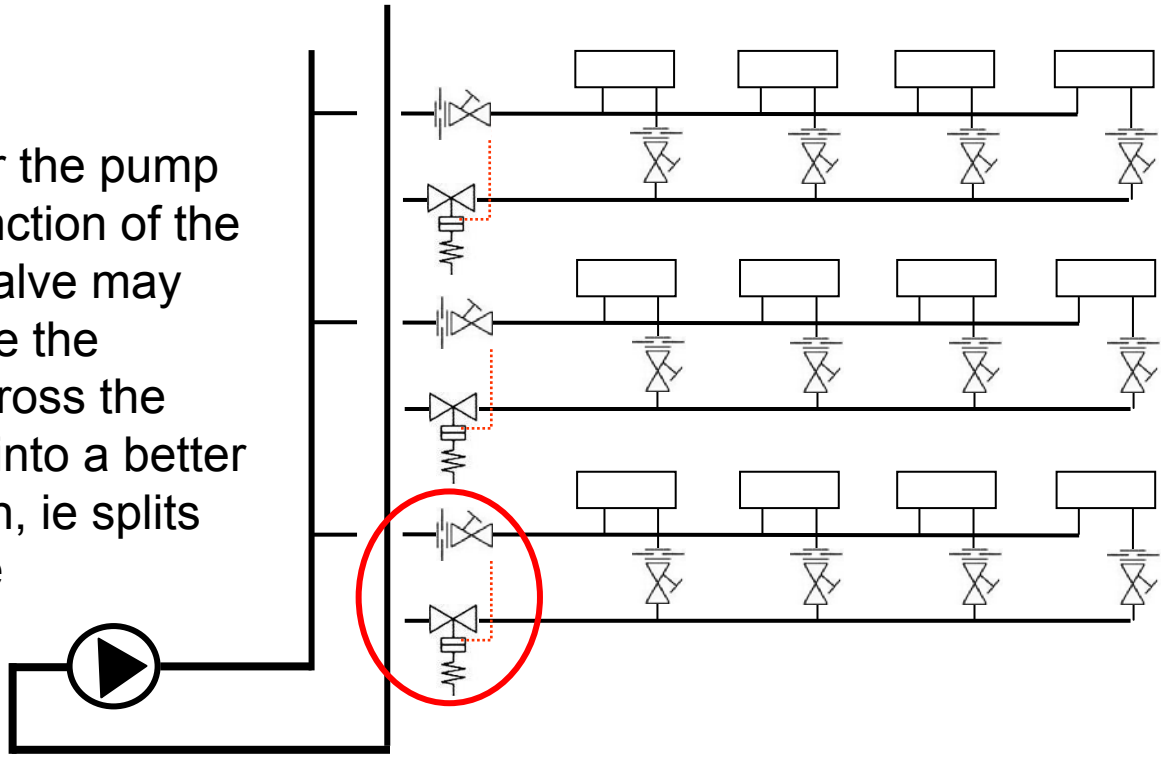
# Commissioning Variable Flow Systems

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



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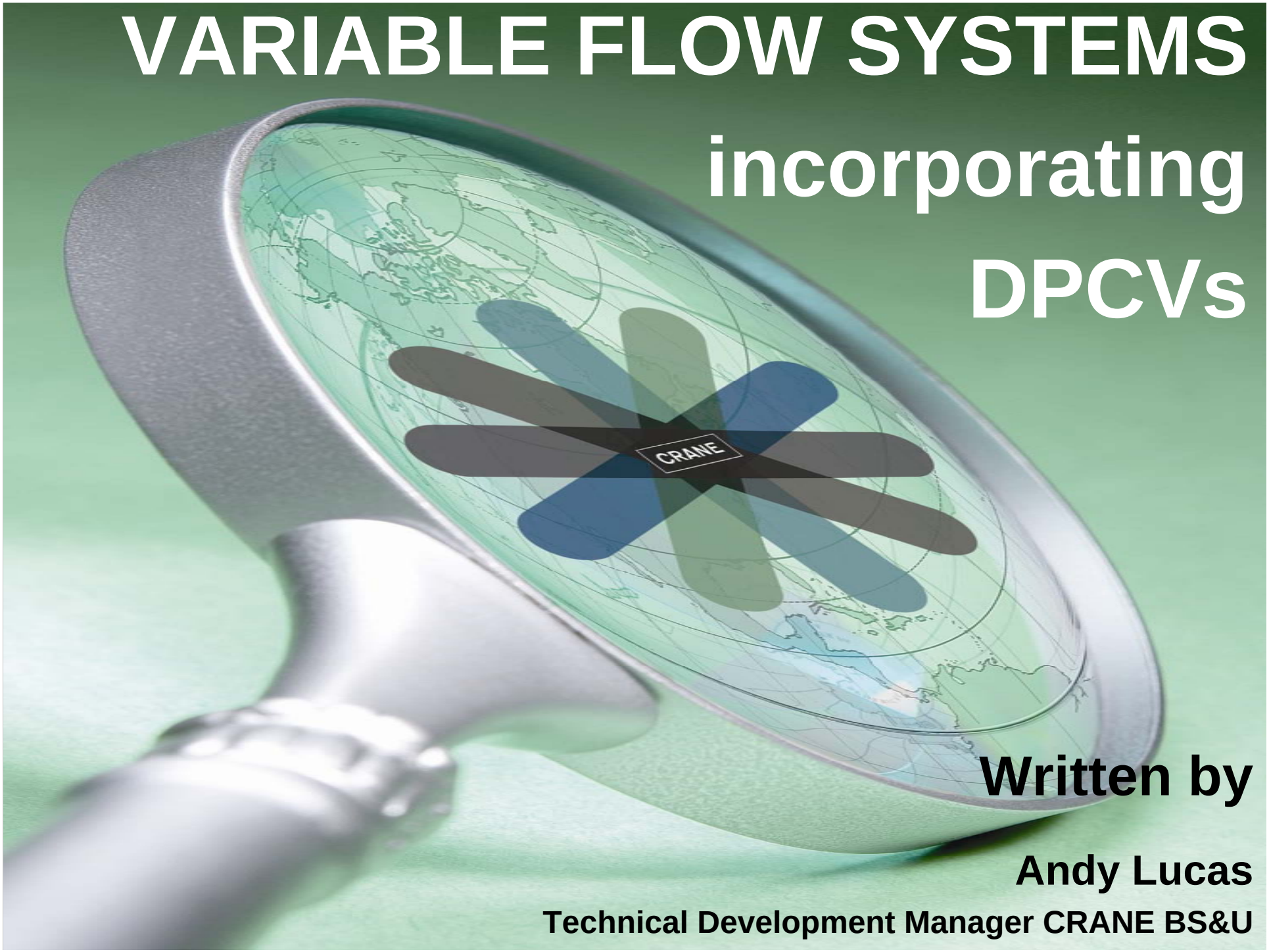
# To summarise

- 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
- provision for pump turndown, typically 10 – 20%
- terminal units commissioned by conventional proportional method
- branches commissioned by use of ‘Companion’ Valve & DPCV
- branches commissioned independently of each other
- pressure sensors used to set pump speed

# VARIABLE FLOW SYSTEMS incorporating DPCVs




**Written by**

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